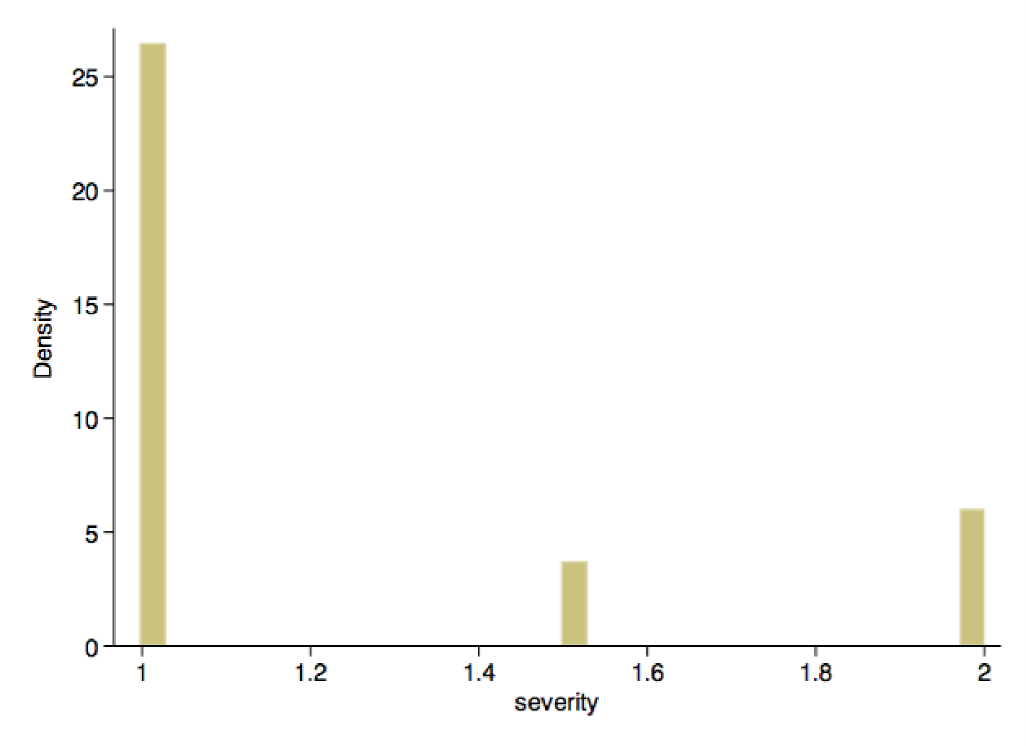
EDAV Project 2: Regression with Principal Components

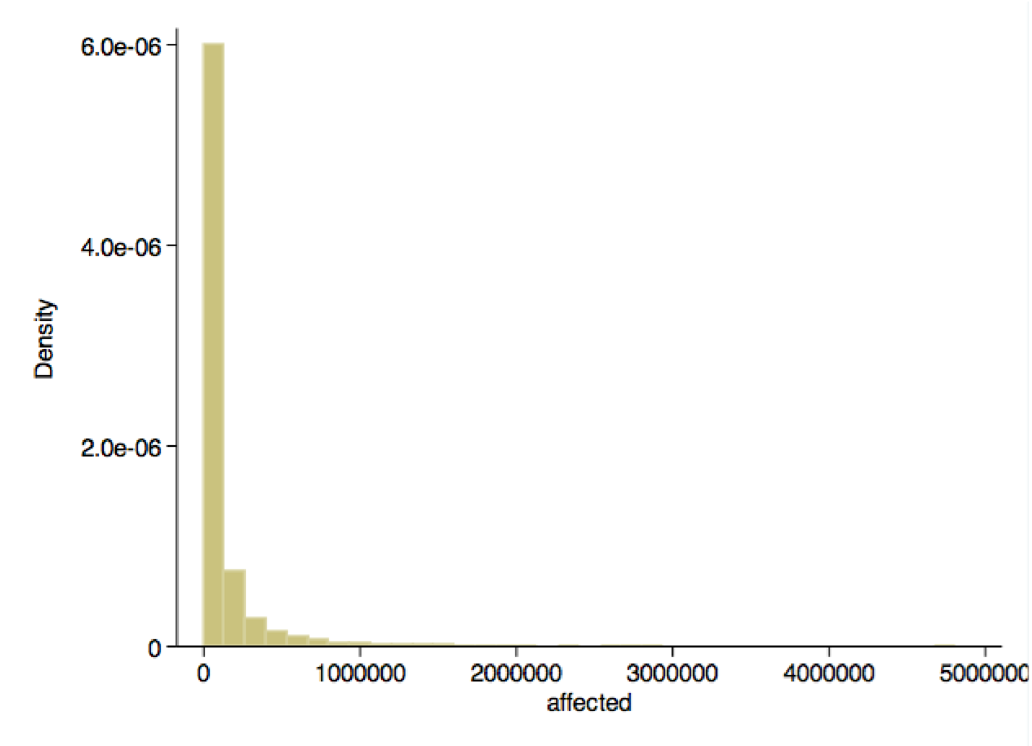
Aim: Visualize relationship between flood characteristics and number of people displaced

1. Visualize distribution of variables

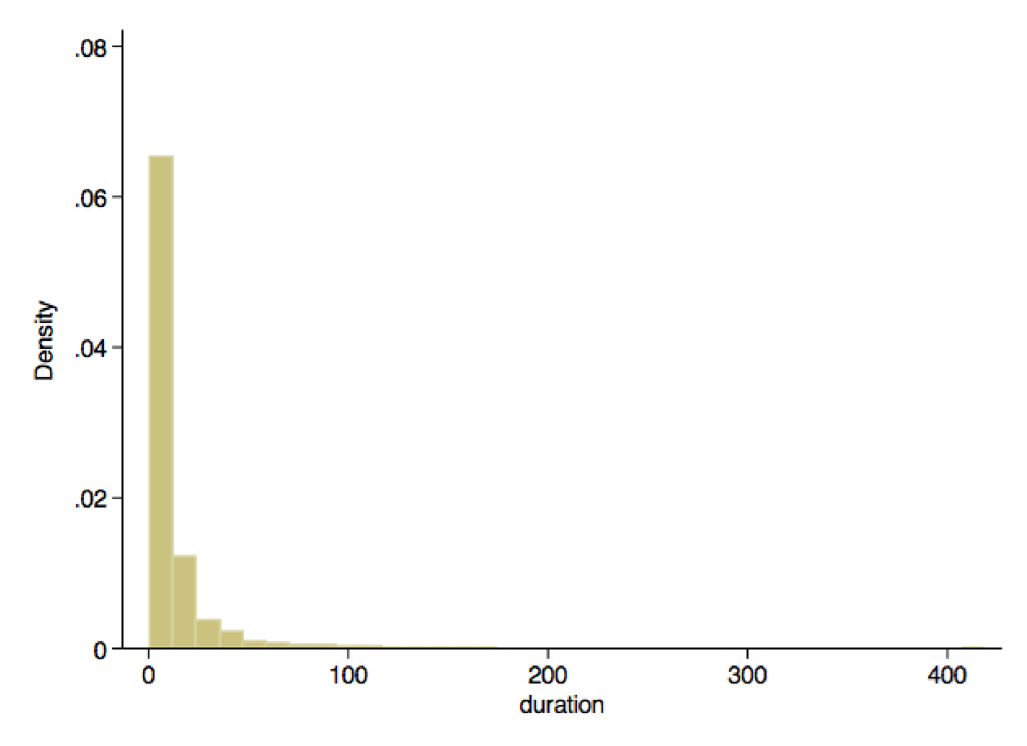
- Severity:



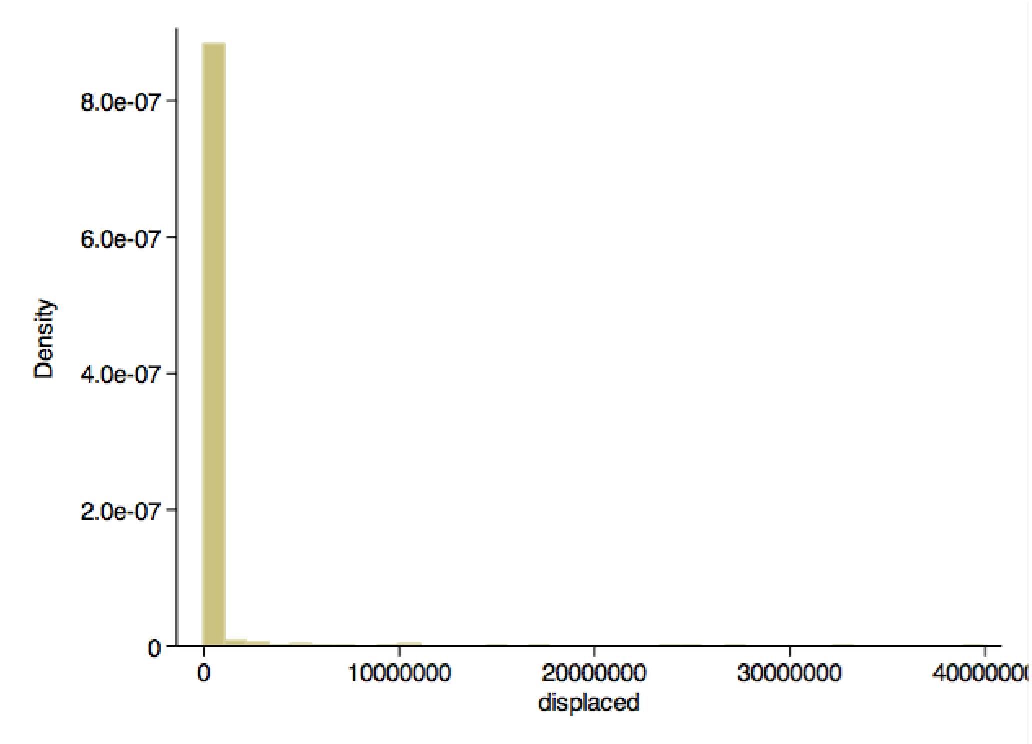
- Affected area:



- Duration:



- Number displaced:



2. Center and scale

Except for severity, other variables appear skewed, so log-transform them and then center and s cale them.

3. Linear regression

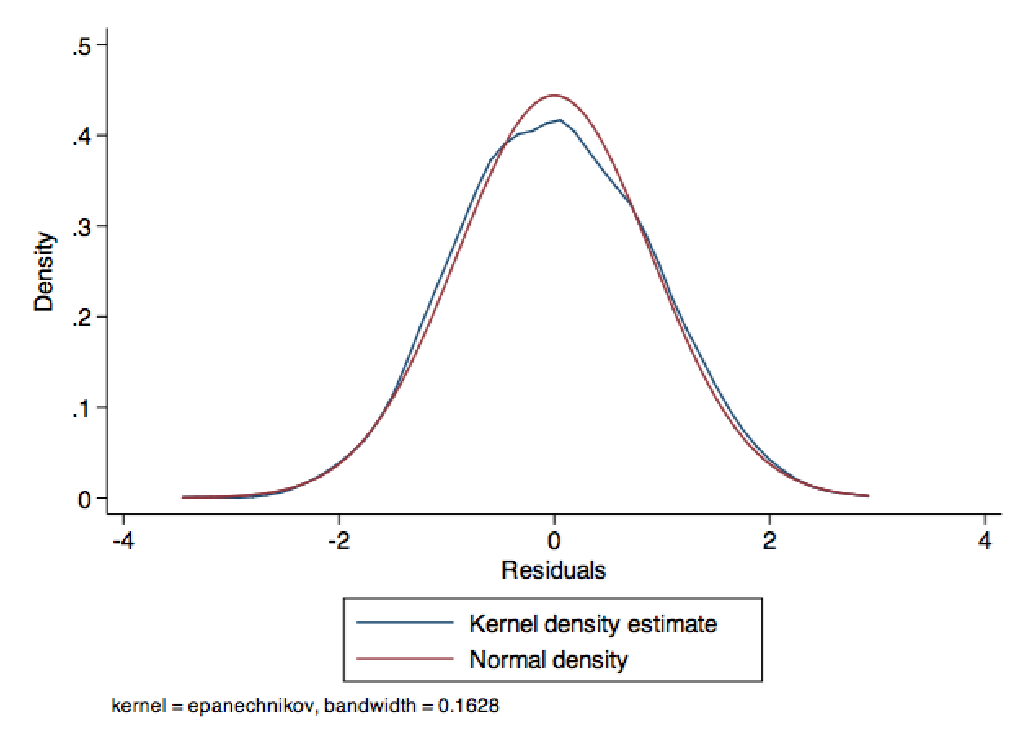
Perform multiple linear regression with "displaced" as dependent variable and other three varia bles as independent variables.

This model seems to explain ~19% of number of people displaced.

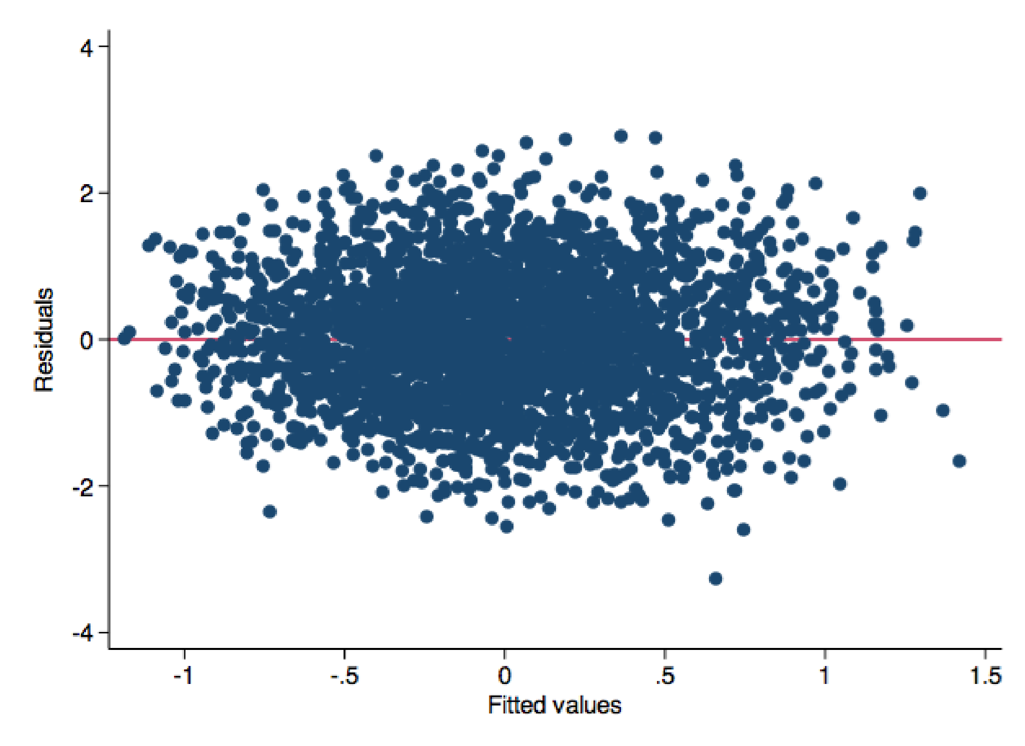
```
1 .  regress std_log_displaced severity std_log_affected std_log_duration

      Source |       SS       df       MS              Number of obs =    3034
-------------+------------------------------           F(  3,  3030) =  239.40
       Model |  581.158345     3  193.719448           Prob > F      =  0.0000
    Residual |  2451.84164  3030  .809188658           R-squared     =  0.1916
-------------+------------------------------           Adj R-squared =  0.1908
       Total |  3032.99998  3033  .999999994           Root MSE      =  .89955

------------------------------------------------------------------------------
std_log_displa~d |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-----------------+------------------------------------------------------------
        severity |   .1240879   .0421517     2.94   0.003     .0414392    .2067367
std_log_affected |   .1801437   .0188169     9.57   0.000     .1432485     .217039
std_log_duration |   .3070196   .0184443    16.65   0.000     .2708549    .3431842
           _cons |  -.2192853   .0545864    -4.02   0.000    -.3263154   -.1122551
------------------------------------------------------------------------------
```

Check assumptions of linear regression:

- Assumption of normality of residuals appears satisfied.



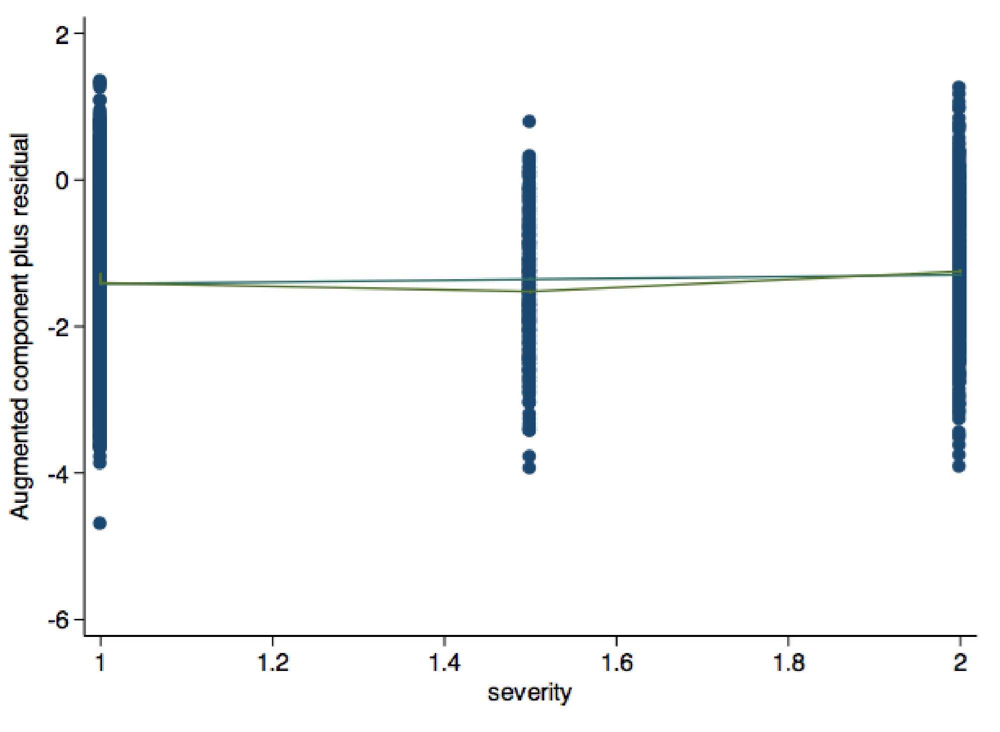
- Assumption of homoscedasticity of residuals appears satisfied.

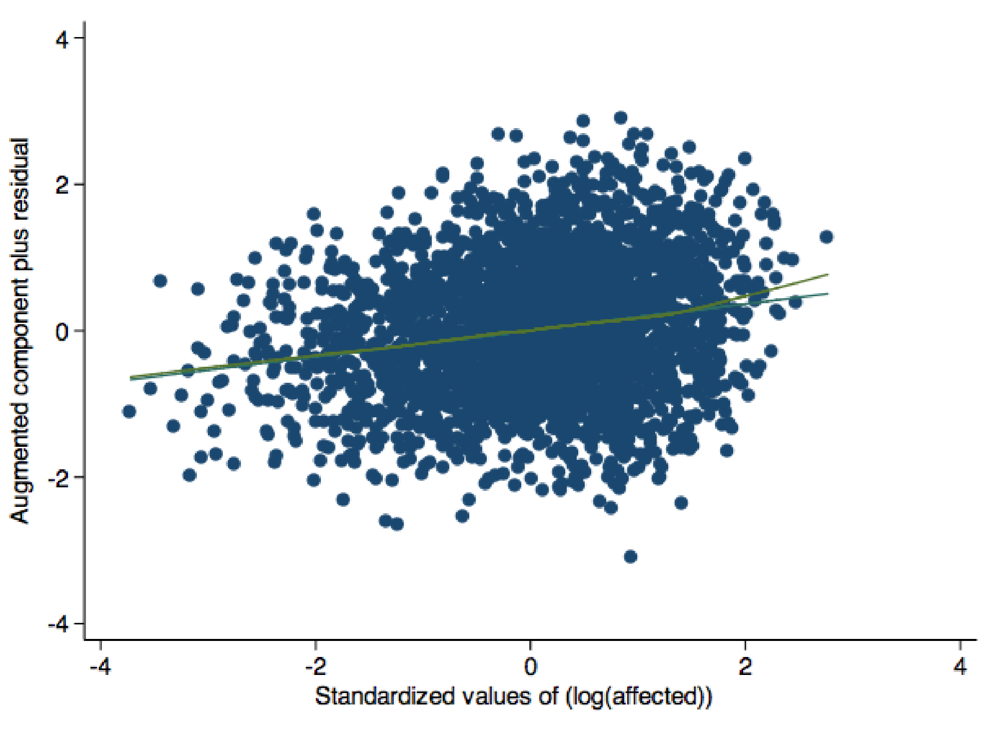


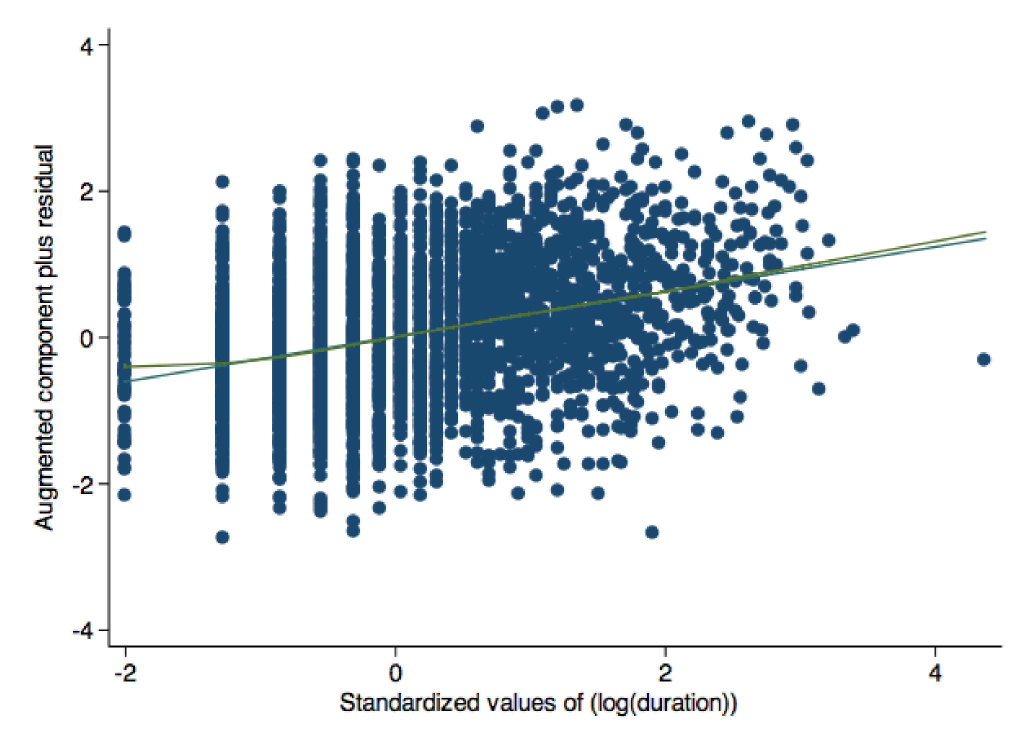
- No evidence of significant collinearity (VIF <10).

```
2 .  vif

    Variable |       VIF       1/VIF
-------------+----------------------
std_log_du~n |      1.30    0.766732
std_log_af~d |      1.29    0.774600
    severity |      1.06    0.945632
-------------+----------------------
    Mean VIF |      1.22
```

- Assumption of linearity appears satisfied.







4. Perform principal components analysis on "affected", "severity", and "duration"

Estimate principal components.

```
3 .  pca severity std_log_affected std_log_duration

Principal components/correlation                 Number of obs    =      4312
                                                 Number of comp.  =         3
                                                 Trace            =         3
    Rotation: (unrotated = principal)            Rho              =    1.0000

    --------------------------------------------------------------------------
       Component |   Eigenvalue   Difference         Proportion   Cumulative
    -------------+------------------------------------------------------------
           Comp1 |      1.58649      .701889             0.5288       0.5288
           Comp2 |      .884599      .355685             0.2949       0.8237
           Comp3 |      .528914            .             0.1763       1.0000
    --------------------------------------------------------------------------

Principal components (eigenvectors)

    ----------------------------------------------------------
        Variable |    Comp1     Comp2     Comp3 | Unexplained
    -------------+------------------------------+-------------
        severity |   0.4067    0.9125    0.0443 |           0
    std_log_af~d |   0.6412   -0.3196    0.6977 |           0
    std_log_du~n |   0.6508   -0.2554   -0.7150 |           0
    ----------------------------------------------------------
```

Component 1 explains ~53% of variance, so compute score of that component (pc1) and regress on that alone.

As seen, model R2 is similar to earlier model with separate terms for "magnitude" and "duration " (R2 ~0.18 versus ~0.19).

```
4 .  regress std_log_displaced pc1

      Source |       SS       df       MS              Number of obs =    3034
-------------+------------------------------           F(  1,  3032) =  660.36
       Model |  542.436732     1  542.436732           Prob > F      =  0.0000
    Residual |  2490.56325  3032  .821425874           R-squared     =  0.1788
-------------+------------------------------           Adj R-squared =  0.1786
```

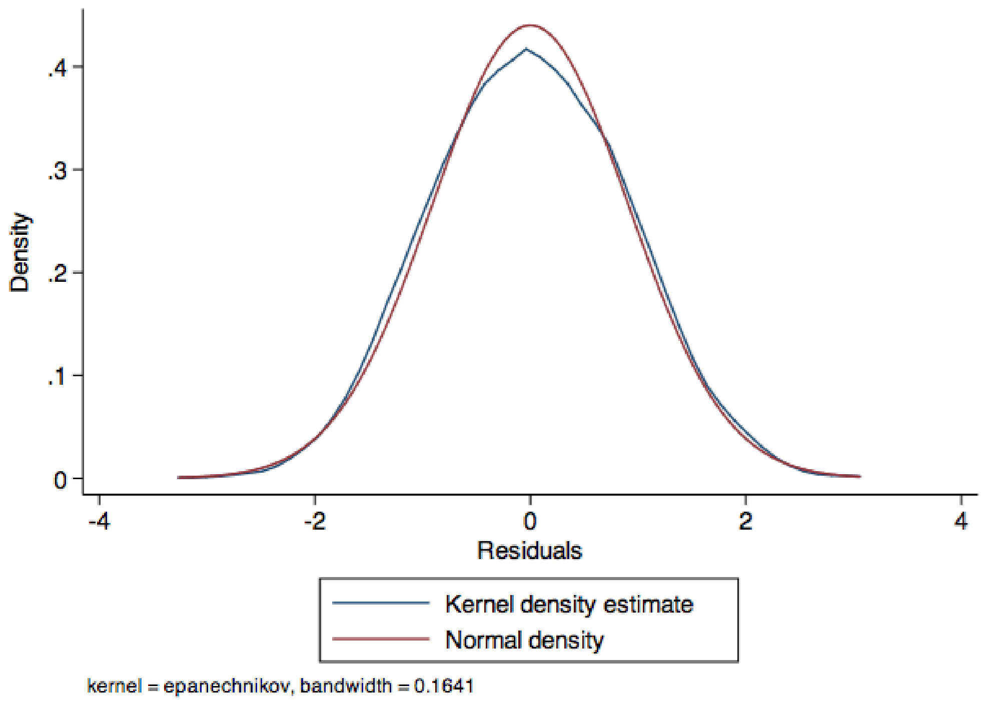
```
       Total |  3032.99998  3033  .999999994           Root MSE      =  .90633

------------------------------------------------------------------------------
std_log_di~d |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         pc1 |   .3320503   .0129215    25.70   0.000     .3067145    .3573861
       _cons |  -.0640488   .0166419    -3.85   0.000    -.0966794   -.0314183
------------------------------------------------------------------------------
```

Regression model with "pc1" appears to be equal to or superior R2 to regression models with "du ration" alone or "magnitude" alone.

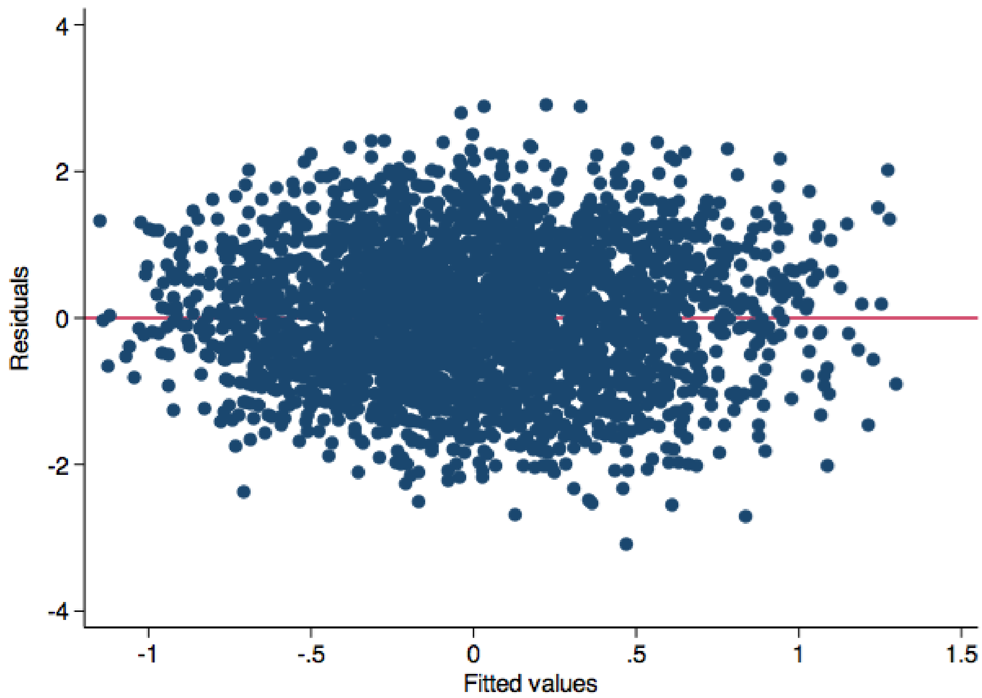
```
5 .  regress std_log_displaced severity

      Source |       SS       df       MS              Number of obs =    3034
-------------+------------------------------           F(  1,  3032) =   67.93
       Model |  66.4655162     1  66.4655162           Prob > F      =  0.0000
    Residual |  2966.53446  3032  .978408464           R-squared     =  0.0219
-------------+------------------------------           Adj R-squared =  0.0216
       Total |  3032.99998  3033  .999999994           Root MSE      =  .98915

------------------------------------------------------------------------------
std_log_di~d |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    severity |   .3714916   .0450724     8.24   0.000      .283116    .4598672
       _cons |  -.4636299   .0590483    -7.85   0.000    -.5794086   -.3478511
------------------------------------------------------------------------------


6 . regress std_log_displaced std_log_affected

      Source |       SS       df       MS              Number of obs =    3034
-------------+------------------------------           F(  1,  3032) =  374.66
       Model |  333.563804     1  333.563804           Prob > F      =  0.0000
    Residual |  2699.43618  3032  .890315361           R-squared     =  0.1100
-------------+------------------------------           Adj R-squared =  0.1097
       Total |  3032.99998  3033  .999999994           Root MSE      =  .94357

----------------------------------------------------------------------------------
std_log_displa~d |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-----------------+----------------------------------------------------------------
std_log_affected |   .3362418   .0173714    19.36   0.000     .3021809    .3703027
           _cons |  -.0289544   .0171955    -1.68   0.092    -.0626704    .0047615
----------------------------------------------------------------------------------


7 . regress std_log_displaced std_log_duration

      Source |       SS       df       MS              Number of obs =    3034
-------------+------------------------------           F(  1,  3032) =  590.56
       Model |  494.448928     1  494.448928           Prob > F      =  0.0000
    Residual |  2538.55105  3032  .837252986           R-squared     =  0.1630
-------------+------------------------------           Adj R-squared =  0.1627
       Total |  3032.99998  3033  .999999994           Root MSE      =  .91502

----------------------------------------------------------------------------------
std_log_displa~d |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-----------------+----------------------------------------------------------------
std_log_duration |   .3992275   .0164281    24.30   0.000     .3670161    .4314389
           _cons |   -.063597   .0168168    -3.78   0.000    -.0965705   -.0306235
----------------------------------------------------------------------------------
```

Check assumptions of linear regression for model with principal component alone:

- Assumption of normality of residuals appears satisfied.



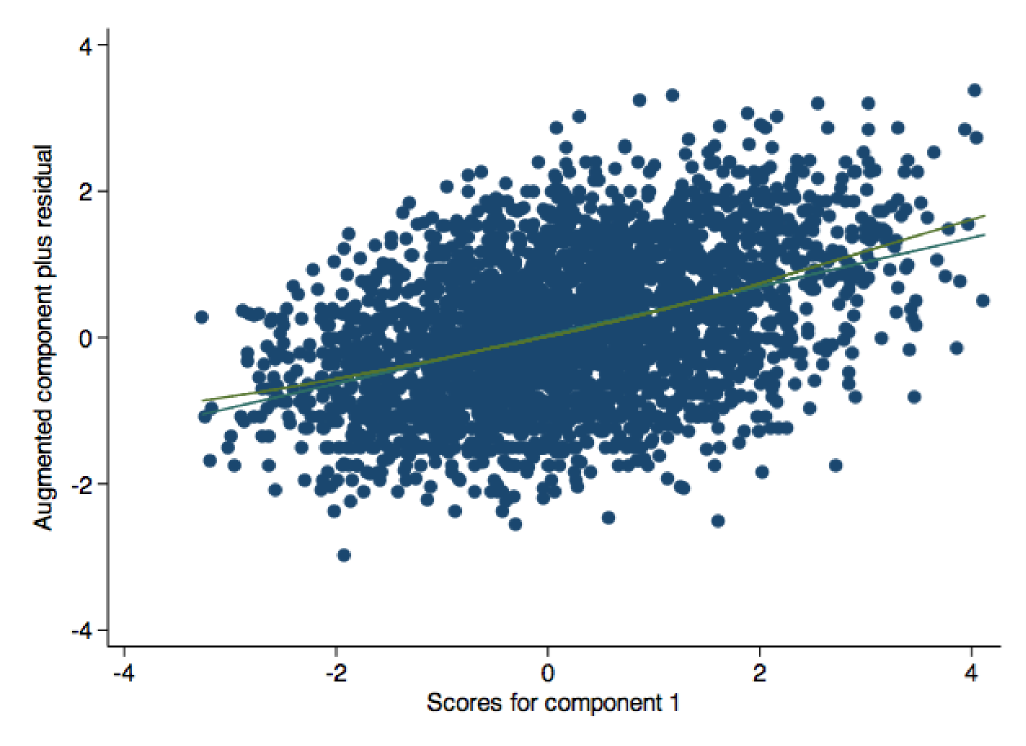
- Assumption of homoscedasticity of residuals appears satisfied.



- No evidence of significant collinearity (VIF <10).

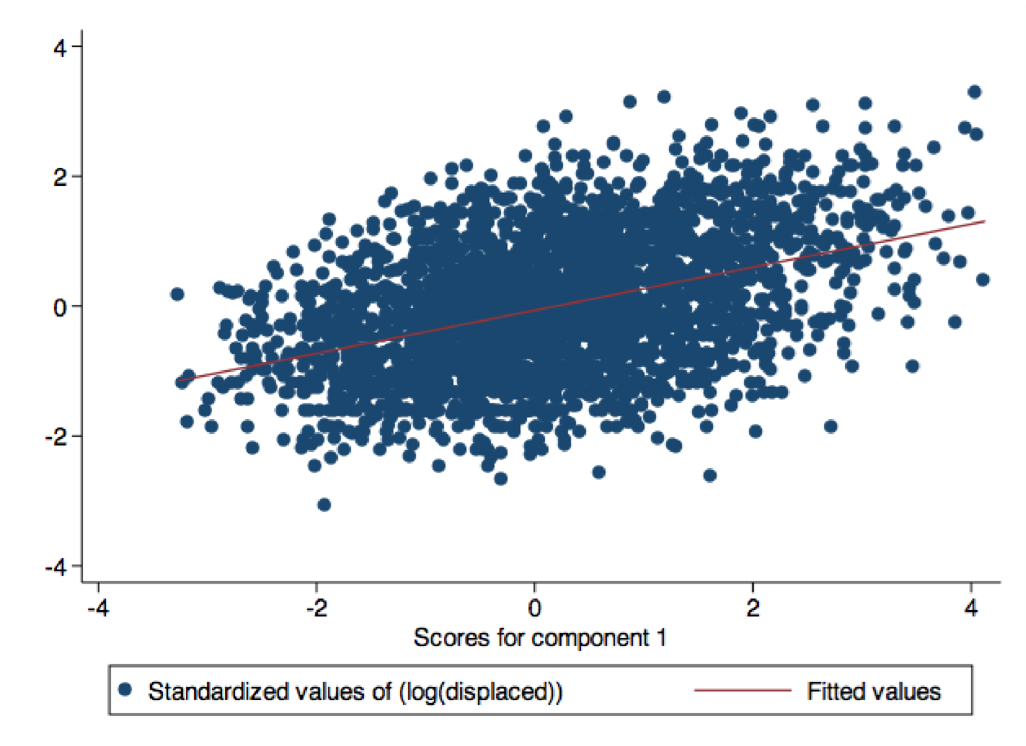
```
8 .  vif

     Variable |       VIF       1/VIF
-------------+----------------------
          pc1 |      1.00    1.000000
-------------+----------------------
     Mean VIF |      1.00
```

- Assumption of linearity appears satisfied.



5. Visually assess relationship between multiple flood characteristics and # displaced

Such a visualization would be difficult to perform with traditional linear regression in the pr esence of multiple independent variables.



6. Summmary

Principal components analysis allowed dimension reduction to one dimension, thereby allowing di rect visualization.

Prediction using one principal component was equally predictive as regression limited to one tr aditional independent variable and additionally allowed direct visualization between predictor and outcome. However, the disad vantage of this approach is that the first principal component is more difficult to conceptually understand than a traditional p redictor such as severity.