A Bayesian Quadraic Regression Model for the East Greenwich Tax Levy

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November 11, 2018

Summary of Results

Historical levy values may be regarded as adequate, since each year the budget has to be balanced (or nearly balanced).

That being the case, we can use the historical levy values to predict adequate levy values. Using a Bayesian model (like Nate Silver uses on 538.com) it is possible to give a predicted probability distribution for the adequate levy.

By seeing where the tax revenue in the budget falls in this distribution, it is possible to assign a probability that the budgeted revenue will be adequate.

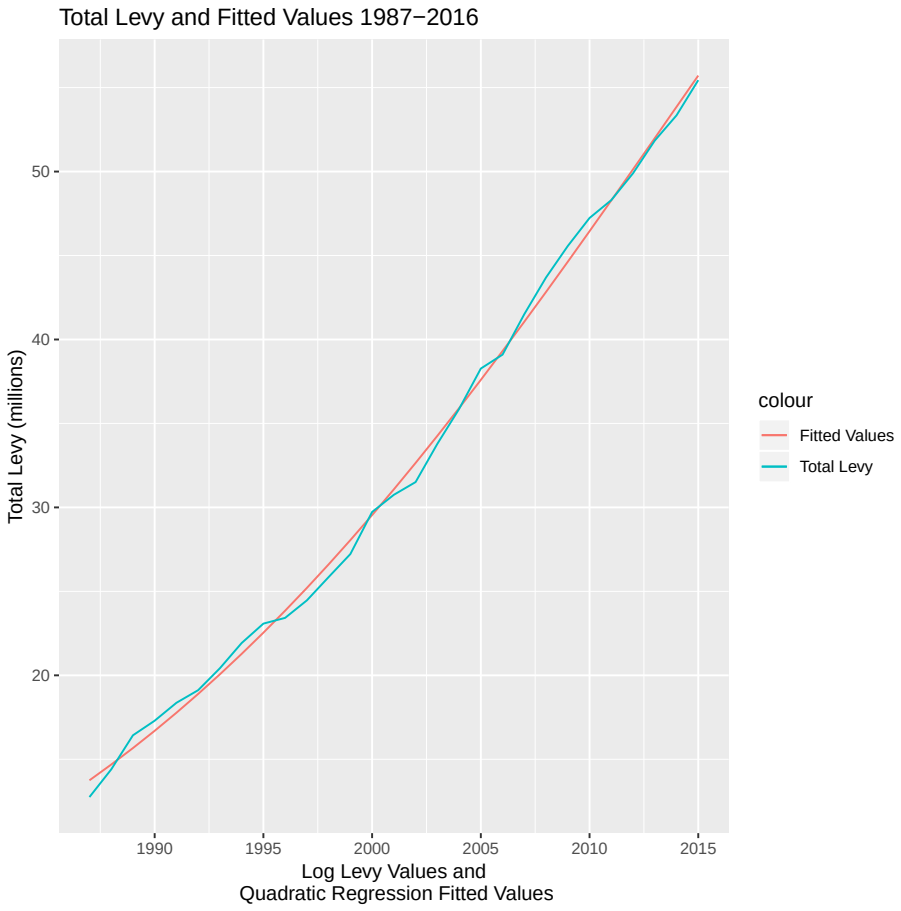
That is to say, if the budgeted revenue falls near the middle of the predicted distribution, the tax rate is adequate. If if falls in the lower tail, the tax rate is most likely not adequate.

The results of this analysis using the levy data from 1987 to 2015 to predict the levy for FY2017, FY2018, and FY2019 are:

- The estimated probability that the FY2017 tax rate is adequate is 38.4%
- The estimated probability that the FY2018 tax rate is adequate is 5.2%
- The estimated probability that the FY2019 tax rate is adequate is 0.8%

The following graph shows the levy values and fitted values plotted on the same axes:

Actual and Fitted Levy Values 1987-2016

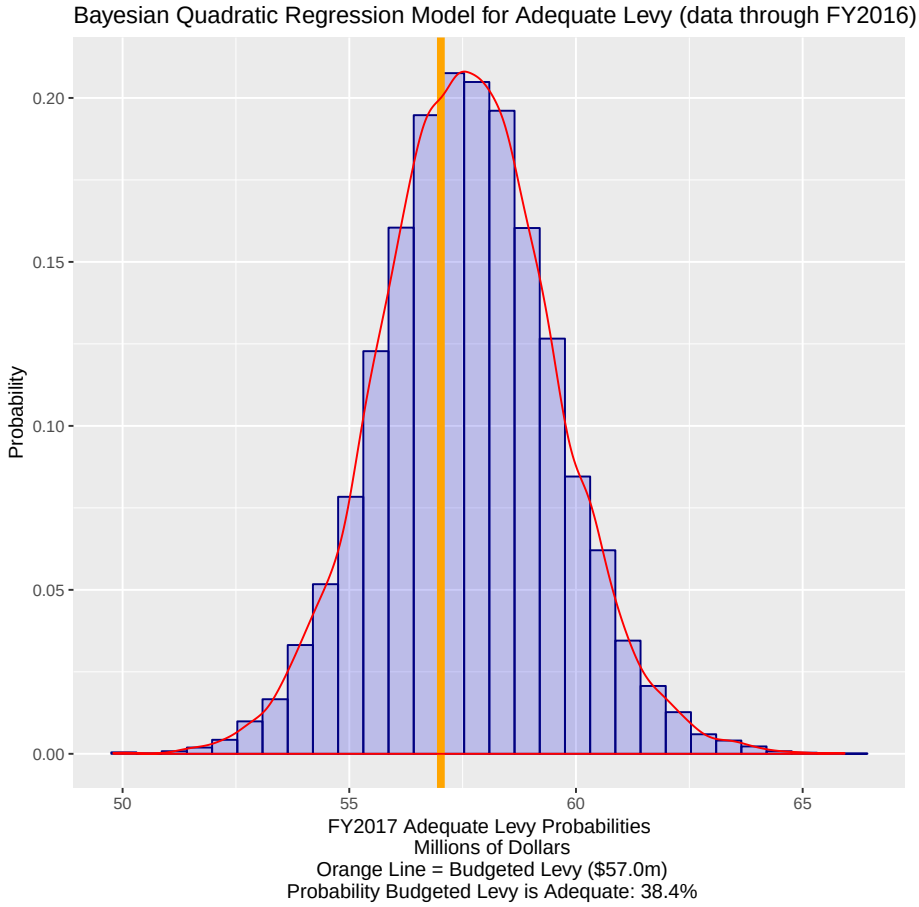


Probability Distribution of Predicted Adequate Levy Values (FY2017)

This graph shows the predicted probabilities for various levy values. These can be interpreted as showing the probability that each levy value corresponding to a bar is adequate.

The first graph is for FY2017 and shows that the actual budget revenue $57.0 million is greater than or equal to the predicted adequate levy 38.4% of the time.

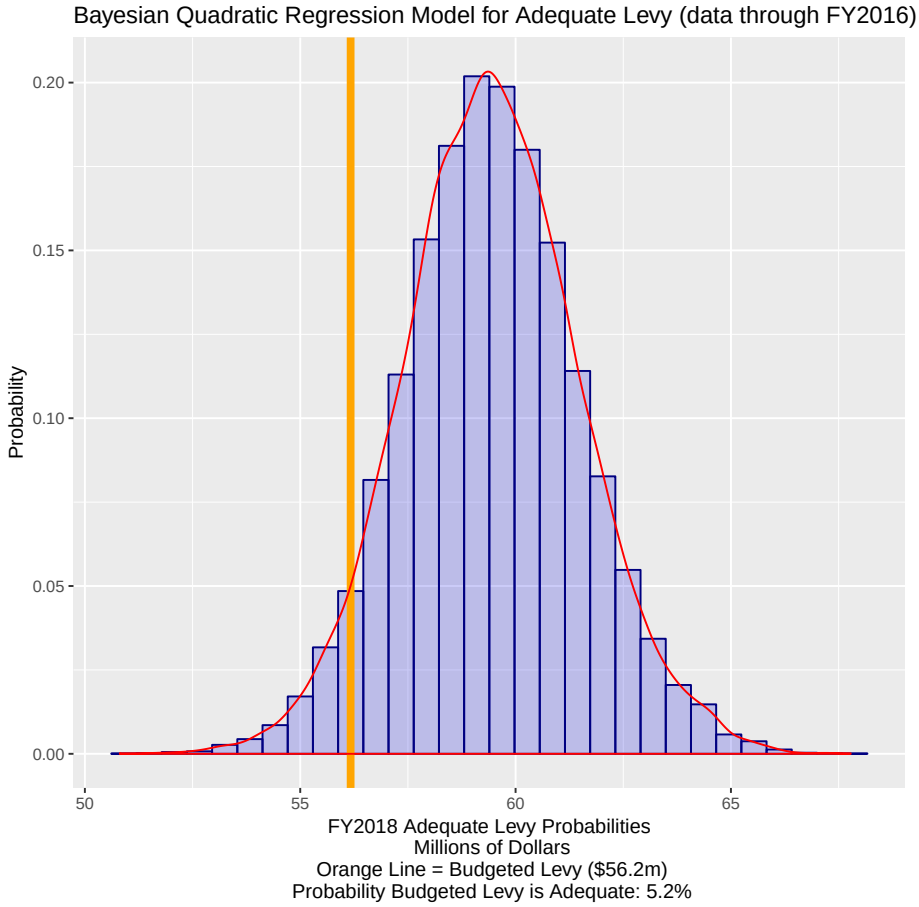
This indicates that the budget revenue is probably adequate to cover expenses for FY2017 (i.e., the tax rate is about right).



Probability Distribution of Predicted Adequate Levy Values (FY2018)

The second graph is for FY2018 and shows that the estimated budget revenue of $56.2 million is greater than or equal to the predicted levy only 5.2% of the time.

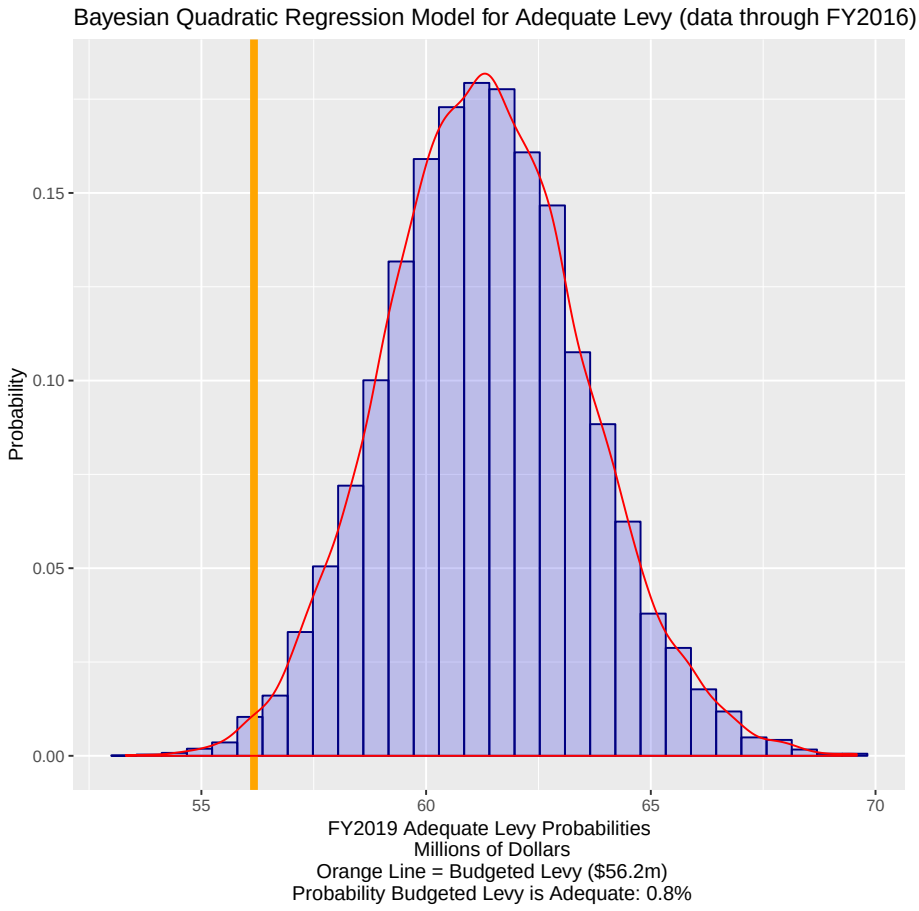
This indicates that the budget revenue of $56.2 million for FY2018 is probably not adequate (i.e., the tax rate was set too low).



Probability Distribution of Predicted Adequate Levy Values (FY2019)

The third graph is for FY2019 and shows that the actual budget revenue is greater than or equal to the predicted levy only 0.8% of the time.

This indicates that the budget revenue for FY2019 is almost certainly too low, that is, the tax rate is set too low.



Data Listing and Model Overview

The historical levy data back to 1987 can be fit to a quadratic regression predicting the log transformed levy from the year index and year index squared. The data is:

```
df

##    Year     Town Fire.District total_levy Yearm Yearm2 fiscal_year
## 1  2017 56169910             0   56.16991    15    225        2018
## 2  2016 57019409             0   57.01941    14    196        2017
## 3  2015 55443802             0   55.44380    13    169        2016
## 4  2014 53345988             0   53.34599    12    144        2015
## 5  2013 51845789             0   51.84579    11    121        2014
## 6  2012 45381128       4515726   49.89685    10    100        2013
```

```
## 7  2011 44015850       4283936   48.29979     9     81        2012
## 8  2010 43145369       4089627   47.23500     8     64        2011
## 9  2009 41524344       4043438   45.56778     7     49        2010
## 10 2008 39575719       4118991   43.69471     6     36        2009
## 11 2007 37726180       3781609   41.50779     5     25        2008
## 12 2006 35309164       3789535   39.09870     4     16        2007
## 13 2005 34598256       3670147   38.26840     3      9        2006
## 14 2004 32745057       3114944   35.86000     2      4        2005
## 15 2003 31034832       2749913   33.78475     1      1        2004
## 16 2002 29087641       2421471   31.50911     0      0        2003
## 17 2001 28495352       2254679   30.75003    -1      1        2002
## 18 2000 27280262       2447900   29.72816    -2      4        2001
## 19 1999 24831179       2390575   27.22175    -3      9        2000
## 20 1998 23610647       2239369   25.85002    -4     16        1999
## 21 1997 22193962       2269697   24.46366    -5     25        1998
## 22 1996 21236148       2185933   23.42208    -6     36        1997
## 23 1995 20863957       2216158   23.08011    -7     49        1996
## 24 1994 19857249       2065485   21.92273    -8     64        1995
## 25 1993 18625795       1796412   20.42221    -9     81        1994
## 26 1992 17372127       1744031   19.11616   -10    100        1993
## 27 1991 16763016       1600494   18.36351   -11    121        1992
## 28 1990 15740762       1557003   17.29777   -12    144        1991
## 29 1989 14941606       1486513   16.42812   -13    169        1990
## 30 1988 13171368       1222298   14.39367   -14    196        1989
## 31 1987 11622935       1127621   12.75056   -15    225        1988
##    log_levy
## 1  4.028381
## 2  4.043392
## 3  4.015370
## 4  3.976799
## 5  3.948274
## 6  3.909958
## 7  3.877427
## 8  3.855135
## 9  3.819201
## 10 3.777227
## 11 3.725881
## 12 3.666089
## 13 3.644625
## 14 3.579622
## 15 3.520009
## 16 3.450277
## 17 3.425891
## 18 3.392095
## 19 3.304016
```

```
## 20 3.252311
## 21 3.197189
## 22 3.153679
## 23 3.138971
## 24 3.087524
## 25 3.016623
## 26 2.950534
## 27 2.910366
## 28 2.850577
## 29 2.798994
## 30 2.666788
## 31 2.545575
```