Unpaid Lunch Debt in Durham, NC

Julia Donheiser

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Introduction

When families can't afford to pay for student lunches, school districts foot the bill. But with major cuts to educational funding in North Carolina—where some schools don't even have enough funds to pay for students' textbooks—this means school districts can wrack up tens of thousands of dollars in debt. In Durham, students with five or more unpaid lunches only receive a juice and a sandwich instead of a hot lunch. This lends its way to "lunch shaming", where students who can't afford pay skip the meal altogether to avoid the embarrassment of eating a cold lunch. This is a major issue, since student performance in school is directly tied to access to quality food.

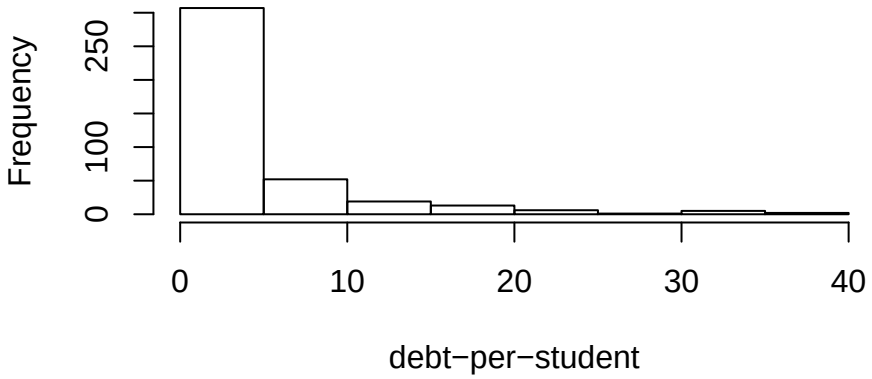
Data Sources

- End-of-Year unpaid meal data from James Keaten, director of child nutrition services at DPS.
- All free/reduced price lunch data was obtained from ncpublicschools.org
- 2010-11 through 2015-16 demographic data was obtained from the NCES ELSI table generator, code 91803
- 2017-18 ADM data from ncpublicschools.org's Average Daily Membership and Membership Last Day by School
- 2016-17, 2017-18 demographic data from Durham Public Schools

Exploratory Data Analysis

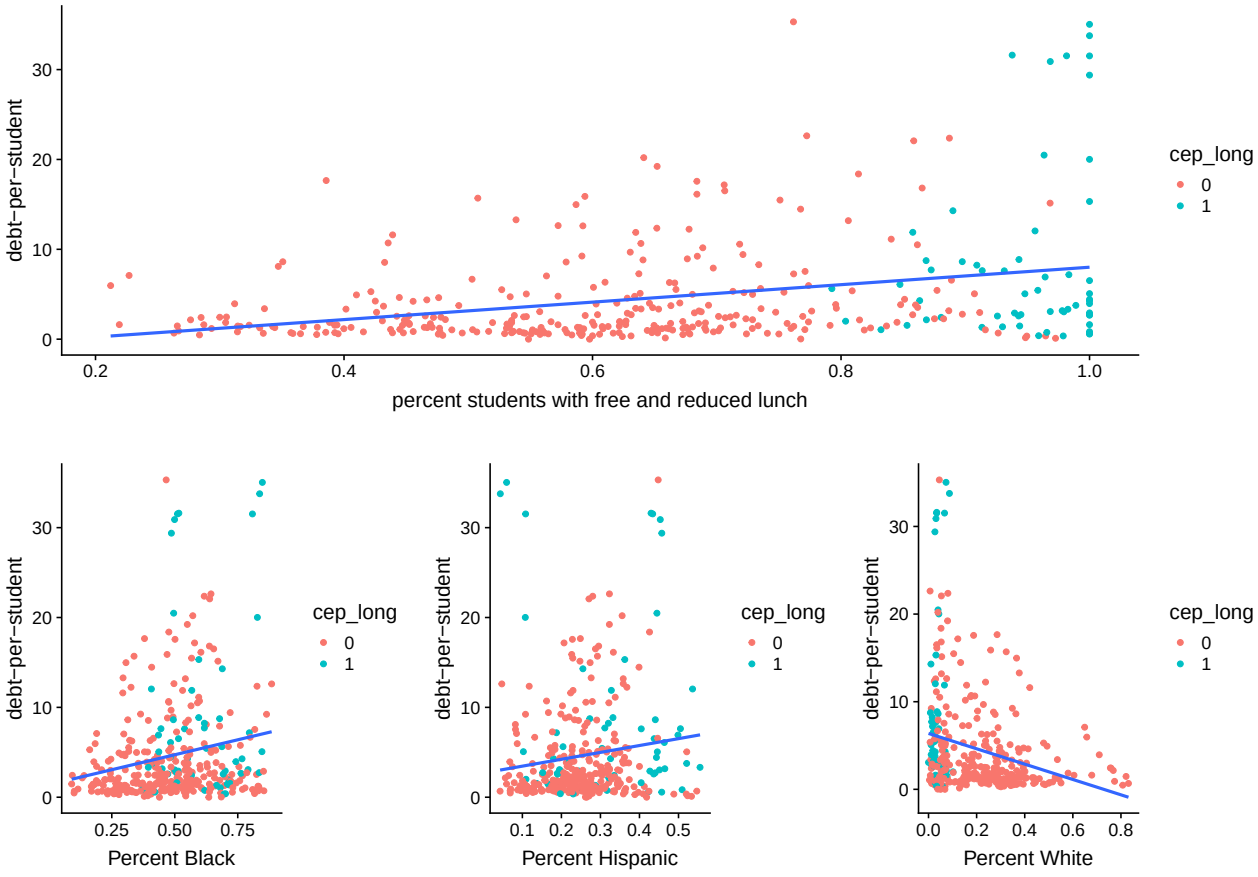
```
## # A tibble: 8 x 4
##   year    total_debt mean_debt_per_student fullprice_lunches
##   <chr>        <dbl>                 <dbl>             <dbl>
## 1 2010-11    204692.                  7.34            70584.
## 2 2011-12    111567.                  4.53            38472.
## 3 2012-13    117526.                  4.54            40526.
## 4 2013-14    108231.                  3.76            37321.
## 5 2014-15     85093.                  2.51            29342.
## 6 2015-16     78428.                  2.25            27044.
## 7 2016-17    127940.                  3.38            44117.
## 8 2017-18    209022.                  5.10            72076.
```

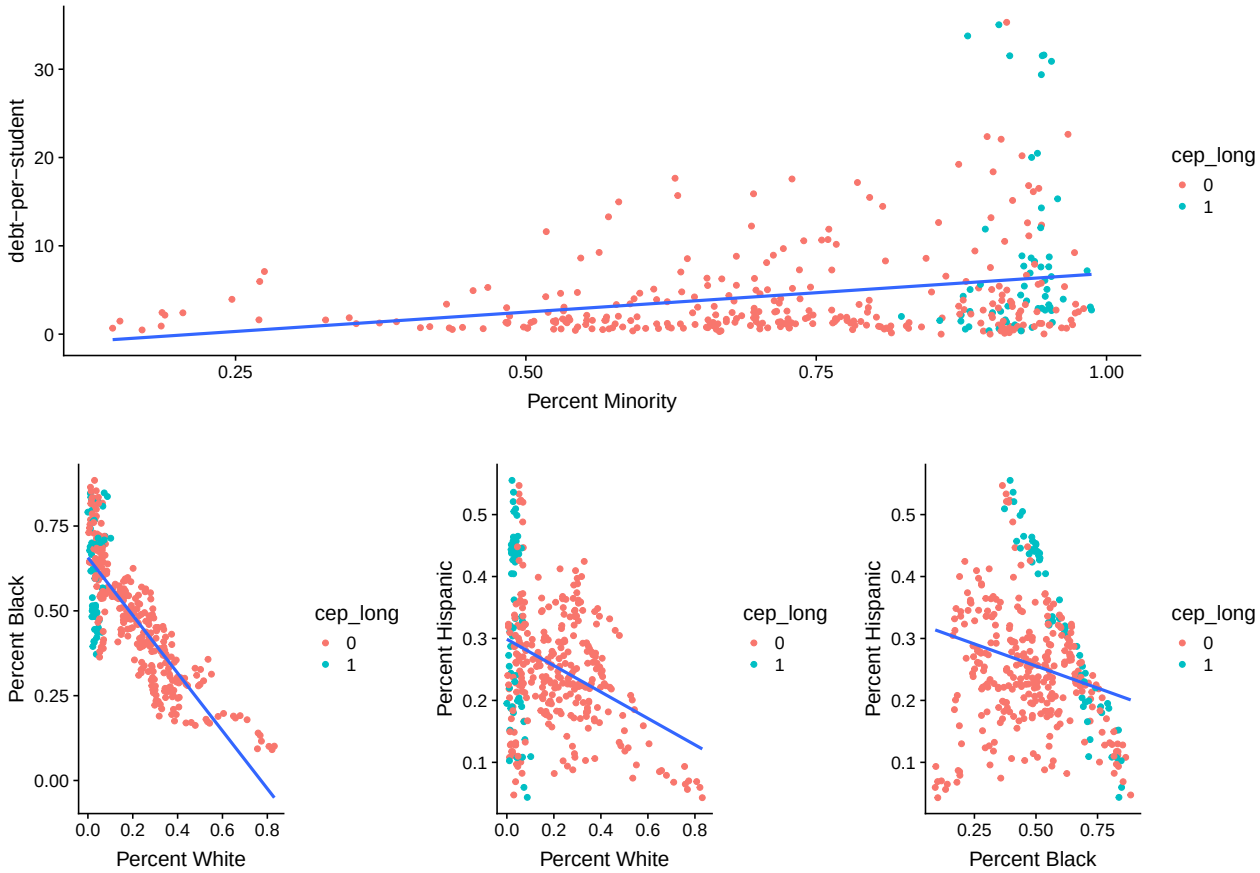
At the end of the 2017-18 academic year, DPS had over $209,000 in school lunch debt. That's over 72,000 unpaid lunches, with an average of $5.10 of debt per student. It's also the most debt the school district has seen in the past eight years.



Most schools have less than $5 of lunch debt per student. In Durham, a full-priced lunch costs $2.90, and a reduced-price lunch cost $0.40, according to the Durham Public Schools website. That's about two unpaid full-priced lunches per student, or just over 12 unpaid reduced-price lunches per student. For the rest of my EDA, I'll delve into which schools have more debt and whether we can find systematic issues. I'll also be looking at schools that are part of the Community Eligibility Provision, which means all students receive free lunch.

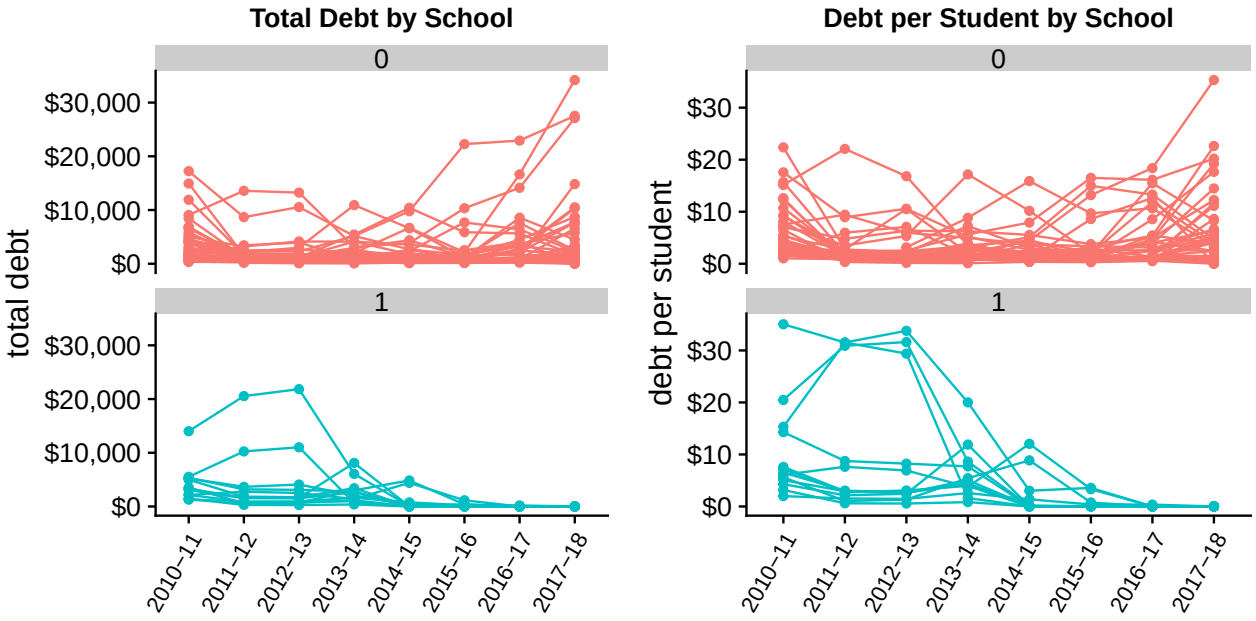
Debt and Demographics





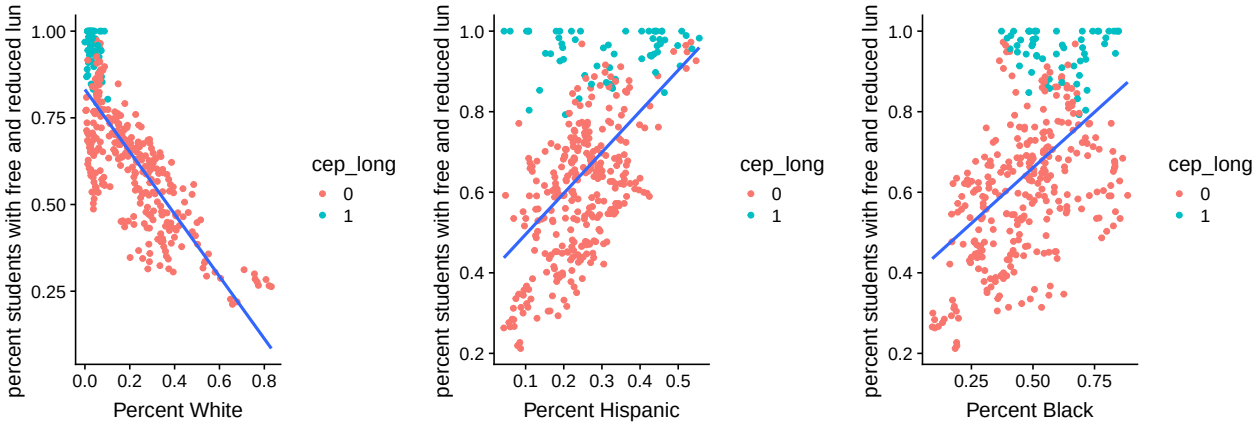
There is a weak positive correlation between the percentage of students who have free and reduced price lunch and the debt-per-student at each school. It looks like schools with CEP status generally have a higher percentage of students on free/reduced lunch. As for demographics, there is also a weak positive correlation between the percentage of black students and debt-per-student. Conversely, there is a weak negative correlation between the percent of white students and debt-per-student. There doesn't appear to be a much of a relationship between the percentage of hispanic students and debt-per-student. That being said, if we look at the total percentage of minority students — the percentage of black *and* hispanic students — there is a positive correlation with debt-per-student. Schools that CEP status are also starkly segregated, with very few white students and primarily black and hispanic students.

Debt over time



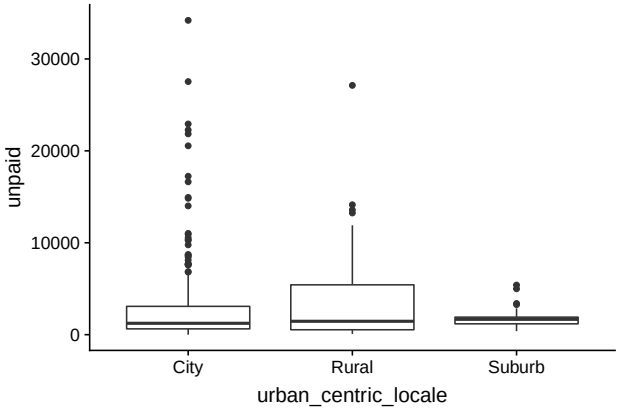
Schools with CEP status generally had a large amount of debt until the 2014-15 school year, when they gained CEP status. That being said, other schools with similar amounts of debt did not gain CEP status.

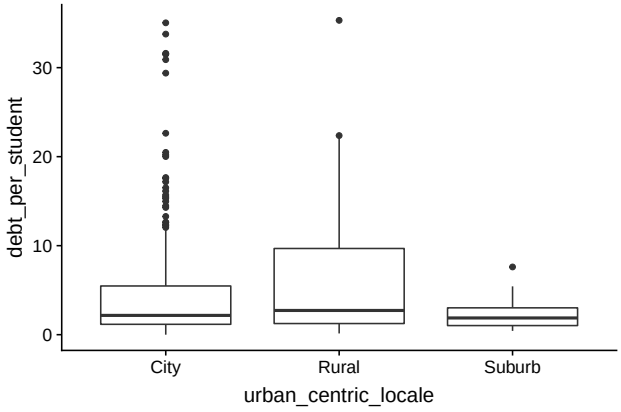
Demographics and need



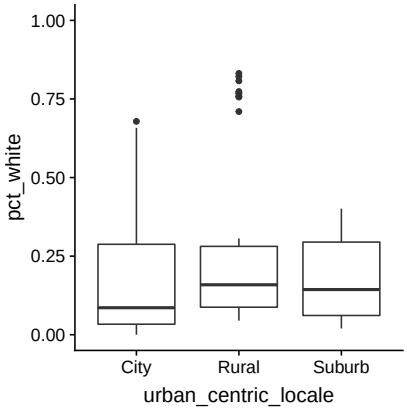
We can also see that race is a proxy for need. The percentage of black and hispanic schools have a strong, positive correlation with the percentage of students on free and reduced price lunch. For white students, this relationship is strong and negative.

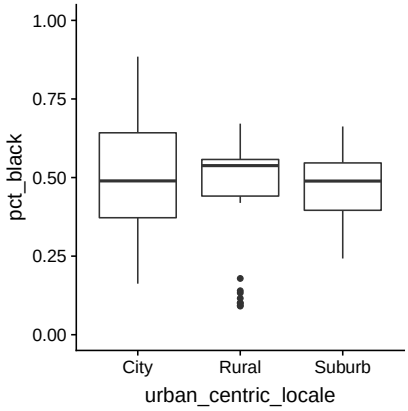
Locale and debt, race

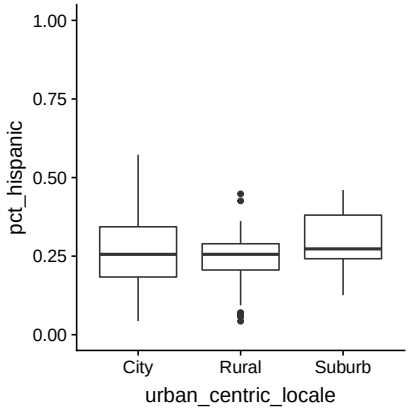




There don't seem to be major differences in debt by location.





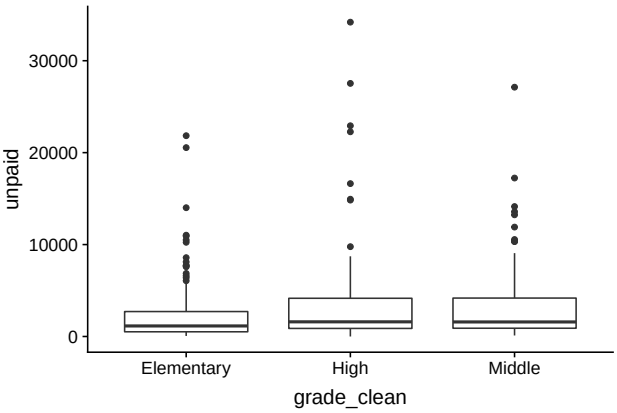


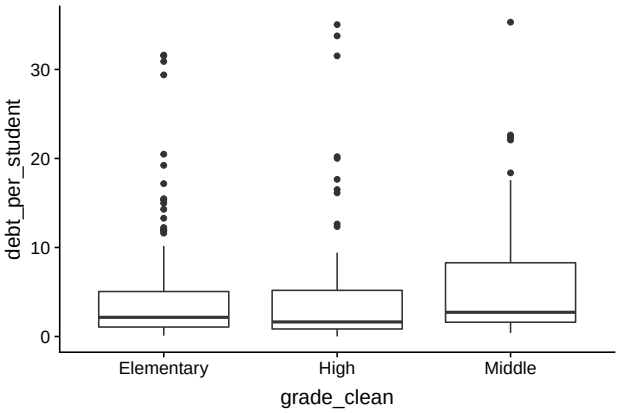
On average, we also don't see any major differences in race by locale. However, there is a subset of rural schools that seem to primarily be white.

Debt and grade

```
## # A tibble: 3 x 3
##   grade_clean mean_debt mean_dps
##   <chr>           <dbl>    <dbl>
## 1 Elementary      2181.     4.10
## 2 High            4016.     4.94
## 3 Middle          3541.     5.70
```

On average, high schools have the most total debt. However, middle schools, on average, have the most debt per student.





CEP Status and Grade Level

```
## # A tibble: 3 x 2
##   grade_clean cep_schools
##   <chr>             <int>
## 1 Elementary           12
## 2 High                  1
## 3 Middle                0
```

Most CEP schools are elementary schools. However, we're also seeing that the schools with the most debt are, on average, middle and high schools.

Regression

I built four linear models to predict debt per student based on various combinations of the percentage of students on free/reduced price lunch, school level, locale and demographics.

```
##
## Call:
## lm(formula = debt_per_student ~ pct_white + pct_black + pct_hispanic +
##     grade_clean + urban_centric_locale, data = df[df$cep == 0,
##     ])
##
## Residuals:
##    Min     1Q Median     3Q    Max
## -7.310 -3.676 -1.376  1.125 29.175
##
## Coefficients:
##                             Estimate Std. Error t value Pr(>|t|)
## (Intercept)                -25.3323    12.7037  -1.994  0.04691 *
## pct_white                   25.4683    14.3101   1.780  0.07598 .
## pct_black                   31.1973    13.2494   2.355  0.01909 *
## pct_hispanic                36.3672    13.6907   2.656  0.00826 **
## grade_cleanHigh              0.7252     0.8709   0.833  0.40554
## grade_cleanMiddle            0.5730     0.8173   0.701  0.48374
## urban_centric_localeRural    1.8556     1.0228   1.814  0.07049 .
## urban_centric_localeSuburb  -2.0712     1.1810  -1.754  0.08035 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
```

```
## Residual standard error: 5.888 on 352 degrees of freedom
## Multiple R-squared:  0.1089, Adjusted R-squared:  0.09116
## F-statistic: 6.144 on 7 and 352 DF,  p-value: 8.602e-07
```

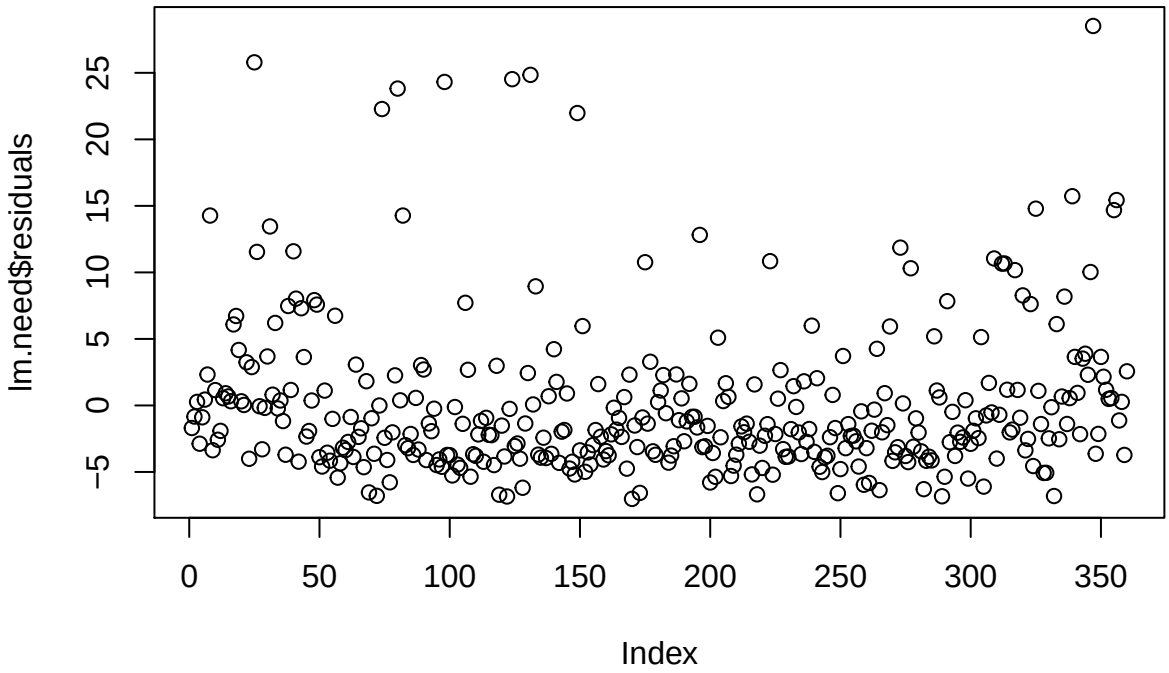
```
##
## Call:
## lm(formula = debt_per_student ~ pct_white + pct_black + pct_hispanic +
##     grade_clean, data = df[df$cep == 0, ])
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -7.2952 -3.6920 -1.5521  0.9941 29.1285
##
## Coefficients:
##                   Estimate Std. Error t value Pr(>|t|)
## (Intercept)       -32.7320    12.3511  -2.650  0.00841 **
## pct_white          34.2576    13.8253   2.478  0.01368 *
## pct_black          39.0118    12.8545   3.035  0.00258 **
## pct_hispanic       43.6114    13.3574   3.265  0.00120 **
## grade_cleanHigh     0.4748     0.8686   0.547  0.58495
## grade_cleanMiddle   1.0232     0.8037   1.273  0.20383
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 5.927 on 354 degrees of freedom
## Multiple R-squared:  0.09181,    Adjusted R-squared:  0.07898
## F-statistic: 7.157 on 5 and 354 DF,  p-value: 2.14e-06
```

```
##
## Call:
## lm(formula = debt_per_student ~ pct_free_reduced + grade_clean +
##     urban_centric_locale, data = df[df$cep == 0, ])
##
## Residuals:
##    Min     1Q Median     3Q    Max
## -7.216 -3.589 -1.418  1.512 26.790
##
## Coefficients:
##                             Estimate Std. Error t value Pr(>|t|)
## (Intercept)                  -3.3171     1.1615  -2.856  0.00455 **
## pct_free_reduced             10.8225     1.5643   6.919 2.15e-11 ***
## grade_cleanHigh               2.1531     0.8007   2.689  0.00750 **
## grade_cleanMiddle             1.3322     0.7628   1.746  0.08162 .
## urban_centric_localeRural     2.2654     0.9569   2.367  0.01845 *
## urban_centric_localeSuburb   -2.2109     1.1515  -1.920  0.05566 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 5.755 on 354 degrees of freedom
## Multiple R-squared:  0.1437, Adjusted R-squared:  0.1316
## F-statistic: 11.88 on 5 and 354 DF,  p-value: 1.217e-10
```

```
##
## Call:
## lm(formula = debt_per_student ~ pct_free_reduced + grade_clean,
```

```
##     data = df[df$cep == 0, ])
##
## Residuals:
##    Min     1Q Median     3Q    Max
## -7.023 -3.657 -1.698  1.163 28.521
##
## Coefficients:
##                   Estimate Std. Error t value Pr(>|t|)
## (Intercept)        -2.9827     1.1501  -2.593   0.0099 **
## pct_free_reduced   10.3904     1.5744   6.600  1.5e-10 ***
## grade_cleanHigh     1.8390     0.7997   2.300   0.0220 *
## grade_cleanMiddle   1.8609     0.7526   2.473   0.0139 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 5.82 on 356 degrees of freedom
## Multiple R-squared:  0.1195, Adjusted R-squared:  0.112
## F-statistic:  16.1 on 3 and 356 DF,  p-value: 7.782e-10
```

```
## Analysis of Variance Table
##
## Model 1: debt_per_student ~ pct_white + pct_black + pct_hispanic + grade_clean +
##     urban_centric_locale
## Model 2: debt_per_student ~ pct_white + pct_black + pct_hispanic + grade_clean
## Model 3: debt_per_student ~ pct_free_reduced + grade_clean + urban_centric_locale
## Model 4: debt_per_student ~ pct_free_reduced + grade_clean
##   Res.Df   RSS Df Sum of Sq      F  Pr(>F)
## 1    352 12202
## 2    354 12436 -2   -233.79 3.3722 0.03543 *
## 3    354 11725  0    710.61
## 4    356 12057 -2   -331.94 4.7879 0.00888 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

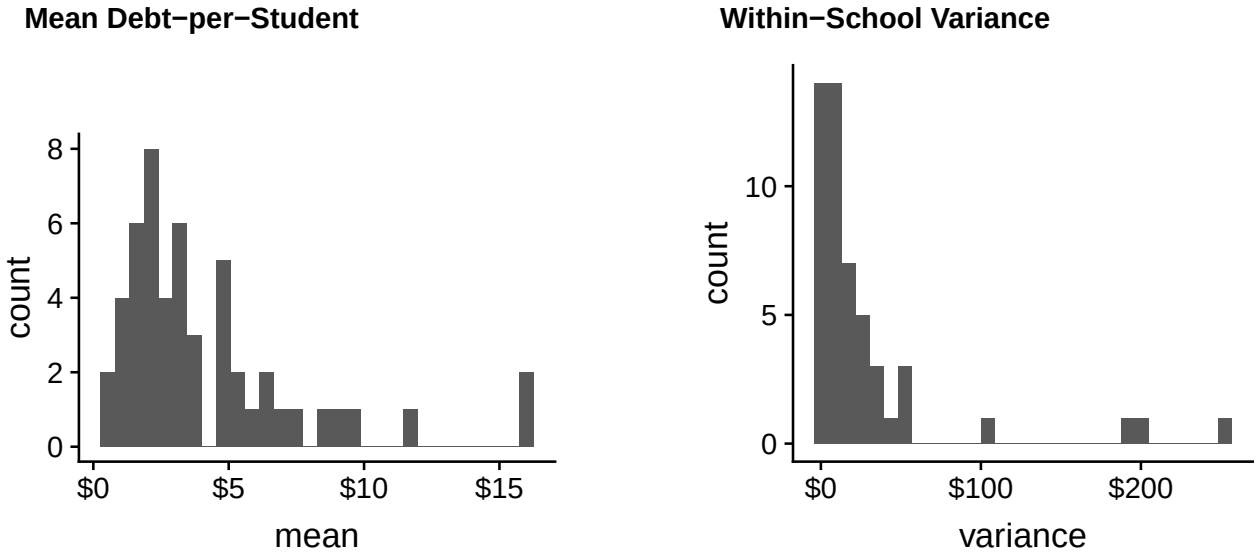


None

of my models for predicting debt per student explained a large amount of the variance in the data, but I was able to single out the best of my models. The percentage of students who receive free or reduced price lunch is a major predictor of debt per student. For every one percent increase in students who receive free/reduced price lunch, the average debt per student increases by $0.10. Based on our EDA, we also know that schools with a high percentage of free/reduced lunch students tend to be mostly black and hispanic. Our model also found that high schools have $1.84 more debt per student than elementary schools. For middle schools, that value is $1.86. This is interesting, since most CEP schools are actually elementary schools.

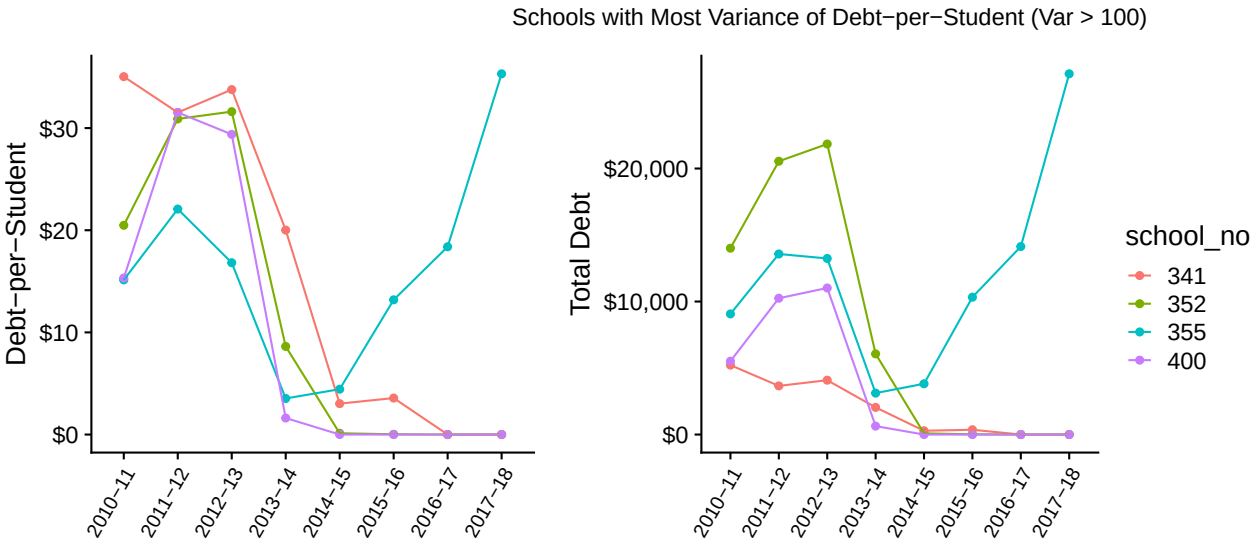
Mean and variance of debt within schools

I also looked at the mean and variance of debt per student by school. This gives us a sense of *how* much debt per student fluctuates within in each school. Schools with a high variance should be looked into—perhaps fluctuations in debt are tied to CEP status? Or someone bailing a school out of debt? Similarly, schools with a generally high mean debt per student are of interest. Why are these schools struggling more than others?

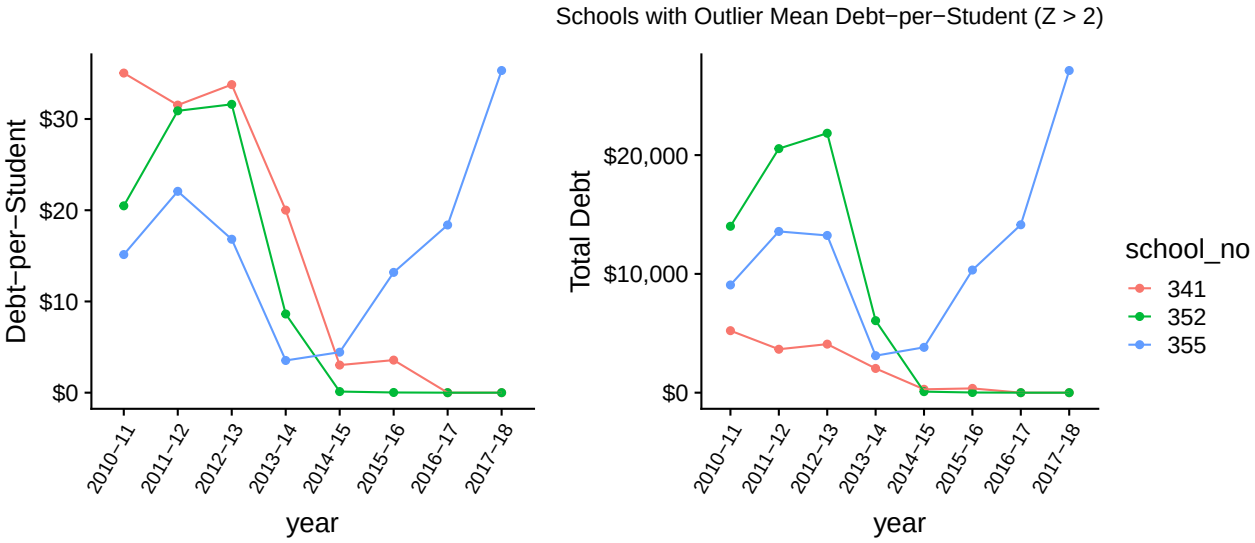


There are definitely some outliers in our data when it comes to variance of within-school debt per student and mean debt-per-student. Let's pull any schools that fall greater than 2 standard deviations from the mean (proper outliers) and see what their debt-per-student looks like longitudinally.

High variance schools



Schools with the most debt



NOTES:

- CEP provisions began in 2014-15 in NC
- data collected at different times so numbers won't match perfectly
- 353 is housed in Durham Tech, which complicates some of the data
- For the most part, aside from missing data, it seems like schools with no debt are CEP schools. We can't get CEP status starting in 2010-11, since those were pilot years.
- CEP schools for 2017-18 all have > 90% free/reduced, setting to 100% (doesn't affect analysis since excluded from regression)

REPORTING QUESTIONS: - how do students get assigned to schools? any diversity initiatives? - does the district track when debt is payed off? - can a student graduate with debt? are they barred from anything? what are consequences besides food?