## Upload the big dataset (>250MB) to MATLAB Drive and read table

```
BitcoinData = readtable('bitcoin-dataset.csv');
```

```
Warning: Column headers from the file were modified to make them valid MATLAB identifiers
before creating variable names for the table. The original column headers are saved in the
VariableDescriptions property.
Set 'VariableNamingRule' to 'preserve' to use the original column headers as table variable names.
```

```
Tablesize = size(BitcoinData)
```

```
Tablesize = 1×2
     4857377           8
```

```
head(BitcoinData,1)
```

```
ans = 1×8 table
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                
...
```

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 1 | 1.3253e+09 | 4.3900 | 4.3900 | 4.3900 | 4.3900 | 0.4556 |

## Convert timestamp

```
datetest = BitcoinData(:,1);
datetest = table2array(datetest);
BitcoinData.Timestamp = datetime(datetest, 'ConvertFrom', 'posixtime');
```

## Remove NaNs

```
% how many NaNs in each column
NaN2 = sum(isnan(BitcoinData.Open))
```

```
NaN2 = 1243608
```

```
NaN3 = sum(isnan(BitcoinData.High))
```

```
NaN3 = 1243608
```

```
NaN4 = sum(isnan(BitcoinData.Low))
```

```
NaN4 = 1243608
```

```
NaN5 = sum(isnan(BitcoinData.Close))
```

```
NaN5 = 1243608
```

```
NaN6 = sum(isnan(BitcoinData.Volume__BTC_))
```

```
NaN6 = 1243608
```

```
NaN7 = sum(isnan(BitcoinData.Volume__Currency_))
```

```
NaN7 = 1243608
```

```
NaN8 = sum(isnan(BitcoinData.Weighted_Price))
```

```
NaN8 = 1243608
```

```
% remove NaNs
BitcoinData = BitcoinData(isnan(BitcoinData.High) == 0,:);
```

## Select data

```
BitcoinDataTimetable = table2timetable(BitcoinData);

% March 2013
 S = timerange('17-Mar-2013 00:00:00','18-Mar-2013 23:59:00'); %2days
% S = timerange('17-Mar-2013 00:00:00','23-Mar-2013 23:59:00'); %7days
% S = timerange('17-Mar-2013 00:00:00','30-Mar-2013 23:59:00'); %14days

% March 2016
% S = timerange('17-Mar-2016 00:00:00','18-Mar-2016 23:59:00'); %2days
% S = timerange('17-Mar-2016 00:00:00','23-Mar-2016 23:59:00'); %7days
% S = timerange('17-Mar-2016 00:00:00','30-Mar-2016 23:59:00'); %14days

% March 2019
% S = timerange('17-Mar-2019 00:00:00','18-Mar-2019 23:59:00'); %2days
% S = timerange('17-Mar-2019 00:00:00','23-Mar-2019 23:59:00'); %7days
% S = timerange('17-Mar-2019 00:00:00','30-Mar-2019 23:59:00'); %14days

% March 2021
% S = timerange('17-Mar-2021 00:00:00','18-Mar-2021 23:59:00'); %2days
% S = timerange('17-Mar-2021 00:00:00','23-Mar-2021 23:59:00'); %7days
% S = timerange('17-Mar-2021 00:00:00','30-Mar-2021 23:59:00'); %14days

BitcoinData = BitcoinDataTimetable(S,:);
Tablesize = size(BitcoinData)
```

```
Tablesize = 1×2
   521     7
```

## Create model - preprocessing

```
% standardization, and Initial predictor set (matrix)

Y = BitcoinData{:,"Close"}
```

```
Y = 521×1
   46.7000
   46.7400
   46.7400
   46.7400
   46.7800
   46.7800
   46.7800
   46.7800
   46.7800
   46.8100
      ⋮
```

```
X = BitcoinData{:,[1:3]}
```

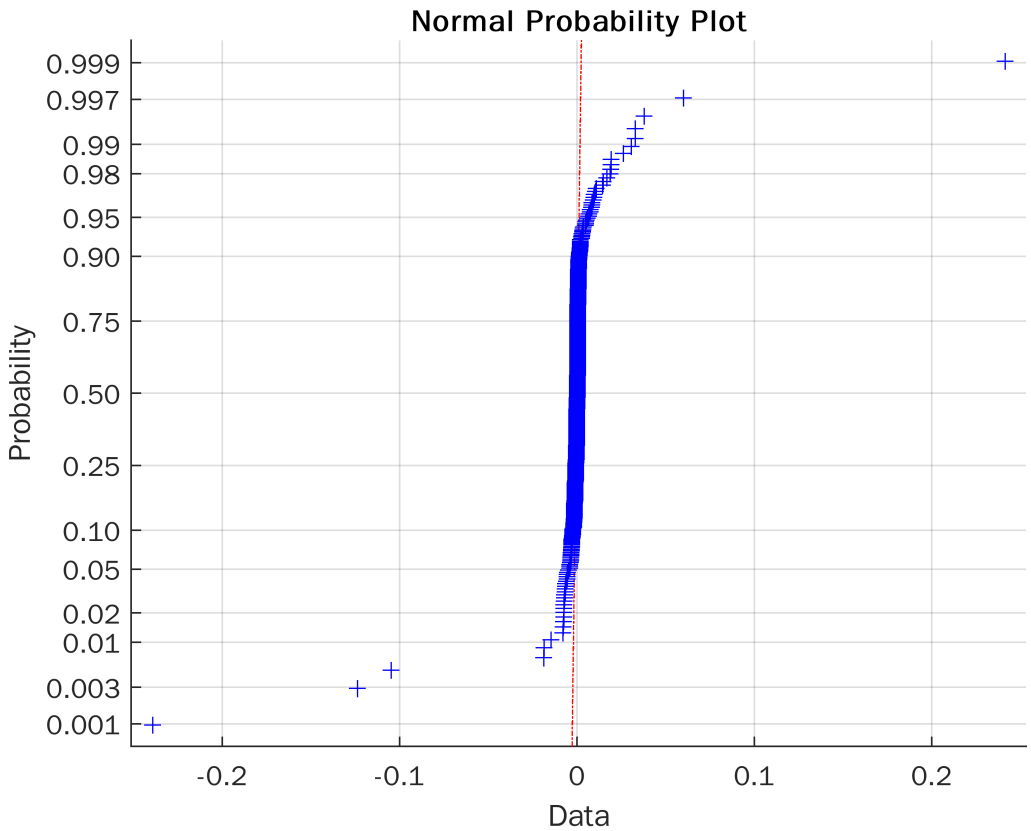
```
X = 521×3
   46.7000   46.7000   46.7000
   46.7400   46.7400   46.7400
   46.7400   46.7400   46.7400
   46.7400   46.7400   46.7400
   46.7800   46.7800   46.7800
   46.7800   46.7800   46.7800
```

```
   46.7800   46.7800   46.7800
   46.7800   46.7800   46.7800
   46.7800   46.7800   46.7800
   46.8100   46.8100   46.8100
      ⋮
```

```
%Check model for outliers

LRPre = fitlm(zscore(X),Y)
```

```
LRPre = 
Linear regression model:
    y ~ 1 + x1 + x2 + x3

Estimated Coefficients:
                   Estimate       SE         tStat       pValue  
                   ________    _________    _______    ___________

    (Intercept)      47.487    0.0007615      62360              0
    x1             -0.67419     0.024271    -27.778    1.3383e-104
    x2              0.70837     0.017264     41.032    9.8557e-165
    x3              0.78511     0.017834     44.022    5.0928e-177


Number of observations: 521, Error degrees of freedom: 517
Root Mean Squared Error: 0.0174
R-squared: 1,  Adjusted R-Squared: 1
F-statistic vs. constant model: 3.85e+05, p-value = 0
```

```
normplot(LRPre.Residuals.Raw)
```




## Identify and Remove Outliers

```
idx = isoutlier(BitcoinData.Close)
```

```
idx = 521×1 logical array
   0
   0
   0
   0
   0
   0
   0
   0
   0
   0
     ⋮
```

```
sum(idx)
```

```
ans = 59
```

```
BitcoinData(idx,:) = []
```

```
BitcoinData = 462×7 timetable
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                
...
```

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 1 | 17-Mar-2013 00:06:00 | 46.7000 | 46.7000 | 46.7000 | 46.7000 | 1 |

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 2 | 17-Mar-2013 00:21:00 | 46.7400 | 46.7400 | 46.7400 | 46.7400 | 1.9399 |
| 3 | 17-Mar-2013 00:38:00 | 46.7400 | 46.7400 | 46.7400 | 46.7400 | 67.6000 |
| 4 | 17-Mar-2013 01:32:00 | 46.7400 | 46.7400 | 46.7400 | 46.7400 | 0.0018 |
| 5 | 17-Mar-2013 01:43:00 | 46.7800 | 46.7800 | 46.7800 | 46.7800 | 21.2770 |
| 6 | 17-Mar-2013 01:54:00 | 46.7800 | 46.7800 | 46.7800 | 46.7800 | 3 |
| 7 | 17-Mar-2013 01:56:00 | 46.7800 | 46.7800 | 46.7800 | 46.7800 | 4 |
| 8 | 17-Mar-2013 01:58:00 | 46.7800 | 46.7800 | 46.7800 | 46.7800 | 0.9000 |
| 9 | 17-Mar-2013 02:10:00 | 46.7800 | 46.7800 | 46.7800 | 46.7800 | 0.0130 |
| 10 | 17-Mar-2013 02:21:00 | 46.8100 | 46.8100 | 46.8100 | 46.8100 | 0.9446 |
| 11 | 17-Mar-2013 02:28:00 | 46.8100 | 46.8100 | 46.8100 | 46.8100 | 1.8400 |
| 12 | 17-Mar-2013 02:32:00 | 46.8400 | 46.8400 | 46.8400 | 46.8400 | 0.0587 |
| 13 | 17-Mar-2013 03:01:00 | 46.8500 | 46.8500 | 46.8500 | 46.8500 | 0.9153 |
| 14 | 17-Mar-2013 03:12:00 | 46.8700 | 46.8700 | 46.8700 | 46.8700 | 0.9153 |
| 15 | 17-Mar-2013 03:20:00 | 47 | 47 | 47 | 47 | 1.3472 |
| 16 | 17-Mar-2013 03:22:00 | 47 | 47 | 47 | 47 | 0.2919 |
| 17 | 17-Mar-2013 03:30:00 | 46.8500 | 46.8500 | 46.8500 | 46.8500 | 0.4894 |
| 18 | 17-Mar-2013 03:45:00 | 46.8500 | 46.8500 | 46.8500 | 46.8500 | 0.5000 |
| 19 | 17-Mar-2013 04:10:00 | 46.8500 | 46.8500 | 46.8500 | 46.8500 | 0.0106 |
| 20 | 17-Mar-2013 04:29:00 | 46.8500 | 46.8500 | 46.8300 | 46.8300 | 1.8758 |
| 21 | 17-Mar-2013 04:45:00 | 46.8900 | 46.8900 | 46.8900 | 46.8900 | 1.4587 |
| 22 | 17-Mar-2013 04:48:00 | 47 | 47 | 47 | 47 | 0.0411 |
| 23 | 17-Mar-2013 04:50:00 | 47 | 47 | 47 | 47 | 0.0394 |
| 24 | 17-Mar-2013 04:56:00 | 47 | 47 | 47 | 47 | 2.2030 |
| 25 | 17-Mar-2013 05:19:00 | 47 | 47 | 47 | 47 | 1.9385 |
| 26 | 17-Mar-2013 05:47:00 | 46.8900 | 46.8900 | 46.8900 | 46.8900 | 2 |
| 27 | 17-Mar-2013 05:53:00 | 47 | 47 | 47 | 47 | 10.0828 |
| 28 | 17-Mar-2013 06:51:00 | 47 | 47 | 47 | 47 | 3.6594 |
| 29 | 17-Mar-2013 08:13:00 | 46.9300 | 46.9300 | 46.9300 | 46.9300 | 1 |
| 30 | 17-Mar-2013 08:21:00 | 46.9900 | 46.9900 | 46.9900 | 46.9900 | 2.4499 |
| 31 | 17-Mar-2013 08:34:00 | 46.9300 | 46.9300 | 46.9300 | 46.9300 | 1.0214 |
| 32 | 17-Mar-2013 08:35:00 | 46.9300 | 46.9300 | 46.9300 | 46.9300 | 0.5304 |
| 33 | 17-Mar-2013 08:45:00 | 46.9000 | 46.9000 | 46.9000 | 46.9000 | 0.4459 |
| 34 | 17-Mar-2013 08:46:00 | 46.8900 | 46.8900 | 46.8900 | 46.8900 | 0.2219 |

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 35 | 17-Mar-2013 08:47:00 | 46.8700 | 46.8700 | 46.8700 | 46.8700 | 0.1105 |
| 36 | 17-Mar-2013 08:48:00 | 46.8600 | 46.8600 | 46.8600 | 46.8600 | 0.6743 |
| 37 | 17-Mar-2013 08:49:00 | 46.8400 | 46.8400 | 46.8400 | 46.8400 | 0.0823 |
| 38 | 17-Mar-2013 08:50:00 | 46.8300 | 46.8300 | 46.8300 | 46.8300 | 0.4320 |
| 39 | 17-Mar-2013 08:51:00 | 46.8100 | 46.8100 | 46.8100 | 46.8100 | 4.2072 |
| 40 | 17-Mar-2013 08:52:00 | 46.7500 | 46.7500 | 46.7500 | 46.7500 | 0.0883 |
| 41 | 17-Mar-2013 09:13:00 | 46.9400 | 46.9400 | 46.9400 | 46.9400 | 1.3892 |
| 42 | 17-Mar-2013 09:19:00 | 46.9900 | 46.9900 | 46.9900 | 46.9900 | 15.5041 |
| 43 | 17-Mar-2013 09:24:00 | 47 | 47 | 47 | 47 | 2.0455 |
| 44 | 17-Mar-2013 09:27:00 | 47 | 47 | 47 | 47 | 0.8623 |
| 45 | 17-Mar-2013 09:32:00 | 47 | 47 | 47 | 47 | 5.5077 |
| 46 | 17-Mar-2013 09:48:00 | 47 | 47 | 47 | 47 | 79.5934 |
| 47 | 17-Mar-2013 10:09:00 | 46.9900 | 46.9900 | 46.9900 | 46.9900 | 4.7000 |
| 48 | 17-Mar-2013 10:18:00 | 47 | 47 | 47 | 47 | 4.7890 |
| 49 | 17-Mar-2013 10:19:00 | 47 | 47 | 47 | 47 | 2.0774 |
| 50 | 17-Mar-2013 10:21:00 | 47 | 47 | 47 | 47 | 9.5221 |
| 51 | 17-Mar-2013 10:23:00 | 47 | 47 | 47 | 47 | 0.5270 |
| 52 | 17-Mar-2013 10:24:00 | 47 | 47 | 47 | 47 | 3.4269 |
| 53 | 17-Mar-2013 10:25:00 | 46.9000 | 46.9000 | 46.9000 | 46.9000 | 6.6952 |
| 54 | 17-Mar-2013 10:26:00 | 46.9000 | 46.9000 | 46.9000 | 46.9000 | 2.8357 |
| 55 | 17-Mar-2013 10:31:00 | 46.9000 | 46.9000 | 46.9000 | 46.9000 | 20.4691 |
| 56 | 17-Mar-2013 10:36:00 | 46.8500 | 46.8500 | 46.8500 | 46.8500 | 15 |
| 57 | 17-Mar-2013 10:37:00 | 47 | 47 | 47 | 47 | 54.9791 |
| 58 | 17-Mar-2013 10:38:00 | 47 | 47 | 47 | 47 | 9.2845 |
| 59 | 17-Mar-2013 11:16:00 | 46.8600 | 46.8600 | 46.8500 | 46.8500 | 6.7900 |
| 60 | 17-Mar-2013 11:19:00 | 46.9000 | 46.9000 | 46.9000 | 46.9000 | 0.3511 |
| 61 | 17-Mar-2013 11:30:00 | 46.8500 | 46.8500 | 46.8500 | 46.8500 | 0.6489 |
| 62 | 17-Mar-2013 11:40:00 | 46.9800 | 46.9900 | 46.9800 | 46.9900 | 6.0302 |
| 63 | 17-Mar-2013 11:50:00 | 47 | 47 | 47 | 47 | 0.0213 |
| 64 | 17-Mar-2013 11:55:00 | 47 | 47 | 47 | 47 | 2.4419 |
| 65 | 17-Mar-2013 11:58:00 | 46.8500 | 46.8500 | 46.8500 | 46.8500 | 6.3800 |
| 66 | 17-Mar-2013 12:03:00 | 47 | 47 | 47 | 47 | 4.1873 |
| 67 | 17-Mar-2013 12:15:00 | 46.8400 | 46.8400 | 46.8400 | 46.8400 | 0.4114 |

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 68 | 17-Mar-2013 12:16:00 | 47 | 47 | 47 | 47 | 4.2383 |
| 69 | 17-Mar-2013 12:17:00 | 47 | 47 | 47 | 47 | 2.1300 |
| 70 | 17-Mar-2013 12:29:00 | 47 | 47.0700 | 47 | 47.0700 | 94.9699 |
| 71 | 17-Mar-2013 12:30:00 | 47.0700 | 47.0700 | 46.8800 | 46.8800 | 1.2102 |
| 72 | 17-Mar-2013 12:31:00 | 46.8800 | 46.8800 | 46.8800 | 46.8800 | 2.7150 |
| 73 | 17-Mar-2013 12:33:00 | 47 | 47 | 47 | 47 | 0.8098 |
| 74 | 17-Mar-2013 12:34:00 | 47 | 47 | 47 | 47 | 0.6296 |
| 75 | 17-Mar-2013 12:35:00 | 47.0600 | 47.0700 | 47.0600 | 47.0700 | 15.1967 |
| 76 | 17-Mar-2013 12:36:00 | 47.0700 | 47.0700 | 47.0700 | 47.0700 | 0.6286 |
| 77 | 17-Mar-2013 12:39:00 | 46.9500 | 46.9500 | 46.9500 | 46.9500 | 0.6700 |
| 78 | 17-Mar-2013 12:45:00 | 46.8900 | 46.8900 | 46.8900 | 46.8900 | 0.5167 |
| 79 | 17-Mar-2013 13:04:00 | 46.9900 | 46.9900 | 46.9900 | 46.9900 | 0.0357 |
| 80 | 17-Mar-2013 13:23:00 | 47.0600 | 47.0600 | 47.0600 | 47.0600 | 0.7507 |
| 81 | 17-Mar-2013 13:24:00 | 47.0600 | 47.0600 | 47.0600 | 47.0600 | 0.0001 |
| 82 | 17-Mar-2013 13:25:00 | 47.0700 | 47.0700 | 47.0700 | 47.0700 | 0.6963 |
| 83 | 17-Mar-2013 13:35:00 | 47.0700 | 47.0700 | 47.0700 | 47.0700 | 8.8693 |
| 84 | 17-Mar-2013 13:46:00 | 47.0900 | 47.0900 | 47.0900 | 47.0900 | 1.7059 |
| 85 | 17-Mar-2013 13:52:00 | 46.9900 | 46.9900 | 46.9600 | 46.9600 | 4.8200 |
| 86 | 17-Mar-2013 13:59:00 | 46.9600 | 46.9600 | 46.9600 | 46.9600 | 60 |
| 87 | 17-Mar-2013 14:10:00 | 46.9600 | 46.9600 | 46.9600 | 46.9600 | 30 |
| 88 | 17-Mar-2013 14:55:00 | 46.9800 | 46.9800 | 46.9800 | 46.9800 | 0.3754 |
| 89 | 17-Mar-2013 14:56:00 | 47 | 47 | 47 | 47 | 0.1877 |
| 90 | 17-Mar-2013 15:11:00 | 47.0800 | 47.0800 | 47.0800 | 47.0800 | 1.3291 |
| 91 | 17-Mar-2013 15:12:00 | 47 | 47 | 47 | 47 | 0.0961 |
| 92 | 17-Mar-2013 15:13:00 | 47 | 47 | 47 | 47 | 0.0004 |
| 93 | 17-Mar-2013 15:14:00 | 47 | 47 | 47 | 47 | 0.0001 |
| 94 | 17-Mar-2013 15:15:00 | 47 | 47 | 47 | 47 | 0.0001 |
| 95 | 17-Mar-2013 15:16:00 | 47 | 47 | 47 | 47 | 0.0001 |
| 96 | 17-Mar-2013 15:17:00 | 47 | 47 | 47 | 47 | 0.0001 |
| 97 | 17-Mar-2013 15:18:00 | 47 | 47 | 47 | 47 | 0.0001 |
| 98 | 17-Mar-2013 15:19:00 | 47 | 47 | 47 | 47 | 0.0001 |
| 99 | 17-Mar-2013 15:20:00 | 47 | 47 | 47 | 47 | 0.0001 |
| 100 | 17-Mar-2013 15:21:00 | 47 | 47 | 47 | 47 | 0.0001 |

```
    ⋮
```

```
%outliers = outlier(BitcoinData.Close)

%Rerun model to check for more outliers
Y = BitcoinData{:,"Close"}
```

```
Y = 462×1
   46.7000
   46.7400
   46.7400
   46.7400
   46.7800
   46.7800
   46.7800
   46.7800
   46.7800
   46.8100
     ⋮
```

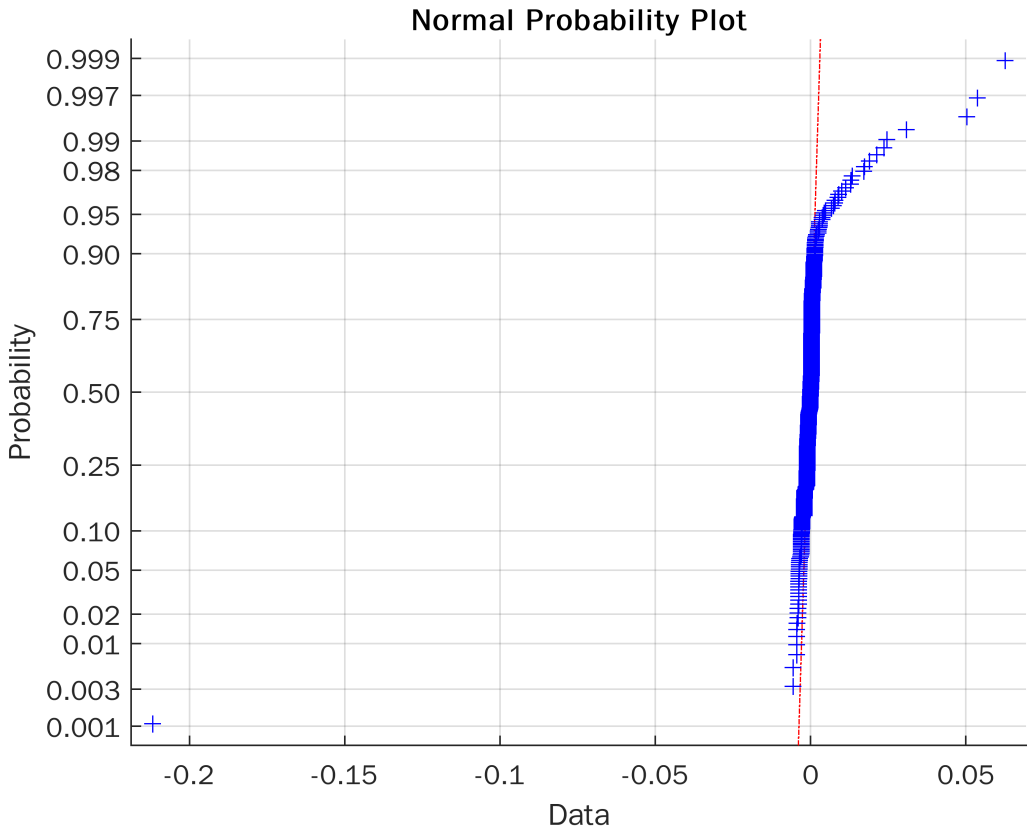
```
X = BitcoinData{:,[1:3]}
```

```
X = 462×3
   46.7000   46.7000   46.7000
   46.7400   46.7400   46.7400
   46.7400   46.7400   46.7400
   46.7400   46.7400   46.7400
   46.7800   46.7800   46.7800
   46.7800   46.7800   46.7800
   46.7800   46.7800   46.7800
   46.7800   46.7800   46.7800
   46.7800   46.7800   46.7800
   46.8100   46.8100   46.8100
     ⋮
```

```
LRPre = fitlm(zscore(X),Y)
```

```
LRPre = 
Linear regression model:
    y ~ 1 + x1 + x2 + x3

Estimated Coefficients:
                   Estimate        SE         tStat       pValue  
                   ________    __________    _______    __________

    (Intercept)      47.232    0.00053255      88691              0
    x1             -0.23268      0.009886    -23.536     7.2286e-81
    x2              0.23743     0.0063431     37.432    1.9907e-141
    x3              0.30927     0.0077685     39.811    8.2964e-151


Number of observations: 462, Error degrees of freedom: 458
Root Mean Squared Error: 0.0114
R-squared: 0.999,  Adjusted R-Squared: 0.999
F-statistic vs. constant model: 1.16e+05, p-value = 0
```

```
normplot(LRPre.Residuals.Raw)
```




```
idx = isoutlier(BitcoinData.Close)
```

```
idx = 462×1 logical array
   0
   0
   0
   0
   0
   0
   0
   0
   0
   0
   ⋮
```

```
sum(idx)
```

```
ans = 37
```

```
BitcoinData(idx,:) = []
```

```
BitcoinData = 425×7 timetable
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                
```
...
```

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 1 | 17-Mar-2013 00:06:00 | 46.7000 | 46.7000 | 46.7000 | 46.7000 | 1 |
| 2 | 17-Mar-2013 00:21:00 | 46.7400 | 46.7400 | 46.7400 | 46.7400 | 1.9399 |
```

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 3 | 17-Mar-2013 00:38:00 | 46.7400 | 46.7400 | 46.7400 | 46.7400 | 67.6000 |
| 4 | 17-Mar-2013 01:32:00 | 46.7400 | 46.7400 | 46.7400 | 46.7400 | 0.0018 |
| 5 | 17-Mar-2013 01:43:00 | 46.7800 | 46.7800 | 46.7800 | 46.7800 | 21.2770 |
| 6 | 17-Mar-2013 01:54:00 | 46.7800 | 46.7800 | 46.7800 | 46.7800 | 3 |
| 7 | 17-Mar-2013 01:56:00 | 46.7800 | 46.7800 | 46.7800 | 46.7800 | 4 |
| 8 | 17-Mar-2013 01:58:00 | 46.7800 | 46.7800 | 46.7800 | 46.7800 | 0.9000 |
| 9 | 17-Mar-2013 02:10:00 | 46.7800 | 46.7800 | 46.7800 | 46.7800 | 0.0130 |
| 10 | 17-Mar-2013 02:21:00 | 46.8100 | 46.8100 | 46.8100 | 46.8100 | 0.9446 |
| 11 | 17-Mar-2013 02:28:00 | 46.8100 | 46.8100 | 46.8100 | 46.8100 | 1.8400 |
| 12 | 17-Mar-2013 02:32:00 | 46.8400 | 46.8400 | 46.8400 | 46.8400 | 0.0587 |
| 13 | 17-Mar-2013 03:01:00 | 46.8500 | 46.8500 | 46.8500 | 46.8500 | 0.9153 |
| 14 | 17-Mar-2013 03:12:00 | 46.8700 | 46.8700 | 46.8700 | 46.8700 | 0.9153 |
| 15 | 17-Mar-2013 03:20:00 | 47 | 47 | 47 | 47 | 1.3472 |
| 16 | 17-Mar-2013 03:22:00 | 47 | 47 | 47 | 47 | 0.2919 |
| 17 | 17-Mar-2013 03:30:00 | 46.8500 | 46.8500 | 46.8500 | 46.8500 | 0.4894 |
| 18 | 17-Mar-2013 03:45:00 | 46.8500 | 46.8500 | 46.8500 | 46.8500 | 0.5000 |
| 19 | 17-Mar-2013 04:10:00 | 46.8500 | 46.8500 | 46.8500 | 46.8500 | 0.0106 |
| 20 | 17-Mar-2013 04:29:00 | 46.8500 | 46.8500 | 46.8300 | 46.8300 | 1.8758 |
| 21 | 17-Mar-2013 04:45:00 | 46.8900 | 46.8900 | 46.8900 | 46.8900 | 1.4587 |
| 22 | 17-Mar-2013 04:48:00 | 47 | 47 | 47 | 47 | 0.0411 |
| 23 | 17-Mar-2013 04:50:00 | 47 | 47 | 47 | 47 | 0.0394 |
| 24 | 17-Mar-2013 04:56:00 | 47 | 47 | 47 | 47 | 2.2030 |
| 25 | 17-Mar-2013 05:19:00 | 47 | 47 | 47 | 47 | 1.9385 |
| 26 | 17-Mar-2013 05:47:00 | 46.8900 | 46.8900 | 46.8900 | 46.8900 | 2 |
| 27 | 17-Mar-2013 05:53:00 | 47 | 47 | 47 | 47 | 10.0828 |
| 28 | 17-Mar-2013 06:51:00 | 47 | 47 | 47 | 47 | 3.6594 |
| 29 | 17-Mar-2013 08:13:00 | 46.9300 | 46.9300 | 46.9300 | 46.9300 | 1 |
| 30 | 17-Mar-2013 08:21:00 | 46.9900 | 46.9900 | 46.9900 | 46.9900 | 2.4499 |
| 31 | 17-Mar-2013 08:34:00 | 46.9300 | 46.9300 | 46.9300 | 46.9300 | 1.0214 |
| 32 | 17-Mar-2013 08:35:00 | 46.9300 | 46.9300 | 46.9300 | 46.9300 | 0.5304 |
| 33 | 17-Mar-2013 08:45:00 | 46.9000 | 46.9000 | 46.9000 | 46.9000 | 0.4459 |
| 34 | 17-Mar-2013 08:46:00 | 46.8900 | 46.8900 | 46.8900 | 46.8900 | 0.2219 |
| 35 | 17-Mar-2013 08:47:00 | 46.8700 | 46.8700 | 46.8700 | 46.8700 | 0.1105 |

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 36 | 17-Mar-2013 08:48:00 | 46.8600 | 46.8600 | 46.8600 | 46.8600 | 0.6743 |
| 37 | 17-Mar-2013 08:49:00 | 46.8400 | 46.8400 | 46.8400 | 46.8400 | 0.0823 |
| 38 | 17-Mar-2013 08:50:00 | 46.8300 | 46.8300 | 46.8300 | 46.8300 | 0.4320 |
| 39 | 17-Mar-2013 08:51:00 | 46.8100 | 46.8100 | 46.8100 | 46.8100 | 4.2072 |
| 40 | 17-Mar-2013 08:52:00 | 46.7500 | 46.7500 | 46.7500 | 46.7500 | 0.0883 |
| 41 | 17-Mar-2013 09:13:00 | 46.9400 | 46.9400 | 46.9400 | 46.9400 | 1.3892 |
| 42 | 17-Mar-2013 09:19:00 | 46.9900 | 46.9900 | 46.9900 | 46.9900 | 15.5041 |
| 43 | 17-Mar-2013 09:24:00 | 47 | 47 | 47 | 47 | 2.0455 |
| 44 | 17-Mar-2013 09:27:00 | 47 | 47 | 47 | 47 | 0.8623 |
| 45 | 17-Mar-2013 09:32:00 | 47 | 47 | 47 | 47 | 5.5077 |
| 46 | 17-Mar-2013 09:48:00 | 47 | 47 | 47 | 47 | 79.5934 |
| 47 | 17-Mar-2013 10:09:00 | 46.9900 | 46.9900 | 46.9900 | 46.9900 | 4.7000 |
| 48 | 17-Mar-2013 10:18:00 | 47 | 47 | 47 | 47 | 4.7890 |
| 49 | 17-Mar-2013 10:19:00 | 47 | 47 | 47 | 47 | 2.0774 |
| 50 | 17-Mar-2013 10:21:00 | 47 | 47 | 47 | 47 | 9.5221 |
| 51 | 17-Mar-2013 10:23:00 | 47 | 47 | 47 | 47 | 0.5270 |
| 52 | 17-Mar-2013 10:24:00 | 47 | 47 | 47 | 47 | 3.4269 |
| 53 | 17-Mar-2013 10:25:00 | 46.9000 | 46.9000 | 46.9000 | 46.9000 | 6.6952 |
| 54 | 17-Mar-2013 10:26:00 | 46.9000 | 46.9000 | 46.9000 | 46.9000 | 2.8357 |
| 55 | 17-Mar-2013 10:31:00 | 46.9000 | 46.9000 | 46.9000 | 46.9000 | 20.4691 |
| 56 | 17-Mar-2013 10:36:00 | 46.8500 | 46.8500 | 46.8500 | 46.8500 | 15 |
| 57 | 17-Mar-2013 10:37:00 | 47 | 47 | 47 | 47 | 54.9791 |
| 58 | 17-Mar-2013 10:38:00 | 47 | 47 | 47 | 47 | 9.2845 |
| 59 | 17-Mar-2013 11:16:00 | 46.8600 | 46.8600 | 46.8500 | 46.8500 | 6.7900 |
| 60 | 17-Mar-2013 11:19:00 | 46.9000 | 46.9000 | 46.9000 | 46.9000 | 0.3511 |
| 61 | 17-Mar-2013 11:30:00 | 46.8500 | 46.8500 | 46.8500 | 46.8500 | 0.6489 |
| 62 | 17-Mar-2013 11:40:00 | 46.9800 | 46.9900 | 46.9800 | 46.9900 | 6.0302 |
| 63 | 17-Mar-2013 11:50:00 | 47 | 47 | 47 | 47 | 0.0213 |
| 64 | 17-Mar-2013 11:55:00 | 47 | 47 | 47 | 47 | 2.4419 |
| 65 | 17-Mar-2013 11:58:00 | 46.8500 | 46.8500 | 46.8500 | 46.8500 | 6.3800 |
| 66 | 17-Mar-2013 12:03:00 | 47 | 47 | 47 | 47 | 4.1873 |
| 67 | 17-Mar-2013 12:15:00 | 46.8400 | 46.8400 | 46.8400 | 46.8400 | 0.4114 |
| 68 | 17-Mar-2013 12:16:00 | 47 | 47 | 47 | 47 | 4.2383 |

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 69 | 17-Mar-2013 12:17:00 | 47 | 47 | 47 | 47 | 2.1300 |
| 70 | 17-Mar-2013 12:29:00 | 47 | 47.0700 | 47 | 47.0700 | 94.9699 |
| 71 | 17-Mar-2013 12:30:00 | 47.0700 | 47.0700 | 46.8800 | 46.8800 | 1.2102 |
| 72 | 17-Mar-2013 12:31:00 | 46.8800 | 46.8800 | 46.8800 | 46.8800 | 2.7150 |
| 73 | 17-Mar-2013 12:33:00 | 47 | 47 | 47 | 47 | 0.8098 |
| 74 | 17-Mar-2013 12:34:00 | 47 | 47 | 47 | 47 | 0.6296 |
| 75 | 17-Mar-2013 12:35:00 | 47.0600 | 47.0700 | 47.0600 | 47.0700 | 15.1967 |
| 76 | 17-Mar-2013 12:36:00 | 47.0700 | 47.0700 | 47.0700 | 47.0700 | 0.6286 |
| 77 | 17-Mar-2013 12:39:00 | 46.9500 | 46.9500 | 46.9500 | 46.9500 | 0.6700 |
| 78 | 17-Mar-2013 12:45:00 | 46.8900 | 46.8900 | 46.8900 | 46.8900 | 0.5167 |
| 79 | 17-Mar-2013 13:04:00 | 46.9900 | 46.9900 | 46.9900 | 46.9900 | 0.0357 |
| 80 | 17-Mar-2013 13:23:00 | 47.0600 | 47.0600 | 47.0600 | 47.0600 | 0.7507 |
| 81 | 17-Mar-2013 13:24:00 | 47.0600 | 47.0600 | 47.0600 | 47.0600 | 0.0001 |
| 82 | 17-Mar-2013 13:25:00 | 47.0700 | 47.0700 | 47.0700 | 47.0700 | 0.6963 |
| 83 | 17-Mar-2013 13:35:00 | 47.0700 | 47.0700 | 47.0700 | 47.0700 | 8.8693 |
| 84 | 17-Mar-2013 13:46:00 | 47.0900 | 47.0900 | 47.0900 | 47.0900 | 1.7059 |
| 85 | 17-Mar-2013 13:52:00 | 46.9900 | 46.9900 | 46.9600 | 46.9600 | 4.8200 |
| 86 | 17-Mar-2013 13:59:00 | 46.9600 | 46.9600 | 46.9600 | 46.9600 | 60 |
| 87 | 17-Mar-2013 14:10:00 | 46.9600 | 46.9600 | 46.9600 | 46.9600 | 30 |
| 88 | 17-Mar-2013 14:55:00 | 46.9800 | 46.9800 | 46.9800 | 46.9800 | 0.3754 |
| 89 | 17-Mar-2013 14:56:00 | 47 | 47 | 47 | 47 | 0.1877 |
| 90 | 17-Mar-2013 15:11:00 | 47.0800 | 47.0800 | 47.0800 | 47.0800 | 1.3291 |
| 91 | 17-Mar-2013 15:12:00 | 47 | 47 | 47 | 47 | 0.0961 |
| 92 | 17-Mar-2013 15:13:00 | 47 | 47 | 47 | 47 | 0.0004 |
| 93 | 17-Mar-2013 15:14:00 | 47 | 47 | 47 | 47 | 0.0001 |
| 94 | 17-Mar-2013 15:15:00 | 47 | 47 | 47 | 47 | 0.0001 |
| 95 | 17-Mar-2013 15:16:00 | 47 | 47 | 47 | 47 | 0.0001 |
| 96 | 17-Mar-2013 15:17:00 | 47 | 47 | 47 | 47 | 0.0001 |
| 97 | 17-Mar-2013 15:18:00 | 47 | 47 | 47 | 47 | 0.0001 |
| 98 | 17-Mar-2013 15:19:00 | 47 | 47 | 47 | 47 | 0.0001 |
| 99 | 17-Mar-2013 15:20:00 | 47 | 47 | 47 | 47 | 0.0001 |
| 100 | 17-Mar-2013 15:21:00 | 47 | 47 | 47 | 47 | 0.0001 |

⋮

```
%outliers = outlier(BitcoinData.Close)
```

## Split dataset into training and testing data

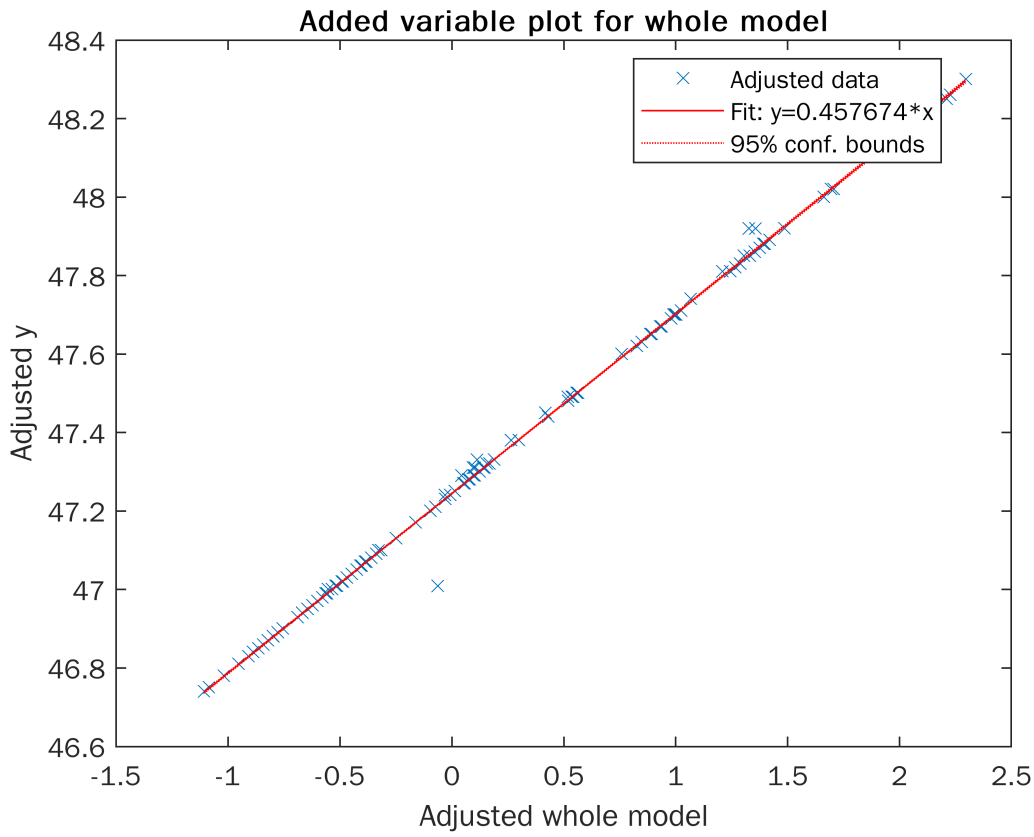
```
BitcoinData_new = [X, Y];

PD = 0.20;
cv = cvpartition(size(BitcoinData_new,1),'HoldOut',PD);
Xtrain = BitcoinData_new(cv.training,[1:end - 1]);
Ytrain = BitcoinData_new(cv.training,end);
Xtest = BitcoinData_new(cv.test, [1:end - 1]);
Ytest = BitcoinData_new(cv.test,end);
```

## Linear model with training-testing split

```
LRModel = fitlm(zscore(Xtrain),Ytrain)
```

```
LRModel = 
Linear regression model:
    y ~ 1 + x1 + x2 + x3

Estimated Coefficients:
                   Estimate        SE          tStat       pValue  
                   ________    __________    _______    ___________

    (Intercept)      47.245    0.00065553      72071              0
    x1             -0.23069       0.01377    -16.754     3.6192e-47
    x2              0.23669     0.0075015     31.552    1.8874e-106
    x3              0.31658      0.011723     27.005      3.914e-89


Number of observations: 370, Error degrees of freedom: 366
Root Mean Squared Error: 0.0126
R-squared: 0.998,  Adjusted R-Squared: 0.998
F-statistic vs. constant model: 8.04e+04, p-value = 0
```

```
plot(LRModel)
```




```
LRModel.RMSE
```

```
ans = 0.0126
```

## Predict

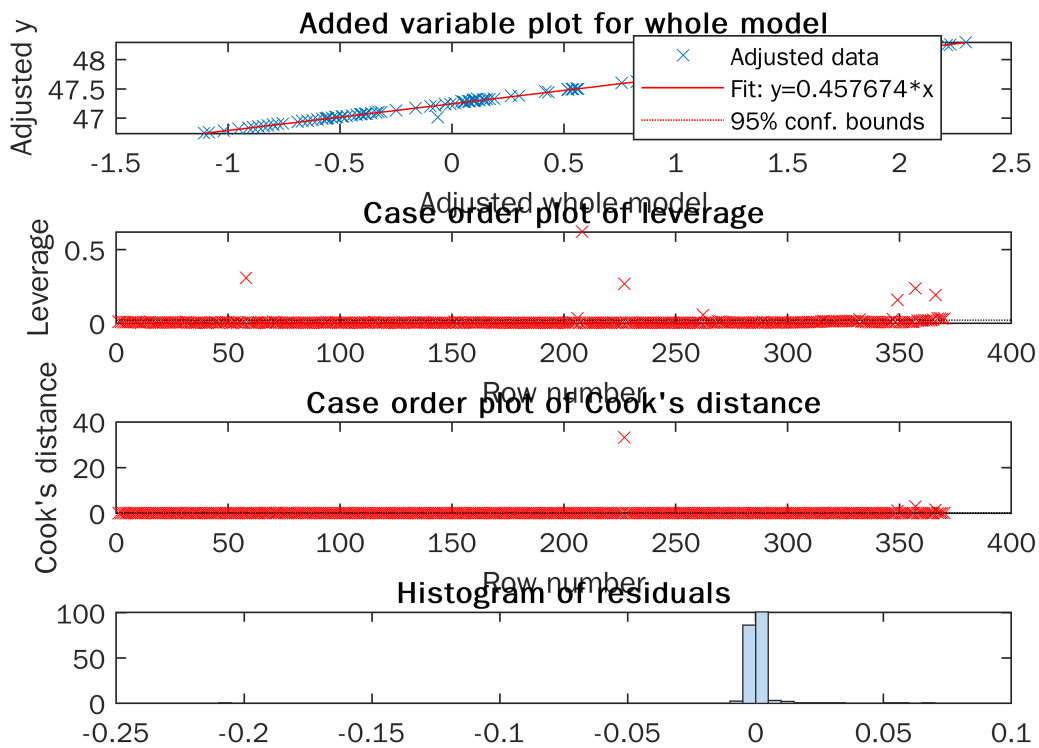
```
[YPred, Scores] = predict(LRModel,Xtest)
```

```
YPred = 92×1
   62.3092
   62.3221
   62.3350
   62.3576
   62.4060
   62.4060
   62.4060
   62.3511
   62.3447
   62.4060
      ⋮

Scores = 92×2
   62.2488   62.3696
   62.2617   62.3825
   62.2745   62.3955
   62.2970   62.4182
   62.3452   62.4667
   62.3452   62.4667
   62.3452   62.4667
   62.2906   62.4117
   62.2842   62.4052
```

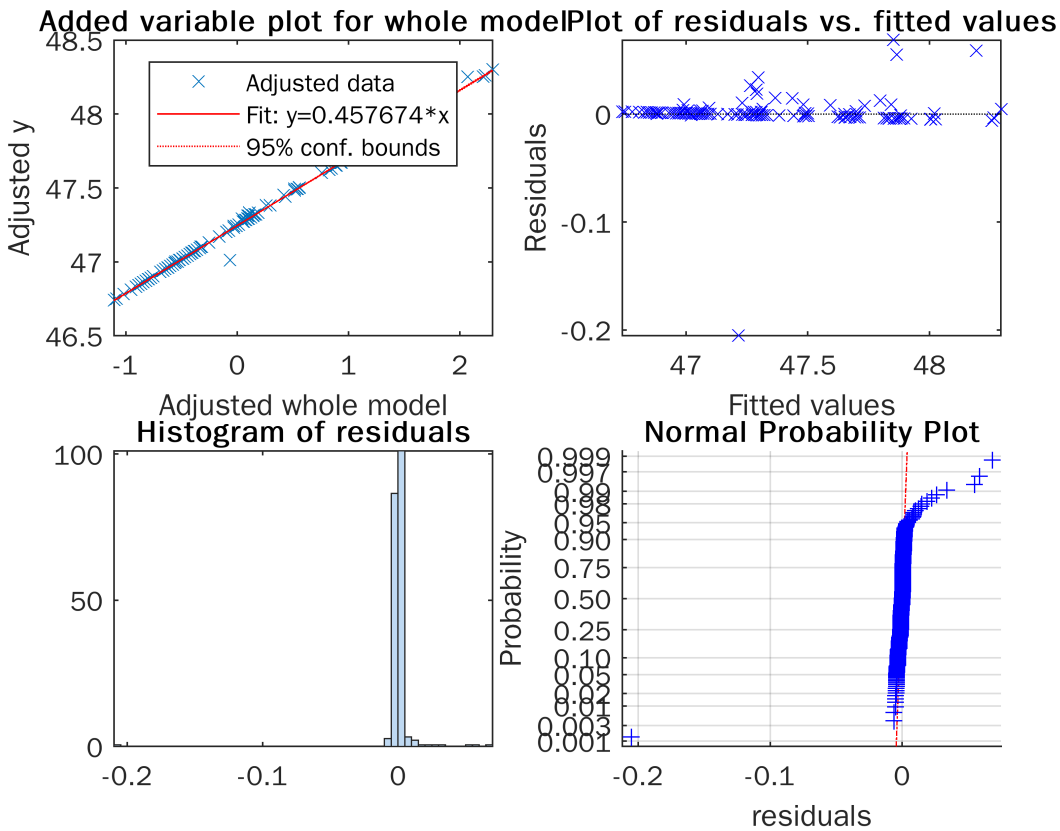
```
   62.3452   62.4667
      ⋮
```

## Plots

```
figure,
subplot(4, 1, 1), plot(LRModel)
subplot(4, 1, 2), plotDiagnostics(LRModel)
subplot(4, 1, 3), plotDiagnostics(LRModel, 'cookd')
subplot(4, 1, 4), plotResiduals(LRModel)
```




```
figure,
subplot(2, 2, 1), plot(LRModel)
subplot(2, 2, 2), plotResiduals(LRModel,'fitted')
subplot(2, 2, 3), plotResiduals(LRModel)
subplot(2, 2, 4), normplot(LRModel.Residuals.Raw)
xlabel('residuals')
```


Added variable plot for whole model
Adjusted data
Fit: y=0.457674*x
95% conf. bounds
Adjusted y
Adjusted whole model
Plot of residuals vs. fitted values
Residuals
Fitted values
Histogram of residuals
Normal Probability Plot
Probability
residuals

## Upload the big dataset (>250MB) to MATLAB Drive and read table

```
BitcoinData = readtable('bitcoin-dataset.csv');
```

```
Warning: Column headers from the file were modified to make them valid MATLAB identifiers
before creating variable names for the table. The original column headers are saved in the
VariableDescriptions property.
Set 'VariableNamingRule' to 'preserve' to use the original column headers as table variable names.
```

```
Tablesize = size(BitcoinData)
```

```
Tablesize = 1×2
     4857377           8
```

```
head(BitcoinData,1)
```

```
ans = 1×8 table
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                
...
```

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 1 | 1.3253e+09 | 4.3900 | 4.3900 | 4.3900 | 4.3900 | 0.4556 |

## Convert timestamp

```
datetest = BitcoinData(:,1);
datetest = table2array(datetest);
BitcoinData.Timestamp = datetime(datetest, 'ConvertFrom', 'posixtime');
```

## Remove NaNs

```
% how many NaNs in each column
NaN2 = sum(isnan(BitcoinData.Open))
```

```
NaN2 = 1243608
```

```
NaN3 = sum(isnan(BitcoinData.High))
```

```
NaN3 = 1243608
```

```
NaN4 = sum(isnan(BitcoinData.Low))
```

```
NaN4 = 1243608
```

```
NaN5 = sum(isnan(BitcoinData.Close))
```

```
NaN5 = 1243608
```

```
NaN6 = sum(isnan(BitcoinData.Volume__BTC_))
```

```
NaN6 = 1243608
```

```
NaN7 = sum(isnan(BitcoinData.Volume__Currency_))
```

```
NaN7 = 1243608
```

```
NaN8 = sum(isnan(BitcoinData.Weighted_Price))
```

```
NaN8 = 1243608
```

```
% remove NaNs
BitcoinData = BitcoinData(isnan(BitcoinData.High) == 0,:);
```

## Select data

```
BitcoinDataTimetable = table2timetable(BitcoinData);

% March 2013
% S = timerange('17-Mar-2013 00:00:00','18-Mar-2013 23:59:00'); %2days
 S = timerange('17-Mar-2013 00:00:00','23-Mar-2013 23:59:00'); %7days
% S = timerange('17-Mar-2013 00:00:00','30-Mar-2013 23:59:00'); %14days

% March 2016
% S = timerange('17-Mar-2016 00:00:00','18-Mar-2016 23:59:00'); %2days
% S = timerange('17-Mar-2016 00:00:00','23-Mar-2016 23:59:00'); %7days
% S = timerange('17-Mar-2016 00:00:00','30-Mar-2016 23:59:00'); %14days

% March 2019
% S = timerange('17-Mar-2019 00:00:00','18-Mar-2019 23:59:00'); %2days
% S = timerange('17-Mar-2019 00:00:00','23-Mar-2019 23:59:00'); %7days
% S = timerange('17-Mar-2019 00:00:00','30-Mar-2019 23:59:00'); %14days

% March 2021
% S = timerange('17-Mar-2021 00:00:00','18-Mar-2021 23:59:00'); %2days
% S = timerange('17-Mar-2021 00:00:00','23-Mar-2021 23:59:00'); %7days
% S = timerange('17-Mar-2021 00:00:00','30-Mar-2021 23:59:00'); %14days

BitcoinData = BitcoinDataTimetable(S,:);
Tablesize = size(BitcoinData)
```

```
Tablesize = 1×2
        3784           7
```

## Create model - preprocessing

```
% standardization, and Initial predictor set (matrix)

Y = BitcoinData{:,"Close"}
```

```
Y = 3784×1
   46.7000
   46.7400
   46.7400
   46.7400
   46.7800
   46.7800
   46.7800
   46.7800
   46.7800
   46.8100
      ⋮
```

```
X = BitcoinData{:,[1:3]}
```

```
X = 3784×3
   46.7000   46.7000   46.7000
   46.7400   46.7400   46.7400
   46.7400   46.7400   46.7400
   46.7400   46.7400   46.7400
   46.7800   46.7800   46.7800
   46.7800   46.7800   46.7800
```

```
   46.7800   46.7800   46.7800
   46.7800   46.7800   46.7800
   46.7800   46.7800   46.7800
   46.8100   46.8100   46.8100
      ⋮
```

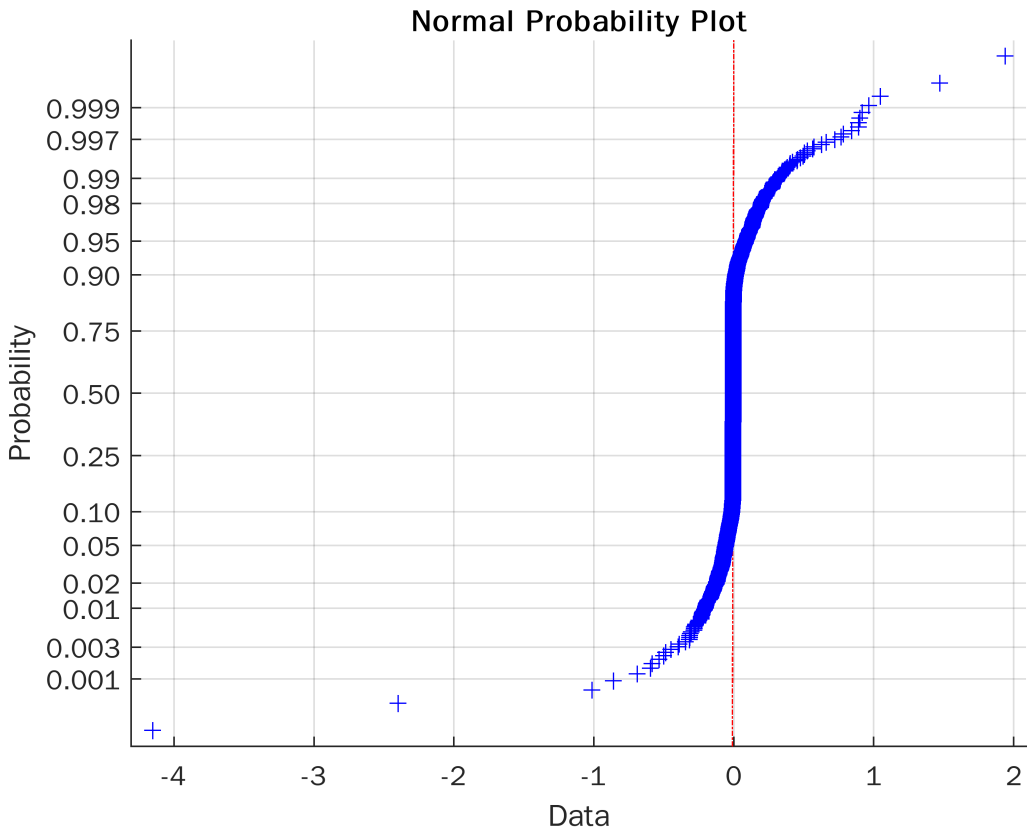
```
%Check model for outliers

LRPre = fitlm(zscore(X),Y)
```

```
LRPre =
Linear regression model:
    y ~ 1 + x1 + x2 + x3

Estimated Coefficients:
```

| | Estimate | SE | tStat | pValue |
|---|---|---|---|---|
| **(Intercept)** | 62.117 | 0.0019548 | 31777 | 0 |
| **x1** | -4.6965 | 0.11724 | -40.058 | 8.9887e-293 |
| **x2** | 6.0171 | 0.073743 | 81.595 | 0 |
| **x3** | 7.1817 | 0.091338 | 78.627 | 0 |

```
Number of observations: 3784, Error degrees of freedom: 3780
Root Mean Squared Error: 0.12
R-squared: 1,  Adjusted R-Squared: 1
F-statistic vs. constant model: 6.3e+06, p-value = 0
```

```
normplot(LRPre.Residuals.Raw)
```




## Identify and Remove Outliers

```
idx = isoutlier(BitcoinData.Close)
```

```
idx = 3784×1 logical array
   0
   0
   0
   0
   0
   0
   0
   0
   0
   0
     ⋮
```

```
sum(idx)
```

```
ans = 0
```

```
BitcoinData(idx,:) = []
```

```
BitcoinData = 3784×7 timetable
                                                                                    ...
```

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 1 | 17-Mar-2013 00:06:00 | 46.7000 | 46.7000 | 46.7000 | 46.7000 | 1 |

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 2 | 17-Mar-2013 00:21:00 | 46.7400 | 46.7400 | 46.7400 | 46.7400 | 1.9399 |
| 3 | 17-Mar-2013 00:38:00 | 46.7400 | 46.7400 | 46.7400 | 46.7400 | 67.6000 |
| 4 | 17-Mar-2013 01:32:00 | 46.7400 | 46.7400 | 46.7400 | 46.7400 | 0.0018 |
| 5 | 17-Mar-2013 01:43:00 | 46.7800 | 46.7800 | 46.7800 | 46.7800 | 21.2770 |
| 6 | 17-Mar-2013 01:54:00 | 46.7800 | 46.7800 | 46.7800 | 46.7800 | 3 |
| 7 | 17-Mar-2013 01:56:00 | 46.7800 | 46.7800 | 46.7800 | 46.7800 | 4 |
| 8 | 17-Mar-2013 01:58:00 | 46.7800 | 46.7800 | 46.7800 | 46.7800 | 0.9000 |
| 9 | 17-Mar-2013 02:10:00 | 46.7800 | 46.7800 | 46.7800 | 46.7800 | 0.0130 |
| 10 | 17-Mar-2013 02:21:00 | 46.8100 | 46.8100 | 46.8100 | 46.8100 | 0.9446 |
| 11 | 17-Mar-2013 02:28:00 | 46.8100 | 46.8100 | 46.8100 | 46.8100 | 1.8400 |
| 12 | 17-Mar-2013 02:32:00 | 46.8400 | 46.8400 | 46.8400 | 46.8400 | 0.0587 |
| 13 | 17-Mar-2013 03:01:00 | 46.8500 | 46.8500 | 46.8500 | 46.8500 | 0.9153 |
| 14 | 17-Mar-2013 03:12:00 | 46.8700 | 46.8700 | 46.8700 | 46.8700 | 0.9153 |
| 15 | 17-Mar-2013 03:20:00 | 47 | 47 | 47 | 47 | 1.3472 |
| 16 | 17-Mar-2013 03:22:00 | 47 | 47 | 47 | 47 | 0.2919 |
| 17 | 17-Mar-2013 03:30:00 | 46.8500 | 46.8500 | 46.8500 | 46.8500 | 0.4894 |
| 18 | 17-Mar-2013 03:45:00 | 46.8500 | 46.8500 | 46.8500 | 46.8500 | 0.5000 |
| 19 | 17-Mar-2013 04:10:00 | 46.8500 | 46.8500 | 46.8500 | 46.8500 | 0.0106 |
| 20 | 17-Mar-2013 04:29:00 | 46.8500 | 46.8500 | 46.8300 | 46.8300 | 1.8758 |
| 21 | 17-Mar-2013 04:45:00 | 46.8900 | 46.8900 | 46.8900 | 46.8900 | 1.4587 |
| 22 | 17-Mar-2013 04:48:00 | 47 | 47 | 47 | 47 | 0.0411 |
| 23 | 17-Mar-2013 04:50:00 | 47 | 47 | 47 | 47 | 0.0394 |
| 24 | 17-Mar-2013 04:56:00 | 47 | 47 | 47 | 47 | 2.2030 |
| 25 | 17-Mar-2013 05:19:00 | 47 | 47 | 47 | 47 | 1.9385 |
| 26 | 17-Mar-2013 05:47:00 | 46.8900 | 46.8900 | 46.8900 | 46.8900 | 2 |
| 27 | 17-Mar-2013 05:53:00 | 47 | 47 | 47 | 47 | 10.0828 |
| 28 | 17-Mar-2013 06:51:00 | 47 | 47 | 47 | 47 | 3.6594 |
| 29 | 17-Mar-2013 08:13:00 | 46.9300 | 46.9300 | 46.9300 | 46.9300 | 1 |
| 30 | 17-Mar-2013 08:21:00 | 46.9900 | 46.9900 | 46.9900 | 46.9900 | 2.4499 |
| 31 | 17-Mar-2013 08:34:00 | 46.9300 | 46.9300 | 46.9300 | 46.9300 | 1.0214 |
| 32 | 17-Mar-2013 08:35:00 | 46.9300 | 46.9300 | 46.9300 | 46.9300 | 0.5304 |
| 33 | 17-Mar-2013 08:45:00 | 46.9000 | 46.9000 | 46.9000 | 46.9000 | 0.4459 |
| 34 | 17-Mar-2013 08:46:00 | 46.8900 | 46.8900 | 46.8900 | 46.8900 | 0.2219 |

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 35 | 17-Mar-2013 08:47:00 | 46.8700 | 46.8700 | 46.8700 | 46.8700 | 0.1105 |
| 36 | 17-Mar-2013 08:48:00 | 46.8600 | 46.8600 | 46.8600 | 46.8600 | 0.6743 |
| 37 | 17-Mar-2013 08:49:00 | 46.8400 | 46.8400 | 46.8400 | 46.8400 | 0.0823 |
| 38 | 17-Mar-2013 08:50:00 | 46.8300 | 46.8300 | 46.8300 | 46.8300 | 0.4320 |
| 39 | 17-Mar-2013 08:51:00 | 46.8100 | 46.8100 | 46.8100 | 46.8100 | 4.2072 |
| 40 | 17-Mar-2013 08:52:00 | 46.7500 | 46.7500 | 46.7500 | 46.7500 | 0.0883 |
| 41 | 17-Mar-2013 09:13:00 | 46.9400 | 46.9400 | 46.9400 | 46.9400 | 1.3892 |
| 42 | 17-Mar-2013 09:19:00 | 46.9900 | 46.9900 | 46.9900 | 46.9900 | 15.5041 |
| 43 | 17-Mar-2013 09:24:00 | 47 | 47 | 47 | 47 | 2.0455 |
| 44 | 17-Mar-2013 09:27:00 | 47 | 47 | 47 | 47 | 0.8623 |
| 45 | 17-Mar-2013 09:32:00 | 47 | 47 | 47 | 47 | 5.5077 |
| 46 | 17-Mar-2013 09:48:00 | 47 | 47 | 47 | 47 | 79.5934 |
| 47 | 17-Mar-2013 10:09:00 | 46.9900 | 46.9900 | 46.9900 | 46.9900 | 4.7000 |
| 48 | 17-Mar-2013 10:18:00 | 47 | 47 | 47 | 47 | 4.7890 |
| 49 | 17-Mar-2013 10:19:00 | 47 | 47 | 47 | 47 | 2.0774 |
| 50 | 17-Mar-2013 10:21:00 | 47 | 47 | 47 | 47 | 9.5221 |
| 51 | 17-Mar-2013 10:23:00 | 47 | 47 | 47 | 47 | 0.5270 |
| 52 | 17-Mar-2013 10:24:00 | 47 | 47 | 47 | 47 | 3.4269 |
| 53 | 17-Mar-2013 10:25:00 | 46.9000 | 46.9000 | 46.9000 | 46.9000 | 6.6952 |
| 54 | 17-Mar-2013 10:26:00 | 46.9000 | 46.9000 | 46.9000 | 46.9000 | 2.8357 |
| 55 | 17-Mar-2013 10:31:00 | 46.9000 | 46.9000 | 46.9000 | 46.9000 | 20.4691 |
| 56 | 17-Mar-2013 10:36:00 | 46.8500 | 46.8500 | 46.8500 | 46.8500 | 15 |
| 57 | 17-Mar-2013 10:37:00 | 47 | 47 | 47 | 47 | 54.9791 |
| 58 | 17-Mar-2013 10:38:00 | 47 | 47 | 47 | 47 | 9.2845 |
| 59 | 17-Mar-2013 11:16:00 | 46.8600 | 46.8600 | 46.8500 | 46.8500 | 6.7900 |
| 60 | 17-Mar-2013 11:19:00 | 46.9000 | 46.9000 | 46.9000 | 46.9000 | 0.3511 |
| 61 | 17-Mar-2013 11:30:00 | 46.8500 | 46.8500 | 46.8500 | 46.8500 | 0.6489 |
| 62 | 17-Mar-2013 11:40:00 | 46.9800 | 46.9900 | 46.9800 | 46.9900 | 6.0302 |
| 63 | 17-Mar-2013 11:50:00 | 47 | 47 | 47 | 47 | 0.0213 |
| 64 | 17-Mar-2013 11:55:00 | 47 | 47 | 47 | 47 | 2.4419 |
| 65 | 17-Mar-2013 11:58:00 | 46.8500 | 46.8500 | 46.8500 | 46.8500 | 6.3800 |
| 66 | 17-Mar-2013 12:03:00 | 47 | 47 | 47 | 47 | 4.1873 |
| 67 | 17-Mar-2013 12:15:00 | 46.8400 | 46.8400 | 46.8400 | 46.8400 | 0.4114 |

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 68 | 17-Mar-2013 12:16:00 | 47 | 47 | 47 | 47 | 4.2383 |
| 69 | 17-Mar-2013 12:17:00 | 47 | 47 | 47 | 47 | 2.1300 |
| 70 | 17-Mar-2013 12:29:00 | 47 | 47.0700 | 47 | 47.0700 | 94.9699 |
| 71 | 17-Mar-2013 12:30:00 | 47.0700 | 47.0700 | 46.8800 | 46.8800 | 1.2102 |
| 72 | 17-Mar-2013 12:31:00 | 46.8800 | 46.8800 | 46.8800 | 46.8800 | 2.7150 |
| 73 | 17-Mar-2013 12:33:00 | 47 | 47 | 47 | 47 | 0.8098 |
| 74 | 17-Mar-2013 12:34:00 | 47 | 47 | 47 | 47 | 0.6296 |
| 75 | 17-Mar-2013 12:35:00 | 47.0600 | 47.0700 | 47.0600 | 47.0700 | 15.1967 |
| 76 | 17-Mar-2013 12:36:00 | 47.0700 | 47.0700 | 47.0700 | 47.0700 | 0.6286 |
| 77 | 17-Mar-2013 12:39:00 | 46.9500 | 46.9500 | 46.9500 | 46.9500 | 0.6700 |
| 78 | 17-Mar-2013 12:45:00 | 46.8900 | 46.8900 | 46.8900 | 46.8900 | 0.5167 |
| 79 | 17-Mar-2013 13:04:00 | 46.9900 | 46.9900 | 46.9900 | 46.9900 | 0.0357 |
| 80 | 17-Mar-2013 13:23:00 | 47.0600 | 47.0600 | 47.0600 | 47.0600 | 0.7507 |
| 81 | 17-Mar-2013 13:24:00 | 47.0600 | 47.0600 | 47.0600 | 47.0600 | 0.0001 |
| 82 | 17-Mar-2013 13:25:00 | 47.0700 | 47.0700 | 47.0700 | 47.0700 | 0.6963 |
| 83 | 17-Mar-2013 13:35:00 | 47.0700 | 47.0700 | 47.0700 | 47.0700 | 8.8693 |
| 84 | 17-Mar-2013 13:46:00 | 47.0900 | 47.0900 | 47.0900 | 47.0900 | 1.7059 |
| 85 | 17-Mar-2013 13:52:00 | 46.9900 | 46.9900 | 46.9600 | 46.9600 | 4.8200 |
| 86 | 17-Mar-2013 13:59:00 | 46.9600 | 46.9600 | 46.9600 | 46.9600 | 60 |
| 87 | 17-Mar-2013 14:10:00 | 46.9600 | 46.9600 | 46.9600 | 46.9600 | 30 |
| 88 | 17-Mar-2013 14:55:00 | 46.9800 | 46.9800 | 46.9800 | 46.9800 | 0.3754 |
| 89 | 17-Mar-2013 14:56:00 | 47 | 47 | 47 | 47 | 0.1877 |
| 90 | 17-Mar-2013 15:11:00 | 47.0800 | 47.0800 | 47.0800 | 47.0800 | 1.3291 |
| 91 | 17-Mar-2013 15:12:00 | 47 | 47 | 47 | 47 | 0.0961 |
| 92 | 17-Mar-2013 15:13:00 | 47 | 47 | 47 | 47 | 0.0004 |
| 93 | 17-Mar-2013 15:14:00 | 47 | 47 | 47 | 47 | 0.0001 |
| 94 | 17-Mar-2013 15:15:00 | 47 | 47 | 47 | 47 | 0.0001 |
| 95 | 17-Mar-2013 15:16:00 | 47 | 47 | 47 | 47 | 0.0001 |
| 96 | 17-Mar-2013 15:17:00 | 47 | 47 | 47 | 47 | 0.0001 |
| 97 | 17-Mar-2013 15:18:00 | 47 | 47 | 47 | 47 | 0.0001 |
| 98 | 17-Mar-2013 15:19:00 | 47 | 47 | 47 | 47 | 0.0001 |
| 99 | 17-Mar-2013 15:20:00 | 47 | 47 | 47 | 47 | 0.0001 |
| 100 | 17-Mar-2013 15:21:00 | 47 | 47 | 47 | 47 | 0.0001 |

```
    ⋮
```

```
%outliers = outlier(BitcoinData.Close)

%Rerun model to check for more outliers
Y = BitcoinData{:,"Close"}
```

```
Y = 3784×1
   46.7000
   46.7400
   46.7400
   46.7400
   46.7800
   46.7800
   46.7800
   46.7800
   46.7800
   46.8100
     ⋮
```

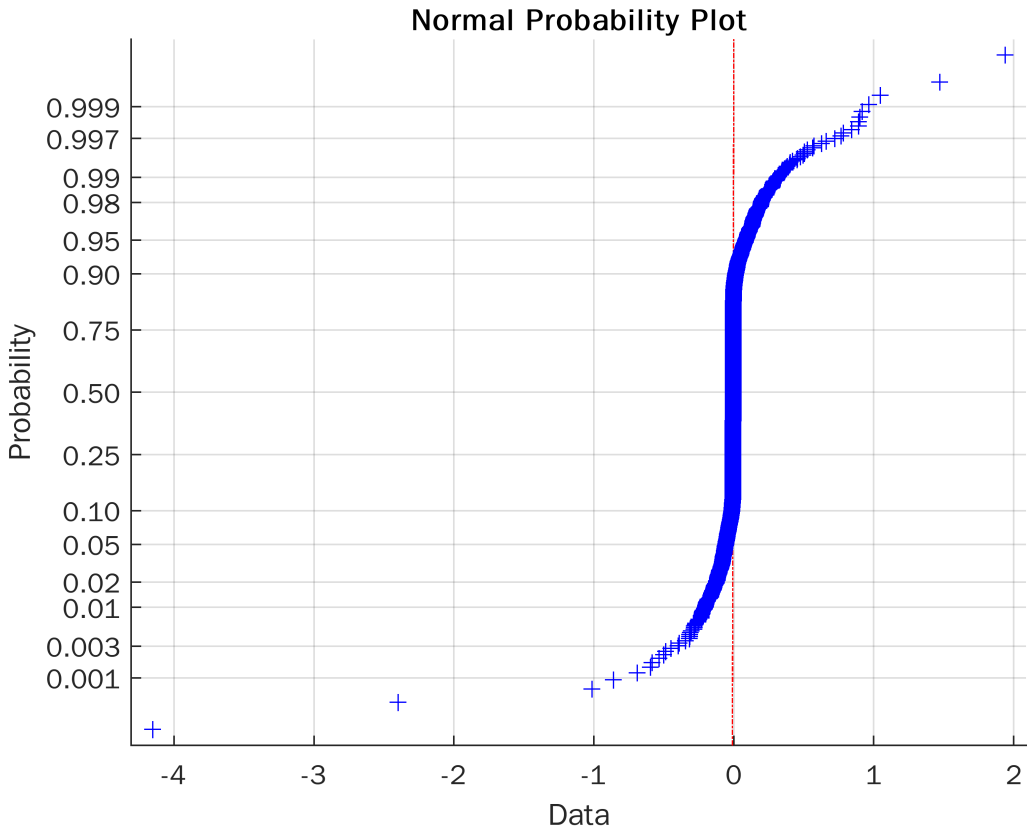
```
X = BitcoinData{:,[1:3]}
```

```
X = 3784×3
   46.7000   46.7000   46.7000
   46.7400   46.7400   46.7400
   46.7400   46.7400   46.7400
   46.7400   46.7400   46.7400
   46.7800   46.7800   46.7800
   46.7800   46.7800   46.7800
   46.7800   46.7800   46.7800
   46.7800   46.7800   46.7800
   46.7800   46.7800   46.7800
   46.8100   46.8100   46.8100
     ⋮
```

```
LRPre = fitlm(zscore(X),Y)
```

```
LRPre = 
Linear regression model:
    y ~ 1 + x1 + x2 + x3

Estimated Coefficients:
                   Estimate       SE         tStat       pValue  
                   ________    _________    _______    ___________

    (Intercept)     62.117     0.0019548      31777              0
    x1             -4.6965       0.11724    -40.058    8.9887e-293
    x2              6.0171      0.073743     81.595              0
    x3              7.1817      0.091338     78.627              0


Number of observations: 3784, Error degrees of freedom: 3780
Root Mean Squared Error: 0.12
R-squared: 1,  Adjusted R-Squared: 1
F-statistic vs. constant model: 6.3e+06, p-value = 0
```

```
normplot(LRPre.Residuals.Raw)
```




```
idx = isoutlier(BitcoinData.Close)
```

```
idx = 3784×1 logical array
   0
   0
   0
   0
   0
   0
   0
   0
   0
   0
   0
   ⋮
```

```
sum(idx)
```

```
ans = 0
```

```
BitcoinData(idx,:) = []
```

```
BitcoinData = 3784×7 timetable
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                
```
...
```

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 1 | 17-Mar-2013 00:06:00 | 46.7000 | 46.7000 | 46.7000 | 46.7000 | 1 |
| 2 | 17-Mar-2013 00:21:00 | 46.7400 | 46.7400 | 46.7400 | 46.7400 | 1.9399 |
```

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 3 | 17-Mar-2013 00:38:00 | 46.7400 | 46.7400 | 46.7400 | 46.7400 | 67.6000 |
| 4 | 17-Mar-2013 01:32:00 | 46.7400 | 46.7400 | 46.7400 | 46.7400 | 0.0018 |
| 5 | 17-Mar-2013 01:43:00 | 46.7800 | 46.7800 | 46.7800 | 46.7800 | 21.2770 |
| 6 | 17-Mar-2013 01:54:00 | 46.7800 | 46.7800 | 46.7800 | 46.7800 | 3 |
| 7 | 17-Mar-2013 01:56:00 | 46.7800 | 46.7800 | 46.7800 | 46.7800 | 4 |
| 8 | 17-Mar-2013 01:58:00 | 46.7800 | 46.7800 | 46.7800 | 46.7800 | 0.9000 |
| 9 | 17-Mar-2013 02:10:00 | 46.7800 | 46.7800 | 46.7800 | 46.7800 | 0.0130 |
| 10 | 17-Mar-2013 02:21:00 | 46.8100 | 46.8100 | 46.8100 | 46.8100 | 0.9446 |
| 11 | 17-Mar-2013 02:28:00 | 46.8100 | 46.8100 | 46.8100 | 46.8100 | 1.8400 |
| 12 | 17-Mar-2013 02:32:00 | 46.8400 | 46.8400 | 46.8400 | 46.8400 | 0.0587 |
| 13 | 17-Mar-2013 03:01:00 | 46.8500 | 46.8500 | 46.8500 | 46.8500 | 0.9153 |
| 14 | 17-Mar-2013 03:12:00 | 46.8700 | 46.8700 | 46.8700 | 46.8700 | 0.9153 |
| 15 | 17-Mar-2013 03:20:00 | 47 | 47 | 47 | 47 | 1.3472 |
| 16 | 17-Mar-2013 03:22:00 | 47 | 47 | 47 | 47 | 0.2919 |
| 17 | 17-Mar-2013 03:30:00 | 46.8500 | 46.8500 | 46.8500 | 46.8500 | 0.4894 |
| 18 | 17-Mar-2013 03:45:00 | 46.8500 | 46.8500 | 46.8500 | 46.8500 | 0.5000 |
| 19 | 17-Mar-2013 04:10:00 | 46.8500 | 46.8500 | 46.8500 | 46.8500 | 0.0106 |
| 20 | 17-Mar-2013 04:29:00 | 46.8500 | 46.8500 | 46.8300 | 46.8300 | 1.8758 |
| 21 | 17-Mar-2013 04:45:00 | 46.8900 | 46.8900 | 46.8900 | 46.8900 | 1.4587 |
| 22 | 17-Mar-2013 04:48:00 | 47 | 47 | 47 | 47 | 0.0411 |
| 23 | 17-Mar-2013 04:50:00 | 47 | 47 | 47 | 47 | 0.0394 |
| 24 | 17-Mar-2013 04:56:00 | 47 | 47 | 47 | 47 | 2.2030 |
| 25 | 17-Mar-2013 05:19:00 | 47 | 47 | 47 | 47 | 1.9385 |
| 26 | 17-Mar-2013 05:47:00 | 46.8900 | 46.8900 | 46.8900 | 46.8900 | 2 |
| 27 | 17-Mar-2013 05:53:00 | 47 | 47 | 47 | 47 | 10.0828 |
| 28 | 17-Mar-2013 06:51:00 | 47 | 47 | 47 | 47 | 3.6594 |
| 29 | 17-Mar-2013 08:13:00 | 46.9300 | 46.9300 | 46.9300 | 46.9300 | 1 |
| 30 | 17-Mar-2013 08:21:00 | 46.9900 | 46.9900 | 46.9900 | 46.9900 | 2.4499 |
| 31 | 17-Mar-2013 08:34:00 | 46.9300 | 46.9300 | 46.9300 | 46.9300 | 1.0214 |
| 32 | 17-Mar-2013 08:35:00 | 46.9300 | 46.9300 | 46.9300 | 46.9300 | 0.5304 |
| 33 | 17-Mar-2013 08:45:00 | 46.9000 | 46.9000 | 46.9000 | 46.9000 | 0.4459 |
| 34 | 17-Mar-2013 08:46:00 | 46.8900 | 46.8900 | 46.8900 | 46.8900 | 0.2219 |
| 35 | 17-Mar-2013 08:47:00 | 46.8700 | 46.8700 | 46.8700 | 46.8700 | 0.1105 |

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 36 | 17-Mar-2013 08:48:00 | 46.8600 | 46.8600 | 46.8600 | 46.8600 | 0.6743 |
| 37 | 17-Mar-2013 08:49:00 | 46.8400 | 46.8400 | 46.8400 | 46.8400 | 0.0823 |
| 38 | 17-Mar-2013 08:50:00 | 46.8300 | 46.8300 | 46.8300 | 46.8300 | 0.4320 |
| 39 | 17-Mar-2013 08:51:00 | 46.8100 | 46.8100 | 46.8100 | 46.8100 | 4.2072 |
| 40 | 17-Mar-2013 08:52:00 | 46.7500 | 46.7500 | 46.7500 | 46.7500 | 0.0883 |
| 41 | 17-Mar-2013 09:13:00 | 46.9400 | 46.9400 | 46.9400 | 46.9400 | 1.3892 |
| 42 | 17-Mar-2013 09:19:00 | 46.9900 | 46.9900 | 46.9900 | 46.9900 | 15.5041 |
| 43 | 17-Mar-2013 09:24:00 | 47 | 47 | 47 | 47 | 2.0455 |
| 44 | 17-Mar-2013 09:27:00 | 47 | 47 | 47 | 47 | 0.8623 |
| 45 | 17-Mar-2013 09:32:00 | 47 | 47 | 47 | 47 | 5.5077 |
| 46 | 17-Mar-2013 09:48:00 | 47 | 47 | 47 | 47 | 79.5934 |
| 47 | 17-Mar-2013 10:09:00 | 46.9900 | 46.9900 | 46.9900 | 46.9900 | 4.7000 |
| 48 | 17-Mar-2013 10:18:00 | 47 | 47 | 47 | 47 | 4.7890 |
| 49 | 17-Mar-2013 10:19:00 | 47 | 47 | 47 | 47 | 2.0774 |
| 50 | 17-Mar-2013 10:21:00 | 47 | 47 | 47 | 47 | 9.5221 |
| 51 | 17-Mar-2013 10:23:00 | 47 | 47 | 47 | 47 | 0.5270 |
| 52 | 17-Mar-2013 10:24:00 | 47 | 47 | 47 | 47 | 3.4269 |
| 53 | 17-Mar-2013 10:25:00 | 46.9000 | 46.9000 | 46.9000 | 46.9000 | 6.6952 |
| 54 | 17-Mar-2013 10:26:00 | 46.9000 | 46.9000 | 46.9000 | 46.9000 | 2.8357 |
| 55 | 17-Mar-2013 10:31:00 | 46.9000 | 46.9000 | 46.9000 | 46.9000 | 20.4691 |
| 56 | 17-Mar-2013 10:36:00 | 46.8500 | 46.8500 | 46.8500 | 46.8500 | 15 |
| 57 | 17-Mar-2013 10:37:00 | 47 | 47 | 47 | 47 | 54.9791 |
| 58 | 17-Mar-2013 10:38:00 | 47 | 47 | 47 | 47 | 9.2845 |
| 59 | 17-Mar-2013 11:16:00 | 46.8600 | 46.8600 | 46.8500 | 46.8500 | 6.7900 |
| 60 | 17-Mar-2013 11:19:00 | 46.9000 | 46.9000 | 46.9000 | 46.9000 | 0.3511 |
| 61 | 17-Mar-2013 11:30:00 | 46.8500 | 46.8500 | 46.8500 | 46.8500 | 0.6489 |
| 62 | 17-Mar-2013 11:40:00 | 46.9800 | 46.9900 | 46.9800 | 46.9900 | 6.0302 |
| 63 | 17-Mar-2013 11:50:00 | 47 | 47 | 47 | 47 | 0.0213 |
| 64 | 17-Mar-2013 11:55:00 | 47 | 47 | 47 | 47 | 2.4419 |
| 65 | 17-Mar-2013 11:58:00 | 46.8500 | 46.8500 | 46.8500 | 46.8500 | 6.3800 |
| 66 | 17-Mar-2013 12:03:00 | 47 | 47 | 47 | 47 | 4.1873 |
| 67 | 17-Mar-2013 12:15:00 | 46.8400 | 46.8400 | 46.8400 | 46.8400 | 0.4114 |
| 68 | 17-Mar-2013 12:16:00 | 47 | 47 | 47 | 47 | 4.2383 |

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 69 | 17-Mar-2013 12:17:00 | 47 | 47 | 47 | 47 | 2.1300 |
| 70 | 17-Mar-2013 12:29:00 | 47 | 47.0700 | 47 | 47.0700 | 94.9699 |
| 71 | 17-Mar-2013 12:30:00 | 47.0700 | 47.0700 | 46.8800 | 46.8800 | 1.2102 |
| 72 | 17-Mar-2013 12:31:00 | 46.8800 | 46.8800 | 46.8800 | 46.8800 | 2.7150 |
| 73 | 17-Mar-2013 12:33:00 | 47 | 47 | 47 | 47 | 0.8098 |
| 74 | 17-Mar-2013 12:34:00 | 47 | 47 | 47 | 47 | 0.6296 |
| 75 | 17-Mar-2013 12:35:00 | 47.0600 | 47.0700 | 47.0600 | 47.0700 | 15.1967 |
| 76 | 17-Mar-2013 12:36:00 | 47.0700 | 47.0700 | 47.0700 | 47.0700 | 0.6286 |
| 77 | 17-Mar-2013 12:39:00 | 46.9500 | 46.9500 | 46.9500 | 46.9500 | 0.6700 |
| 78 | 17-Mar-2013 12:45:00 | 46.8900 | 46.8900 | 46.8900 | 46.8900 | 0.5167 |
| 79 | 17-Mar-2013 13:04:00 | 46.9900 | 46.9900 | 46.9900 | 46.9900 | 0.0357 |
| 80 | 17-Mar-2013 13:23:00 | 47.0600 | 47.0600 | 47.0600 | 47.0600 | 0.7507 |
| 81 | 17-Mar-2013 13:24:00 | 47.0600 | 47.0600 | 47.0600 | 47.0600 | 0.0001 |
| 82 | 17-Mar-2013 13:25:00 | 47.0700 | 47.0700 | 47.0700 | 47.0700 | 0.6963 |
| 83 | 17-Mar-2013 13:35:00 | 47.0700 | 47.0700 | 47.0700 | 47.0700 | 8.8693 |
| 84 | 17-Mar-2013 13:46:00 | 47.0900 | 47.0900 | 47.0900 | 47.0900 | 1.7059 |
| 85 | 17-Mar-2013 13:52:00 | 46.9900 | 46.9900 | 46.9600 | 46.9600 | 4.8200 |
| 86 | 17-Mar-2013 13:59:00 | 46.9600 | 46.9600 | 46.9600 | 46.9600 | 60 |
| 87 | 17-Mar-2013 14:10:00 | 46.9600 | 46.9600 | 46.9600 | 46.9600 | 30 |
| 88 | 17-Mar-2013 14:55:00 | 46.9800 | 46.9800 | 46.9800 | 46.9800 | 0.3754 |
| 89 | 17-Mar-2013 14:56:00 | 47 | 47 | 47 | 47 | 0.1877 |
| 90 | 17-Mar-2013 15:11:00 | 47.0800 | 47.0800 | 47.0800 | 47.0800 | 1.3291 |
| 91 | 17-Mar-2013 15:12:00 | 47 | 47 | 47 | 47 | 0.0961 |
| 92 | 17-Mar-2013 15:13:00 | 47 | 47 | 47 | 47 | 0.0004 |
| 93 | 17-Mar-2013 15:14:00 | 47 | 47 | 47 | 47 | 0.0001 |
| 94 | 17-Mar-2013 15:15:00 | 47 | 47 | 47 | 47 | 0.0001 |
| 95 | 17-Mar-2013 15:16:00 | 47 | 47 | 47 | 47 | 0.0001 |
| 96 | 17-Mar-2013 15:17:00 | 47 | 47 | 47 | 47 | 0.0001 |
| 97 | 17-Mar-2013 15:18:00 | 47 | 47 | 47 | 47 | 0.0001 |
| 98 | 17-Mar-2013 15:19:00 | 47 | 47 | 47 | 47 | 0.0001 |
| 99 | 17-Mar-2013 15:20:00 | 47 | 47 | 47 | 47 | 0.0001 |
| 100 | 17-Mar-2013 15:21:00 | 47 | 47 | 47 | 47 | 0.0001 |

⋮

```
%outliers = outlier(BitcoinData.Close)
```

## Split dataset into training and testing data

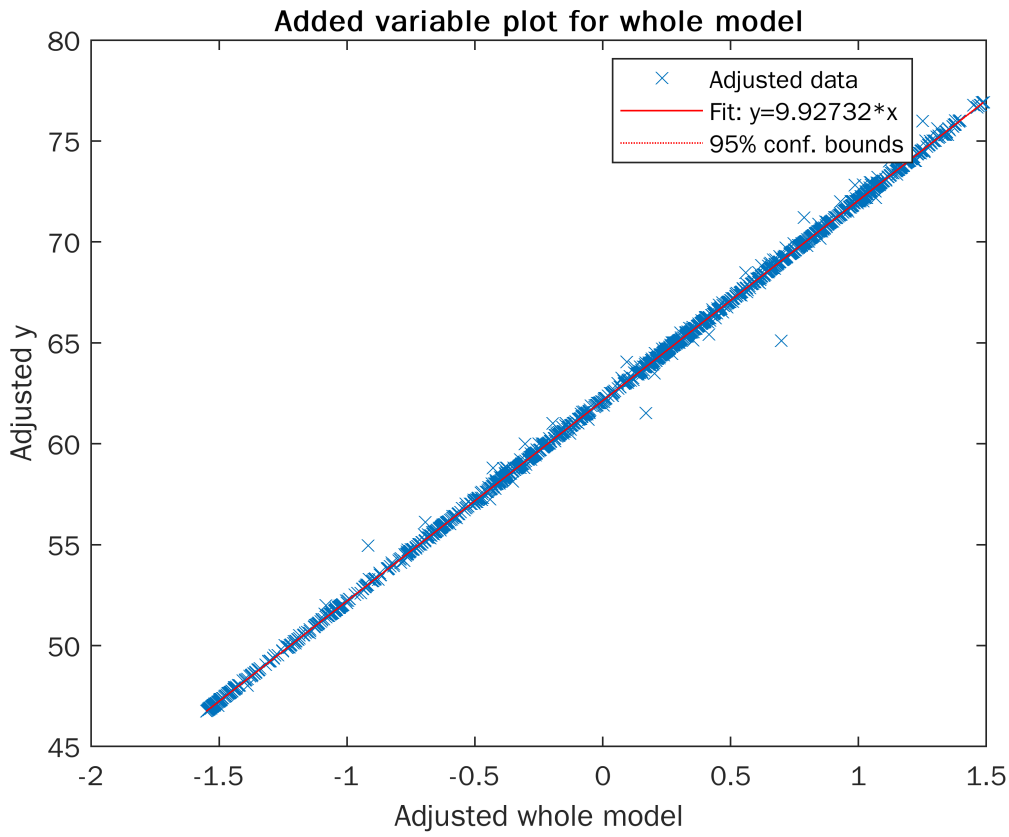
```
BitcoinData_new = [X, Y];

PD = 0.20;
cv = cvpartition(size(BitcoinData_new,1),'HoldOut',PD);
Xtrain = BitcoinData_new(cv.training,[1:end - 1]);
Ytrain = BitcoinData_new(cv.training,end);
Xtest = BitcoinData_new(cv.test, [1:end - 1]);
Ytest = BitcoinData_new(cv.test,end);
```

## Linear model with training-testing split

```
LRModel = fitlm(zscore(Xtrain),Ytrain)
```

```
LRModel = 
Linear regression model:
    y ~ 1 + x1 + x2 + x3

Estimated Coefficients:
                   Estimate       SE         tStat       pValue  
                   ________    _________    _______    ___________

    (Intercept)     62.134     0.0023032      26977              0
    x1             -4.1802       0.14196    -29.446    8.7225e-168
    x2              5.7225      0.084347     67.844              0
    x3               6.952       0.11435     60.797              0


Number of observations: 3028, Error degrees of freedom: 3024
Root Mean Squared Error: 0.127
R-squared: 1,  Adjusted R-Squared: 1
F-statistic vs. constant model: 4.53e+06, p-value = 0
```

```
plot(LRModel)
```




```
LRModel.RMSE
```

```
ans = 0.1267
```

## Predict

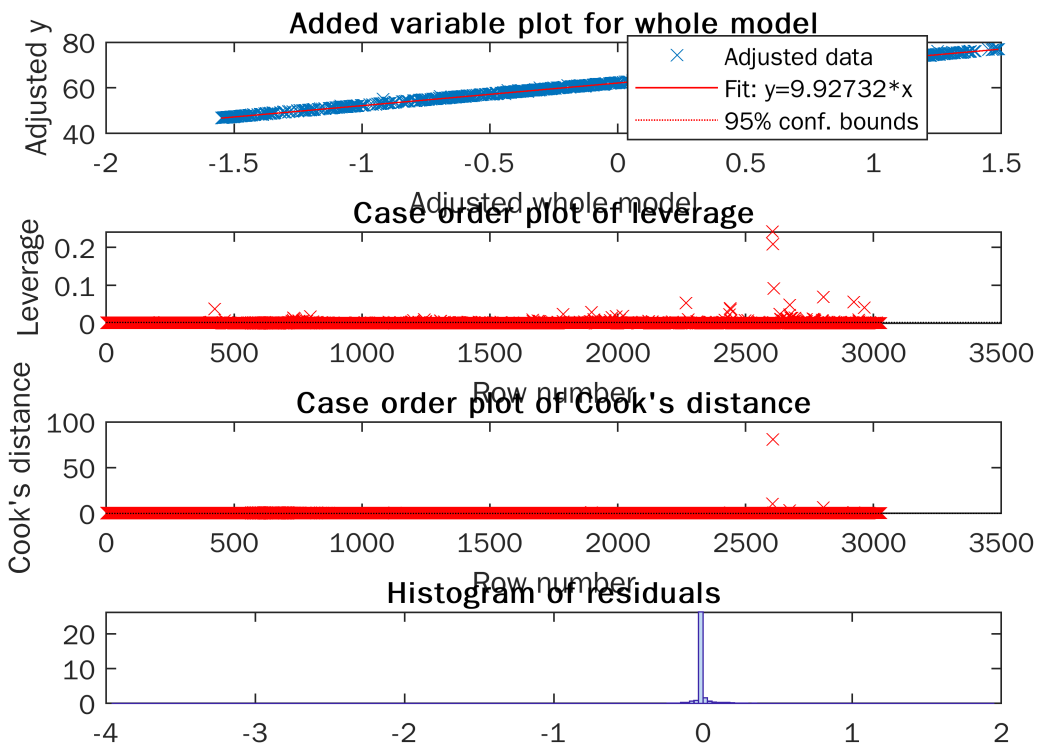
```
[YPred, Scores] = predict(LRModel,Xtest)
```

```
YPred = 756×1
  458.8167
  459.7511
  460.0059
  460.2608
  460.0909
  460.0909
  460.4306
  461.2801
  460.0059
  461.2801
      ⋮

Scores = 756×2
  458.6057  459.0278
  459.5396  459.9626
  459.7943  460.2176
  460.0490  460.4725
  459.8792  460.3026
  459.8792  460.3026
  460.2188  460.6425
  461.0678  461.4924
  459.7943  460.2176
```

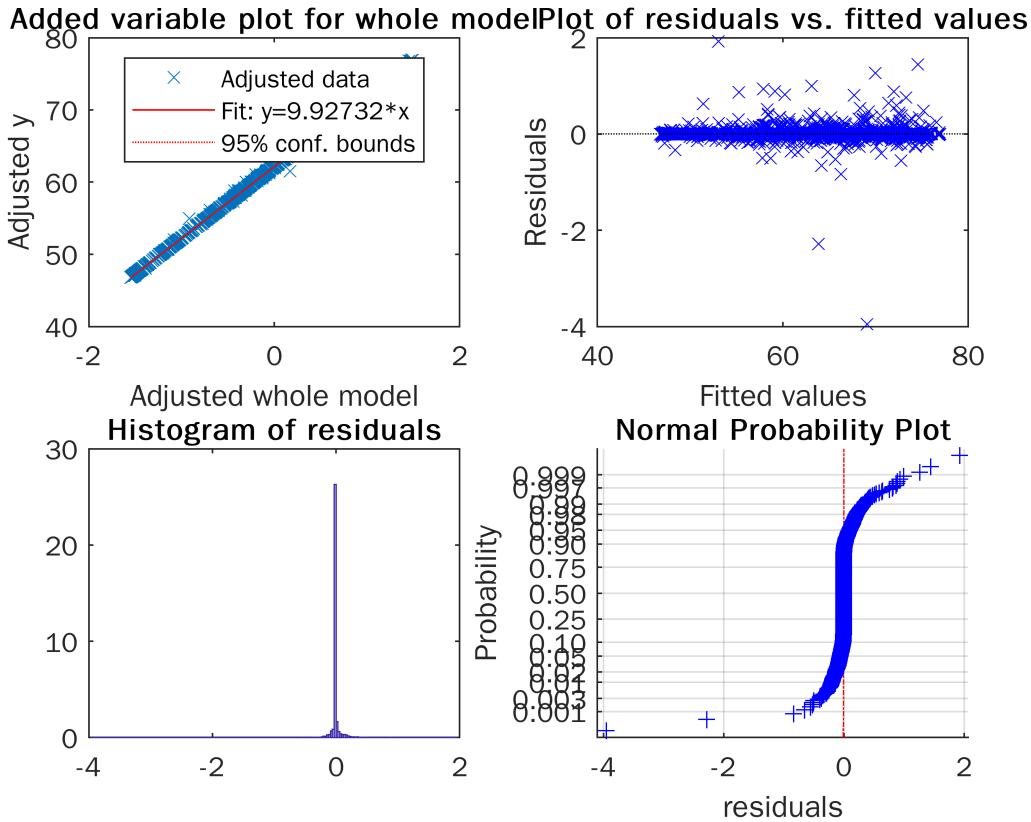
```
  461.0678  461.4924
      ⋮
```

## Plots

```
figure,
subplot(4, 1, 1), plot(LRModel)
subplot(4, 1, 2), plotDiagnostics(LRModel)
subplot(4, 1, 3), plotDiagnostics(LRModel, 'cookd')
subplot(4, 1, 4), plotResiduals(LRModel)
```




```
figure,
subplot(2, 2, 1), plot(LRModel)
subplot(2, 2, 2), plotResiduals(LRModel,'fitted')
subplot(2, 2, 3), plotResiduals(LRModel)
subplot(2, 2, 4), normplot(LRModel.Residuals.Raw)
xlabel('residuals')
```


Added variable plot for whole model
Adjusted data
Fit: y=9.92732*x
95% conf. bounds
Adjusted y
Adjusted whole model
Plot of residuals vs. fitted values
Residuals
Fitted values
Histogram of residuals
Normal Probability Plot
Probability
residuals

## Upload the big dataset (>250MB) to MATLAB Drive and read table

```
BitcoinData = readtable('bitcoin-dataset.csv');
```

```
Warning: Column headers from the file were modified to make them valid MATLAB identifiers
before creating variable names for the table. The original column headers are saved in the
VariableDescriptions property.
Set 'VariableNamingRule' to 'preserve' to use the original column headers as table variable names.
```

```
Tablesize = size(BitcoinData)
```

```
Tablesize = 1×2
     4857377           8
```

```
head(BitcoinData,1)
```

```
ans = 1×8 table
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                
...
```

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 1 | 1.3253e+09 | 4.3900 | 4.3900 | 4.3900 | 4.3900 | 0.4556 |

## Convert timestamp

```
datetest = BitcoinData(:,1);
datetest = table2array(datetest);
BitcoinData.Timestamp = datetime(datetest, 'ConvertFrom', 'posixtime');
```

## Remove NaNs

```
% how many NaNs in each column
NaN2 = sum(isnan(BitcoinData.Open))
```

```
NaN2 = 1243608
```

```
NaN3 = sum(isnan(BitcoinData.High))
```

```
NaN3 = 1243608
```

```
NaN4 = sum(isnan(BitcoinData.Low))
```

```
NaN4 = 1243608
```

```
NaN5 = sum(isnan(BitcoinData.Close))
```

```
NaN5 = 1243608
```

```
NaN6 = sum(isnan(BitcoinData.Volume__BTC_))
```

```
NaN6 = 1243608
```

```
NaN7 = sum(isnan(BitcoinData.Volume__Currency_))
```

```
NaN7 = 1243608
```

```
NaN8 = sum(isnan(BitcoinData.Weighted_Price))
```

```
NaN8 = 1243608
```

```
% remove NaNs
BitcoinData = BitcoinData(isnan(BitcoinData.High) == 0,:);
```

## Select data

```
BitcoinDataTimetable = table2timetable(BitcoinData);

% March 2013
% S = timerange('17-Mar-2013 00:00:00','18-Mar-2013 23:59:00'); %2days
% S = timerange('17-Mar-2013 00:00:00','23-Mar-2013 23:59:00'); %7days
 S = timerange('17-Mar-2013 00:00:00','30-Mar-2013 23:59:00'); %14days

% March 2016
% S = timerange('17-Mar-2016 00:00:00','18-Mar-2016 23:59:00'); %2days
% S = timerange('17-Mar-2016 00:00:00','23-Mar-2016 23:59:00'); %7days
% S = timerange('17-Mar-2016 00:00:00','30-Mar-2016 23:59:00'); %14days

% March 2019
% S = timerange('17-Mar-2019 00:00:00','18-Mar-2019 23:59:00'); %2days
% S = timerange('17-Mar-2019 00:00:00','23-Mar-2019 23:59:00'); %7days
% S = timerange('17-Mar-2019 00:00:00','30-Mar-2019 23:59:00'); %14days

% March 2021
% S = timerange('17-Mar-2021 00:00:00','18-Mar-2021 23:59:00'); %2days
% S = timerange('17-Mar-2021 00:00:00','23-Mar-2021 23:59:00'); %7days
% S = timerange('17-Mar-2021 00:00:00','30-Mar-2021 23:59:00'); %14days

BitcoinData = BitcoinDataTimetable(S,:);
Tablesize = size(BitcoinData)
```

```
Tablesize = 1×2
        7409           7
```

## Create model - preprocessing

```
% standardization, and Initial predictor set (matrix)

Y = BitcoinData{:,"Close"}
```

```
Y = 7409×1
   46.7000
   46.7400
   46.7400
   46.7400
   46.7800
   46.7800
   46.7800
   46.7800
   46.7800
   46.8100
      ⋮
```

```
X = BitcoinData{:,[1:3]}
```

```
X = 7409×3
   46.7000   46.7000   46.7000
   46.7400   46.7400   46.7400
   46.7400   46.7400   46.7400
   46.7400   46.7400   46.7400
   46.7800   46.7800   46.7800
   46.7800   46.7800   46.7800
```

```
   46.7800   46.7800   46.7800
   46.7800   46.7800   46.7800
   46.7800   46.7800   46.7800
   46.8100   46.8100   46.8100
      ⋮
```

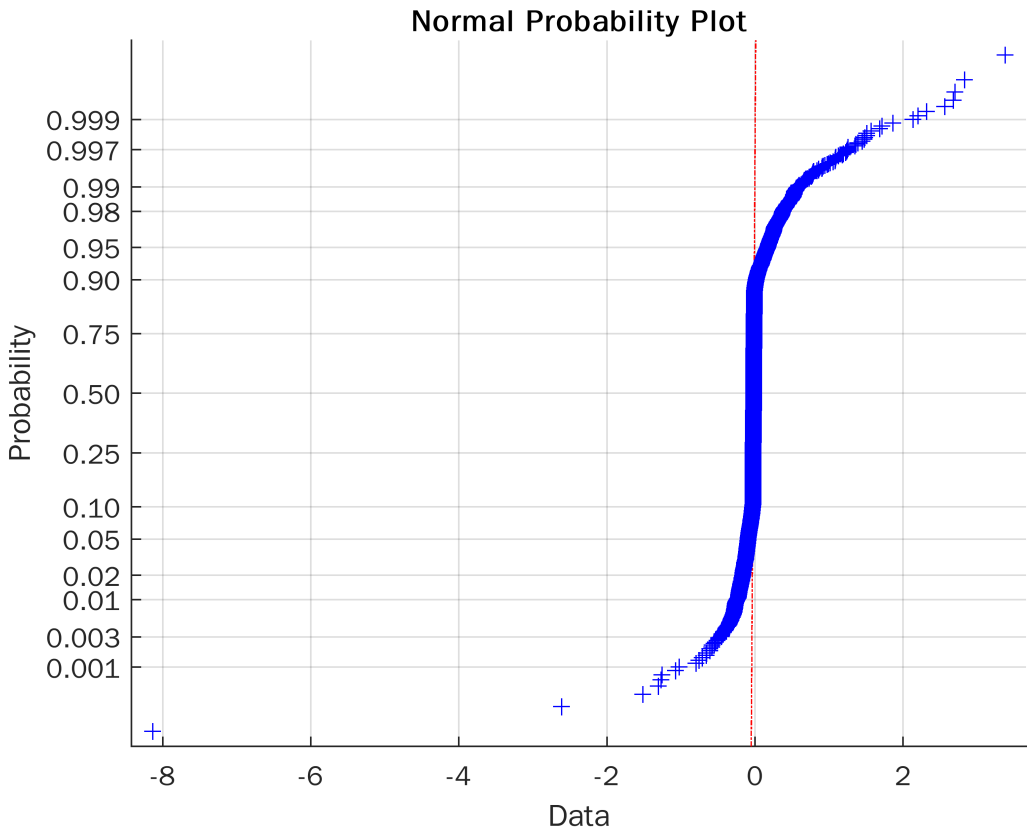
```
%Check model for outliers

LRPre = fitlm(zscore(X),Y)
```

```
LRPre =
Linear regression model:
    y ~ 1 + x1 + x2 + x3

Estimated Coefficients:
```

| | Estimate | SE | tStat | pValue |
|---|---|---|---|---|
| **(Intercept)** | 72.708 | 0.0021927 | 33160 | 0 |
| **x1** | -3.4003 | 0.16533 | -20.567 | 1.8707e-91 |
| **x2** | 6.1335 | 0.084466 | 72.615 | 0 |
| **x3** | 11.109 | 0.14164 | 78.427 | 0 |

```
Number of observations: 7409, Error degrees of freedom: 7405
Root Mean Squared Error: 0.189
R-squared: 1,  Adjusted R-Squared: 1
F-statistic vs. constant model: 1.33e+07, p-value = 0
```

```
normplot(LRPre.Residuals.Raw)
```




## Identify and Remove Outliers

```
idx = isoutlier(BitcoinData.Close)
```

```
idx = 7409×1 logical array
   0
   0
   0
   0
   0
   0
   0
   0
   0
   0
     ⋮
```

```
sum(idx)
```

```
ans = 0
```

```
BitcoinData(idx,:) = []
```

```
BitcoinData = 7409×7 timetable
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                
```
...
```

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 1 | 17-Mar-2013 00:06:00 | 46.7000 | 46.7000 | 46.7000 | 46.7000 | 1 |
```

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 2 | 17-Mar-2013 00:21:00 | 46.7400 | 46.7400 | 46.7400 | 46.7400 | 1.9399 |
| 3 | 17-Mar-2013 00:38:00 | 46.7400 | 46.7400 | 46.7400 | 46.7400 | 67.6000 |
| 4 | 17-Mar-2013 01:32:00 | 46.7400 | 46.7400 | 46.7400 | 46.7400 | 0.0018 |
| 5 | 17-Mar-2013 01:43:00 | 46.7800 | 46.7800 | 46.7800 | 46.7800 | 21.2770 |
| 6 | 17-Mar-2013 01:54:00 | 46.7800 | 46.7800 | 46.7800 | 46.7800 | 3 |
| 7 | 17-Mar-2013 01:56:00 | 46.7800 | 46.7800 | 46.7800 | 46.7800 | 4 |
| 8 | 17-Mar-2013 01:58:00 | 46.7800 | 46.7800 | 46.7800 | 46.7800 | 0.9000 |
| 9 | 17-Mar-2013 02:10:00 | 46.7800 | 46.7800 | 46.7800 | 46.7800 | 0.0130 |
| 10 | 17-Mar-2013 02:21:00 | 46.8100 | 46.8100 | 46.8100 | 46.8100 | 0.9446 |
| 11 | 17-Mar-2013 02:28:00 | 46.8100 | 46.8100 | 46.8100 | 46.8100 | 1.8400 |
| 12 | 17-Mar-2013 02:32:00 | 46.8400 | 46.8400 | 46.8400 | 46.8400 | 0.0587 |
| 13 | 17-Mar-2013 03:01:00 | 46.8500 | 46.8500 | 46.8500 | 46.8500 | 0.9153 |
| 14 | 17-Mar-2013 03:12:00 | 46.8700 | 46.8700 | 46.8700 | 46.8700 | 0.9153 |
| 15 | 17-Mar-2013 03:20:00 | 47 | 47 | 47 | 47 | 1.3472 |
| 16 | 17-Mar-2013 03:22:00 | 47 | 47 | 47 | 47 | 0.2919 |
| 17 | 17-Mar-2013 03:30:00 | 46.8500 | 46.8500 | 46.8500 | 46.8500 | 0.4894 |
| 18 | 17-Mar-2013 03:45:00 | 46.8500 | 46.8500 | 46.8500 | 46.8500 | 0.5000 |
| 19 | 17-Mar-2013 04:10:00 | 46.8500 | 46.8500 | 46.8500 | 46.8500 | 0.0106 |
| 20 | 17-Mar-2013 04:29:00 | 46.8500 | 46.8500 | 46.8300 | 46.8300 | 1.8758 |
| 21 | 17-Mar-2013 04:45:00 | 46.8900 | 46.8900 | 46.8900 | 46.8900 | 1.4587 |
| 22 | 17-Mar-2013 04:48:00 | 47 | 47 | 47 | 47 | 0.0411 |
| 23 | 17-Mar-2013 04:50:00 | 47 | 47 | 47 | 47 | 0.0394 |
| 24 | 17-Mar-2013 04:56:00 | 47 | 47 | 47 | 47 | 2.2030 |
| 25 | 17-Mar-2013 05:19:00 | 47 | 47 | 47 | 47 | 1.9385 |
| 26 | 17-Mar-2013 05:47:00 | 46.8900 | 46.8900 | 46.8900 | 46.8900 | 2 |
| 27 | 17-Mar-2013 05:53:00 | 47 | 47 | 47 | 47 | 10.0828 |
| 28 | 17-Mar-2013 06:51:00 | 47 | 47 | 47 | 47 | 3.6594 |
| 29 | 17-Mar-2013 08:13:00 | 46.9300 | 46.9300 | 46.9300 | 46.9300 | 1 |
| 30 | 17-Mar-2013 08:21:00 | 46.9900 | 46.9900 | 46.9900 | 46.9900 | 2.4499 |
| 31 | 17-Mar-2013 08:34:00 | 46.9300 | 46.9300 | 46.9300 | 46.9300 | 1.0214 |
| 32 | 17-Mar-2013 08:35:00 | 46.9300 | 46.9300 | 46.9300 | 46.9300 | 0.5304 |
| 33 | 17-Mar-2013 08:45:00 | 46.9000 | 46.9000 | 46.9000 | 46.9000 | 0.4459 |
| 34 | 17-Mar-2013 08:46:00 | 46.8900 | 46.8900 | 46.8900 | 46.8900 | 0.2219 |

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 35 | 17-Mar-2013 08:47:00 | 46.8700 | 46.8700 | 46.8700 | 46.8700 | 0.1105 |
| 36 | 17-Mar-2013 08:48:00 | 46.8600 | 46.8600 | 46.8600 | 46.8600 | 0.6743 |
| 37 | 17-Mar-2013 08:49:00 | 46.8400 | 46.8400 | 46.8400 | 46.8400 | 0.0823 |
| 38 | 17-Mar-2013 08:50:00 | 46.8300 | 46.8300 | 46.8300 | 46.8300 | 0.4320 |
| 39 | 17-Mar-2013 08:51:00 | 46.8100 | 46.8100 | 46.8100 | 46.8100 | 4.2072 |
| 40 | 17-Mar-2013 08:52:00 | 46.7500 | 46.7500 | 46.7500 | 46.7500 | 0.0883 |
| 41 | 17-Mar-2013 09:13:00 | 46.9400 | 46.9400 | 46.9400 | 46.9400 | 1.3892 |
| 42 | 17-Mar-2013 09:19:00 | 46.9900 | 46.9900 | 46.9900 | 46.9900 | 15.5041 |
| 43 | 17-Mar-2013 09:24:00 | 47 | 47 | 47 | 47 | 2.0455 |
| 44 | 17-Mar-2013 09:27:00 | 47 | 47 | 47 | 47 | 0.8623 |
| 45 | 17-Mar-2013 09:32:00 | 47 | 47 | 47 | 47 | 5.5077 |
| 46 | 17-Mar-2013 09:48:00 | 47 | 47 | 47 | 47 | 79.5934 |
| 47 | 17-Mar-2013 10:09:00 | 46.9900 | 46.9900 | 46.9900 | 46.9900 | 4.7000 |
| 48 | 17-Mar-2013 10:18:00 | 47 | 47 | 47 | 47 | 4.7890 |
| 49 | 17-Mar-2013 10:19:00 | 47 | 47 | 47 | 47 | 2.0774 |
| 50 | 17-Mar-2013 10:21:00 | 47 | 47 | 47 | 47 | 9.5221 |
| 51 | 17-Mar-2013 10:23:00 | 47 | 47 | 47 | 47 | 0.5270 |
| 52 | 17-Mar-2013 10:24:00 | 47 | 47 | 47 | 47 | 3.4269 |
| 53 | 17-Mar-2013 10:25:00 | 46.9000 | 46.9000 | 46.9000 | 46.9000 | 6.6952 |
| 54 | 17-Mar-2013 10:26:00 | 46.9000 | 46.9000 | 46.9000 | 46.9000 | 2.8357 |
| 55 | 17-Mar-2013 10:31:00 | 46.9000 | 46.9000 | 46.9000 | 46.9000 | 20.4691 |
| 56 | 17-Mar-2013 10:36:00 | 46.8500 | 46.8500 | 46.8500 | 46.8500 | 15 |
| 57 | 17-Mar-2013 10:37:00 | 47 | 47 | 47 | 47 | 54.9791 |
| 58 | 17-Mar-2013 10:38:00 | 47 | 47 | 47 | 47 | 9.2845 |
| 59 | 17-Mar-2013 11:16:00 | 46.8600 | 46.8600 | 46.8500 | 46.8500 | 6.7900 |
| 60 | 17-Mar-2013 11:19:00 | 46.9000 | 46.9000 | 46.9000 | 46.9000 | 0.3511 |
| 61 | 17-Mar-2013 11:30:00 | 46.8500 | 46.8500 | 46.8500 | 46.8500 | 0.6489 |
| 62 | 17-Mar-2013 11:40:00 | 46.9800 | 46.9900 | 46.9800 | 46.9900 | 6.0302 |
| 63 | 17-Mar-2013 11:50:00 | 47 | 47 | 47 | 47 | 0.0213 |
| 64 | 17-Mar-2013 11:55:00 | 47 | 47 | 47 | 47 | 2.4419 |
| 65 | 17-Mar-2013 11:58:00 | 46.8500 | 46.8500 | 46.8500 | 46.8500 | 6.3800 |
| 66 | 17-Mar-2013 12:03:00 | 47 | 47 | 47 | 47 | 4.1873 |
| 67 | 17-Mar-2013 12:15:00 | 46.8400 | 46.8400 | 46.8400 | 46.8400 | 0.4114 |

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 68 | 17-Mar-2013 12:16:00 | 47 | 47 | 47 | 47 | 4.2383 |
| 69 | 17-Mar-2013 12:17:00 | 47 | 47 | 47 | 47 | 2.1300 |
| 70 | 17-Mar-2013 12:29:00 | 47 | 47.0700 | 47 | 47.0700 | 94.9699 |
| 71 | 17-Mar-2013 12:30:00 | 47.0700 | 47.0700 | 46.8800 | 46.8800 | 1.2102 |
| 72 | 17-Mar-2013 12:31:00 | 46.8800 | 46.8800 | 46.8800 | 46.8800 | 2.7150 |
| 73 | 17-Mar-2013 12:33:00 | 47 | 47 | 47 | 47 | 0.8098 |
| 74 | 17-Mar-2013 12:34:00 | 47 | 47 | 47 | 47 | 0.6296 |
| 75 | 17-Mar-2013 12:35:00 | 47.0600 | 47.0700 | 47.0600 | 47.0700 | 15.1967 |
| 76 | 17-Mar-2013 12:36:00 | 47.0700 | 47.0700 | 47.0700 | 47.0700 | 0.6286 |
| 77 | 17-Mar-2013 12:39:00 | 46.9500 | 46.9500 | 46.9500 | 46.9500 | 0.6700 |
| 78 | 17-Mar-2013 12:45:00 | 46.8900 | 46.8900 | 46.8900 | 46.8900 | 0.5167 |
| 79 | 17-Mar-2013 13:04:00 | 46.9900 | 46.9900 | 46.9900 | 46.9900 | 0.0357 |
| 80 | 17-Mar-2013 13:23:00 | 47.0600 | 47.0600 | 47.0600 | 47.0600 | 0.7507 |
| 81 | 17-Mar-2013 13:24:00 | 47.0600 | 47.0600 | 47.0600 | 47.0600 | 0.0001 |
| 82 | 17-Mar-2013 13:25:00 | 47.0700 | 47.0700 | 47.0700 | 47.0700 | 0.6963 |
| 83 | 17-Mar-2013 13:35:00 | 47.0700 | 47.0700 | 47.0700 | 47.0700 | 8.8693 |
| 84 | 17-Mar-2013 13:46:00 | 47.0900 | 47.0900 | 47.0900 | 47.0900 | 1.7059 |
| 85 | 17-Mar-2013 13:52:00 | 46.9900 | 46.9900 | 46.9600 | 46.9600 | 4.8200 |
| 86 | 17-Mar-2013 13:59:00 | 46.9600 | 46.9600 | 46.9600 | 46.9600 | 60 |
| 87 | 17-Mar-2013 14:10:00 | 46.9600 | 46.9600 | 46.9600 | 46.9600 | 30 |
| 88 | 17-Mar-2013 14:55:00 | 46.9800 | 46.9800 | 46.9800 | 46.9800 | 0.3754 |
| 89 | 17-Mar-2013 14:56:00 | 47 | 47 | 47 | 47 | 0.1877 |
| 90 | 17-Mar-2013 15:11:00 | 47.0800 | 47.0800 | 47.0800 | 47.0800 | 1.3291 |
| 91 | 17-Mar-2013 15:12:00 | 47 | 47 | 47 | 47 | 0.0961 |
| 92 | 17-Mar-2013 15:13:00 | 47 | 47 | 47 | 47 | 0.0004 |
| 93 | 17-Mar-2013 15:14:00 | 47 | 47 | 47 | 47 | 0.0001 |
| 94 | 17-Mar-2013 15:15:00 | 47 | 47 | 47 | 47 | 0.0001 |
| 95 | 17-Mar-2013 15:16:00 | 47 | 47 | 47 | 47 | 0.0001 |
| 96 | 17-Mar-2013 15:17:00 | 47 | 47 | 47 | 47 | 0.0001 |
| 97 | 17-Mar-2013 15:18:00 | 47 | 47 | 47 | 47 | 0.0001 |
| 98 | 17-Mar-2013 15:19:00 | 47 | 47 | 47 | 47 | 0.0001 |
| 99 | 17-Mar-2013 15:20:00 | 47 | 47 | 47 | 47 | 0.0001 |
| 100 | 17-Mar-2013 15:21:00 | 47 | 47 | 47 | 47 | 0.0001 |

```
    ⋮
```

```
%outliers = outlier(BitcoinData.Close)

%Rerun model to check for more outliers
Y = BitcoinData{:,"Close"}
```

```
Y = 7409×1
   46.7000
   46.7400
   46.7400
   46.7400
   46.7800
   46.7800
   46.7800
   46.7800
   46.7800
   46.8100
     ⋮
```

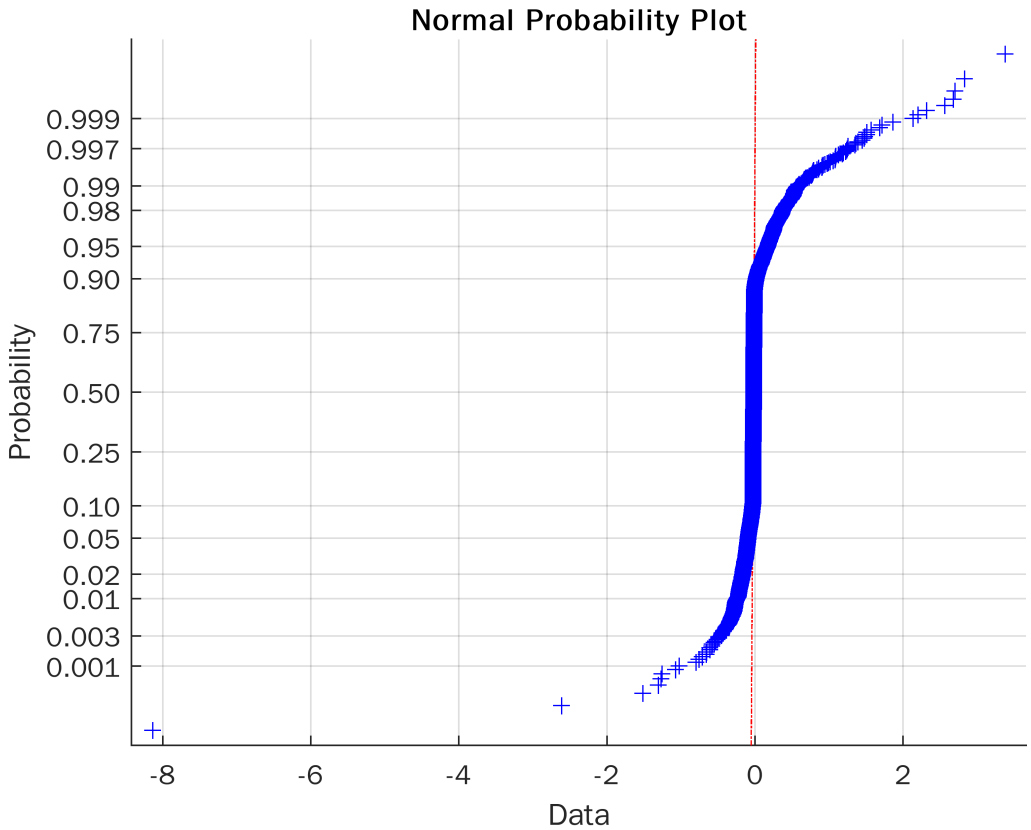
```
X = BitcoinData{:,[1:3]}
```

```
X = 7409×3
   46.7000   46.7000   46.7000
   46.7400   46.7400   46.7400
   46.7400   46.7400   46.7400
   46.7400   46.7400   46.7400
   46.7800   46.7800   46.7800
   46.7800   46.7800   46.7800
   46.7800   46.7800   46.7800
   46.7800   46.7800   46.7800
   46.7800   46.7800   46.7800
   46.8100   46.8100   46.8100
     ⋮
```

```
LRPre = fitlm(zscore(X),Y)
```

```
LRPre = 
Linear regression model:
    y ~ 1 + x1 + x2 + x3

Estimated Coefficients:
                   Estimate       SE         tStat       pValue  
                   ________    _________    _______    __________

    (Intercept)     72.708     0.0021927      33160             0
    x1             -3.4003       0.16533    -20.567    1.8707e-91
    x2              6.1335      0.084466     72.615             0
    x3              11.109       0.14164     78.427             0


Number of observations: 7409, Error degrees of freedom: 7405
Root Mean Squared Error: 0.189
R-squared: 1,  Adjusted R-Squared: 1
F-statistic vs. constant model: 1.33e+07, p-value = 0
```

```
normplot(LRPre.Residuals.Raw)
```




```
idx = isoutlier(BitcoinData.Close)
```

```
idx = 7409×1 logical array
   0
   0
   0
   0
   0
   0
   0
   0
   0
   0
   0
   ⋮
```

```
sum(idx)
```

```
ans = 0
```

```
BitcoinData(idx,:) = []
```

```
BitcoinData = 7409×7 timetable
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                
```
...
```

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 1 | 17-Mar-2013 00:06:00 | 46.7000 | 46.7000 | 46.7000 | 46.7000 | 1 |
| 2 | 17-Mar-2013 00:21:00 | 46.7400 | 46.7400 | 46.7400 | 46.7400 | 1.9399 |
```

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 3 | 17-Mar-2013 00:38:00 | 46.7400 | 46.7400 | 46.7400 | 46.7400 | 67.6000 |
| 4 | 17-Mar-2013 01:32:00 | 46.7400 | 46.7400 | 46.7400 | 46.7400 | 0.0018 |
| 5 | 17-Mar-2013 01:43:00 | 46.7800 | 46.7800 | 46.7800 | 46.7800 | 21.2770 |
| 6 | 17-Mar-2013 01:54:00 | 46.7800 | 46.7800 | 46.7800 | 46.7800 | 3 |
| 7 | 17-Mar-2013 01:56:00 | 46.7800 | 46.7800 | 46.7800 | 46.7800 | 4 |
| 8 | 17-Mar-2013 01:58:00 | 46.7800 | 46.7800 | 46.7800 | 46.7800 | 0.9000 |
| 9 | 17-Mar-2013 02:10:00 | 46.7800 | 46.7800 | 46.7800 | 46.7800 | 0.0130 |
| 10 | 17-Mar-2013 02:21:00 | 46.8100 | 46.8100 | 46.8100 | 46.8100 | 0.9446 |
| 11 | 17-Mar-2013 02:28:00 | 46.8100 | 46.8100 | 46.8100 | 46.8100 | 1.8400 |
| 12 | 17-Mar-2013 02:32:00 | 46.8400 | 46.8400 | 46.8400 | 46.8400 | 0.0587 |
| 13 | 17-Mar-2013 03:01:00 | 46.8500 | 46.8500 | 46.8500 | 46.8500 | 0.9153 |
| 14 | 17-Mar-2013 03:12:00 | 46.8700 | 46.8700 | 46.8700 | 46.8700 | 0.9153 |
| 15 | 17-Mar-2013 03:20:00 | 47 | 47 | 47 | 47 | 1.3472 |
| 16 | 17-Mar-2013 03:22:00 | 47 | 47 | 47 | 47 | 0.2919 |
| 17 | 17-Mar-2013 03:30:00 | 46.8500 | 46.8500 | 46.8500 | 46.8500 | 0.4894 |
| 18 | 17-Mar-2013 03:45:00 | 46.8500 | 46.8500 | 46.8500 | 46.8500 | 0.5000 |
| 19 | 17-Mar-2013 04:10:00 | 46.8500 | 46.8500 | 46.8500 | 46.8500 | 0.0106 |
| 20 | 17-Mar-2013 04:29:00 | 46.8500 | 46.8500 | 46.8300 | 46.8300 | 1.8758 |
| 21 | 17-Mar-2013 04:45:00 | 46.8900 | 46.8900 | 46.8900 | 46.8900 | 1.4587 |
| 22 | 17-Mar-2013 04:48:00 | 47 | 47 | 47 | 47 | 0.0411 |
| 23 | 17-Mar-2013 04:50:00 | 47 | 47 | 47 | 47 | 0.0394 |
| 24 | 17-Mar-2013 04:56:00 | 47 | 47 | 47 | 47 | 2.2030 |
| 25 | 17-Mar-2013 05:19:00 | 47 | 47 | 47 | 47 | 1.9385 |
| 26 | 17-Mar-2013 05:47:00 | 46.8900 | 46.8900 | 46.8900 | 46.8900 | 2 |
| 27 | 17-Mar-2013 05:53:00 | 47 | 47 | 47 | 47 | 10.0828 |
| 28 | 17-Mar-2013 06:51:00 | 47 | 47 | 47 | 47 | 3.6594 |
| 29 | 17-Mar-2013 08:13:00 | 46.9300 | 46.9300 | 46.9300 | 46.9300 | 1 |
| 30 | 17-Mar-2013 08:21:00 | 46.9900 | 46.9900 | 46.9900 | 46.9900 | 2.4499 |
| 31 | 17-Mar-2013 08:34:00 | 46.9300 | 46.9300 | 46.9300 | 46.9300 | 1.0214 |
| 32 | 17-Mar-2013 08:35:00 | 46.9300 | 46.9300 | 46.9300 | 46.9300 | 0.5304 |
| 33 | 17-Mar-2013 08:45:00 | 46.9000 | 46.9000 | 46.9000 | 46.9000 | 0.4459 |
| 34 | 17-Mar-2013 08:46:00 | 46.8900 | 46.8900 | 46.8900 | 46.8900 | 0.2219 |
| 35 | 17-Mar-2013 08:47:00 | 46.8700 | 46.8700 | 46.8700 | 46.8700 | 0.1105 |

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 36 | 17-Mar-2013 08:48:00 | 46.8600 | 46.8600 | 46.8600 | 46.8600 | 0.6743 |
| 37 | 17-Mar-2013 08:49:00 | 46.8400 | 46.8400 | 46.8400 | 46.8400 | 0.0823 |
| 38 | 17-Mar-2013 08:50:00 | 46.8300 | 46.8300 | 46.8300 | 46.8300 | 0.4320 |
| 39 | 17-Mar-2013 08:51:00 | 46.8100 | 46.8100 | 46.8100 | 46.8100 | 4.2072 |
| 40 | 17-Mar-2013 08:52:00 | 46.7500 | 46.7500 | 46.7500 | 46.7500 | 0.0883 |
| 41 | 17-Mar-2013 09:13:00 | 46.9400 | 46.9400 | 46.9400 | 46.9400 | 1.3892 |
| 42 | 17-Mar-2013 09:19:00 | 46.9900 | 46.9900 | 46.9900 | 46.9900 | 15.5041 |
| 43 | 17-Mar-2013 09:24:00 | 47 | 47 | 47 | 47 | 2.0455 |
| 44 | 17-Mar-2013 09:27:00 | 47 | 47 | 47 | 47 | 0.8623 |
| 45 | 17-Mar-2013 09:32:00 | 47 | 47 | 47 | 47 | 5.5077 |
| 46 | 17-Mar-2013 09:48:00 | 47 | 47 | 47 | 47 | 79.5934 |
| 47 | 17-Mar-2013 10:09:00 | 46.9900 | 46.9900 | 46.9900 | 46.9900 | 4.7000 |
| 48 | 17-Mar-2013 10:18:00 | 47 | 47 | 47 | 47 | 4.7890 |
| 49 | 17-Mar-2013 10:19:00 | 47 | 47 | 47 | 47 | 2.0774 |
| 50 | 17-Mar-2013 10:21:00 | 47 | 47 | 47 | 47 | 9.5221 |
| 51 | 17-Mar-2013 10:23:00 | 47 | 47 | 47 | 47 | 0.5270 |
| 52 | 17-Mar-2013 10:24:00 | 47 | 47 | 47 | 47 | 3.4269 |
| 53 | 17-Mar-2013 10:25:00 | 46.9000 | 46.9000 | 46.9000 | 46.9000 | 6.6952 |
| 54 | 17-Mar-2013 10:26:00 | 46.9000 | 46.9000 | 46.9000 | 46.9000 | 2.8357 |
| 55 | 17-Mar-2013 10:31:00 | 46.9000 | 46.9000 | 46.9000 | 46.9000 | 20.4691 |
| 56 | 17-Mar-2013 10:36:00 | 46.8500 | 46.8500 | 46.8500 | 46.8500 | 15 |
| 57 | 17-Mar-2013 10:37:00 | 47 | 47 | 47 | 47 | 54.9791 |
| 58 | 17-Mar-2013 10:38:00 | 47 | 47 | 47 | 47 | 9.2845 |
| 59 | 17-Mar-2013 11:16:00 | 46.8600 | 46.8600 | 46.8500 | 46.8500 | 6.7900 |
| 60 | 17-Mar-2013 11:19:00 | 46.9000 | 46.9000 | 46.9000 | 46.9000 | 0.3511 |
| 61 | 17-Mar-2013 11:30:00 | 46.8500 | 46.8500 | 46.8500 | 46.8500 | 0.6489 |
| 62 | 17-Mar-2013 11:40:00 | 46.9800 | 46.9900 | 46.9800 | 46.9900 | 6.0302 |
| 63 | 17-Mar-2013 11:50:00 | 47 | 47 | 47 | 47 | 0.0213 |
| 64 | 17-Mar-2013 11:55:00 | 47 | 47 | 47 | 47 | 2.4419 |
| 65 | 17-Mar-2013 11:58:00 | 46.8500 | 46.8500 | 46.8500 | 46.8500 | 6.3800 |
| 66 | 17-Mar-2013 12:03:00 | 47 | 47 | 47 | 47 | 4.1873 |
| 67 | 17-Mar-2013 12:15:00 | 46.8400 | 46.8400 | 46.8400 | 46.8400 | 0.4114 |
| 68 | 17-Mar-2013 12:16:00 | 47 | 47 | 47 | 47 | 4.2383 |

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 69 | 17-Mar-2013 12:17:00 | 47 | 47 | 47 | 47 | 2.1300 |
| 70 | 17-Mar-2013 12:29:00 | 47 | 47.0700 | 47 | 47.0700 | 94.9699 |
| 71 | 17-Mar-2013 12:30:00 | 47.0700 | 47.0700 | 46.8800 | 46.8800 | 1.2102 |
| 72 | 17-Mar-2013 12:31:00 | 46.8800 | 46.8800 | 46.8800 | 46.8800 | 2.7150 |
| 73 | 17-Mar-2013 12:33:00 | 47 | 47 | 47 | 47 | 0.8098 |
| 74 | 17-Mar-2013 12:34:00 | 47 | 47 | 47 | 47 | 0.6296 |
| 75 | 17-Mar-2013 12:35:00 | 47.0600 | 47.0700 | 47.0600 | 47.0700 | 15.1967 |
| 76 | 17-Mar-2013 12:36:00 | 47.0700 | 47.0700 | 47.0700 | 47.0700 | 0.6286 |
| 77 | 17-Mar-2013 12:39:00 | 46.9500 | 46.9500 | 46.9500 | 46.9500 | 0.6700 |
| 78 | 17-Mar-2013 12:45:00 | 46.8900 | 46.8900 | 46.8900 | 46.8900 | 0.5167 |
| 79 | 17-Mar-2013 13:04:00 | 46.9900 | 46.9900 | 46.9900 | 46.9900 | 0.0357 |
| 80 | 17-Mar-2013 13:23:00 | 47.0600 | 47.0600 | 47.0600 | 47.0600 | 0.7507 |
| 81 | 17-Mar-2013 13:24:00 | 47.0600 | 47.0600 | 47.0600 | 47.0600 | 0.0001 |
| 82 | 17-Mar-2013 13:25:00 | 47.0700 | 47.0700 | 47.0700 | 47.0700 | 0.6963 |
| 83 | 17-Mar-2013 13:35:00 | 47.0700 | 47.0700 | 47.0700 | 47.0700 | 8.8693 |
| 84 | 17-Mar-2013 13:46:00 | 47.0900 | 47.0900 | 47.0900 | 47.0900 | 1.7059 |
| 85 | 17-Mar-2013 13:52:00 | 46.9900 | 46.9900 | 46.9600 | 46.9600 | 4.8200 |
| 86 | 17-Mar-2013 13:59:00 | 46.9600 | 46.9600 | 46.9600 | 46.9600 | 60 |
| 87 | 17-Mar-2013 14:10:00 | 46.9600 | 46.9600 | 46.9600 | 46.9600 | 30 |
| 88 | 17-Mar-2013 14:55:00 | 46.9800 | 46.9800 | 46.9800 | 46.9800 | 0.3754 |
| 89 | 17-Mar-2013 14:56:00 | 47 | 47 | 47 | 47 | 0.1877 |
| 90 | 17-Mar-2013 15:11:00 | 47.0800 | 47.0800 | 47.0800 | 47.0800 | 1.3291 |
| 91 | 17-Mar-2013 15:12:00 | 47 | 47 | 47 | 47 | 0.0961 |
| 92 | 17-Mar-2013 15:13:00 | 47 | 47 | 47 | 47 | 0.0004 |
| 93 | 17-Mar-2013 15:14:00 | 47 | 47 | 47 | 47 | 0.0001 |
| 94 | 17-Mar-2013 15:15:00 | 47 | 47 | 47 | 47 | 0.0001 |
| 95 | 17-Mar-2013 15:16:00 | 47 | 47 | 47 | 47 | 0.0001 |
| 96 | 17-Mar-2013 15:17:00 | 47 | 47 | 47 | 47 | 0.0001 |
| 97 | 17-Mar-2013 15:18:00 | 47 | 47 | 47 | 47 | 0.0001 |
| 98 | 17-Mar-2013 15:19:00 | 47 | 47 | 47 | 47 | 0.0001 |
| 99 | 17-Mar-2013 15:20:00 | 47 | 47 | 47 | 47 | 0.0001 |
| 100 | 17-Mar-2013 15:21:00 | 47 | 47 | 47 | 47 | 0.0001 |

⋮

```
%outliers = outlier(BitcoinData.Close)
```

## Split dataset into training and testing data

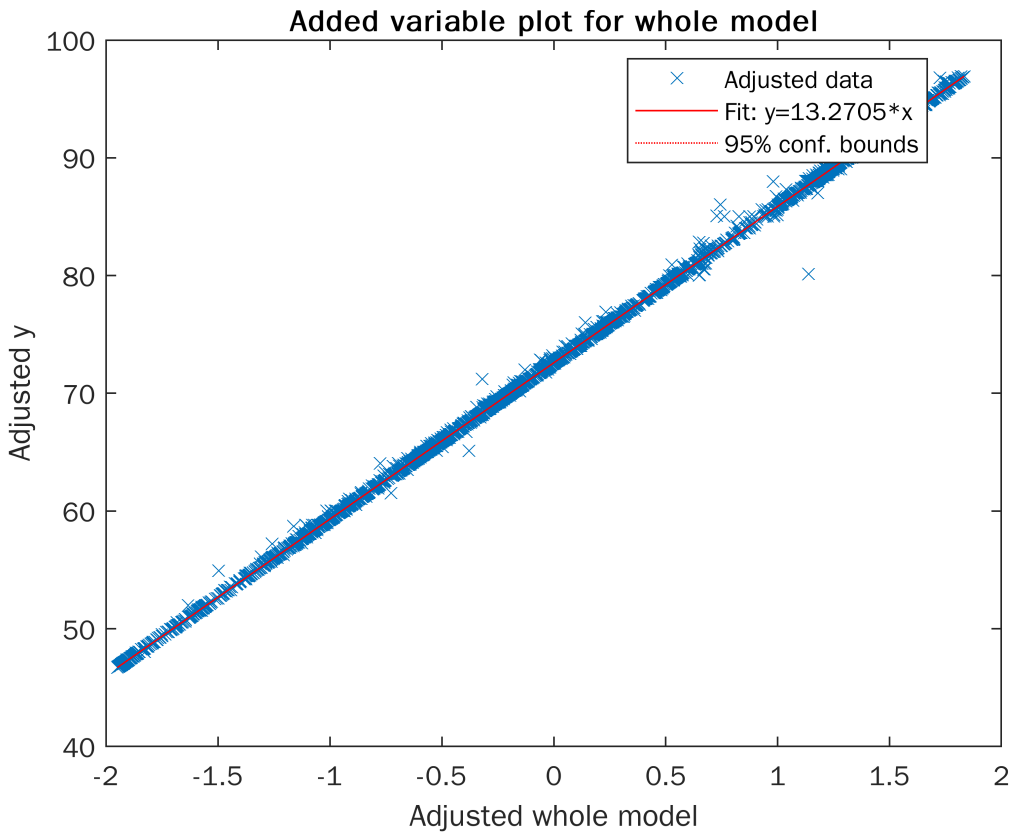
```
BitcoinData_new = [X, Y];

PD = 0.20;
cv = cvpartition(size(BitcoinData_new,1),'HoldOut',PD);
Xtrain = BitcoinData_new(cv.training,[1:end - 1]);
Ytrain = BitcoinData_new(cv.training,end);
Xtest = BitcoinData_new(cv.test, [1:end - 1]);
Ytest = BitcoinData_new(cv.test,end);
```

## Linear model with training-testing split

```
LRModel = fitlm(zscore(Xtrain),Ytrain)
```

```
LRModel = 
Linear regression model:
    y ~ 1 + x1 + x2 + x3

Estimated Coefficients:
                   Estimate       SE         tStat       pValue  
                   ________    _________    _______    __________

    (Intercept)     72.594     0.0025882      28048             0
    x1             -3.3642       0.19095    -17.618    9.3749e-68
    x2              5.7727      0.091689      62.96             0
    x3              11.466       0.16669     68.787             0


Number of observations: 5928, Error degrees of freedom: 5924
Root Mean Squared Error: 0.199
R-squared: 1,  Adjusted R-Squared: 1
F-statistic vs. constant model: 9.58e+06, p-value = 0
```

```
plot(LRModel)
```




```
LRModel.RMSE
```

```
ans = 0.1993
```

## Predict

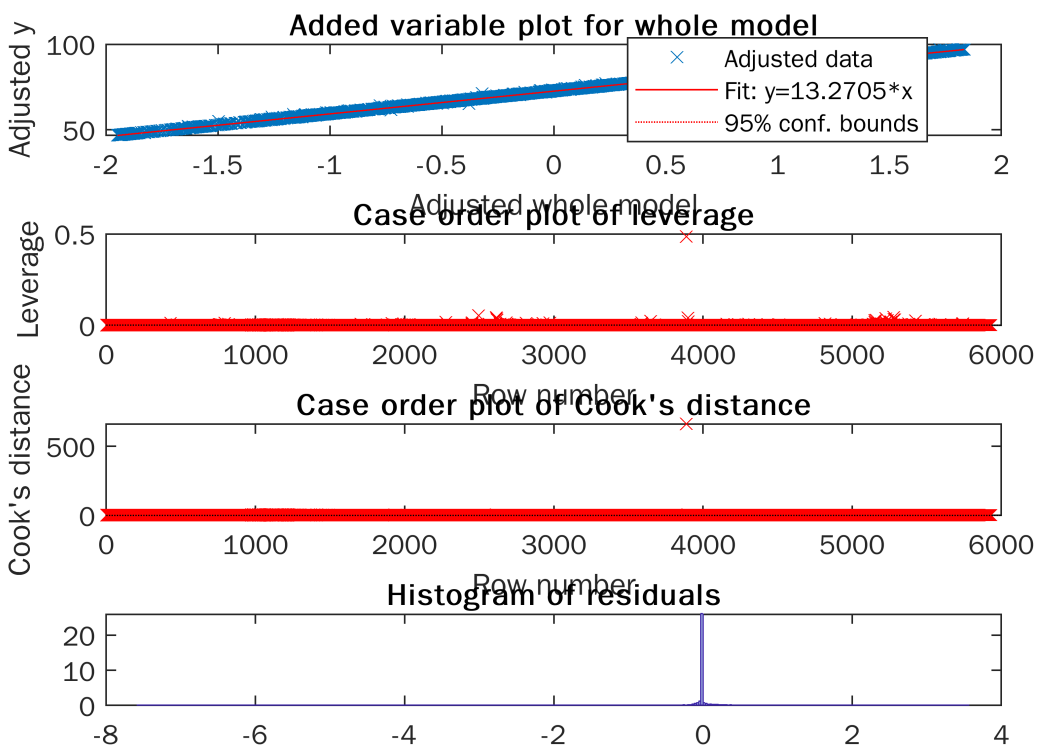
```
[YPred, Scores] = predict(LRModel,Xtest)
```

```
YPred = 1481×1
10^3 ×
    0.7211
    0.7229
    0.7247
    0.7226
    0.7226
    0.7247
    0.7247
    0.7223
    0.7246
    0.7247
      ⋮

Scores = 1481×2
10^3 ×
    0.7208    0.7213
    0.7226    0.7231
    0.7245    0.7249
    0.7224    0.7228
    0.7224    0.7228
    0.7245    0.7249
```

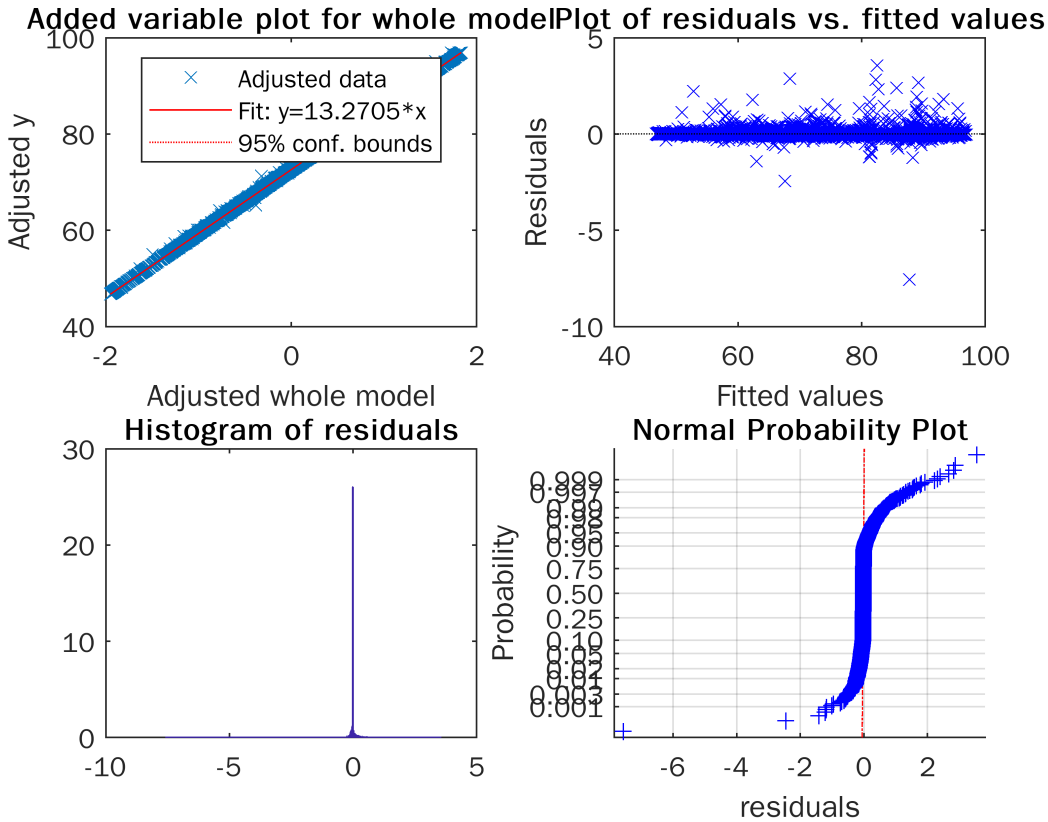
```
    0.7245    0.7249
    0.7221    0.7226
    0.7243    0.7248
    0.7245    0.7249
      ⋮
```

## Plots

```
figure,
subplot(4, 1, 1), plot(LRModel)
subplot(4, 1, 2), plotDiagnostics(LRModel)
subplot(4, 1, 3), plotDiagnostics(LRModel, 'cookd')
subplot(4, 1, 4), plotResiduals(LRModel)
```




```
figure,
subplot(2, 2, 1), plot(LRModel)
subplot(2, 2, 2), plotResiduals(LRModel,'fitted')
subplot(2, 2, 3), plotResiduals(LRModel)
subplot(2, 2, 4), normplot(LRModel.Residuals.Raw)
xlabel('residuals')
```


Added variable plot for whole model
Adjusted data
Fit: y=13.2705*x
95% conf. bounds
Adjusted y
Adjusted whole model
Plot of residuals vs. fitted values
Residuals
Fitted values
Histogram of residuals
Normal Probability Plot
Probability
residuals

## Upload the big dataset (>250MB) to MATLAB Drive and read table

```
BitcoinData = readtable('bitcoin-dataset.csv');
```

```
Warning: Column headers from the file were modified to make them valid MATLAB identifiers
before creating variable names for the table. The original column headers are saved in the
VariableDescriptions property.
Set 'VariableNamingRule' to 'preserve' to use the original column headers as table variable names.
```

```
Tablesize = size(BitcoinData)
```

```
Tablesize = 1×2
     4857377           8
```

```
head(BitcoinData,1)
```

```
ans = 1×8 table
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                
...
```

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 1 | 1.3253e+09 | 4.3900 | 4.3900 | 4.3900 | 4.3900 | 0.4556 |

## Convert timestamp

```
datetest = BitcoinData(:,1);
datetest = table2array(datetest);
BitcoinData.Timestamp = datetime(datetest, 'ConvertFrom', 'posixtime');
```

## Remove NaNs

```
% how many NaNs in each column
NaN2 = sum(isnan(BitcoinData.Open))
```

```
NaN2 = 1243608
```

```
NaN3 = sum(isnan(BitcoinData.High))
```

```
NaN3 = 1243608
```

```
NaN4 = sum(isnan(BitcoinData.Low))
```

```
NaN4 = 1243608
```

```
NaN5 = sum(isnan(BitcoinData.Close))
```

```
NaN5 = 1243608
```

```
NaN6 = sum(isnan(BitcoinData.Volume__BTC_))
```

```
NaN6 = 1243608
```

```
NaN7 = sum(isnan(BitcoinData.Volume__Currency_))
```

```
NaN7 = 1243608
```

```
NaN8 = sum(isnan(BitcoinData.Weighted_Price))
```

```
NaN8 = 1243608
```

```
% remove NaNs
BitcoinData = BitcoinData(isnan(BitcoinData.High) == 0,:);
```

## Select data

```
BitcoinDataTimetable = table2timetable(BitcoinData);

% March 2013
% S = timerange('17-Mar-2013 00:00:00','18-Mar-2013 23:59:00'); %2days
% S = timerange('17-Mar-2013 00:00:00','23-Mar-2013 23:59:00'); %7days
% S = timerange('17-Mar-2013 00:00:00','30-Mar-2013 23:59:00'); %14days

% March 2016
 S = timerange('17-Mar-2016 00:00:00','18-Mar-2016 23:59:00'); %2days
% S = timerange('17-Mar-2016 00:00:00','23-Mar-2016 23:59:00'); %7days
% S = timerange('17-Mar-2016 00:00:00','30-Mar-2016 23:59:00'); %14days

% March 2019
% S = timerange('17-Mar-2019 00:00:00','18-Mar-2019 23:59:00'); %2days
% S = timerange('17-Mar-2019 00:00:00','23-Mar-2019 23:59:00'); %7days
% S = timerange('17-Mar-2019 00:00:00','30-Mar-2019 23:59:00'); %14days

% March 2021
% S = timerange('17-Mar-2021 00:00:00','18-Mar-2021 23:59:00'); %2days
% S = timerange('17-Mar-2021 00:00:00','23-Mar-2021 23:59:00'); %7days
% S = timerange('17-Mar-2021 00:00:00','30-Mar-2021 23:59:00'); %14days

BitcoinData = BitcoinDataTimetable(S,:);
Tablesize = size(BitcoinData)
```

```
Tablesize = 1×2
        2043           7
```

## Create model - preprocessing

```
% standardization, and Initial predictor set (matrix)

Y = BitcoinData{:,"Close"}
```

```
Y = 2043×1
  416.5700
  416.5700
  416.5700
  416.5700
  416.8000
  416.4400
  416.7900
  416.7900
  416.7900
  416.7900
     ⋮
```

```
X = BitcoinData{:,[1:3]}
```

```
X = 2043×3
  416.5200  416.5700  416.5200
  416.5700  416.5700  416.5700
  416.5700  416.5700  416.5700
  416.5700  416.5700  416.5700
  416.2600  416.8000  416.2600
  416.7800  416.7800  416.4400
```

```
  416.5300  416.7900  416.5300
  416.1600  416.7900  416.1600
  416.7900  416.7900  416.7900
  416.7900  416.7900  416.7900
     ⋮
```

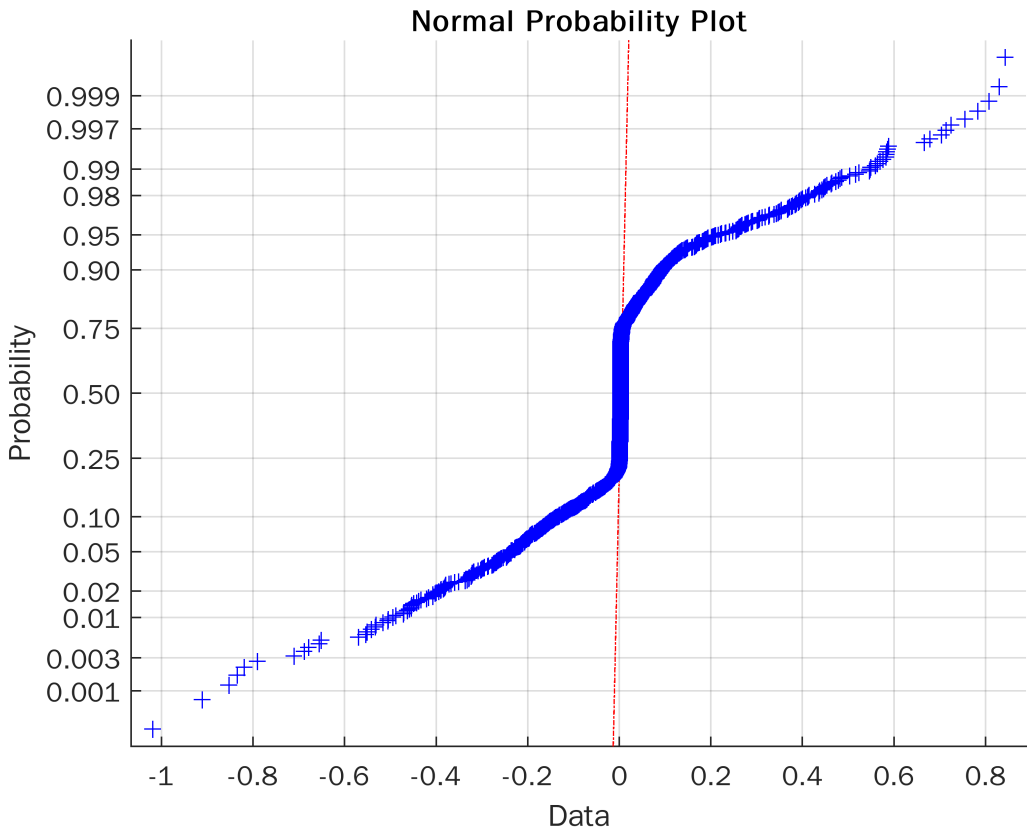
```
%Check model for outliers

LRPre = fitlm(zscore(X),Y)
```

```
LRPre =
Linear regression model:
    y ~ 1 + x1 + x2 + x3

Estimated Coefficients:
```

| | Estimate | SE | tStat | pValue |
|---|---|---|---|---|
| **(Intercept)** | 414.58 | 0.0033325 | 1.244e+05 | 0 |
| **x1** | -2.3249 | 0.092512 | -25.131 | 1.2355e-121 |
| **x2** | 3.8196 | 0.073794 | 51.761 | 0 |
| **x3** | 3.0102 | 0.061216 | 49.173 | 0 |

```
Number of observations: 2043, Error degrees of freedom: 2039
Root Mean Squared Error: 0.151
R-squared: 0.999,  Adjusted R-Squared: 0.999
F-statistic vs. constant model: 6.08e+05, p-value = 0
```

```
normplot(LRPre.Residuals.Raw)
```




## Identify and Remove Outliers

```
idx = isoutlier(BitcoinData.Close)
```

```
idx = 2043×1 logical array
   0
   0
   0
   0
   0
   0
   0
   0
   0
   0
     ⋮
```

```
sum(idx)
```

```
ans = 342
```

```
BitcoinData(idx,:) = []
```

```
BitcoinData = 1701×7 timetable
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                
```
...
```

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 1 | 17-Mar-2016 00:00:00 | 416.5200 | 416.5700 | 416.5200 | 416.5700 | 1.9988 |
```

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 2 | 17-Mar-2016 00:01:00 | 416.5700 | 416.5700 | 416.5700 | 416.5700 | 0.0427 |
| 3 | 17-Mar-2016 00:02:00 | 416.5700 | 416.5700 | 416.5700 | 416.5700 | 0.1000 |
| 4 | 17-Mar-2016 00:03:00 | 416.5700 | 416.5700 | 416.5700 | 416.5700 | 0.0760 |
| 5 | 17-Mar-2016 00:04:00 | 416.2600 | 416.8000 | 416.2600 | 416.8000 | 0.8190 |
| 6 | 17-Mar-2016 00:05:00 | 416.7800 | 416.7800 | 416.4400 | 416.4400 | 0.1365 |
| 7 | 17-Mar-2016 00:06:00 | 416.5300 | 416.7900 | 416.5300 | 416.7900 | 5.3670 |
| 8 | 17-Mar-2016 00:07:00 | 416.1600 | 416.7900 | 416.1600 | 416.7900 | 4.0567 |
| 9 | 17-Mar-2016 00:08:00 | 416.7900 | 416.7900 | 416.7900 | 416.7900 | 0.0200 |
| 10 | 17-Mar-2016 00:09:00 | 416.7900 | 416.7900 | 416.7900 | 416.7900 | 1.0823 |
| 11 | 17-Mar-2016 00:10:00 | 416.7900 | 416.7900 | 416.7900 | 416.7900 | 0.1460 |
| 12 | 17-Mar-2016 00:11:00 | 416.7900 | 416.7900 | 416.7900 | 416.7900 | 0.0500 |
| 13 | 17-Mar-2016 00:12:00 | 416.7900 | 416.8000 | 416.4200 | 416.4200 | 0.2654 |
| 14 | 17-Mar-2016 00:16:00 | 416.8000 | 416.8000 | 416.8000 | 416.8000 | 0.6906 |
| 15 | 17-Mar-2016 00:18:00 | 416.7900 | 416.7900 | 416.7900 | 416.7900 | 0.0300 |
| 16 | 17-Mar-2016 00:20:00 | 416.8000 | 416.8000 | 416.8000 | 416.8000 | 0.2970 |
| 17 | 17-Mar-2016 00:22:00 | 416.7800 | 416.7800 | 416.7800 | 416.7800 | 0.1492 |
| 18 | 17-Mar-2016 00:23:00 | 416.7900 | 416.7900 | 416.7900 | 416.7900 | 0.2085 |
| 19 | 17-Mar-2016 00:24:00 | 416.7800 | 416.8000 | 416.7800 | 416.8000 | 0.2446 |
| 20 | 17-Mar-2016 00:25:00 | 416.8000 | 416.8000 | 416.8000 | 416.8000 | 0.4203 |
| 21 | 17-Mar-2016 00:27:00 | 416.8000 | 416.8000 | 416.8000 | 416.8000 | 0.2292 |
| 22 | 17-Mar-2016 00:28:00 | 416.8800 | 416.8800 | 416.8800 | 416.8800 | 0.0878 |
| 23 | 17-Mar-2016 00:30:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 2.1660 |
| 24 | 17-Mar-2016 00:35:00 | 416.8200 | 416.8200 | 416.8200 | 416.8200 | 0.1287 |
| 25 | 17-Mar-2016 00:36:00 | 416.8700 | 416.8700 | 416.2300 | 416.2300 | 1.3485 |
| 26 | 17-Mar-2016 00:38:00 | 416.6700 | 416.6700 | 416.6700 | 416.6700 | 0.3488 |
| 27 | 17-Mar-2016 00:39:00 | 416.6700 | 416.6700 | 416.6700 | 416.6700 | 0.3990 |
| 28 | 17-Mar-2016 00:40:00 | 416.6600 | 416.6600 | 416.6600 | 416.6600 | 0.0720 |
| 29 | 17-Mar-2016 00:41:00 | 416.6500 | 416.6500 | 416.6500 | 416.6500 | 0.0472 |
| 30 | 17-Mar-2016 00:42:00 | 416.6500 | 416.6500 | 416.6500 | 416.6500 | 0.0623 |
| 31 | 17-Mar-2016 00:43:00 | 416.8000 | 416.8000 | 416.8000 | 416.8000 | 0.7251 |
| 32 | 17-Mar-2016 00:44:00 | 416.8000 | 416.8000 | 416.8000 | 416.8000 | 2.8363 |
| 33 | 17-Mar-2016 00:45:00 | 416.4600 | 416.8800 | 416.4600 | 416.8800 | 2.7474 |
| 34 | 17-Mar-2016 00:47:00 | 416.8800 | 416.8800 | 416.8800 | 416.8800 | 0.0625 |

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 35 | 17-Mar-2016 00:49:00 | 416.6000 | 416.6000 | 416.6000 | 416.6000 | 0.0136 |
| 36 | 17-Mar-2016 00:50:00 | 416.8800 | 416.8900 | 416.8800 | 416.8900 | 1.1145 |
| 37 | 17-Mar-2016 00:52:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 0.1970 |
| 38 | 17-Mar-2016 00:54:00 | 416.8800 | 416.8800 | 416.8800 | 416.8800 | 0.7271 |
| 39 | 17-Mar-2016 00:55:00 | 416.8800 | 416.8800 | 416.8800 | 416.8800 | 0.0127 |
| 40 | 17-Mar-2016 00:58:00 | 416.8100 | 416.8100 | 416.8100 | 416.8100 | 0.1500 |
| 41 | 17-Mar-2016 00:59:00 | 416.7700 | 416.7700 | 416.6600 | 416.6600 | 0.0909 |
| 42 | 17-Mar-2016 01:00:00 | 416.6600 | 416.6600 | 416.6600 | 416.6600 | 0.2000 |
| 43 | 17-Mar-2016 01:01:00 | 416.6600 | 416.6600 | 416.3600 | 416.6600 | 2.8050 |
| 44 | 17-Mar-2016 01:03:00 | 416.6600 | 416.8000 | 416.6600 | 416.8000 | 0.9954 |
| 45 | 17-Mar-2016 01:05:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.1163 |
| 46 | 17-Mar-2016 01:06:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.1290 |
| 47 | 17-Mar-2016 01:07:00 | 416.8400 | 416.8400 | 416.8000 | 416.8400 | 0.6477 |
| 48 | 17-Mar-2016 01:08:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.3348 |
| 49 | 17-Mar-2016 01:09:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 1.5653 |
| 50 | 17-Mar-2016 01:12:00 | 416.8100 | 416.8100 | 416.8100 | 416.8100 | 4.6978 |
| 51 | 17-Mar-2016 01:13:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.1136 |
| 52 | 17-Mar-2016 01:14:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.3083 |
| 53 | 17-Mar-2016 01:15:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.1000 |
| 54 | 17-Mar-2016 01:16:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 1.6008 |
| 55 | 17-Mar-2016 01:17:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.3113 |
| 56 | 17-Mar-2016 01:18:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.9211 |
| 57 | 17-Mar-2016 01:19:00 | 416.8100 | 416.8400 | 416.8100 | 416.8400 | 0.2923 |
| 58 | 17-Mar-2016 01:20:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.1120 |
| 59 | 17-Mar-2016 01:22:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 1.1004 |
| 60 | 17-Mar-2016 01:24:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.2070 |
| 61 | 17-Mar-2016 01:26:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.3395 |
| 62 | 17-Mar-2016 01:27:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.5258 |
| 63 | 17-Mar-2016 01:28:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.0210 |
| 64 | 17-Mar-2016 01:29:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.8659 |
| 65 | 17-Mar-2016 01:30:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.5916 |
| 66 | 17-Mar-2016 01:31:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.5606 |
| 67 | 17-Mar-2016 01:32:00 | 416.8100 | 416.8900 | 416.8100 | 416.8900 | 2.1192 |

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 68 | 17-Mar-2016 01:33:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 0.9575 |
| 69 | 17-Mar-2016 01:34:00 | 416.8700 | 416.8700 | 416.8700 | 416.8700 | 0.0489 |
| 70 | 17-Mar-2016 01:36:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 0.1472 |
| 71 | 17-Mar-2016 01:38:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 0.2163 |
| 72 | 17-Mar-2016 01:41:00 | 416.8900 | 416.9000 | 416.8900 | 416.9000 | 2.2546 |
| 73 | 17-Mar-2016 01:44:00 | 416.8100 | 416.9400 | 416.8000 | 416.9400 | 16.8117 |
| 74 | 17-Mar-2016 01:45:00 | 416.4000 | 416.4800 | 416.4000 | 416.4800 | 1 |
| 75 | 17-Mar-2016 01:46:00 | 416.5500 | 416.5500 | 416.3000 | 416.3000 | 21.7090 |
| 76 | 17-Mar-2016 01:48:00 | 416.7900 | 416.7900 | 416.7900 | 416.7900 | 0.7270 |
| 77 | 17-Mar-2016 01:49:00 | 416.1800 | 416.1800 | 416.1800 | 416.1800 | 0.0383 |
| 78 | 17-Mar-2016 01:50:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.1287 |
| 79 | 17-Mar-2016 01:52:00 | 416.8600 | 416.8600 | 416.8600 | 416.8600 | 0.0698 |
| 80 | 17-Mar-2016 01:54:00 | 416.8600 | 416.8600 | 416.8600 | 416.8600 | 0.0350 |
| 81 | 17-Mar-2016 01:56:00 | 416.8200 | 416.8200 | 416.6800 | 416.6800 | 0.9092 |
| 82 | 17-Mar-2016 02:02:00 | 416.8700 | 416.8700 | 416.8700 | 416.8700 | 0.0720 |
| 83 | 17-Mar-2016 02:03:00 | 416.8700 | 416.8900 | 416.8700 | 416.8900 | 1.1726 |
| 84 | 17-Mar-2016 02:04:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 0.0815 |
| 85 | 17-Mar-2016 02:06:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 0.6386 |
| 86 | 17-Mar-2016 02:08:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 0.8200 |
| 87 | 17-Mar-2016 02:11:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 0.2919 |
| 88 | 17-Mar-2016 02:12:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 0.2130 |
| 89 | 17-Mar-2016 02:14:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 0.7212 |
| 90 | 17-Mar-2016 02:16:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 0.1397 |
| 91 | 17-Mar-2016 02:17:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 1.3198 |
| 92 | 17-Mar-2016 02:19:00 | 416.8900 | 416.9100 | 416.8900 | 416.9100 | 0.0870 |
| 93 | 17-Mar-2016 02:20:00 | 416.9100 | 416.9100 | 416.9100 | 416.9100 | 0.4450 |
| 94 | 17-Mar-2016 02:26:00 | 416.9100 | 416.9100 | 416.9100 | 416.9100 | 1.2543 |
| 95 | 17-Mar-2016 02:27:00 | 416.9100 | 416.9100 | 416.9100 | 416.9100 | 3.4761 |
| 96 | 17-Mar-2016 02:28:00 | 416.9100 | 416.9100 | 416.9100 | 416.9100 | 0.0657 |
| 97 | 17-Mar-2016 02:30:00 | 416.9100 | 416.9200 | 416.9100 | 416.9200 | 3.5193 |
| 98 | 17-Mar-2016 02:31:00 | 416.2900 | 416.2900 | 416.2900 | 416.2900 | 0.3679 |
| 99 | 17-Mar-2016 02:34:00 | 416.9200 | 416.9200 | 416.9200 | 416.9200 | 1.0972 |
| 100 | 17-Mar-2016 02:35:00 | 416.9200 | 416.9200 | 416.9200 | 416.9200 | 0.4245 |

```
    ⋮
```

```
%outliers = outlier(BitcoinData.Close)

%Rerun model to check for more outliers
Y = BitcoinData{:,"Close"}
```

```
Y = 1701×1
  416.5700
  416.5700
  416.5700
  416.5700
  416.8000
  416.4400
  416.7900
  416.7900
  416.7900
  416.7900
    ⋮
```

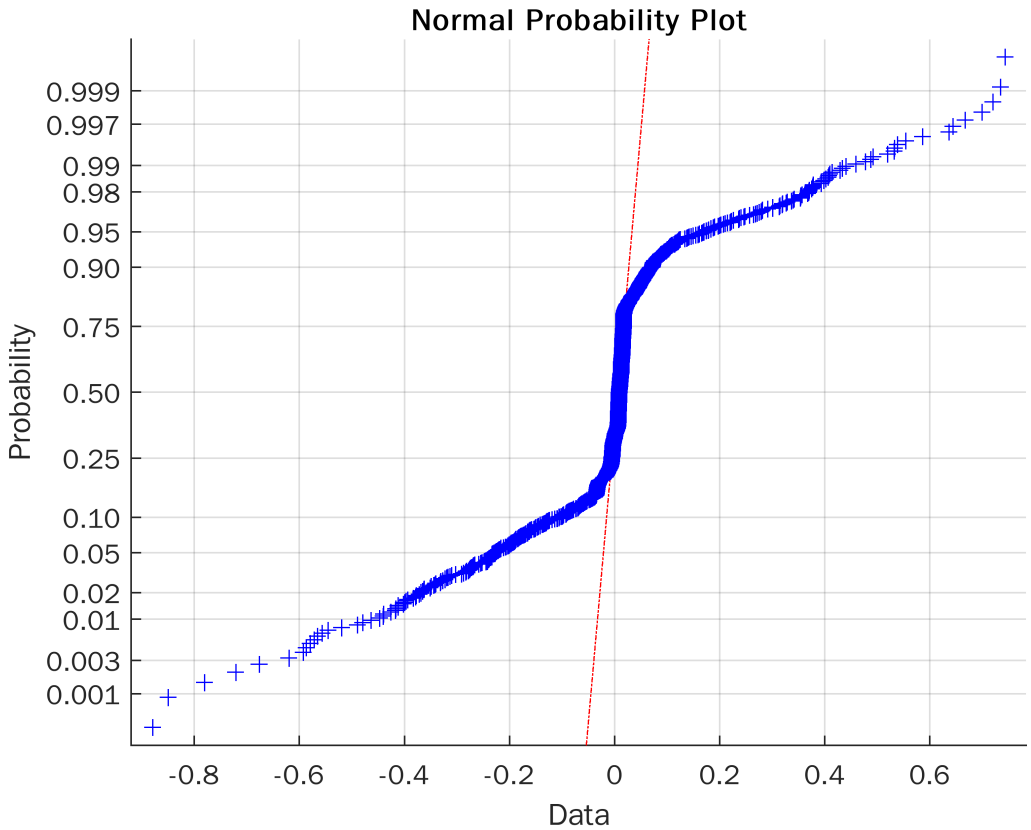
```
X = BitcoinData{:,[1:3]}
```

```
X = 1701×3
  416.5200  416.5700  416.5200
  416.5700  416.5700  416.5700
  416.5700  416.5700  416.5700
  416.5700  416.5700  416.5700
  416.2600  416.8000  416.2600
  416.7800  416.7800  416.4400
  416.5300  416.7900  416.5300
  416.1600  416.7900  416.1600
  416.7900  416.7900  416.7900
  416.7900  416.7900  416.7900
    ⋮
```

```
LRPre = fitlm(zscore(X),Y)
```

```
LRPre = 
Linear regression model:
    y ~ 1 + x1 + x2 + x3

Estimated Coefficients:
                   Estimate       SE          tStat         pValue  
                   ________    _________    __________    __________

    (Intercept)     416.15     0.0032524    1.2795e+05              0
    x1             -1.5695      0.066412       -23.633    5.5917e-107
    x2              2.7307      0.051375        53.154              0
    x3              1.9233       0.04535        42.411    1.3363e-268


Number of observations: 1701, Error degrees of freedom: 1697
Root Mean Squared Error: 0.134
R-squared: 0.998,  Adjusted R-Squared: 0.998
F-statistic vs. constant model: 2.99e+05, p-value = 0
```

```
normplot(LRPre.Residuals.Raw)
```




```
idx = isoutlier(BitcoinData.Close)
```

```
idx = 1701×1 logical array
   0
   0
   0
   0
   0
   0
   0
   0
   0
   0
   0
   ⋮
```

```
sum(idx)
```

```
ans = 174
```

```
BitcoinData(idx,:) = []
```

```
BitcoinData = 1527×7 timetable
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                
```
...
```

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 1 | 17-Mar-2016 00:00:00 | 416.5200 | 416.5700 | 416.5200 | 416.5700 | 1.9988 |
| 2 | 17-Mar-2016 00:01:00 | 416.5700 | 416.5700 | 416.5700 | 416.5700 | 0.0427 |
```

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 3 | 17-Mar-2016 00:02:00 | 416.5700 | 416.5700 | 416.5700 | 416.5700 | 0.1000 |
| 4 | 17-Mar-2016 00:03:00 | 416.5700 | 416.5700 | 416.5700 | 416.5700 | 0.0760 |
| 5 | 17-Mar-2016 00:04:00 | 416.2600 | 416.8000 | 416.2600 | 416.8000 | 0.8190 |
| 6 | 17-Mar-2016 00:05:00 | 416.7800 | 416.7800 | 416.4400 | 416.4400 | 0.1365 |
| 7 | 17-Mar-2016 00:06:00 | 416.5300 | 416.7900 | 416.5300 | 416.7900 | 5.3670 |
| 8 | 17-Mar-2016 00:07:00 | 416.1600 | 416.7900 | 416.1600 | 416.7900 | 4.0567 |
| 9 | 17-Mar-2016 00:08:00 | 416.7900 | 416.7900 | 416.7900 | 416.7900 | 0.0200 |
| 10 | 17-Mar-2016 00:09:00 | 416.7900 | 416.7900 | 416.7900 | 416.7900 | 1.0823 |
| 11 | 17-Mar-2016 00:10:00 | 416.7900 | 416.7900 | 416.7900 | 416.7900 | 0.1460 |
| 12 | 17-Mar-2016 00:11:00 | 416.7900 | 416.7900 | 416.7900 | 416.7900 | 0.0500 |
| 13 | 17-Mar-2016 00:12:00 | 416.7900 | 416.8000 | 416.4200 | 416.4200 | 0.2654 |
| 14 | 17-Mar-2016 00:16:00 | 416.8000 | 416.8000 | 416.8000 | 416.8000 | 0.6906 |
| 15 | 17-Mar-2016 00:18:00 | 416.7900 | 416.7900 | 416.7900 | 416.7900 | 0.0300 |
| 16 | 17-Mar-2016 00:20:00 | 416.8000 | 416.8000 | 416.8000 | 416.8000 | 0.2970 |
| 17 | 17-Mar-2016 00:22:00 | 416.7800 | 416.7800 | 416.7800 | 416.7800 | 0.1492 |
| 18 | 17-Mar-2016 00:23:00 | 416.7900 | 416.7900 | 416.7900 | 416.7900 | 0.2085 |
| 19 | 17-Mar-2016 00:24:00 | 416.7800 | 416.8000 | 416.7800 | 416.8000 | 0.2446 |
| 20 | 17-Mar-2016 00:25:00 | 416.8000 | 416.8000 | 416.8000 | 416.8000 | 0.4203 |
| 21 | 17-Mar-2016 00:27:00 | 416.8000 | 416.8000 | 416.8000 | 416.8000 | 0.2292 |
| 22 | 17-Mar-2016 00:28:00 | 416.8800 | 416.8800 | 416.8800 | 416.8800 | 0.0878 |
| 23 | 17-Mar-2016 00:30:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 2.1660 |
| 24 | 17-Mar-2016 00:35:00 | 416.8200 | 416.8200 | 416.8200 | 416.8200 | 0.1287 |
| 25 | 17-Mar-2016 00:36:00 | 416.8700 | 416.8700 | 416.2300 | 416.2300 | 1.3485 |
| 26 | 17-Mar-2016 00:38:00 | 416.6700 | 416.6700 | 416.6700 | 416.6700 | 0.3488 |
| 27 | 17-Mar-2016 00:39:00 | 416.6700 | 416.6700 | 416.6700 | 416.6700 | 0.3990 |
| 28 | 17-Mar-2016 00:40:00 | 416.6600 | 416.6600 | 416.6600 | 416.6600 | 0.0720 |
| 29 | 17-Mar-2016 00:41:00 | 416.6500 | 416.6500 | 416.6500 | 416.6500 | 0.0472 |
| 30 | 17-Mar-2016 00:42:00 | 416.6500 | 416.6500 | 416.6500 | 416.6500 | 0.0623 |
| 31 | 17-Mar-2016 00:43:00 | 416.8000 | 416.8000 | 416.8000 | 416.8000 | 0.7251 |
| 32 | 17-Mar-2016 00:44:00 | 416.8000 | 416.8000 | 416.8000 | 416.8000 | 2.8363 |
| 33 | 17-Mar-2016 00:45:00 | 416.4600 | 416.8800 | 416.4600 | 416.8800 | 2.7474 |
| 34 | 17-Mar-2016 00:47:00 | 416.8800 | 416.8800 | 416.8800 | 416.8800 | 0.0625 |
| 35 | 17-Mar-2016 00:49:00 | 416.6000 | 416.6000 | 416.6000 | 416.6000 | 0.0136 |

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 36 | 17-Mar-2016 00:50:00 | 416.8800 | 416.8900 | 416.8800 | 416.8900 | 1.1145 |
| 37 | 17-Mar-2016 00:52:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 0.1970 |
| 38 | 17-Mar-2016 00:54:00 | 416.8800 | 416.8800 | 416.8800 | 416.8800 | 0.7271 |
| 39 | 17-Mar-2016 00:55:00 | 416.8800 | 416.8800 | 416.8800 | 416.8800 | 0.0127 |
| 40 | 17-Mar-2016 00:58:00 | 416.8100 | 416.8100 | 416.8100 | 416.8100 | 0.1500 |
| 41 | 17-Mar-2016 00:59:00 | 416.7700 | 416.7700 | 416.6600 | 416.6600 | 0.0909 |
| 42 | 17-Mar-2016 01:00:00 | 416.6600 | 416.6600 | 416.6600 | 416.6600 | 0.2000 |
| 43 | 17-Mar-2016 01:01:00 | 416.6600 | 416.6600 | 416.3600 | 416.6600 | 2.8050 |
| 44 | 17-Mar-2016 01:03:00 | 416.6600 | 416.8000 | 416.6600 | 416.8000 | 0.9954 |
| 45 | 17-Mar-2016 01:05:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.1163 |
| 46 | 17-Mar-2016 01:06:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.1290 |
| 47 | 17-Mar-2016 01:07:00 | 416.8400 | 416.8400 | 416.8000 | 416.8400 | 0.6477 |
| 48 | 17-Mar-2016 01:08:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.3348 |
| 49 | 17-Mar-2016 01:09:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 1.5653 |
| 50 | 17-Mar-2016 01:12:00 | 416.8100 | 416.8100 | 416.8100 | 416.8100 | 4.6978 |
| 51 | 17-Mar-2016 01:13:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.1136 |
| 52 | 17-Mar-2016 01:14:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.3083 |
| 53 | 17-Mar-2016 01:15:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.1000 |
| 54 | 17-Mar-2016 01:16:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 1.6008 |
| 55 | 17-Mar-2016 01:17:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.3113 |
| 56 | 17-Mar-2016 01:18:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.9211 |
| 57 | 17-Mar-2016 01:19:00 | 416.8100 | 416.8400 | 416.8100 | 416.8400 | 0.2923 |
| 58 | 17-Mar-2016 01:20:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.1120 |
| 59 | 17-Mar-2016 01:22:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 1.1004 |
| 60 | 17-Mar-2016 01:24:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.2070 |
| 61 | 17-Mar-2016 01:26:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.3395 |
| 62 | 17-Mar-2016 01:27:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.5258 |
| 63 | 17-Mar-2016 01:28:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.0210 |
| 64 | 17-Mar-2016 01:29:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.8659 |
| 65 | 17-Mar-2016 01:30:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.5916 |
| 66 | 17-Mar-2016 01:31:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.5606 |
| 67 | 17-Mar-2016 01:32:00 | 416.8100 | 416.8900 | 416.8100 | 416.8900 | 2.1192 |
| 68 | 17-Mar-2016 01:33:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 0.9575 |

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 69 | 17-Mar-2016 01:34:00 | 416.8700 | 416.8700 | 416.8700 | 416.8700 | 0.0489 |
| 70 | 17-Mar-2016 01:36:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 0.1472 |
| 71 | 17-Mar-2016 01:38:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 0.2163 |
| 72 | 17-Mar-2016 01:41:00 | 416.8900 | 416.9000 | 416.8900 | 416.9000 | 2.2546 |
| 73 | 17-Mar-2016 01:44:00 | 416.8100 | 416.9400 | 416.8000 | 416.9400 | 16.8117 |
| 74 | 17-Mar-2016 01:45:00 | 416.4000 | 416.4800 | 416.4000 | 416.4800 | 1 |
| 75 | 17-Mar-2016 01:46:00 | 416.5500 | 416.5500 | 416.3000 | 416.3000 | 21.7090 |
| 76 | 17-Mar-2016 01:48:00 | 416.7900 | 416.7900 | 416.7900 | 416.7900 | 0.7270 |
| 77 | 17-Mar-2016 01:49:00 | 416.1800 | 416.1800 | 416.1800 | 416.1800 | 0.0383 |
| 78 | 17-Mar-2016 01:50:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.1287 |
| 79 | 17-Mar-2016 01:52:00 | 416.8600 | 416.8600 | 416.8600 | 416.8600 | 0.0698 |
| 80 | 17-Mar-2016 01:54:00 | 416.8600 | 416.8600 | 416.8600 | 416.8600 | 0.0350 |
| 81 | 17-Mar-2016 01:56:00 | 416.8200 | 416.8200 | 416.6800 | 416.6800 | 0.9092 |
| 82 | 17-Mar-2016 02:02:00 | 416.8700 | 416.8700 | 416.8700 | 416.8700 | 0.0720 |
| 83 | 17-Mar-2016 02:03:00 | 416.8700 | 416.8900 | 416.8700 | 416.8900 | 1.1726 |
| 84 | 17-Mar-2016 02:04:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 0.0815 |
| 85 | 17-Mar-2016 02:06:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 0.6386 |
| 86 | 17-Mar-2016 02:08:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 0.8200 |
| 87 | 17-Mar-2016 02:11:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 0.2919 |
| 88 | 17-Mar-2016 02:12:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 0.2130 |
| 89 | 17-Mar-2016 02:14:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 0.7212 |
| 90 | 17-Mar-2016 02:16:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 0.1397 |
| 91 | 17-Mar-2016 02:17:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 1.3198 |
| 92 | 17-Mar-2016 02:19:00 | 416.8900 | 416.9100 | 416.8900 | 416.9100 | 0.0870 |
| 93 | 17-Mar-2016 02:20:00 | 416.9100 | 416.9100 | 416.9100 | 416.9100 | 0.4450 |
| 94 | 17-Mar-2016 02:26:00 | 416.9100 | 416.9100 | 416.9100 | 416.9100 | 1.2543 |
| 95 | 17-Mar-2016 02:27:00 | 416.9100 | 416.9100 | 416.9100 | 416.9100 | 3.4761 |
| 96 | 17-Mar-2016 02:28:00 | 416.9100 | 416.9100 | 416.9100 | 416.9100 | 0.0657 |
| 97 | 17-Mar-2016 02:30:00 | 416.9100 | 416.9200 | 416.9100 | 416.9200 | 3.5193 |
| 98 | 17-Mar-2016 02:31:00 | 416.2900 | 416.2900 | 416.2900 | 416.2900 | 0.3679 |
| 99 | 17-Mar-2016 02:34:00 | 416.9200 | 416.9200 | 416.9200 | 416.9200 | 1.0972 |
| 100 | 17-Mar-2016 02:35:00 | 416.9200 | 416.9200 | 416.9200 | 416.9200 | 0.4245 |

⋮

```
%outliers = outlier(BitcoinData.Close)
```

## Split dataset into training and testing data

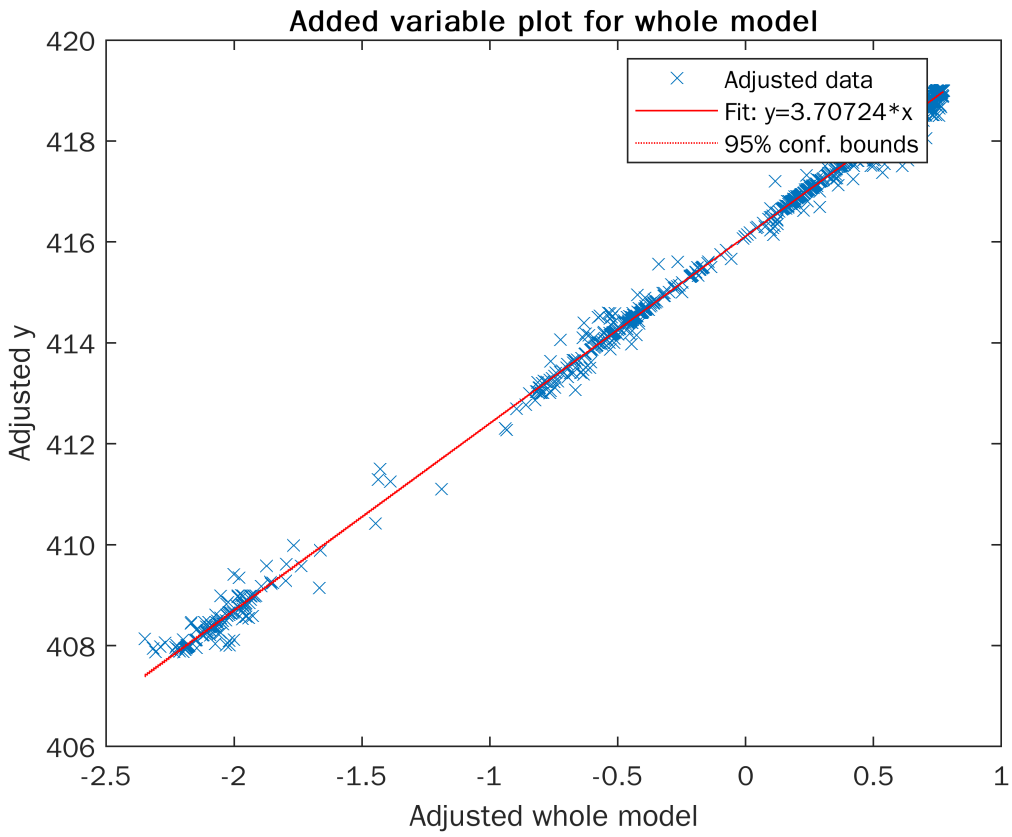
```
BitcoinData_new = [X, Y];

PD = 0.20;
cv = cvpartition(size(BitcoinData_new,1),'HoldOut',PD);
Xtrain = BitcoinData_new(cv.training,[1:end - 1]);
Ytrain = BitcoinData_new(cv.training,end);
Xtest = BitcoinData_new(cv.test, [1:end - 1]);
Ytest = BitcoinData_new(cv.test,end);
```

## Linear model with training-testing split

```
LRModel = fitlm(zscore(Xtrain),Ytrain)
```

```
LRModel = 
Linear regression model:
    y ~ 1 + x1 + x2 + x3

Estimated Coefficients:
                   Estimate       SE          tStat         pValue  
                   ________    _________    __________    __________

    (Intercept)     416.11     0.0036741    1.1326e+05              0
    x1             -1.5758      0.075037       -21.001     5.1854e-85
    x2               2.753      0.057901        47.548    3.0888e-291
    x3              1.9186        0.0509        37.694    2.4244e-213


Number of observations: 1361, Error degrees of freedom: 1357
Root Mean Squared Error: 0.136
R-squared: 0.998,  Adjusted R-Squared: 0.998
F-statistic vs. constant model: 2.36e+05, p-value = 0
```

```
plot(LRModel)
```




```
LRModel.RMSE
```

```
ans = 0.1355
```

## Predict

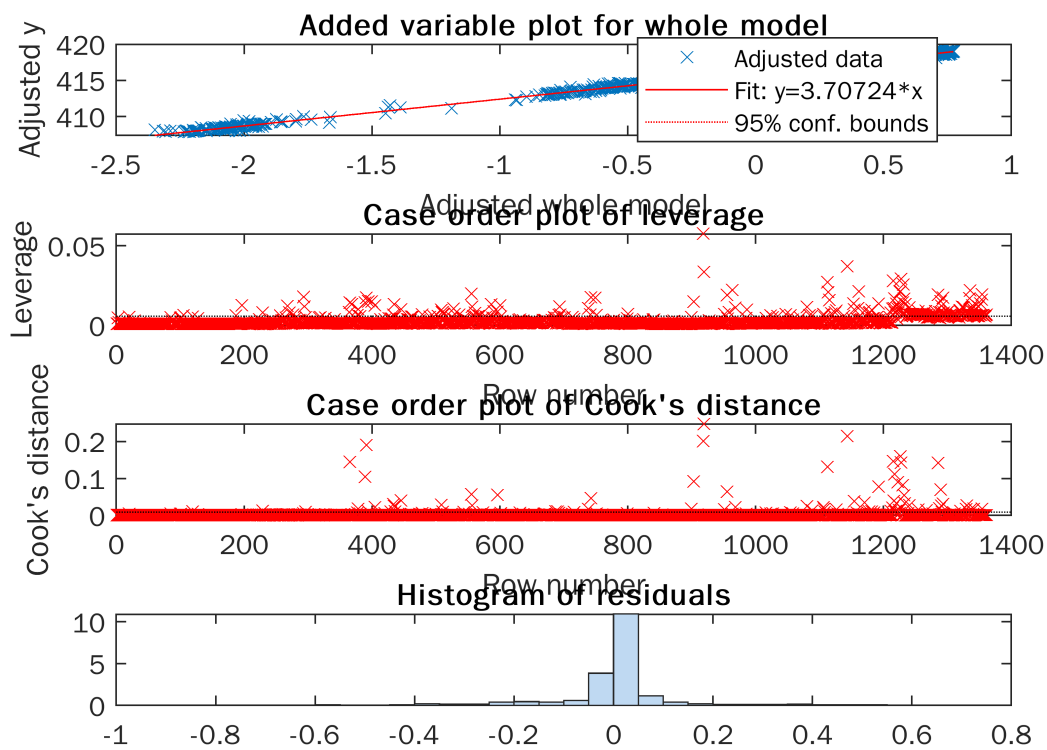
```
[YPred, Scores] = predict(LRModel,Xtest)
```

```
YPred = 340×1
10^3 ×
    1.7057
    1.7057
    1.7062
    1.7067
    1.7065
    1.7067
    1.7067
    1.7066
    1.7066
    1.7066
      ⋮

Scores = 340×2
10^3 ×
    1.7027    1.7087
    1.7027    1.7087
    1.7032    1.7092
    1.7037    1.7097
    1.7035    1.7095
    1.7037    1.7097
```

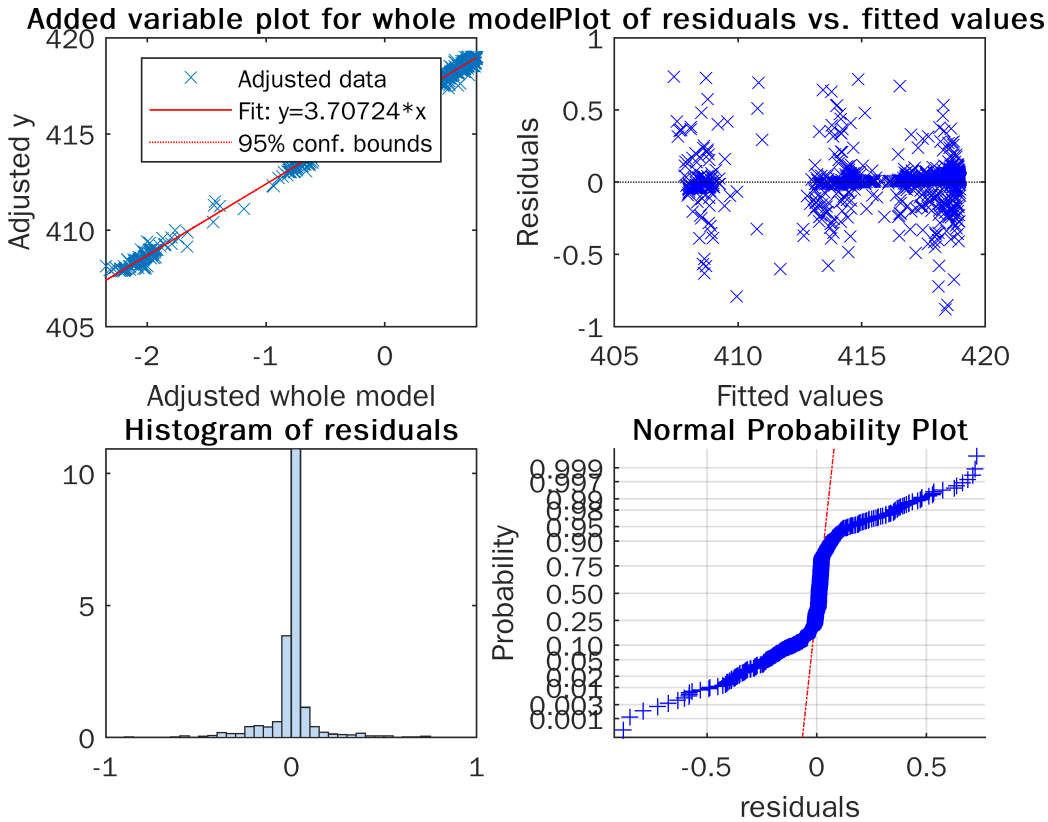
```
    1.7037    1.7097
    1.7036    1.7096
    1.7036    1.7096
    1.7036    1.7096
      ⋮
```

## Plots

```
figure,
subplot(4, 1, 1), plot(LRModel)
subplot(4, 1, 2), plotDiagnostics(LRModel)
subplot(4, 1, 3), plotDiagnostics(LRModel, 'cookd')
subplot(4, 1, 4), plotResiduals(LRModel)
```




```
figure,
subplot(2, 2, 1), plot(LRModel)
subplot(2, 2, 2), plotResiduals(LRModel,'fitted')
subplot(2, 2, 3), plotResiduals(LRModel)
subplot(2, 2, 4), normplot(LRModel.Residuals.Raw)
xlabel('residuals')
```


Added variable plot for whole model
Adjusted data
Fit: y=3.70724*x
95% conf. bounds
Adjusted y
Adjusted whole model
Plot of residuals vs. fitted values
Residuals
Fitted values
Histogram of residuals
Normal Probability Plot
Probability
residuals

## Upload the big dataset (>250MB) to MATLAB Drive and read table

```
BitcoinData = readtable('bitcoin-dataset.csv');
```

```
Warning: Column headers from the file were modified to make them valid MATLAB identifiers
before creating variable names for the table. The original column headers are saved in the
VariableDescriptions property.
Set 'VariableNamingRule' to 'preserve' to use the original column headers as table variable names.
```

```
Tablesize = size(BitcoinData)
```

```
Tablesize = 1×2
     4857377           8
```

```
head(BitcoinData,1)
```

```
ans = 1×8 table
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                
...
```

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 1 | 1.3253e+09 | 4.3900 | 4.3900 | 4.3900 | 4.3900 | 0.4556 |

## Convert timestamp

```
datetest = BitcoinData(:,1);
datetest = table2array(datetest);
BitcoinData.Timestamp = datetime(datetest, 'ConvertFrom', 'posixtime');
```

## Remove NaNs

```
% how many NaNs in each column
NaN2 = sum(isnan(BitcoinData.Open))
```

```
NaN2 = 1243608
```

```
NaN3 = sum(isnan(BitcoinData.High))
```

```
NaN3 = 1243608
```

```
NaN4 = sum(isnan(BitcoinData.Low))
```

```
NaN4 = 1243608
```

```
NaN5 = sum(isnan(BitcoinData.Close))
```

```
NaN5 = 1243608
```

```
NaN6 = sum(isnan(BitcoinData.Volume__BTC_))
```

```
NaN6 = 1243608
```

```
NaN7 = sum(isnan(BitcoinData.Volume__Currency_))
```

```
NaN7 = 1243608
```

```
NaN8 = sum(isnan(BitcoinData.Weighted_Price))
```

```
NaN8 = 1243608
```

```
% remove NaNs
BitcoinData = BitcoinData(isnan(BitcoinData.High) == 0,:);
```

## Select data

```
BitcoinDataTimetable = table2timetable(BitcoinData);

% March 2013
% S = timerange('17-Mar-2013 00:00:00','18-Mar-2013 23:59:00'); %2days
% S = timerange('17-Mar-2013 00:00:00','23-Mar-2013 23:59:00'); %7days
% S = timerange('17-Mar-2013 00:00:00','30-Mar-2013 23:59:00'); %14days

% March 2016
% S = timerange('17-Mar-2016 00:00:00','18-Mar-2016 23:59:00'); %2days
 S = timerange('17-Mar-2016 00:00:00','23-Mar-2016 23:59:00'); %7days
% S = timerange('17-Mar-2016 00:00:00','30-Mar-2016 23:59:00'); %14days

% March 2019
% S = timerange('17-Mar-2019 00:00:00','18-Mar-2019 23:59:00'); %2days
% S = timerange('17-Mar-2019 00:00:00','23-Mar-2019 23:59:00'); %7days
% S = timerange('17-Mar-2019 00:00:00','30-Mar-2019 23:59:00'); %14days

% March 2021
% S = timerange('17-Mar-2021 00:00:00','18-Mar-2021 23:59:00'); %2days
% S = timerange('17-Mar-2021 00:00:00','23-Mar-2021 23:59:00'); %7days
% S = timerange('17-Mar-2021 00:00:00','30-Mar-2021 23:59:00'); %14days

BitcoinData = BitcoinDataTimetable(S,:);
Tablesize = size(BitcoinData)
```

```
Tablesize = 1×2
        7640           7
```

## Create model - preprocessing

```
% standardization, and Initial predictor set (matrix)

Y = BitcoinData{:,"Close"}
```

```
Y = 7640×1
  416.5700
  416.5700
  416.5700
  416.5700
  416.8000
  416.4400
  416.7900
  416.7900
  416.7900
  416.7900
     ⋮
```

```
X = BitcoinData{:,[1:3]}
```

```
X = 7640×3
  416.5200  416.5700  416.5200
  416.5700  416.5700  416.5700
  416.5700  416.5700  416.5700
  416.5700  416.5700  416.5700
  416.2600  416.8000  416.2600
  416.7800  416.7800  416.4400
```

```
  416.5300  416.7900  416.5300
  416.1600  416.7900  416.1600
  416.7900  416.7900  416.7900
  416.7900  416.7900  416.7900
     ⋮
```

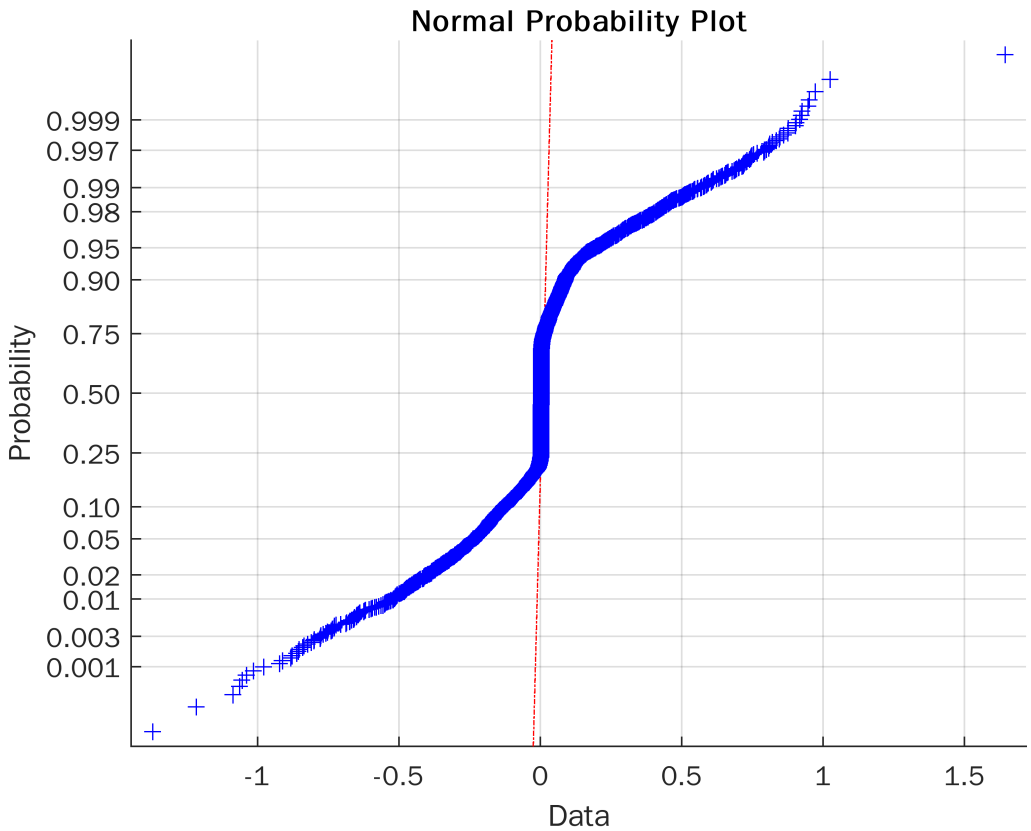
```
%Check model for outliers

LRPre = fitlm(zscore(X),Y)
```

```
LRPre =
Linear regression model:
    y ~ 1 + x1 + x2 + x3

Estimated Coefficients:
```

| | Estimate | SE | tStat | pValue |
|---|---|---|---|---|
| **(Intercept)** | 412.67 | 0.0017815 | 2.3164e+05 | 0 |
| **x1** | -2.329 | 0.044213 | -52.676 | 0 |
| **x2** | 3.6527 | 0.033486 | 109.08 | 0 |
| **x3** | 2.9062 | 0.030428 | 95.512 | 0 |

```
Number of observations: 7640, Error degrees of freedom: 7636
Root Mean Squared Error: 0.156
R-squared: 0.999,  Adjusted R-Squared: 0.999
F-statistic vs. constant model: 1.88e+06, p-value = 0
```

```
normplot(LRPre.Residuals.Raw)
```




## Identify and Remove Outliers

```
idx = isoutlier(BitcoinData.Close)
```

```
idx = 7640×1 logical array
   0
   0
   0
   0
   0
   0
   0
   0
   0
   0
     ⋮
```

```
sum(idx)
```

```
ans = 0
```

```
BitcoinData(idx,:) = []
```

```
BitcoinData = 7640×7 timetable
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                
```
...
```

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 1 | 17-Mar-2016 00:00:00 | 416.5200 | 416.5700 | 416.5200 | 416.5700 | 1.9988 |
```

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 2 | 17-Mar-2016 00:01:00 | 416.5700 | 416.5700 | 416.5700 | 416.5700 | 0.0427 |
| 3 | 17-Mar-2016 00:02:00 | 416.5700 | 416.5700 | 416.5700 | 416.5700 | 0.1000 |
| 4 | 17-Mar-2016 00:03:00 | 416.5700 | 416.5700 | 416.5700 | 416.5700 | 0.0760 |
| 5 | 17-Mar-2016 00:04:00 | 416.2600 | 416.8000 | 416.2600 | 416.8000 | 0.8190 |
| 6 | 17-Mar-2016 00:05:00 | 416.7800 | 416.7800 | 416.4400 | 416.4400 | 0.1365 |
| 7 | 17-Mar-2016 00:06:00 | 416.5300 | 416.7900 | 416.5300 | 416.7900 | 5.3670 |
| 8 | 17-Mar-2016 00:07:00 | 416.1600 | 416.7900 | 416.1600 | 416.7900 | 4.0567 |
| 9 | 17-Mar-2016 00:08:00 | 416.7900 | 416.7900 | 416.7900 | 416.7900 | 0.0200 |
| 10 | 17-Mar-2016 00:09:00 | 416.7900 | 416.7900 | 416.7900 | 416.7900 | 1.0823 |
| 11 | 17-Mar-2016 00:10:00 | 416.7900 | 416.7900 | 416.7900 | 416.7900 | 0.1460 |
| 12 | 17-Mar-2016 00:11:00 | 416.7900 | 416.7900 | 416.7900 | 416.7900 | 0.0500 |
| 13 | 17-Mar-2016 00:12:00 | 416.7900 | 416.8000 | 416.4200 | 416.4200 | 0.2654 |
| 14 | 17-Mar-2016 00:16:00 | 416.8000 | 416.8000 | 416.8000 | 416.8000 | 0.6906 |
| 15 | 17-Mar-2016 00:18:00 | 416.7900 | 416.7900 | 416.7900 | 416.7900 | 0.0300 |
| 16 | 17-Mar-2016 00:20:00 | 416.8000 | 416.8000 | 416.8000 | 416.8000 | 0.2970 |
| 17 | 17-Mar-2016 00:22:00 | 416.7800 | 416.7800 | 416.7800 | 416.7800 | 0.1492 |
| 18 | 17-Mar-2016 00:23:00 | 416.7900 | 416.7900 | 416.7900 | 416.7900 | 0.2085 |
| 19 | 17-Mar-2016 00:24:00 | 416.7800 | 416.8000 | 416.7800 | 416.8000 | 0.2446 |
| 20 | 17-Mar-2016 00:25:00 | 416.8000 | 416.8000 | 416.8000 | 416.8000 | 0.4203 |
| 21 | 17-Mar-2016 00:27:00 | 416.8000 | 416.8000 | 416.8000 | 416.8000 | 0.2292 |
| 22 | 17-Mar-2016 00:28:00 | 416.8800 | 416.8800 | 416.8800 | 416.8800 | 0.0878 |
| 23 | 17-Mar-2016 00:30:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 2.1660 |
| 24 | 17-Mar-2016 00:35:00 | 416.8200 | 416.8200 | 416.8200 | 416.8200 | 0.1287 |
| 25 | 17-Mar-2016 00:36:00 | 416.8700 | 416.8700 | 416.2300 | 416.2300 | 1.3485 |
| 26 | 17-Mar-2016 00:38:00 | 416.6700 | 416.6700 | 416.6700 | 416.6700 | 0.3488 |
| 27 | 17-Mar-2016 00:39:00 | 416.6700 | 416.6700 | 416.6700 | 416.6700 | 0.3990 |
| 28 | 17-Mar-2016 00:40:00 | 416.6600 | 416.6600 | 416.6600 | 416.6600 | 0.0720 |
| 29 | 17-Mar-2016 00:41:00 | 416.6500 | 416.6500 | 416.6500 | 416.6500 | 0.0472 |
| 30 | 17-Mar-2016 00:42:00 | 416.6500 | 416.6500 | 416.6500 | 416.6500 | 0.0623 |
| 31 | 17-Mar-2016 00:43:00 | 416.8000 | 416.8000 | 416.8000 | 416.8000 | 0.7251 |
| 32 | 17-Mar-2016 00:44:00 | 416.8000 | 416.8000 | 416.8000 | 416.8000 | 2.8363 |
| 33 | 17-Mar-2016 00:45:00 | 416.4600 | 416.8800 | 416.4600 | 416.8800 | 2.7474 |
| 34 | 17-Mar-2016 00:47:00 | 416.8800 | 416.8800 | 416.8800 | 416.8800 | 0.0625 |

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 35 | 17-Mar-2016 00:49:00 | 416.6000 | 416.6000 | 416.6000 | 416.6000 | 0.0136 |
| 36 | 17-Mar-2016 00:50:00 | 416.8800 | 416.8900 | 416.8800 | 416.8900 | 1.1145 |
| 37 | 17-Mar-2016 00:52:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 0.1970 |
| 38 | 17-Mar-2016 00:54:00 | 416.8800 | 416.8800 | 416.8800 | 416.8800 | 0.7271 |
| 39 | 17-Mar-2016 00:55:00 | 416.8800 | 416.8800 | 416.8800 | 416.8800 | 0.0127 |
| 40 | 17-Mar-2016 00:58:00 | 416.8100 | 416.8100 | 416.8100 | 416.8100 | 0.1500 |
| 41 | 17-Mar-2016 00:59:00 | 416.7700 | 416.7700 | 416.6600 | 416.6600 | 0.0909 |
| 42 | 17-Mar-2016 01:00:00 | 416.6600 | 416.6600 | 416.6600 | 416.6600 | 0.2000 |
| 43 | 17-Mar-2016 01:01:00 | 416.6600 | 416.6600 | 416.3600 | 416.6600 | 2.8050 |
| 44 | 17-Mar-2016 01:03:00 | 416.6600 | 416.8000 | 416.6600 | 416.8000 | 0.9954 |
| 45 | 17-Mar-2016 01:05:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.1163 |
| 46 | 17-Mar-2016 01:06:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.1290 |
| 47 | 17-Mar-2016 01:07:00 | 416.8400 | 416.8400 | 416.8000 | 416.8400 | 0.6477 |
| 48 | 17-Mar-2016 01:08:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.3348 |
| 49 | 17-Mar-2016 01:09:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 1.5653 |
| 50 | 17-Mar-2016 01:12:00 | 416.8100 | 416.8100 | 416.8100 | 416.8100 | 4.6978 |
| 51 | 17-Mar-2016 01:13:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.1136 |
| 52 | 17-Mar-2016 01:14:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.3083 |
| 53 | 17-Mar-2016 01:15:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.1000 |
| 54 | 17-Mar-2016 01:16:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 1.6008 |
| 55 | 17-Mar-2016 01:17:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.3113 |
| 56 | 17-Mar-2016 01:18:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.9211 |
| 57 | 17-Mar-2016 01:19:00 | 416.8100 | 416.8400 | 416.8100 | 416.8400 | 0.2923 |
| 58 | 17-Mar-2016 01:20:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.1120 |
| 59 | 17-Mar-2016 01:22:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 1.1004 |
| 60 | 17-Mar-2016 01:24:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.2070 |
| 61 | 17-Mar-2016 01:26:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.3395 |
| 62 | 17-Mar-2016 01:27:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.5258 |
| 63 | 17-Mar-2016 01:28:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.0210 |
| 64 | 17-Mar-2016 01:29:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.8659 |
| 65 | 17-Mar-2016 01:30:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.5916 |
| 66 | 17-Mar-2016 01:31:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.5606 |
| 67 | 17-Mar-2016 01:32:00 | 416.8100 | 416.8900 | 416.8100 | 416.8900 | 2.1192 |

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 68 | 17-Mar-2016 01:33:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 0.9575 |
| 69 | 17-Mar-2016 01:34:00 | 416.8700 | 416.8700 | 416.8700 | 416.8700 | 0.0489 |
| 70 | 17-Mar-2016 01:36:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 0.1472 |
| 71 | 17-Mar-2016 01:38:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 0.2163 |
| 72 | 17-Mar-2016 01:41:00 | 416.8900 | 416.9000 | 416.8900 | 416.9000 | 2.2546 |
| 73 | 17-Mar-2016 01:44:00 | 416.8100 | 416.9400 | 416.8000 | 416.9400 | 16.8117 |
| 74 | 17-Mar-2016 01:45:00 | 416.4000 | 416.4800 | 416.4000 | 416.4800 | 1 |
| 75 | 17-Mar-2016 01:46:00 | 416.5500 | 416.5500 | 416.3000 | 416.3000 | 21.7090 |
| 76 | 17-Mar-2016 01:48:00 | 416.7900 | 416.7900 | 416.7900 | 416.7900 | 0.7270 |
| 77 | 17-Mar-2016 01:49:00 | 416.1800 | 416.1800 | 416.1800 | 416.1800 | 0.0383 |
| 78 | 17-Mar-2016 01:50:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.1287 |
| 79 | 17-Mar-2016 01:52:00 | 416.8600 | 416.8600 | 416.8600 | 416.8600 | 0.0698 |
| 80 | 17-Mar-2016 01:54:00 | 416.8600 | 416.8600 | 416.8600 | 416.8600 | 0.0350 |
| 81 | 17-Mar-2016 01:56:00 | 416.8200 | 416.8200 | 416.6800 | 416.6800 | 0.9092 |
| 82 | 17-Mar-2016 02:02:00 | 416.8700 | 416.8700 | 416.8700 | 416.8700 | 0.0720 |
| 83 | 17-Mar-2016 02:03:00 | 416.8700 | 416.8900 | 416.8700 | 416.8900 | 1.1726 |
| 84 | 17-Mar-2016 02:04:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 0.0815 |
| 85 | 17-Mar-2016 02:06:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 0.6386 |
| 86 | 17-Mar-2016 02:08:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 0.8200 |
| 87 | 17-Mar-2016 02:11:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 0.2919 |
| 88 | 17-Mar-2016 02:12:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 0.2130 |
| 89 | 17-Mar-2016 02:14:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 0.7212 |
| 90 | 17-Mar-2016 02:16:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 0.1397 |
| 91 | 17-Mar-2016 02:17:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 1.3198 |
| 92 | 17-Mar-2016 02:19:00 | 416.8900 | 416.9100 | 416.8900 | 416.9100 | 0.0870 |
| 93 | 17-Mar-2016 02:20:00 | 416.9100 | 416.9100 | 416.9100 | 416.9100 | 0.4450 |
| 94 | 17-Mar-2016 02:26:00 | 416.9100 | 416.9100 | 416.9100 | 416.9100 | 1.2543 |
| 95 | 17-Mar-2016 02:27:00 | 416.9100 | 416.9100 | 416.9100 | 416.9100 | 3.4761 |
| 96 | 17-Mar-2016 02:28:00 | 416.9100 | 416.9100 | 416.9100 | 416.9100 | 0.0657 |
| 97 | 17-Mar-2016 02:30:00 | 416.9100 | 416.9200 | 416.9100 | 416.9200 | 3.5193 |
| 98 | 17-Mar-2016 02:31:00 | 416.2900 | 416.2900 | 416.2900 | 416.2900 | 0.3679 |
| 99 | 17-Mar-2016 02:34:00 | 416.9200 | 416.9200 | 416.9200 | 416.9200 | 1.0972 |
| 100 | 17-Mar-2016 02:35:00 | 416.9200 | 416.9200 | 416.9200 | 416.9200 | 0.4245 |

```
    ⋮
```

```
%outliers = outlier(BitcoinData.Close)

%Rerun model to check for more outliers
Y = BitcoinData{:,"Close"}
```

```
Y = 7640×1
  416.5700
  416.5700
  416.5700
  416.5700
  416.8000
  416.4400
  416.7900
  416.7900
  416.7900
  416.7900
    ⋮
```

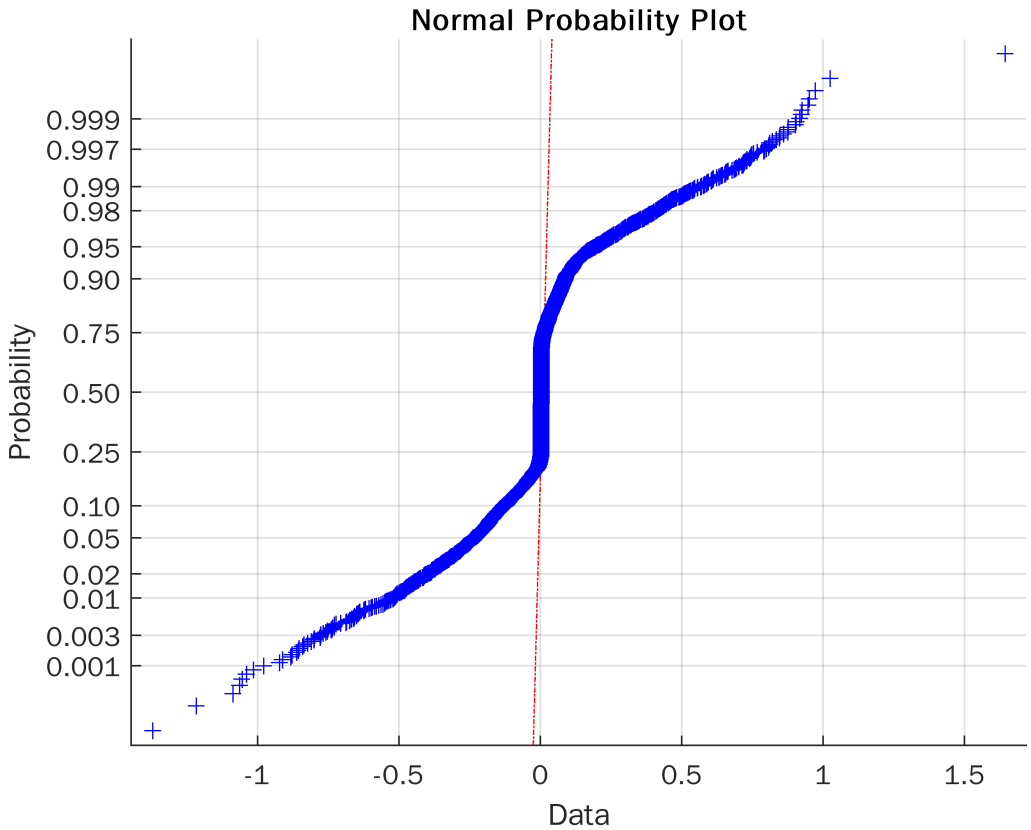
```
X = BitcoinData{:,[1:3]}
```

```
X = 7640×3
  416.5200  416.5700  416.5200
  416.5700  416.5700  416.5700
  416.5700  416.5700  416.5700
  416.5700  416.5700  416.5700
  416.2600  416.8000  416.2600
  416.7800  416.7800  416.4400
  416.5300  416.7900  416.5300
  416.1600  416.7900  416.1600
  416.7900  416.7900  416.7900
  416.7900  416.7900  416.7900
    ⋮
```

```
LRPre = fitlm(zscore(X),Y)
```

```
LRPre = 
Linear regression model:
    y ~ 1 + x1 + x2 + x3

Estimated Coefficients:
                   Estimate       SE          tStat       pValue  
                   ________    _________    __________    ______

    (Intercept)     412.67     0.0017815    2.3164e+05      0    
    x1              -2.329      0.044213       -52.676      0    
    x2              3.6527      0.033486        109.08      0    
    x3              2.9062      0.030428        95.512      0    


Number of observations: 7640, Error degrees of freedom: 7636
Root Mean Squared Error: 0.156
R-squared: 0.999,  Adjusted R-Squared: 0.999
F-statistic vs. constant model: 1.88e+06, p-value = 0
```

```
normplot(LRPre.Residuals.Raw)
```




```
idx = isoutlier(BitcoinData.Close)
```

```
idx = 7640×1 logical array
   0
   0
   0
   0
   0
   0
   0
   0
   0
   0
   0
   ⋮
```

```
sum(idx)
```

```
ans = 0
```

```
BitcoinData(idx,:) = []
```

```
BitcoinData = 7640×7 timetable
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                
```
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                
```
```

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 1 | 17-Mar-2016 00:00:00 | 416.5200 | 416.5700 | 416.5200 | 416.5700 | 1.9988 |
| 2 | 17-Mar-2016 00:01:00 | 416.5700 | 416.5700 | 416.5700 | 416.5700 | 0.0427 |

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 3 | 17-Mar-2016 00:02:00 | 416.5700 | 416.5700 | 416.5700 | 416.5700 | 0.1000 |
| 4 | 17-Mar-2016 00:03:00 | 416.5700 | 416.5700 | 416.5700 | 416.5700 | 0.0760 |
| 5 | 17-Mar-2016 00:04:00 | 416.2600 | 416.8000 | 416.2600 | 416.8000 | 0.8190 |
| 6 | 17-Mar-2016 00:05:00 | 416.7800 | 416.7800 | 416.4400 | 416.4400 | 0.1365 |
| 7 | 17-Mar-2016 00:06:00 | 416.5300 | 416.7900 | 416.5300 | 416.7900 | 5.3670 |
| 8 | 17-Mar-2016 00:07:00 | 416.1600 | 416.7900 | 416.1600 | 416.7900 | 4.0567 |
| 9 | 17-Mar-2016 00:08:00 | 416.7900 | 416.7900 | 416.7900 | 416.7900 | 0.0200 |
| 10 | 17-Mar-2016 00:09:00 | 416.7900 | 416.7900 | 416.7900 | 416.7900 | 1.0823 |
| 11 | 17-Mar-2016 00:10:00 | 416.7900 | 416.7900 | 416.7900 | 416.7900 | 0.1460 |
| 12 | 17-Mar-2016 00:11:00 | 416.7900 | 416.7900 | 416.7900 | 416.7900 | 0.0500 |
| 13 | 17-Mar-2016 00:12:00 | 416.7900 | 416.8000 | 416.4200 | 416.4200 | 0.2654 |
| 14 | 17-Mar-2016 00:16:00 | 416.8000 | 416.8000 | 416.8000 | 416.8000 | 0.6906 |
| 15 | 17-Mar-2016 00:18:00 | 416.7900 | 416.7900 | 416.7900 | 416.7900 | 0.0300 |
| 16 | 17-Mar-2016 00:20:00 | 416.8000 | 416.8000 | 416.8000 | 416.8000 | 0.2970 |
| 17 | 17-Mar-2016 00:22:00 | 416.7800 | 416.7800 | 416.7800 | 416.7800 | 0.1492 |
| 18 | 17-Mar-2016 00:23:00 | 416.7900 | 416.7900 | 416.7900 | 416.7900 | 0.2085 |
| 19 | 17-Mar-2016 00:24:00 | 416.7800 | 416.8000 | 416.7800 | 416.8000 | 0.2446 |
| 20 | 17-Mar-2016 00:25:00 | 416.8000 | 416.8000 | 416.8000 | 416.8000 | 0.4203 |
| 21 | 17-Mar-2016 00:27:00 | 416.8000 | 416.8000 | 416.8000 | 416.8000 | 0.2292 |
| 22 | 17-Mar-2016 00:28:00 | 416.8800 | 416.8800 | 416.8800 | 416.8800 | 0.0878 |
| 23 | 17-Mar-2016 00:30:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 2.1660 |
| 24 | 17-Mar-2016 00:35:00 | 416.8200 | 416.8200 | 416.8200 | 416.8200 | 0.1287 |
| 25 | 17-Mar-2016 00:36:00 | 416.8700 | 416.8700 | 416.2300 | 416.2300 | 1.3485 |
| 26 | 17-Mar-2016 00:38:00 | 416.6700 | 416.6700 | 416.6700 | 416.6700 | 0.3488 |
| 27 | 17-Mar-2016 00:39:00 | 416.6700 | 416.6700 | 416.6700 | 416.6700 | 0.3990 |
| 28 | 17-Mar-2016 00:40:00 | 416.6600 | 416.6600 | 416.6600 | 416.6600 | 0.0720 |
| 29 | 17-Mar-2016 00:41:00 | 416.6500 | 416.6500 | 416.6500 | 416.6500 | 0.0472 |
| 30 | 17-Mar-2016 00:42:00 | 416.6500 | 416.6500 | 416.6500 | 416.6500 | 0.0623 |
| 31 | 17-Mar-2016 00:43:00 | 416.8000 | 416.8000 | 416.8000 | 416.8000 | 0.7251 |
| 32 | 17-Mar-2016 00:44:00 | 416.8000 | 416.8000 | 416.8000 | 416.8000 | 2.8363 |
| 33 | 17-Mar-2016 00:45:00 | 416.4600 | 416.8800 | 416.4600 | 416.8800 | 2.7474 |
| 34 | 17-Mar-2016 00:47:00 | 416.8800 | 416.8800 | 416.8800 | 416.8800 | 0.0625 |
| 35 | 17-Mar-2016 00:49:00 | 416.6000 | 416.6000 | 416.6000 | 416.6000 | 0.0136 |

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 36 | 17-Mar-2016 00:50:00 | 416.8800 | 416.8900 | 416.8800 | 416.8900 | 1.1145 |
| 37 | 17-Mar-2016 00:52:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 0.1970 |
| 38 | 17-Mar-2016 00:54:00 | 416.8800 | 416.8800 | 416.8800 | 416.8800 | 0.7271 |
| 39 | 17-Mar-2016 00:55:00 | 416.8800 | 416.8800 | 416.8800 | 416.8800 | 0.0127 |
| 40 | 17-Mar-2016 00:58:00 | 416.8100 | 416.8100 | 416.8100 | 416.8100 | 0.1500 |
| 41 | 17-Mar-2016 00:59:00 | 416.7700 | 416.7700 | 416.6600 | 416.6600 | 0.0909 |
| 42 | 17-Mar-2016 01:00:00 | 416.6600 | 416.6600 | 416.6600 | 416.6600 | 0.2000 |
| 43 | 17-Mar-2016 01:01:00 | 416.6600 | 416.6600 | 416.3600 | 416.6600 | 2.8050 |
| 44 | 17-Mar-2016 01:03:00 | 416.6600 | 416.8000 | 416.6600 | 416.8000 | 0.9954 |
| 45 | 17-Mar-2016 01:05:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.1163 |
| 46 | 17-Mar-2016 01:06:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.1290 |
| 47 | 17-Mar-2016 01:07:00 | 416.8400 | 416.8400 | 416.8000 | 416.8400 | 0.6477 |
| 48 | 17-Mar-2016 01:08:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.3348 |
| 49 | 17-Mar-2016 01:09:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 1.5653 |
| 50 | 17-Mar-2016 01:12:00 | 416.8100 | 416.8100 | 416.8100 | 416.8100 | 4.6978 |
| 51 | 17-Mar-2016 01:13:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.1136 |
| 52 | 17-Mar-2016 01:14:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.3083 |
| 53 | 17-Mar-2016 01:15:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.1000 |
| 54 | 17-Mar-2016 01:16:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 1.6008 |
| 55 | 17-Mar-2016 01:17:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.3113 |
| 56 | 17-Mar-2016 01:18:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.9211 |
| 57 | 17-Mar-2016 01:19:00 | 416.8100 | 416.8400 | 416.8100 | 416.8400 | 0.2923 |
| 58 | 17-Mar-2016 01:20:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.1120 |
| 59 | 17-Mar-2016 01:22:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 1.1004 |
| 60 | 17-Mar-2016 01:24:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.2070 |
| 61 | 17-Mar-2016 01:26:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.3395 |
| 62 | 17-Mar-2016 01:27:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.5258 |
| 63 | 17-Mar-2016 01:28:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.0210 |
| 64 | 17-Mar-2016 01:29:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.8659 |
| 65 | 17-Mar-2016 01:30:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.5916 |
| 66 | 17-Mar-2016 01:31:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.5606 |
| 67 | 17-Mar-2016 01:32:00 | 416.8100 | 416.8900 | 416.8100 | 416.8900 | 2.1192 |
| 68 | 17-Mar-2016 01:33:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 0.9575 |

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 69 | 17-Mar-2016 01:34:00 | 416.8700 | 416.8700 | 416.8700 | 416.8700 | 0.0489 |
| 70 | 17-Mar-2016 01:36:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 0.1472 |
| 71 | 17-Mar-2016 01:38:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 0.2163 |
| 72 | 17-Mar-2016 01:41:00 | 416.8900 | 416.9000 | 416.8900 | 416.9000 | 2.2546 |
| 73 | 17-Mar-2016 01:44:00 | 416.8100 | 416.9400 | 416.8000 | 416.9400 | 16.8117 |
| 74 | 17-Mar-2016 01:45:00 | 416.4000 | 416.4800 | 416.4000 | 416.4800 | 1 |
| 75 | 17-Mar-2016 01:46:00 | 416.5500 | 416.5500 | 416.3000 | 416.3000 | 21.7090 |
| 76 | 17-Mar-2016 01:48:00 | 416.7900 | 416.7900 | 416.7900 | 416.7900 | 0.7270 |
| 77 | 17-Mar-2016 01:49:00 | 416.1800 | 416.1800 | 416.1800 | 416.1800 | 0.0383 |
| 78 | 17-Mar-2016 01:50:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.1287 |
| 79 | 17-Mar-2016 01:52:00 | 416.8600 | 416.8600 | 416.8600 | 416.8600 | 0.0698 |
| 80 | 17-Mar-2016 01:54:00 | 416.8600 | 416.8600 | 416.8600 | 416.8600 | 0.0350 |
| 81 | 17-Mar-2016 01:56:00 | 416.8200 | 416.8200 | 416.6800 | 416.6800 | 0.9092 |
| 82 | 17-Mar-2016 02:02:00 | 416.8700 | 416.8700 | 416.8700 | 416.8700 | 0.0720 |
| 83 | 17-Mar-2016 02:03:00 | 416.8700 | 416.8900 | 416.8700 | 416.8900 | 1.1726 |
| 84 | 17-Mar-2016 02:04:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 0.0815 |
| 85 | 17-Mar-2016 02:06:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 0.6386 |
| 86 | 17-Mar-2016 02:08:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 0.8200 |
| 87 | 17-Mar-2016 02:11:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 0.2919 |
| 88 | 17-Mar-2016 02:12:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 0.2130 |
| 89 | 17-Mar-2016 02:14:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 0.7212 |
| 90 | 17-Mar-2016 02:16:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 0.1397 |
| 91 | 17-Mar-2016 02:17:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 1.3198 |
| 92 | 17-Mar-2016 02:19:00 | 416.8900 | 416.9100 | 416.8900 | 416.9100 | 0.0870 |
| 93 | 17-Mar-2016 02:20:00 | 416.9100 | 416.9100 | 416.9100 | 416.9100 | 0.4450 |
| 94 | 17-Mar-2016 02:26:00 | 416.9100 | 416.9100 | 416.9100 | 416.9100 | 1.2543 |
| 95 | 17-Mar-2016 02:27:00 | 416.9100 | 416.9100 | 416.9100 | 416.9100 | 3.4761 |
| 96 | 17-Mar-2016 02:28:00 | 416.9100 | 416.9100 | 416.9100 | 416.9100 | 0.0657 |
| 97 | 17-Mar-2016 02:30:00 | 416.9100 | 416.9200 | 416.9100 | 416.9200 | 3.5193 |
| 98 | 17-Mar-2016 02:31:00 | 416.2900 | 416.2900 | 416.2900 | 416.2900 | 0.3679 |
| 99 | 17-Mar-2016 02:34:00 | 416.9200 | 416.9200 | 416.9200 | 416.9200 | 1.0972 |
| 100 | 17-Mar-2016 02:35:00 | 416.9200 | 416.9200 | 416.9200 | 416.9200 | 0.4245 |

⋮

```
%outliers = outlier(BitcoinData.Close)
```

## Split dataset into training and testing data

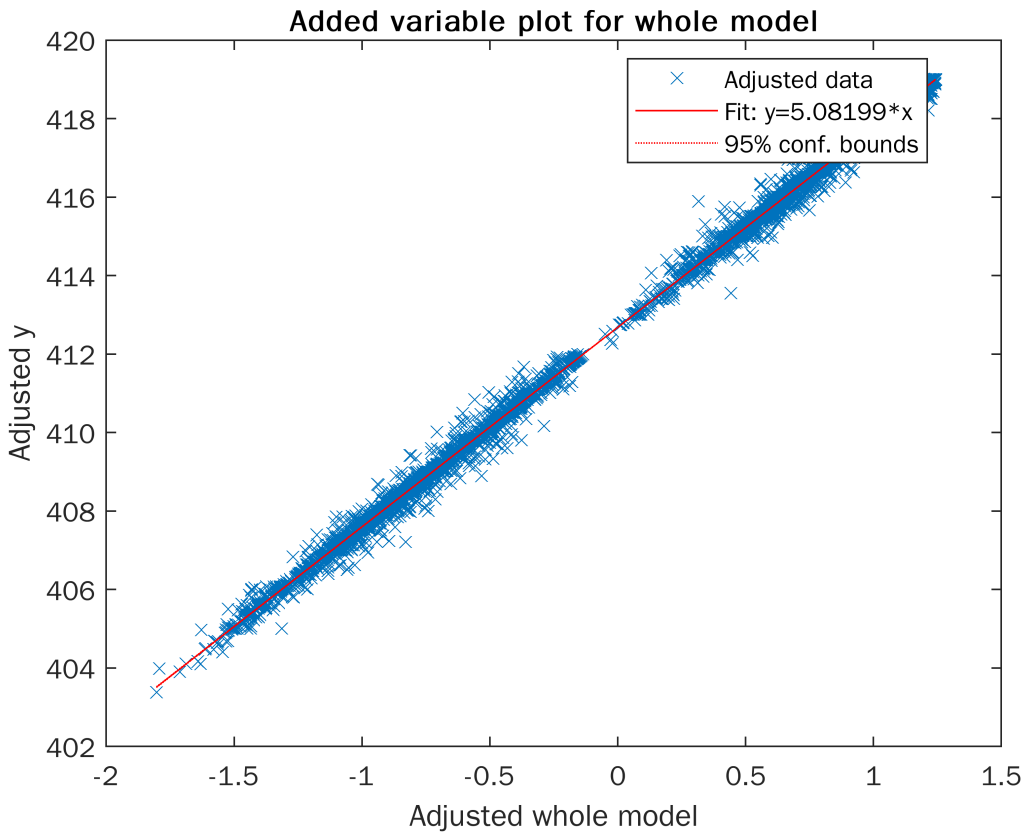
```
BitcoinData_new = [X, Y];

PD = 0.20;
cv = cvpartition(size(BitcoinData_new,1),'HoldOut',PD);
Xtrain = BitcoinData_new(cv.training,[1:end - 1]);
Ytrain = BitcoinData_new(cv.training,end);
Xtest = BitcoinData_new(cv.test, [1:end - 1]);
Ytest = BitcoinData_new(cv.test,end);
```

## Linear model with training-testing split

```
LRModel = fitlm(zscore(Xtrain),Ytrain)
```

```
LRModel = 
Linear regression model:
    y ~ 1 + x1 + x2 + x3

Estimated Coefficients:
                   Estimate       SE          tStat       pValue  
                   ________    _________    __________    ______

    (Intercept)     412.68     0.0020326    2.0303e+05      0    
    x1             -2.2074       0.05005       -44.103      0    
    x2              3.5878      0.037838        94.819      0    
    x3              2.8429      0.034499        82.404      0    


Number of observations: 6112, Error degrees of freedom: 6108
Root Mean Squared Error: 0.159
R-squared: 0.999,  Adjusted R-Squared: 0.999
F-statistic vs. constant model: 1.44e+06, p-value = 0
```

```
plot(LRModel)
```




```
LRModel.RMSE
```

```
ans = 0.1589
```

## Predict

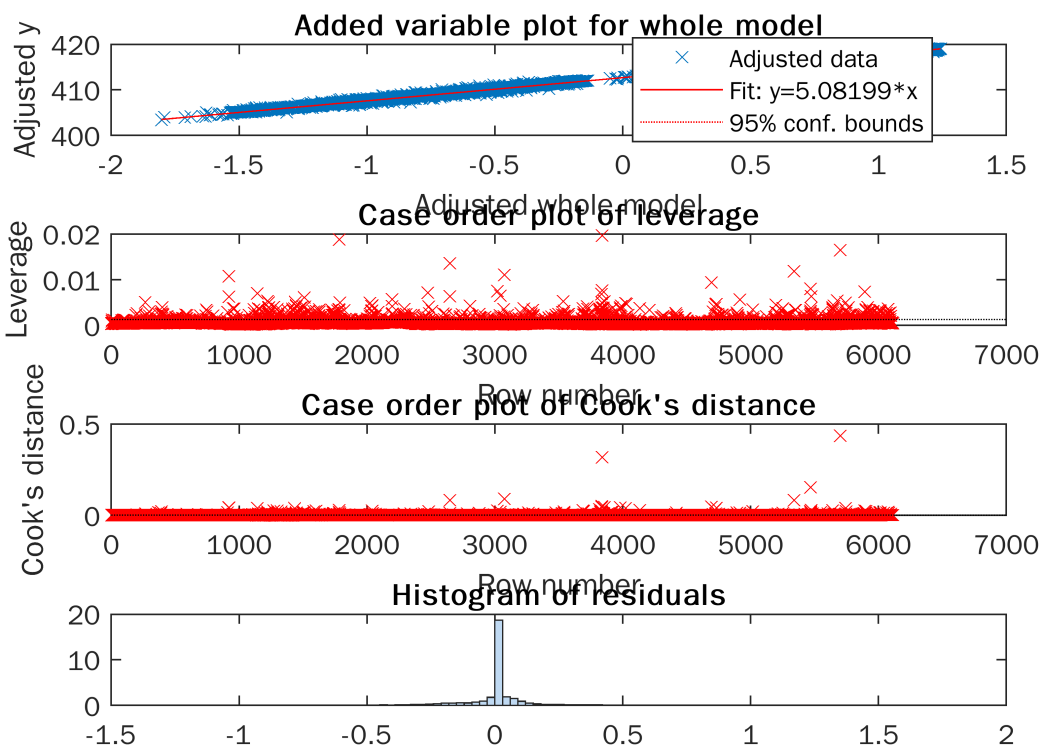
```
[YPred, Scores] = predict(LRModel,Xtest)
```

```
YPred = 1528×1
10^3 ×
    2.1727
    2.1729
    2.1730
    2.1724
    2.1723
    2.1733
    2.1733
    2.1731
    2.1730
    2.1731
      ⋮

Scores = 1528×2
10^3 ×
    2.1711    2.1744
    2.1712    2.1746
    2.1713    2.1746
    2.1707    2.1741
    2.1707    2.1740
    2.1717    2.1750
```

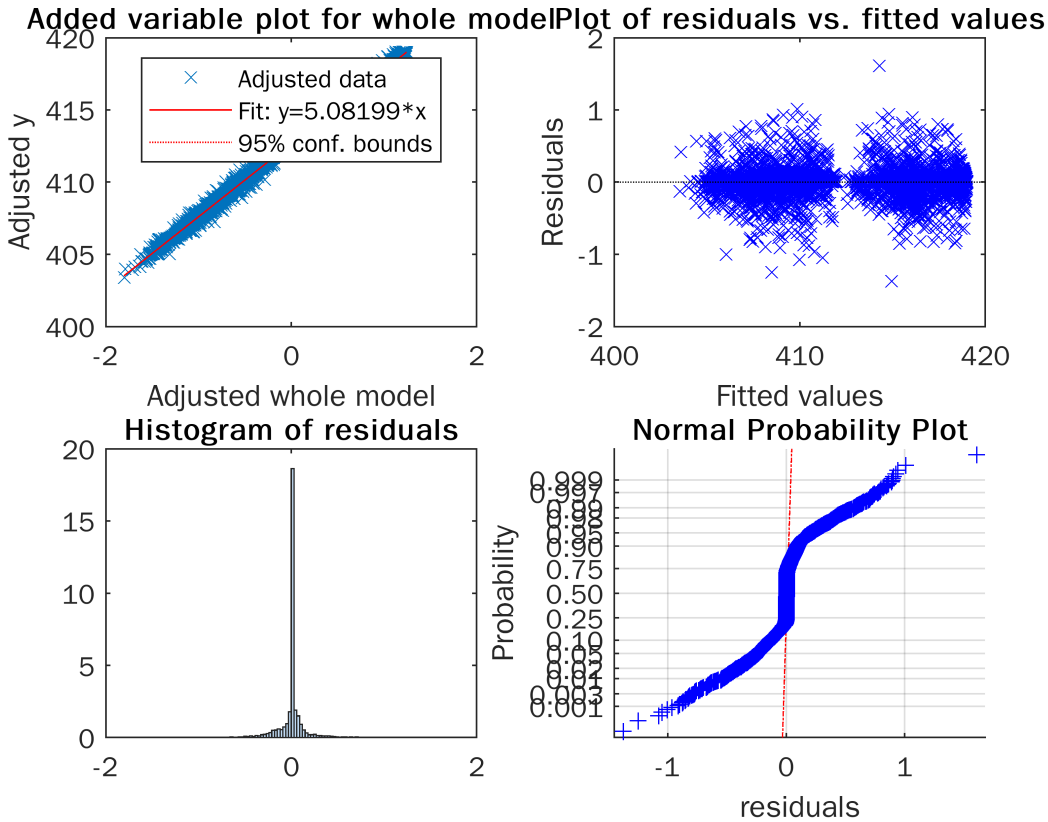
```
    2.1716    2.1750
    2.1715    2.1748
    2.1713    2.1747
    2.1715    2.1748
      ⋮
```

## Plots

```
figure,
subplot(4, 1, 1), plot(LRModel)
subplot(4, 1, 2), plotDiagnostics(LRModel)
subplot(4, 1, 3), plotDiagnostics(LRModel, 'cookd')
subplot(4, 1, 4), plotResiduals(LRModel)
```




```
figure,
subplot(2, 2, 1), plot(LRModel)
subplot(2, 2, 2), plotResiduals(LRModel,'fitted')
subplot(2, 2, 3), plotResiduals(LRModel)
subplot(2, 2, 4), normplot(LRModel.Residuals.Raw)
xlabel('residuals')
```


Added variable plot for whole model
Adjusted data
Fit: y=5.08199*x
95% conf. bounds
Adjusted y
Adjusted whole model
Plot of residuals vs. fitted values
Residuals
Fitted values
Histogram of residuals
Normal Probability Plot
Probability
residuals

## Upload the big dataset (>250MB) to MATLAB Drive and read table

```
BitcoinData = readtable('bitcoin-dataset.csv');
```

```
Warning: Column headers from the file were modified to make them valid MATLAB identifiers
before creating variable names for the table. The original column headers are saved in the
VariableDescriptions property.
Set 'VariableNamingRule' to 'preserve' to use the original column headers as table variable names.
```

```
Tablesize = size(BitcoinData)
```

```
Tablesize = 1×2
     4857377           8
```

```
head(BitcoinData,1)
```

```
ans = 1×8 table
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                
...
```

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 1 | 1.3253e+09 | 4.3900 | 4.3900 | 4.3900 | 4.3900 | 0.4556 |

## Convert timestamp

```
datetest = BitcoinData(:,1);
datetest = table2array(datetest);
BitcoinData.Timestamp = datetime(datetest, 'ConvertFrom', 'posixtime');
```

## Remove NaNs

```
% how many NaNs in each column
NaN2 = sum(isnan(BitcoinData.Open))
```

```
NaN2 = 1243608
```

```
NaN3 = sum(isnan(BitcoinData.High))
```

```
NaN3 = 1243608
```

```
NaN4 = sum(isnan(BitcoinData.Low))
```

```
NaN4 = 1243608
```

```
NaN5 = sum(isnan(BitcoinData.Close))
```

```
NaN5 = 1243608
```

```
NaN6 = sum(isnan(BitcoinData.Volume__BTC_))
```

```
NaN6 = 1243608
```

```
NaN7 = sum(isnan(BitcoinData.Volume__Currency_))
```

```
NaN7 = 1243608
```

```
NaN8 = sum(isnan(BitcoinData.Weighted_Price))
```

```
NaN8 = 1243608
```

```
% remove NaNs
BitcoinData = BitcoinData(isnan(BitcoinData.High) == 0,:);
```

## Select data

```
BitcoinDataTimetable = table2timetable(BitcoinData);

% March 2013
% S = timerange('17-Mar-2013 00:00:00','18-Mar-2013 23:59:00'); %2days
% S = timerange('17-Mar-2013 00:00:00','23-Mar-2013 23:59:00'); %7days
% S = timerange('17-Mar-2013 00:00:00','30-Mar-2013 23:59:00'); %14days

% March 2016
% S = timerange('17-Mar-2016 00:00:00','18-Mar-2016 23:59:00'); %2days
% S = timerange('17-Mar-2016 00:00:00','23-Mar-2016 23:59:00'); %7days
 S = timerange('17-Mar-2016 00:00:00','30-Mar-2016 23:59:00'); %14days

% March 2019
% S = timerange('17-Mar-2019 00:00:00','18-Mar-2019 23:59:00'); %2days
% S = timerange('17-Mar-2019 00:00:00','23-Mar-2019 23:59:00'); %7days
% S = timerange('17-Mar-2019 00:00:00','30-Mar-2019 23:59:00'); %14days

% March 2021
% S = timerange('17-Mar-2021 00:00:00','18-Mar-2021 23:59:00'); %2days
% S = timerange('17-Mar-2021 00:00:00','23-Mar-2021 23:59:00'); %7days
% S = timerange('17-Mar-2021 00:00:00','30-Mar-2021 23:59:00'); %14days

BitcoinData = BitcoinDataTimetable(S,:);
Tablesize = size(BitcoinData)
```

```
Tablesize = 1×2
       14704           7
```

## Create model - preprocessing

```
% standardization, and Initial predictor set (matrix)

Y = BitcoinData{:,"Close"}
```

```
Y = 14704×1
  416.5700
  416.5700
  416.5700
  416.5700
  416.8000
  416.4400
  416.7900
  416.7900
  416.7900
  416.7900
     ⋮
```

```
X = BitcoinData{:,[1:3]}
```

```
X = 14704×3
  416.5200  416.5700  416.5200
  416.5700  416.5700  416.5700
  416.5700  416.5700  416.5700
  416.5700  416.5700  416.5700
  416.2600  416.8000  416.2600
  416.7800  416.7800  416.4400
```

```
  416.5300  416.7900  416.5300
  416.1600  416.7900  416.1600
  416.7900  416.7900  416.7900
  416.7900  416.7900  416.7900
     ⋮
```

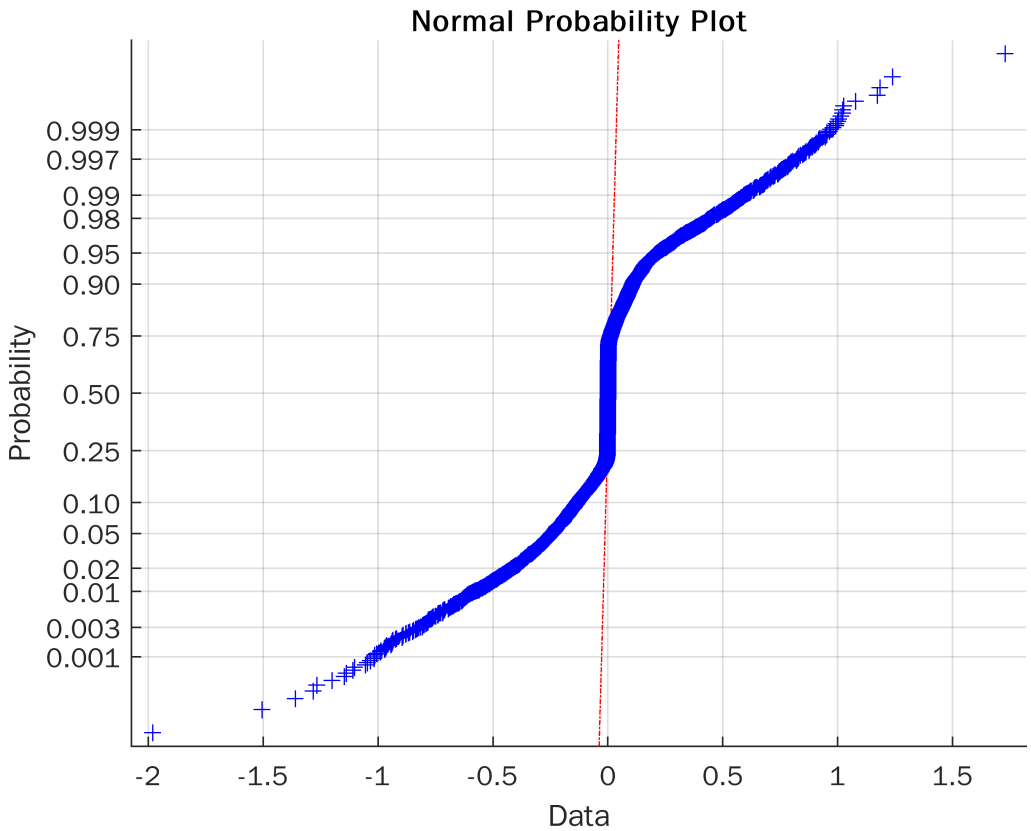
```
%Check model for outliers

LRPre = fitlm(zscore(X),Y)
```

```
LRPre =
Linear regression model:
    y ~ 1 + x1 + x2 + x3

Estimated Coefficients:
```

| | Estimate | SE | tStat | pValue |
|---|---|---|---|---|
| **(Intercept)** | 414.77 | 0.001375 | 3.0165e+05 | 0 |
| **x1** | -2.5178 | 0.034736 | -72.483 | 0 |
| **x2** | 3.8031 | 0.026332 | 144.43 | 0 |
| **x3** | 3.3268 | 0.024218 | 137.37 | 0 |

```
Number of observations: 14704, Error degrees of freedom: 14700
Root Mean Squared Error: 0.167
R-squared: 0.999,  Adjusted R-Squared: 0.999
F-statistic vs. constant model: 3.75e+06, p-value = 0
```

```
normplot(LRPre.Residuals.Raw)
```




## Identify and Remove Outliers

```
idx = isoutlier(BitcoinData.Close)
```

```
idx = 14704×1 logical array
   0
   0
   0
   0
   0
   0
   0
   0
   0
   0
     ⋮
```

```
sum(idx)
```

```
ans = 233
```

```
BitcoinData(idx,:) = []
```

```
BitcoinData = 14471×7 timetable
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                
```
...
```

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 1 | 17-Mar-2016 00:00:00 | 416.5200 | 416.5700 | 416.5200 | 416.5700 | 1.9988 |
```

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 2 | 17-Mar-2016 00:01:00 | 416.5700 | 416.5700 | 416.5700 | 416.5700 | 0.0427 |
| 3 | 17-Mar-2016 00:02:00 | 416.5700 | 416.5700 | 416.5700 | 416.5700 | 0.1000 |
| 4 | 17-Mar-2016 00:03:00 | 416.5700 | 416.5700 | 416.5700 | 416.5700 | 0.0760 |
| 5 | 17-Mar-2016 00:04:00 | 416.2600 | 416.8000 | 416.2600 | 416.8000 | 0.8190 |
| 6 | 17-Mar-2016 00:05:00 | 416.7800 | 416.7800 | 416.4400 | 416.4400 | 0.1365 |
| 7 | 17-Mar-2016 00:06:00 | 416.5300 | 416.7900 | 416.5300 | 416.7900 | 5.3670 |
| 8 | 17-Mar-2016 00:07:00 | 416.1600 | 416.7900 | 416.1600 | 416.7900 | 4.0567 |
| 9 | 17-Mar-2016 00:08:00 | 416.7900 | 416.7900 | 416.7900 | 416.7900 | 0.0200 |
| 10 | 17-Mar-2016 00:09:00 | 416.7900 | 416.7900 | 416.7900 | 416.7900 | 1.0823 |
| 11 | 17-Mar-2016 00:10:00 | 416.7900 | 416.7900 | 416.7900 | 416.7900 | 0.1460 |
| 12 | 17-Mar-2016 00:11:00 | 416.7900 | 416.7900 | 416.7900 | 416.7900 | 0.0500 |
| 13 | 17-Mar-2016 00:12:00 | 416.7900 | 416.8000 | 416.4200 | 416.4200 | 0.2654 |
| 14 | 17-Mar-2016 00:16:00 | 416.8000 | 416.8000 | 416.8000 | 416.8000 | 0.6906 |
| 15 | 17-Mar-2016 00:18:00 | 416.7900 | 416.7900 | 416.7900 | 416.7900 | 0.0300 |
| 16 | 17-Mar-2016 00:20:00 | 416.8000 | 416.8000 | 416.8000 | 416.8000 | 0.2970 |
| 17 | 17-Mar-2016 00:22:00 | 416.7800 | 416.7800 | 416.7800 | 416.7800 | 0.1492 |
| 18 | 17-Mar-2016 00:23:00 | 416.7900 | 416.7900 | 416.7900 | 416.7900 | 0.2085 |
| 19 | 17-Mar-2016 00:24:00 | 416.7800 | 416.8000 | 416.7800 | 416.8000 | 0.2446 |
| 20 | 17-Mar-2016 00:25:00 | 416.8000 | 416.8000 | 416.8000 | 416.8000 | 0.4203 |
| 21 | 17-Mar-2016 00:27:00 | 416.8000 | 416.8000 | 416.8000 | 416.8000 | 0.2292 |
| 22 | 17-Mar-2016 00:28:00 | 416.8800 | 416.8800 | 416.8800 | 416.8800 | 0.0878 |
| 23 | 17-Mar-2016 00:30:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 2.1660 |
| 24 | 17-Mar-2016 00:35:00 | 416.8200 | 416.8200 | 416.8200 | 416.8200 | 0.1287 |
| 25 | 17-Mar-2016 00:36:00 | 416.8700 | 416.8700 | 416.2300 | 416.2300 | 1.3485 |
| 26 | 17-Mar-2016 00:38:00 | 416.6700 | 416.6700 | 416.6700 | 416.6700 | 0.3488 |
| 27 | 17-Mar-2016 00:39:00 | 416.6700 | 416.6700 | 416.6700 | 416.6700 | 0.3990 |
| 28 | 17-Mar-2016 00:40:00 | 416.6600 | 416.6600 | 416.6600 | 416.6600 | 0.0720 |
| 29 | 17-Mar-2016 00:41:00 | 416.6500 | 416.6500 | 416.6500 | 416.6500 | 0.0472 |
| 30 | 17-Mar-2016 00:42:00 | 416.6500 | 416.6500 | 416.6500 | 416.6500 | 0.0623 |
| 31 | 17-Mar-2016 00:43:00 | 416.8000 | 416.8000 | 416.8000 | 416.8000 | 0.7251 |
| 32 | 17-Mar-2016 00:44:00 | 416.8000 | 416.8000 | 416.8000 | 416.8000 | 2.8363 |
| 33 | 17-Mar-2016 00:45:00 | 416.4600 | 416.8800 | 416.4600 | 416.8800 | 2.7474 |
| 34 | 17-Mar-2016 00:47:00 | 416.8800 | 416.8800 | 416.8800 | 416.8800 | 0.0625 |

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 35 | 17-Mar-2016 00:49:00 | 416.6000 | 416.6000 | 416.6000 | 416.6000 | 0.0136 |
| 36 | 17-Mar-2016 00:50:00 | 416.8800 | 416.8900 | 416.8800 | 416.8900 | 1.1145 |
| 37 | 17-Mar-2016 00:52:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 0.1970 |
| 38 | 17-Mar-2016 00:54:00 | 416.8800 | 416.8800 | 416.8800 | 416.8800 | 0.7271 |
| 39 | 17-Mar-2016 00:55:00 | 416.8800 | 416.8800 | 416.8800 | 416.8800 | 0.0127 |
| 40 | 17-Mar-2016 00:58:00 | 416.8100 | 416.8100 | 416.8100 | 416.8100 | 0.1500 |
| 41 | 17-Mar-2016 00:59:00 | 416.7700 | 416.7700 | 416.6600 | 416.6600 | 0.0909 |
| 42 | 17-Mar-2016 01:00:00 | 416.6600 | 416.6600 | 416.6600 | 416.6600 | 0.2000 |
| 43 | 17-Mar-2016 01:01:00 | 416.6600 | 416.6600 | 416.3600 | 416.6600 | 2.8050 |
| 44 | 17-Mar-2016 01:03:00 | 416.6600 | 416.8000 | 416.6600 | 416.8000 | 0.9954 |
| 45 | 17-Mar-2016 01:05:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.1163 |
| 46 | 17-Mar-2016 01:06:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.1290 |
| 47 | 17-Mar-2016 01:07:00 | 416.8400 | 416.8400 | 416.8000 | 416.8400 | 0.6477 |
| 48 | 17-Mar-2016 01:08:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.3348 |
| 49 | 17-Mar-2016 01:09:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 1.5653 |
| 50 | 17-Mar-2016 01:12:00 | 416.8100 | 416.8100 | 416.8100 | 416.8100 | 4.6978 |
| 51 | 17-Mar-2016 01:13:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.1136 |
| 52 | 17-Mar-2016 01:14:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.3083 |
| 53 | 17-Mar-2016 01:15:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.1000 |
| 54 | 17-Mar-2016 01:16:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 1.6008 |
| 55 | 17-Mar-2016 01:17:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.3113 |
| 56 | 17-Mar-2016 01:18:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.9211 |
| 57 | 17-Mar-2016 01:19:00 | 416.8100 | 416.8400 | 416.8100 | 416.8400 | 0.2923 |
| 58 | 17-Mar-2016 01:20:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.1120 |
| 59 | 17-Mar-2016 01:22:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 1.1004 |
| 60 | 17-Mar-2016 01:24:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.2070 |
| 61 | 17-Mar-2016 01:26:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.3395 |
| 62 | 17-Mar-2016 01:27:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.5258 |
| 63 | 17-Mar-2016 01:28:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.0210 |
| 64 | 17-Mar-2016 01:29:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.8659 |
| 65 | 17-Mar-2016 01:30:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.5916 |
| 66 | 17-Mar-2016 01:31:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.5606 |
| 67 | 17-Mar-2016 01:32:00 | 416.8100 | 416.8900 | 416.8100 | 416.8900 | 2.1192 |

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 68 | 17-Mar-2016 01:33:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 0.9575 |
| 69 | 17-Mar-2016 01:34:00 | 416.8700 | 416.8700 | 416.8700 | 416.8700 | 0.0489 |
| 70 | 17-Mar-2016 01:36:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 0.1472 |
| 71 | 17-Mar-2016 01:38:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 0.2163 |
| 72 | 17-Mar-2016 01:41:00 | 416.8900 | 416.9000 | 416.8900 | 416.9000 | 2.2546 |
| 73 | 17-Mar-2016 01:44:00 | 416.8100 | 416.9400 | 416.8000 | 416.9400 | 16.8117 |
| 74 | 17-Mar-2016 01:45:00 | 416.4000 | 416.4800 | 416.4000 | 416.4800 | 1 |
| 75 | 17-Mar-2016 01:46:00 | 416.5500 | 416.5500 | 416.3000 | 416.3000 | 21.7090 |
| 76 | 17-Mar-2016 01:48:00 | 416.7900 | 416.7900 | 416.7900 | 416.7900 | 0.7270 |
| 77 | 17-Mar-2016 01:49:00 | 416.1800 | 416.1800 | 416.1800 | 416.1800 | 0.0383 |
| 78 | 17-Mar-2016 01:50:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.1287 |
| 79 | 17-Mar-2016 01:52:00 | 416.8600 | 416.8600 | 416.8600 | 416.8600 | 0.0698 |
| 80 | 17-Mar-2016 01:54:00 | 416.8600 | 416.8600 | 416.8600 | 416.8600 | 0.0350 |
| 81 | 17-Mar-2016 01:56:00 | 416.8200 | 416.8200 | 416.6800 | 416.6800 | 0.9092 |
| 82 | 17-Mar-2016 02:02:00 | 416.8700 | 416.8700 | 416.8700 | 416.8700 | 0.0720 |
| 83 | 17-Mar-2016 02:03:00 | 416.8700 | 416.8900 | 416.8700 | 416.8900 | 1.1726 |
| 84 | 17-Mar-2016 02:04:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 0.0815 |
| 85 | 17-Mar-2016 02:06:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 0.6386 |
| 86 | 17-Mar-2016 02:08:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 0.8200 |
| 87 | 17-Mar-2016 02:11:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 0.2919 |
| 88 | 17-Mar-2016 02:12:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 0.2130 |
| 89 | 17-Mar-2016 02:14:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 0.7212 |
| 90 | 17-Mar-2016 02:16:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 0.1397 |
| 91 | 17-Mar-2016 02:17:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 1.3198 |
| 92 | 17-Mar-2016 02:19:00 | 416.8900 | 416.9100 | 416.8900 | 416.9100 | 0.0870 |
| 93 | 17-Mar-2016 02:20:00 | 416.9100 | 416.9100 | 416.9100 | 416.9100 | 0.4450 |
| 94 | 17-Mar-2016 02:26:00 | 416.9100 | 416.9100 | 416.9100 | 416.9100 | 1.2543 |
| 95 | 17-Mar-2016 02:27:00 | 416.9100 | 416.9100 | 416.9100 | 416.9100 | 3.4761 |
| 96 | 17-Mar-2016 02:28:00 | 416.9100 | 416.9100 | 416.9100 | 416.9100 | 0.0657 |
| 97 | 17-Mar-2016 02:30:00 | 416.9100 | 416.9200 | 416.9100 | 416.9200 | 3.5193 |
| 98 | 17-Mar-2016 02:31:00 | 416.2900 | 416.2900 | 416.2900 | 416.2900 | 0.3679 |
| 99 | 17-Mar-2016 02:34:00 | 416.9200 | 416.9200 | 416.9200 | 416.9200 | 1.0972 |
| 100 | 17-Mar-2016 02:35:00 | 416.9200 | 416.9200 | 416.9200 | 416.9200 | 0.4245 |

```
    ⋮
```

```
%outliers = outlier(BitcoinData.Close)

%Rerun model to check for more outliers
Y = BitcoinData{:,"Close"}
```

```
Y = 14471×1
  416.5700
  416.5700
  416.5700
  416.5700
  416.8000
  416.4400
  416.7900
  416.7900
  416.7900
  416.7900
    ⋮
```

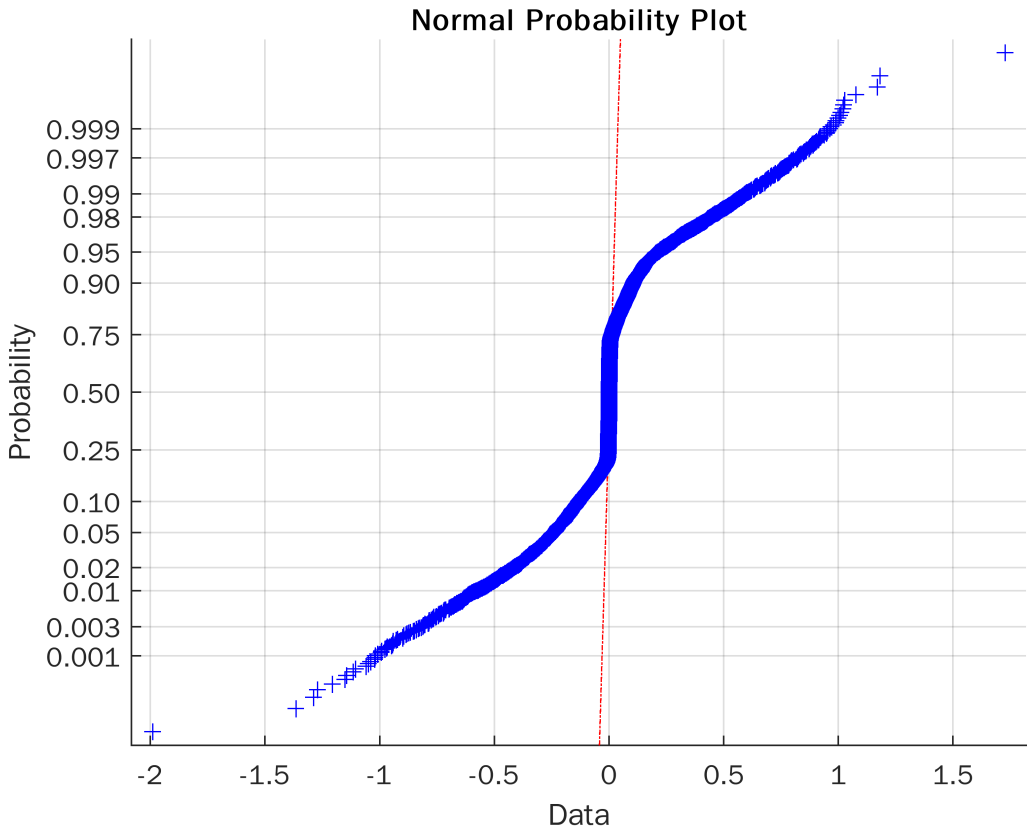
```
X = BitcoinData{:,[1:3]}
```

```
X = 14471×3
  416.5200  416.5700  416.5200
  416.5700  416.5700  416.5700
  416.5700  416.5700  416.5700
  416.5700  416.5700  416.5700
  416.2600  416.8000  416.2600
  416.7800  416.7800  416.4400
  416.5300  416.7900  416.5300
  416.1600  416.7900  416.1600
  416.7900  416.7900  416.7900
  416.7900  416.7900  416.7900
    ⋮
```

```
LRPre = fitlm(zscore(X),Y)
```

```
LRPre = 
Linear regression model:
    y ~ 1 + x1 + x2 + x3

Estimated Coefficients:
                   Estimate       SE          tStat       pValue  
                   ________    _________    __________    ______

    (Intercept)     414.68     0.0013765    3.0125e+05      0    
    x1             -2.4316      0.033604       -72.361      0    
    x2              3.6691      0.025496        143.91      0    
    x3              3.1926      0.023361        136.66      0    


Number of observations: 14471, Error degrees of freedom: 14467
Root Mean Squared Error: 0.166
R-squared: 0.999,  Adjusted R-Squared: 0.999
F-statistic vs. constant model: 3.45e+06, p-value = 0
```

```
normplot(LRPre.Residuals.Raw)
```




```
idx = isoutlier(BitcoinData.Close)
```

```
idx = 14471×1 logical array
   0
   0
   0
   0
   0
   0
   0
   0
   0
   0
   0
   ⋮
```

```
sum(idx)
```

```
ans = 183
```

```
BitcoinData(idx,:) = []
```

```
BitcoinData = 14288×7 timetable
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                
```
...
```

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 1 | 17-Mar-2016 00:00:00 | 416.5200 | 416.5700 | 416.5200 | 416.5700 | 1.9988 |
| 2 | 17-Mar-2016 00:01:00 | 416.5700 | 416.5700 | 416.5700 | 416.5700 | 0.0427 |
```

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 3 | 17-Mar-2016 00:02:00 | 416.5700 | 416.5700 | 416.5700 | 416.5700 | 0.1000 |
| 4 | 17-Mar-2016 00:03:00 | 416.5700 | 416.5700 | 416.5700 | 416.5700 | 0.0760 |
| 5 | 17-Mar-2016 00:04:00 | 416.2600 | 416.8000 | 416.2600 | 416.8000 | 0.8190 |
| 6 | 17-Mar-2016 00:05:00 | 416.7800 | 416.7800 | 416.4400 | 416.4400 | 0.1365 |
| 7 | 17-Mar-2016 00:06:00 | 416.5300 | 416.7900 | 416.5300 | 416.7900 | 5.3670 |
| 8 | 17-Mar-2016 00:07:00 | 416.1600 | 416.7900 | 416.1600 | 416.7900 | 4.0567 |
| 9 | 17-Mar-2016 00:08:00 | 416.7900 | 416.7900 | 416.7900 | 416.7900 | 0.0200 |
| 10 | 17-Mar-2016 00:09:00 | 416.7900 | 416.7900 | 416.7900 | 416.7900 | 1.0823 |
| 11 | 17-Mar-2016 00:10:00 | 416.7900 | 416.7900 | 416.7900 | 416.7900 | 0.1460 |
| 12 | 17-Mar-2016 00:11:00 | 416.7900 | 416.7900 | 416.7900 | 416.7900 | 0.0500 |
| 13 | 17-Mar-2016 00:12:00 | 416.7900 | 416.8000 | 416.4200 | 416.4200 | 0.2654 |
| 14 | 17-Mar-2016 00:16:00 | 416.8000 | 416.8000 | 416.8000 | 416.8000 | 0.6906 |
| 15 | 17-Mar-2016 00:18:00 | 416.7900 | 416.7900 | 416.7900 | 416.7900 | 0.0300 |
| 16 | 17-Mar-2016 00:20:00 | 416.8000 | 416.8000 | 416.8000 | 416.8000 | 0.2970 |
| 17 | 17-Mar-2016 00:22:00 | 416.7800 | 416.7800 | 416.7800 | 416.7800 | 0.1492 |
| 18 | 17-Mar-2016 00:23:00 | 416.7900 | 416.7900 | 416.7900 | 416.7900 | 0.2085 |
| 19 | 17-Mar-2016 00:24:00 | 416.7800 | 416.8000 | 416.7800 | 416.8000 | 0.2446 |
| 20 | 17-Mar-2016 00:25:00 | 416.8000 | 416.8000 | 416.8000 | 416.8000 | 0.4203 |
| 21 | 17-Mar-2016 00:27:00 | 416.8000 | 416.8000 | 416.8000 | 416.8000 | 0.2292 |
| 22 | 17-Mar-2016 00:28:00 | 416.8800 | 416.8800 | 416.8800 | 416.8800 | 0.0878 |
| 23 | 17-Mar-2016 00:30:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 2.1660 |
| 24 | 17-Mar-2016 00:35:00 | 416.8200 | 416.8200 | 416.8200 | 416.8200 | 0.1287 |
| 25 | 17-Mar-2016 00:36:00 | 416.8700 | 416.8700 | 416.2300 | 416.2300 | 1.3485 |
| 26 | 17-Mar-2016 00:38:00 | 416.6700 | 416.6700 | 416.6700 | 416.6700 | 0.3488 |
| 27 | 17-Mar-2016 00:39:00 | 416.6700 | 416.6700 | 416.6700 | 416.6700 | 0.3990 |
| 28 | 17-Mar-2016 00:40:00 | 416.6600 | 416.6600 | 416.6600 | 416.6600 | 0.0720 |
| 29 | 17-Mar-2016 00:41:00 | 416.6500 | 416.6500 | 416.6500 | 416.6500 | 0.0472 |
| 30 | 17-Mar-2016 00:42:00 | 416.6500 | 416.6500 | 416.6500 | 416.6500 | 0.0623 |
| 31 | 17-Mar-2016 00:43:00 | 416.8000 | 416.8000 | 416.8000 | 416.8000 | 0.7251 |
| 32 | 17-Mar-2016 00:44:00 | 416.8000 | 416.8000 | 416.8000 | 416.8000 | 2.8363 |
| 33 | 17-Mar-2016 00:45:00 | 416.4600 | 416.8800 | 416.4600 | 416.8800 | 2.7474 |
| 34 | 17-Mar-2016 00:47:00 | 416.8800 | 416.8800 | 416.8800 | 416.8800 | 0.0625 |
| 35 | 17-Mar-2016 00:49:00 | 416.6000 | 416.6000 | 416.6000 | 416.6000 | 0.0136 |

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 36 | 17-Mar-2016 00:50:00 | 416.8800 | 416.8900 | 416.8800 | 416.8900 | 1.1145 |
| 37 | 17-Mar-2016 00:52:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 0.1970 |
| 38 | 17-Mar-2016 00:54:00 | 416.8800 | 416.8800 | 416.8800 | 416.8800 | 0.7271 |
| 39 | 17-Mar-2016 00:55:00 | 416.8800 | 416.8800 | 416.8800 | 416.8800 | 0.0127 |
| 40 | 17-Mar-2016 00:58:00 | 416.8100 | 416.8100 | 416.8100 | 416.8100 | 0.1500 |
| 41 | 17-Mar-2016 00:59:00 | 416.7700 | 416.7700 | 416.6600 | 416.6600 | 0.0909 |
| 42 | 17-Mar-2016 01:00:00 | 416.6600 | 416.6600 | 416.6600 | 416.6600 | 0.2000 |
| 43 | 17-Mar-2016 01:01:00 | 416.6600 | 416.6600 | 416.3600 | 416.6600 | 2.8050 |
| 44 | 17-Mar-2016 01:03:00 | 416.6600 | 416.8000 | 416.6600 | 416.8000 | 0.9954 |
| 45 | 17-Mar-2016 01:05:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.1163 |
| 46 | 17-Mar-2016 01:06:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.1290 |
| 47 | 17-Mar-2016 01:07:00 | 416.8400 | 416.8400 | 416.8000 | 416.8400 | 0.6477 |
| 48 | 17-Mar-2016 01:08:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.3348 |
| 49 | 17-Mar-2016 01:09:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 1.5653 |
| 50 | 17-Mar-2016 01:12:00 | 416.8100 | 416.8100 | 416.8100 | 416.8100 | 4.6978 |
| 51 | 17-Mar-2016 01:13:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.1136 |
| 52 | 17-Mar-2016 01:14:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.3083 |
| 53 | 17-Mar-2016 01:15:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.1000 |
| 54 | 17-Mar-2016 01:16:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 1.6008 |
| 55 | 17-Mar-2016 01:17:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.3113 |
| 56 | 17-Mar-2016 01:18:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.9211 |
| 57 | 17-Mar-2016 01:19:00 | 416.8100 | 416.8400 | 416.8100 | 416.8400 | 0.2923 |
| 58 | 17-Mar-2016 01:20:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.1120 |
| 59 | 17-Mar-2016 01:22:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 1.1004 |
| 60 | 17-Mar-2016 01:24:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.2070 |
| 61 | 17-Mar-2016 01:26:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.3395 |
| 62 | 17-Mar-2016 01:27:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.5258 |
| 63 | 17-Mar-2016 01:28:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.0210 |
| 64 | 17-Mar-2016 01:29:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.8659 |
| 65 | 17-Mar-2016 01:30:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.5916 |
| 66 | 17-Mar-2016 01:31:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.5606 |
| 67 | 17-Mar-2016 01:32:00 | 416.8100 | 416.8900 | 416.8100 | 416.8900 | 2.1192 |
| 68 | 17-Mar-2016 01:33:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 0.9575 |

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 69 | 17-Mar-2016 01:34:00 | 416.8700 | 416.8700 | 416.8700 | 416.8700 | 0.0489 |
| 70 | 17-Mar-2016 01:36:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 0.1472 |
| 71 | 17-Mar-2016 01:38:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 0.2163 |
| 72 | 17-Mar-2016 01:41:00 | 416.8900 | 416.9000 | 416.8900 | 416.9000 | 2.2546 |
| 73 | 17-Mar-2016 01:44:00 | 416.8100 | 416.9400 | 416.8000 | 416.9400 | 16.8117 |
| 74 | 17-Mar-2016 01:45:00 | 416.4000 | 416.4800 | 416.4000 | 416.4800 | 1 |
| 75 | 17-Mar-2016 01:46:00 | 416.5500 | 416.5500 | 416.3000 | 416.3000 | 21.7090 |
| 76 | 17-Mar-2016 01:48:00 | 416.7900 | 416.7900 | 416.7900 | 416.7900 | 0.7270 |
| 77 | 17-Mar-2016 01:49:00 | 416.1800 | 416.1800 | 416.1800 | 416.1800 | 0.0383 |
| 78 | 17-Mar-2016 01:50:00 | 416.8400 | 416.8400 | 416.8400 | 416.8400 | 0.1287 |
| 79 | 17-Mar-2016 01:52:00 | 416.8600 | 416.8600 | 416.8600 | 416.8600 | 0.0698 |
| 80 | 17-Mar-2016 01:54:00 | 416.8600 | 416.8600 | 416.8600 | 416.8600 | 0.0350 |
| 81 | 17-Mar-2016 01:56:00 | 416.8200 | 416.8200 | 416.6800 | 416.6800 | 0.9092 |
| 82 | 17-Mar-2016 02:02:00 | 416.8700 | 416.8700 | 416.8700 | 416.8700 | 0.0720 |
| 83 | 17-Mar-2016 02:03:00 | 416.8700 | 416.8900 | 416.8700 | 416.8900 | 1.1726 |
| 84 | 17-Mar-2016 02:04:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 0.0815 |
| 85 | 17-Mar-2016 02:06:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 0.6386 |
| 86 | 17-Mar-2016 02:08:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 0.8200 |
| 87 | 17-Mar-2016 02:11:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 0.2919 |
| 88 | 17-Mar-2016 02:12:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 0.2130 |
| 89 | 17-Mar-2016 02:14:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 0.7212 |
| 90 | 17-Mar-2016 02:16:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 0.1397 |
| 91 | 17-Mar-2016 02:17:00 | 416.8900 | 416.8900 | 416.8900 | 416.8900 | 1.3198 |
| 92 | 17-Mar-2016 02:19:00 | 416.8900 | 416.9100 | 416.8900 | 416.9100 | 0.0870 |
| 93 | 17-Mar-2016 02:20:00 | 416.9100 | 416.9100 | 416.9100 | 416.9100 | 0.4450 |
| 94 | 17-Mar-2016 02:26:00 | 416.9100 | 416.9100 | 416.9100 | 416.9100 | 1.2543 |
| 95 | 17-Mar-2016 02:27:00 | 416.9100 | 416.9100 | 416.9100 | 416.9100 | 3.4761 |
| 96 | 17-Mar-2016 02:28:00 | 416.9100 | 416.9100 | 416.9100 | 416.9100 | 0.0657 |
| 97 | 17-Mar-2016 02:30:00 | 416.9100 | 416.9200 | 416.9100 | 416.9200 | 3.5193 |
| 98 | 17-Mar-2016 02:31:00 | 416.2900 | 416.2900 | 416.2900 | 416.2900 | 0.3679 |
| 99 | 17-Mar-2016 02:34:00 | 416.9200 | 416.9200 | 416.9200 | 416.9200 | 1.0972 |
| 100 | 17-Mar-2016 02:35:00 | 416.9200 | 416.9200 | 416.9200 | 416.9200 | 0.4245 |

⋮

```
%outliers = outlier(BitcoinData.Close)
```

## Split dataset into training and testing data

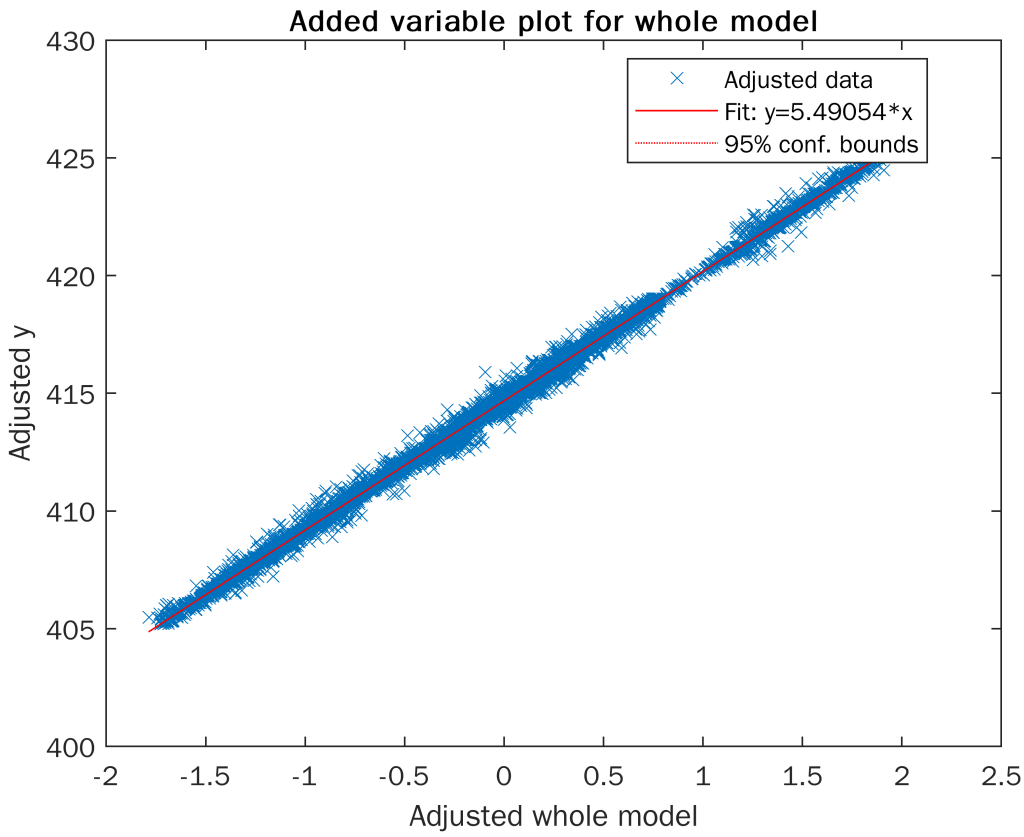
```
BitcoinData_new = [X, Y];

PD = 0.20;
cv = cvpartition(size(BitcoinData_new,1),'HoldOut',PD);
Xtrain = BitcoinData_new(cv.training,[1:end - 1]);
Ytrain = BitcoinData_new(cv.training,end);
Xtest = BitcoinData_new(cv.test, [1:end - 1]);
Ytest = BitcoinData_new(cv.test,end);
```

## Linear model with training-testing split

```
LRModel = fitlm(zscore(Xtrain),Ytrain)
```

```
LRModel = 
Linear regression model:
    y ~ 1 + x1 + x2 + x3

Estimated Coefficients:
                   Estimate       SE          tStat       pValue  
                   ________    _________    __________    ______

    (Intercept)     414.68     0.0015484    2.6781e+05      0    
    x1              -2.471      0.037717       -65.514      0    
    x2              3.6933      0.028886        127.85      0    
    x3              3.2249      0.025996        124.06      0    


Number of observations: 11577, Error degrees of freedom: 11573
Root Mean Squared Error: 0.167
R-squared: 0.999,  Adjusted R-Squared: 0.999
F-statistic vs. constant model: 2.75e+06, p-value = 0
```

```
plot(LRModel)
```




```
LRModel.RMSE
```

```
ans = 0.1666
```

## Predict

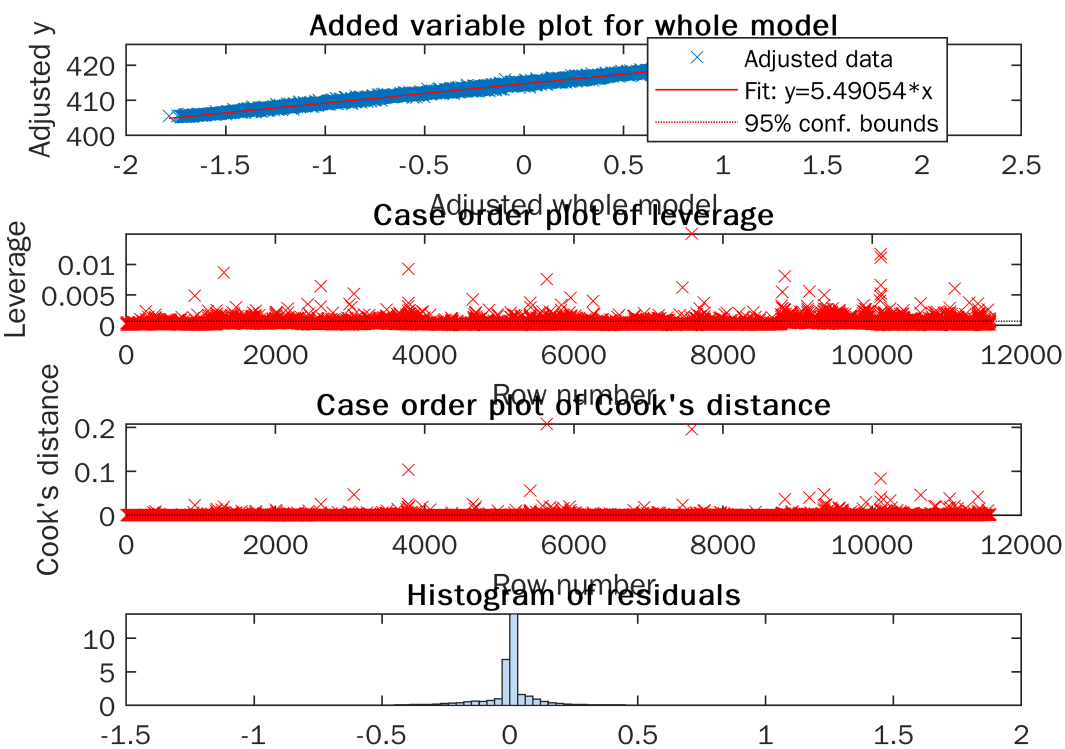
```
[YPred, Scores] = predict(LRModel,Xtest)
```

```
YPred = 2894×1
10^3 ×
    2.2672
    2.2677
    2.2682
    2.2682
    2.2683
    2.2686
    2.2676
    2.2674
    2.2687
    2.2686
      ⋮

Scores = 2894×2
10^3 ×
    2.2660    2.2685
    2.2665    2.2690
    2.2670    2.2695
    2.2670    2.2695
    2.2670    2.2695
    2.2674    2.2699
```

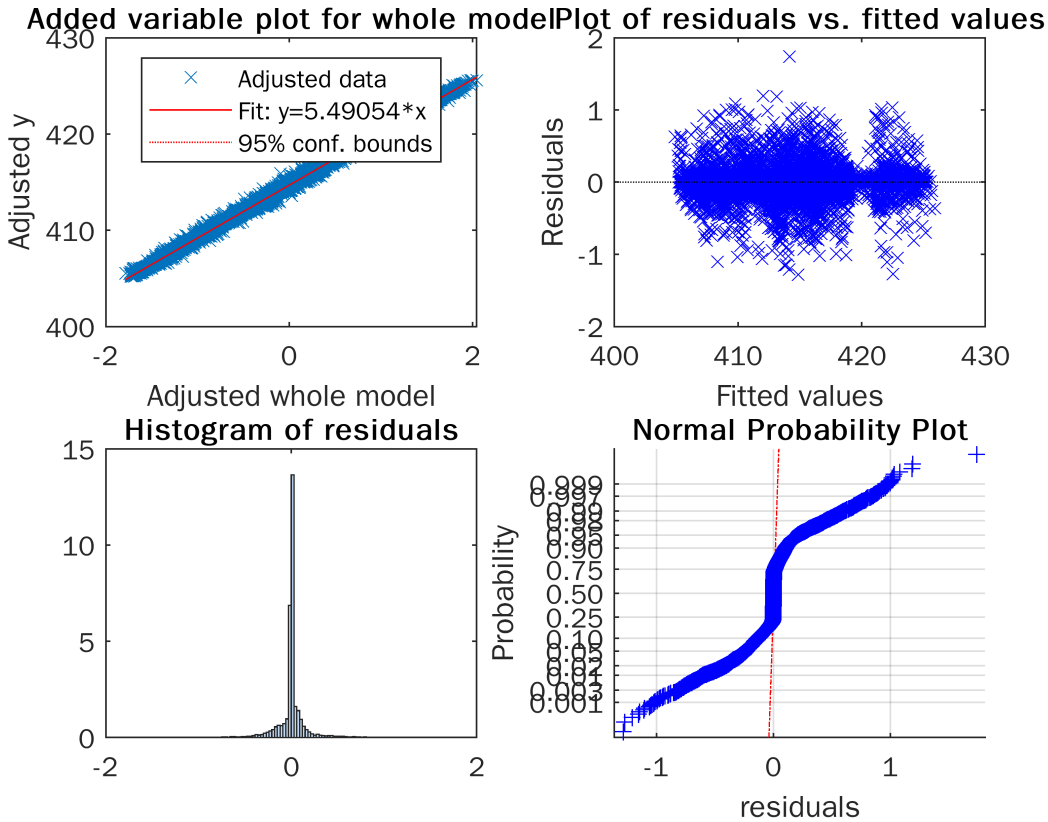
```
    2.2663    2.2689
    2.2661    2.2686
    2.2674    2.2699
    2.2674    2.2699
      ⋮
```

## Plots

```
figure,
subplot(4, 1, 1), plot(LRModel)
subplot(4, 1, 2), plotDiagnostics(LRModel)
subplot(4, 1, 3), plotDiagnostics(LRModel, 'cookd')
subplot(4, 1, 4), plotResiduals(LRModel)
```




```
figure,
subplot(2, 2, 1), plot(LRModel)
subplot(2, 2, 2), plotResiduals(LRModel,'fitted')
subplot(2, 2, 3), plotResiduals(LRModel)
subplot(2, 2, 4), normplot(LRModel.Residuals.Raw)
xlabel('residuals')
```


Added variable plot for whole model
Adjusted data
Fit: y=5.49054*x
95% conf. bounds
Adjusted y
Adjusted whole model
Plot of residuals vs. fitted values
Residuals
Fitted values
Histogram of residuals
Normal Probability Plot
Probability
residuals

## Upload the big dataset (>250MB) to MATLAB Drive and read table

```
BitcoinData = readtable('bitcoin-dataset.csv');
```

```
Warning: Column headers from the file were modified to make them valid MATLAB identifiers
before creating variable names for the table. The original column headers are saved in the
VariableDescriptions property.
Set 'VariableNamingRule' to 'preserve' to use the original column headers as table variable names.
```

```
Tablesize = size(BitcoinData)
```

```
Tablesize = 1×2
     4857377           8
```

```
head(BitcoinData,1)
```

```
ans = 1×8 table
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                
...
```

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 1 | 1.3253e+09 | 4.3900 | 4.3900 | 4.3900 | 4.3900 | 0.4556 |

## Convert timestamp

```
datetest = BitcoinData(:,1);
datetest = table2array(datetest);
BitcoinData.Timestamp = datetime(datetest, 'ConvertFrom', 'posixtime');
```

## Remove NaNs

```
% how many NaNs in each column
NaN2 = sum(isnan(BitcoinData.Open))
```

```
NaN2 = 1243608
```

```
NaN3 = sum(isnan(BitcoinData.High))
```

```
NaN3 = 1243608
```

```
NaN4 = sum(isnan(BitcoinData.Low))
```

```
NaN4 = 1243608
```

```
NaN5 = sum(isnan(BitcoinData.Close))
```

```
NaN5 = 1243608
```

```
NaN6 = sum(isnan(BitcoinData.Volume__BTC_))
```

```
NaN6 = 1243608
```

```
NaN7 = sum(isnan(BitcoinData.Volume__Currency_))
```

```
NaN7 = 1243608
```

```
NaN8 = sum(isnan(BitcoinData.Weighted_Price))
```

```
NaN8 = 1243608
```

```
% remove NaNs
BitcoinData = BitcoinData(isnan(BitcoinData.High) == 0,:);
```

## Select data

```
BitcoinDataTimetable = table2timetable(BitcoinData);

% March 2013
% S = timerange('17-Mar-2013 00:00:00','18-Mar-2013 23:59:00'); %2days
% S = timerange('17-Mar-2013 00:00:00','23-Mar-2013 23:59:00'); %7days
% S = timerange('17-Mar-2013 00:00:00','30-Mar-2013 23:59:00'); %14days

% March 2016
% S = timerange('17-Mar-2016 00:00:00','18-Mar-2016 23:59:00'); %2days
% S = timerange('17-Mar-2016 00:00:00','23-Mar-2016 23:59:00'); %7days
% S = timerange('17-Mar-2016 00:00:00','30-Mar-2016 23:59:00'); %14days

% March 2019
 S = timerange('17-Mar-2019 00:00:00','18-Mar-2019 23:59:00'); %2days
% S = timerange('17-Mar-2019 00:00:00','23-Mar-2019 23:59:00'); %7days
% S = timerange('17-Mar-2019 00:00:00','30-Mar-2019 23:59:00'); %14days

% March 2021
% S = timerange('17-Mar-2021 00:00:00','18-Mar-2021 23:59:00'); %2days
% S = timerange('17-Mar-2021 00:00:00','23-Mar-2021 23:59:00'); %7days
% S = timerange('17-Mar-2021 00:00:00','30-Mar-2021 23:59:00'); %14days

BitcoinData = BitcoinDataTimetable(S,:);
Tablesize = size(BitcoinData)
```

```
Tablesize = 1×2
        2528           7
```

## Create model - preprocessing

```
% standardization, and Initial predictor set (matrix)

Y = BitcoinData{:,"Close"}
```

```
Y = 2528×1
10^3 ×
    3.9900
    3.9899
    3.9909
    3.9924
    3.9902
    3.9918
    3.9922
    3.9922
    3.9919
    3.9919
     ⋮
```

```
X = BitcoinData{:,[1:3]}
```

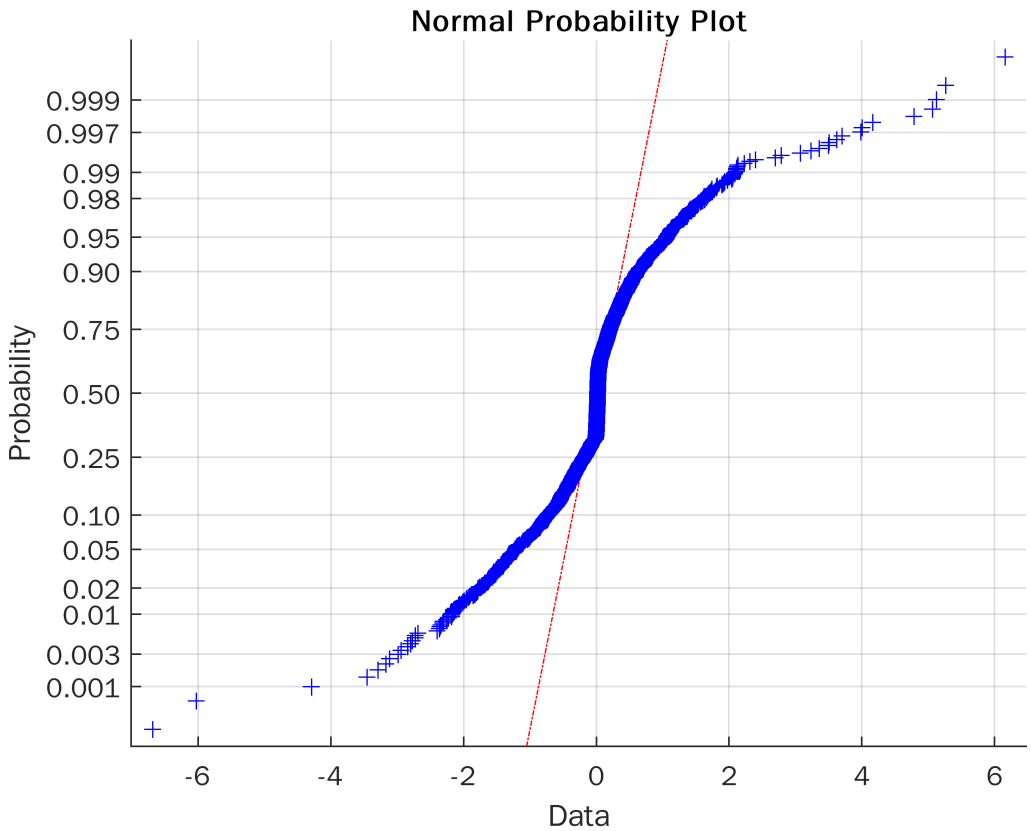
```
X = 2528×3
10^3 ×
    3.9900    3.9900    3.9900
    3.9900    3.9900    3.9899
    3.9900    3.9918    3.9900
    3.9910    3.9924    3.9899
```

```
    3.9902    3.9902    3.9902
    3.9914    3.9918    3.9914
    3.9922    3.9922    3.9922
    3.9909    3.9922    3.9909
    3.9919    3.9919    3.9919
    3.9919    3.9919    3.9919
     ⋮
```

```
%Check model for outliers

LRPre = fitlm(zscore(X),Y)
```

```
LRPre = 
Linear regression model:
    y ~ 1 + x1 + x2 + x3

Estimated Coefficients:
                   Estimate       SE         tStat         pValue  
                   ________    ________    __________    __________

    (Intercept)     3966.4     0.014769    2.6857e+05             0
    x1             -7.0633      0.20745       -34.048    2.0105e-209
    x2              10.668      0.16385        65.105             0
    x3              9.2436       0.1417        65.235             0


Number of observations: 2528, Error degrees of freedom: 2524
Root Mean Squared Error: 0.743
R-squared: 0.997,  Adjusted R-Squared: 0.997
F-statistic vs. constant model: 2.52e+05, p-value = 0
```

```
normplot(LRPre.Residuals.Raw)
```




## Identify and Remove Outliers

```
idx = isoutlier(BitcoinData.Close)
```

```
idx = 2528×1 logical array
   0
   0
   0
   0
   0
   0
   0
   0
   0
   0
     ⋮
```

```
sum(idx)
```

```
ans = 112
```

```
BitcoinData(idx,:) = []
```

```
BitcoinData = 2416×7 timetable
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                
```
...
```

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 1 | 17-Mar-2019 00:00:00 | 3990 | 3990 | 3990 | 3990 | 1.6034 |
```

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 2 | 17-Mar-2019 00:01:00 | 3990 | 3990 | 3.9899e+03 | 3.9899e+03 | 0.9532 |
| 3 | 17-Mar-2019 00:02:00 | 3990 | 3.9918e+03 | 3990 | 3.9909e+03 | 2.0498 |
| 4 | 17-Mar-2019 00:04:00 | 3.9910e+03 | 3.9924e+03 | 3.9899e+03 | 3.9924e+03 | 3.2865 |
| 5 | 17-Mar-2019 00:06:00 | 3.9902e+03 | 3.9902e+03 | 3.9902e+03 | 3.9902e+03 | 0.1500 |
| 6 | 17-Mar-2019 00:07:00 | 3.9914e+03 | 3.9918e+03 | 3.9914e+03 | 3.9918e+03 | 0.2979 |
| 7 | 17-Mar-2019 00:08:00 | 3.9922e+03 | 3.9922e+03 | 3.9922e+03 | 3.9922e+03 | 0.0500 |
| 8 | 17-Mar-2019 00:09:00 | 3.9909e+03 | 3.9922e+03 | 3.9909e+03 | 3.9922e+03 | 1.3248 |
| 9 | 17-Mar-2019 00:10:00 | 3.9919e+03 | 3.9919e+03 | 3.9919e+03 | 3.9919e+03 | 0.0119 |
| 10 | 17-Mar-2019 00:11:00 | 3.9919e+03 | 3.9919e+03 | 3.9919e+03 | 3.9919e+03 | 0.0578 |
| 11 | 17-Mar-2019 00:12:00 | 3.9919e+03 | 3.9919e+03 | 3.9919e+03 | 3.9919e+03 | 0.0119 |
| 12 | 17-Mar-2019 00:13:00 | 3.9900e+03 | 3.9907e+03 | 3.9883e+03 | 3.9907e+03 | 0.7568 |
| 13 | 17-Mar-2019 00:14:00 | 3.9882e+03 | 3.9890e+03 | 3.9850e+03 | 3.9880e+03 | 8.6849 |
| 14 | 17-Mar-2019 00:15:00 | 3.9850e+03 | 3.9885e+03 | 3.9850e+03 | 3.9881e+03 | 2.7837 |
| 15 | 17-Mar-2019 00:16:00 | 3.9880e+03 | 3.9880e+03 | 3.9852e+03 | 3.9852e+03 | 0.2055 |
| 16 | 17-Mar-2019 00:17:00 | 3.9848e+03 | 3.9849e+03 | 3.9750e+03 | 3.9751e+03 | 34.7895 |
| 17 | 17-Mar-2019 00:18:00 | 3974 | 3.9744e+03 | 3.9589e+03 | 3.9641e+03 | 95.6286 |
| 18 | 17-Mar-2019 00:19:00 | 3.9641e+03 | 3.9763e+03 | 3.9641e+03 | 3.9763e+03 | 6.4694 |
| 19 | 17-Mar-2019 00:20:00 | 3.9763e+03 | 3.9763e+03 | 3.9746e+03 | 3.9753e+03 | 1.0630 |
| 20 | 17-Mar-2019 00:21:00 | 3.9769e+03 | 3.9783e+03 | 3.9769e+03 | 3.9783e+03 | 2.1030 |
| 21 | 17-Mar-2019 00:22:00 | 3.9793e+03 | 3.9805e+03 | 3.9793e+03 | 3.9802e+03 | 0.1511 |
| 22 | 17-Mar-2019 00:23:00 | 3.9773e+03 | 3.9773e+03 | 3.9746e+03 | 3.9746e+03 | 0.0450 |
| 23 | 17-Mar-2019 00:24:00 | 3.9817e+03 | 3.9818e+03 | 3.9809e+03 | 3.9809e+03 | 1.3872 |
| 24 | 17-Mar-2019 00:25:00 | 3.9771e+03 | 3.9771e+03 | 3.9767e+03 | 3.9767e+03 | 0.3348 |
| 25 | 17-Mar-2019 00:26:00 | 3.9760e+03 | 3.9771e+03 | 3.9738e+03 | 3.9771e+03 | 0.3810 |
| 26 | 17-Mar-2019 00:27:00 | 3.9781e+03 | 3.9791e+03 | 3.9781e+03 | 3.9791e+03 | 0.9907 |
| 27 | 17-Mar-2019 00:28:00 | 3.9797e+03 | 3.9806e+03 | 3.9797e+03 | 3.9806e+03 | 0.1389 |
| 28 | 17-Mar-2019 00:29:00 | 3.9798e+03 | 3.9798e+03 | 3.9797e+03 | 3.9797e+03 | 1.2995 |
| 29 | 17-Mar-2019 00:30:00 | 3.9765e+03 | 3.9774e+03 | 3.9727e+03 | 3.9732e+03 | 3.9176 |
| 30 | 17-Mar-2019 00:31:00 | 3.9732e+03 | 3.9736e+03 | 3.9700e+03 | 3.9700e+03 | 0.8799 |
| 31 | 17-Mar-2019 00:32:00 | 3.9692e+03 | 3.9692e+03 | 3.9691e+03 | 3.9691e+03 | 3.1234 |
| 32 | 17-Mar-2019 00:33:00 | 3.9733e+03 | 3.9733e+03 | 3.9733e+03 | 3.9733e+03 | 0.0303 |
| 33 | 17-Mar-2019 00:34:00 | 3.9743e+03 | 3.9744e+03 | 3.9743e+03 | 3.9744e+03 | 1.1186 |
| 34 | 17-Mar-2019 00:35:00 | 3.9702e+03 | 3.9702e+03 | 3.9694e+03 | 3.9694e+03 | 1.1398 |

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 35 | 17-Mar-2019 00:36:00 | 3.9700e+03 | 3.9700e+03 | 3.9668e+03 | 3.9668e+03 | 1.6151 |
| 36 | 17-Mar-2019 00:37:00 | 3.9679e+03 | 3.9685e+03 | 3.9629e+03 | 3.9629e+03 | 5.5367 |
| 37 | 17-Mar-2019 00:38:00 | 3.9616e+03 | 3.9616e+03 | 3.9556e+03 | 3.9593e+03 | 31.6548 |
| 38 | 17-Mar-2019 00:39:00 | 3.9629e+03 | 3.9660e+03 | 3.9628e+03 | 3.9660e+03 | 8.2058 |
| 39 | 17-Mar-2019 00:40:00 | 3.9670e+03 | 3.9670e+03 | 3960 | 3.9652e+03 | 80.6532 |
| 40 | 17-Mar-2019 00:41:00 | 3.9650e+03 | 3.9650e+03 | 3.9607e+03 | 3.9607e+03 | 2.2074 |
| 41 | 17-Mar-2019 00:42:00 | 3.9612e+03 | 3.9625e+03 | 3.9585e+03 | 3.9602e+03 | 4.8431 |
| 42 | 17-Mar-2019 00:43:00 | 3.9592e+03 | 3.9613e+03 | 3.9592e+03 | 3.9613e+03 | 0.7638 |
| 43 | 17-Mar-2019 00:44:00 | 3.9616e+03 | 3.9645e+03 | 3.9616e+03 | 3.9645e+03 | 0.4583 |
| 44 | 17-Mar-2019 00:45:00 | 3.9614e+03 | 3.9614e+03 | 3.9614e+03 | 3.9614e+03 | 0.5045 |
| 45 | 17-Mar-2019 00:46:00 | 3.9587e+03 | 3.9594e+03 | 3.9587e+03 | 3.9594e+03 | 0.9039 |
| 46 | 17-Mar-2019 00:47:00 | 3.9603e+03 | 3.9626e+03 | 3.9560e+03 | 3.9626e+03 | 20.0262 |
| 47 | 17-Mar-2019 00:48:00 | 3.9654e+03 | 3.9654e+03 | 3.9634e+03 | 3.9634e+03 | 0.7011 |
| 48 | 17-Mar-2019 00:49:00 | 3.9646e+03 | 3.9646e+03 | 3.9646e+03 | 3.9646e+03 | 0.0393 |
| 49 | 17-Mar-2019 00:50:00 | 3.9678e+03 | 3.9678e+03 | 3.9678e+03 | 3.9678e+03 | 0.0300 |
| 50 | 17-Mar-2019 00:51:00 | 3.9680e+03 | 3.9688e+03 | 3965 | 3965 | 5.5533 |
| 51 | 17-Mar-2019 00:52:00 | 3.9684e+03 | 3.9684e+03 | 3.9684e+03 | 3.9684e+03 | 0.0177 |
| 52 | 17-Mar-2019 00:54:00 | 3.9667e+03 | 3.9693e+03 | 3.9659e+03 | 3.9693e+03 | 0.1114 |
| 53 | 17-Mar-2019 00:55:00 | 3.9697e+03 | 3.9697e+03 | 3.9697e+03 | 3.9697e+03 | 1.1700 |
| 54 | 17-Mar-2019 00:56:00 | 3965 | 3965 | 3965 | 3965 | 0.1984 |
| 55 | 17-Mar-2019 00:57:00 | 3.9648e+03 | 3.9671e+03 | 3.9648e+03 | 3.9659e+03 | 1.0521 |
| 56 | 17-Mar-2019 00:58:00 | 3.9669e+03 | 3.9672e+03 | 3.9669e+03 | 3.9672e+03 | 0.0705 |
| 57 | 17-Mar-2019 00:59:00 | 3.9649e+03 | 3.9651e+03 | 3.9639e+03 | 3.9639e+03 | 2.7885 |
| 58 | 17-Mar-2019 01:01:00 | 3.9633e+03 | 3.9707e+03 | 3.9632e+03 | 3.9666e+03 | 16.0571 |
| 59 | 17-Mar-2019 01:02:00 | 3.9682e+03 | 3.9704e+03 | 3.9682e+03 | 3.9682e+03 | 3.7277 |
| 60 | 17-Mar-2019 01:04:00 | 3.9694e+03 | 3.9721e+03 | 3.9694e+03 | 3.9721e+03 | 2.3479 |
| 61 | 17-Mar-2019 01:08:00 | 3.9686e+03 | 3.9695e+03 | 3.9686e+03 | 3.9695e+03 | 0.8484 |
| 62 | 17-Mar-2019 01:09:00 | 3.9690e+03 | 3.9690e+03 | 3.9690e+03 | 3.9690e+03 | 0.2202 |
| 63 | 17-Mar-2019 01:11:00 | 3.9705e+03 | 3.9705e+03 | 3.9705e+03 | 3.9705e+03 | 0.0113 |
| 64 | 17-Mar-2019 01:12:00 | 3.9698e+03 | 3.9698e+03 | 3.9698e+03 | 3.9698e+03 | 0.5000 |
| 65 | 17-Mar-2019 01:14:00 | 3.9699e+03 | 3.9699e+03 | 3.9699e+03 | 3.9699e+03 | 0.5462 |
| 66 | 17-Mar-2019 01:16:00 | 3.9718e+03 | 3.9718e+03 | 3.9718e+03 | 3.9718e+03 | 0.1049 |
| 67 | 17-Mar-2019 01:17:00 | 3.9725e+03 | 3.9725e+03 | 3.9705e+03 | 3.9705e+03 | 0.1226 |

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 68 | 17-Mar-2019 01:18:00 | 3.9705e+03 | 3.9705e+03 | 3.9705e+03 | 3.9705e+03 | 0.2105 |
| 69 | 17-Mar-2019 01:19:00 | 3.9726e+03 | 3.9726e+03 | 3.9726e+03 | 3.9726e+03 | 0.3957 |
| 70 | 17-Mar-2019 01:21:00 | 3.9714e+03 | 3.9716e+03 | 3.9698e+03 | 3.9698e+03 | 2.7867 |
| 71 | 17-Mar-2019 01:22:00 | 3.9708e+03 | 3.9708e+03 | 3.9701e+03 | 3.9701e+03 | 0.0991 |
| 72 | 17-Mar-2019 01:23:00 | 3.9697e+03 | 3.9697e+03 | 3.9697e+03 | 3.9697e+03 | 0.0582 |
| 73 | 17-Mar-2019 01:24:00 | 3.9697e+03 | 3.9697e+03 | 3.9688e+03 | 3.9688e+03 | 0.2065 |
| 74 | 17-Mar-2019 01:25:00 | 3.9684e+03 | 3.9684e+03 | 3.9684e+03 | 3.9684e+03 | 0.0385 |
| 75 | 17-Mar-2019 01:27:00 | 3.9676e+03 | 3.9676e+03 | 3.9676e+03 | 3.9676e+03 | 1.5375 |
| 76 | 17-Mar-2019 01:28:00 | 3.9680e+03 | 3.9680e+03 | 3.9680e+03 | 3.9680e+03 | 0.0178 |
| 77 | 17-Mar-2019 01:29:00 | 3.9696e+03 | 3.9696e+03 | 3.9696e+03 | 3.9696e+03 | 0.2409 |
| 78 | 17-Mar-2019 01:31:00 | 3.9696e+03 | 3.9696e+03 | 3.9696e+03 | 3.9696e+03 | 0.0104 |
| 79 | 17-Mar-2019 01:33:00 | 3.9696e+03 | 3.9696e+03 | 3.9696e+03 | 3.9696e+03 | 0.1079 |
| 80 | 17-Mar-2019 01:34:00 | 3.9696e+03 | 3.9696e+03 | 3.9688e+03 | 3.9696e+03 | 0.1726 |
| 81 | 17-Mar-2019 01:36:00 | 3.9706e+03 | 3.9712e+03 | 3.9697e+03 | 3.9712e+03 | 0.2806 |
| 82 | 17-Mar-2019 01:37:00 | 3.9712e+03 | 3.9712e+03 | 3.9712e+03 | 3.9712e+03 | 0.2512 |
| 83 | 17-Mar-2019 01:38:00 | 3.9712e+03 | 3.9712e+03 | 3.9712e+03 | 3.9712e+03 | 0.0035 |
| 84 | 17-Mar-2019 01:39:00 | 3.9712e+03 | 3.9714e+03 | 3.9712e+03 | 3.9714e+03 | 0.8625 |
| 85 | 17-Mar-2019 01:41:00 | 3.9723e+03 | 3.9728e+03 | 3.9723e+03 | 3.9728e+03 | 0.2312 |
| 86 | 17-Mar-2019 01:43:00 | 3.9730e+03 | 3.9730e+03 | 3.9730e+03 | 3.9730e+03 | 0.0191 |
| 87 | 17-Mar-2019 01:44:00 | 3.9724e+03 | 3.9730e+03 | 3.9724e+03 | 3.9730e+03 | 0.1219 |
| 88 | 17-Mar-2019 01:45:00 | 3.9725e+03 | 3.9725e+03 | 3.9725e+03 | 3.9725e+03 | 0.3859 |
| 89 | 17-Mar-2019 01:46:00 | 3.9730e+03 | 3.9739e+03 | 3.9724e+03 | 3.9724e+03 | 3.7617 |
| 90 | 17-Mar-2019 01:47:00 | 3.9734e+03 | 3.9734e+03 | 3.9730e+03 | 3.9730e+03 | 0.3111 |
| 91 | 17-Mar-2019 01:48:00 | 3.9741e+03 | 3.9741e+03 | 3.9741e+03 | 3.9741e+03 | 0.0962 |
| 92 | 17-Mar-2019 01:49:00 | 3.9730e+03 | 3.9741e+03 | 3.9730e+03 | 3.9741e+03 | 0.2203 |
| 93 | 17-Mar-2019 01:50:00 | 3.9741e+03 | 3.9741e+03 | 3.9730e+03 | 3.9730e+03 | 2.0141 |
| 94 | 17-Mar-2019 01:51:00 | 3.9722e+03 | 3.9722e+03 | 3.9722e+03 | 3.9722e+03 | 0.0192 |
| 95 | 17-Mar-2019 01:53:00 | 3.9711e+03 | 3.9711e+03 | 3.9711e+03 | 3.9711e+03 | 0.7685 |
| 96 | 17-Mar-2019 01:54:00 | 3.9711e+03 | 3.9712e+03 | 3.9693e+03 | 3.9693e+03 | 0.2490 |
| 97 | 17-Mar-2019 01:57:00 | 3.9705e+03 | 3.9705e+03 | 3.9705e+03 | 3.9705e+03 | 0.6593 |
| 98 | 17-Mar-2019 01:58:00 | 3.9695e+03 | 3.9695e+03 | 3.9695e+03 | 3.9695e+03 | 0.0644 |
| 99 | 17-Mar-2019 01:59:00 | 3.9686e+03 | 3.9686e+03 | 3.9686e+03 | 3.9686e+03 | 0.4034 |
| 100 | 17-Mar-2019 02:00:00 | 3.9686e+03 | 3.9694e+03 | 3.9682e+03 | 3.9685e+03 | 1.7836 |

```
    ⋮
```

```
%outliers = outlier(BitcoinData.Close)

%Rerun model to check for more outliers
Y = BitcoinData{:,"Close"}
```

```
Y = 2416×1
10^3 ×
    3.9900
    3.9899
    3.9909
    3.9924
    3.9902
    3.9918
    3.9922
    3.9922
    3.9919
    3.9919
    ⋮
```

```
X = BitcoinData{:,[1:3]}
```

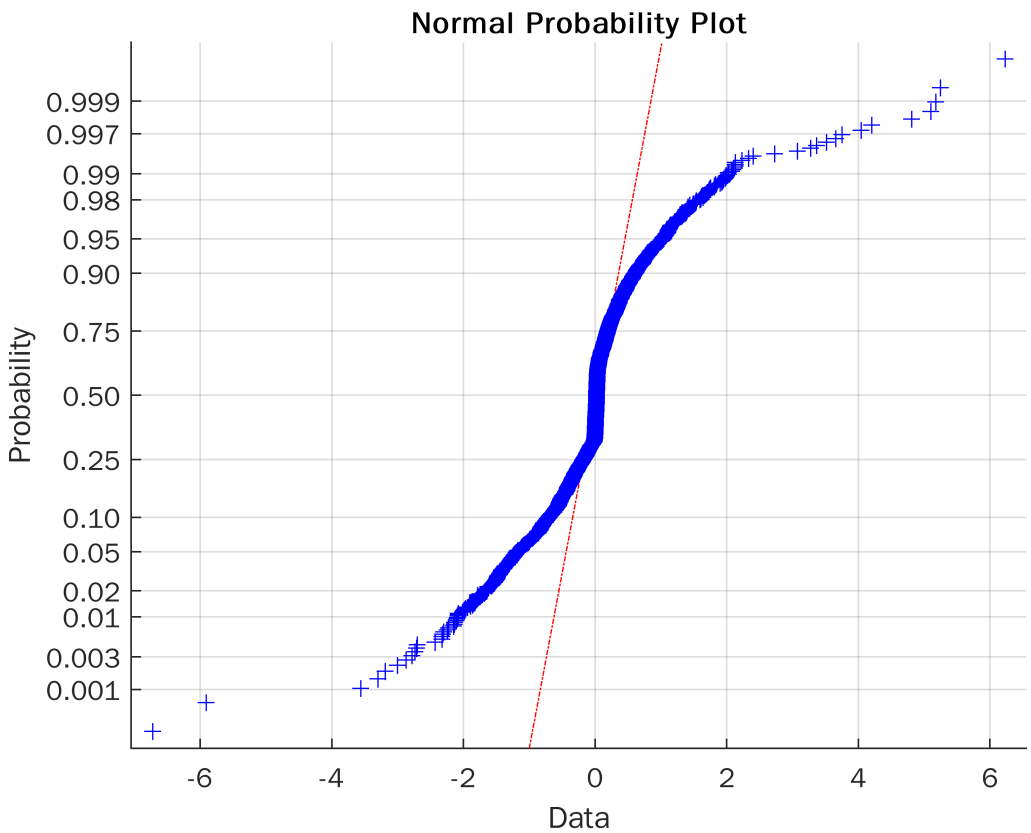
```
X = 2416×3
10^3 ×
    3.9900    3.9900    3.9900
    3.9900    3.9900    3.9899
    3.9900    3.9918    3.9900
    3.9910    3.9924    3.9899
    3.9902    3.9902    3.9902
    3.9914    3.9918    3.9914
    3.9922    3.9922    3.9922
    3.9909    3.9922    3.9909
    3.9919    3.9919    3.9919
    3.9919    3.9919    3.9919
    ⋮
```

```
LRPre = fitlm(zscore(X),Y)
```

```
LRPre =
Linear regression model:
    y ~ 1 + x1 + x2 + x3

Estimated Coefficients:
                   Estimate       SE         tStat        pValue
                   ________    ________    __________    __________

    (Intercept)     3964.8     0.014602    2.7153e+05             0
    x1             -5.9223      0.17343       -34.149    7.7577e-209
    x2              8.7423       0.1387        63.031              0
    x3              7.6558      0.11563        66.207              0


Number of observations: 2416, Error degrees of freedom: 2412
Root Mean Squared Error: 0.718
```

```
R-squared: 0.995,  Adjusted R-Squared: 0.995
F-statistic vs. constant model: 1.71e+05, p-value = 0
```

```
normplot(LRPre.Residuals.Raw)
```




```
idx = isoutlier(BitcoinData.Close)
```

```
idx = 2416×1 logical array
   0
   0
   0
   0
   0
   0
   0
   0
   0
   0
     ⋮
```

```
sum(idx)
```

```
ans = 21
```

```
BitcoinData(idx,:) = []
```

```
BitcoinData = 2395×7 timetable
                                                                    ...
```

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 1 | 17-Mar-2019 00:00:00 | 3990 | 3990 | 3990 | 3990 | 1.6034 |
| 2 | 17-Mar-2019 00:01:00 | 3990 | 3990 | 3.9899e+03 | 3.9899e+03 | 0.9532 |
| 3 | 17-Mar-2019 00:02:00 | 3990 | 3.9918e+03 | 3990 | 3.9909e+03 | 2.0498 |
| 4 | 17-Mar-2019 00:04:00 | 3.9910e+03 | 3.9924e+03 | 3.9899e+03 | 3.9924e+03 | 3.2865 |
| 5 | 17-Mar-2019 00:06:00 | 3.9902e+03 | 3.9902e+03 | 3.9902e+03 | 3.9902e+03 | 0.1500 |
| 6 | 17-Mar-2019 00:07:00 | 3.9914e+03 | 3.9918e+03 | 3.9914e+03 | 3.9918e+03 | 0.2979 |
| 7 | 17-Mar-2019 00:08:00 | 3.9922e+03 | 3.9922e+03 | 3.9922e+03 | 3.9922e+03 | 0.0500 |
| 8 | 17-Mar-2019 00:09:00 | 3.9909e+03 | 3.9922e+03 | 3.9909e+03 | 3.9922e+03 | 1.3248 |
| 9 | 17-Mar-2019 00:10:00 | 3.9919e+03 | 3.9919e+03 | 3.9919e+03 | 3.9919e+03 | 0.0119 |
| 10 | 17-Mar-2019 00:11:00 | 3.9919e+03 | 3.9919e+03 | 3.9919e+03 | 3.9919e+03 | 0.0578 |
| 11 | 17-Mar-2019 00:12:00 | 3.9919e+03 | 3.9919e+03 | 3.9919e+03 | 3.9919e+03 | 0.0119 |
| 12 | 17-Mar-2019 00:13:00 | 3.9900e+03 | 3.9907e+03 | 3.9883e+03 | 3.9907e+03 | 0.7568 |
| 13 | 17-Mar-2019 00:14:00 | 3.9882e+03 | 3.9890e+03 | 3.9850e+03 | 3.9880e+03 | 8.6849 |
| 14 | 17-Mar-2019 00:15:00 | 3.9850e+03 | 3.9885e+03 | 3.9850e+03 | 3.9881e+03 | 2.7837 |
| 15 | 17-Mar-2019 00:16:00 | 3.9880e+03 | 3.9880e+03 | 3.9852e+03 | 3.9852e+03 | 0.2055 |
| 16 | 17-Mar-2019 00:17:00 | 3.9848e+03 | 3.9849e+03 | 3.9750e+03 | 3.9751e+03 | 34.7895 |
| 17 | 17-Mar-2019 00:18:00 | 3974 | 3.9744e+03 | 3.9589e+03 | 3.9641e+03 | 95.6286 |
| 18 | 17-Mar-2019 00:19:00 | 3.9641e+03 | 3.9763e+03 | 3.9641e+03 | 3.9763e+03 | 6.4694 |
| 19 | 17-Mar-2019 00:20:00 | 3.9763e+03 | 3.9763e+03 | 3.9746e+03 | 3.9753e+03 | 1.0630 |
| 20 | 17-Mar-2019 00:21:00 | 3.9769e+03 | 3.9783e+03 | 3.9769e+03 | 3.9783e+03 | 2.1030 |
| 21 | 17-Mar-2019 00:22:00 | 3.9793e+03 | 3.9805e+03 | 3.9793e+03 | 3.9802e+03 | 0.1511 |
| 22 | 17-Mar-2019 00:23:00 | 3.9773e+03 | 3.9773e+03 | 3.9746e+03 | 3.9746e+03 | 0.0450 |
| 23 | 17-Mar-2019 00:24:00 | 3.9817e+03 | 3.9818e+03 | 3.9809e+03 | 3.9809e+03 | 1.3872 |
| 24 | 17-Mar-2019 00:25:00 | 3.9771e+03 | 3.9771e+03 | 3.9767e+03 | 3.9767e+03 | 0.3348 |
| 25 | 17-Mar-2019 00:26:00 | 3.9760e+03 | 3.9771e+03 | 3.9738e+03 | 3.9771e+03 | 0.3810 |
| 26 | 17-Mar-2019 00:27:00 | 3.9781e+03 | 3.9791e+03 | 3.9781e+03 | 3.9791e+03 | 0.9907 |
| 27 | 17-Mar-2019 00:28:00 | 3.9797e+03 | 3.9806e+03 | 3.9797e+03 | 3.9806e+03 | 0.1389 |
| 28 | 17-Mar-2019 00:29:00 | 3.9798e+03 | 3.9798e+03 | 3.9797e+03 | 3.9797e+03 | 1.2995 |
| 29 | 17-Mar-2019 00:30:00 | 3.9765e+03 | 3.9774e+03 | 3.9727e+03 | 3.9732e+03 | 3.9176 |
| 30 | 17-Mar-2019 00:31:00 | 3.9732e+03 | 3.9736e+03 | 3.9700e+03 | 3.9700e+03 | 0.8799 |
| 31 | 17-Mar-2019 00:32:00 | 3.9692e+03 | 3.9692e+03 | 3.9691e+03 | 3.9691e+03 | 3.1234 |
| 32 | 17-Mar-2019 00:33:00 | 3.9733e+03 | 3.9733e+03 | 3.9733e+03 | 3.9733e+03 | 0.0303 |
| 33 | 17-Mar-2019 00:34:00 | 3.9743e+03 | 3.9744e+03 | 3.9743e+03 | 3.9744e+03 | 1.1186 |

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 34 | 17-Mar-2019 00:35:00 | 3.9702e+03 | 3.9702e+03 | 3.9694e+03 | 3.9694e+03 | 1.1398 |
| 35 | 17-Mar-2019 00:36:00 | 3.9700e+03 | 3.9700e+03 | 3.9668e+03 | 3.9668e+03 | 1.6151 |
| 36 | 17-Mar-2019 00:37:00 | 3.9679e+03 | 3.9685e+03 | 3.9629e+03 | 3.9629e+03 | 5.5367 |
| 37 | 17-Mar-2019 00:38:00 | 3.9616e+03 | 3.9616e+03 | 3.9556e+03 | 3.9593e+03 | 31.6548 |
| 38 | 17-Mar-2019 00:39:00 | 3.9629e+03 | 3.9660e+03 | 3.9628e+03 | 3.9660e+03 | 8.2058 |
| 39 | 17-Mar-2019 00:40:00 | 3.9670e+03 | 3.9670e+03 | 3960 | 3.9652e+03 | 80.6532 |
| 40 | 17-Mar-2019 00:41:00 | 3.9650e+03 | 3.9650e+03 | 3.9607e+03 | 3.9607e+03 | 2.2074 |
| 41 | 17-Mar-2019 00:42:00 | 3.9612e+03 | 3.9625e+03 | 3.9585e+03 | 3.9602e+03 | 4.8431 |
| 42 | 17-Mar-2019 00:43:00 | 3.9592e+03 | 3.9613e+03 | 3.9592e+03 | 3.9613e+03 | 0.7638 |
| 43 | 17-Mar-2019 00:44:00 | 3.9616e+03 | 3.9645e+03 | 3.9616e+03 | 3.9645e+03 | 0.4583 |
| 44 | 17-Mar-2019 00:45:00 | 3.9614e+03 | 3.9614e+03 | 3.9614e+03 | 3.9614e+03 | 0.5045 |
| 45 | 17-Mar-2019 00:46:00 | 3.9587e+03 | 3.9594e+03 | 3.9587e+03 | 3.9594e+03 | 0.9039 |
| 46 | 17-Mar-2019 00:47:00 | 3.9603e+03 | 3.9626e+03 | 3.9560e+03 | 3.9626e+03 | 20.0262 |
| 47 | 17-Mar-2019 00:48:00 | 3.9654e+03 | 3.9654e+03 | 3.9634e+03 | 3.9634e+03 | 0.7011 |
| 48 | 17-Mar-2019 00:49:00 | 3.9646e+03 | 3.9646e+03 | 3.9646e+03 | 3.9646e+03 | 0.0393 |
| 49 | 17-Mar-2019 00:50:00 | 3.9678e+03 | 3.9678e+03 | 3.9678e+03 | 3.9678e+03 | 0.0300 |
| 50 | 17-Mar-2019 00:51:00 | 3.9680e+03 | 3.9688e+03 | 3965 | 3965 | 5.5533 |
| 51 | 17-Mar-2019 00:52:00 | 3.9684e+03 | 3.9684e+03 | 3.9684e+03 | 3.9684e+03 | 0.0177 |
| 52 | 17-Mar-2019 00:54:00 | 3.9667e+03 | 3.9693e+03 | 3.9659e+03 | 3.9693e+03 | 0.1114 |
| 53 | 17-Mar-2019 00:55:00 | 3.9697e+03 | 3.9697e+03 | 3.9697e+03 | 3.9697e+03 | 1.1700 |
| 54 | 17-Mar-2019 00:56:00 | 3965 | 3965 | 3965 | 3965 | 0.1984 |
| 55 | 17-Mar-2019 00:57:00 | 3.9648e+03 | 3.9671e+03 | 3.9648e+03 | 3.9659e+03 | 1.0521 |
| 56 | 17-Mar-2019 00:58:00 | 3.9669e+03 | 3.9672e+03 | 3.9669e+03 | 3.9672e+03 | 0.0705 |
| 57 | 17-Mar-2019 00:59:00 | 3.9649e+03 | 3.9651e+03 | 3.9639e+03 | 3.9639e+03 | 2.7885 |
| 58 | 17-Mar-2019 01:01:00 | 3.9633e+03 | 3.9707e+03 | 3.9632e+03 | 3.9666e+03 | 16.0571 |
| 59 | 17-Mar-2019 01:02:00 | 3.9682e+03 | 3.9704e+03 | 3.9682e+03 | 3.9682e+03 | 3.7277 |
| 60 | 17-Mar-2019 01:04:00 | 3.9694e+03 | 3.9721e+03 | 3.9694e+03 | 3.9721e+03 | 2.3479 |
| 61 | 17-Mar-2019 01:08:00 | 3.9686e+03 | 3.9695e+03 | 3.9686e+03 | 3.9695e+03 | 0.8484 |
| 62 | 17-Mar-2019 01:09:00 | 3.9690e+03 | 3.9690e+03 | 3.9690e+03 | 3.9690e+03 | 0.2202 |
| 63 | 17-Mar-2019 01:11:00 | 3.9705e+03 | 3.9705e+03 | 3.9705e+03 | 3.9705e+03 | 0.0113 |
| 64 | 17-Mar-2019 01:12:00 | 3.9698e+03 | 3.9698e+03 | 3.9698e+03 | 3.9698e+03 | 0.5000 |
| 65 | 17-Mar-2019 01:14:00 | 3.9699e+03 | 3.9699e+03 | 3.9699e+03 | 3.9699e+03 | 0.5462 |
| 66 | 17-Mar-2019 01:16:00 | 3.9718e+03 | 3.9718e+03 | 3.9718e+03 | 3.9718e+03 | 0.1049 |

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 67 | 17-Mar-2019 01:17:00 | 3.9725e+03 | 3.9725e+03 | 3.9705e+03 | 3.9705e+03 | 0.1226 |
| 68 | 17-Mar-2019 01:18:00 | 3.9705e+03 | 3.9705e+03 | 3.9705e+03 | 3.9705e+03 | 0.2105 |
| 69 | 17-Mar-2019 01:19:00 | 3.9726e+03 | 3.9726e+03 | 3.9726e+03 | 3.9726e+03 | 0.3957 |
| 70 | 17-Mar-2019 01:21:00 | 3.9714e+03 | 3.9716e+03 | 3.9698e+03 | 3.9698e+03 | 2.7867 |
| 71 | 17-Mar-2019 01:22:00 | 3.9708e+03 | 3.9708e+03 | 3.9701e+03 | 3.9701e+03 | 0.0991 |
| 72 | 17-Mar-2019 01:23:00 | 3.9697e+03 | 3.9697e+03 | 3.9697e+03 | 3.9697e+03 | 0.0582 |
| 73 | 17-Mar-2019 01:24:00 | 3.9697e+03 | 3.9697e+03 | 3.9688e+03 | 3.9688e+03 | 0.2065 |
| 74 | 17-Mar-2019 01:25:00 | 3.9684e+03 | 3.9684e+03 | 3.9684e+03 | 3.9684e+03 | 0.0385 |
| 75 | 17-Mar-2019 01:27:00 | 3.9676e+03 | 3.9676e+03 | 3.9676e+03 | 3.9676e+03 | 1.5375 |
| 76 | 17-Mar-2019 01:28:00 | 3.9680e+03 | 3.9680e+03 | 3.9680e+03 | 3.9680e+03 | 0.0178 |
| 77 | 17-Mar-2019 01:29:00 | 3.9696e+03 | 3.9696e+03 | 3.9696e+03 | 3.9696e+03 | 0.2409 |
| 78 | 17-Mar-2019 01:31:00 | 3.9696e+03 | 3.9696e+03 | 3.9696e+03 | 3.9696e+03 | 0.0104 |
| 79 | 17-Mar-2019 01:33:00 | 3.9696e+03 | 3.9696e+03 | 3.9696e+03 | 3.9696e+03 | 0.1079 |
| 80 | 17-Mar-2019 01:34:00 | 3.9696e+03 | 3.9696e+03 | 3.9688e+03 | 3.9696e+03 | 0.1726 |
| 81 | 17-Mar-2019 01:36:00 | 3.9706e+03 | 3.9712e+03 | 3.9697e+03 | 3.9712e+03 | 0.2806 |
| 82 | 17-Mar-2019 01:37:00 | 3.9712e+03 | 3.9712e+03 | 3.9712e+03 | 3.9712e+03 | 0.2512 |
| 83 | 17-Mar-2019 01:38:00 | 3.9712e+03 | 3.9712e+03 | 3.9712e+03 | 3.9712e+03 | 0.0035 |
| 84 | 17-Mar-2019 01:39:00 | 3.9712e+03 | 3.9714e+03 | 3.9712e+03 | 3.9714e+03 | 0.8625 |
| 85 | 17-Mar-2019 01:41:00 | 3.9723e+03 | 3.9728e+03 | 3.9723e+03 | 3.9728e+03 | 0.2312 |
| 86 | 17-Mar-2019 01:43:00 | 3.9730e+03 | 3.9730e+03 | 3.9730e+03 | 3.9730e+03 | 0.0191 |
| 87 | 17-Mar-2019 01:44:00 | 3.9724e+03 | 3.9730e+03 | 3.9724e+03 | 3.9730e+03 | 0.1219 |
| 88 | 17-Mar-2019 01:45:00 | 3.9725e+03 | 3.9725e+03 | 3.9725e+03 | 3.9725e+03 | 0.3859 |
| 89 | 17-Mar-2019 01:46:00 | 3.9730e+03 | 3.9739e+03 | 3.9724e+03 | 3.9724e+03 | 3.7617 |
| 90 | 17-Mar-2019 01:47:00 | 3.9734e+03 | 3.9734e+03 | 3.9730e+03 | 3.9730e+03 | 0.3111 |
| 91 | 17-Mar-2019 01:48:00 | 3.9741e+03 | 3.9741e+03 | 3.9741e+03 | 3.9741e+03 | 0.0962 |
| 92 | 17-Mar-2019 01:49:00 | 3.9730e+03 | 3.9741e+03 | 3.9730e+03 | 3.9741e+03 | 0.2203 |
| 93 | 17-Mar-2019 01:50:00 | 3.9741e+03 | 3.9741e+03 | 3.9730e+03 | 3.9730e+03 | 2.0141 |
| 94 | 17-Mar-2019 01:51:00 | 3.9722e+03 | 3.9722e+03 | 3.9722e+03 | 3.9722e+03 | 0.0192 |
| 95 | 17-Mar-2019 01:53:00 | 3.9711e+03 | 3.9711e+03 | 3.9711e+03 | 3.9711e+03 | 0.7685 |
| 96 | 17-Mar-2019 01:54:00 | 3.9711e+03 | 3.9712e+03 | 3.9693e+03 | 3.9693e+03 | 0.2490 |
| 97 | 17-Mar-2019 01:57:00 | 3.9705e+03 | 3.9705e+03 | 3.9705e+03 | 3.9705e+03 | 0.6593 |
| 98 | 17-Mar-2019 01:58:00 | 3.9695e+03 | 3.9695e+03 | 3.9695e+03 | 3.9695e+03 | 0.0644 |
| 99 | 17-Mar-2019 01:59:00 | 3.9686e+03 | 3.9686e+03 | 3.9686e+03 | 3.9686e+03 | 0.4034 |

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 100 | 17-Mar-2019 02:00:00 | 3.9686e+03 | 3.9694e+03 | 3.9682e+03 | 3.9685e+03 | 1.7836 |

⋮

```
%outliers = outlier(BitcoinData.Close)
```

## Split dataset into training and testing data

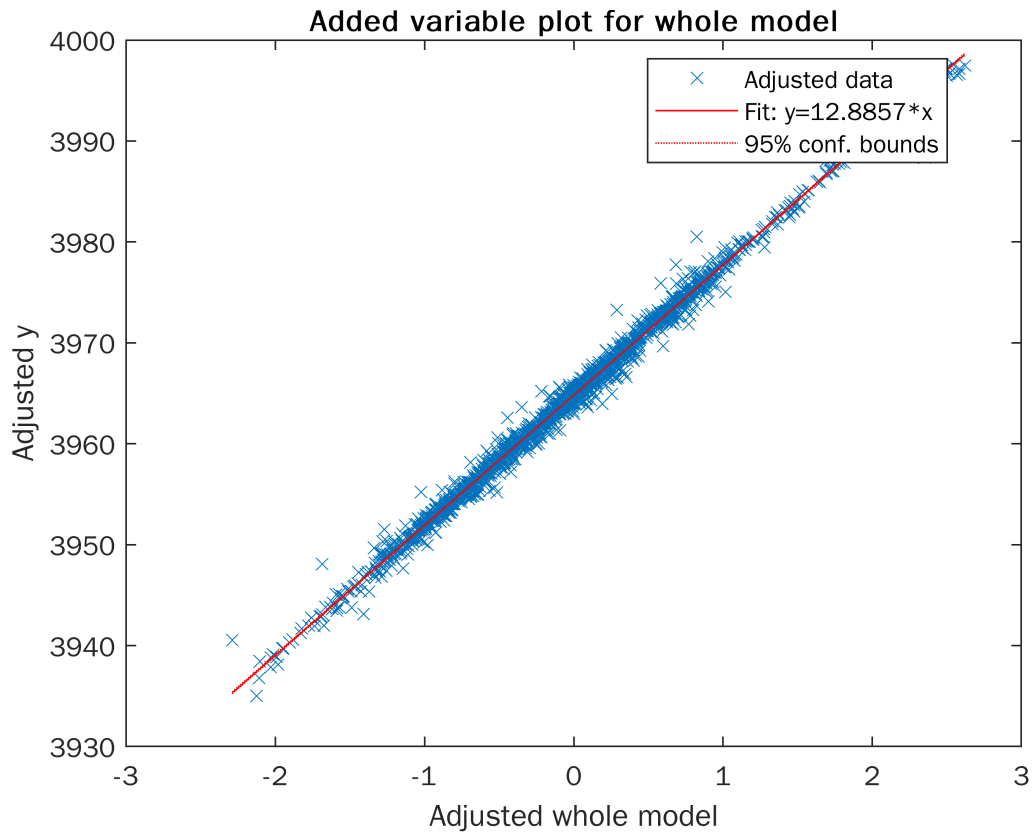
```
BitcoinData_new = [X, Y];

PD = 0.20;
cv = cvpartition(size(BitcoinData_new,1),'HoldOut',PD);
Xtrain = BitcoinData_new(cv.training,[1:end - 1]);
Ytrain = BitcoinData_new(cv.training,end);
Xtest = BitcoinData_new(cv.test, [1:end - 1]);
Ytest = BitcoinData_new(cv.test,end);
```

## Linear model with training-testing split

```
LRModel = fitlm(zscore(Xtrain),Ytrain)
```

```
LRModel = 
Linear regression model:
    y ~ 1 + x1 + x2 + x3

Estimated Coefficients:
                   Estimate       SE         tStat        pValue  
                   ________    ________    _________    ___________

    (Intercept)     3964.8     0.016084    2.465e+05              0
    x1             -5.7387      0.19542      -29.365    5.4098e-157
    x2               8.747      0.15171       57.655              0
    x3              7.5232      0.13509       55.689              0


Number of observations: 1933, Error degrees of freedom: 1929
Root Mean Squared Error: 0.707
R-squared: 0.996,  Adjusted R-Squared: 0.995
F-statistic vs. constant model: 1.42e+05, p-value = 0
```

```
plot(LRModel)
```




```
LRModel.RMSE
```

```
ans = 0.7072
```

## Predict

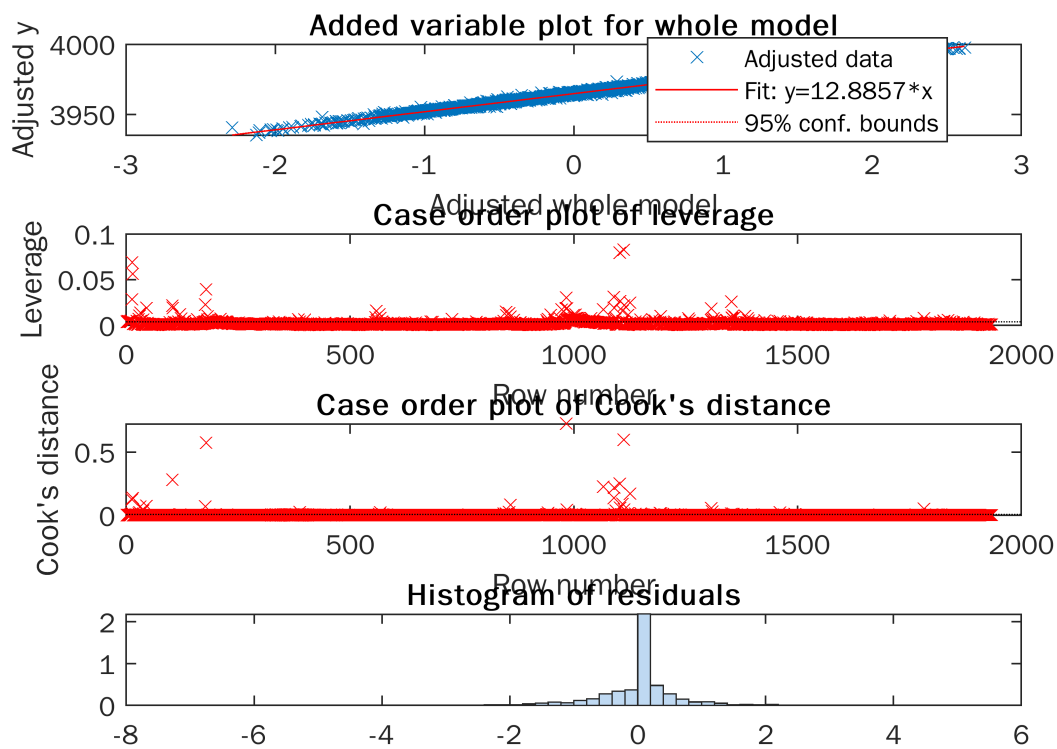
```
[YPred, Scores] = predict(LRModel,Xtest)
```

```
YPred = 483×1
10^4 ×
    4.6000
    4.6004
    4.5963
    4.5943
    4.5869
    4.5885
    4.5788
    4.5810
    4.5684
    4.5712
      ⋮

Scores = 483×2
10^4 ×
    4.5874    4.6127
    4.5878    4.6130
    4.5837    4.6090
    4.5817    4.6069
    4.5743    4.5995
    4.5759    4.6011
```

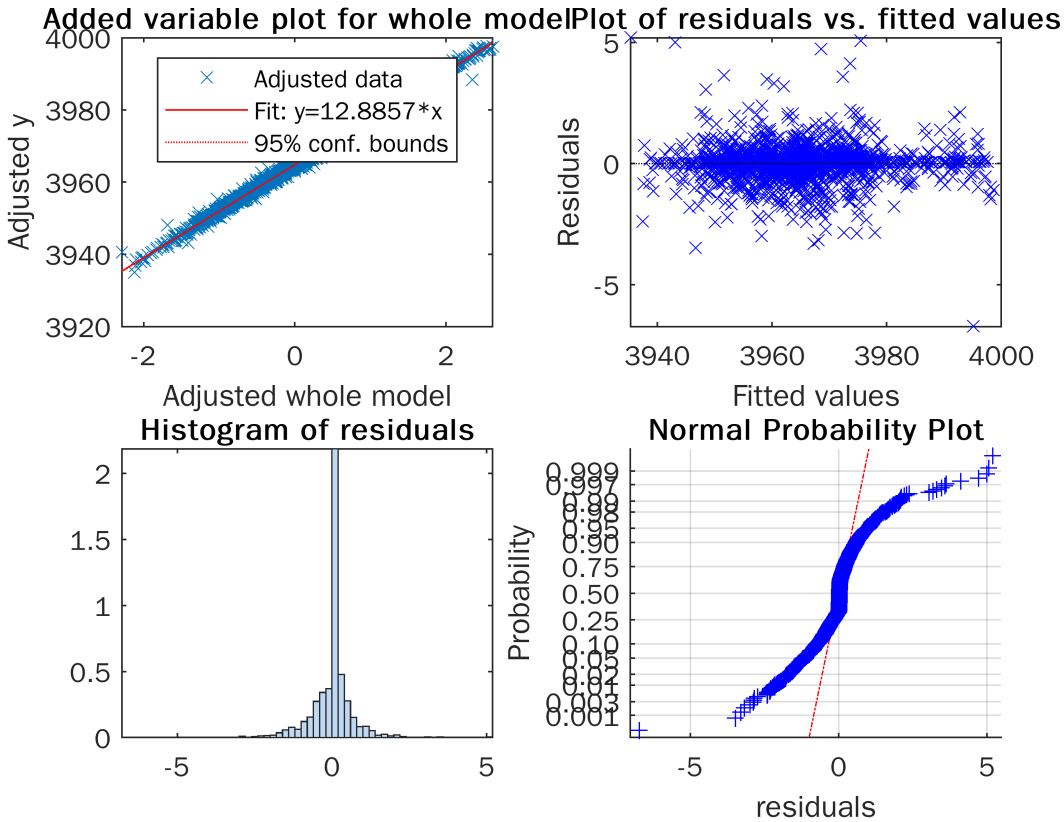
```
    4.5662    4.5914
    4.5684    4.5935
    4.5559    4.5810
    4.5586    4.5837
      ⋮
```

## Plots

```
figure,
subplot(4, 1, 1), plot(LRModel)
subplot(4, 1, 2), plotDiagnostics(LRModel)
subplot(4, 1, 3), plotDiagnostics(LRModel, 'cookd')
subplot(4, 1, 4), plotResiduals(LRModel)
```




```
figure,
subplot(2, 2, 1), plot(LRModel)
subplot(2, 2, 2), plotResiduals(LRModel,'fitted')
subplot(2, 2, 3), plotResiduals(LRModel)
subplot(2, 2, 4), normplot(LRModel.Residuals.Raw)
xlabel('residuals')
```


Added variable plot for whole model
Adjusted data
Fit: y=12.8857*x
95% conf. bounds
Adjusted y
Adjusted whole model
Plot of residuals vs. fitted values
Residuals
Fitted values
Histogram of residuals
Normal Probability Plot
Probability
residuals

## Upload the big dataset (>250MB) to MATLAB Drive and read table

```
BitcoinData = readtable('bitcoin-dataset.csv');
```

```
Warning: Column headers from the file were modified to make them valid MATLAB identifiers
before creating variable names for the table. The original column headers are saved in the
VariableDescriptions property.
Set 'VariableNamingRule' to 'preserve' to use the original column headers as table variable names.
```

```
Tablesize = size(BitcoinData)
```

```
Tablesize = 1×2
     4857377           8
```

```
head(BitcoinData,1)
```

```
ans = 1×8 table
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                
...
```

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 1 | 1.3253e+09 | 4.3900 | 4.3900 | 4.3900 | 4.3900 | 0.4556 |

## Convert timestamp

```
datetest = BitcoinData(:,1);
datetest = table2array(datetest);
BitcoinData.Timestamp = datetime(datetest, 'ConvertFrom', 'posixtime');
```

## Remove NaNs

```
% how many NaNs in each column
NaN2 = sum(isnan(BitcoinData.Open))
```

```
NaN2 = 1243608
```

```
NaN3 = sum(isnan(BitcoinData.High))
```

```
NaN3 = 1243608
```

```
NaN4 = sum(isnan(BitcoinData.Low))
```

```
NaN4 = 1243608
```

```
NaN5 = sum(isnan(BitcoinData.Close))
```

```
NaN5 = 1243608
```

```
NaN6 = sum(isnan(BitcoinData.Volume__BTC_))
```

```
NaN6 = 1243608
```

```
NaN7 = sum(isnan(BitcoinData.Volume__Currency_))
```

```
NaN7 = 1243608
```

```
NaN8 = sum(isnan(BitcoinData.Weighted_Price))
```

```
NaN8 = 1243608
```

```
% remove NaNs
BitcoinData = BitcoinData(isnan(BitcoinData.High) == 0,:);
```

## Select data

```
BitcoinDataTimetable = table2timetable(BitcoinData);

% March 2013
% S = timerange('17-Mar-2013 00:00:00','18-Mar-2013 23:59:00'); %2days
% S = timerange('17-Mar-2013 00:00:00','23-Mar-2013 23:59:00'); %7days
% S = timerange('17-Mar-2013 00:00:00','30-Mar-2013 23:59:00'); %14days

% March 2016
% S = timerange('17-Mar-2016 00:00:00','18-Mar-2016 23:59:00'); %2days
% S = timerange('17-Mar-2016 00:00:00','23-Mar-2016 23:59:00'); %7days
% S = timerange('17-Mar-2016 00:00:00','30-Mar-2016 23:59:00'); %14days

% March 2019
% S = timerange('17-Mar-2019 00:00:00','18-Mar-2019 23:59:00'); %2days
 S = timerange('17-Mar-2019 00:00:00','23-Mar-2019 23:59:00'); %7days
% S = timerange('17-Mar-2019 00:00:00','30-Mar-2019 23:59:00'); %14days

% March 2021
% S = timerange('17-Mar-2021 00:00:00','18-Mar-2021 23:59:00'); %2days
% S = timerange('17-Mar-2021 00:00:00','23-Mar-2021 23:59:00'); %7days
% S = timerange('17-Mar-2021 00:00:00','30-Mar-2021 23:59:00'); %14days

BitcoinData = BitcoinDataTimetable(S,:);
Tablesize = size(BitcoinData)
```

```
Tablesize = 1×2
        9238           7
```

## Create model - preprocessing

```
% standardization, and Initial predictor set (matrix)

Y = BitcoinData{:,"Close"}
```

```
Y = 9238×1
10^3 ×
    3.9900
    3.9899
    3.9909
    3.9924
    3.9902
    3.9918
    3.9922
    3.9922
    3.9919
    3.9919
     ⋮
```

```
X = BitcoinData{:,[1:3]}
```

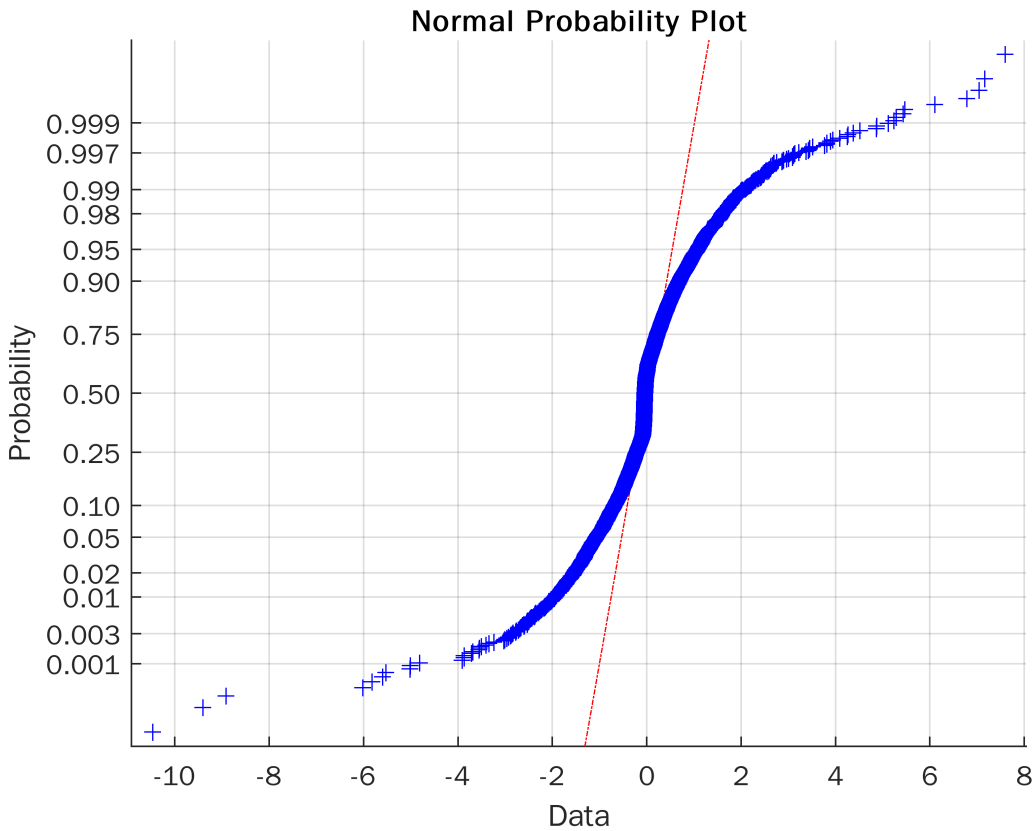
```
X = 9238×3
10^3 ×
    3.9900    3.9900    3.9900
    3.9900    3.9900    3.9899
    3.9900    3.9918    3.9900
    3.9910    3.9924    3.9899
```

```
    3.9902    3.9902    3.9902
    3.9914    3.9918    3.9914
    3.9922    3.9922    3.9922
    3.9909    3.9922    3.9909
    3.9919    3.9919    3.9919
    3.9919    3.9919    3.9919
     ⋮
```

```
%Check model for outliers

LRPre = fitlm(zscore(X),Y)
```

```
LRPre = 
Linear regression model:
    y ~ 1 + x1 + x2 + x3

Estimated Coefficients:
                   Estimate       SE          tStat       pValue  
                   ________    _________    __________    ______

    (Intercept)     3982.2     0.0075273    5.2904e+05      0    
    x1             -11.004       0.17707       -62.146      0    
    x2              15.787       0.13494        116.99      0    
    x3              16.163       0.12102        133.55      0    


Number of observations: 9238, Error degrees of freedom: 9234
Root Mean Squared Error: 0.723
R-squared: 0.999,  Adjusted R-Squared: 0.999
F-statistic vs. constant model: 2.58e+06, p-value = 0
```

```
normplot(LRPre.Residuals.Raw)
```




## Identify and Remove Outliers

```
idx = isoutlier(BitcoinData.Close)
```

```
idx = 9238×1 logical array
   0
   0
   0
   0
   0
   0
   0
   0
   0
   0
     ⋮
```

```
sum(idx)
```

```
ans = 347
```

```
BitcoinData(idx,:) = []
```

```
BitcoinData = 8891×7 timetable
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                
```
...
```

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 1 | 17-Mar-2019 00:00:00 | 3990 | 3990 | 3990 | 3990 | 1.6034 |
```

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 2 | 17-Mar-2019 00:01:00 | 3990 | 3990 | 3.9899e+03 | 3.9899e+03 | 0.9532 |
| 3 | 17-Mar-2019 00:02:00 | 3990 | 3.9918e+03 | 3990 | 3.9909e+03 | 2.0498 |
| 4 | 17-Mar-2019 00:04:00 | 3.9910e+03 | 3.9924e+03 | 3.9899e+03 | 3.9924e+03 | 3.2865 |
| 5 | 17-Mar-2019 00:06:00 | 3.9902e+03 | 3.9902e+03 | 3.9902e+03 | 3.9902e+03 | 0.1500 |
| 6 | 17-Mar-2019 00:07:00 | 3.9914e+03 | 3.9918e+03 | 3.9914e+03 | 3.9918e+03 | 0.2979 |
| 7 | 17-Mar-2019 00:08:00 | 3.9922e+03 | 3.9922e+03 | 3.9922e+03 | 3.9922e+03 | 0.0500 |
| 8 | 17-Mar-2019 00:09:00 | 3.9909e+03 | 3.9922e+03 | 3.9909e+03 | 3.9922e+03 | 1.3248 |
| 9 | 17-Mar-2019 00:10:00 | 3.9919e+03 | 3.9919e+03 | 3.9919e+03 | 3.9919e+03 | 0.0119 |
| 10 | 17-Mar-2019 00:11:00 | 3.9919e+03 | 3.9919e+03 | 3.9919e+03 | 3.9919e+03 | 0.0578 |
| 11 | 17-Mar-2019 00:12:00 | 3.9919e+03 | 3.9919e+03 | 3.9919e+03 | 3.9919e+03 | 0.0119 |
| 12 | 17-Mar-2019 00:13:00 | 3.9900e+03 | 3.9907e+03 | 3.9883e+03 | 3.9907e+03 | 0.7568 |
| 13 | 17-Mar-2019 00:14:00 | 3.9882e+03 | 3.9890e+03 | 3.9850e+03 | 3.9880e+03 | 8.6849 |
| 14 | 17-Mar-2019 00:15:00 | 3.9850e+03 | 3.9885e+03 | 3.9850e+03 | 3.9881e+03 | 2.7837 |
| 15 | 17-Mar-2019 00:16:00 | 3.9880e+03 | 3.9880e+03 | 3.9852e+03 | 3.9852e+03 | 0.2055 |
| 16 | 17-Mar-2019 00:17:00 | 3.9848e+03 | 3.9849e+03 | 3.9750e+03 | 3.9751e+03 | 34.7895 |
| 17 | 17-Mar-2019 00:18:00 | 3974 | 3.9744e+03 | 3.9589e+03 | 3.9641e+03 | 95.6286 |
| 18 | 17-Mar-2019 00:19:00 | 3.9641e+03 | 3.9763e+03 | 3.9641e+03 | 3.9763e+03 | 6.4694 |
| 19 | 17-Mar-2019 00:20:00 | 3.9763e+03 | 3.9763e+03 | 3.9746e+03 | 3.9753e+03 | 1.0630 |
| 20 | 17-Mar-2019 00:21:00 | 3.9769e+03 | 3.9783e+03 | 3.9769e+03 | 3.9783e+03 | 2.1030 |
| 21 | 17-Mar-2019 00:22:00 | 3.9793e+03 | 3.9805e+03 | 3.9793e+03 | 3.9802e+03 | 0.1511 |
| 22 | 17-Mar-2019 00:23:00 | 3.9773e+03 | 3.9773e+03 | 3.9746e+03 | 3.9746e+03 | 0.0450 |
| 23 | 17-Mar-2019 00:24:00 | 3.9817e+03 | 3.9818e+03 | 3.9809e+03 | 3.9809e+03 | 1.3872 |
| 24 | 17-Mar-2019 00:25:00 | 3.9771e+03 | 3.9771e+03 | 3.9767e+03 | 3.9767e+03 | 0.3348 |
| 25 | 17-Mar-2019 00:26:00 | 3.9760e+03 | 3.9771e+03 | 3.9738e+03 | 3.9771e+03 | 0.3810 |
| 26 | 17-Mar-2019 00:27:00 | 3.9781e+03 | 3.9791e+03 | 3.9781e+03 | 3.9791e+03 | 0.9907 |
| 27 | 17-Mar-2019 00:28:00 | 3.9797e+03 | 3.9806e+03 | 3.9797e+03 | 3.9806e+03 | 0.1389 |
| 28 | 17-Mar-2019 00:29:00 | 3.9798e+03 | 3.9798e+03 | 3.9797e+03 | 3.9797e+03 | 1.2995 |
| 29 | 17-Mar-2019 00:30:00 | 3.9765e+03 | 3.9774e+03 | 3.9727e+03 | 3.9732e+03 | 3.9176 |
| 30 | 17-Mar-2019 00:31:00 | 3.9732e+03 | 3.9736e+03 | 3.9700e+03 | 3.9700e+03 | 0.8799 |
| 31 | 17-Mar-2019 00:32:00 | 3.9692e+03 | 3.9692e+03 | 3.9691e+03 | 3.9691e+03 | 3.1234 |
| 32 | 17-Mar-2019 00:33:00 | 3.9733e+03 | 3.9733e+03 | 3.9733e+03 | 3.9733e+03 | 0.0303 |
| 33 | 17-Mar-2019 00:34:00 | 3.9743e+03 | 3.9744e+03 | 3.9743e+03 | 3.9744e+03 | 1.1186 |
| 34 | 17-Mar-2019 00:35:00 | 3.9702e+03 | 3.9702e+03 | 3.9694e+03 | 3.9694e+03 | 1.1398 |

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 35 | 17-Mar-2019 00:36:00 | 3.9700e+03 | 3.9700e+03 | 3.9668e+03 | 3.9668e+03 | 1.6151 |
| 36 | 17-Mar-2019 00:37:00 | 3.9679e+03 | 3.9685e+03 | 3.9629e+03 | 3.9629e+03 | 5.5367 |
| 37 | 17-Mar-2019 00:38:00 | 3.9616e+03 | 3.9616e+03 | 3.9556e+03 | 3.9593e+03 | 31.6548 |
| 38 | 17-Mar-2019 00:39:00 | 3.9629e+03 | 3.9660e+03 | 3.9628e+03 | 3.9660e+03 | 8.2058 |
| 39 | 17-Mar-2019 00:40:00 | 3.9670e+03 | 3.9670e+03 | 3960 | 3.9652e+03 | 80.6532 |
| 40 | 17-Mar-2019 00:41:00 | 3.9650e+03 | 3.9650e+03 | 3.9607e+03 | 3.9607e+03 | 2.2074 |
| 41 | 17-Mar-2019 00:42:00 | 3.9612e+03 | 3.9625e+03 | 3.9585e+03 | 3.9602e+03 | 4.8431 |
| 42 | 17-Mar-2019 00:43:00 | 3.9592e+03 | 3.9613e+03 | 3.9592e+03 | 3.9613e+03 | 0.7638 |
| 43 | 17-Mar-2019 00:44:00 | 3.9616e+03 | 3.9645e+03 | 3.9616e+03 | 3.9645e+03 | 0.4583 |
| 44 | 17-Mar-2019 00:45:00 | 3.9614e+03 | 3.9614e+03 | 3.9614e+03 | 3.9614e+03 | 0.5045 |
| 45 | 17-Mar-2019 00:46:00 | 3.9587e+03 | 3.9594e+03 | 3.9587e+03 | 3.9594e+03 | 0.9039 |
| 46 | 17-Mar-2019 00:47:00 | 3.9603e+03 | 3.9626e+03 | 3.9560e+03 | 3.9626e+03 | 20.0262 |
| 47 | 17-Mar-2019 00:48:00 | 3.9654e+03 | 3.9654e+03 | 3.9634e+03 | 3.9634e+03 | 0.7011 |
| 48 | 17-Mar-2019 00:49:00 | 3.9646e+03 | 3.9646e+03 | 3.9646e+03 | 3.9646e+03 | 0.0393 |
| 49 | 17-Mar-2019 00:50:00 | 3.9678e+03 | 3.9678e+03 | 3.9678e+03 | 3.9678e+03 | 0.0300 |
| 50 | 17-Mar-2019 00:51:00 | 3.9680e+03 | 3.9688e+03 | 3965 | 3965 | 5.5533 |
| 51 | 17-Mar-2019 00:52:00 | 3.9684e+03 | 3.9684e+03 | 3.9684e+03 | 3.9684e+03 | 0.0177 |
| 52 | 17-Mar-2019 00:54:00 | 3.9667e+03 | 3.9693e+03 | 3.9659e+03 | 3.9693e+03 | 0.1114 |
| 53 | 17-Mar-2019 00:55:00 | 3.9697e+03 | 3.9697e+03 | 3.9697e+03 | 3.9697e+03 | 1.1700 |
| 54 | 17-Mar-2019 00:56:00 | 3965 | 3965 | 3965 | 3965 | 0.1984 |
| 55 | 17-Mar-2019 00:57:00 | 3.9648e+03 | 3.9671e+03 | 3.9648e+03 | 3.9659e+03 | 1.0521 |
| 56 | 17-Mar-2019 00:58:00 | 3.9669e+03 | 3.9672e+03 | 3.9669e+03 | 3.9672e+03 | 0.0705 |
| 57 | 17-Mar-2019 00:59:00 | 3.9649e+03 | 3.9651e+03 | 3.9639e+03 | 3.9639e+03 | 2.7885 |
| 58 | 17-Mar-2019 01:01:00 | 3.9633e+03 | 3.9707e+03 | 3.9632e+03 | 3.9666e+03 | 16.0571 |
| 59 | 17-Mar-2019 01:02:00 | 3.9682e+03 | 3.9704e+03 | 3.9682e+03 | 3.9682e+03 | 3.7277 |
| 60 | 17-Mar-2019 01:04:00 | 3.9694e+03 | 3.9721e+03 | 3.9694e+03 | 3.9721e+03 | 2.3479 |
| 61 | 17-Mar-2019 01:08:00 | 3.9686e+03 | 3.9695e+03 | 3.9686e+03 | 3.9695e+03 | 0.8484 |
| 62 | 17-Mar-2019 01:09:00 | 3.9690e+03 | 3.9690e+03 | 3.9690e+03 | 3.9690e+03 | 0.2202 |
| 63 | 17-Mar-2019 01:11:00 | 3.9705e+03 | 3.9705e+03 | 3.9705e+03 | 3.9705e+03 | 0.0113 |
| 64 | 17-Mar-2019 01:12:00 | 3.9698e+03 | 3.9698e+03 | 3.9698e+03 | 3.9698e+03 | 0.5000 |
| 65 | 17-Mar-2019 01:14:00 | 3.9699e+03 | 3.9699e+03 | 3.9699e+03 | 3.9699e+03 | 0.5462 |
| 66 | 17-Mar-2019 01:16:00 | 3.9718e+03 | 3.9718e+03 | 3.9718e+03 | 3.9718e+03 | 0.1049 |
| 67 | 17-Mar-2019 01:17:00 | 3.9725e+03 | 3.9725e+03 | 3.9705e+03 | 3.9705e+03 | 0.1226 |

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 68 | 17-Mar-2019 01:18:00 | 3.9705e+03 | 3.9705e+03 | 3.9705e+03 | 3.9705e+03 | 0.2105 |
| 69 | 17-Mar-2019 01:19:00 | 3.9726e+03 | 3.9726e+03 | 3.9726e+03 | 3.9726e+03 | 0.3957 |
| 70 | 17-Mar-2019 01:21:00 | 3.9714e+03 | 3.9716e+03 | 3.9698e+03 | 3.9698e+03 | 2.7867 |
| 71 | 17-Mar-2019 01:22:00 | 3.9708e+03 | 3.9708e+03 | 3.9701e+03 | 3.9701e+03 | 0.0991 |
| 72 | 17-Mar-2019 01:23:00 | 3.9697e+03 | 3.9697e+03 | 3.9697e+03 | 3.9697e+03 | 0.0582 |
| 73 | 17-Mar-2019 01:24:00 | 3.9697e+03 | 3.9697e+03 | 3.9688e+03 | 3.9688e+03 | 0.2065 |
| 74 | 17-Mar-2019 01:25:00 | 3.9684e+03 | 3.9684e+03 | 3.9684e+03 | 3.9684e+03 | 0.0385 |
| 75 | 17-Mar-2019 01:27:00 | 3.9676e+03 | 3.9676e+03 | 3.9676e+03 | 3.9676e+03 | 1.5375 |
| 76 | 17-Mar-2019 01:28:00 | 3.9680e+03 | 3.9680e+03 | 3.9680e+03 | 3.9680e+03 | 0.0178 |
| 77 | 17-Mar-2019 01:29:00 | 3.9696e+03 | 3.9696e+03 | 3.9696e+03 | 3.9696e+03 | 0.2409 |
| 78 | 17-Mar-2019 01:31:00 | 3.9696e+03 | 3.9696e+03 | 3.9696e+03 | 3.9696e+03 | 0.0104 |
| 79 | 17-Mar-2019 01:33:00 | 3.9696e+03 | 3.9696e+03 | 3.9696e+03 | 3.9696e+03 | 0.1079 |
| 80 | 17-Mar-2019 01:34:00 | 3.9696e+03 | 3.9696e+03 | 3.9688e+03 | 3.9696e+03 | 0.1726 |
| 81 | 17-Mar-2019 01:36:00 | 3.9706e+03 | 3.9712e+03 | 3.9697e+03 | 3.9712e+03 | 0.2806 |
| 82 | 17-Mar-2019 01:37:00 | 3.9712e+03 | 3.9712e+03 | 3.9712e+03 | 3.9712e+03 | 0.2512 |
| 83 | 17-Mar-2019 01:38:00 | 3.9712e+03 | 3.9712e+03 | 3.9712e+03 | 3.9712e+03 | 0.0035 |
| 84 | 17-Mar-2019 01:39:00 | 3.9712e+03 | 3.9714e+03 | 3.9712e+03 | 3.9714e+03 | 0.8625 |
| 85 | 17-Mar-2019 01:41:00 | 3.9723e+03 | 3.9728e+03 | 3.9723e+03 | 3.9728e+03 | 0.2312 |
| 86 | 17-Mar-2019 01:43:00 | 3.9730e+03 | 3.9730e+03 | 3.9730e+03 | 3.9730e+03 | 0.0191 |
| 87 | 17-Mar-2019 01:44:00 | 3.9724e+03 | 3.9730e+03 | 3.9724e+03 | 3.9730e+03 | 0.1219 |
| 88 | 17-Mar-2019 01:45:00 | 3.9725e+03 | 3.9725e+03 | 3.9725e+03 | 3.9725e+03 | 0.3859 |
| 89 | 17-Mar-2019 01:46:00 | 3.9730e+03 | 3.9739e+03 | 3.9724e+03 | 3.9724e+03 | 3.7617 |
| 90 | 17-Mar-2019 01:47:00 | 3.9734e+03 | 3.9734e+03 | 3.9730e+03 | 3.9730e+03 | 0.3111 |
| 91 | 17-Mar-2019 01:48:00 | 3.9741e+03 | 3.9741e+03 | 3.9741e+03 | 3.9741e+03 | 0.0962 |
| 92 | 17-Mar-2019 01:49:00 | 3.9730e+03 | 3.9741e+03 | 3.9730e+03 | 3.9741e+03 | 0.2203 |
| 93 | 17-Mar-2019 01:50:00 | 3.9741e+03 | 3.9741e+03 | 3.9730e+03 | 3.9730e+03 | 2.0141 |
| 94 | 17-Mar-2019 01:51:00 | 3.9722e+03 | 3.9722e+03 | 3.9722e+03 | 3.9722e+03 | 0.0192 |
| 95 | 17-Mar-2019 01:53:00 | 3.9711e+03 | 3.9711e+03 | 3.9711e+03 | 3.9711e+03 | 0.7685 |
| 96 | 17-Mar-2019 01:54:00 | 3.9711e+03 | 3.9712e+03 | 3.9693e+03 | 3.9693e+03 | 0.2490 |
| 97 | 17-Mar-2019 01:57:00 | 3.9705e+03 | 3.9705e+03 | 3.9705e+03 | 3.9705e+03 | 0.6593 |
| 98 | 17-Mar-2019 01:58:00 | 3.9695e+03 | 3.9695e+03 | 3.9695e+03 | 3.9695e+03 | 0.0644 |
| 99 | 17-Mar-2019 01:59:00 | 3.9686e+03 | 3.9686e+03 | 3.9686e+03 | 3.9686e+03 | 0.4034 |
| 100 | 17-Mar-2019 02:00:00 | 3.9686e+03 | 3.9694e+03 | 3.9682e+03 | 3.9685e+03 | 1.7836 |

```
    ⋮
```

```
%outliers = outlier(BitcoinData.Close)

%Rerun model to check for more outliers
Y = BitcoinData{:,"Close"}
```

```
Y = 8891×1
10^3 ×
    3.9900
    3.9899
    3.9909
    3.9924
    3.9902
    3.9918
    3.9922
    3.9922
    3.9919
    3.9919
     ⋮
```

```
X = BitcoinData{:,[1:3]}
```

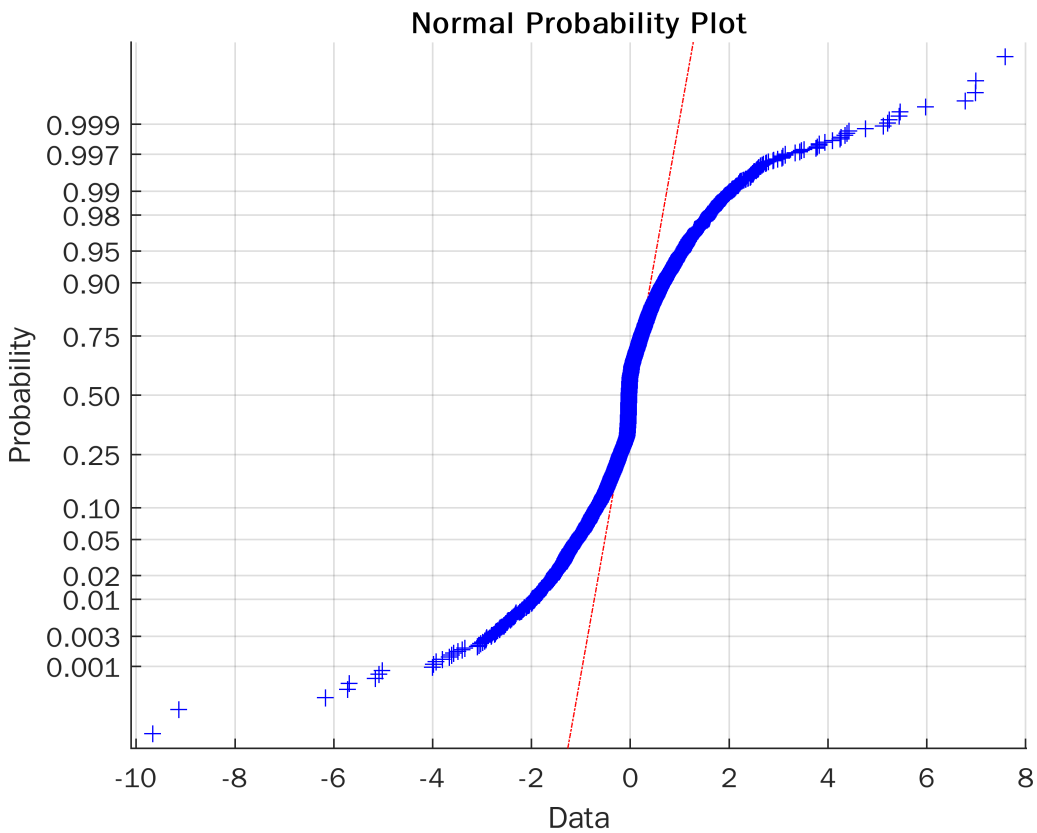
```
X = 8891×3
10^3 ×
    3.9900    3.9900    3.9900
    3.9900    3.9900    3.9899
    3.9900    3.9918    3.9900
    3.9910    3.9924    3.9899
    3.9902    3.9902    3.9902
    3.9914    3.9918    3.9914
    3.9922    3.9922    3.9922
    3.9909    3.9922    3.9909
    3.9919    3.9919    3.9919
    3.9919    3.9919    3.9919
     ⋮
```

```
LRPre = fitlm(zscore(X),Y)
```

```
LRPre =
Linear regression model:
    y ~ 1 + x1 + x2 + x3

Estimated Coefficients:
                   Estimate       SE          tStat       pValue
                   ________    _________    __________    ______

    (Intercept)     3980.2     0.0075428    5.2768e+05      0
    x1             -10.042       0.15985       -62.822      0
    x2              14.256       0.12321        115.71      0
    x3              14.238       0.10724        132.76      0


Number of observations: 8891, Error degrees of freedom: 8887
Root Mean Squared Error: 0.711
```

```
R-squared: 0.999,  Adjusted R-Squared: 0.999
F-statistic vs. constant model: 1.99e+06, p-value = 0
```

```
normplot(LRPre.Residuals.Raw)
```




```
idx = isoutlier(BitcoinData.Close)
```

```
idx = 8891×1 logical array
   0
   0
   0
   0
   0
   0
   0
   0
   0
   0
     ⋮
```

```
sum(idx)
```

```
ans = 215
```

```
BitcoinData(idx,:) = []
```

```
BitcoinData = 8676×7 timetable
                                                                    ...
```

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 1 | 17-Mar-2019 00:00:00 | 3990 | 3990 | 3990 | 3990 | 1.6034 |
| 2 | 17-Mar-2019 00:01:00 | 3990 | 3990 | 3.9899e+03 | 3.9899e+03 | 0.9532 |
| 3 | 17-Mar-2019 00:02:00 | 3990 | 3.9918e+03 | 3990 | 3.9909e+03 | 2.0498 |
| 4 | 17-Mar-2019 00:04:00 | 3.9910e+03 | 3.9924e+03 | 3.9899e+03 | 3.9924e+03 | 3.2865 |
| 5 | 17-Mar-2019 00:06:00 | 3.9902e+03 | 3.9902e+03 | 3.9902e+03 | 3.9902e+03 | 0.1500 |
| 6 | 17-Mar-2019 00:07:00 | 3.9914e+03 | 3.9918e+03 | 3.9914e+03 | 3.9918e+03 | 0.2979 |
| 7 | 17-Mar-2019 00:08:00 | 3.9922e+03 | 3.9922e+03 | 3.9922e+03 | 3.9922e+03 | 0.0500 |
| 8 | 17-Mar-2019 00:09:00 | 3.9909e+03 | 3.9922e+03 | 3.9909e+03 | 3.9922e+03 | 1.3248 |
| 9 | 17-Mar-2019 00:10:00 | 3.9919e+03 | 3.9919e+03 | 3.9919e+03 | 3.9919e+03 | 0.0119 |
| 10 | 17-Mar-2019 00:11:00 | 3.9919e+03 | 3.9919e+03 | 3.9919e+03 | 3.9919e+03 | 0.0578 |
| 11 | 17-Mar-2019 00:12:00 | 3.9919e+03 | 3.9919e+03 | 3.9919e+03 | 3.9919e+03 | 0.0119 |
| 12 | 17-Mar-2019 00:13:00 | 3.9900e+03 | 3.9907e+03 | 3.9883e+03 | 3.9907e+03 | 0.7568 |
| 13 | 17-Mar-2019 00:14:00 | 3.9882e+03 | 3.9890e+03 | 3.9850e+03 | 3.9880e+03 | 8.6849 |
| 14 | 17-Mar-2019 00:15:00 | 3.9850e+03 | 3.9885e+03 | 3.9850e+03 | 3.9881e+03 | 2.7837 |
| 15 | 17-Mar-2019 00:16:00 | 3.9880e+03 | 3.9880e+03 | 3.9852e+03 | 3.9852e+03 | 0.2055 |
| 16 | 17-Mar-2019 00:17:00 | 3.9848e+03 | 3.9849e+03 | 3.9750e+03 | 3.9751e+03 | 34.7895 |
| 17 | 17-Mar-2019 00:18:00 | 3974 | 3.9744e+03 | 3.9589e+03 | 3.9641e+03 | 95.6286 |
| 18 | 17-Mar-2019 00:19:00 | 3.9641e+03 | 3.9763e+03 | 3.9641e+03 | 3.9763e+03 | 6.4694 |
| 19 | 17-Mar-2019 00:20:00 | 3.9763e+03 | 3.9763e+03 | 3.9746e+03 | 3.9753e+03 | 1.0630 |
| 20 | 17-Mar-2019 00:21:00 | 3.9769e+03 | 3.9783e+03 | 3.9769e+03 | 3.9783e+03 | 2.1030 |
| 21 | 17-Mar-2019 00:22:00 | 3.9793e+03 | 3.9805e+03 | 3.9793e+03 | 3.9802e+03 | 0.1511 |
| 22 | 17-Mar-2019 00:23:00 | 3.9773e+03 | 3.9773e+03 | 3.9746e+03 | 3.9746e+03 | 0.0450 |
| 23 | 17-Mar-2019 00:24:00 | 3.9817e+03 | 3.9818e+03 | 3.9809e+03 | 3.9809e+03 | 1.3872 |
| 24 | 17-Mar-2019 00:25:00 | 3.9771e+03 | 3.9771e+03 | 3.9767e+03 | 3.9767e+03 | 0.3348 |
| 25 | 17-Mar-2019 00:26:00 | 3.9760e+03 | 3.9771e+03 | 3.9738e+03 | 3.9771e+03 | 0.3810 |
| 26 | 17-Mar-2019 00:27:00 | 3.9781e+03 | 3.9791e+03 | 3.9781e+03 | 3.9791e+03 | 0.9907 |
| 27 | 17-Mar-2019 00:28:00 | 3.9797e+03 | 3.9806e+03 | 3.9797e+03 | 3.9806e+03 | 0.1389 |
| 28 | 17-Mar-2019 00:29:00 | 3.9798e+03 | 3.9798e+03 | 3.9797e+03 | 3.9797e+03 | 1.2995 |
| 29 | 17-Mar-2019 00:30:00 | 3.9765e+03 | 3.9774e+03 | 3.9727e+03 | 3.9732e+03 | 3.9176 |
| 30 | 17-Mar-2019 00:31:00 | 3.9732e+03 | 3.9736e+03 | 3.9700e+03 | 3.9700e+03 | 0.8799 |
| 31 | 17-Mar-2019 00:32:00 | 3.9692e+03 | 3.9692e+03 | 3.9691e+03 | 3.9691e+03 | 3.1234 |
| 32 | 17-Mar-2019 00:33:00 | 3.9733e+03 | 3.9733e+03 | 3.9733e+03 | 3.9733e+03 | 0.0303 |
| 33 | 17-Mar-2019 00:34:00 | 3.9743e+03 | 3.9744e+03 | 3.9743e+03 | 3.9744e+03 | 1.1186 |

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 34 | 17-Mar-2019 00:35:00 | 3.9702e+03 | 3.9702e+03 | 3.9694e+03 | 3.9694e+03 | 1.1398 |
| 35 | 17-Mar-2019 00:36:00 | 3.9700e+03 | 3.9700e+03 | 3.9668e+03 | 3.9668e+03 | 1.6151 |
| 36 | 17-Mar-2019 00:37:00 | 3.9679e+03 | 3.9685e+03 | 3.9629e+03 | 3.9629e+03 | 5.5367 |
| 37 | 17-Mar-2019 00:38:00 | 3.9616e+03 | 3.9616e+03 | 3.9556e+03 | 3.9593e+03 | 31.6548 |
| 38 | 17-Mar-2019 00:39:00 | 3.9629e+03 | 3.9660e+03 | 3.9628e+03 | 3.9660e+03 | 8.2058 |
| 39 | 17-Mar-2019 00:40:00 | 3.9670e+03 | 3.9670e+03 | 3960 | 3.9652e+03 | 80.6532 |
| 40 | 17-Mar-2019 00:41:00 | 3.9650e+03 | 3.9650e+03 | 3.9607e+03 | 3.9607e+03 | 2.2074 |
| 41 | 17-Mar-2019 00:42:00 | 3.9612e+03 | 3.9625e+03 | 3.9585e+03 | 3.9602e+03 | 4.8431 |
| 42 | 17-Mar-2019 00:43:00 | 3.9592e+03 | 3.9613e+03 | 3.9592e+03 | 3.9613e+03 | 0.7638 |
| 43 | 17-Mar-2019 00:44:00 | 3.9616e+03 | 3.9645e+03 | 3.9616e+03 | 3.9645e+03 | 0.4583 |
| 44 | 17-Mar-2019 00:45:00 | 3.9614e+03 | 3.9614e+03 | 3.9614e+03 | 3.9614e+03 | 0.5045 |
| 45 | 17-Mar-2019 00:46:00 | 3.9587e+03 | 3.9594e+03 | 3.9587e+03 | 3.9594e+03 | 0.9039 |
| 46 | 17-Mar-2019 00:47:00 | 3.9603e+03 | 3.9626e+03 | 3.9560e+03 | 3.9626e+03 | 20.0262 |
| 47 | 17-Mar-2019 00:48:00 | 3.9654e+03 | 3.9654e+03 | 3.9634e+03 | 3.9634e+03 | 0.7011 |
| 48 | 17-Mar-2019 00:49:00 | 3.9646e+03 | 3.9646e+03 | 3.9646e+03 | 3.9646e+03 | 0.0393 |
| 49 | 17-Mar-2019 00:50:00 | 3.9678e+03 | 3.9678e+03 | 3.9678e+03 | 3.9678e+03 | 0.0300 |
| 50 | 17-Mar-2019 00:51:00 | 3.9680e+03 | 3.9688e+03 | 3965 | 3965 | 5.5533 |
| 51 | 17-Mar-2019 00:52:00 | 3.9684e+03 | 3.9684e+03 | 3.9684e+03 | 3.9684e+03 | 0.0177 |
| 52 | 17-Mar-2019 00:54:00 | 3.9667e+03 | 3.9693e+03 | 3.9659e+03 | 3.9693e+03 | 0.1114 |
| 53 | 17-Mar-2019 00:55:00 | 3.9697e+03 | 3.9697e+03 | 3.9697e+03 | 3.9697e+03 | 1.1700 |
| 54 | 17-Mar-2019 00:56:00 | 3965 | 3965 | 3965 | 3965 | 0.1984 |
| 55 | 17-Mar-2019 00:57:00 | 3.9648e+03 | 3.9671e+03 | 3.9648e+03 | 3.9659e+03 | 1.0521 |
| 56 | 17-Mar-2019 00:58:00 | 3.9669e+03 | 3.9672e+03 | 3.9669e+03 | 3.9672e+03 | 0.0705 |
| 57 | 17-Mar-2019 00:59:00 | 3.9649e+03 | 3.9651e+03 | 3.9639e+03 | 3.9639e+03 | 2.7885 |
| 58 | 17-Mar-2019 01:01:00 | 3.9633e+03 | 3.9707e+03 | 3.9632e+03 | 3.9666e+03 | 16.0571 |
| 59 | 17-Mar-2019 01:02:00 | 3.9682e+03 | 3.9704e+03 | 3.9682e+03 | 3.9682e+03 | 3.7277 |
| 60 | 17-Mar-2019 01:04:00 | 3.9694e+03 | 3.9721e+03 | 3.9694e+03 | 3.9721e+03 | 2.3479 |
| 61 | 17-Mar-2019 01:08:00 | 3.9686e+03 | 3.9695e+03 | 3.9686e+03 | 3.9695e+03 | 0.8484 |
| 62 | 17-Mar-2019 01:09:00 | 3.9690e+03 | 3.9690e+03 | 3.9690e+03 | 3.9690e+03 | 0.2202 |
| 63 | 17-Mar-2019 01:11:00 | 3.9705e+03 | 3.9705e+03 | 3.9705e+03 | 3.9705e+03 | 0.0113 |
| 64 | 17-Mar-2019 01:12:00 | 3.9698e+03 | 3.9698e+03 | 3.9698e+03 | 3.9698e+03 | 0.5000 |
| 65 | 17-Mar-2019 01:14:00 | 3.9699e+03 | 3.9699e+03 | 3.9699e+03 | 3.9699e+03 | 0.5462 |
| 66 | 17-Mar-2019 01:16:00 | 3.9718e+03 | 3.9718e+03 | 3.9718e+03 | 3.9718e+03 | 0.1049 |

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 67 | 17-Mar-2019 01:17:00 | 3.9725e+03 | 3.9725e+03 | 3.9705e+03 | 3.9705e+03 | 0.1226 |
| 68 | 17-Mar-2019 01:18:00 | 3.9705e+03 | 3.9705e+03 | 3.9705e+03 | 3.9705e+03 | 0.2105 |
| 69 | 17-Mar-2019 01:19:00 | 3.9726e+03 | 3.9726e+03 | 3.9726e+03 | 3.9726e+03 | 0.3957 |
| 70 | 17-Mar-2019 01:21:00 | 3.9714e+03 | 3.9716e+03 | 3.9698e+03 | 3.9698e+03 | 2.7867 |
| 71 | 17-Mar-2019 01:22:00 | 3.9708e+03 | 3.9708e+03 | 3.9701e+03 | 3.9701e+03 | 0.0991 |
| 72 | 17-Mar-2019 01:23:00 | 3.9697e+03 | 3.9697e+03 | 3.9697e+03 | 3.9697e+03 | 0.0582 |
| 73 | 17-Mar-2019 01:24:00 | 3.9697e+03 | 3.9697e+03 | 3.9688e+03 | 3.9688e+03 | 0.2065 |
| 74 | 17-Mar-2019 01:25:00 | 3.9684e+03 | 3.9684e+03 | 3.9684e+03 | 3.9684e+03 | 0.0385 |
| 75 | 17-Mar-2019 01:27:00 | 3.9676e+03 | 3.9676e+03 | 3.9676e+03 | 3.9676e+03 | 1.5375 |
| 76 | 17-Mar-2019 01:28:00 | 3.9680e+03 | 3.9680e+03 | 3.9680e+03 | 3.9680e+03 | 0.0178 |
| 77 | 17-Mar-2019 01:29:00 | 3.9696e+03 | 3.9696e+03 | 3.9696e+03 | 3.9696e+03 | 0.2409 |
| 78 | 17-Mar-2019 01:31:00 | 3.9696e+03 | 3.9696e+03 | 3.9696e+03 | 3.9696e+03 | 0.0104 |
| 79 | 17-Mar-2019 01:33:00 | 3.9696e+03 | 3.9696e+03 | 3.9696e+03 | 3.9696e+03 | 0.1079 |
| 80 | 17-Mar-2019 01:34:00 | 3.9696e+03 | 3.9696e+03 | 3.9688e+03 | 3.9696e+03 | 0.1726 |
| 81 | 17-Mar-2019 01:36:00 | 3.9706e+03 | 3.9712e+03 | 3.9697e+03 | 3.9712e+03 | 0.2806 |
| 82 | 17-Mar-2019 01:37:00 | 3.9712e+03 | 3.9712e+03 | 3.9712e+03 | 3.9712e+03 | 0.2512 |
| 83 | 17-Mar-2019 01:38:00 | 3.9712e+03 | 3.9712e+03 | 3.9712e+03 | 3.9712e+03 | 0.0035 |
| 84 | 17-Mar-2019 01:39:00 | 3.9712e+03 | 3.9714e+03 | 3.9712e+03 | 3.9714e+03 | 0.8625 |
| 85 | 17-Mar-2019 01:41:00 | 3.9723e+03 | 3.9728e+03 | 3.9723e+03 | 3.9728e+03 | 0.2312 |
| 86 | 17-Mar-2019 01:43:00 | 3.9730e+03 | 3.9730e+03 | 3.9730e+03 | 3.9730e+03 | 0.0191 |
| 87 | 17-Mar-2019 01:44:00 | 3.9724e+03 | 3.9730e+03 | 3.9724e+03 | 3.9730e+03 | 0.1219 |
| 88 | 17-Mar-2019 01:45:00 | 3.9725e+03 | 3.9725e+03 | 3.9725e+03 | 3.9725e+03 | 0.3859 |
| 89 | 17-Mar-2019 01:46:00 | 3.9730e+03 | 3.9739e+03 | 3.9724e+03 | 3.9724e+03 | 3.7617 |
| 90 | 17-Mar-2019 01:47:00 | 3.9734e+03 | 3.9734e+03 | 3.9730e+03 | 3.9730e+03 | 0.3111 |
| 91 | 17-Mar-2019 01:48:00 | 3.9741e+03 | 3.9741e+03 | 3.9741e+03 | 3.9741e+03 | 0.0962 |
| 92 | 17-Mar-2019 01:49:00 | 3.9730e+03 | 3.9741e+03 | 3.9730e+03 | 3.9741e+03 | 0.2203 |
| 93 | 17-Mar-2019 01:50:00 | 3.9741e+03 | 3.9741e+03 | 3.9730e+03 | 3.9730e+03 | 2.0141 |
| 94 | 17-Mar-2019 01:51:00 | 3.9722e+03 | 3.9722e+03 | 3.9722e+03 | 3.9722e+03 | 0.0192 |
| 95 | 17-Mar-2019 01:53:00 | 3.9711e+03 | 3.9711e+03 | 3.9711e+03 | 3.9711e+03 | 0.7685 |
| 96 | 17-Mar-2019 01:54:00 | 3.9711e+03 | 3.9712e+03 | 3.9693e+03 | 3.9693e+03 | 0.2490 |
| 97 | 17-Mar-2019 01:57:00 | 3.9705e+03 | 3.9705e+03 | 3.9705e+03 | 3.9705e+03 | 0.6593 |
| 98 | 17-Mar-2019 01:58:00 | 3.9695e+03 | 3.9695e+03 | 3.9695e+03 | 3.9695e+03 | 0.0644 |
| 99 | 17-Mar-2019 01:59:00 | 3.9686e+03 | 3.9686e+03 | 3.9686e+03 | 3.9686e+03 | 0.4034 |

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 100 | 17-Mar-2019 02:00:00 | 3.9686e+03 | 3.9694e+03 | 3.9682e+03 | 3.9685e+03 | 1.7836 |

⋮

```
%outliers = outlier(BitcoinData.Close)
```

## Split dataset into training and testing data

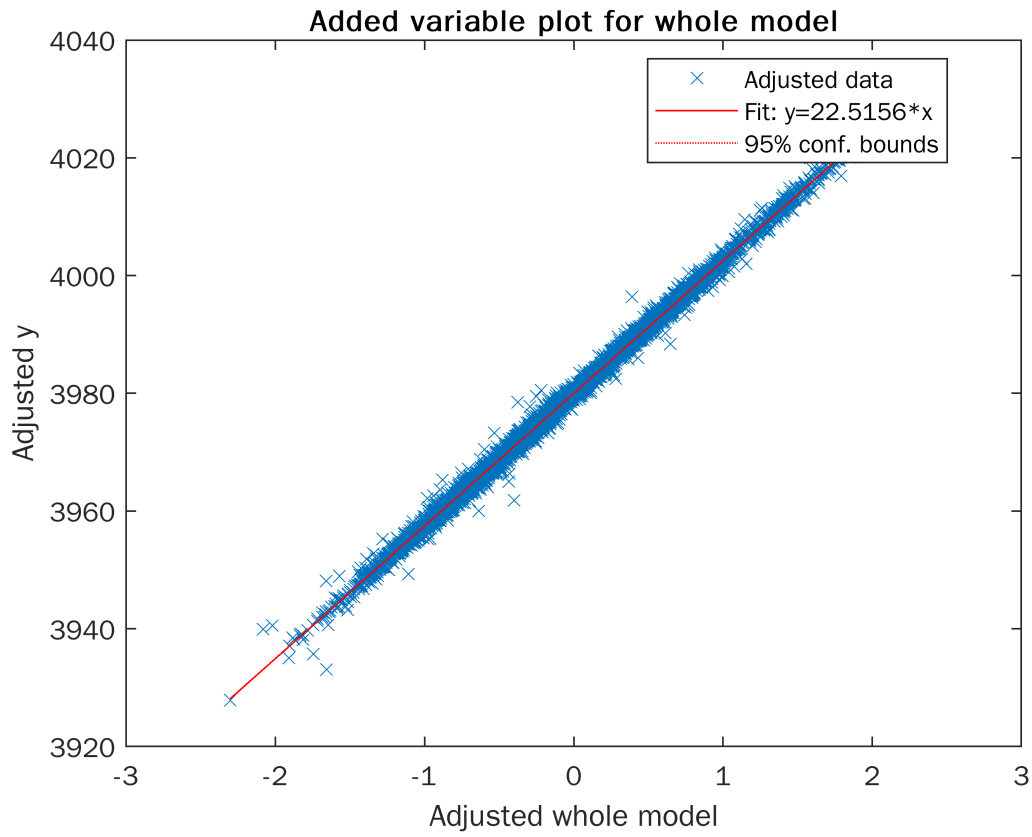
```
BitcoinData_new = [X, Y];

PD = 0.20;
cv = cvpartition(size(BitcoinData_new,1),'HoldOut',PD);
Xtrain = BitcoinData_new(cv.training,[1:end - 1]);
Ytrain = BitcoinData_new(cv.training,end);
Xtest = BitcoinData_new(cv.test, [1:end - 1]);
Ytest = BitcoinData_new(cv.test,end);
```

## Linear model with training-testing split

```
LRModel = fitlm(zscore(Xtrain),Ytrain)
```

```
LRModel = 
Linear regression model:
    y ~ 1 + x1 + x2 + x3

Estimated Coefficients:
                   Estimate       SE          tStat       pValue  
                   ________    _________    __________    ______

    (Intercept)       3980     0.0085048    4.6797e+05      0    
    x1             -10.104       0.17529       -57.644      0    
    x2              14.204       0.13371        106.23      0    
    x3              14.251       0.11775        121.03      0    


Number of observations: 7113, Error degrees of freedom: 7109
Root Mean Squared Error: 0.717
R-squared: 0.998,  Adjusted R-Squared: 0.998
F-statistic vs. constant model: 1.55e+06, p-value = 0
```

```
plot(LRModel)
```




```
LRModel.RMSE
```

```
ans = 0.7173
```

## Predict

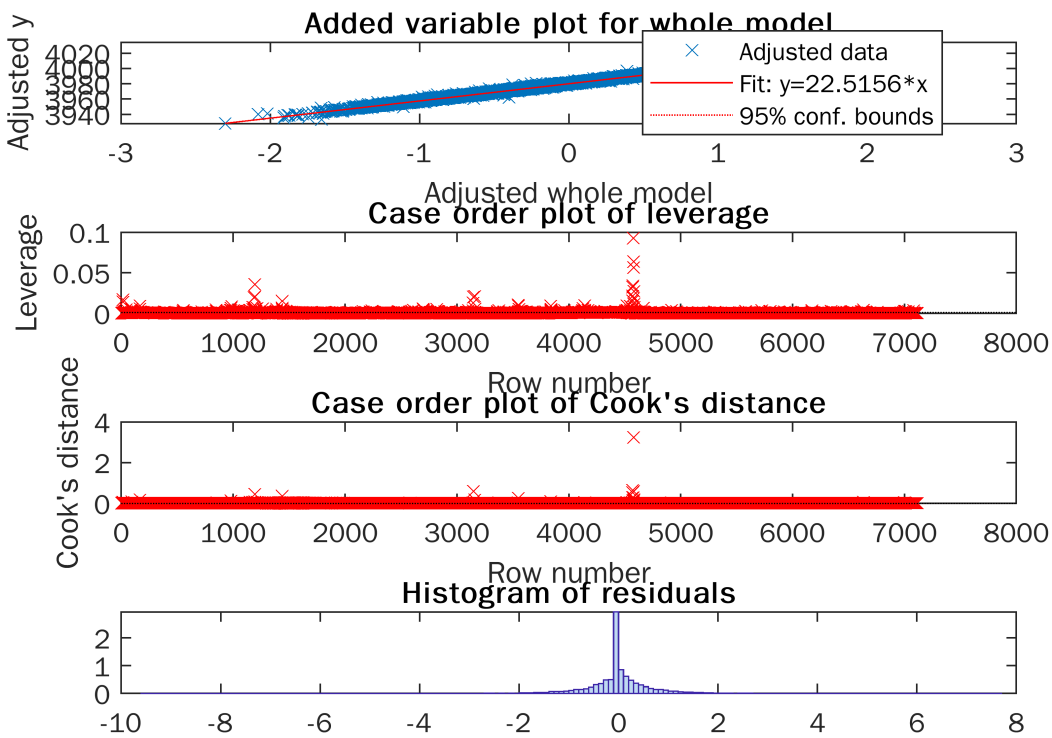
```
[YPred, Scores] = predict(LRModel,Xtest)
```

```
YPred = 1778×1
10^4 ×
    7.7226
    7.7204
    7.6968
    7.7021
    7.7011
    7.6817
    7.6913
    7.6593
    7.6679
    7.6675
      ⋮

Scores = 1778×2
10^4 ×
    7.7159    7.7292
    7.7137    7.7271
    7.6901    7.7034
    7.6955    7.7088
    7.6945    7.7078
    7.6751    7.6883
```

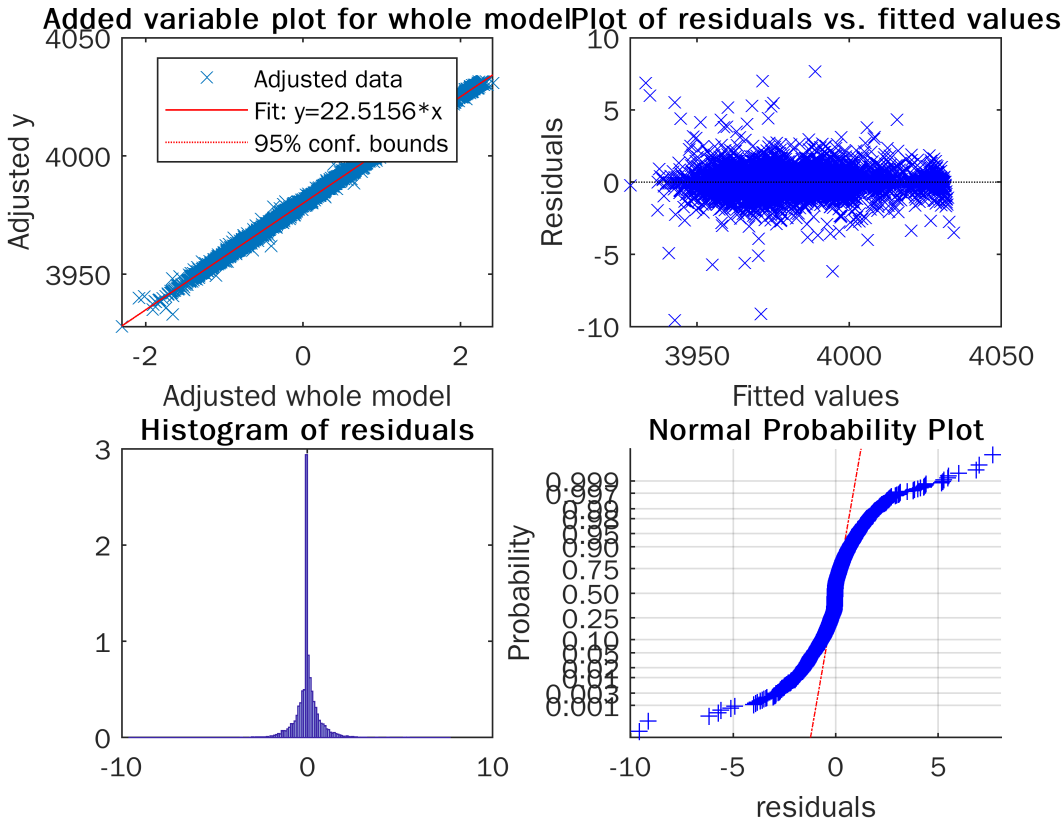
```
    7.6847    7.6979
    7.6527    7.6659
    7.6613    7.6745
    7.6609    7.6741
      ⋮
```

## Plots

```
figure,
subplot(4, 1, 1), plot(LRModel)
subplot(4, 1, 2), plotDiagnostics(LRModel)
subplot(4, 1, 3), plotDiagnostics(LRModel, 'cookd')
subplot(4, 1, 4), plotResiduals(LRModel)
```




```
figure,
subplot(2, 2, 1), plot(LRModel)
subplot(2, 2, 2), plotResiduals(LRModel,'fitted')
subplot(2, 2, 3), plotResiduals(LRModel)
subplot(2, 2, 4), normplot(LRModel.Residuals.Raw)
xlabel('residuals')
```


Added variable plot for whole model
Adjusted data
Fit: y=22.5156*x
95% conf. bounds
Adjusted y
Adjusted whole model
Plot of residuals vs. fitted values
Residuals
Fitted values
Histogram of residuals
Normal Probability Plot
Probability
residuals

## Upload the big dataset (>250MB) to MATLAB Drive and read table

```
BitcoinData = readtable('bitcoin-dataset.csv');
```

```
Warning: Column headers from the file were modified to make them valid MATLAB identifiers
before creating variable names for the table. The original column headers are saved in the
VariableDescriptions property.
Set 'VariableNamingRule' to 'preserve' to use the original column headers as table variable names.
```

```
Tablesize = size(BitcoinData)
```

```
Tablesize = 1×2
     4857377           8
```

```
head(BitcoinData,1)
```

```
ans = 1×8 table
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                
...
```

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 1 | 1.3253e+09 | 4.3900 | 4.3900 | 4.3900 | 4.3900 | 0.4556 |

## Convert timestamp

```
datetest = BitcoinData(:,1);
datetest = table2array(datetest);
BitcoinData.Timestamp = datetime(datetest, 'ConvertFrom', 'posixtime');
```

## Remove NaNs

```
% how many NaNs in each column
NaN2 = sum(isnan(BitcoinData.Open))
```

```
NaN2 = 1243608
```

```
NaN3 = sum(isnan(BitcoinData.High))
```

```
NaN3 = 1243608
```

```
NaN4 = sum(isnan(BitcoinData.Low))
```

```
NaN4 = 1243608
```

```
NaN5 = sum(isnan(BitcoinData.Close))
```

```
NaN5 = 1243608
```

```
NaN6 = sum(isnan(BitcoinData.Volume__BTC_))
```

```
NaN6 = 1243608
```

```
NaN7 = sum(isnan(BitcoinData.Volume__Currency_))
```

```
NaN7 = 1243608
```

```
NaN8 = sum(isnan(BitcoinData.Weighted_Price))
```

```
NaN8 = 1243608
```

```
% remove NaNs
BitcoinData = BitcoinData(isnan(BitcoinData.High) == 0,:);
```

## Select data

```
BitcoinDataTimetable = table2timetable(BitcoinData);

% March 2013
% S = timerange('17-Mar-2013 00:00:00','18-Mar-2013 23:59:00'); %2days
% S = timerange('17-Mar-2013 00:00:00','23-Mar-2013 23:59:00'); %7days
% S = timerange('17-Mar-2013 00:00:00','30-Mar-2013 23:59:00'); %14days

% March 2016
% S = timerange('17-Mar-2016 00:00:00','18-Mar-2016 23:59:00'); %2days
% S = timerange('17-Mar-2016 00:00:00','23-Mar-2016 23:59:00'); %7days
% S = timerange('17-Mar-2016 00:00:00','30-Mar-2016 23:59:00'); %14days

% March 2019
% S = timerange('17-Mar-2019 00:00:00','18-Mar-2019 23:59:00'); %2days
% S = timerange('17-Mar-2019 00:00:00','23-Mar-2019 23:59:00'); %7days
 S = timerange('17-Mar-2019 00:00:00','30-Mar-2019 23:59:00'); %14days

% March 2021
% S = timerange('17-Mar-2021 00:00:00','18-Mar-2021 23:59:00'); %2days
% S = timerange('17-Mar-2021 00:00:00','23-Mar-2021 23:59:00'); %7days
% S = timerange('17-Mar-2021 00:00:00','30-Mar-2021 23:59:00'); %14days

BitcoinData = BitcoinDataTimetable(S,:);
Tablesize = size(BitcoinData)
```

```
Tablesize = 1×2
       18719           7
```

## Create model - preprocessing

```
% standardization, and Initial predictor set (matrix)

Y = BitcoinData{:,"Close"}
```

```
Y = 18719×1
10^3 ×
    3.9900
    3.9899
    3.9909
    3.9924
    3.9902
    3.9918
    3.9922
    3.9922
    3.9919
    3.9919
     ⋮
```

```
X = BitcoinData{:,[1:3]}
```

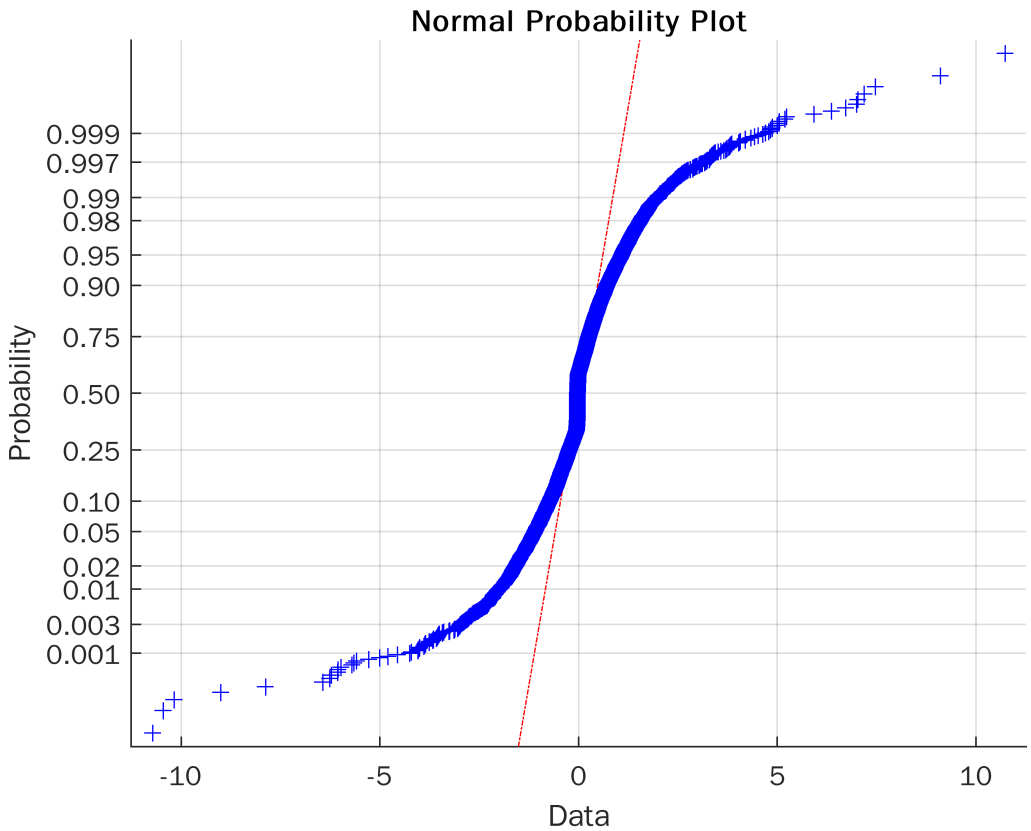
```
X = 18719×3
10^3 ×
    3.9900    3.9900    3.9900
    3.9900    3.9900    3.9899
    3.9900    3.9918    3.9900
    3.9910    3.9924    3.9899
```

```
    3.9902    3.9902    3.9902
    3.9914    3.9918    3.9914
    3.9922    3.9922    3.9922
    3.9909    3.9922    3.9909
    3.9919    3.9919    3.9919
    3.9919    3.9919    3.9919
     ⋮
```

```
%Check model for outliers

LRPre = fitlm(zscore(X),Y)
```

```
LRPre = 
Linear regression model:
    y ~ 1 + x1 + x2 + x3

Estimated Coefficients:
                   Estimate       SE          tStat       pValue  
                   ________    _________    __________    ______ 

    (Intercept)       3989     0.0053429    7.4659e+05      0    
    x1             -22.112       0.27068       -81.689      0    
    x2              34.004        0.2086        163.02      0    
    x3              33.453       0.18908        176.92      0    


Number of observations: 18719, Error degrees of freedom: 18715
Root Mean Squared Error: 0.731
R-squared: 1,  Adjusted R-Squared: 1
F-statistic vs. constant model: 2.4e+07, p-value = 0
```

```
normplot(LRPre.Residuals.Raw)
```




## Identify and Remove Outliers

```
idx = isoutlier(BitcoinData.Close)
```

```
idx = 18719×1 logical array
   0
   0
   0
   0
   0
   0
   0
   0
   0
   0
     ⋮
```

```
sum(idx)
```

```
ans = 2301
```

```
BitcoinData(idx,:) = []
```

```
BitcoinData = 16418×7 timetable
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                
```
...
```

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 1 | 17-Mar-2019 00:00:00 | 3990 | 3990 | 3990 | 3990 | 1.6034 |
```

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 2 | 17-Mar-2019 00:01:00 | 3990 | 3990 | 3.9899e+03 | 3.9899e+03 | 0.9532 |
| 3 | 17-Mar-2019 00:02:00 | 3990 | 3.9918e+03 | 3990 | 3.9909e+03 | 2.0498 |
| 4 | 17-Mar-2019 00:04:00 | 3.9910e+03 | 3.9924e+03 | 3.9899e+03 | 3.9924e+03 | 3.2865 |
| 5 | 17-Mar-2019 00:06:00 | 3.9902e+03 | 3.9902e+03 | 3.9902e+03 | 3.9902e+03 | 0.1500 |
| 6 | 17-Mar-2019 00:07:00 | 3.9914e+03 | 3.9918e+03 | 3.9914e+03 | 3.9918e+03 | 0.2979 |
| 7 | 17-Mar-2019 00:08:00 | 3.9922e+03 | 3.9922e+03 | 3.9922e+03 | 3.9922e+03 | 0.0500 |
| 8 | 17-Mar-2019 00:09:00 | 3.9909e+03 | 3.9922e+03 | 3.9909e+03 | 3.9922e+03 | 1.3248 |
| 9 | 17-Mar-2019 00:10:00 | 3.9919e+03 | 3.9919e+03 | 3.9919e+03 | 3.9919e+03 | 0.0119 |
| 10 | 17-Mar-2019 00:11:00 | 3.9919e+03 | 3.9919e+03 | 3.9919e+03 | 3.9919e+03 | 0.0578 |
| 11 | 17-Mar-2019 00:12:00 | 3.9919e+03 | 3.9919e+03 | 3.9919e+03 | 3.9919e+03 | 0.0119 |
| 12 | 17-Mar-2019 00:13:00 | 3.9900e+03 | 3.9907e+03 | 3.9883e+03 | 3.9907e+03 | 0.7568 |
| 13 | 17-Mar-2019 00:14:00 | 3.9882e+03 | 3.9890e+03 | 3.9850e+03 | 3.9880e+03 | 8.6849 |
| 14 | 17-Mar-2019 00:15:00 | 3.9850e+03 | 3.9885e+03 | 3.9850e+03 | 3.9881e+03 | 2.7837 |
| 15 | 17-Mar-2019 00:16:00 | 3.9880e+03 | 3.9880e+03 | 3.9852e+03 | 3.9852e+03 | 0.2055 |
| 16 | 17-Mar-2019 00:17:00 | 3.9848e+03 | 3.9849e+03 | 3.9750e+03 | 3.9751e+03 | 34.7895 |
| 17 | 17-Mar-2019 00:18:00 | 3974 | 3.9744e+03 | 3.9589e+03 | 3.9641e+03 | 95.6286 |
| 18 | 17-Mar-2019 00:19:00 | 3.9641e+03 | 3.9763e+03 | 3.9641e+03 | 3.9763e+03 | 6.4694 |
| 19 | 17-Mar-2019 00:20:00 | 3.9763e+03 | 3.9763e+03 | 3.9746e+03 | 3.9753e+03 | 1.0630 |
| 20 | 17-Mar-2019 00:21:00 | 3.9769e+03 | 3.9783e+03 | 3.9769e+03 | 3.9783e+03 | 2.1030 |
| 21 | 17-Mar-2019 00:22:00 | 3.9793e+03 | 3.9805e+03 | 3.9793e+03 | 3.9802e+03 | 0.1511 |
| 22 | 17-Mar-2019 00:23:00 | 3.9773e+03 | 3.9773e+03 | 3.9746e+03 | 3.9746e+03 | 0.0450 |
| 23 | 17-Mar-2019 00:24:00 | 3.9817e+03 | 3.9818e+03 | 3.9809e+03 | 3.9809e+03 | 1.3872 |
| 24 | 17-Mar-2019 00:25:00 | 3.9771e+03 | 3.9771e+03 | 3.9767e+03 | 3.9767e+03 | 0.3348 |
| 25 | 17-Mar-2019 00:26:00 | 3.9760e+03 | 3.9771e+03 | 3.9738e+03 | 3.9771e+03 | 0.3810 |
| 26 | 17-Mar-2019 00:27:00 | 3.9781e+03 | 3.9791e+03 | 3.9781e+03 | 3.9791e+03 | 0.9907 |
| 27 | 17-Mar-2019 00:28:00 | 3.9797e+03 | 3.9806e+03 | 3.9797e+03 | 3.9806e+03 | 0.1389 |
| 28 | 17-Mar-2019 00:29:00 | 3.9798e+03 | 3.9798e+03 | 3.9797e+03 | 3.9797e+03 | 1.2995 |
| 29 | 17-Mar-2019 00:30:00 | 3.9765e+03 | 3.9774e+03 | 3.9727e+03 | 3.9732e+03 | 3.9176 |
| 30 | 17-Mar-2019 00:31:00 | 3.9732e+03 | 3.9736e+03 | 3.9700e+03 | 3.9700e+03 | 0.8799 |
| 31 | 17-Mar-2019 00:32:00 | 3.9692e+03 | 3.9692e+03 | 3.9691e+03 | 3.9691e+03 | 3.1234 |
| 32 | 17-Mar-2019 00:33:00 | 3.9733e+03 | 3.9733e+03 | 3.9733e+03 | 3.9733e+03 | 0.0303 |
| 33 | 17-Mar-2019 00:34:00 | 3.9743e+03 | 3.9744e+03 | 3.9743e+03 | 3.9744e+03 | 1.1186 |
| 34 | 17-Mar-2019 00:35:00 | 3.9702e+03 | 3.9702e+03 | 3.9694e+03 | 3.9694e+03 | 1.1398 |

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 35 | 17-Mar-2019 00:36:00 | 3.9700e+03 | 3.9700e+03 | 3.9668e+03 | 3.9668e+03 | 1.6151 |
| 36 | 17-Mar-2019 00:37:00 | 3.9679e+03 | 3.9685e+03 | 3.9629e+03 | 3.9629e+03 | 5.5367 |
| 37 | 17-Mar-2019 00:38:00 | 3.9616e+03 | 3.9616e+03 | 3.9556e+03 | 3.9593e+03 | 31.6548 |
| 38 | 17-Mar-2019 00:39:00 | 3.9629e+03 | 3.9660e+03 | 3.9628e+03 | 3.9660e+03 | 8.2058 |
| 39 | 17-Mar-2019 00:40:00 | 3.9670e+03 | 3.9670e+03 | 3960 | 3.9652e+03 | 80.6532 |
| 40 | 17-Mar-2019 00:41:00 | 3.9650e+03 | 3.9650e+03 | 3.9607e+03 | 3.9607e+03 | 2.2074 |
| 41 | 17-Mar-2019 00:42:00 | 3.9612e+03 | 3.9625e+03 | 3.9585e+03 | 3.9602e+03 | 4.8431 |
| 42 | 17-Mar-2019 00:43:00 | 3.9592e+03 | 3.9613e+03 | 3.9592e+03 | 3.9613e+03 | 0.7638 |
| 43 | 17-Mar-2019 00:44:00 | 3.9616e+03 | 3.9645e+03 | 3.9616e+03 | 3.9645e+03 | 0.4583 |
| 44 | 17-Mar-2019 00:45:00 | 3.9614e+03 | 3.9614e+03 | 3.9614e+03 | 3.9614e+03 | 0.5045 |
| 45 | 17-Mar-2019 00:46:00 | 3.9587e+03 | 3.9594e+03 | 3.9587e+03 | 3.9594e+03 | 0.9039 |
| 46 | 17-Mar-2019 00:47:00 | 3.9603e+03 | 3.9626e+03 | 3.9560e+03 | 3.9626e+03 | 20.0262 |
| 47 | 17-Mar-2019 00:48:00 | 3.9654e+03 | 3.9654e+03 | 3.9634e+03 | 3.9634e+03 | 0.7011 |
| 48 | 17-Mar-2019 00:49:00 | 3.9646e+03 | 3.9646e+03 | 3.9646e+03 | 3.9646e+03 | 0.0393 |
| 49 | 17-Mar-2019 00:50:00 | 3.9678e+03 | 3.9678e+03 | 3.9678e+03 | 3.9678e+03 | 0.0300 |
| 50 | 17-Mar-2019 00:51:00 | 3.9680e+03 | 3.9688e+03 | 3965 | 3965 | 5.5533 |
| 51 | 17-Mar-2019 00:52:00 | 3.9684e+03 | 3.9684e+03 | 3.9684e+03 | 3.9684e+03 | 0.0177 |
| 52 | 17-Mar-2019 00:54:00 | 3.9667e+03 | 3.9693e+03 | 3.9659e+03 | 3.9693e+03 | 0.1114 |
| 53 | 17-Mar-2019 00:55:00 | 3.9697e+03 | 3.9697e+03 | 3.9697e+03 | 3.9697e+03 | 1.1700 |
| 54 | 17-Mar-2019 00:56:00 | 3965 | 3965 | 3965 | 3965 | 0.1984 |
| 55 | 17-Mar-2019 00:57:00 | 3.9648e+03 | 3.9671e+03 | 3.9648e+03 | 3.9659e+03 | 1.0521 |
| 56 | 17-Mar-2019 00:58:00 | 3.9669e+03 | 3.9672e+03 | 3.9669e+03 | 3.9672e+03 | 0.0705 |
| 57 | 17-Mar-2019 00:59:00 | 3.9649e+03 | 3.9651e+03 | 3.9639e+03 | 3.9639e+03 | 2.7885 |
| 58 | 17-Mar-2019 01:01:00 | 3.9633e+03 | 3.9707e+03 | 3.9632e+03 | 3.9666e+03 | 16.0571 |
| 59 | 17-Mar-2019 01:02:00 | 3.9682e+03 | 3.9704e+03 | 3.9682e+03 | 3.9682e+03 | 3.7277 |
| 60 | 17-Mar-2019 01:04:00 | 3.9694e+03 | 3.9721e+03 | 3.9694e+03 | 3.9721e+03 | 2.3479 |
| 61 | 17-Mar-2019 01:08:00 | 3.9686e+03 | 3.9695e+03 | 3.9686e+03 | 3.9695e+03 | 0.8484 |
| 62 | 17-Mar-2019 01:09:00 | 3.9690e+03 | 3.9690e+03 | 3.9690e+03 | 3.9690e+03 | 0.2202 |
| 63 | 17-Mar-2019 01:11:00 | 3.9705e+03 | 3.9705e+03 | 3.9705e+03 | 3.9705e+03 | 0.0113 |
| 64 | 17-Mar-2019 01:12:00 | 3.9698e+03 | 3.9698e+03 | 3.9698e+03 | 3.9698e+03 | 0.5000 |
| 65 | 17-Mar-2019 01:14:00 | 3.9699e+03 | 3.9699e+03 | 3.9699e+03 | 3.9699e+03 | 0.5462 |
| 66 | 17-Mar-2019 01:16:00 | 3.9718e+03 | 3.9718e+03 | 3.9718e+03 | 3.9718e+03 | 0.1049 |
| 67 | 17-Mar-2019 01:17:00 | 3.9725e+03 | 3.9725e+03 | 3.9705e+03 | 3.9705e+03 | 0.1226 |

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 68 | 17-Mar-2019 01:18:00 | 3.9705e+03 | 3.9705e+03 | 3.9705e+03 | 3.9705e+03 | 0.2105 |
| 69 | 17-Mar-2019 01:19:00 | 3.9726e+03 | 3.9726e+03 | 3.9726e+03 | 3.9726e+03 | 0.3957 |
| 70 | 17-Mar-2019 01:21:00 | 3.9714e+03 | 3.9716e+03 | 3.9698e+03 | 3.9698e+03 | 2.7867 |
| 71 | 17-Mar-2019 01:22:00 | 3.9708e+03 | 3.9708e+03 | 3.9701e+03 | 3.9701e+03 | 0.0991 |
| 72 | 17-Mar-2019 01:23:00 | 3.9697e+03 | 3.9697e+03 | 3.9697e+03 | 3.9697e+03 | 0.0582 |
| 73 | 17-Mar-2019 01:24:00 | 3.9697e+03 | 3.9697e+03 | 3.9688e+03 | 3.9688e+03 | 0.2065 |
| 74 | 17-Mar-2019 01:25:00 | 3.9684e+03 | 3.9684e+03 | 3.9684e+03 | 3.9684e+03 | 0.0385 |
| 75 | 17-Mar-2019 01:27:00 | 3.9676e+03 | 3.9676e+03 | 3.9676e+03 | 3.9676e+03 | 1.5375 |
| 76 | 17-Mar-2019 01:28:00 | 3.9680e+03 | 3.9680e+03 | 3.9680e+03 | 3.9680e+03 | 0.0178 |
| 77 | 17-Mar-2019 01:29:00 | 3.9696e+03 | 3.9696e+03 | 3.9696e+03 | 3.9696e+03 | 0.2409 |
| 78 | 17-Mar-2019 01:31:00 | 3.9696e+03 | 3.9696e+03 | 3.9696e+03 | 3.9696e+03 | 0.0104 |
| 79 | 17-Mar-2019 01:33:00 | 3.9696e+03 | 3.9696e+03 | 3.9696e+03 | 3.9696e+03 | 0.1079 |
| 80 | 17-Mar-2019 01:34:00 | 3.9696e+03 | 3.9696e+03 | 3.9688e+03 | 3.9696e+03 | 0.1726 |
| 81 | 17-Mar-2019 01:36:00 | 3.9706e+03 | 3.9712e+03 | 3.9697e+03 | 3.9712e+03 | 0.2806 |
| 82 | 17-Mar-2019 01:37:00 | 3.9712e+03 | 3.9712e+03 | 3.9712e+03 | 3.9712e+03 | 0.2512 |
| 83 | 17-Mar-2019 01:38:00 | 3.9712e+03 | 3.9712e+03 | 3.9712e+03 | 3.9712e+03 | 0.0035 |
| 84 | 17-Mar-2019 01:39:00 | 3.9712e+03 | 3.9714e+03 | 3.9712e+03 | 3.9714e+03 | 0.8625 |
| 85 | 17-Mar-2019 01:41:00 | 3.9723e+03 | 3.9728e+03 | 3.9723e+03 | 3.9728e+03 | 0.2312 |
| 86 | 17-Mar-2019 01:43:00 | 3.9730e+03 | 3.9730e+03 | 3.9730e+03 | 3.9730e+03 | 0.0191 |
| 87 | 17-Mar-2019 01:44:00 | 3.9724e+03 | 3.9730e+03 | 3.9724e+03 | 3.9730e+03 | 0.1219 |
| 88 | 17-Mar-2019 01:45:00 | 3.9725e+03 | 3.9725e+03 | 3.9725e+03 | 3.9725e+03 | 0.3859 |
| 89 | 17-Mar-2019 01:46:00 | 3.9730e+03 | 3.9739e+03 | 3.9724e+03 | 3.9724e+03 | 3.7617 |
| 90 | 17-Mar-2019 01:47:00 | 3.9734e+03 | 3.9734e+03 | 3.9730e+03 | 3.9730e+03 | 0.3111 |
| 91 | 17-Mar-2019 01:48:00 | 3.9741e+03 | 3.9741e+03 | 3.9741e+03 | 3.9741e+03 | 0.0962 |
| 92 | 17-Mar-2019 01:49:00 | 3.9730e+03 | 3.9741e+03 | 3.9730e+03 | 3.9741e+03 | 0.2203 |
| 93 | 17-Mar-2019 01:50:00 | 3.9741e+03 | 3.9741e+03 | 3.9730e+03 | 3.9730e+03 | 2.0141 |
| 94 | 17-Mar-2019 01:51:00 | 3.9722e+03 | 3.9722e+03 | 3.9722e+03 | 3.9722e+03 | 0.0192 |
| 95 | 17-Mar-2019 01:53:00 | 3.9711e+03 | 3.9711e+03 | 3.9711e+03 | 3.9711e+03 | 0.7685 |
| 96 | 17-Mar-2019 01:54:00 | 3.9711e+03 | 3.9712e+03 | 3.9693e+03 | 3.9693e+03 | 0.2490 |
| 97 | 17-Mar-2019 01:57:00 | 3.9705e+03 | 3.9705e+03 | 3.9705e+03 | 3.9705e+03 | 0.6593 |
| 98 | 17-Mar-2019 01:58:00 | 3.9695e+03 | 3.9695e+03 | 3.9695e+03 | 3.9695e+03 | 0.0644 |
| 99 | 17-Mar-2019 01:59:00 | 3.9686e+03 | 3.9686e+03 | 3.9686e+03 | 3.9686e+03 | 0.4034 |
| 100 | 17-Mar-2019 02:00:00 | 3.9686e+03 | 3.9694e+03 | 3.9682e+03 | 3.9685e+03 | 1.7836 |

```
    ⋮
```

```
%outliers = outlier(BitcoinData.Close)

%Rerun model to check for more outliers
Y = BitcoinData{:,"Close"}
```

```
Y = 16418×1
10^3 ×
    3.9900
    3.9899
    3.9909
    3.9924
    3.9902
    3.9918
    3.9922
    3.9922
    3.9919
    3.9919
    ⋮
```

```
X = BitcoinData{:,[1:3]}
```

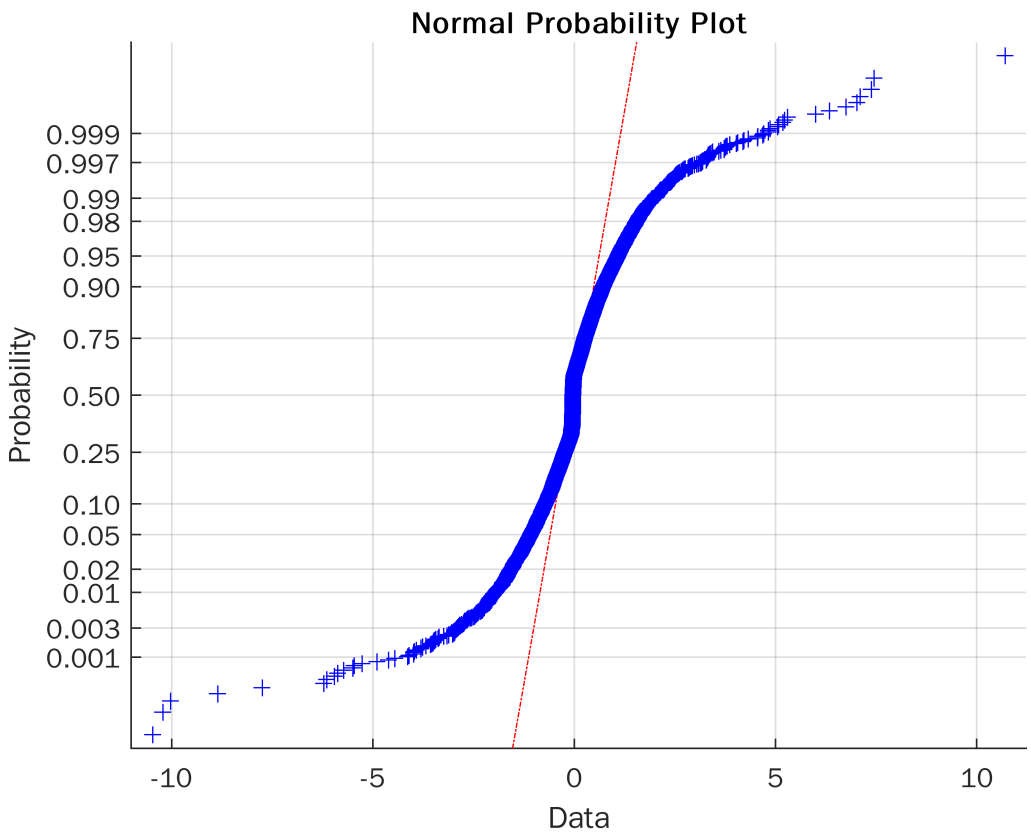
```
X = 16418×3
10^3 ×
    3.9900    3.9900    3.9900
    3.9900    3.9900    3.9899
    3.9900    3.9918    3.9900
    3.9910    3.9924    3.9899
    3.9902    3.9902    3.9902
    3.9914    3.9918    3.9914
    3.9922    3.9922    3.9922
    3.9909    3.9922    3.9909
    3.9919    3.9919    3.9919
    3.9919    3.9919    3.9919
    ⋮
```

```
LRPre = fitlm(zscore(X),Y)
```

```
LRPre =
Linear regression model:
    y ~ 1 + x1 + x2 + x3

Estimated Coefficients:
                   Estimate       SE          tStat       pValue
                   ________    _________    __________    ______

    (Intercept)     3978.4     0.0056682    7.0188e+05      0
    x1             -14.643       0.20022       -73.132      0
    x2               22.76       0.15426        147.55      0
    x3               22.73       0.13907        163.44      0


Number of observations: 16418, Error degrees of freedom: 16414
Root Mean Squared Error: 0.726
```

```
R-squared: 0.999,  Adjusted R-Squared: 0.999
F-statistic vs. constant model: 9.87e+06, p-value = 0
```

```
normplot(LRPre.Residuals.Raw)
```




```
idx = isoutlier(BitcoinData.Close)
```

```
idx = 16418×1 logical array
   0
   0
   0
   0
   0
   0
   0
   0
   0
   0
     ⋮
```

```
sum(idx)
```

```
ans = 558
```

```
BitcoinData(idx,:) = []
```

```
BitcoinData = 15860×7 timetable
                                                                    ...
```

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 1 | 17-Mar-2019 00:00:00 | 3990 | 3990 | 3990 | 3990 | 1.6034 |
| 2 | 17-Mar-2019 00:01:00 | 3990 | 3990 | 3.9899e+03 | 3.9899e+03 | 0.9532 |
| 3 | 17-Mar-2019 00:02:00 | 3990 | 3.9918e+03 | 3990 | 3.9909e+03 | 2.0498 |
| 4 | 17-Mar-2019 00:04:00 | 3.9910e+03 | 3.9924e+03 | 3.9899e+03 | 3.9924e+03 | 3.2865 |
| 5 | 17-Mar-2019 00:06:00 | 3.9902e+03 | 3.9902e+03 | 3.9902e+03 | 3.9902e+03 | 0.1500 |
| 6 | 17-Mar-2019 00:07:00 | 3.9914e+03 | 3.9918e+03 | 3.9914e+03 | 3.9918e+03 | 0.2979 |
| 7 | 17-Mar-2019 00:08:00 | 3.9922e+03 | 3.9922e+03 | 3.9922e+03 | 3.9922e+03 | 0.0500 |
| 8 | 17-Mar-2019 00:09:00 | 3.9909e+03 | 3.9922e+03 | 3.9909e+03 | 3.9922e+03 | 1.3248 |
| 9 | 17-Mar-2019 00:10:00 | 3.9919e+03 | 3.9919e+03 | 3.9919e+03 | 3.9919e+03 | 0.0119 |
| 10 | 17-Mar-2019 00:11:00 | 3.9919e+03 | 3.9919e+03 | 3.9919e+03 | 3.9919e+03 | 0.0578 |
| 11 | 17-Mar-2019 00:12:00 | 3.9919e+03 | 3.9919e+03 | 3.9919e+03 | 3.9919e+03 | 0.0119 |
| 12 | 17-Mar-2019 00:13:00 | 3.9900e+03 | 3.9907e+03 | 3.9883e+03 | 3.9907e+03 | 0.7568 |
| 13 | 17-Mar-2019 00:14:00 | 3.9882e+03 | 3.9890e+03 | 3.9850e+03 | 3.9880e+03 | 8.6849 |
| 14 | 17-Mar-2019 00:15:00 | 3.9850e+03 | 3.9885e+03 | 3.9850e+03 | 3.9881e+03 | 2.7837 |
| 15 | 17-Mar-2019 00:16:00 | 3.9880e+03 | 3.9880e+03 | 3.9852e+03 | 3.9852e+03 | 0.2055 |
| 16 | 17-Mar-2019 00:17:00 | 3.9848e+03 | 3.9849e+03 | 3.9750e+03 | 3.9751e+03 | 34.7895 |
| 17 | 17-Mar-2019 00:18:00 | 3974 | 3.9744e+03 | 3.9589e+03 | 3.9641e+03 | 95.6286 |
| 18 | 17-Mar-2019 00:19:00 | 3.9641e+03 | 3.9763e+03 | 3.9641e+03 | 3.9763e+03 | 6.4694 |
| 19 | 17-Mar-2019 00:20:00 | 3.9763e+03 | 3.9763e+03 | 3.9746e+03 | 3.9753e+03 | 1.0630 |
| 20 | 17-Mar-2019 00:21:00 | 3.9769e+03 | 3.9783e+03 | 3.9769e+03 | 3.9783e+03 | 2.1030 |
| 21 | 17-Mar-2019 00:22:00 | 3.9793e+03 | 3.9805e+03 | 3.9793e+03 | 3.9802e+03 | 0.1511 |
| 22 | 17-Mar-2019 00:23:00 | 3.9773e+03 | 3.9773e+03 | 3.9746e+03 | 3.9746e+03 | 0.0450 |
| 23 | 17-Mar-2019 00:24:00 | 3.9817e+03 | 3.9818e+03 | 3.9809e+03 | 3.9809e+03 | 1.3872 |
| 24 | 17-Mar-2019 00:25:00 | 3.9771e+03 | 3.9771e+03 | 3.9767e+03 | 3.9767e+03 | 0.3348 |
| 25 | 17-Mar-2019 00:26:00 | 3.9760e+03 | 3.9771e+03 | 3.9738e+03 | 3.9771e+03 | 0.3810 |
| 26 | 17-Mar-2019 00:27:00 | 3.9781e+03 | 3.9791e+03 | 3.9781e+03 | 3.9791e+03 | 0.9907 |
| 27 | 17-Mar-2019 00:28:00 | 3.9797e+03 | 3.9806e+03 | 3.9797e+03 | 3.9806e+03 | 0.1389 |
| 28 | 17-Mar-2019 00:29:00 | 3.9798e+03 | 3.9798e+03 | 3.9797e+03 | 3.9797e+03 | 1.2995 |
| 29 | 17-Mar-2019 00:30:00 | 3.9765e+03 | 3.9774e+03 | 3.9727e+03 | 3.9732e+03 | 3.9176 |
| 30 | 17-Mar-2019 00:31:00 | 3.9732e+03 | 3.9736e+03 | 3.9700e+03 | 3.9700e+03 | 0.8799 |
| 31 | 17-Mar-2019 00:32:00 | 3.9692e+03 | 3.9692e+03 | 3.9691e+03 | 3.9691e+03 | 3.1234 |
| 32 | 17-Mar-2019 00:33:00 | 3.9733e+03 | 3.9733e+03 | 3.9733e+03 | 3.9733e+03 | 0.0303 |
| 33 | 17-Mar-2019 00:34:00 | 3.9743e+03 | 3.9744e+03 | 3.9743e+03 | 3.9744e+03 | 1.1186 |

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 34 | 17-Mar-2019 00:35:00 | 3.9702e+03 | 3.9702e+03 | 3.9694e+03 | 3.9694e+03 | 1.1398 |
| 35 | 17-Mar-2019 00:36:00 | 3.9700e+03 | 3.9700e+03 | 3.9668e+03 | 3.9668e+03 | 1.6151 |
| 36 | 17-Mar-2019 00:37:00 | 3.9679e+03 | 3.9685e+03 | 3.9629e+03 | 3.9629e+03 | 5.5367 |
| 37 | 17-Mar-2019 00:38:00 | 3.9616e+03 | 3.9616e+03 | 3.9556e+03 | 3.9593e+03 | 31.6548 |
| 38 | 17-Mar-2019 00:39:00 | 3.9629e+03 | 3.9660e+03 | 3.9628e+03 | 3.9660e+03 | 8.2058 |
| 39 | 17-Mar-2019 00:40:00 | 3.9670e+03 | 3.9670e+03 | 3960 | 3.9652e+03 | 80.6532 |
| 40 | 17-Mar-2019 00:41:00 | 3.9650e+03 | 3.9650e+03 | 3.9607e+03 | 3.9607e+03 | 2.2074 |
| 41 | 17-Mar-2019 00:42:00 | 3.9612e+03 | 3.9625e+03 | 3.9585e+03 | 3.9602e+03 | 4.8431 |
| 42 | 17-Mar-2019 00:43:00 | 3.9592e+03 | 3.9613e+03 | 3.9592e+03 | 3.9613e+03 | 0.7638 |
| 43 | 17-Mar-2019 00:44:00 | 3.9616e+03 | 3.9645e+03 | 3.9616e+03 | 3.9645e+03 | 0.4583 |
| 44 | 17-Mar-2019 00:45:00 | 3.9614e+03 | 3.9614e+03 | 3.9614e+03 | 3.9614e+03 | 0.5045 |
| 45 | 17-Mar-2019 00:46:00 | 3.9587e+03 | 3.9594e+03 | 3.9587e+03 | 3.9594e+03 | 0.9039 |
| 46 | 17-Mar-2019 00:47:00 | 3.9603e+03 | 3.9626e+03 | 3.9560e+03 | 3.9626e+03 | 20.0262 |
| 47 | 17-Mar-2019 00:48:00 | 3.9654e+03 | 3.9654e+03 | 3.9634e+03 | 3.9634e+03 | 0.7011 |
| 48 | 17-Mar-2019 00:49:00 | 3.9646e+03 | 3.9646e+03 | 3.9646e+03 | 3.9646e+03 | 0.0393 |
| 49 | 17-Mar-2019 00:50:00 | 3.9678e+03 | 3.9678e+03 | 3.9678e+03 | 3.9678e+03 | 0.0300 |
| 50 | 17-Mar-2019 00:51:00 | 3.9680e+03 | 3.9688e+03 | 3965 | 3965 | 5.5533 |
| 51 | 17-Mar-2019 00:52:00 | 3.9684e+03 | 3.9684e+03 | 3.9684e+03 | 3.9684e+03 | 0.0177 |
| 52 | 17-Mar-2019 00:54:00 | 3.9667e+03 | 3.9693e+03 | 3.9659e+03 | 3.9693e+03 | 0.1114 |
| 53 | 17-Mar-2019 00:55:00 | 3.9697e+03 | 3.9697e+03 | 3.9697e+03 | 3.9697e+03 | 1.1700 |
| 54 | 17-Mar-2019 00:56:00 | 3965 | 3965 | 3965 | 3965 | 0.1984 |
| 55 | 17-Mar-2019 00:57:00 | 3.9648e+03 | 3.9671e+03 | 3.9648e+03 | 3.9659e+03 | 1.0521 |
| 56 | 17-Mar-2019 00:58:00 | 3.9669e+03 | 3.9672e+03 | 3.9669e+03 | 3.9672e+03 | 0.0705 |
| 57 | 17-Mar-2019 00:59:00 | 3.9649e+03 | 3.9651e+03 | 3.9639e+03 | 3.9639e+03 | 2.7885 |
| 58 | 17-Mar-2019 01:01:00 | 3.9633e+03 | 3.9707e+03 | 3.9632e+03 | 3.9666e+03 | 16.0571 |
| 59 | 17-Mar-2019 01:02:00 | 3.9682e+03 | 3.9704e+03 | 3.9682e+03 | 3.9682e+03 | 3.7277 |
| 60 | 17-Mar-2019 01:04:00 | 3.9694e+03 | 3.9721e+03 | 3.9694e+03 | 3.9721e+03 | 2.3479 |
| 61 | 17-Mar-2019 01:08:00 | 3.9686e+03 | 3.9695e+03 | 3.9686e+03 | 3.9695e+03 | 0.8484 |
| 62 | 17-Mar-2019 01:09:00 | 3.9690e+03 | 3.9690e+03 | 3.9690e+03 | 3.9690e+03 | 0.2202 |
| 63 | 17-Mar-2019 01:11:00 | 3.9705e+03 | 3.9705e+03 | 3.9705e+03 | 3.9705e+03 | 0.0113 |
| 64 | 17-Mar-2019 01:12:00 | 3.9698e+03 | 3.9698e+03 | 3.9698e+03 | 3.9698e+03 | 0.5000 |
| 65 | 17-Mar-2019 01:14:00 | 3.9699e+03 | 3.9699e+03 | 3.9699e+03 | 3.9699e+03 | 0.5462 |
| 66 | 17-Mar-2019 01:16:00 | 3.9718e+03 | 3.9718e+03 | 3.9718e+03 | 3.9718e+03 | 0.1049 |

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 67 | 17-Mar-2019 01:17:00 | 3.9725e+03 | 3.9725e+03 | 3.9705e+03 | 3.9705e+03 | 0.1226 |
| 68 | 17-Mar-2019 01:18:00 | 3.9705e+03 | 3.9705e+03 | 3.9705e+03 | 3.9705e+03 | 0.2105 |
| 69 | 17-Mar-2019 01:19:00 | 3.9726e+03 | 3.9726e+03 | 3.9726e+03 | 3.9726e+03 | 0.3957 |
| 70 | 17-Mar-2019 01:21:00 | 3.9714e+03 | 3.9716e+03 | 3.9698e+03 | 3.9698e+03 | 2.7867 |
| 71 | 17-Mar-2019 01:22:00 | 3.9708e+03 | 3.9708e+03 | 3.9701e+03 | 3.9701e+03 | 0.0991 |
| 72 | 17-Mar-2019 01:23:00 | 3.9697e+03 | 3.9697e+03 | 3.9697e+03 | 3.9697e+03 | 0.0582 |
| 73 | 17-Mar-2019 01:24:00 | 3.9697e+03 | 3.9697e+03 | 3.9688e+03 | 3.9688e+03 | 0.2065 |
| 74 | 17-Mar-2019 01:25:00 | 3.9684e+03 | 3.9684e+03 | 3.9684e+03 | 3.9684e+03 | 0.0385 |
| 75 | 17-Mar-2019 01:27:00 | 3.9676e+03 | 3.9676e+03 | 3.9676e+03 | 3.9676e+03 | 1.5375 |
| 76 | 17-Mar-2019 01:28:00 | 3.9680e+03 | 3.9680e+03 | 3.9680e+03 | 3.9680e+03 | 0.0178 |
| 77 | 17-Mar-2019 01:29:00 | 3.9696e+03 | 3.9696e+03 | 3.9696e+03 | 3.9696e+03 | 0.2409 |
| 78 | 17-Mar-2019 01:31:00 | 3.9696e+03 | 3.9696e+03 | 3.9696e+03 | 3.9696e+03 | 0.0104 |
| 79 | 17-Mar-2019 01:33:00 | 3.9696e+03 | 3.9696e+03 | 3.9696e+03 | 3.9696e+03 | 0.1079 |
| 80 | 17-Mar-2019 01:34:00 | 3.9696e+03 | 3.9696e+03 | 3.9688e+03 | 3.9696e+03 | 0.1726 |
| 81 | 17-Mar-2019 01:36:00 | 3.9706e+03 | 3.9712e+03 | 3.9697e+03 | 3.9712e+03 | 0.2806 |
| 82 | 17-Mar-2019 01:37:00 | 3.9712e+03 | 3.9712e+03 | 3.9712e+03 | 3.9712e+03 | 0.2512 |
| 83 | 17-Mar-2019 01:38:00 | 3.9712e+03 | 3.9712e+03 | 3.9712e+03 | 3.9712e+03 | 0.0035 |
| 84 | 17-Mar-2019 01:39:00 | 3.9712e+03 | 3.9714e+03 | 3.9712e+03 | 3.9714e+03 | 0.8625 |
| 85 | 17-Mar-2019 01:41:00 | 3.9723e+03 | 3.9728e+03 | 3.9723e+03 | 3.9728e+03 | 0.2312 |
| 86 | 17-Mar-2019 01:43:00 | 3.9730e+03 | 3.9730e+03 | 3.9730e+03 | 3.9730e+03 | 0.0191 |
| 87 | 17-Mar-2019 01:44:00 | 3.9724e+03 | 3.9730e+03 | 3.9724e+03 | 3.9730e+03 | 0.1219 |
| 88 | 17-Mar-2019 01:45:00 | 3.9725e+03 | 3.9725e+03 | 3.9725e+03 | 3.9725e+03 | 0.3859 |
| 89 | 17-Mar-2019 01:46:00 | 3.9730e+03 | 3.9739e+03 | 3.9724e+03 | 3.9724e+03 | 3.7617 |
| 90 | 17-Mar-2019 01:47:00 | 3.9734e+03 | 3.9734e+03 | 3.9730e+03 | 3.9730e+03 | 0.3111 |
| 91 | 17-Mar-2019 01:48:00 | 3.9741e+03 | 3.9741e+03 | 3.9741e+03 | 3.9741e+03 | 0.0962 |
| 92 | 17-Mar-2019 01:49:00 | 3.9730e+03 | 3.9741e+03 | 3.9730e+03 | 3.9741e+03 | 0.2203 |
| 93 | 17-Mar-2019 01:50:00 | 3.9741e+03 | 3.9741e+03 | 3.9730e+03 | 3.9730e+03 | 2.0141 |
| 94 | 17-Mar-2019 01:51:00 | 3.9722e+03 | 3.9722e+03 | 3.9722e+03 | 3.9722e+03 | 0.0192 |
| 95 | 17-Mar-2019 01:53:00 | 3.9711e+03 | 3.9711e+03 | 3.9711e+03 | 3.9711e+03 | 0.7685 |
| 96 | 17-Mar-2019 01:54:00 | 3.9711e+03 | 3.9712e+03 | 3.9693e+03 | 3.9693e+03 | 0.2490 |
| 97 | 17-Mar-2019 01:57:00 | 3.9705e+03 | 3.9705e+03 | 3.9705e+03 | 3.9705e+03 | 0.6593 |
| 98 | 17-Mar-2019 01:58:00 | 3.9695e+03 | 3.9695e+03 | 3.9695e+03 | 3.9695e+03 | 0.0644 |
| 99 | 17-Mar-2019 01:59:00 | 3.9686e+03 | 3.9686e+03 | 3.9686e+03 | 3.9686e+03 | 0.4034 |

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 100 | 17-Mar-2019 02:00:00 | 3.9686e+03 | 3.9694e+03 | 3.9682e+03 | 3.9685e+03 | 1.7836 |

⋮

```
%outliers = outlier(BitcoinData.Close)
```

## Split dataset into training and testing data

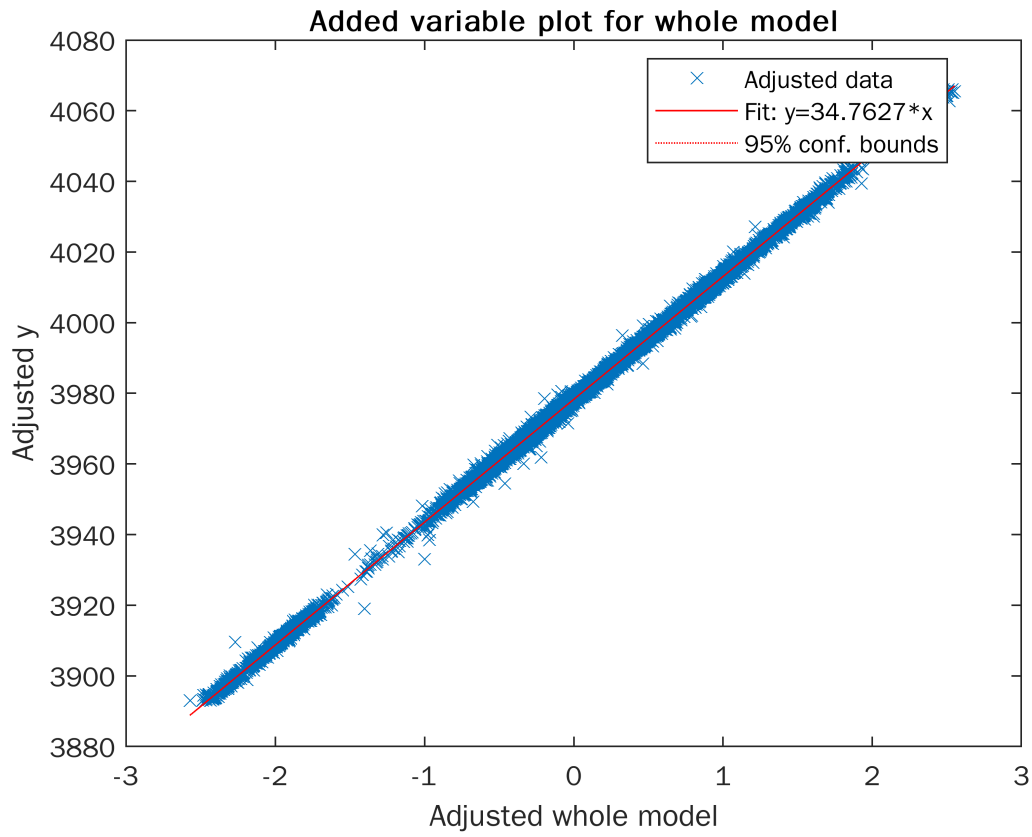
```
BitcoinData_new = [X, Y];

PD = 0.20;
cv = cvpartition(size(BitcoinData_new,1),'HoldOut',PD);
Xtrain = BitcoinData_new(cv.training,[1:end - 1]);
Ytrain = BitcoinData_new(cv.training,end);
Xtest = BitcoinData_new(cv.test, [1:end - 1]);
Ytest = BitcoinData_new(cv.test,end);
```

## Linear model with training-testing split

```
LRModel = fitlm(zscore(Xtrain),Ytrain)
```

```
LRModel = 
Linear regression model:
    y ~ 1 + x1 + x2 + x3

Estimated Coefficients:
                   Estimate       SE          tStat       pValue  
                   ________    _________    __________    ______

    (Intercept)     3978.3     0.0063736    6.2418e+05      0    
    x1             -14.067       0.22669       -62.054      0    
    x2               22.71       0.17528        129.56      0    
    x3              22.244       0.15563        142.93      0    


Number of observations: 13135, Error degrees of freedom: 13131
Root Mean Squared Error: 0.73
R-squared: 0.999,  Adjusted R-Squared: 0.999
F-statistic vs. constant model: 7.82e+06, p-value = 0
```

```
plot(LRModel)
```




```
LRModel.RMSE
```

```
ans = 0.7305
```

## Predict

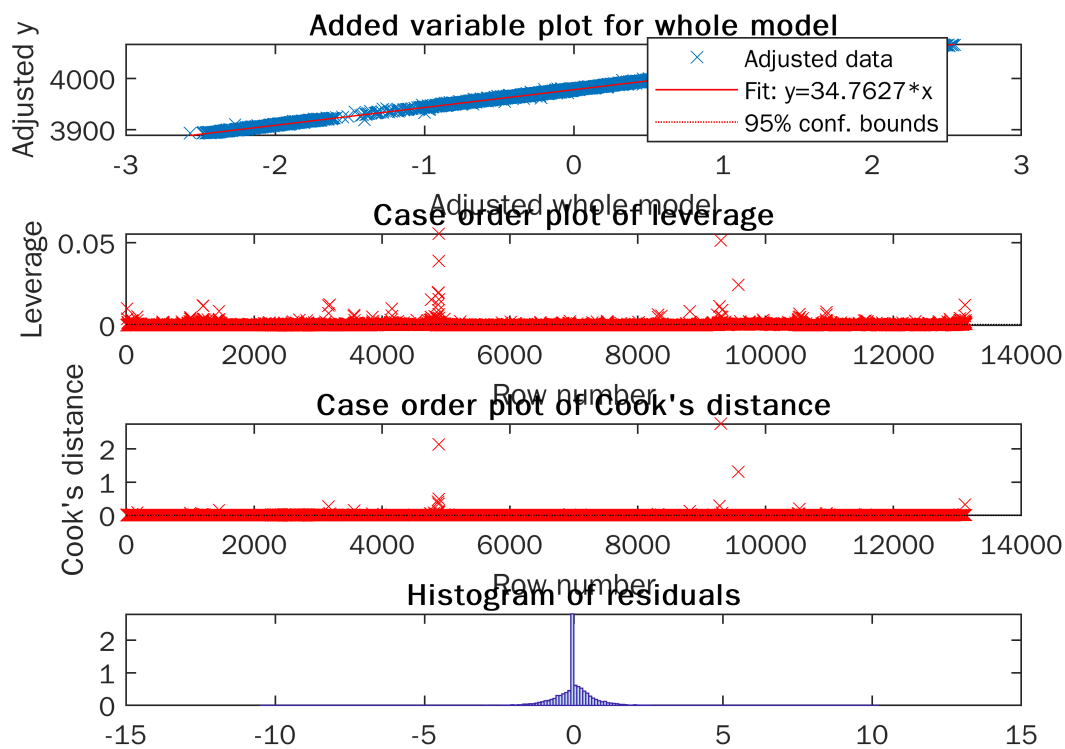
```
[YPred, Scores] = predict(LRModel,Xtest)
```

```
YPred = 3283×1
10^5 ×
    1.2728
    1.2711
    1.2714
    1.2670
    1.2695
    1.2676
    1.2664
    1.2659
    1.2644
    1.2635
      ⋮

Scores = 3283×2
10^5 ×
    1.2723    1.2733
    1.2706    1.2716
    1.2709    1.2719
    1.2665    1.2675
    1.2690    1.2700
    1.2671    1.2681
```

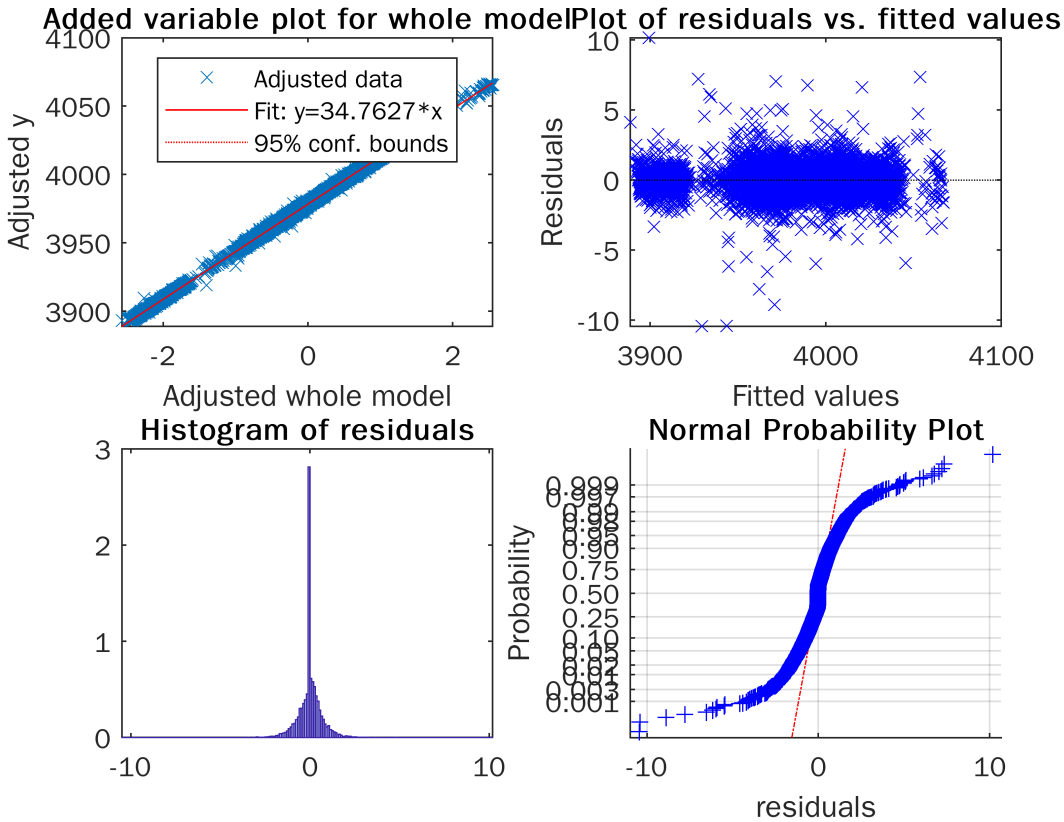
```
    1.2659    1.2669
    1.2654    1.2664
    1.2639    1.2649
    1.2630    1.2640
      ⋮
```

## Plots

```
figure,
subplot(4, 1, 1), plot(LRModel)
subplot(4, 1, 2), plotDiagnostics(LRModel)
subplot(4, 1, 3), plotDiagnostics(LRModel, 'cookd')
subplot(4, 1, 4), plotResiduals(LRModel)
```




```
figure,
subplot(2, 2, 1), plot(LRModel)
subplot(2, 2, 2), plotResiduals(LRModel,'fitted')
subplot(2, 2, 3), plotResiduals(LRModel)
subplot(2, 2, 4), normplot(LRModel.Residuals.Raw)
xlabel('residuals')
```


Added variable plot for whole model
Adjusted data
Fit: y=34.7627*x
95% conf. bounds
Adjusted y
Adjusted whole model
Plot of residuals vs. fitted values
Residuals
Fitted values
Histogram of residuals
Normal Probability Plot
Probability
residuals

## Upload the big dataset (>250MB) to MATLAB Drive and read table

```
BitcoinData = readtable('bitcoin-dataset.csv');
```

```
Warning: Column headers from the file were modified to make them valid MATLAB identifiers
before creating variable names for the table. The original column headers are saved in the
VariableDescriptions property.
Set 'VariableNamingRule' to 'preserve' to use the original column headers as table variable names.
```

```
Tablesize = size(BitcoinData)
```

```
Tablesize = 1×2
     4857377           8
```

```
head(BitcoinData,1)
```

```
ans = 1×8 table
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                
...
```

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 1 | 1.3253e+09 | 4.3900 | 4.3900 | 4.3900 | 4.3900 | 0.4556 |

## Convert timestamp

```
datetest = BitcoinData(:,1);
datetest = table2array(datetest);
BitcoinData.Timestamp = datetime(datetest, 'ConvertFrom', 'posixtime');
```

## Remove NaNs

```
% how many NaNs in each column
NaN2 = sum(isnan(BitcoinData.Open))
```

```
NaN2 = 1243608
```

```
NaN3 = sum(isnan(BitcoinData.High))
```

```
NaN3 = 1243608
```

```
NaN4 = sum(isnan(BitcoinData.Low))
```

```
NaN4 = 1243608
```

```
NaN5 = sum(isnan(BitcoinData.Close))
```

```
NaN5 = 1243608
```

```
NaN6 = sum(isnan(BitcoinData.Volume__BTC_))
```

```
NaN6 = 1243608
```

```
NaN7 = sum(isnan(BitcoinData.Volume__Currency_))
```

```
NaN7 = 1243608
```

```
NaN8 = sum(isnan(BitcoinData.Weighted_Price))
```

```
NaN8 = 1243608
```

```
% remove NaNs
BitcoinData = BitcoinData(isnan(BitcoinData.High) == 0,:);
```

## Select data

```
BitcoinDataTimetable = table2timetable(BitcoinData);

% March 2013
% S = timerange('17-Mar-2013 00:00:00','18-Mar-2013 23:59:00'); %2days
% S = timerange('17-Mar-2013 00:00:00','23-Mar-2013 23:59:00'); %7days
% S = timerange('17-Mar-2013 00:00:00','30-Mar-2013 23:59:00'); %14days

% March 2016
% S = timerange('17-Mar-2016 00:00:00','18-Mar-2016 23:59:00'); %2days
% S = timerange('17-Mar-2016 00:00:00','23-Mar-2016 23:59:00'); %7days
% S = timerange('17-Mar-2016 00:00:00','30-Mar-2016 23:59:00'); %14days

% March 2019
% S = timerange('17-Mar-2019 00:00:00','18-Mar-2019 23:59:00'); %2days
% S = timerange('17-Mar-2019 00:00:00','23-Mar-2019 23:59:00'); %7days
% S = timerange('17-Mar-2019 00:00:00','30-Mar-2019 23:59:00'); %14days

% March 2021
 S = timerange('17-Mar-2021 00:00:00','18-Mar-2021 23:59:00'); %2days
% S = timerange('17-Mar-2021 00:00:00','23-Mar-2021 23:59:00'); %7days
% S = timerange('17-Mar-2021 00:00:00','30-Mar-2021 23:59:00'); %14days

BitcoinData = BitcoinDataTimetable(S,:);
Tablesize = size(BitcoinData)
```

```
Tablesize = 1×2
        2876           7
```

## Create model - preprocessing

```
% standardization, and Initial predictor set (matrix)

Y = BitcoinData{:,"Close"}
```

```
Y = 2876×1
10^4 ×
    5.7128
    5.7150
    5.7104
    5.7109
    5.7005
    5.6926
    5.6905
    5.6856
    5.6941
    5.6964
     ⋮
```

```
X = BitcoinData{:,[1:3]}
```

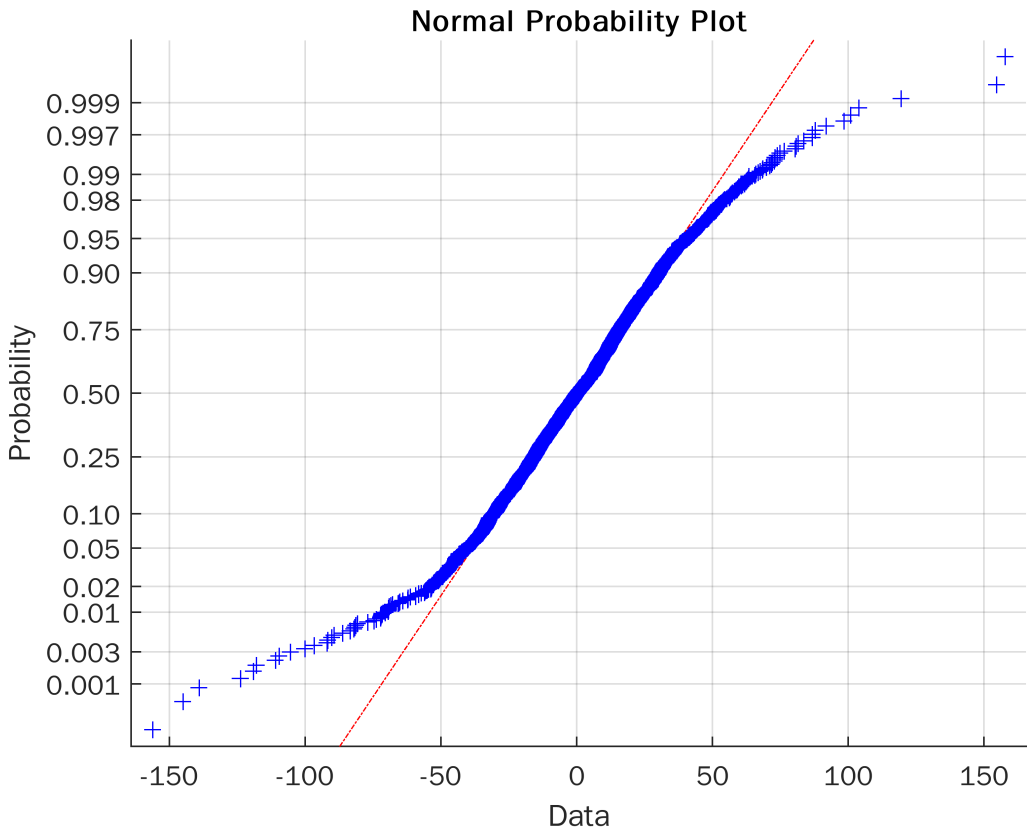
```
X = 2876×3
10^4 ×
    5.6928    5.7150    5.6908
    5.7079    5.7198    5.7035
    5.7149    5.7183    5.7010
    5.7096    5.7158    5.7071
```

```
    5.7112    5.7112    5.7000
    5.7074    5.7074    5.6926
    5.6940    5.6965    5.6890
    5.6905    5.6913    5.6838
    5.6858    5.6970    5.6855
    5.6928    5.6985    5.6918
     ⋮
```

```
%Check model for outliers

LRPre = fitlm(zscore(X),Y)
```

```
LRPre = 
Linear regression model:
    y ~ 1 + x1 + x2 + x3

Estimated Coefficients:
                   Estimate      SE         tStat         pValue  
                   ________    _______    __________    ___________

    (Intercept)      57318     0.49169    1.1657e+05              0
    x1             -833.16       20.79       -40.074    2.5008e-279
    x2                1254      18.904        66.334              0
    x3               1080.5      18.338        58.922              0


Number of observations: 2876, Error degrees of freedom: 2872
Root Mean Squared Error: 26.4
R-squared: 1,  Adjusted R-Squared: 1
F-statistic vs. constant model: 3.11e+06, p-value = 0
```

```
normplot(LRPre.Residuals.Raw)
```




## Identify and Remove Outliers

```
idx = isoutlier(BitcoinData.Close)
```

```
idx = 2876×1 logical array
   0
   0
   0
   0
   0
   0
   0
   0
   0
   0
   ⋮
```

```
sum(idx)
```

```
ans = 0
```

```
BitcoinData(idx,:) = []
```

```
BitcoinData = 2876×7 timetable
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                
```
...
```

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 1 | 17-Mar-2021 00:00:00 | 5.6928e+04 | 57150 | 5.6908e+04 | 5.7128e+04 | 8.8224 |
```

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 2 | 17-Mar-2021 00:01:00 | 5.7079e+04 | 5.7198e+04 | 5.7035e+04 | 5.7150e+04 | 3.4603 |
| 3 | 17-Mar-2021 00:02:00 | 5.7149e+04 | 5.7183e+04 | 5.7010e+04 | 5.7104e+04 | 6.1158 |
| 4 | 17-Mar-2021 00:03:00 | 5.7096e+04 | 5.7158e+04 | 5.7071e+04 | 5.7109e+04 | 5.0098 |
| 5 | 17-Mar-2021 00:04:00 | 5.7112e+04 | 5.7112e+04 | 5.7000e+04 | 5.7005e+04 | 1.8366 |
| 6 | 17-Mar-2021 00:05:00 | 5.7074e+04 | 5.7074e+04 | 56926 | 56926 | 5.0145 |
| 7 | 17-Mar-2021 00:06:00 | 5.6940e+04 | 5.6965e+04 | 56890 | 5.6905e+04 | 7.5988 |
| 8 | 17-Mar-2021 00:07:00 | 5.6905e+04 | 5.6913e+04 | 5.6838e+04 | 5.6856e+04 | 2.4279 |
| 9 | 17-Mar-2021 00:08:00 | 5.6858e+04 | 5.6970e+04 | 5.6855e+04 | 5.6941e+04 | 1.5963 |
| 10 | 17-Mar-2021 00:09:00 | 5.6928e+04 | 5.6985e+04 | 5.6918e+04 | 5.6964e+04 | 3.3036 |
| 11 | 17-Mar-2021 00:10:00 | 5.6988e+04 | 5.6988e+04 | 5.6922e+04 | 5.6936e+04 | 1.4131 |
| 12 | 17-Mar-2021 00:11:00 | 5.6946e+04 | 5.6948e+04 | 5.6804e+04 | 5.6840e+04 | 11.8668 |
| 13 | 17-Mar-2021 00:12:00 | 5.6810e+04 | 5.6810e+04 | 5.6690e+04 | 5.6699e+04 | 0.7883 |
| 14 | 17-Mar-2021 00:13:00 | 5.6699e+04 | 5.6699e+04 | 5.6597e+04 | 5.6598e+04 | 7.9133 |
| 15 | 17-Mar-2021 00:14:00 | 5.6591e+04 | 5.6763e+04 | 5.6591e+04 | 5.6613e+04 | 4.2553 |
| 16 | 17-Mar-2021 00:15:00 | 5.6680e+04 | 5.6737e+04 | 5.6680e+04 | 5.6717e+04 | 0.4147 |
| 17 | 17-Mar-2021 00:16:00 | 5.6717e+04 | 5.6719e+04 | 5.6664e+04 | 5.6717e+04 | 0.5128 |
| 18 | 17-Mar-2021 00:17:00 | 5.6741e+04 | 5.6768e+04 | 5.6667e+04 | 5.6667e+04 | 0.6093 |
| 19 | 17-Mar-2021 00:18:00 | 5.6670e+04 | 5.6708e+04 | 5.6628e+04 | 5.6701e+04 | 2.5378 |
| 20 | 17-Mar-2021 00:19:00 | 5.6706e+04 | 5.6719e+04 | 5.6671e+04 | 5.6711e+04 | 3.0139 |
| 21 | 17-Mar-2021 00:20:00 | 5.6671e+04 | 5.6757e+04 | 5.6671e+04 | 5.6753e+04 | 1.7076 |
| 22 | 17-Mar-2021 00:21:00 | 5.6750e+04 | 5.6775e+04 | 5.6665e+04 | 5.6665e+04 | 9.0640 |
| 23 | 17-Mar-2021 00:22:00 | 5.6676e+04 | 5.6689e+04 | 56540 | 5.6542e+04 | 17.0034 |
| 24 | 17-Mar-2021 00:23:00 | 5.6502e+04 | 5.6566e+04 | 5.6488e+04 | 5.6492e+04 | 1.6817 |
| 25 | 17-Mar-2021 00:24:00 | 5.6488e+04 | 5.6530e+04 | 5.6488e+04 | 5.6503e+04 | 0.1477 |
| 26 | 17-Mar-2021 00:25:00 | 5.6503e+04 | 5.6521e+04 | 5.6435e+04 | 5.6462e+04 | 1.6796 |
| 27 | 17-Mar-2021 00:26:00 | 5.6446e+04 | 5.6481e+04 | 5.6406e+04 | 5.6471e+04 | 0.9282 |
| 28 | 17-Mar-2021 00:27:00 | 5.6462e+04 | 5.6462e+04 | 5.6392e+04 | 5.6418e+04 | 1.0664 |
| 29 | 17-Mar-2021 00:28:00 | 5.6410e+04 | 5.6479e+04 | 56400 | 5.6461e+04 | 2.0418 |
| 30 | 17-Mar-2021 00:29:00 | 5.6460e+04 | 5.6461e+04 | 5.6391e+04 | 5.6434e+04 | 1.0734 |
| 31 | 17-Mar-2021 00:30:00 | 5.6399e+04 | 5.6513e+04 | 5.6399e+04 | 5.6513e+04 | 0.4380 |
| 32 | 17-Mar-2021 00:31:00 | 5.6560e+04 | 5.6676e+04 | 5.6550e+04 | 5.6602e+04 | 1.9544 |
| 33 | 17-Mar-2021 00:32:00 | 5.6579e+04 | 56679 | 5.6579e+04 | 5.6643e+04 | 1.0486 |
| 34 | 17-Mar-2021 00:33:00 | 5.6637e+04 | 5.6664e+04 | 5.6559e+04 | 5.6590e+04 | 4.4152 |

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 35 | 17-Mar-2021 00:34:00 | 5.6590e+04 | 5.6600e+04 | 5.6548e+04 | 5.6564e+04 | 1.5328 |
| 36 | 17-Mar-2021 00:35:00 | 5.6557e+04 | 5.6606e+04 | 5.6545e+04 | 5.6604e+04 | 2.1806 |
| 37 | 17-Mar-2021 00:36:00 | 5.6602e+04 | 5.6640e+04 | 5.6573e+04 | 5.6573e+04 | 4.2177 |
| 38 | 17-Mar-2021 00:37:00 | 5.6565e+04 | 5.6574e+04 | 5.6486e+04 | 5.6486e+04 | 0.8632 |
| 39 | 17-Mar-2021 00:38:00 | 5.6476e+04 | 5.6483e+04 | 5.6429e+04 | 5.6429e+04 | 0.0751 |
| 40 | 17-Mar-2021 00:39:00 | 5.6425e+04 | 5.6601e+04 | 5.6425e+04 | 5.6601e+04 | 2.1780 |
| 41 | 17-Mar-2021 00:40:00 | 5.6586e+04 | 5.6603e+04 | 5.6541e+04 | 5.6547e+04 | 0.6638 |
| 42 | 17-Mar-2021 00:41:00 | 5.6522e+04 | 5.6556e+04 | 5.6516e+04 | 5.6516e+04 | 0.3547 |
| 43 | 17-Mar-2021 00:42:00 | 5.6478e+04 | 5.6498e+04 | 5.6462e+04 | 5.6462e+04 | 0.2020 |
| 44 | 17-Mar-2021 00:43:00 | 5.6455e+04 | 5.6492e+04 | 5.6442e+04 | 5.6492e+04 | 1.3862 |
| 45 | 17-Mar-2021 00:44:00 | 5.6484e+04 | 5.6487e+04 | 5.6466e+04 | 5.6487e+04 | 0.6350 |
| 46 | 17-Mar-2021 00:45:00 | 5.6540e+04 | 5.6546e+04 | 5.6496e+04 | 5.6509e+04 | 0.2570 |
| 47 | 17-Mar-2021 00:46:00 | 5.6516e+04 | 5.6538e+04 | 5.6490e+04 | 5.6516e+04 | 0.5327 |
| 48 | 17-Mar-2021 00:47:00 | 5.6495e+04 | 5.6495e+04 | 56400 | 56400 | 3.9557 |
| 49 | 17-Mar-2021 00:48:00 | 56400 | 56400 | 5.6304e+04 | 5.6341e+04 | 1.8815 |
| 50 | 17-Mar-2021 00:49:00 | 5.6372e+04 | 5.6374e+04 | 5.6372e+04 | 5.6374e+04 | 0.0701 |
| 51 | 17-Mar-2021 00:50:00 | 5.6425e+04 | 5.6428e+04 | 5.6348e+04 | 5.6392e+04 | 0.2851 |
| 52 | 17-Mar-2021 00:51:00 | 5.6374e+04 | 5.6458e+04 | 5.6369e+04 | 5.6401e+04 | 7.3220 |
| 53 | 17-Mar-2021 00:52:00 | 5.6435e+04 | 5.6465e+04 | 5.6379e+04 | 5.6407e+04 | 1.5508 |
| 54 | 17-Mar-2021 00:53:00 | 5.6446e+04 | 5.6446e+04 | 5.6386e+04 | 5.6392e+04 | 0.8589 |
| 55 | 17-Mar-2021 00:54:00 | 5.6397e+04 | 5.6426e+04 | 5.6397e+04 | 5.6409e+04 | 0.4701 |
| 56 | 17-Mar-2021 00:55:00 | 5.6428e+04 | 5.6479e+04 | 5.6423e+04 | 5.6467e+04 | 1.0259 |
| 57 | 17-Mar-2021 00:56:00 | 5.6442e+04 | 5.6442e+04 | 5.6404e+04 | 5.6404e+04 | 0.4875 |
| 58 | 17-Mar-2021 00:57:00 | 5.6416e+04 | 5.6465e+04 | 5.6416e+04 | 5.6461e+04 | 0.0276 |
| 59 | 17-Mar-2021 00:58:00 | 5.6489e+04 | 5.6620e+04 | 5.6489e+04 | 56572 | 5.7969 |
| 60 | 17-Mar-2021 00:59:00 | 5.6591e+04 | 5.6591e+04 | 5.6553e+04 | 5.6554e+04 | 0.2388 |
| 61 | 17-Mar-2021 01:00:00 | 5.6563e+04 | 5.6563e+04 | 5.6505e+04 | 5.6505e+04 | 0.5730 |
| 62 | 17-Mar-2021 01:01:00 | 5.6509e+04 | 5.6550e+04 | 5.6373e+04 | 5.6373e+04 | 1.9064 |
| 63 | 17-Mar-2021 01:02:00 | 5.6361e+04 | 5.6385e+04 | 56338 | 5.6385e+04 | 0.2408 |
| 64 | 17-Mar-2021 01:03:00 | 5.6382e+04 | 5.6478e+04 | 5.6382e+04 | 5.6472e+04 | 0.9928 |
| 65 | 17-Mar-2021 01:04:00 | 5.6470e+04 | 5.6470e+04 | 5.6421e+04 | 5.6421e+04 | 0.4300 |
| 66 | 17-Mar-2021 01:05:00 | 5.6421e+04 | 5.6462e+04 | 5.6417e+04 | 5.6455e+04 | 0.9065 |
| 67 | 17-Mar-2021 01:06:00 | 5.6462e+04 | 5.6507e+04 | 5.6462e+04 | 5.6493e+04 | 3.1484 |

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 68 | 17-Mar-2021 01:07:00 | 5.6513e+04 | 5.6513e+04 | 5.6482e+04 | 5.6482e+04 | 0.2734 |
| 69 | 17-Mar-2021 01:08:00 | 5.6482e+04 | 5.6531e+04 | 5.6482e+04 | 5.6521e+04 | 0.8352 |
| 70 | 17-Mar-2021 01:09:00 | 5.6503e+04 | 5.6556e+04 | 5.6503e+04 | 5.6556e+04 | 0.1540 |
| 71 | 17-Mar-2021 01:10:00 | 5.6543e+04 | 5.6543e+04 | 5.6469e+04 | 5.6469e+04 | 0.7590 |
| 72 | 17-Mar-2021 01:11:00 | 5.6467e+04 | 5.6519e+04 | 5.6467e+04 | 5.6500e+04 | 0.7378 |
| 73 | 17-Mar-2021 01:12:00 | 5.6475e+04 | 5.6501e+04 | 5.6461e+04 | 5.6466e+04 | 0.9920 |
| 74 | 17-Mar-2021 01:13:00 | 5.6419e+04 | 5.6481e+04 | 5.6407e+04 | 5.6407e+04 | 0.5994 |
| 75 | 17-Mar-2021 01:14:00 | 5.6407e+04 | 5.6446e+04 | 5.6396e+04 | 5.6425e+04 | 0.2350 |
| 76 | 17-Mar-2021 01:15:00 | 5.6400e+04 | 5.6402e+04 | 5.6327e+04 | 5.6327e+04 | 0.8526 |
| 77 | 17-Mar-2021 01:16:00 | 5.6331e+04 | 5.6337e+04 | 5.6326e+04 | 5.6330e+04 | 0.6516 |
| 78 | 17-Mar-2021 01:17:00 | 5.6348e+04 | 5.6377e+04 | 5.6346e+04 | 5.6346e+04 | 0.4292 |
| 79 | 17-Mar-2021 01:18:00 | 5.6355e+04 | 5.6355e+04 | 5.6154e+04 | 5.6171e+04 | 7.3241 |
| 80 | 17-Mar-2021 01:19:00 | 5.6170e+04 | 5.6200e+04 | 5.6063e+04 | 5.6188e+04 | 3.0062 |
| 81 | 17-Mar-2021 01:20:00 | 5.6163e+04 | 5.6230e+04 | 5.6163e+04 | 5.6230e+04 | 0.8522 |
| 82 | 17-Mar-2021 01:21:00 | 5.6238e+04 | 5.6278e+04 | 5.6210e+04 | 5.6278e+04 | 3.3718 |
| 83 | 17-Mar-2021 01:22:00 | 5.6283e+04 | 5.6321e+04 | 5.6283e+04 | 5.6318e+04 | 0.3024 |
| 84 | 17-Mar-2021 01:23:00 | 5.6321e+04 | 5.6335e+04 | 5.6270e+04 | 5.6272e+04 | 0.1260 |
| 85 | 17-Mar-2021 01:24:00 | 5.6267e+04 | 5.6315e+04 | 5.6251e+04 | 5.6296e+04 | 0.2969 |
| 86 | 17-Mar-2021 01:25:00 | 56309 | 5.6353e+04 | 5.6297e+04 | 5.6322e+04 | 0.4901 |
| 87 | 17-Mar-2021 01:26:00 | 5.6336e+04 | 5.6529e+04 | 5.6336e+04 | 5.6516e+04 | 2.9663 |
| 88 | 17-Mar-2021 01:27:00 | 5.6517e+04 | 5.6517e+04 | 5.6435e+04 | 5.6476e+04 | 0.6408 |
| 89 | 17-Mar-2021 01:28:00 | 5.6488e+04 | 5.6488e+04 | 5.6429e+04 | 5.6432e+04 | 1.4709 |
| 90 | 17-Mar-2021 01:29:00 | 5.6431e+04 | 5.6478e+04 | 5.6431e+04 | 5.6447e+04 | 1.1060 |
| 91 | 17-Mar-2021 01:30:00 | 5.6447e+04 | 5.6447e+04 | 56393 | 56393 | 0.3997 |
| 92 | 17-Mar-2021 01:31:00 | 5.6396e+04 | 5.6396e+04 | 5.6373e+04 | 5.6373e+04 | 0.5359 |
| 93 | 17-Mar-2021 01:32:00 | 5.6372e+04 | 5.6383e+04 | 5.6357e+04 | 5.6383e+04 | 0.4760 |
| 94 | 17-Mar-2021 01:33:00 | 5.6386e+04 | 5.6393e+04 | 5.6325e+04 | 5.6325e+04 | 2.0810 |
| 95 | 17-Mar-2021 01:34:00 | 5.6338e+04 | 5.6400e+04 | 5.6329e+04 | 5.6391e+04 | 1.3899 |
| 96 | 17-Mar-2021 01:35:00 | 5.6356e+04 | 5.6386e+04 | 5.6356e+04 | 5.6386e+04 | 0.4260 |
| 97 | 17-Mar-2021 01:36:00 | 5.6400e+04 | 5.6431e+04 | 56365 | 56365 | 3.9506 |
| 98 | 17-Mar-2021 01:37:00 | 5.6387e+04 | 5.6387e+04 | 5.6362e+04 | 5.6372e+04 | 0.3137 |
| 99 | 17-Mar-2021 01:38:00 | 5.6365e+04 | 5.6374e+04 | 5.6305e+04 | 5.6305e+04 | 0.2358 |
| 100 | 17-Mar-2021 01:39:00 | 5.6303e+04 | 5.6303e+04 | 5.6249e+04 | 5.6254e+04 | 0.4883 |

```
    ⋮
```

```
%outliers = outlier(BitcoinData.Close)

%Rerun model to check for more outliers
Y = BitcoinData{:,"Close"}
```

```
Y = 2876×1
10^4 ×
    5.7128
    5.7150
    5.7104
    5.7109
    5.7005
    5.6926
    5.6905
    5.6856
    5.6941
    5.6964
     ⋮
```

```
X = BitcoinData{:,[1:3]}
```

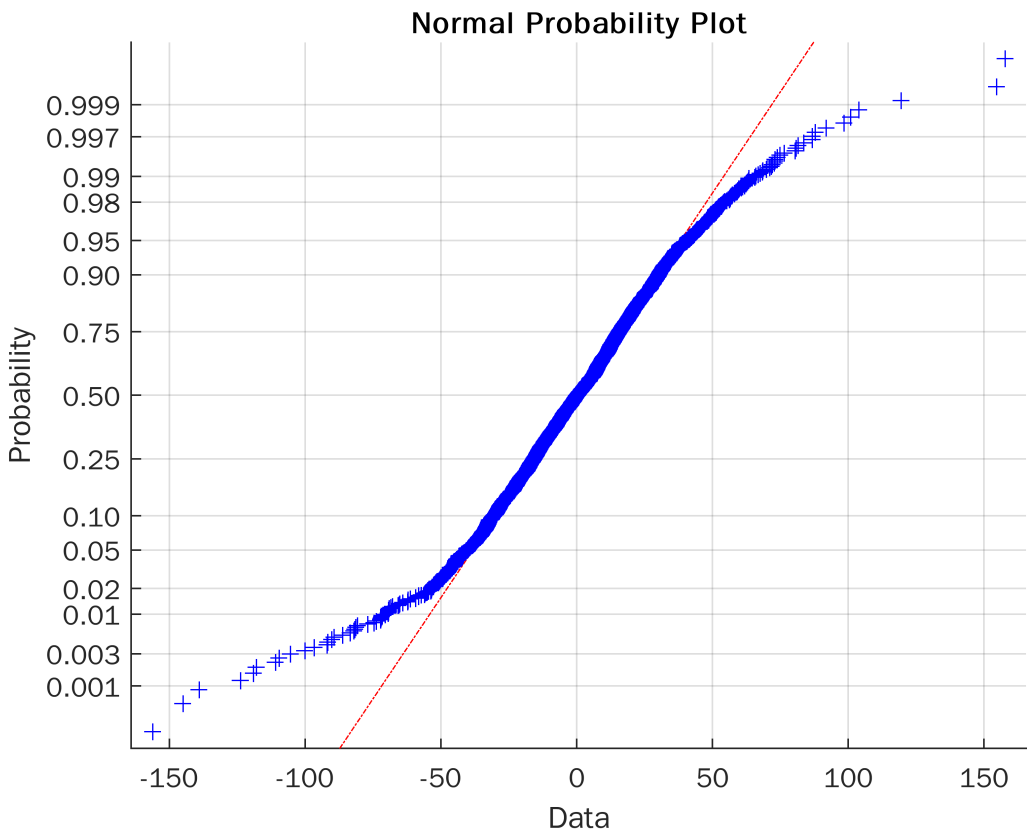
```
X = 2876×3
10^4 ×
    5.6928    5.7150    5.6908
    5.7079    5.7198    5.7035
    5.7149    5.7183    5.7010
    5.7096    5.7158    5.7071
    5.7112    5.7112    5.7000
    5.7074    5.7074    5.6926
    5.6940    5.6965    5.6890
    5.6905    5.6913    5.6838
    5.6858    5.6970    5.6855
    5.6928    5.6985    5.6918
     ⋮
```

```
LRPre = fitlm(zscore(X),Y)
```

```
LRPre =
Linear regression model:
    y ~ 1 + x1 + x2 + x3

Estimated Coefficients:
                   Estimate      SE         tStat         pValue
                   ________    _______    __________    __________

    (Intercept)      57318     0.49169    1.1657e+05             0
    x1             -833.16       20.79       -40.074    2.5008e-279
    x2                1254      18.904        66.334              0
    x3              1080.5      18.338        58.922              0


Number of observations: 2876, Error degrees of freedom: 2872
Root Mean Squared Error: 26.4
```

```
R-squared: 1,  Adjusted R-Squared: 1
F-statistic vs. constant model: 3.11e+06, p-value = 0
```

```
normplot(LRPre.Residuals.Raw)
```




```
idx = isoutlier(BitcoinData.Close)
```

```
idx = 2876×1 logical array
   0
   0
   0
   0
   0
   0
   0
   0
   0
   0
     ⋮
```

```
sum(idx)
```

```
ans = 0
```

```
BitcoinData(idx,:) = []
```

```
BitcoinData = 2876×7 timetable
                                                                    ...
```

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 1 | 17-Mar-2021 00:00:00 | 5.6928e+04 | 57150 | 5.6908e+04 | 5.7128e+04 | 8.8224 |
| 2 | 17-Mar-2021 00:01:00 | 5.7079e+04 | 5.7198e+04 | 5.7035e+04 | 5.7150e+04 | 3.4603 |
| 3 | 17-Mar-2021 00:02:00 | 5.7149e+04 | 5.7183e+04 | 5.7010e+04 | 5.7104e+04 | 6.1158 |
| 4 | 17-Mar-2021 00:03:00 | 5.7096e+04 | 5.7158e+04 | 5.7071e+04 | 5.7109e+04 | 5.0098 |
| 5 | 17-Mar-2021 00:04:00 | 5.7112e+04 | 5.7112e+04 | 5.7000e+04 | 5.7005e+04 | 1.8366 |
| 6 | 17-Mar-2021 00:05:00 | 5.7074e+04 | 5.7074e+04 | 56926 | 56926 | 5.0145 |
| 7 | 17-Mar-2021 00:06:00 | 5.6940e+04 | 5.6965e+04 | 56890 | 5.6905e+04 | 7.5988 |
| 8 | 17-Mar-2021 00:07:00 | 5.6905e+04 | 5.6913e+04 | 5.6838e+04 | 5.6856e+04 | 2.4279 |
| 9 | 17-Mar-2021 00:08:00 | 5.6858e+04 | 5.6970e+04 | 5.6855e+04 | 5.6941e+04 | 1.5963 |
| 10 | 17-Mar-2021 00:09:00 | 5.6928e+04 | 5.6985e+04 | 5.6918e+04 | 5.6964e+04 | 3.3036 |
| 11 | 17-Mar-2021 00:10:00 | 5.6988e+04 | 5.6988e+04 | 5.6922e+04 | 5.6936e+04 | 1.4131 |
| 12 | 17-Mar-2021 00:11:00 | 5.6946e+04 | 5.6948e+04 | 5.6804e+04 | 5.6840e+04 | 11.8668 |
| 13 | 17-Mar-2021 00:12:00 | 5.6810e+04 | 5.6810e+04 | 5.6690e+04 | 5.6699e+04 | 0.7883 |
| 14 | 17-Mar-2021 00:13:00 | 5.6699e+04 | 5.6699e+04 | 5.6597e+04 | 5.6598e+04 | 7.9133 |
| 15 | 17-Mar-2021 00:14:00 | 5.6591e+04 | 5.6763e+04 | 5.6591e+04 | 5.6613e+04 | 4.2553 |
| 16 | 17-Mar-2021 00:15:00 | 5.6680e+04 | 5.6737e+04 | 5.6680e+04 | 5.6717e+04 | 0.4147 |
| 17 | 17-Mar-2021 00:16:00 | 5.6717e+04 | 5.6719e+04 | 5.6664e+04 | 5.6717e+04 | 0.5128 |
| 18 | 17-Mar-2021 00:17:00 | 5.6741e+04 | 5.6768e+04 | 5.6667e+04 | 5.6667e+04 | 0.6093 |
| 19 | 17-Mar-2021 00:18:00 | 5.6670e+04 | 5.6708e+04 | 5.6628e+04 | 5.6701e+04 | 2.5378 |
| 20 | 17-Mar-2021 00:19:00 | 5.6706e+04 | 5.6719e+04 | 5.6671e+04 | 5.6711e+04 | 3.0139 |
| 21 | 17-Mar-2021 00:20:00 | 5.6671e+04 | 5.6757e+04 | 5.6671e+04 | 5.6753e+04 | 1.7076 |
| 22 | 17-Mar-2021 00:21:00 | 5.6750e+04 | 5.6775e+04 | 5.6665e+04 | 5.6665e+04 | 9.0640 |
| 23 | 17-Mar-2021 00:22:00 | 5.6676e+04 | 5.6689e+04 | 56540 | 5.6542e+04 | 17.0034 |
| 24 | 17-Mar-2021 00:23:00 | 5.6502e+04 | 5.6566e+04 | 5.6488e+04 | 5.6492e+04 | 1.6817 |
| 25 | 17-Mar-2021 00:24:00 | 5.6488e+04 | 5.6530e+04 | 5.6488e+04 | 5.6503e+04 | 0.1477 |
| 26 | 17-Mar-2021 00:25:00 | 5.6503e+04 | 5.6521e+04 | 5.6435e+04 | 5.6462e+04 | 1.6796 |
| 27 | 17-Mar-2021 00:26:00 | 5.6446e+04 | 5.6481e+04 | 5.6406e+04 | 5.6471e+04 | 0.9282 |
| 28 | 17-Mar-2021 00:27:00 | 5.6462e+04 | 5.6462e+04 | 5.6392e+04 | 5.6418e+04 | 1.0664 |
| 29 | 17-Mar-2021 00:28:00 | 5.6410e+04 | 5.6479e+04 | 56400 | 5.6461e+04 | 2.0418 |
| 30 | 17-Mar-2021 00:29:00 | 5.6460e+04 | 5.6461e+04 | 5.6391e+04 | 5.6434e+04 | 1.0734 |
| 31 | 17-Mar-2021 00:30:00 | 5.6399e+04 | 5.6513e+04 | 5.6399e+04 | 5.6513e+04 | 0.4380 |
| 32 | 17-Mar-2021 00:31:00 | 5.6560e+04 | 5.6676e+04 | 5.6550e+04 | 5.6602e+04 | 1.9544 |
| 33 | 17-Mar-2021 00:32:00 | 5.6579e+04 | 56679 | 5.6579e+04 | 5.6643e+04 | 1.0486 |

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 34 | 17-Mar-2021 00:33:00 | 5.6637e+04 | 5.6664e+04 | 5.6559e+04 | 5.6590e+04 | 4.4152 |
| 35 | 17-Mar-2021 00:34:00 | 5.6590e+04 | 5.6600e+04 | 5.6548e+04 | 5.6564e+04 | 1.5328 |
| 36 | 17-Mar-2021 00:35:00 | 5.6557e+04 | 5.6606e+04 | 5.6545e+04 | 5.6604e+04 | 2.1806 |
| 37 | 17-Mar-2021 00:36:00 | 5.6602e+04 | 5.6640e+04 | 5.6573e+04 | 5.6573e+04 | 4.2177 |
| 38 | 17-Mar-2021 00:37:00 | 5.6565e+04 | 5.6574e+04 | 5.6486e+04 | 5.6486e+04 | 0.8632 |
| 39 | 17-Mar-2021 00:38:00 | 5.6476e+04 | 5.6483e+04 | 5.6429e+04 | 5.6429e+04 | 0.0751 |
| 40 | 17-Mar-2021 00:39:00 | 5.6425e+04 | 5.6601e+04 | 5.6425e+04 | 5.6601e+04 | 2.1780 |
| 41 | 17-Mar-2021 00:40:00 | 5.6586e+04 | 5.6603e+04 | 5.6541e+04 | 5.6547e+04 | 0.6638 |
| 42 | 17-Mar-2021 00:41:00 | 5.6522e+04 | 5.6556e+04 | 5.6516e+04 | 5.6516e+04 | 0.3547 |
| 43 | 17-Mar-2021 00:42:00 | 5.6478e+04 | 5.6498e+04 | 5.6462e+04 | 5.6462e+04 | 0.2020 |
| 44 | 17-Mar-2021 00:43:00 | 5.6455e+04 | 5.6492e+04 | 5.6442e+04 | 5.6492e+04 | 1.3862 |
| 45 | 17-Mar-2021 00:44:00 | 5.6484e+04 | 5.6487e+04 | 5.6466e+04 | 5.6487e+04 | 0.6350 |
| 46 | 17-Mar-2021 00:45:00 | 5.6540e+04 | 5.6546e+04 | 5.6496e+04 | 5.6509e+04 | 0.2570 |
| 47 | 17-Mar-2021 00:46:00 | 5.6516e+04 | 5.6538e+04 | 5.6490e+04 | 5.6516e+04 | 0.5327 |
| 48 | 17-Mar-2021 00:47:00 | 5.6495e+04 | 5.6495e+04 | 56400 | 56400 | 3.9557 |
| 49 | 17-Mar-2021 00:48:00 | 56400 | 56400 | 5.6304e+04 | 5.6341e+04 | 1.8815 |
| 50 | 17-Mar-2021 00:49:00 | 5.6372e+04 | 5.6374e+04 | 5.6372e+04 | 5.6374e+04 | 0.0701 |
| 51 | 17-Mar-2021 00:50:00 | 5.6425e+04 | 5.6428e+04 | 5.6348e+04 | 5.6392e+04 | 0.2851 |
| 52 | 17-Mar-2021 00:51:00 | 5.6374e+04 | 5.6458e+04 | 5.6369e+04 | 5.6401e+04 | 7.3220 |
| 53 | 17-Mar-2021 00:52:00 | 5.6435e+04 | 5.6465e+04 | 5.6379e+04 | 5.6407e+04 | 1.5508 |
| 54 | 17-Mar-2021 00:53:00 | 5.6446e+04 | 5.6446e+04 | 5.6386e+04 | 5.6392e+04 | 0.8589 |
| 55 | 17-Mar-2021 00:54:00 | 5.6397e+04 | 5.6426e+04 | 5.6397e+04 | 5.6409e+04 | 0.4701 |
| 56 | 17-Mar-2021 00:55:00 | 5.6428e+04 | 5.6479e+04 | 5.6423e+04 | 5.6467e+04 | 1.0259 |
| 57 | 17-Mar-2021 00:56:00 | 5.6442e+04 | 5.6442e+04 | 5.6404e+04 | 5.6404e+04 | 0.4875 |
| 58 | 17-Mar-2021 00:57:00 | 5.6416e+04 | 5.6465e+04 | 5.6416e+04 | 5.6461e+04 | 0.0276 |
| 59 | 17-Mar-2021 00:58:00 | 5.6489e+04 | 5.6620e+04 | 5.6489e+04 | 56572 | 5.7969 |
| 60 | 17-Mar-2021 00:59:00 | 5.6591e+04 | 5.6591e+04 | 5.6553e+04 | 5.6554e+04 | 0.2388 |
| 61 | 17-Mar-2021 01:00:00 | 5.6563e+04 | 5.6563e+04 | 5.6505e+04 | 5.6505e+04 | 0.5730 |
| 62 | 17-Mar-2021 01:01:00 | 5.6509e+04 | 5.6550e+04 | 5.6373e+04 | 5.6373e+04 | 1.9064 |
| 63 | 17-Mar-2021 01:02:00 | 5.6361e+04 | 5.6385e+04 | 56338 | 5.6385e+04 | 0.2408 |
| 64 | 17-Mar-2021 01:03:00 | 5.6382e+04 | 5.6478e+04 | 5.6382e+04 | 5.6472e+04 | 0.9928 |
| 65 | 17-Mar-2021 01:04:00 | 5.6470e+04 | 5.6470e+04 | 5.6421e+04 | 5.6421e+04 | 0.4300 |
| 66 | 17-Mar-2021 01:05:00 | 5.6421e+04 | 5.6462e+04 | 5.6417e+04 | 5.6455e+04 | 0.9065 |

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 67 | 17-Mar-2021 01:06:00 | 5.6462e+04 | 5.6507e+04 | 5.6462e+04 | 5.6493e+04 | 3.1484 |
| 68 | 17-Mar-2021 01:07:00 | 5.6513e+04 | 5.6513e+04 | 5.6482e+04 | 5.6482e+04 | 0.2734 |
| 69 | 17-Mar-2021 01:08:00 | 5.6482e+04 | 5.6531e+04 | 5.6482e+04 | 5.6521e+04 | 0.8352 |
| 70 | 17-Mar-2021 01:09:00 | 5.6503e+04 | 5.6556e+04 | 5.6503e+04 | 5.6556e+04 | 0.1540 |
| 71 | 17-Mar-2021 01:10:00 | 5.6543e+04 | 5.6543e+04 | 5.6469e+04 | 5.6469e+04 | 0.7590 |
| 72 | 17-Mar-2021 01:11:00 | 5.6467e+04 | 5.6519e+04 | 5.6467e+04 | 5.6500e+04 | 0.7378 |
| 73 | 17-Mar-2021 01:12:00 | 5.6475e+04 | 5.6501e+04 | 5.6461e+04 | 5.6466e+04 | 0.9920 |
| 74 | 17-Mar-2021 01:13:00 | 5.6419e+04 | 5.6481e+04 | 5.6407e+04 | 5.6407e+04 | 0.5994 |
| 75 | 17-Mar-2021 01:14:00 | 5.6407e+04 | 5.6446e+04 | 5.6396e+04 | 5.6425e+04 | 0.2350 |
| 76 | 17-Mar-2021 01:15:00 | 5.6400e+04 | 5.6402e+04 | 5.6327e+04 | 5.6327e+04 | 0.8526 |
| 77 | 17-Mar-2021 01:16:00 | 5.6331e+04 | 5.6337e+04 | 5.6326e+04 | 5.6330e+04 | 0.6516 |
| 78 | 17-Mar-2021 01:17:00 | 5.6348e+04 | 5.6377e+04 | 5.6346e+04 | 5.6346e+04 | 0.4292 |
| 79 | 17-Mar-2021 01:18:00 | 5.6355e+04 | 5.6355e+04 | 5.6154e+04 | 5.6171e+04 | 7.3241 |
| 80 | 17-Mar-2021 01:19:00 | 5.6170e+04 | 5.6200e+04 | 5.6063e+04 | 5.6188e+04 | 3.0062 |
| 81 | 17-Mar-2021 01:20:00 | 5.6163e+04 | 5.6230e+04 | 5.6163e+04 | 5.6230e+04 | 0.8522 |
| 82 | 17-Mar-2021 01:21:00 | 5.6238e+04 | 5.6278e+04 | 5.6210e+04 | 5.6278e+04 | 3.3718 |
| 83 | 17-Mar-2021 01:22:00 | 5.6283e+04 | 5.6321e+04 | 5.6283e+04 | 5.6318e+04 | 0.3024 |
| 84 | 17-Mar-2021 01:23:00 | 5.6321e+04 | 5.6335e+04 | 5.6270e+04 | 5.6272e+04 | 0.1260 |
| 85 | 17-Mar-2021 01:24:00 | 5.6267e+04 | 5.6315e+04 | 5.6251e+04 | 5.6296e+04 | 0.2969 |
| 86 | 17-Mar-2021 01:25:00 | 56309 | 5.6353e+04 | 5.6297e+04 | 5.6322e+04 | 0.4901 |
| 87 | 17-Mar-2021 01:26:00 | 5.6336e+04 | 5.6529e+04 | 5.6336e+04 | 5.6516e+04 | 2.9663 |
| 88 | 17-Mar-2021 01:27:00 | 5.6517e+04 | 5.6517e+04 | 5.6435e+04 | 5.6476e+04 | 0.6408 |
| 89 | 17-Mar-2021 01:28:00 | 5.6488e+04 | 5.6488e+04 | 5.6429e+04 | 5.6432e+04 | 1.4709 |
| 90 | 17-Mar-2021 01:29:00 | 5.6431e+04 | 5.6478e+04 | 5.6431e+04 | 5.6447e+04 | 1.1060 |
| 91 | 17-Mar-2021 01:30:00 | 5.6447e+04 | 5.6447e+04 | 56393 | 56393 | 0.3997 |
| 92 | 17-Mar-2021 01:31:00 | 5.6396e+04 | 5.6396e+04 | 5.6373e+04 | 5.6373e+04 | 0.5359 |
| 93 | 17-Mar-2021 01:32:00 | 5.6372e+04 | 5.6383e+04 | 5.6357e+04 | 5.6383e+04 | 0.4760 |
| 94 | 17-Mar-2021 01:33:00 | 5.6386e+04 | 5.6393e+04 | 5.6325e+04 | 5.6325e+04 | 2.0810 |
| 95 | 17-Mar-2021 01:34:00 | 5.6338e+04 | 5.6400e+04 | 5.6329e+04 | 5.6391e+04 | 1.3899 |
| 96 | 17-Mar-2021 01:35:00 | 5.6356e+04 | 5.6386e+04 | 5.6356e+04 | 5.6386e+04 | 0.4260 |
| 97 | 17-Mar-2021 01:36:00 | 5.6400e+04 | 5.6431e+04 | 56365 | 56365 | 3.9506 |
| 98 | 17-Mar-2021 01:37:00 | 5.6387e+04 | 5.6387e+04 | 5.6362e+04 | 5.6372e+04 | 0.3137 |
| 99 | 17-Mar-2021 01:38:00 | 5.6365e+04 | 5.6374e+04 | 5.6305e+04 | 5.6305e+04 | 0.2358 |

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 100 | 17-Mar-2021 01:39:00 | 5.6303e+04 | 5.6303e+04 | 5.6249e+04 | 5.6254e+04 | 0.4883 |

⋮

```
%outliers = outlier(BitcoinData.Close)
```

## Split dataset into training and testing data

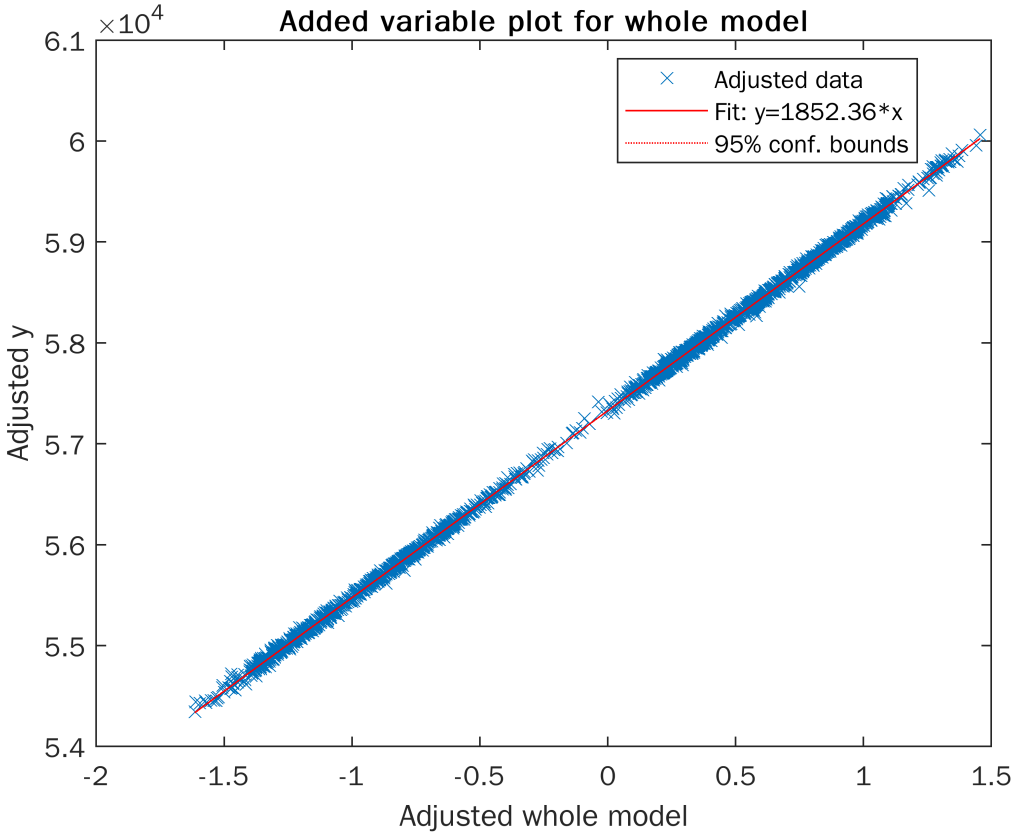
```
BitcoinData_new = [X, Y];

PD = 0.20;
cv = cvpartition(size(BitcoinData_new,1),'HoldOut',PD);
Xtrain = BitcoinData_new(cv.training,[1:end - 1]);
Ytrain = BitcoinData_new(cv.training,end);
Xtest = BitcoinData_new(cv.test, [1:end - 1]);
Ytest = BitcoinData_new(cv.test,end);
```

## Linear model with training-testing split

```
LRModel = fitlm(zscore(Xtrain),Ytrain)
```

```
LRModel = 
Linear regression model:
    y ~ 1 + x1 + x2 + x3

Estimated Coefficients:
                   Estimate       SE         tStat         pValue  
                   ________    _______    __________    ___________

    (Intercept)      57327     0.54742    1.0472e+05              0
    x1             -833.18      23.062       -36.128    1.0288e-226
    x2              1256.1      20.897         60.11              0
    x3              1076.7      20.557        52.376              0


Number of observations: 2301, Error degrees of freedom: 2297
Root Mean Squared Error: 26.3
R-squared: 1,  Adjusted R-Squared: 1
F-statistic vs. constant model: 2.5e+06, p-value = 0
```

```
plot(LRModel)
```




```
LRModel.RMSE
```

```
ans = 26.2589
```

## Predict

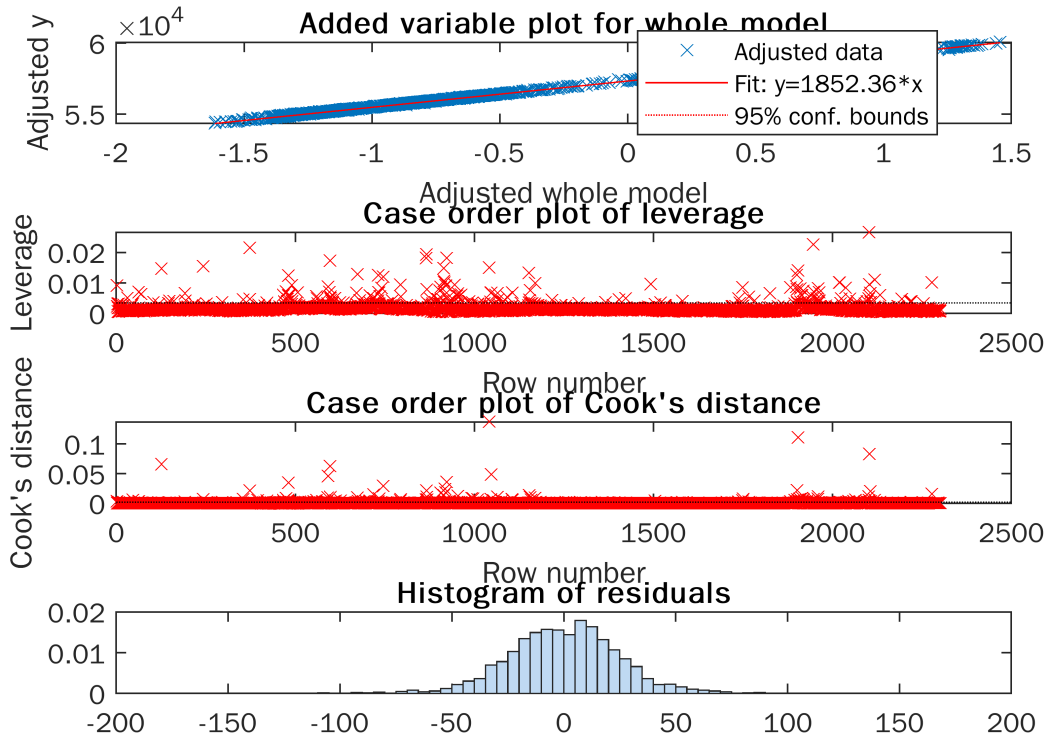
```
[YPred, Scores] = predict(LRModel,Xtest)
```

```
YPred = 575×1
10^7 ×
    8.5137
    8.5055
    8.5042
    8.4705
    8.4652
    8.4725
    8.4777
    8.5010
    8.4954
    8.4745
      ⋮

Scores = 575×2
10^7 ×
    8.5076    8.5199
    8.4994    8.5116
    8.4982    8.5103
    8.4645    8.4766
    8.4591    8.4712
    8.4665    8.4786
```

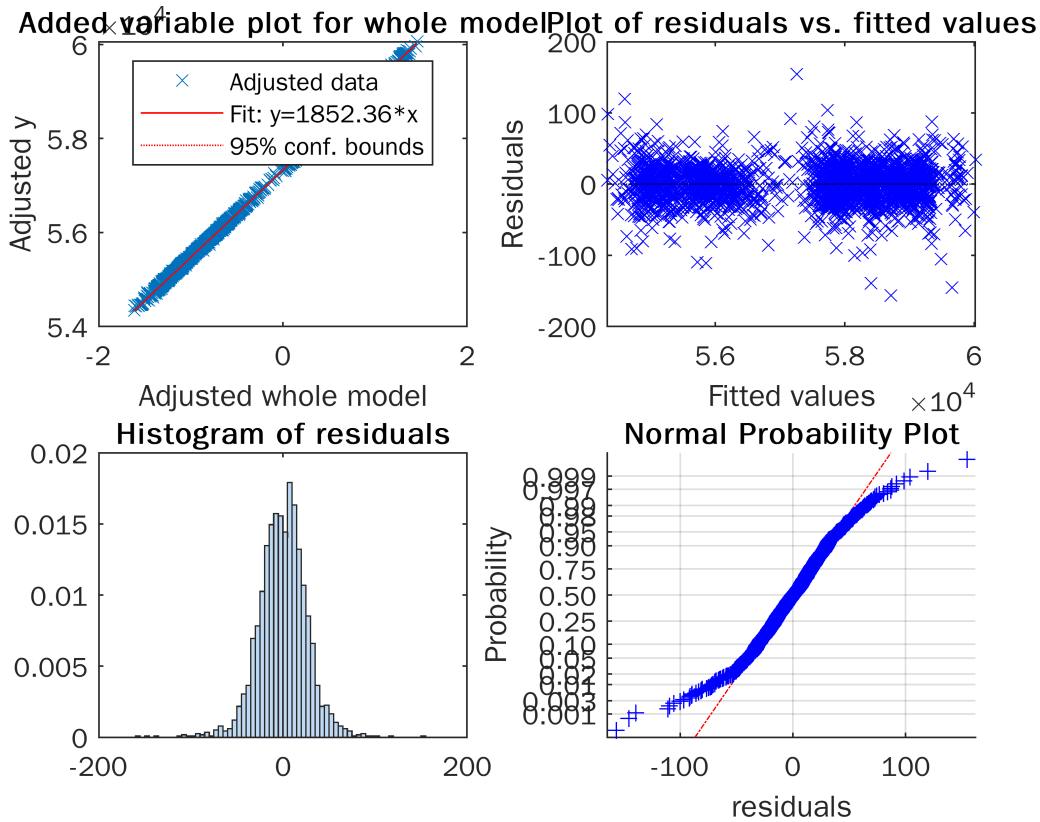
```
    8.4716    8.4838
    8.4949    8.5071
    8.4893    8.5015
    8.4684    8.4806
      ⋮
```

## Plots

```
figure,
subplot(4, 1, 1), plot(LRModel)
subplot(4, 1, 2), plotDiagnostics(LRModel)
subplot(4, 1, 3), plotDiagnostics(LRModel, 'cookd')
subplot(4, 1, 4), plotResiduals(LRModel)
```




```
figure,
subplot(2, 2, 1), plot(LRModel)
subplot(2, 2, 2), plotResiduals(LRModel,'fitted')
subplot(2, 2, 3), plotResiduals(LRModel)
subplot(2, 2, 4), normplot(LRModel.Residuals.Raw)
xlabel('residuals')
```


Added variable plot for whole model
Adjusted data
Fit: y=1852.36*x
95% conf. bounds
Adjusted y
Adjusted whole model
Plot of residuals vs. fitted values
Residuals
Fitted values
Histogram of residuals
Normal Probability Plot
Probability
residuals

## Upload the big dataset (>250MB) to MATLAB Drive and read table

```
BitcoinData = readtable('bitcoin-dataset.csv');
```

```
Warning: Column headers from the file were modified to make them valid MATLAB identifiers
before creating variable names for the table. The original column headers are saved in the
VariableDescriptions property.
Set 'VariableNamingRule' to 'preserve' to use the original column headers as table variable names.
```

```
Tablesize = size(BitcoinData)
```

```
Tablesize = 1×2
     4857377           8
```

```
head(BitcoinData,1)
```

```
ans = 1×8 table
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                
...
```

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 1 | 1.3253e+09 | 4.3900 | 4.3900 | 4.3900 | 4.3900 | 0.4556 |

## Convert timestamp

```
datetest = BitcoinData(:,1);
datetest = table2array(datetest);
BitcoinData.Timestamp = datetime(datetest, 'ConvertFrom', 'posixtime');
```

## Remove NaNs

```
% how many NaNs in each column
NaN2 = sum(isnan(BitcoinData.Open))
```

```
NaN2 = 1243608
```

```
NaN3 = sum(isnan(BitcoinData.High))
```

```
NaN3 = 1243608
```

```
NaN4 = sum(isnan(BitcoinData.Low))
```

```
NaN4 = 1243608
```

```
NaN5 = sum(isnan(BitcoinData.Close))
```

```
NaN5 = 1243608
```

```
NaN6 = sum(isnan(BitcoinData.Volume__BTC_))
```

```
NaN6 = 1243608
```

```
NaN7 = sum(isnan(BitcoinData.Volume__Currency_))
```

```
NaN7 = 1243608
```

```
NaN8 = sum(isnan(BitcoinData.Weighted_Price))
```

```
NaN8 = 1243608
```

```
% remove NaNs
BitcoinData = BitcoinData(isnan(BitcoinData.High) == 0,:);
```

## Select data

```
BitcoinDataTimetable = table2timetable(BitcoinData);

% March 2013
% S = timerange('17-Mar-2013 00:00:00','18-Mar-2013 23:59:00'); %2days
% S = timerange('17-Mar-2013 00:00:00','23-Mar-2013 23:59:00'); %7days
% S = timerange('17-Mar-2013 00:00:00','30-Mar-2013 23:59:00'); %14days

% March 2016
% S = timerange('17-Mar-2016 00:00:00','18-Mar-2016 23:59:00'); %2days
% S = timerange('17-Mar-2016 00:00:00','23-Mar-2016 23:59:00'); %7days
% S = timerange('17-Mar-2016 00:00:00','30-Mar-2016 23:59:00'); %14days

% March 2019
% S = timerange('17-Mar-2019 00:00:00','18-Mar-2019 23:59:00'); %2days
% S = timerange('17-Mar-2019 00:00:00','23-Mar-2019 23:59:00'); %7days
% S = timerange('17-Mar-2019 00:00:00','30-Mar-2019 23:59:00'); %14days

% March 2021
% S = timerange('17-Mar-2021 00:00:00','18-Mar-2021 23:59:00'); %2days
 S = timerange('17-Mar-2021 00:00:00','23-Mar-2021 23:59:00'); %7days
% S = timerange('17-Mar-2021 00:00:00','30-Mar-2021 23:59:00'); %14days

BitcoinData = BitcoinDataTimetable(S,:);
Tablesize = size(BitcoinData)
```

```
Tablesize = 1×2
       10065           7
```

## Create model - preprocessing

```
% standardization, and Initial predictor set (matrix)

Y = BitcoinData{:,"Close"}
```

```
Y = 10065×1
10^4 ×
    5.7128
    5.7150
    5.7104
    5.7109
    5.7005
    5.6926
    5.6905
    5.6856
    5.6941
    5.6964
     ⋮
```

```
X = BitcoinData{:,[1:3]}
```

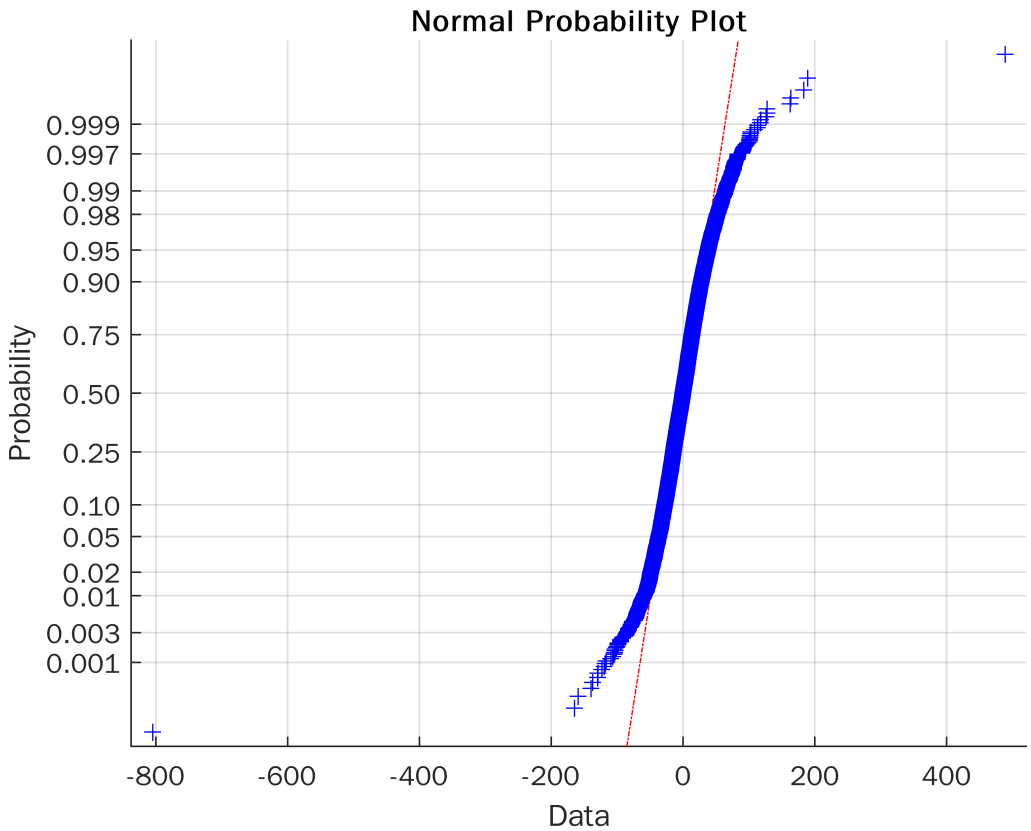
```
X = 10065×3
10^4 ×
    5.6928    5.7150    5.6908
    5.7079    5.7198    5.7035
    5.7149    5.7183    5.7010
    5.7096    5.7158    5.7071
```

```
    5.7112    5.7112    5.7000
    5.7074    5.7074    5.6926
    5.6940    5.6965    5.6890
    5.6905    5.6913    5.6838
    5.6858    5.6970    5.6855
    5.6928    5.6985    5.6918
     ⋮
```

```
%Check model for outliers

LRPre = fitlm(zscore(X),Y)
```

```
LRPre = 
Linear regression model:
    y ~ 1 + x1 + x2 + x3

Estimated Coefficients:
                   Estimate      SE         tStat       pValue  
                   ________    _______    __________    ______ 

    (Intercept)      57216     0.25726    2.2241e+05      0    
    x1             -796.38      11.701       -68.061      0    
    x2              1184.4      10.139        116.82      0    
    x3                1166      9.7543        119.54      0    


Number of observations: 10065, Error degrees of freedom: 10061
Root Mean Squared Error: 25.8
R-squared: 1,  Adjusted R-Squared: 1
F-statistic vs. constant model: 1.22e+07, p-value = 0
```

```
normplot(LRPre.Residuals.Raw)
```




## Identify and Remove Outliers

```
idx = isoutlier(BitcoinData.Close)
```

```
idx = 10065×1 logical array
   0
   0
   0
   0
   0
   0
   0
   0
   0
   0
     ⋮
```

```
sum(idx)
```

```
ans = 0
```

```
BitcoinData(idx,:) = []
```

```
BitcoinData = 10065×7 timetable
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                
```
...
```

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 1 | 17-Mar-2021 00:00:00 | 5.6928e+04 | 57150 | 5.6908e+04 | 5.7128e+04 | 8.8224 |
```

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 2 | 17-Mar-2021 00:01:00 | 5.7079e+04 | 5.7198e+04 | 5.7035e+04 | 5.7150e+04 | 3.4603 |
| 3 | 17-Mar-2021 00:02:00 | 5.7149e+04 | 5.7183e+04 | 5.7010e+04 | 5.7104e+04 | 6.1158 |
| 4 | 17-Mar-2021 00:03:00 | 5.7096e+04 | 5.7158e+04 | 5.7071e+04 | 5.7109e+04 | 5.0098 |
| 5 | 17-Mar-2021 00:04:00 | 5.7112e+04 | 5.7112e+04 | 5.7000e+04 | 5.7005e+04 | 1.8366 |
| 6 | 17-Mar-2021 00:05:00 | 5.7074e+04 | 5.7074e+04 | 56926 | 56926 | 5.0145 |
| 7 | 17-Mar-2021 00:06:00 | 5.6940e+04 | 5.6965e+04 | 56890 | 5.6905e+04 | 7.5988 |
| 8 | 17-Mar-2021 00:07:00 | 5.6905e+04 | 5.6913e+04 | 5.6838e+04 | 5.6856e+04 | 2.4279 |
| 9 | 17-Mar-2021 00:08:00 | 5.6858e+04 | 5.6970e+04 | 5.6855e+04 | 5.6941e+04 | 1.5963 |
| 10 | 17-Mar-2021 00:09:00 | 5.6928e+04 | 5.6985e+04 | 5.6918e+04 | 5.6964e+04 | 3.3036 |
| 11 | 17-Mar-2021 00:10:00 | 5.6988e+04 | 5.6988e+04 | 5.6922e+04 | 5.6936e+04 | 1.4131 |
| 12 | 17-Mar-2021 00:11:00 | 5.6946e+04 | 5.6948e+04 | 5.6804e+04 | 5.6840e+04 | 11.8668 |
| 13 | 17-Mar-2021 00:12:00 | 5.6810e+04 | 5.6810e+04 | 5.6690e+04 | 5.6699e+04 | 0.7883 |
| 14 | 17-Mar-2021 00:13:00 | 5.6699e+04 | 5.6699e+04 | 5.6597e+04 | 5.6598e+04 | 7.9133 |
| 15 | 17-Mar-2021 00:14:00 | 5.6591e+04 | 5.6763e+04 | 5.6591e+04 | 5.6613e+04 | 4.2553 |
| 16 | 17-Mar-2021 00:15:00 | 5.6680e+04 | 5.6737e+04 | 5.6680e+04 | 5.6717e+04 | 0.4147 |
| 17 | 17-Mar-2021 00:16:00 | 5.6717e+04 | 5.6719e+04 | 5.6664e+04 | 5.6717e+04 | 0.5128 |
| 18 | 17-Mar-2021 00:17:00 | 5.6741e+04 | 5.6768e+04 | 5.6667e+04 | 5.6667e+04 | 0.6093 |
| 19 | 17-Mar-2021 00:18:00 | 5.6670e+04 | 5.6708e+04 | 5.6628e+04 | 5.6701e+04 | 2.5378 |
| 20 | 17-Mar-2021 00:19:00 | 5.6706e+04 | 5.6719e+04 | 5.6671e+04 | 5.6711e+04 | 3.0139 |
| 21 | 17-Mar-2021 00:20:00 | 5.6671e+04 | 5.6757e+04 | 5.6671e+04 | 5.6753e+04 | 1.7076 |
| 22 | 17-Mar-2021 00:21:00 | 5.6750e+04 | 5.6775e+04 | 5.6665e+04 | 5.6665e+04 | 9.0640 |
| 23 | 17-Mar-2021 00:22:00 | 5.6676e+04 | 5.6689e+04 | 56540 | 5.6542e+04 | 17.0034 |
| 24 | 17-Mar-2021 00:23:00 | 5.6502e+04 | 5.6566e+04 | 5.6488e+04 | 5.6492e+04 | 1.6817 |
| 25 | 17-Mar-2021 00:24:00 | 5.6488e+04 | 5.6530e+04 | 5.6488e+04 | 5.6503e+04 | 0.1477 |
| 26 | 17-Mar-2021 00:25:00 | 5.6503e+04 | 5.6521e+04 | 5.6435e+04 | 5.6462e+04 | 1.6796 |
| 27 | 17-Mar-2021 00:26:00 | 5.6446e+04 | 5.6481e+04 | 5.6406e+04 | 5.6471e+04 | 0.9282 |
| 28 | 17-Mar-2021 00:27:00 | 5.6462e+04 | 5.6462e+04 | 5.6392e+04 | 5.6418e+04 | 1.0664 |
| 29 | 17-Mar-2021 00:28:00 | 5.6410e+04 | 5.6479e+04 | 56400 | 5.6461e+04 | 2.0418 |
| 30 | 17-Mar-2021 00:29:00 | 5.6460e+04 | 5.6461e+04 | 5.6391e+04 | 5.6434e+04 | 1.0734 |
| 31 | 17-Mar-2021 00:30:00 | 5.6399e+04 | 5.6513e+04 | 5.6399e+04 | 5.6513e+04 | 0.4380 |
| 32 | 17-Mar-2021 00:31:00 | 5.6560e+04 | 5.6676e+04 | 5.6550e+04 | 5.6602e+04 | 1.9544 |
| 33 | 17-Mar-2021 00:32:00 | 5.6579e+04 | 56679 | 5.6579e+04 | 5.6643e+04 | 1.0486 |
| 34 | 17-Mar-2021 00:33:00 | 5.6637e+04 | 5.6664e+04 | 5.6559e+04 | 5.6590e+04 | 4.4152 |

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 35 | 17-Mar-2021 00:34:00 | 5.6590e+04 | 5.6600e+04 | 5.6548e+04 | 5.6564e+04 | 1.5328 |
| 36 | 17-Mar-2021 00:35:00 | 5.6557e+04 | 5.6606e+04 | 5.6545e+04 | 5.6604e+04 | 2.1806 |
| 37 | 17-Mar-2021 00:36:00 | 5.6602e+04 | 5.6640e+04 | 5.6573e+04 | 5.6573e+04 | 4.2177 |
| 38 | 17-Mar-2021 00:37:00 | 5.6565e+04 | 5.6574e+04 | 5.6486e+04 | 5.6486e+04 | 0.8632 |
| 39 | 17-Mar-2021 00:38:00 | 5.6476e+04 | 5.6483e+04 | 5.6429e+04 | 5.6429e+04 | 0.0751 |
| 40 | 17-Mar-2021 00:39:00 | 5.6425e+04 | 5.6601e+04 | 5.6425e+04 | 5.6601e+04 | 2.1780 |
| 41 | 17-Mar-2021 00:40:00 | 5.6586e+04 | 5.6603e+04 | 5.6541e+04 | 5.6547e+04 | 0.6638 |
| 42 | 17-Mar-2021 00:41:00 | 5.6522e+04 | 5.6556e+04 | 5.6516e+04 | 5.6516e+04 | 0.3547 |
| 43 | 17-Mar-2021 00:42:00 | 5.6478e+04 | 5.6498e+04 | 5.6462e+04 | 5.6462e+04 | 0.2020 |
| 44 | 17-Mar-2021 00:43:00 | 5.6455e+04 | 5.6492e+04 | 5.6442e+04 | 5.6492e+04 | 1.3862 |
| 45 | 17-Mar-2021 00:44:00 | 5.6484e+04 | 5.6487e+04 | 5.6466e+04 | 5.6487e+04 | 0.6350 |
| 46 | 17-Mar-2021 00:45:00 | 5.6540e+04 | 5.6546e+04 | 5.6496e+04 | 5.6509e+04 | 0.2570 |
| 47 | 17-Mar-2021 00:46:00 | 5.6516e+04 | 5.6538e+04 | 5.6490e+04 | 5.6516e+04 | 0.5327 |
| 48 | 17-Mar-2021 00:47:00 | 5.6495e+04 | 5.6495e+04 | 56400 | 56400 | 3.9557 |
| 49 | 17-Mar-2021 00:48:00 | 56400 | 56400 | 5.6304e+04 | 5.6341e+04 | 1.8815 |
| 50 | 17-Mar-2021 00:49:00 | 5.6372e+04 | 5.6374e+04 | 5.6372e+04 | 5.6374e+04 | 0.0701 |
| 51 | 17-Mar-2021 00:50:00 | 5.6425e+04 | 5.6428e+04 | 5.6348e+04 | 5.6392e+04 | 0.2851 |
| 52 | 17-Mar-2021 00:51:00 | 5.6374e+04 | 5.6458e+04 | 5.6369e+04 | 5.6401e+04 | 7.3220 |
| 53 | 17-Mar-2021 00:52:00 | 5.6435e+04 | 5.6465e+04 | 5.6379e+04 | 5.6407e+04 | 1.5508 |
| 54 | 17-Mar-2021 00:53:00 | 5.6446e+04 | 5.6446e+04 | 5.6386e+04 | 5.6392e+04 | 0.8589 |
| 55 | 17-Mar-2021 00:54:00 | 5.6397e+04 | 5.6426e+04 | 5.6397e+04 | 5.6409e+04 | 0.4701 |
| 56 | 17-Mar-2021 00:55:00 | 5.6428e+04 | 5.6479e+04 | 5.6423e+04 | 5.6467e+04 | 1.0259 |
| 57 | 17-Mar-2021 00:56:00 | 5.6442e+04 | 5.6442e+04 | 5.6404e+04 | 5.6404e+04 | 0.4875 |
| 58 | 17-Mar-2021 00:57:00 | 5.6416e+04 | 5.6465e+04 | 5.6416e+04 | 5.6461e+04 | 0.0276 |
| 59 | 17-Mar-2021 00:58:00 | 5.6489e+04 | 5.6620e+04 | 5.6489e+04 | 56572 | 5.7969 |
| 60 | 17-Mar-2021 00:59:00 | 5.6591e+04 | 5.6591e+04 | 5.6553e+04 | 5.6554e+04 | 0.2388 |
| 61 | 17-Mar-2021 01:00:00 | 5.6563e+04 | 5.6563e+04 | 5.6505e+04 | 5.6505e+04 | 0.5730 |
| 62 | 17-Mar-2021 01:01:00 | 5.6509e+04 | 5.6550e+04 | 5.6373e+04 | 5.6373e+04 | 1.9064 |
| 63 | 17-Mar-2021 01:02:00 | 5.6361e+04 | 5.6385e+04 | 56338 | 5.6385e+04 | 0.2408 |
| 64 | 17-Mar-2021 01:03:00 | 5.6382e+04 | 5.6478e+04 | 5.6382e+04 | 5.6472e+04 | 0.9928 |
| 65 | 17-Mar-2021 01:04:00 | 5.6470e+04 | 5.6470e+04 | 5.6421e+04 | 5.6421e+04 | 0.4300 |
| 66 | 17-Mar-2021 01:05:00 | 5.6421e+04 | 5.6462e+04 | 5.6417e+04 | 5.6455e+04 | 0.9065 |
| 67 | 17-Mar-2021 01:06:00 | 5.6462e+04 | 5.6507e+04 | 5.6462e+04 | 5.6493e+04 | 3.1484 |

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 68 | 17-Mar-2021 01:07:00 | 5.6513e+04 | 5.6513e+04 | 5.6482e+04 | 5.6482e+04 | 0.2734 |
| 69 | 17-Mar-2021 01:08:00 | 5.6482e+04 | 5.6531e+04 | 5.6482e+04 | 5.6521e+04 | 0.8352 |
| 70 | 17-Mar-2021 01:09:00 | 5.6503e+04 | 5.6556e+04 | 5.6503e+04 | 5.6556e+04 | 0.1540 |
| 71 | 17-Mar-2021 01:10:00 | 5.6543e+04 | 5.6543e+04 | 5.6469e+04 | 5.6469e+04 | 0.7590 |
| 72 | 17-Mar-2021 01:11:00 | 5.6467e+04 | 5.6519e+04 | 5.6467e+04 | 5.6500e+04 | 0.7378 |
| 73 | 17-Mar-2021 01:12:00 | 5.6475e+04 | 5.6501e+04 | 5.6461e+04 | 5.6466e+04 | 0.9920 |
| 74 | 17-Mar-2021 01:13:00 | 5.6419e+04 | 5.6481e+04 | 5.6407e+04 | 5.6407e+04 | 0.5994 |
| 75 | 17-Mar-2021 01:14:00 | 5.6407e+04 | 5.6446e+04 | 5.6396e+04 | 5.6425e+04 | 0.2350 |
| 76 | 17-Mar-2021 01:15:00 | 5.6400e+04 | 5.6402e+04 | 5.6327e+04 | 5.6327e+04 | 0.8526 |
| 77 | 17-Mar-2021 01:16:00 | 5.6331e+04 | 5.6337e+04 | 5.6326e+04 | 5.6330e+04 | 0.6516 |
| 78 | 17-Mar-2021 01:17:00 | 5.6348e+04 | 5.6377e+04 | 5.6346e+04 | 5.6346e+04 | 0.4292 |
| 79 | 17-Mar-2021 01:18:00 | 5.6355e+04 | 5.6355e+04 | 5.6154e+04 | 5.6171e+04 | 7.3241 |
| 80 | 17-Mar-2021 01:19:00 | 5.6170e+04 | 5.6200e+04 | 5.6063e+04 | 5.6188e+04 | 3.0062 |
| 81 | 17-Mar-2021 01:20:00 | 5.6163e+04 | 5.6230e+04 | 5.6163e+04 | 5.6230e+04 | 0.8522 |
| 82 | 17-Mar-2021 01:21:00 | 5.6238e+04 | 5.6278e+04 | 5.6210e+04 | 5.6278e+04 | 3.3718 |
| 83 | 17-Mar-2021 01:22:00 | 5.6283e+04 | 5.6321e+04 | 5.6283e+04 | 5.6318e+04 | 0.3024 |
| 84 | 17-Mar-2021 01:23:00 | 5.6321e+04 | 5.6335e+04 | 5.6270e+04 | 5.6272e+04 | 0.1260 |
| 85 | 17-Mar-2021 01:24:00 | 5.6267e+04 | 5.6315e+04 | 5.6251e+04 | 5.6296e+04 | 0.2969 |
| 86 | 17-Mar-2021 01:25:00 | 56309 | 5.6353e+04 | 5.6297e+04 | 5.6322e+04 | 0.4901 |
| 87 | 17-Mar-2021 01:26:00 | 5.6336e+04 | 5.6529e+04 | 5.6336e+04 | 5.6516e+04 | 2.9663 |
| 88 | 17-Mar-2021 01:27:00 | 5.6517e+04 | 5.6517e+04 | 5.6435e+04 | 5.6476e+04 | 0.6408 |
| 89 | 17-Mar-2021 01:28:00 | 5.6488e+04 | 5.6488e+04 | 5.6429e+04 | 5.6432e+04 | 1.4709 |
| 90 | 17-Mar-2021 01:29:00 | 5.6431e+04 | 5.6478e+04 | 5.6431e+04 | 5.6447e+04 | 1.1060 |
| 91 | 17-Mar-2021 01:30:00 | 5.6447e+04 | 5.6447e+04 | 56393 | 56393 | 0.3997 |
| 92 | 17-Mar-2021 01:31:00 | 5.6396e+04 | 5.6396e+04 | 5.6373e+04 | 5.6373e+04 | 0.5359 |
| 93 | 17-Mar-2021 01:32:00 | 5.6372e+04 | 5.6383e+04 | 5.6357e+04 | 5.6383e+04 | 0.4760 |
| 94 | 17-Mar-2021 01:33:00 | 5.6386e+04 | 5.6393e+04 | 5.6325e+04 | 5.6325e+04 | 2.0810 |
| 95 | 17-Mar-2021 01:34:00 | 5.6338e+04 | 5.6400e+04 | 5.6329e+04 | 5.6391e+04 | 1.3899 |
| 96 | 17-Mar-2021 01:35:00 | 5.6356e+04 | 5.6386e+04 | 5.6356e+04 | 5.6386e+04 | 0.4260 |
| 97 | 17-Mar-2021 01:36:00 | 5.6400e+04 | 5.6431e+04 | 56365 | 56365 | 3.9506 |
| 98 | 17-Mar-2021 01:37:00 | 5.6387e+04 | 5.6387e+04 | 5.6362e+04 | 5.6372e+04 | 0.3137 |
| 99 | 17-Mar-2021 01:38:00 | 5.6365e+04 | 5.6374e+04 | 5.6305e+04 | 5.6305e+04 | 0.2358 |
| 100 | 17-Mar-2021 01:39:00 | 5.6303e+04 | 5.6303e+04 | 5.6249e+04 | 5.6254e+04 | 0.4883 |

```
    ⋮
```

```
%outliers = outlier(BitcoinData.Close)

%Rerun model to check for more outliers
Y = BitcoinData{:,"Close"}
```

```
Y = 10065×1
10^4 ×
    5.7128
    5.7150
    5.7104
    5.7109
    5.7005
    5.6926
    5.6905
    5.6856
    5.6941
    5.6964
     ⋮
```

```
X = BitcoinData{:,[1:3]}
```

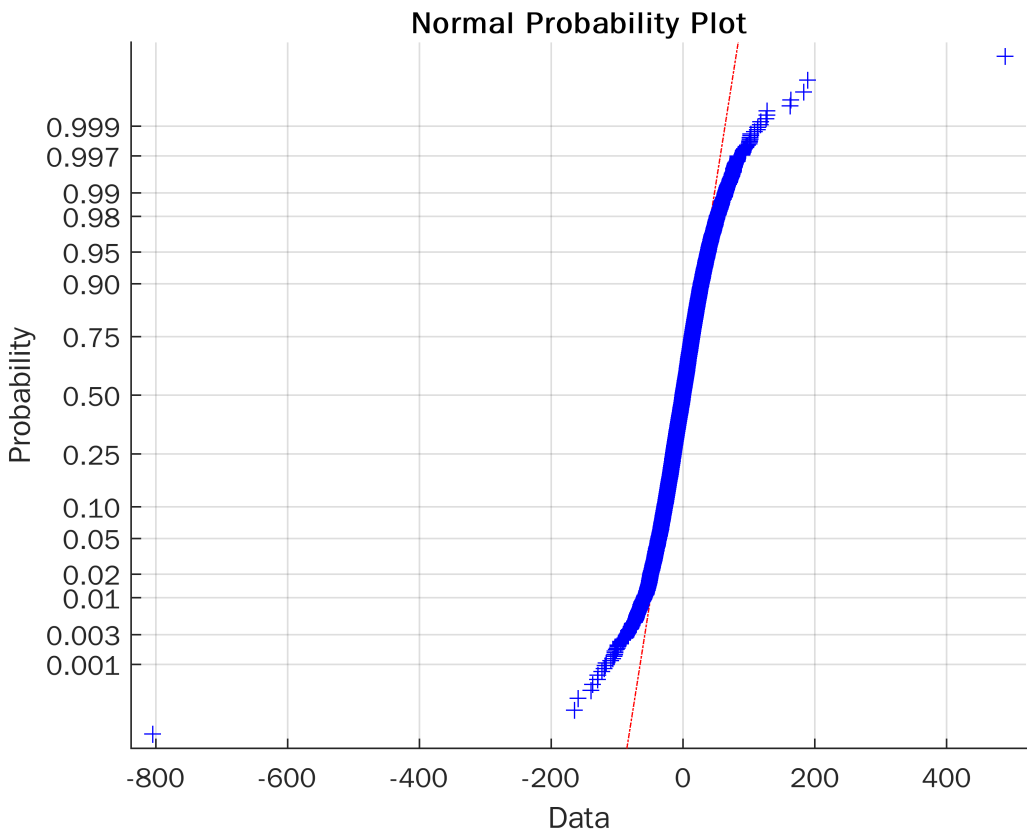
```
X = 10065×3
10^4 ×
    5.6928    5.7150    5.6908
    5.7079    5.7198    5.7035
    5.7149    5.7183    5.7010
    5.7096    5.7158    5.7071
    5.7112    5.7112    5.7000
    5.7074    5.7074    5.6926
    5.6940    5.6965    5.6890
    5.6905    5.6913    5.6838
    5.6858    5.6970    5.6855
    5.6928    5.6985    5.6918
     ⋮
```

```
LRPre = fitlm(zscore(X),Y)
```

```
LRPre =
Linear regression model:
    y ~ 1 + x1 + x2 + x3

Estimated Coefficients:
                   Estimate      SE         tStat       pValue
                   ________    _______    __________    ______

    (Intercept)      57216     0.25726    2.2241e+05      0
    x1             -796.38     11.701       -68.061      0
    x2              1184.4     10.139        116.82      0
    x3                1166     9.7543        119.54      0


Number of observations: 10065, Error degrees of freedom: 10061
Root Mean Squared Error: 25.8
```

```
R-squared: 1,  Adjusted R-Squared: 1
F-statistic vs. constant model: 1.22e+07, p-value = 0
```

```
normplot(LRPre.Residuals.Raw)
```




```
idx = isoutlier(BitcoinData.Close)
```

```
idx = 10065×1 logical array
   0
   0
   0
   0
   0
   0
   0
   0
   0
   0
     ⋮
```

```
sum(idx)
```

```
ans = 0
```

```
BitcoinData(idx,:) = []
```

```
BitcoinData = 10065×7 timetable
                                                                    ...
```

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 1 | 17-Mar-2021 00:00:00 | 5.6928e+04 | 57150 | 5.6908e+04 | 5.7128e+04 | 8.8224 |
| 2 | 17-Mar-2021 00:01:00 | 5.7079e+04 | 5.7198e+04 | 5.7035e+04 | 5.7150e+04 | 3.4603 |
| 3 | 17-Mar-2021 00:02:00 | 5.7149e+04 | 5.7183e+04 | 5.7010e+04 | 5.7104e+04 | 6.1158 |
| 4 | 17-Mar-2021 00:03:00 | 5.7096e+04 | 5.7158e+04 | 5.7071e+04 | 5.7109e+04 | 5.0098 |
| 5 | 17-Mar-2021 00:04:00 | 5.7112e+04 | 5.7112e+04 | 5.7000e+04 | 5.7005e+04 | 1.8366 |
| 6 | 17-Mar-2021 00:05:00 | 5.7074e+04 | 5.7074e+04 | 56926 | 56926 | 5.0145 |
| 7 | 17-Mar-2021 00:06:00 | 5.6940e+04 | 5.6965e+04 | 56890 | 5.6905e+04 | 7.5988 |
| 8 | 17-Mar-2021 00:07:00 | 5.6905e+04 | 5.6913e+04 | 5.6838e+04 | 5.6856e+04 | 2.4279 |
| 9 | 17-Mar-2021 00:08:00 | 5.6858e+04 | 5.6970e+04 | 5.6855e+04 | 5.6941e+04 | 1.5963 |
| 10 | 17-Mar-2021 00:09:00 | 5.6928e+04 | 5.6985e+04 | 5.6918e+04 | 5.6964e+04 | 3.3036 |
| 11 | 17-Mar-2021 00:10:00 | 5.6988e+04 | 5.6988e+04 | 5.6922e+04 | 5.6936e+04 | 1.4131 |
| 12 | 17-Mar-2021 00:11:00 | 5.6946e+04 | 5.6948e+04 | 5.6804e+04 | 5.6840e+04 | 11.8668 |
| 13 | 17-Mar-2021 00:12:00 | 5.6810e+04 | 5.6810e+04 | 5.6690e+04 | 5.6699e+04 | 0.7883 |
| 14 | 17-Mar-2021 00:13:00 | 5.6699e+04 | 5.6699e+04 | 5.6597e+04 | 5.6598e+04 | 7.9133 |
| 15 | 17-Mar-2021 00:14:00 | 5.6591e+04 | 5.6763e+04 | 5.6591e+04 | 5.6613e+04 | 4.2553 |
| 16 | 17-Mar-2021 00:15:00 | 5.6680e+04 | 5.6737e+04 | 5.6680e+04 | 5.6717e+04 | 0.4147 |
| 17 | 17-Mar-2021 00:16:00 | 5.6717e+04 | 5.6719e+04 | 5.6664e+04 | 5.6717e+04 | 0.5128 |
| 18 | 17-Mar-2021 00:17:00 | 5.6741e+04 | 5.6768e+04 | 5.6667e+04 | 5.6667e+04 | 0.6093 |
| 19 | 17-Mar-2021 00:18:00 | 5.6670e+04 | 5.6708e+04 | 5.6628e+04 | 5.6701e+04 | 2.5378 |
| 20 | 17-Mar-2021 00:19:00 | 5.6706e+04 | 5.6719e+04 | 5.6671e+04 | 5.6711e+04 | 3.0139 |
| 21 | 17-Mar-2021 00:20:00 | 5.6671e+04 | 5.6757e+04 | 5.6671e+04 | 5.6753e+04 | 1.7076 |
| 22 | 17-Mar-2021 00:21:00 | 5.6750e+04 | 5.6775e+04 | 5.6665e+04 | 5.6665e+04 | 9.0640 |
| 23 | 17-Mar-2021 00:22:00 | 5.6676e+04 | 5.6689e+04 | 56540 | 5.6542e+04 | 17.0034 |
| 24 | 17-Mar-2021 00:23:00 | 5.6502e+04 | 5.6566e+04 | 5.6488e+04 | 5.6492e+04 | 1.6817 |
| 25 | 17-Mar-2021 00:24:00 | 5.6488e+04 | 5.6530e+04 | 5.6488e+04 | 5.6503e+04 | 0.1477 |
| 26 | 17-Mar-2021 00:25:00 | 5.6503e+04 | 5.6521e+04 | 5.6435e+04 | 5.6462e+04 | 1.6796 |
| 27 | 17-Mar-2021 00:26:00 | 5.6446e+04 | 5.6481e+04 | 5.6406e+04 | 5.6471e+04 | 0.9282 |
| 28 | 17-Mar-2021 00:27:00 | 5.6462e+04 | 5.6462e+04 | 5.6392e+04 | 5.6418e+04 | 1.0664 |
| 29 | 17-Mar-2021 00:28:00 | 5.6410e+04 | 5.6479e+04 | 56400 | 5.6461e+04 | 2.0418 |
| 30 | 17-Mar-2021 00:29:00 | 5.6460e+04 | 5.6461e+04 | 5.6391e+04 | 5.6434e+04 | 1.0734 |
| 31 | 17-Mar-2021 00:30:00 | 5.6399e+04 | 5.6513e+04 | 5.6399e+04 | 5.6513e+04 | 0.4380 |
| 32 | 17-Mar-2021 00:31:00 | 5.6560e+04 | 5.6676e+04 | 5.6550e+04 | 5.6602e+04 | 1.9544 |
| 33 | 17-Mar-2021 00:32:00 | 5.6579e+04 | 56679 | 5.6579e+04 | 5.6643e+04 | 1.0486 |

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 34 | 17-Mar-2021 00:33:00 | 5.6637e+04 | 5.6664e+04 | 5.6559e+04 | 5.6590e+04 | 4.4152 |
| 35 | 17-Mar-2021 00:34:00 | 5.6590e+04 | 5.6600e+04 | 5.6548e+04 | 5.6564e+04 | 1.5328 |
| 36 | 17-Mar-2021 00:35:00 | 5.6557e+04 | 5.6606e+04 | 5.6545e+04 | 5.6604e+04 | 2.1806 |
| 37 | 17-Mar-2021 00:36:00 | 5.6602e+04 | 5.6640e+04 | 5.6573e+04 | 5.6573e+04 | 4.2177 |
| 38 | 17-Mar-2021 00:37:00 | 5.6565e+04 | 5.6574e+04 | 5.6486e+04 | 5.6486e+04 | 0.8632 |
| 39 | 17-Mar-2021 00:38:00 | 5.6476e+04 | 5.6483e+04 | 5.6429e+04 | 5.6429e+04 | 0.0751 |
| 40 | 17-Mar-2021 00:39:00 | 5.6425e+04 | 5.6601e+04 | 5.6425e+04 | 5.6601e+04 | 2.1780 |
| 41 | 17-Mar-2021 00:40:00 | 5.6586e+04 | 5.6603e+04 | 5.6541e+04 | 5.6547e+04 | 0.6638 |
| 42 | 17-Mar-2021 00:41:00 | 5.6522e+04 | 5.6556e+04 | 5.6516e+04 | 5.6516e+04 | 0.3547 |
| 43 | 17-Mar-2021 00:42:00 | 5.6478e+04 | 5.6498e+04 | 5.6462e+04 | 5.6462e+04 | 0.2020 |
| 44 | 17-Mar-2021 00:43:00 | 5.6455e+04 | 5.6492e+04 | 5.6442e+04 | 5.6492e+04 | 1.3862 |
| 45 | 17-Mar-2021 00:44:00 | 5.6484e+04 | 5.6487e+04 | 5.6466e+04 | 5.6487e+04 | 0.6350 |
| 46 | 17-Mar-2021 00:45:00 | 5.6540e+04 | 5.6546e+04 | 5.6496e+04 | 5.6509e+04 | 0.2570 |
| 47 | 17-Mar-2021 00:46:00 | 5.6516e+04 | 5.6538e+04 | 5.6490e+04 | 5.6516e+04 | 0.5327 |
| 48 | 17-Mar-2021 00:47:00 | 5.6495e+04 | 5.6495e+04 | 56400 | 56400 | 3.9557 |
| 49 | 17-Mar-2021 00:48:00 | 56400 | 56400 | 5.6304e+04 | 5.6341e+04 | 1.8815 |
| 50 | 17-Mar-2021 00:49:00 | 5.6372e+04 | 5.6374e+04 | 5.6372e+04 | 5.6374e+04 | 0.0701 |
| 51 | 17-Mar-2021 00:50:00 | 5.6425e+04 | 5.6428e+04 | 5.6348e+04 | 5.6392e+04 | 0.2851 |
| 52 | 17-Mar-2021 00:51:00 | 5.6374e+04 | 5.6458e+04 | 5.6369e+04 | 5.6401e+04 | 7.3220 |
| 53 | 17-Mar-2021 00:52:00 | 5.6435e+04 | 5.6465e+04 | 5.6379e+04 | 5.6407e+04 | 1.5508 |
| 54 | 17-Mar-2021 00:53:00 | 5.6446e+04 | 5.6446e+04 | 5.6386e+04 | 5.6392e+04 | 0.8589 |
| 55 | 17-Mar-2021 00:54:00 | 5.6397e+04 | 5.6426e+04 | 5.6397e+04 | 5.6409e+04 | 0.4701 |
| 56 | 17-Mar-2021 00:55:00 | 5.6428e+04 | 5.6479e+04 | 5.6423e+04 | 5.6467e+04 | 1.0259 |
| 57 | 17-Mar-2021 00:56:00 | 5.6442e+04 | 5.6442e+04 | 5.6404e+04 | 5.6404e+04 | 0.4875 |
| 58 | 17-Mar-2021 00:57:00 | 5.6416e+04 | 5.6465e+04 | 5.6416e+04 | 5.6461e+04 | 0.0276 |
| 59 | 17-Mar-2021 00:58:00 | 5.6489e+04 | 5.6620e+04 | 5.6489e+04 | 56572 | 5.7969 |
| 60 | 17-Mar-2021 00:59:00 | 5.6591e+04 | 5.6591e+04 | 5.6553e+04 | 5.6554e+04 | 0.2388 |
| 61 | 17-Mar-2021 01:00:00 | 5.6563e+04 | 5.6563e+04 | 5.6505e+04 | 5.6505e+04 | 0.5730 |
| 62 | 17-Mar-2021 01:01:00 | 5.6509e+04 | 5.6550e+04 | 5.6373e+04 | 5.6373e+04 | 1.9064 |
| 63 | 17-Mar-2021 01:02:00 | 5.6361e+04 | 5.6385e+04 | 56338 | 5.6385e+04 | 0.2408 |
| 64 | 17-Mar-2021 01:03:00 | 5.6382e+04 | 5.6478e+04 | 5.6382e+04 | 5.6472e+04 | 0.9928 |
| 65 | 17-Mar-2021 01:04:00 | 5.6470e+04 | 5.6470e+04 | 5.6421e+04 | 5.6421e+04 | 0.4300 |
| 66 | 17-Mar-2021 01:05:00 | 5.6421e+04 | 5.6462e+04 | 5.6417e+04 | 5.6455e+04 | 0.9065 |

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 67 | 17-Mar-2021 01:06:00 | 5.6462e+04 | 5.6507e+04 | 5.6462e+04 | 5.6493e+04 | 3.1484 |
| 68 | 17-Mar-2021 01:07:00 | 5.6513e+04 | 5.6513e+04 | 5.6482e+04 | 5.6482e+04 | 0.2734 |
| 69 | 17-Mar-2021 01:08:00 | 5.6482e+04 | 5.6531e+04 | 5.6482e+04 | 5.6521e+04 | 0.8352 |
| 70 | 17-Mar-2021 01:09:00 | 5.6503e+04 | 5.6556e+04 | 5.6503e+04 | 5.6556e+04 | 0.1540 |
| 71 | 17-Mar-2021 01:10:00 | 5.6543e+04 | 5.6543e+04 | 5.6469e+04 | 5.6469e+04 | 0.7590 |
| 72 | 17-Mar-2021 01:11:00 | 5.6467e+04 | 5.6519e+04 | 5.6467e+04 | 5.6500e+04 | 0.7378 |
| 73 | 17-Mar-2021 01:12:00 | 5.6475e+04 | 5.6501e+04 | 5.6461e+04 | 5.6466e+04 | 0.9920 |
| 74 | 17-Mar-2021 01:13:00 | 5.6419e+04 | 5.6481e+04 | 5.6407e+04 | 5.6407e+04 | 0.5994 |
| 75 | 17-Mar-2021 01:14:00 | 5.6407e+04 | 5.6446e+04 | 5.6396e+04 | 5.6425e+04 | 0.2350 |
| 76 | 17-Mar-2021 01:15:00 | 5.6400e+04 | 5.6402e+04 | 5.6327e+04 | 5.6327e+04 | 0.8526 |
| 77 | 17-Mar-2021 01:16:00 | 5.6331e+04 | 5.6337e+04 | 5.6326e+04 | 5.6330e+04 | 0.6516 |
| 78 | 17-Mar-2021 01:17:00 | 5.6348e+04 | 5.6377e+04 | 5.6346e+04 | 5.6346e+04 | 0.4292 |
| 79 | 17-Mar-2021 01:18:00 | 5.6355e+04 | 5.6355e+04 | 5.6154e+04 | 5.6171e+04 | 7.3241 |
| 80 | 17-Mar-2021 01:19:00 | 5.6170e+04 | 5.6200e+04 | 5.6063e+04 | 5.6188e+04 | 3.0062 |
| 81 | 17-Mar-2021 01:20:00 | 5.6163e+04 | 5.6230e+04 | 5.6163e+04 | 5.6230e+04 | 0.8522 |
| 82 | 17-Mar-2021 01:21:00 | 5.6238e+04 | 5.6278e+04 | 5.6210e+04 | 5.6278e+04 | 3.3718 |
| 83 | 17-Mar-2021 01:22:00 | 5.6283e+04 | 5.6321e+04 | 5.6283e+04 | 5.6318e+04 | 0.3024 |
| 84 | 17-Mar-2021 01:23:00 | 5.6321e+04 | 5.6335e+04 | 5.6270e+04 | 5.6272e+04 | 0.1260 |
| 85 | 17-Mar-2021 01:24:00 | 5.6267e+04 | 5.6315e+04 | 5.6251e+04 | 5.6296e+04 | 0.2969 |
| 86 | 17-Mar-2021 01:25:00 | 56309 | 5.6353e+04 | 5.6297e+04 | 5.6322e+04 | 0.4901 |
| 87 | 17-Mar-2021 01:26:00 | 5.6336e+04 | 5.6529e+04 | 5.6336e+04 | 5.6516e+04 | 2.9663 |
| 88 | 17-Mar-2021 01:27:00 | 5.6517e+04 | 5.6517e+04 | 5.6435e+04 | 5.6476e+04 | 0.6408 |
| 89 | 17-Mar-2021 01:28:00 | 5.6488e+04 | 5.6488e+04 | 5.6429e+04 | 5.6432e+04 | 1.4709 |
| 90 | 17-Mar-2021 01:29:00 | 5.6431e+04 | 5.6478e+04 | 5.6431e+04 | 5.6447e+04 | 1.1060 |
| 91 | 17-Mar-2021 01:30:00 | 5.6447e+04 | 5.6447e+04 | 56393 | 56393 | 0.3997 |
| 92 | 17-Mar-2021 01:31:00 | 5.6396e+04 | 5.6396e+04 | 5.6373e+04 | 5.6373e+04 | 0.5359 |
| 93 | 17-Mar-2021 01:32:00 | 5.6372e+04 | 5.6383e+04 | 5.6357e+04 | 5.6383e+04 | 0.4760 |
| 94 | 17-Mar-2021 01:33:00 | 5.6386e+04 | 5.6393e+04 | 5.6325e+04 | 5.6325e+04 | 2.0810 |
| 95 | 17-Mar-2021 01:34:00 | 5.6338e+04 | 5.6400e+04 | 5.6329e+04 | 5.6391e+04 | 1.3899 |
| 96 | 17-Mar-2021 01:35:00 | 5.6356e+04 | 5.6386e+04 | 5.6356e+04 | 5.6386e+04 | 0.4260 |
| 97 | 17-Mar-2021 01:36:00 | 5.6400e+04 | 5.6431e+04 | 56365 | 56365 | 3.9506 |
| 98 | 17-Mar-2021 01:37:00 | 5.6387e+04 | 5.6387e+04 | 5.6362e+04 | 5.6372e+04 | 0.3137 |
| 99 | 17-Mar-2021 01:38:00 | 5.6365e+04 | 5.6374e+04 | 5.6305e+04 | 5.6305e+04 | 0.2358 |

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 100 | 17-Mar-2021 01:39:00 | 5.6303e+04 | 5.6303e+04 | 5.6249e+04 | 5.6254e+04 | 0.4883 |

⋮

```
%outliers = outlier(BitcoinData.Close)
```

## Split dataset into training and testing data

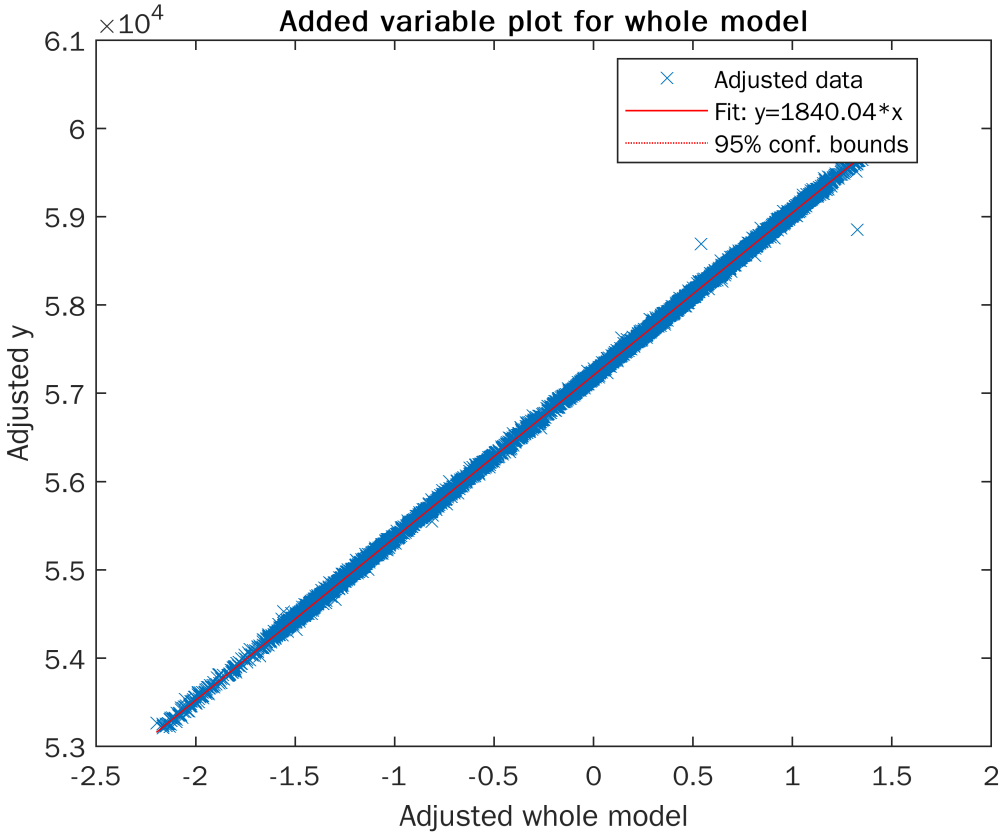
```
BitcoinData_new = [X, Y];

PD = 0.20;
cv = cvpartition(size(BitcoinData_new,1),'HoldOut',PD);
Xtrain = BitcoinData_new(cv.training,[1:end - 1]);
Ytrain = BitcoinData_new(cv.training,end);
Xtest = BitcoinData_new(cv.test, [1:end - 1]);
Ytest = BitcoinData_new(cv.test,end);
```

## Linear model with training-testing split

```
LRModel = fitlm(zscore(Xtrain),Ytrain)
```

```
LRModel = 
Linear regression model:
    y ~ 1 + x1 + x2 + x3

Estimated Coefficients:
                   Estimate      SE         tStat       pValue  
                   ________    _______    __________    _______

    (Intercept)      57204     0.29202    1.9589e+05      0    
    x1             -791.26      13.201        -59.94      0    
    x2              1172.8      11.385        103.01      0    
    x3              1176.5      11.024        106.72      0    


Number of observations: 8052, Error degrees of freedom: 8048
Root Mean Squared Error: 26.2
R-squared: 1,  Adjusted R-Squared: 1
F-statistic vs. constant model: 9.49e+06, p-value = 0
```

```
plot(LRModel)
```




```
LRModel.RMSE
```

```
ans = 26.2039
```

## Predict

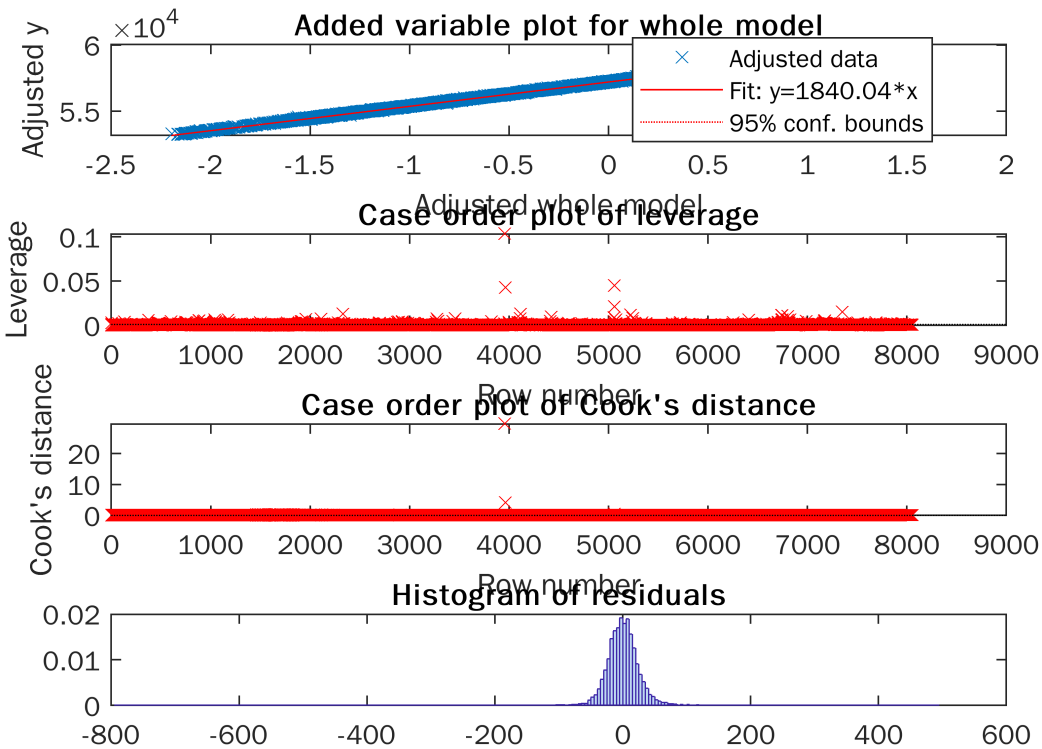
```
[YPred, Scores] = predict(LRModel,Xtest)
```

```
YPred = 2013×1
10^7 ×
    8.8975
    8.8909
    8.8810
    8.8431
    8.8434
    8.8406
    8.8217
    8.8149
    8.8177
    8.8058
      ⋮

Scores = 2013×2
10^7 ×
    8.8942    8.9008
    8.8876    8.8942
    8.8777    8.8842
    8.8398    8.8464
    8.8402    8.8467
    8.8373    8.8438
```

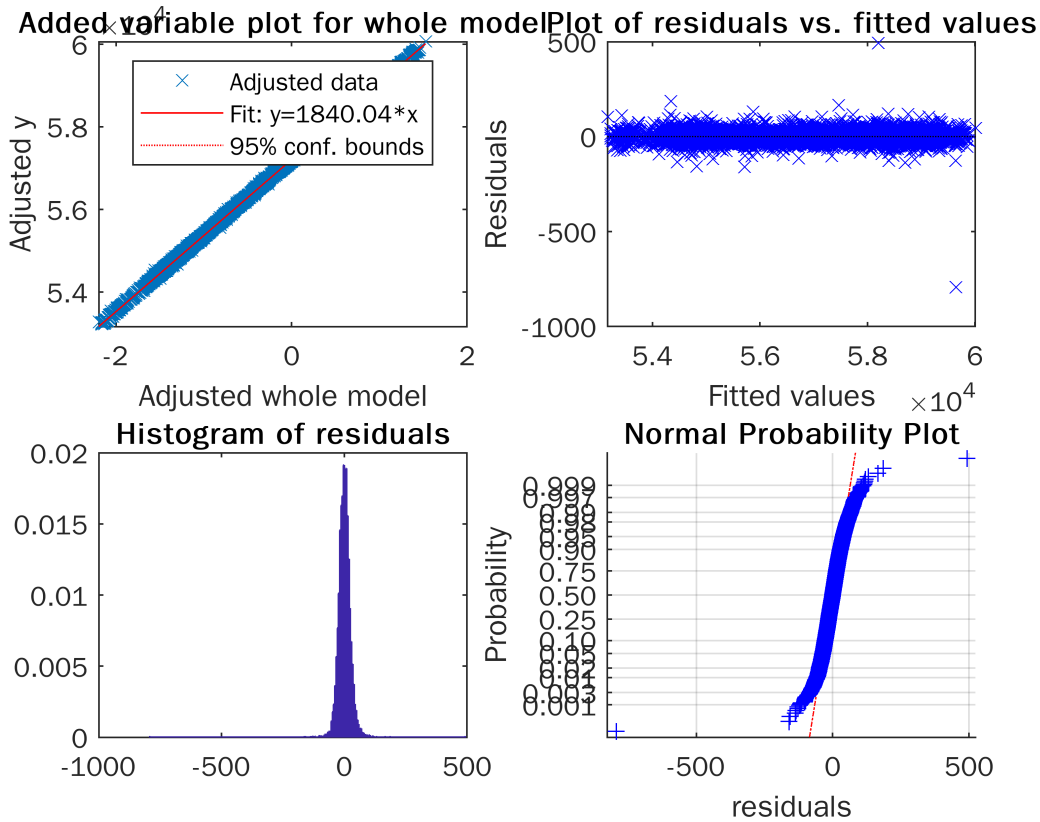
```
    8.8184    8.8249
    8.8116    8.8181
    8.8144    8.8209
    8.8025    8.8090
      ⋮
```

## Plots

```
figure,
subplot(4, 1, 1), plot(LRModel)
subplot(4, 1, 2), plotDiagnostics(LRModel)
subplot(4, 1, 3), plotDiagnostics(LRModel, 'cookd')
subplot(4, 1, 4), plotResiduals(LRModel)
```




```
figure,
subplot(2, 2, 1), plot(LRModel)
subplot(2, 2, 2), plotResiduals(LRModel,'fitted')
subplot(2, 2, 3), plotResiduals(LRModel)
subplot(2, 2, 4), normplot(LRModel.Residuals.Raw)
xlabel('residuals')
```


Added variable plot for whole model
Adjusted data
Fit: y=1840.04*x
95% conf. bounds
Adjusted y
Adjusted whole model
Plot of residuals vs. fitted values
Residuals
Fitted values
Histogram of residuals
Normal Probability Plot
Probability
residuals

## Upload the big dataset (>250MB) to MATLAB Drive and read table

```
BitcoinData = readtable('bitcoin-dataset.csv');
```

```
Warning: Column headers from the file were modified to make them valid MATLAB identifiers
before creating variable names for the table. The original column headers are saved in the
VariableDescriptions property.
Set 'VariableNamingRule' to 'preserve' to use the original column headers as table variable names.
```

```
Tablesize = size(BitcoinData)
```

```
Tablesize = 1×2
     4857377           8
```

```
head(BitcoinData,1)
```

```
ans = 1×8 table
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                
...
```

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 1 | 1.3253e+09 | 4.3900 | 4.3900 | 4.3900 | 4.3900 | 0.4556 |

## Convert timestamp

```
datetest = BitcoinData(:,1);
datetest = table2array(datetest);
BitcoinData.Timestamp = datetime(datetest, 'ConvertFrom', 'posixtime');
```

## Remove NaNs

```
% how many NaNs in each column
NaN2 = sum(isnan(BitcoinData.Open))
```

```
NaN2 = 1243608
```

```
NaN3 = sum(isnan(BitcoinData.High))
```

```
NaN3 = 1243608
```

```
NaN4 = sum(isnan(BitcoinData.Low))
```

```
NaN4 = 1243608
```

```
NaN5 = sum(isnan(BitcoinData.Close))
```

```
NaN5 = 1243608
```

```
NaN6 = sum(isnan(BitcoinData.Volume__BTC_))
```

```
NaN6 = 1243608
```

```
NaN7 = sum(isnan(BitcoinData.Volume__Currency_))
```

```
NaN7 = 1243608
```

```
NaN8 = sum(isnan(BitcoinData.Weighted_Price))
```

```
NaN8 = 1243608
```

```
% remove NaNs
BitcoinData = BitcoinData(isnan(BitcoinData.High) == 0,:);
```

## Select data

```
BitcoinDataTimetable = table2timetable(BitcoinData);

% March 2013
% S = timerange('17-Mar-2013 00:00:00','18-Mar-2013 23:59:00'); %2days
% S = timerange('17-Mar-2013 00:00:00','23-Mar-2013 23:59:00'); %7days
% S = timerange('17-Mar-2013 00:00:00','30-Mar-2013 23:59:00'); %14days

% March 2016
% S = timerange('17-Mar-2016 00:00:00','18-Mar-2016 23:59:00'); %2days
% S = timerange('17-Mar-2016 00:00:00','23-Mar-2016 23:59:00'); %7days
% S = timerange('17-Mar-2016 00:00:00','30-Mar-2016 23:59:00'); %14days

% March 2019
% S = timerange('17-Mar-2019 00:00:00','18-Mar-2019 23:59:00'); %2days
% S = timerange('17-Mar-2019 00:00:00','23-Mar-2019 23:59:00'); %7days
% S = timerange('17-Mar-2019 00:00:00','30-Mar-2019 23:59:00'); %14days

% March 2021
% S = timerange('17-Mar-2021 00:00:00','18-Mar-2021 23:59:00'); %2days
% S = timerange('17-Mar-2021 00:00:00','23-Mar-2021 23:59:00'); %7days
 S = timerange('17-Mar-2021 00:00:00','30-Mar-2021 23:59:00'); %14days

BitcoinData = BitcoinDataTimetable(S,:);
Tablesize = size(BitcoinData)
```

```
Tablesize = 1×2
       20108           7
```

## Create model - preprocessing

```
% standardization, and Initial predictor set (matrix)

Y = BitcoinData{:,"Close"}
```

```
Y = 20108×1
10^4 ×
    5.7128
    5.7150
    5.7104
    5.7109
    5.7005
    5.6926
    5.6905
    5.6856
    5.6941
    5.6964
     ⋮
```

```
X = BitcoinData{:,[1:3]}
```

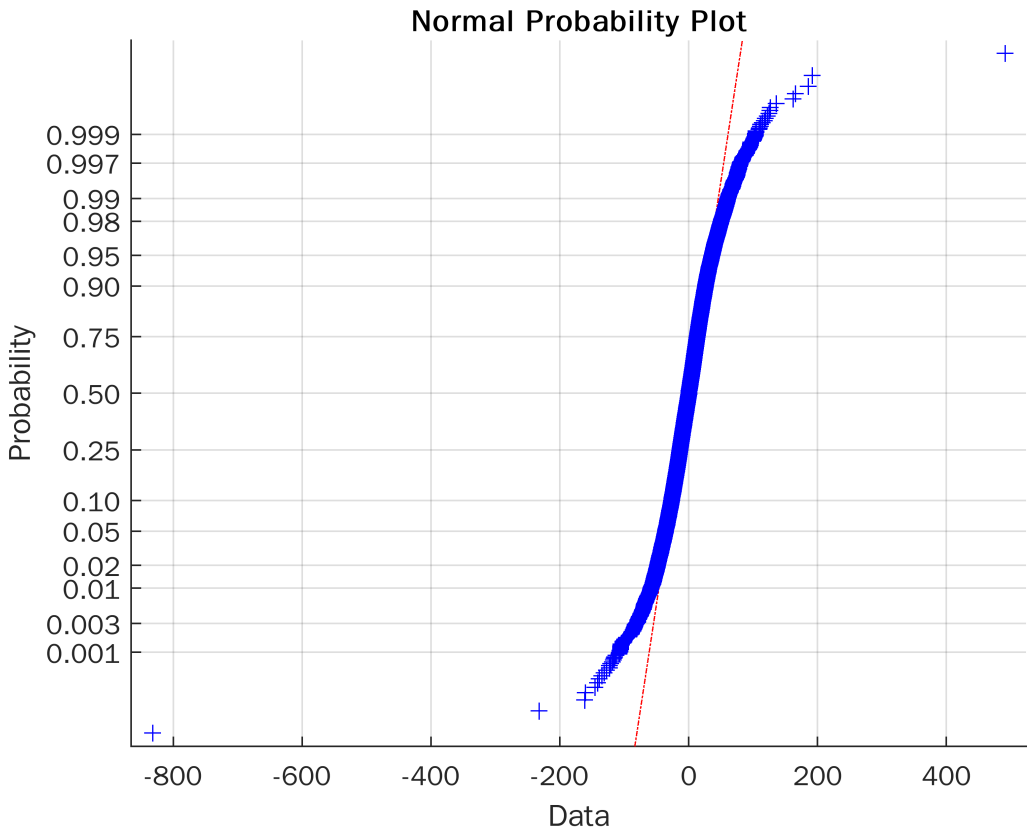
```
X = 20108×3
10^4 ×
    5.6928    5.7150    5.6908
    5.7079    5.7198    5.7035
    5.7149    5.7183    5.7010
    5.7096    5.7158    5.7071
```

```
    5.7112    5.7112    5.7000
    5.7074    5.7074    5.6926
    5.6940    5.6965    5.6890
    5.6905    5.6913    5.6838
    5.6858    5.6970    5.6855
    5.6928    5.6985    5.6918
     ⋮
```

```
%Check model for outliers

LRPre = fitlm(zscore(X),Y)
```

```
LRPre = 
Linear regression model:
    y ~ 1 + x1 + x2 + x3

Estimated Coefficients:
                   Estimate      SE        tStat       pValue  
                   ________    ______    __________    ______  

    (Intercept)      56236     0.1697    3.3138e+05      0    
    x1             -1131.4     10.877       -104.02      0    
    x2              1653.2     9.2543        178.64      0    
    x3              1580.1     9.3217        169.51      0    


Number of observations: 20108, Error degrees of freedom: 20104
Root Mean Squared Error: 24.1
R-squared: 1,  Adjusted R-Squared: 1
F-statistic vs. constant model: 5.11e+07, p-value = 0
```

```
normplot(LRPre.Residuals.Raw)
```




## Identify and Remove Outliers

```
idx = isoutlier(BitcoinData.Close)
```

```
idx = 20108×1 logical array
   0
   0
   0
   0
   0
   0
   0
   0
   0
   0
   ⋮
```

```
sum(idx)
```

```
ans = 0
```

```
BitcoinData(idx,:) = []
```

```
BitcoinData = 20108×7 timetable
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                
```
...
```

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 1 | 17-Mar-2021 00:00:00 | 5.6928e+04 | 57150 | 5.6908e+04 | 5.7128e+04 | 8.8224 |
```

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 2 | 17-Mar-2021 00:01:00 | 5.7079e+04 | 5.7198e+04 | 5.7035e+04 | 5.7150e+04 | 3.4603 |
| 3 | 17-Mar-2021 00:02:00 | 5.7149e+04 | 5.7183e+04 | 5.7010e+04 | 5.7104e+04 | 6.1158 |
| 4 | 17-Mar-2021 00:03:00 | 5.7096e+04 | 5.7158e+04 | 5.7071e+04 | 5.7109e+04 | 5.0098 |
| 5 | 17-Mar-2021 00:04:00 | 5.7112e+04 | 5.7112e+04 | 5.7000e+04 | 5.7005e+04 | 1.8366 |
| 6 | 17-Mar-2021 00:05:00 | 5.7074e+04 | 5.7074e+04 | 56926 | 56926 | 5.0145 |
| 7 | 17-Mar-2021 00:06:00 | 5.6940e+04 | 5.6965e+04 | 56890 | 5.6905e+04 | 7.5988 |
| 8 | 17-Mar-2021 00:07:00 | 5.6905e+04 | 5.6913e+04 | 5.6838e+04 | 5.6856e+04 | 2.4279 |
| 9 | 17-Mar-2021 00:08:00 | 5.6858e+04 | 5.6970e+04 | 5.6855e+04 | 5.6941e+04 | 1.5963 |
| 10 | 17-Mar-2021 00:09:00 | 5.6928e+04 | 5.6985e+04 | 5.6918e+04 | 5.6964e+04 | 3.3036 |
| 11 | 17-Mar-2021 00:10:00 | 5.6988e+04 | 5.6988e+04 | 5.6922e+04 | 5.6936e+04 | 1.4131 |
| 12 | 17-Mar-2021 00:11:00 | 5.6946e+04 | 5.6948e+04 | 5.6804e+04 | 5.6840e+04 | 11.8668 |
| 13 | 17-Mar-2021 00:12:00 | 5.6810e+04 | 5.6810e+04 | 5.6690e+04 | 5.6699e+04 | 0.7883 |
| 14 | 17-Mar-2021 00:13:00 | 5.6699e+04 | 5.6699e+04 | 5.6597e+04 | 5.6598e+04 | 7.9133 |
| 15 | 17-Mar-2021 00:14:00 | 5.6591e+04 | 5.6763e+04 | 5.6591e+04 | 5.6613e+04 | 4.2553 |
| 16 | 17-Mar-2021 00:15:00 | 5.6680e+04 | 5.6737e+04 | 5.6680e+04 | 5.6717e+04 | 0.4147 |
| 17 | 17-Mar-2021 00:16:00 | 5.6717e+04 | 5.6719e+04 | 5.6664e+04 | 5.6717e+04 | 0.5128 |
| 18 | 17-Mar-2021 00:17:00 | 5.6741e+04 | 5.6768e+04 | 5.6667e+04 | 5.6667e+04 | 0.6093 |
| 19 | 17-Mar-2021 00:18:00 | 5.6670e+04 | 5.6708e+04 | 5.6628e+04 | 5.6701e+04 | 2.5378 |
| 20 | 17-Mar-2021 00:19:00 | 5.6706e+04 | 5.6719e+04 | 5.6671e+04 | 5.6711e+04 | 3.0139 |
| 21 | 17-Mar-2021 00:20:00 | 5.6671e+04 | 5.6757e+04 | 5.6671e+04 | 5.6753e+04 | 1.7076 |
| 22 | 17-Mar-2021 00:21:00 | 5.6750e+04 | 5.6775e+04 | 5.6665e+04 | 5.6665e+04 | 9.0640 |
| 23 | 17-Mar-2021 00:22:00 | 5.6676e+04 | 5.6689e+04 | 56540 | 5.6542e+04 | 17.0034 |
| 24 | 17-Mar-2021 00:23:00 | 5.6502e+04 | 5.6566e+04 | 5.6488e+04 | 5.6492e+04 | 1.6817 |
| 25 | 17-Mar-2021 00:24:00 | 5.6488e+04 | 5.6530e+04 | 5.6488e+04 | 5.6503e+04 | 0.1477 |
| 26 | 17-Mar-2021 00:25:00 | 5.6503e+04 | 5.6521e+04 | 5.6435e+04 | 5.6462e+04 | 1.6796 |
| 27 | 17-Mar-2021 00:26:00 | 5.6446e+04 | 5.6481e+04 | 5.6406e+04 | 5.6471e+04 | 0.9282 |
| 28 | 17-Mar-2021 00:27:00 | 5.6462e+04 | 5.6462e+04 | 5.6392e+04 | 5.6418e+04 | 1.0664 |
| 29 | 17-Mar-2021 00:28:00 | 5.6410e+04 | 5.6479e+04 | 56400 | 5.6461e+04 | 2.0418 |
| 30 | 17-Mar-2021 00:29:00 | 5.6460e+04 | 5.6461e+04 | 5.6391e+04 | 5.6434e+04 | 1.0734 |
| 31 | 17-Mar-2021 00:30:00 | 5.6399e+04 | 5.6513e+04 | 5.6399e+04 | 5.6513e+04 | 0.4380 |
| 32 | 17-Mar-2021 00:31:00 | 5.6560e+04 | 5.6676e+04 | 5.6550e+04 | 5.6602e+04 | 1.9544 |
| 33 | 17-Mar-2021 00:32:00 | 5.6579e+04 | 56679 | 5.6579e+04 | 5.6643e+04 | 1.0486 |
| 34 | 17-Mar-2021 00:33:00 | 5.6637e+04 | 5.6664e+04 | 5.6559e+04 | 5.6590e+04 | 4.4152 |

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 35 | 17-Mar-2021 00:34:00 | 5.6590e+04 | 5.6600e+04 | 5.6548e+04 | 5.6564e+04 | 1.5328 |
| 36 | 17-Mar-2021 00:35:00 | 5.6557e+04 | 5.6606e+04 | 5.6545e+04 | 5.6604e+04 | 2.1806 |
| 37 | 17-Mar-2021 00:36:00 | 5.6602e+04 | 5.6640e+04 | 5.6573e+04 | 5.6573e+04 | 4.2177 |
| 38 | 17-Mar-2021 00:37:00 | 5.6565e+04 | 5.6574e+04 | 5.6486e+04 | 5.6486e+04 | 0.8632 |
| 39 | 17-Mar-2021 00:38:00 | 5.6476e+04 | 5.6483e+04 | 5.6429e+04 | 5.6429e+04 | 0.0751 |
| 40 | 17-Mar-2021 00:39:00 | 5.6425e+04 | 5.6601e+04 | 5.6425e+04 | 5.6601e+04 | 2.1780 |
| 41 | 17-Mar-2021 00:40:00 | 5.6586e+04 | 5.6603e+04 | 5.6541e+04 | 5.6547e+04 | 0.6638 |
| 42 | 17-Mar-2021 00:41:00 | 5.6522e+04 | 5.6556e+04 | 5.6516e+04 | 5.6516e+04 | 0.3547 |
| 43 | 17-Mar-2021 00:42:00 | 5.6478e+04 | 5.6498e+04 | 5.6462e+04 | 5.6462e+04 | 0.2020 |
| 44 | 17-Mar-2021 00:43:00 | 5.6455e+04 | 5.6492e+04 | 5.6442e+04 | 5.6492e+04 | 1.3862 |
| 45 | 17-Mar-2021 00:44:00 | 5.6484e+04 | 5.6487e+04 | 5.6466e+04 | 5.6487e+04 | 0.6350 |
| 46 | 17-Mar-2021 00:45:00 | 5.6540e+04 | 5.6546e+04 | 5.6496e+04 | 5.6509e+04 | 0.2570 |
| 47 | 17-Mar-2021 00:46:00 | 5.6516e+04 | 5.6538e+04 | 5.6490e+04 | 5.6516e+04 | 0.5327 |
| 48 | 17-Mar-2021 00:47:00 | 5.6495e+04 | 5.6495e+04 | 56400 | 56400 | 3.9557 |
| 49 | 17-Mar-2021 00:48:00 | 56400 | 56400 | 5.6304e+04 | 5.6341e+04 | 1.8815 |
| 50 | 17-Mar-2021 00:49:00 | 5.6372e+04 | 5.6374e+04 | 5.6372e+04 | 5.6374e+04 | 0.0701 |
| 51 | 17-Mar-2021 00:50:00 | 5.6425e+04 | 5.6428e+04 | 5.6348e+04 | 5.6392e+04 | 0.2851 |
| 52 | 17-Mar-2021 00:51:00 | 5.6374e+04 | 5.6458e+04 | 5.6369e+04 | 5.6401e+04 | 7.3220 |
| 53 | 17-Mar-2021 00:52:00 | 5.6435e+04 | 5.6465e+04 | 5.6379e+04 | 5.6407e+04 | 1.5508 |
| 54 | 17-Mar-2021 00:53:00 | 5.6446e+04 | 5.6446e+04 | 5.6386e+04 | 5.6392e+04 | 0.8589 |
| 55 | 17-Mar-2021 00:54:00 | 5.6397e+04 | 5.6426e+04 | 5.6397e+04 | 5.6409e+04 | 0.4701 |
| 56 | 17-Mar-2021 00:55:00 | 5.6428e+04 | 5.6479e+04 | 5.6423e+04 | 5.6467e+04 | 1.0259 |
| 57 | 17-Mar-2021 00:56:00 | 5.6442e+04 | 5.6442e+04 | 5.6404e+04 | 5.6404e+04 | 0.4875 |
| 58 | 17-Mar-2021 00:57:00 | 5.6416e+04 | 5.6465e+04 | 5.6416e+04 | 5.6461e+04 | 0.0276 |
| 59 | 17-Mar-2021 00:58:00 | 5.6489e+04 | 5.6620e+04 | 5.6489e+04 | 56572 | 5.7969 |
| 60 | 17-Mar-2021 00:59:00 | 5.6591e+04 | 5.6591e+04 | 5.6553e+04 | 5.6554e+04 | 0.2388 |
| 61 | 17-Mar-2021 01:00:00 | 5.6563e+04 | 5.6563e+04 | 5.6505e+04 | 5.6505e+04 | 0.5730 |
| 62 | 17-Mar-2021 01:01:00 | 5.6509e+04 | 5.6550e+04 | 5.6373e+04 | 5.6373e+04 | 1.9064 |
| 63 | 17-Mar-2021 01:02:00 | 5.6361e+04 | 5.6385e+04 | 56338 | 5.6385e+04 | 0.2408 |
| 64 | 17-Mar-2021 01:03:00 | 5.6382e+04 | 5.6478e+04 | 5.6382e+04 | 5.6472e+04 | 0.9928 |
| 65 | 17-Mar-2021 01:04:00 | 5.6470e+04 | 5.6470e+04 | 5.6421e+04 | 5.6421e+04 | 0.4300 |
| 66 | 17-Mar-2021 01:05:00 | 5.6421e+04 | 5.6462e+04 | 5.6417e+04 | 5.6455e+04 | 0.9065 |
| 67 | 17-Mar-2021 01:06:00 | 5.6462e+04 | 5.6507e+04 | 5.6462e+04 | 5.6493e+04 | 3.1484 |

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 68 | 17-Mar-2021 01:07:00 | 5.6513e+04 | 5.6513e+04 | 5.6482e+04 | 5.6482e+04 | 0.2734 |
| 69 | 17-Mar-2021 01:08:00 | 5.6482e+04 | 5.6531e+04 | 5.6482e+04 | 5.6521e+04 | 0.8352 |
| 70 | 17-Mar-2021 01:09:00 | 5.6503e+04 | 5.6556e+04 | 5.6503e+04 | 5.6556e+04 | 0.1540 |
| 71 | 17-Mar-2021 01:10:00 | 5.6543e+04 | 5.6543e+04 | 5.6469e+04 | 5.6469e+04 | 0.7590 |
| 72 | 17-Mar-2021 01:11:00 | 5.6467e+04 | 5.6519e+04 | 5.6467e+04 | 5.6500e+04 | 0.7378 |
| 73 | 17-Mar-2021 01:12:00 | 5.6475e+04 | 5.6501e+04 | 5.6461e+04 | 5.6466e+04 | 0.9920 |
| 74 | 17-Mar-2021 01:13:00 | 5.6419e+04 | 5.6481e+04 | 5.6407e+04 | 5.6407e+04 | 0.5994 |
| 75 | 17-Mar-2021 01:14:00 | 5.6407e+04 | 5.6446e+04 | 5.6396e+04 | 5.6425e+04 | 0.2350 |
| 76 | 17-Mar-2021 01:15:00 | 5.6400e+04 | 5.6402e+04 | 5.6327e+04 | 5.6327e+04 | 0.8526 |
| 77 | 17-Mar-2021 01:16:00 | 5.6331e+04 | 5.6337e+04 | 5.6326e+04 | 5.6330e+04 | 0.6516 |
| 78 | 17-Mar-2021 01:17:00 | 5.6348e+04 | 5.6377e+04 | 5.6346e+04 | 5.6346e+04 | 0.4292 |
| 79 | 17-Mar-2021 01:18:00 | 5.6355e+04 | 5.6355e+04 | 5.6154e+04 | 5.6171e+04 | 7.3241 |
| 80 | 17-Mar-2021 01:19:00 | 5.6170e+04 | 5.6200e+04 | 5.6063e+04 | 5.6188e+04 | 3.0062 |
| 81 | 17-Mar-2021 01:20:00 | 5.6163e+04 | 5.6230e+04 | 5.6163e+04 | 5.6230e+04 | 0.8522 |
| 82 | 17-Mar-2021 01:21:00 | 5.6238e+04 | 5.6278e+04 | 5.6210e+04 | 5.6278e+04 | 3.3718 |
| 83 | 17-Mar-2021 01:22:00 | 5.6283e+04 | 5.6321e+04 | 5.6283e+04 | 5.6318e+04 | 0.3024 |
| 84 | 17-Mar-2021 01:23:00 | 5.6321e+04 | 5.6335e+04 | 5.6270e+04 | 5.6272e+04 | 0.1260 |
| 85 | 17-Mar-2021 01:24:00 | 5.6267e+04 | 5.6315e+04 | 5.6251e+04 | 5.6296e+04 | 0.2969 |
| 86 | 17-Mar-2021 01:25:00 | 56309 | 5.6353e+04 | 5.6297e+04 | 5.6322e+04 | 0.4901 |
| 87 | 17-Mar-2021 01:26:00 | 5.6336e+04 | 5.6529e+04 | 5.6336e+04 | 5.6516e+04 | 2.9663 |
| 88 | 17-Mar-2021 01:27:00 | 5.6517e+04 | 5.6517e+04 | 5.6435e+04 | 5.6476e+04 | 0.6408 |
| 89 | 17-Mar-2021 01:28:00 | 5.6488e+04 | 5.6488e+04 | 5.6429e+04 | 5.6432e+04 | 1.4709 |
| 90 | 17-Mar-2021 01:29:00 | 5.6431e+04 | 5.6478e+04 | 5.6431e+04 | 5.6447e+04 | 1.1060 |
| 91 | 17-Mar-2021 01:30:00 | 5.6447e+04 | 5.6447e+04 | 56393 | 56393 | 0.3997 |
| 92 | 17-Mar-2021 01:31:00 | 5.6396e+04 | 5.6396e+04 | 5.6373e+04 | 5.6373e+04 | 0.5359 |
| 93 | 17-Mar-2021 01:32:00 | 5.6372e+04 | 5.6383e+04 | 5.6357e+04 | 5.6383e+04 | 0.4760 |
| 94 | 17-Mar-2021 01:33:00 | 5.6386e+04 | 5.6393e+04 | 5.6325e+04 | 5.6325e+04 | 2.0810 |
| 95 | 17-Mar-2021 01:34:00 | 5.6338e+04 | 5.6400e+04 | 5.6329e+04 | 5.6391e+04 | 1.3899 |
| 96 | 17-Mar-2021 01:35:00 | 5.6356e+04 | 5.6386e+04 | 5.6356e+04 | 5.6386e+04 | 0.4260 |
| 97 | 17-Mar-2021 01:36:00 | 5.6400e+04 | 5.6431e+04 | 56365 | 56365 | 3.9506 |
| 98 | 17-Mar-2021 01:37:00 | 5.6387e+04 | 5.6387e+04 | 5.6362e+04 | 5.6372e+04 | 0.3137 |
| 99 | 17-Mar-2021 01:38:00 | 5.6365e+04 | 5.6374e+04 | 5.6305e+04 | 5.6305e+04 | 0.2358 |
| 100 | 17-Mar-2021 01:39:00 | 5.6303e+04 | 5.6303e+04 | 5.6249e+04 | 5.6254e+04 | 0.4883 |

```
    ⋮
```

```
%outliers = outlier(BitcoinData.Close)

%Rerun model to check for more outliers
Y = BitcoinData{:,"Close"}
```

```
Y = 20108×1
10^4 ×
    5.7128
    5.7150
    5.7104
    5.7109
    5.7005
    5.6926
    5.6905
    5.6856
    5.6941
    5.6964
     ⋮
```

```
X = BitcoinData{:,[1:3]}
```

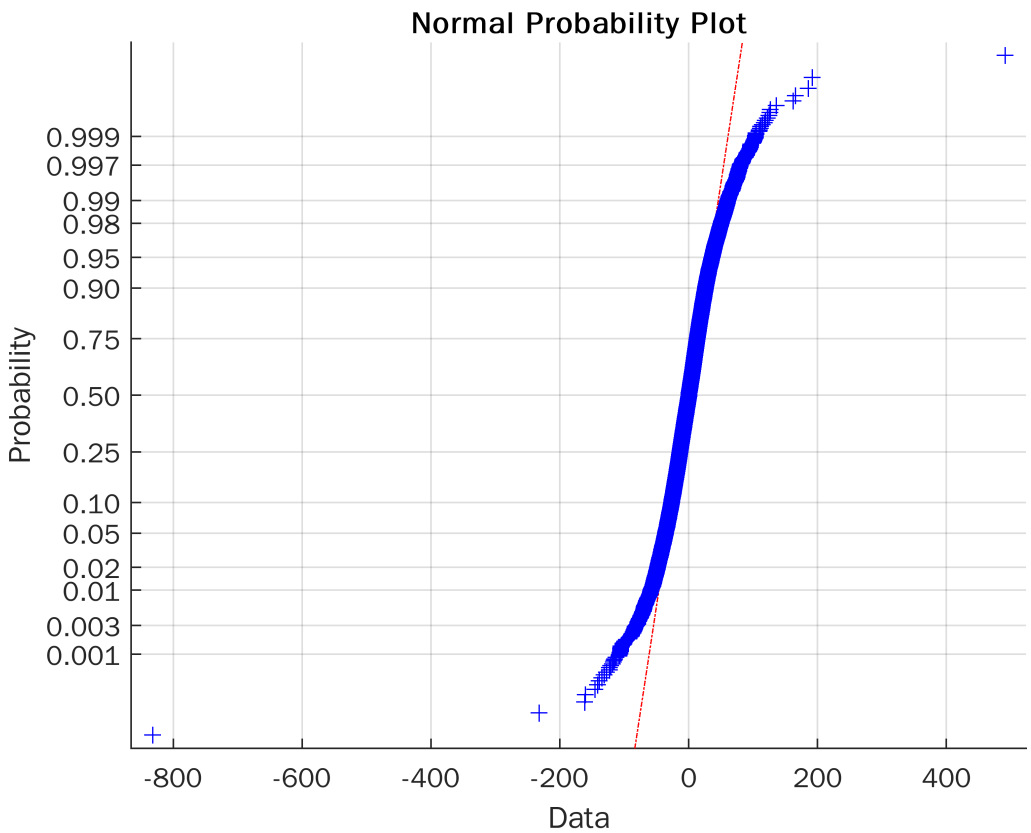
```
X = 20108×3
10^4 ×
    5.6928    5.7150    5.6908
    5.7079    5.7198    5.7035
    5.7149    5.7183    5.7010
    5.7096    5.7158    5.7071
    5.7112    5.7112    5.7000
    5.7074    5.7074    5.6926
    5.6940    5.6965    5.6890
    5.6905    5.6913    5.6838
    5.6858    5.6970    5.6855
    5.6928    5.6985    5.6918
     ⋮
```

```
LRPre = fitlm(zscore(X),Y)
```

```
LRPre =
Linear regression model:
    y ~ 1 + x1 + x2 + x3

Estimated Coefficients:
                   Estimate      SE        tStat       pValue
                   ________    ______    __________    ______

    (Intercept)      56236     0.1697    3.3138e+05      0
    x1             -1131.4     10.877       -104.02      0
    x2              1653.2     9.2543        178.64      0
    x3              1580.1     9.3217        169.51      0


Number of observations: 20108, Error degrees of freedom: 20104
Root Mean Squared Error: 24.1
```

```
R-squared: 1,  Adjusted R-Squared: 1
F-statistic vs. constant model: 5.11e+07, p-value = 0
```

```
normplot(LRPre.Residuals.Raw)
```




```
idx = isoutlier(BitcoinData.Close)
```

```
idx = 20108×1 logical array
   0
   0
   0
   0
   0
   0
   0
   0
   0
   0
     ⋮
```

```
sum(idx)
```

```
ans = 0
```

```
BitcoinData(idx,:) = []
```

```
BitcoinData = 20108×7 timetable
                                                                    ...
```

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 1 | 17-Mar-2021 00:00:00 | 5.6928e+04 | 57150 | 5.6908e+04 | 5.7128e+04 | 8.8224 |
| 2 | 17-Mar-2021 00:01:00 | 5.7079e+04 | 5.7198e+04 | 5.7035e+04 | 5.7150e+04 | 3.4603 |
| 3 | 17-Mar-2021 00:02:00 | 5.7149e+04 | 5.7183e+04 | 5.7010e+04 | 5.7104e+04 | 6.1158 |
| 4 | 17-Mar-2021 00:03:00 | 5.7096e+04 | 5.7158e+04 | 5.7071e+04 | 5.7109e+04 | 5.0098 |
| 5 | 17-Mar-2021 00:04:00 | 5.7112e+04 | 5.7112e+04 | 5.7000e+04 | 5.7005e+04 | 1.8366 |
| 6 | 17-Mar-2021 00:05:00 | 5.7074e+04 | 5.7074e+04 | 56926 | 56926 | 5.0145 |
| 7 | 17-Mar-2021 00:06:00 | 5.6940e+04 | 5.6965e+04 | 56890 | 5.6905e+04 | 7.5988 |
| 8 | 17-Mar-2021 00:07:00 | 5.6905e+04 | 5.6913e+04 | 5.6838e+04 | 5.6856e+04 | 2.4279 |
| 9 | 17-Mar-2021 00:08:00 | 5.6858e+04 | 5.6970e+04 | 5.6855e+04 | 5.6941e+04 | 1.5963 |
| 10 | 17-Mar-2021 00:09:00 | 5.6928e+04 | 5.6985e+04 | 5.6918e+04 | 5.6964e+04 | 3.3036 |
| 11 | 17-Mar-2021 00:10:00 | 5.6988e+04 | 5.6988e+04 | 5.6922e+04 | 5.6936e+04 | 1.4131 |
| 12 | 17-Mar-2021 00:11:00 | 5.6946e+04 | 5.6948e+04 | 5.6804e+04 | 5.6840e+04 | 11.8668 |
| 13 | 17-Mar-2021 00:12:00 | 5.6810e+04 | 5.6810e+04 | 5.6690e+04 | 5.6699e+04 | 0.7883 |
| 14 | 17-Mar-2021 00:13:00 | 5.6699e+04 | 5.6699e+04 | 5.6597e+04 | 5.6598e+04 | 7.9133 |
| 15 | 17-Mar-2021 00:14:00 | 5.6591e+04 | 5.6763e+04 | 5.6591e+04 | 5.6613e+04 | 4.2553 |
| 16 | 17-Mar-2021 00:15:00 | 5.6680e+04 | 5.6737e+04 | 5.6680e+04 | 5.6717e+04 | 0.4147 |
| 17 | 17-Mar-2021 00:16:00 | 5.6717e+04 | 5.6719e+04 | 5.6664e+04 | 5.6717e+04 | 0.5128 |
| 18 | 17-Mar-2021 00:17:00 | 5.6741e+04 | 5.6768e+04 | 5.6667e+04 | 5.6667e+04 | 0.6093 |
| 19 | 17-Mar-2021 00:18:00 | 5.6670e+04 | 5.6708e+04 | 5.6628e+04 | 5.6701e+04 | 2.5378 |
| 20 | 17-Mar-2021 00:19:00 | 5.6706e+04 | 5.6719e+04 | 5.6671e+04 | 5.6711e+04 | 3.0139 |
| 21 | 17-Mar-2021 00:20:00 | 5.6671e+04 | 5.6757e+04 | 5.6671e+04 | 5.6753e+04 | 1.7076 |
| 22 | 17-Mar-2021 00:21:00 | 5.6750e+04 | 5.6775e+04 | 5.6665e+04 | 5.6665e+04 | 9.0640 |
| 23 | 17-Mar-2021 00:22:00 | 5.6676e+04 | 5.6689e+04 | 56540 | 5.6542e+04 | 17.0034 |
| 24 | 17-Mar-2021 00:23:00 | 5.6502e+04 | 5.6566e+04 | 5.6488e+04 | 5.6492e+04 | 1.6817 |
| 25 | 17-Mar-2021 00:24:00 | 5.6488e+04 | 5.6530e+04 | 5.6488e+04 | 5.6503e+04 | 0.1477 |
| 26 | 17-Mar-2021 00:25:00 | 5.6503e+04 | 5.6521e+04 | 5.6435e+04 | 5.6462e+04 | 1.6796 |
| 27 | 17-Mar-2021 00:26:00 | 5.6446e+04 | 5.6481e+04 | 5.6406e+04 | 5.6471e+04 | 0.9282 |
| 28 | 17-Mar-2021 00:27:00 | 5.6462e+04 | 5.6462e+04 | 5.6392e+04 | 5.6418e+04 | 1.0664 |
| 29 | 17-Mar-2021 00:28:00 | 5.6410e+04 | 5.6479e+04 | 56400 | 5.6461e+04 | 2.0418 |
| 30 | 17-Mar-2021 00:29:00 | 5.6460e+04 | 5.6461e+04 | 5.6391e+04 | 5.6434e+04 | 1.0734 |
| 31 | 17-Mar-2021 00:30:00 | 5.6399e+04 | 5.6513e+04 | 5.6399e+04 | 5.6513e+04 | 0.4380 |
| 32 | 17-Mar-2021 00:31:00 | 5.6560e+04 | 5.6676e+04 | 5.6550e+04 | 5.6602e+04 | 1.9544 |
| 33 | 17-Mar-2021 00:32:00 | 5.6579e+04 | 56679 | 5.6579e+04 | 5.6643e+04 | 1.0486 |

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 34 | 17-Mar-2021 00:33:00 | 5.6637e+04 | 5.6664e+04 | 5.6559e+04 | 5.6590e+04 | 4.4152 |
| 35 | 17-Mar-2021 00:34:00 | 5.6590e+04 | 5.6600e+04 | 5.6548e+04 | 5.6564e+04 | 1.5328 |
| 36 | 17-Mar-2021 00:35:00 | 5.6557e+04 | 5.6606e+04 | 5.6545e+04 | 5.6604e+04 | 2.1806 |
| 37 | 17-Mar-2021 00:36:00 | 5.6602e+04 | 5.6640e+04 | 5.6573e+04 | 5.6573e+04 | 4.2177 |
| 38 | 17-Mar-2021 00:37:00 | 5.6565e+04 | 5.6574e+04 | 5.6486e+04 | 5.6486e+04 | 0.8632 |
| 39 | 17-Mar-2021 00:38:00 | 5.6476e+04 | 5.6483e+04 | 5.6429e+04 | 5.6429e+04 | 0.0751 |
| 40 | 17-Mar-2021 00:39:00 | 5.6425e+04 | 5.6601e+04 | 5.6425e+04 | 5.6601e+04 | 2.1780 |
| 41 | 17-Mar-2021 00:40:00 | 5.6586e+04 | 5.6603e+04 | 5.6541e+04 | 5.6547e+04 | 0.6638 |
| 42 | 17-Mar-2021 00:41:00 | 5.6522e+04 | 5.6556e+04 | 5.6516e+04 | 5.6516e+04 | 0.3547 |
| 43 | 17-Mar-2021 00:42:00 | 5.6478e+04 | 5.6498e+04 | 5.6462e+04 | 5.6462e+04 | 0.2020 |
| 44 | 17-Mar-2021 00:43:00 | 5.6455e+04 | 5.6492e+04 | 5.6442e+04 | 5.6492e+04 | 1.3862 |
| 45 | 17-Mar-2021 00:44:00 | 5.6484e+04 | 5.6487e+04 | 5.6466e+04 | 5.6487e+04 | 0.6350 |
| 46 | 17-Mar-2021 00:45:00 | 5.6540e+04 | 5.6546e+04 | 5.6496e+04 | 5.6509e+04 | 0.2570 |
| 47 | 17-Mar-2021 00:46:00 | 5.6516e+04 | 5.6538e+04 | 5.6490e+04 | 5.6516e+04 | 0.5327 |
| 48 | 17-Mar-2021 00:47:00 | 5.6495e+04 | 5.6495e+04 | 56400 | 56400 | 3.9557 |
| 49 | 17-Mar-2021 00:48:00 | 56400 | 56400 | 5.6304e+04 | 5.6341e+04 | 1.8815 |
| 50 | 17-Mar-2021 00:49:00 | 5.6372e+04 | 5.6374e+04 | 5.6372e+04 | 5.6374e+04 | 0.0701 |
| 51 | 17-Mar-2021 00:50:00 | 5.6425e+04 | 5.6428e+04 | 5.6348e+04 | 5.6392e+04 | 0.2851 |
| 52 | 17-Mar-2021 00:51:00 | 5.6374e+04 | 5.6458e+04 | 5.6369e+04 | 5.6401e+04 | 7.3220 |
| 53 | 17-Mar-2021 00:52:00 | 5.6435e+04 | 5.6465e+04 | 5.6379e+04 | 5.6407e+04 | 1.5508 |
| 54 | 17-Mar-2021 00:53:00 | 5.6446e+04 | 5.6446e+04 | 5.6386e+04 | 5.6392e+04 | 0.8589 |
| 55 | 17-Mar-2021 00:54:00 | 5.6397e+04 | 5.6426e+04 | 5.6397e+04 | 5.6409e+04 | 0.4701 |
| 56 | 17-Mar-2021 00:55:00 | 5.6428e+04 | 5.6479e+04 | 5.6423e+04 | 5.6467e+04 | 1.0259 |
| 57 | 17-Mar-2021 00:56:00 | 5.6442e+04 | 5.6442e+04 | 5.6404e+04 | 5.6404e+04 | 0.4875 |
| 58 | 17-Mar-2021 00:57:00 | 5.6416e+04 | 5.6465e+04 | 5.6416e+04 | 5.6461e+04 | 0.0276 |
| 59 | 17-Mar-2021 00:58:00 | 5.6489e+04 | 5.6620e+04 | 5.6489e+04 | 56572 | 5.7969 |
| 60 | 17-Mar-2021 00:59:00 | 5.6591e+04 | 5.6591e+04 | 5.6553e+04 | 5.6554e+04 | 0.2388 |
| 61 | 17-Mar-2021 01:00:00 | 5.6563e+04 | 5.6563e+04 | 5.6505e+04 | 5.6505e+04 | 0.5730 |
| 62 | 17-Mar-2021 01:01:00 | 5.6509e+04 | 5.6550e+04 | 5.6373e+04 | 5.6373e+04 | 1.9064 |
| 63 | 17-Mar-2021 01:02:00 | 5.6361e+04 | 5.6385e+04 | 56338 | 5.6385e+04 | 0.2408 |
| 64 | 17-Mar-2021 01:03:00 | 5.6382e+04 | 5.6478e+04 | 5.6382e+04 | 5.6472e+04 | 0.9928 |
| 65 | 17-Mar-2021 01:04:00 | 5.6470e+04 | 5.6470e+04 | 5.6421e+04 | 5.6421e+04 | 0.4300 |
| 66 | 17-Mar-2021 01:05:00 | 5.6421e+04 | 5.6462e+04 | 5.6417e+04 | 5.6455e+04 | 0.9065 |

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 67 | 17-Mar-2021 01:06:00 | 5.6462e+04 | 5.6507e+04 | 5.6462e+04 | 5.6493e+04 | 3.1484 |
| 68 | 17-Mar-2021 01:07:00 | 5.6513e+04 | 5.6513e+04 | 5.6482e+04 | 5.6482e+04 | 0.2734 |
| 69 | 17-Mar-2021 01:08:00 | 5.6482e+04 | 5.6531e+04 | 5.6482e+04 | 5.6521e+04 | 0.8352 |
| 70 | 17-Mar-2021 01:09:00 | 5.6503e+04 | 5.6556e+04 | 5.6503e+04 | 5.6556e+04 | 0.1540 |
| 71 | 17-Mar-2021 01:10:00 | 5.6543e+04 | 5.6543e+04 | 5.6469e+04 | 5.6469e+04 | 0.7590 |
| 72 | 17-Mar-2021 01:11:00 | 5.6467e+04 | 5.6519e+04 | 5.6467e+04 | 5.6500e+04 | 0.7378 |
| 73 | 17-Mar-2021 01:12:00 | 5.6475e+04 | 5.6501e+04 | 5.6461e+04 | 5.6466e+04 | 0.9920 |
| 74 | 17-Mar-2021 01:13:00 | 5.6419e+04 | 5.6481e+04 | 5.6407e+04 | 5.6407e+04 | 0.5994 |
| 75 | 17-Mar-2021 01:14:00 | 5.6407e+04 | 5.6446e+04 | 5.6396e+04 | 5.6425e+04 | 0.2350 |
| 76 | 17-Mar-2021 01:15:00 | 5.6400e+04 | 5.6402e+04 | 5.6327e+04 | 5.6327e+04 | 0.8526 |
| 77 | 17-Mar-2021 01:16:00 | 5.6331e+04 | 5.6337e+04 | 5.6326e+04 | 5.6330e+04 | 0.6516 |
| 78 | 17-Mar-2021 01:17:00 | 5.6348e+04 | 5.6377e+04 | 5.6346e+04 | 5.6346e+04 | 0.4292 |
| 79 | 17-Mar-2021 01:18:00 | 5.6355e+04 | 5.6355e+04 | 5.6154e+04 | 5.6171e+04 | 7.3241 |
| 80 | 17-Mar-2021 01:19:00 | 5.6170e+04 | 5.6200e+04 | 5.6063e+04 | 5.6188e+04 | 3.0062 |
| 81 | 17-Mar-2021 01:20:00 | 5.6163e+04 | 5.6230e+04 | 5.6163e+04 | 5.6230e+04 | 0.8522 |
| 82 | 17-Mar-2021 01:21:00 | 5.6238e+04 | 5.6278e+04 | 5.6210e+04 | 5.6278e+04 | 3.3718 |
| 83 | 17-Mar-2021 01:22:00 | 5.6283e+04 | 5.6321e+04 | 5.6283e+04 | 5.6318e+04 | 0.3024 |
| 84 | 17-Mar-2021 01:23:00 | 5.6321e+04 | 5.6335e+04 | 5.6270e+04 | 5.6272e+04 | 0.1260 |
| 85 | 17-Mar-2021 01:24:00 | 5.6267e+04 | 5.6315e+04 | 5.6251e+04 | 5.6296e+04 | 0.2969 |
| 86 | 17-Mar-2021 01:25:00 | 56309 | 5.6353e+04 | 5.6297e+04 | 5.6322e+04 | 0.4901 |
| 87 | 17-Mar-2021 01:26:00 | 5.6336e+04 | 5.6529e+04 | 5.6336e+04 | 5.6516e+04 | 2.9663 |
| 88 | 17-Mar-2021 01:27:00 | 5.6517e+04 | 5.6517e+04 | 5.6435e+04 | 5.6476e+04 | 0.6408 |
| 89 | 17-Mar-2021 01:28:00 | 5.6488e+04 | 5.6488e+04 | 5.6429e+04 | 5.6432e+04 | 1.4709 |
| 90 | 17-Mar-2021 01:29:00 | 5.6431e+04 | 5.6478e+04 | 5.6431e+04 | 5.6447e+04 | 1.1060 |
| 91 | 17-Mar-2021 01:30:00 | 5.6447e+04 | 5.6447e+04 | 56393 | 56393 | 0.3997 |
| 92 | 17-Mar-2021 01:31:00 | 5.6396e+04 | 5.6396e+04 | 5.6373e+04 | 5.6373e+04 | 0.5359 |
| 93 | 17-Mar-2021 01:32:00 | 5.6372e+04 | 5.6383e+04 | 5.6357e+04 | 5.6383e+04 | 0.4760 |
| 94 | 17-Mar-2021 01:33:00 | 5.6386e+04 | 5.6393e+04 | 5.6325e+04 | 5.6325e+04 | 2.0810 |
| 95 | 17-Mar-2021 01:34:00 | 5.6338e+04 | 5.6400e+04 | 5.6329e+04 | 5.6391e+04 | 1.3899 |
| 96 | 17-Mar-2021 01:35:00 | 5.6356e+04 | 5.6386e+04 | 5.6356e+04 | 5.6386e+04 | 0.4260 |
| 97 | 17-Mar-2021 01:36:00 | 5.6400e+04 | 5.6431e+04 | 56365 | 56365 | 3.9506 |
| 98 | 17-Mar-2021 01:37:00 | 5.6387e+04 | 5.6387e+04 | 5.6362e+04 | 5.6372e+04 | 0.3137 |
| 99 | 17-Mar-2021 01:38:00 | 5.6365e+04 | 5.6374e+04 | 5.6305e+04 | 5.6305e+04 | 0.2358 |

| | Timestamp | Open | High | Low | Close | Volume__BTC_ |
|---|---|---|---|---|---|---|
| 100 | 17-Mar-2021 01:39:00 | 5.6303e+04 | 5.6303e+04 | 5.6249e+04 | 5.6254e+04 | 0.4883 |

⋮

```
%outliers = outlier(BitcoinData.Close)
```

## Split dataset into training and testing data

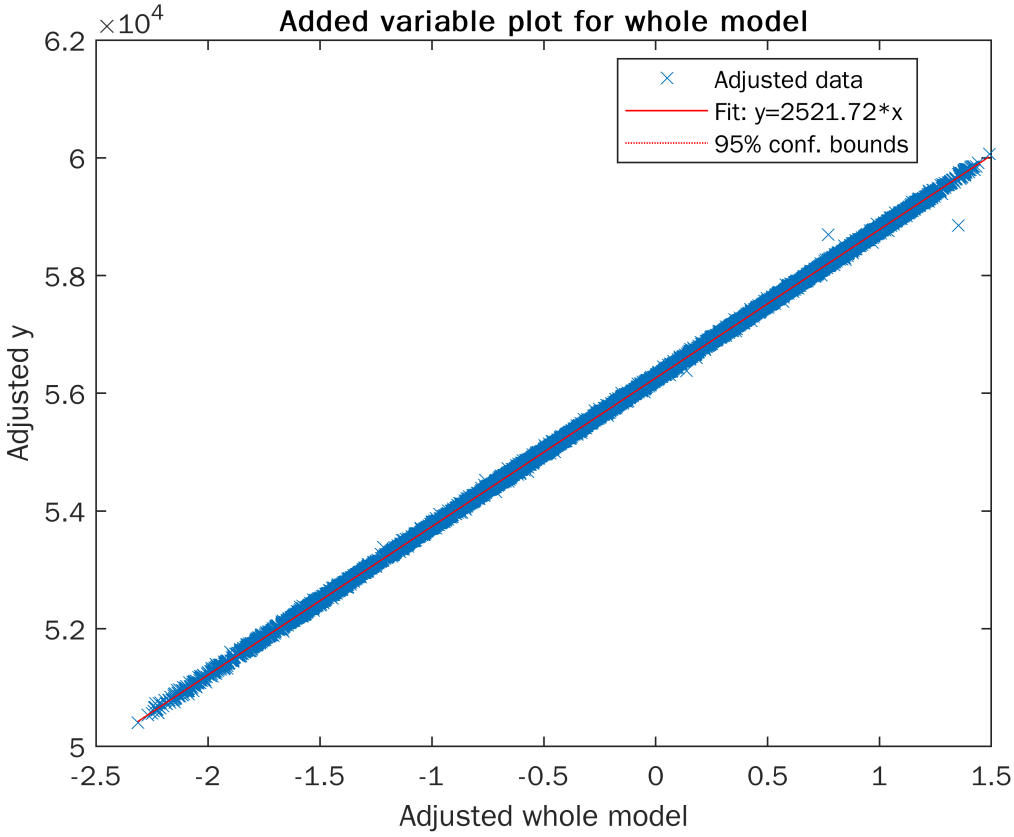
```
BitcoinData_new = [X, Y];

PD = 0.20;
cv = cvpartition(size(BitcoinData_new,1),'HoldOut',PD);
Xtrain = BitcoinData_new(cv.training,[1:end - 1]);
Ytrain = BitcoinData_new(cv.training,end);
Xtest = BitcoinData_new(cv.test, [1:end - 1]);
Ytest = BitcoinData_new(cv.test,end);
```

## Linear model with training-testing split

```
LRModel = fitlm(zscore(Xtrain),Ytrain)
```

```
LRModel = 
Linear regression model:
    y ~ 1 + x1 + x2 + x3

Estimated Coefficients:
                   Estimate       SE         tStat       pValue  
                   ________    _______    _________    ______  

    (Intercept)      56260     0.19162    2.936e+05       0    
    x1             -1105.7      12.266      -90.142       0    
    x2              1628.1      10.419       156.27       0    
    x3              1576.7      10.511          150       0    


Number of observations: 16087, Error degrees of freedom: 16083
Root Mean Squared Error: 24.3
R-squared: 1,  Adjusted R-Squared: 1
F-statistic vs. constant model: 4e+07, p-value = 0
```

```
plot(LRModel)
```




```
LRModel.RMSE
```

```
ans = 24.3038
```

## Predict

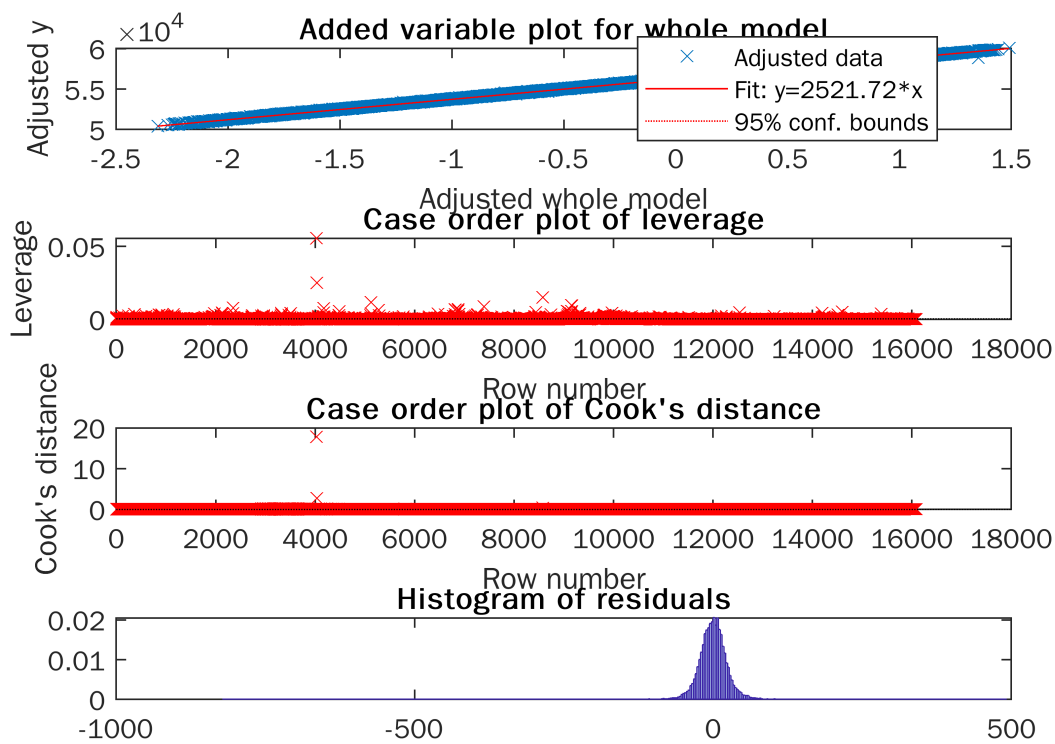
```
[YPred, Scores] = predict(LRModel,Xtest)
```

```
YPred = 4021×1
10^8 ×
    1.1963
    1.1954
    1.1963
    1.1891
    1.1913
    1.1915
    1.1874
    1.1870
    1.1854
    1.1886
      ⋮

Scores = 4021×2
10^8 ×
    1.1961    1.1965
    1.1952    1.1956
    1.1961    1.1965
    1.1889    1.1893
    1.1911    1.1915
    1.1913    1.1918
```

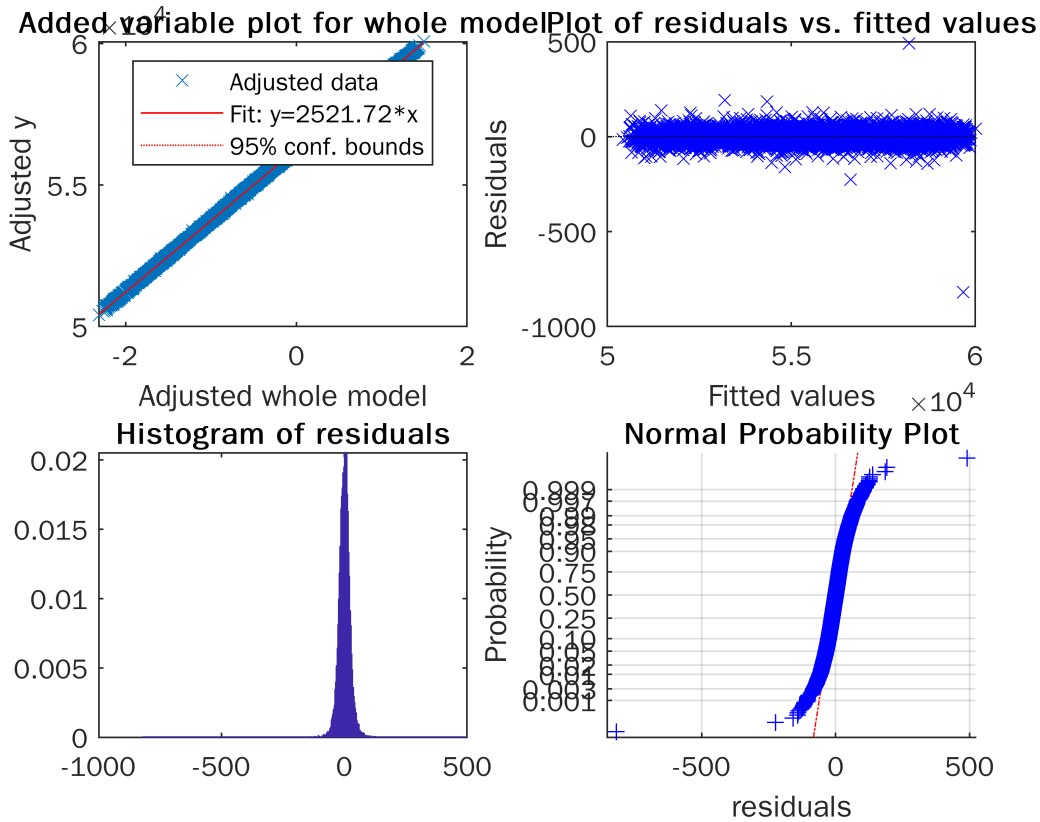
```
    1.1872    1.1876
    1.1868    1.1872
    1.1852    1.1856
    1.1884    1.1889
      ⋮
```

## Plots

```
figure,
subplot(4, 1, 1), plot(LRModel)
subplot(4, 1, 2), plotDiagnostics(LRModel)
subplot(4, 1, 3), plotDiagnostics(LRModel, 'cookd')
subplot(4, 1, 4), plotResiduals(LRModel)
```




```
figure,
subplot(2, 2, 1), plot(LRModel)
subplot(2, 2, 2), plotResiduals(LRModel,'fitted')
subplot(2, 2, 3), plotResiduals(LRModel)
subplot(2, 2, 4), normplot(LRModel.Residuals.Raw)
xlabel('residuals')
```


Added variable plot for whole model
Adjusted data
Fit: y=2521.72*x
95% conf. bounds
Adjusted y
Adjusted whole model
Plot of residuals vs. fitted values
Residuals
Fitted values
Histogram of residuals
Normal Probability Plot
Probability
residuals