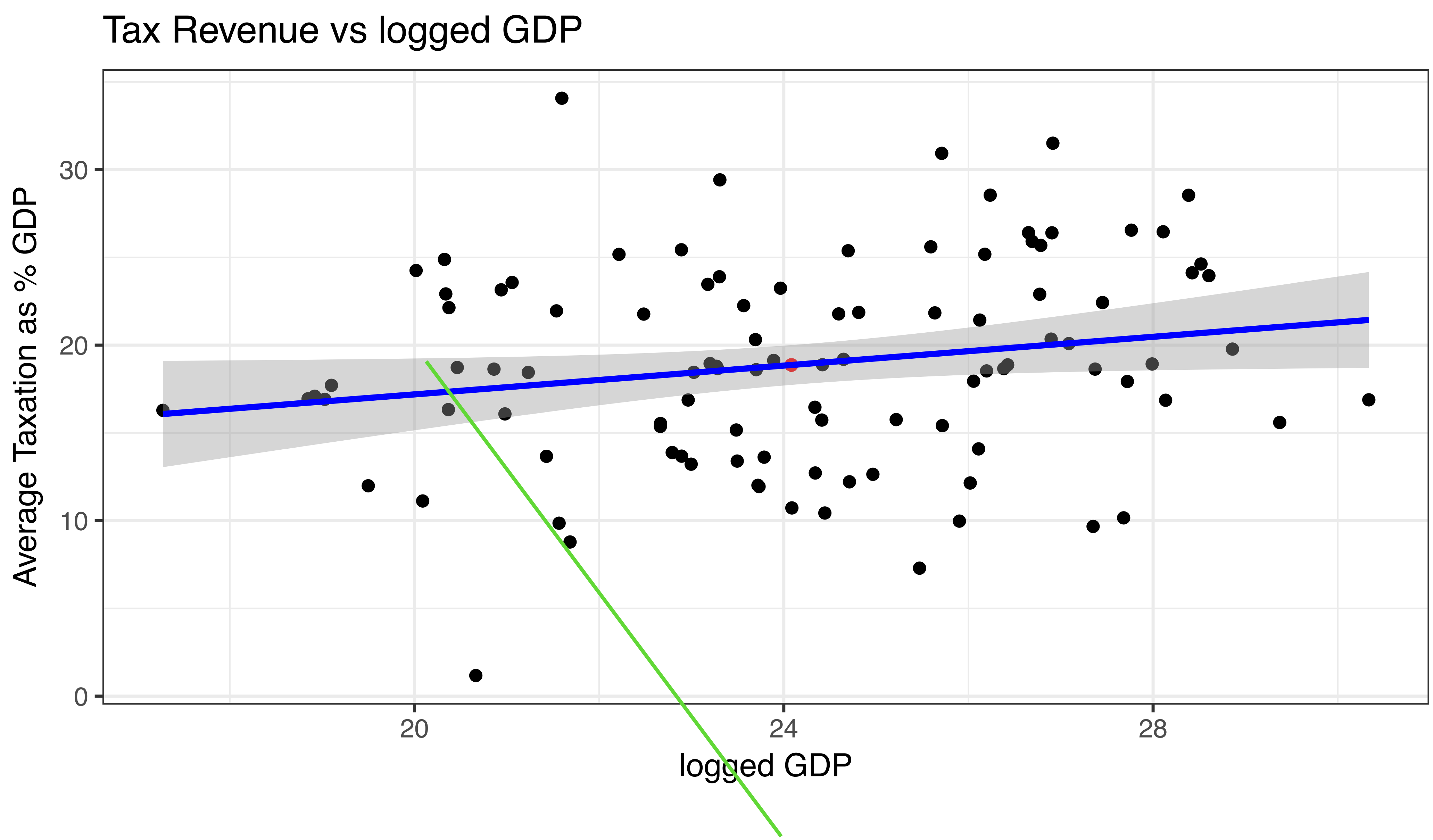
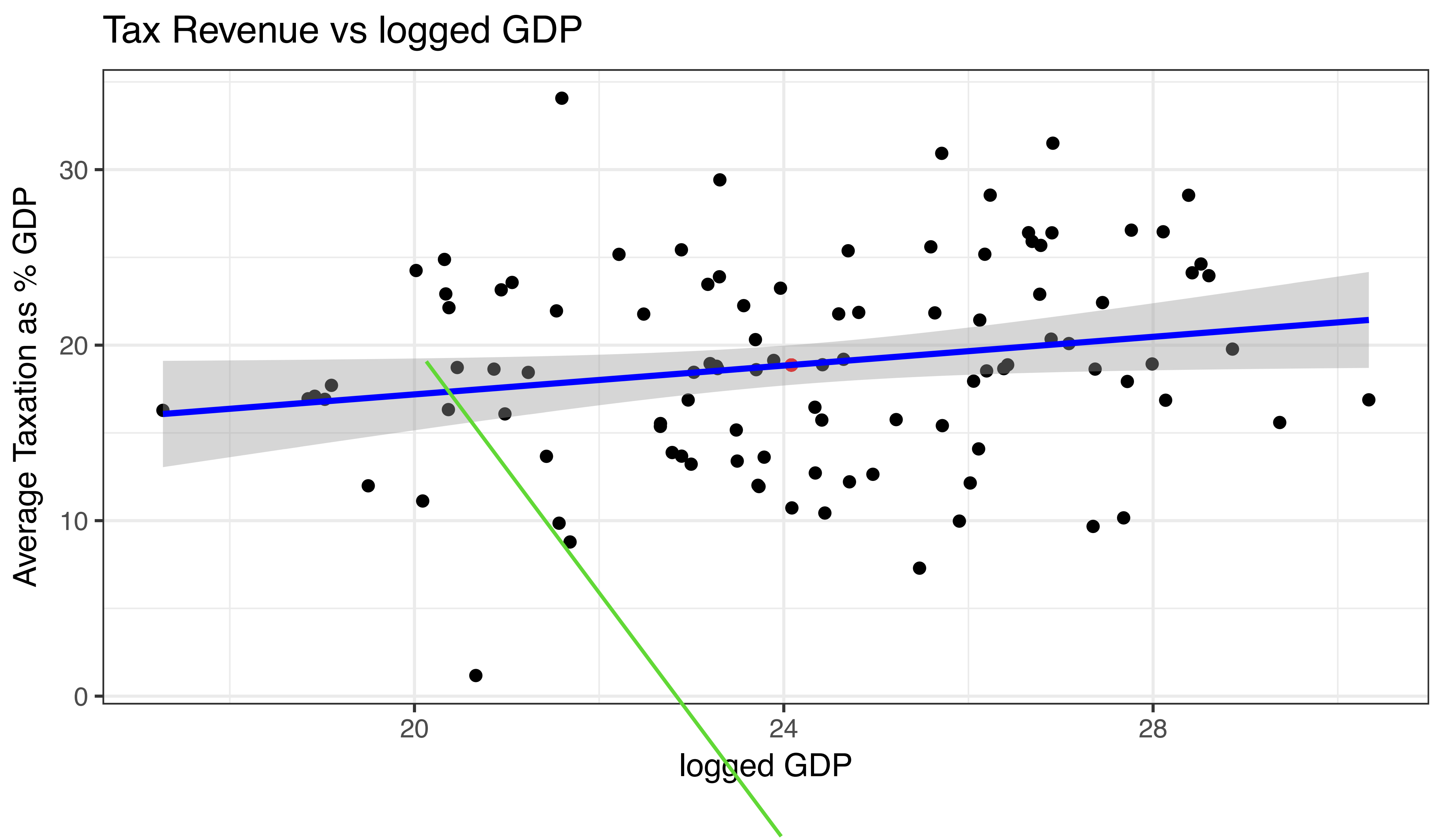
# Regression lines minimize distance to all points

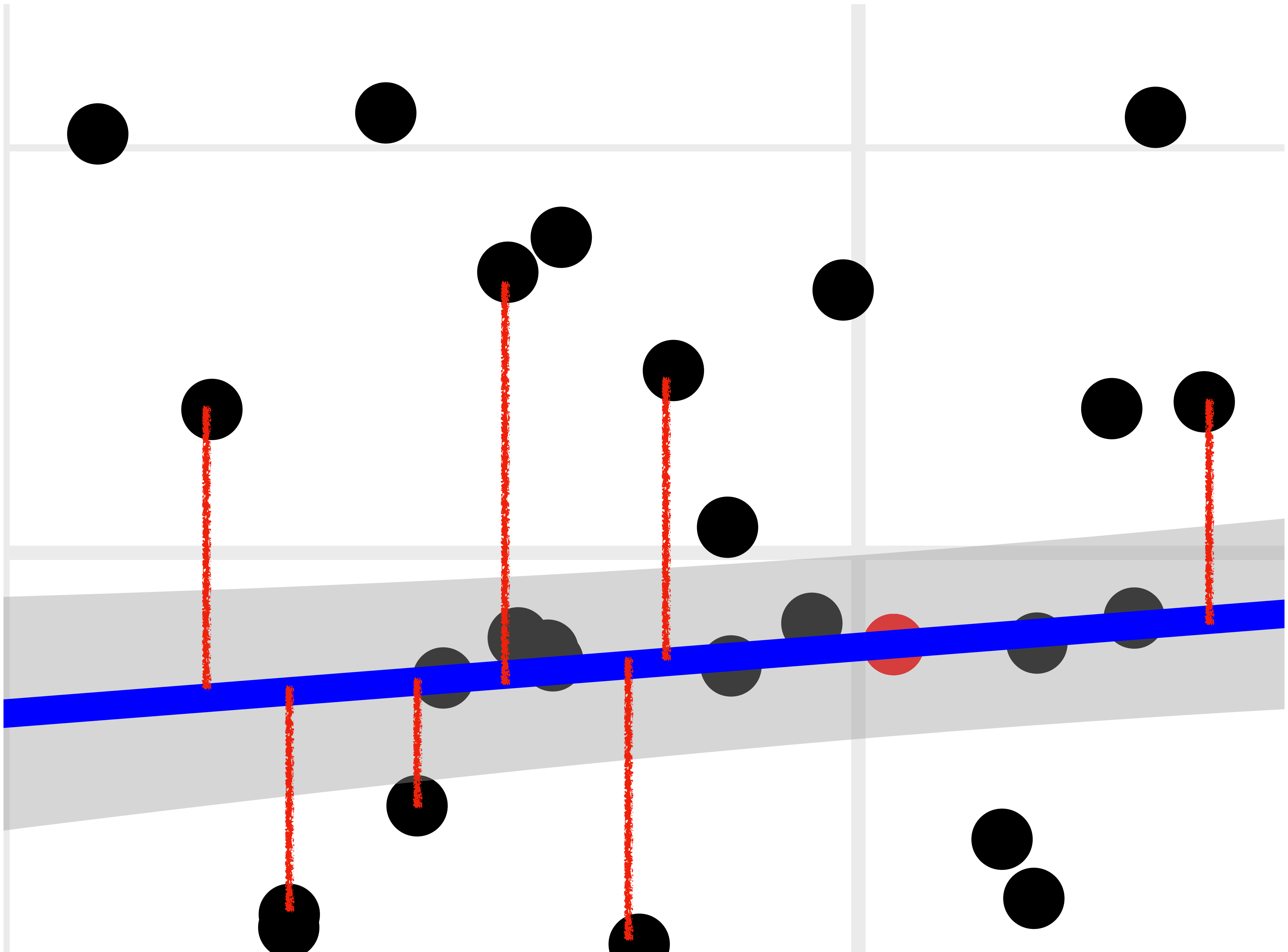


# But the line does not go through all points

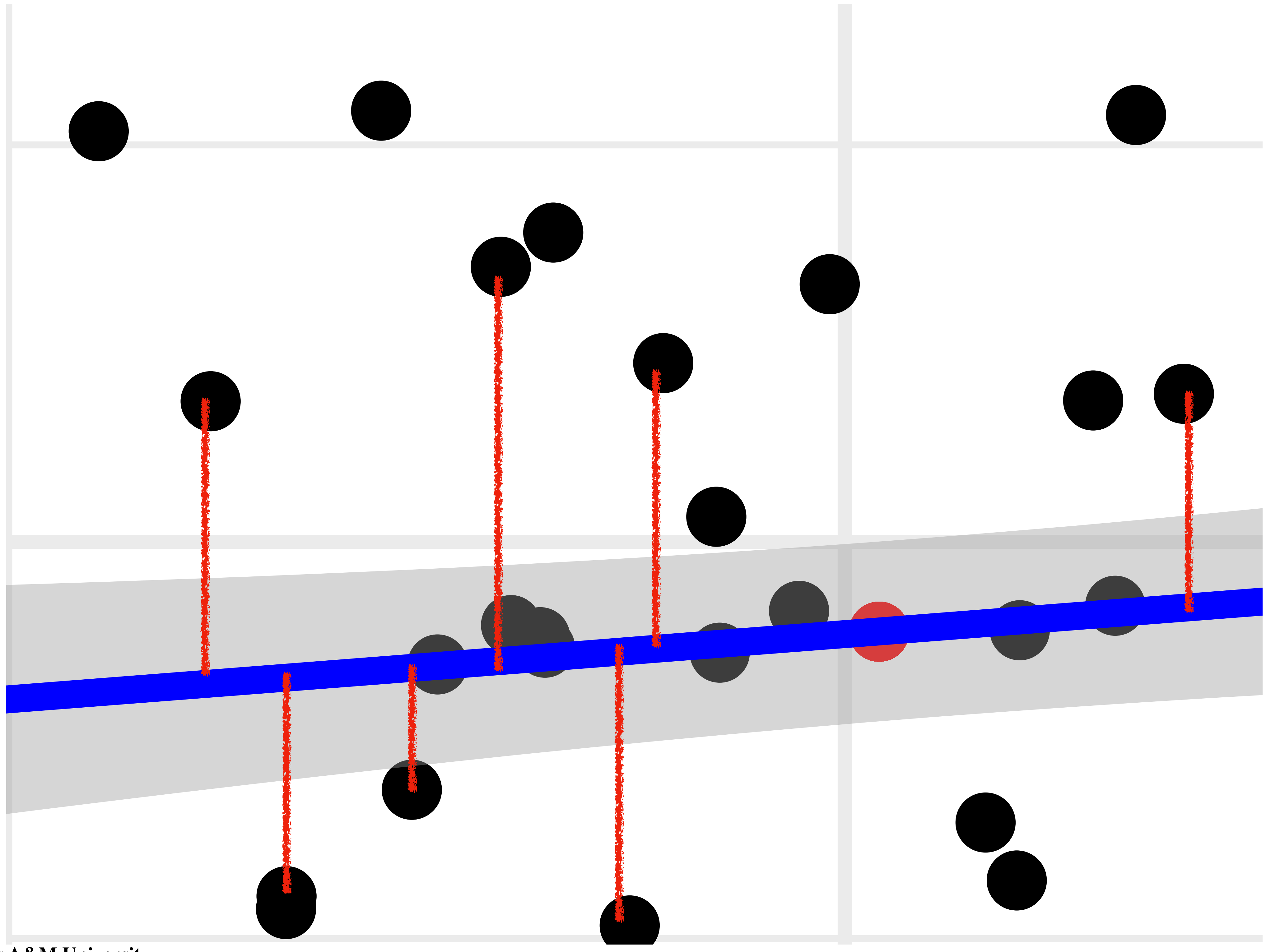


# Each point is associated with an error:

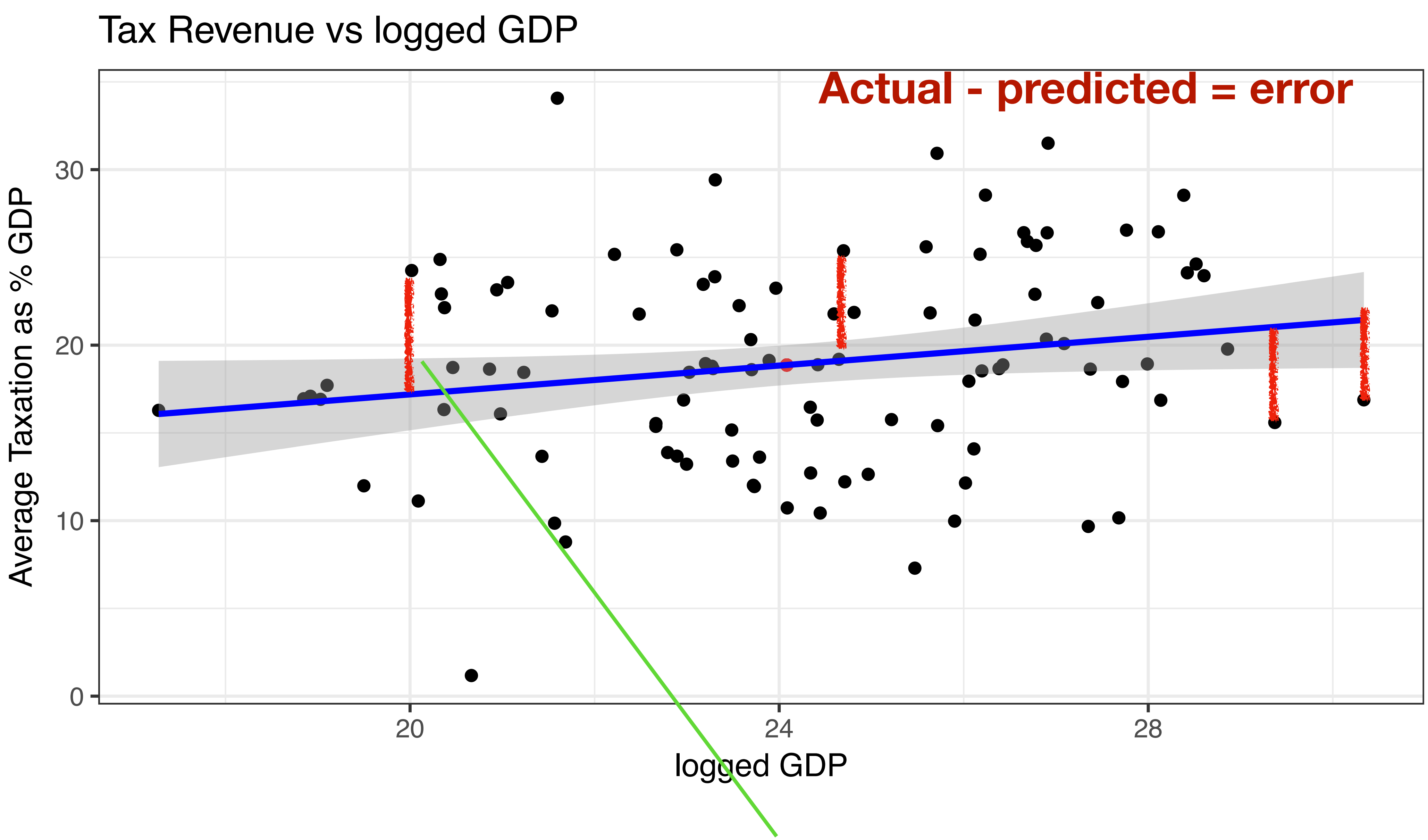
**prediction at x - actual value of y at x**



# Error = prediction - actual y

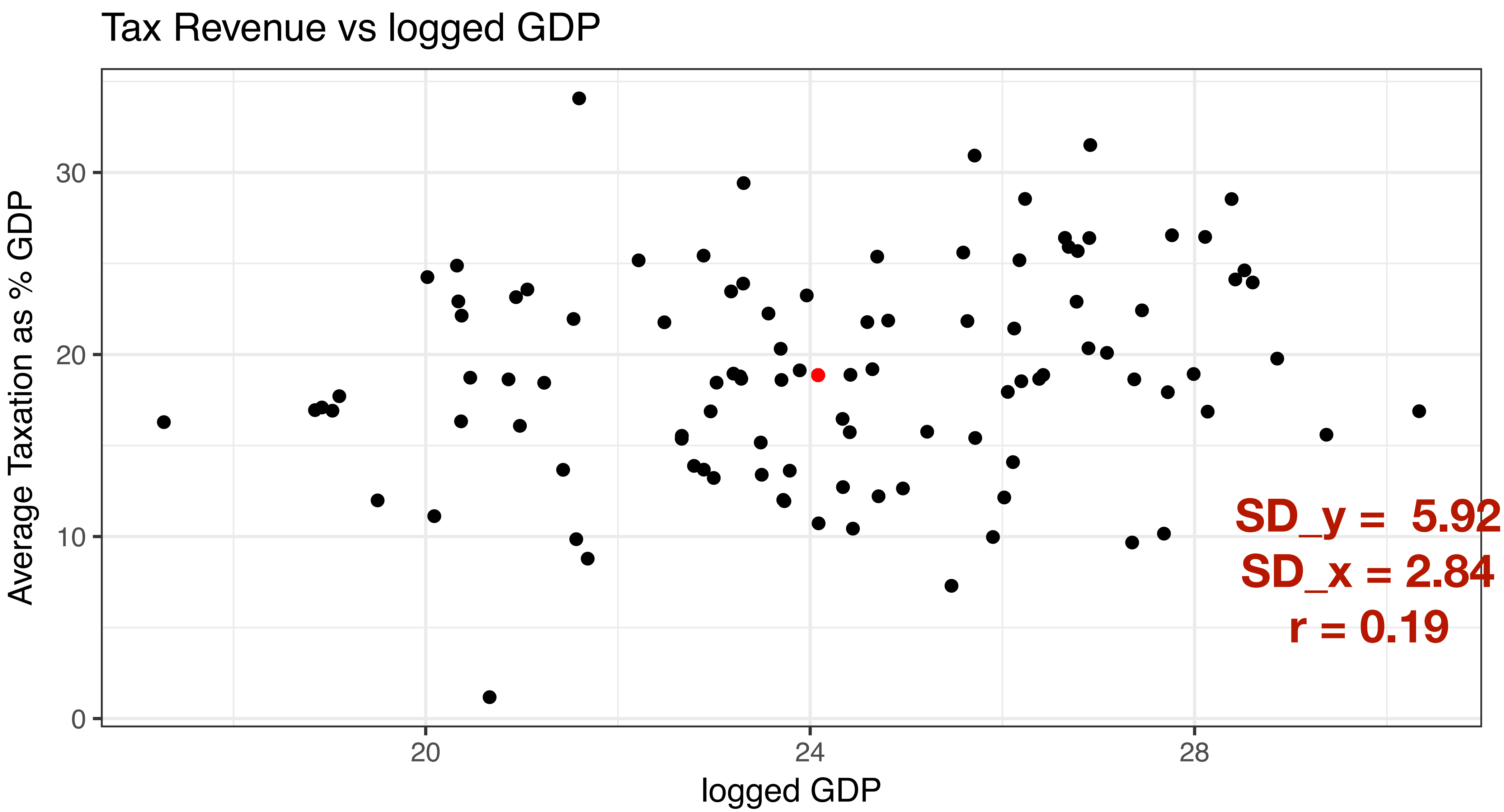


# But regression lines are not perfect




**We always measure the error in terms of prediction error in y! Why?**

# Example of error calculation




**Slope of regression line: 5.92*0.19/2.84 = 0.4**

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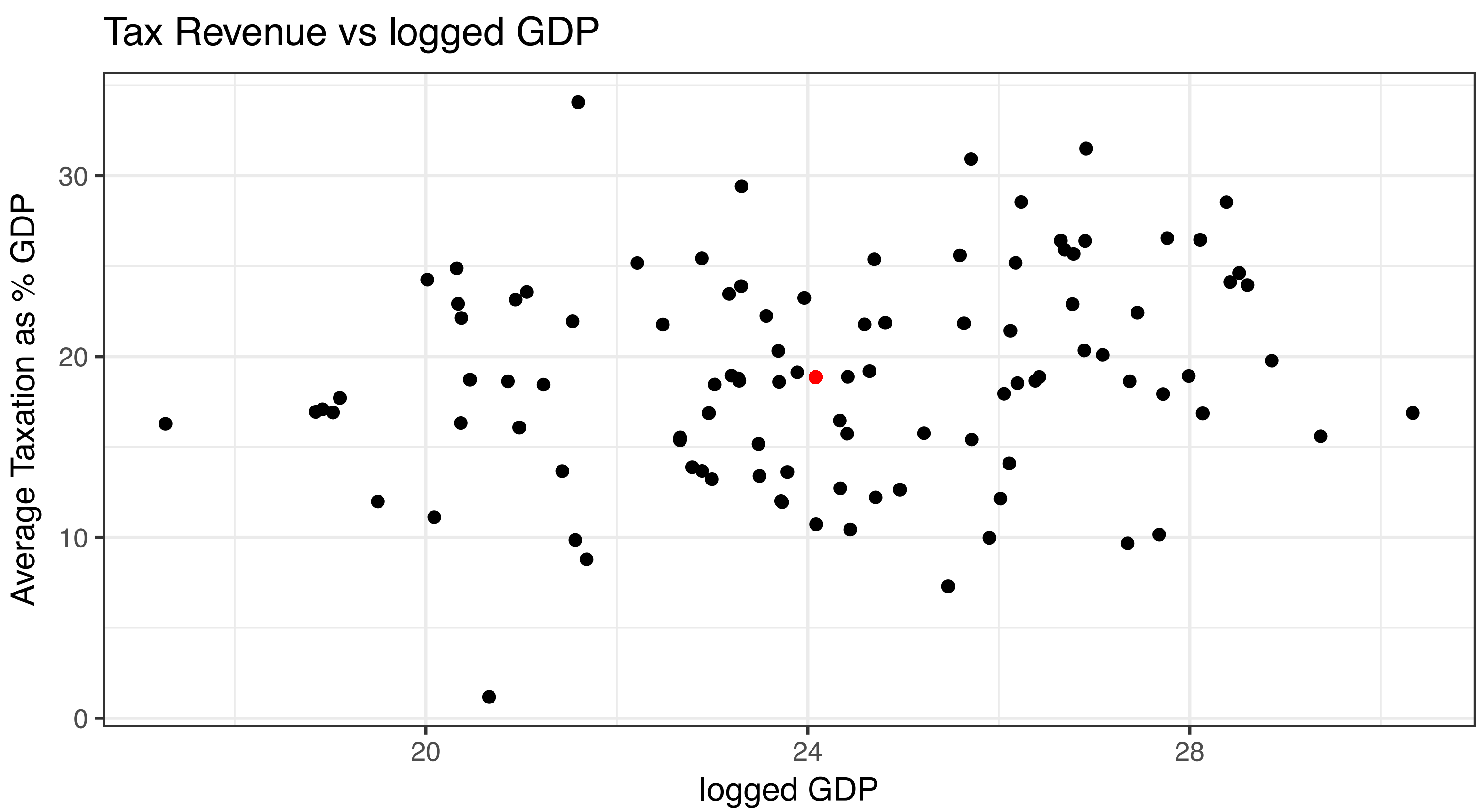


**Mean_y = 18.87**
**Mean_x = 24.09**
**SD_y = 5.92**
**SD_x = 2.84**
**r = 0.19**

**Slope of regression line: 0.4**

**What is the prediction for x = 27.35????**

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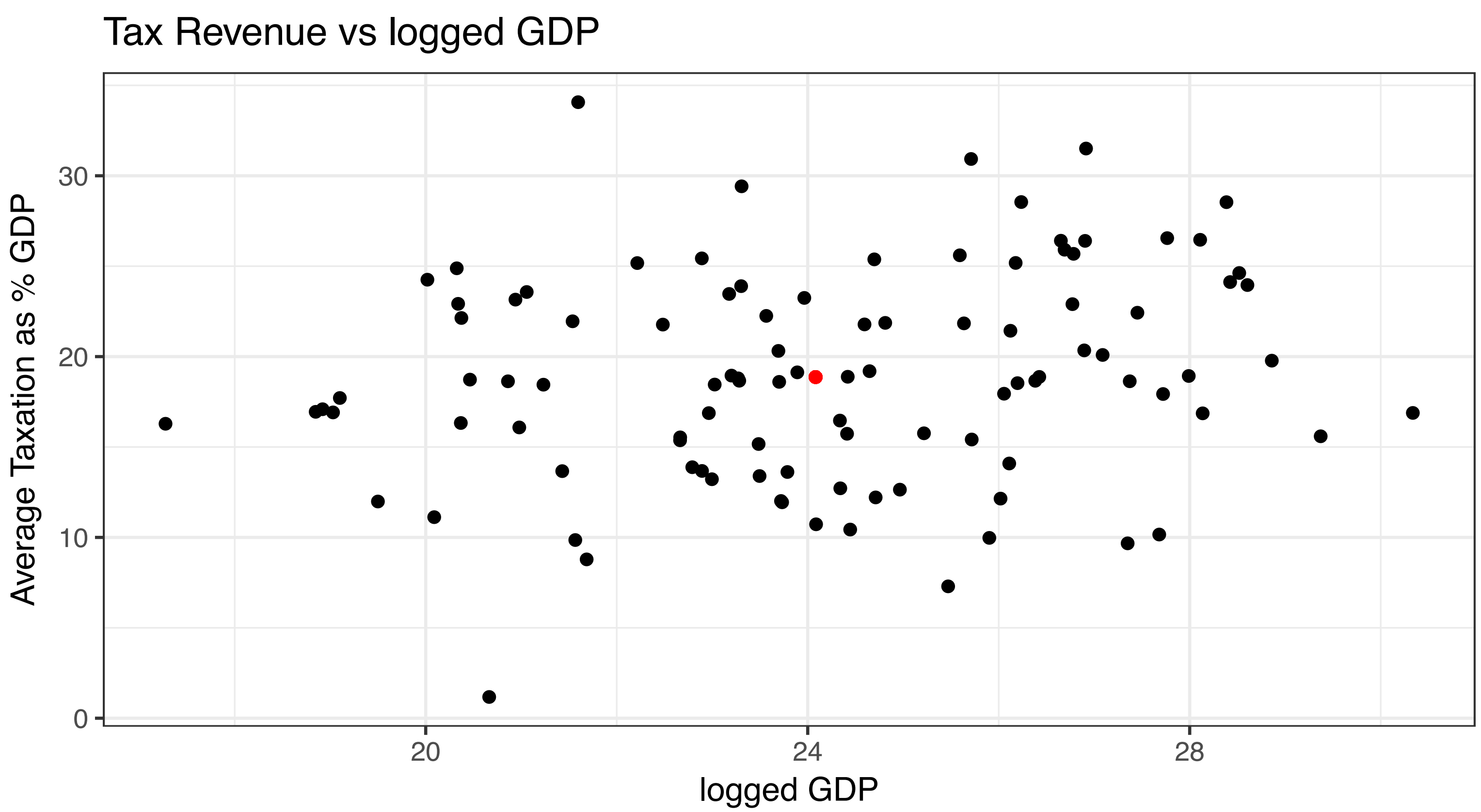


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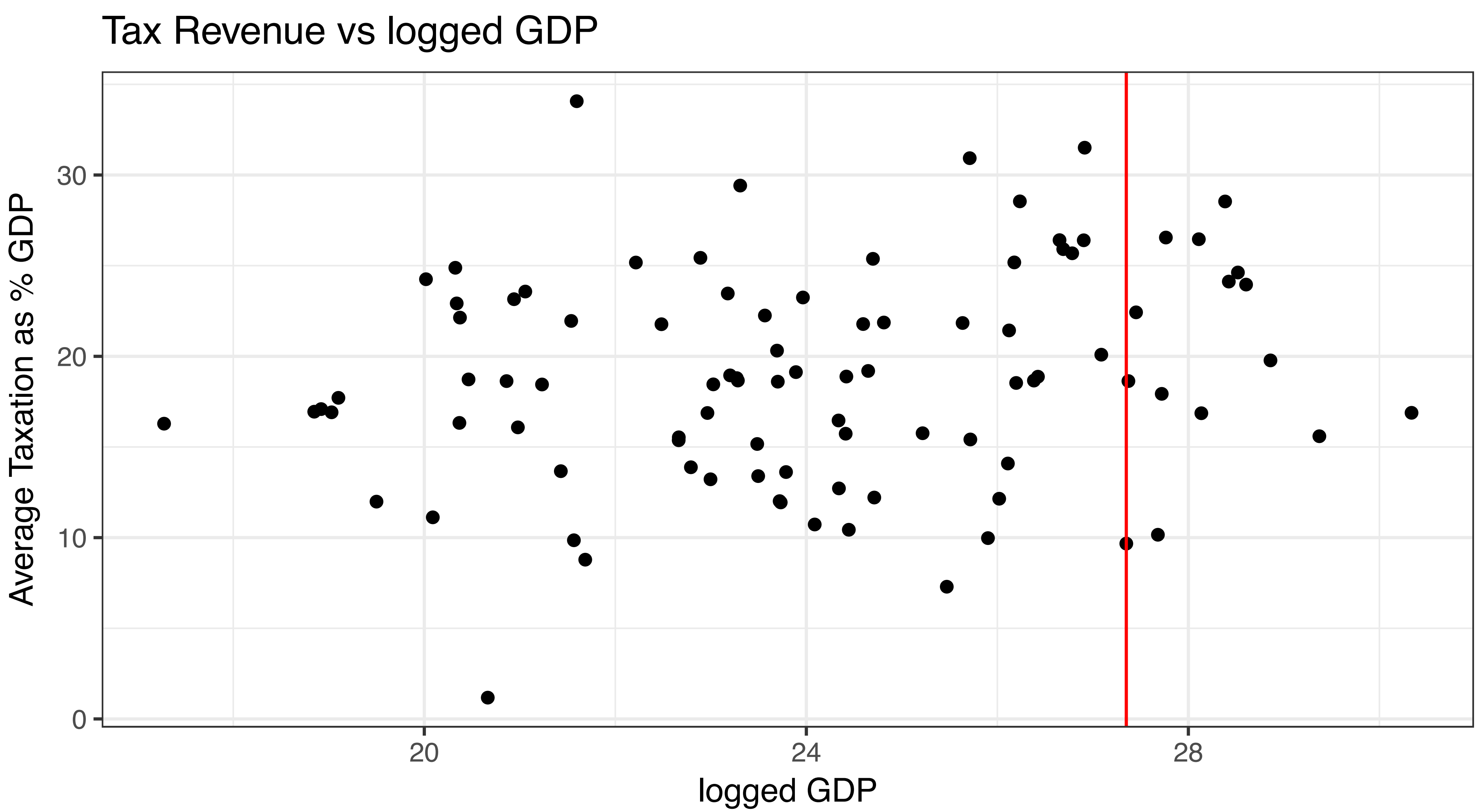



**What is the prediction for x = 27.35????**
**y_pred = 20.16**
**Actual Y: 9.67**
**Error = 9.67 - 20.16 = -10.49**

Coach Sumlin asked for a prediction of the number of running plays that the Florida Gators will run on Saturday given that 2 inches of rain are expected. The correlation between rain in inches and number of running plays is 0.6. The average amount of rain in Gainesville is 0.5 inches with a standard deviation of 1. The Florida Gators run 35 running plays on average, with a standard deviation of 8.6. Based on 2 inches of rain, what is your prediction for the number of run plays executed by the Gators on Saturday?

**But we had 0 inches of rain. What is the prediction?**

32.42 predicted run plays

Actual number of run plays: 42

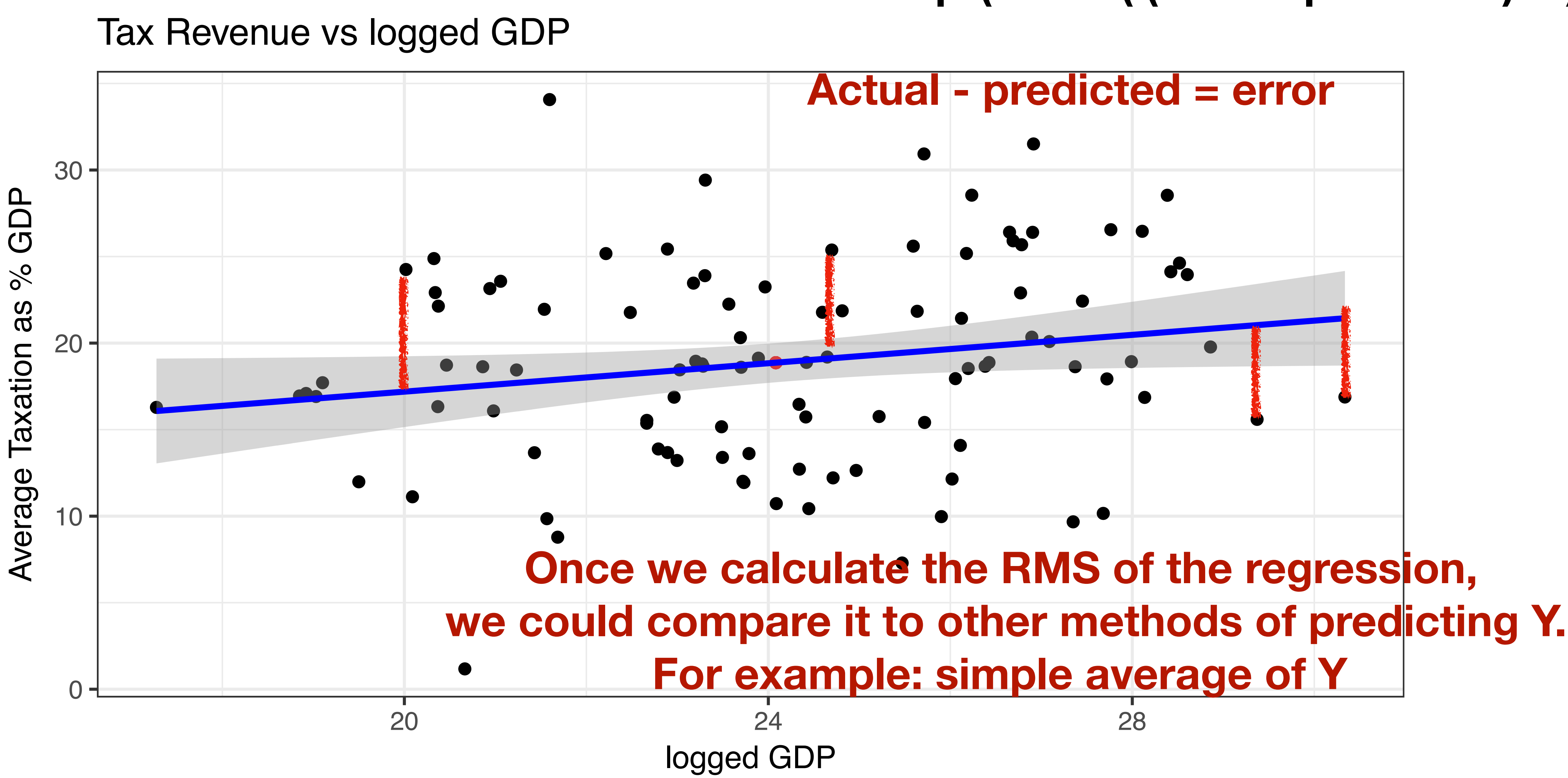
Error: 42 - 32.42 = 9.58

# Recall the root mean squared error

- RMS = square root of the mean of the squared errors
- Approximately equal to the average of how far points are above and below the line
- RMS is always in the unit of the dependent variable (the variable to be predicted - y)
- Why can't we just take the average of the errors?

# But regression lines are not perfect

**RMS = sqrt(mean ( (actual-predicted)^2))**



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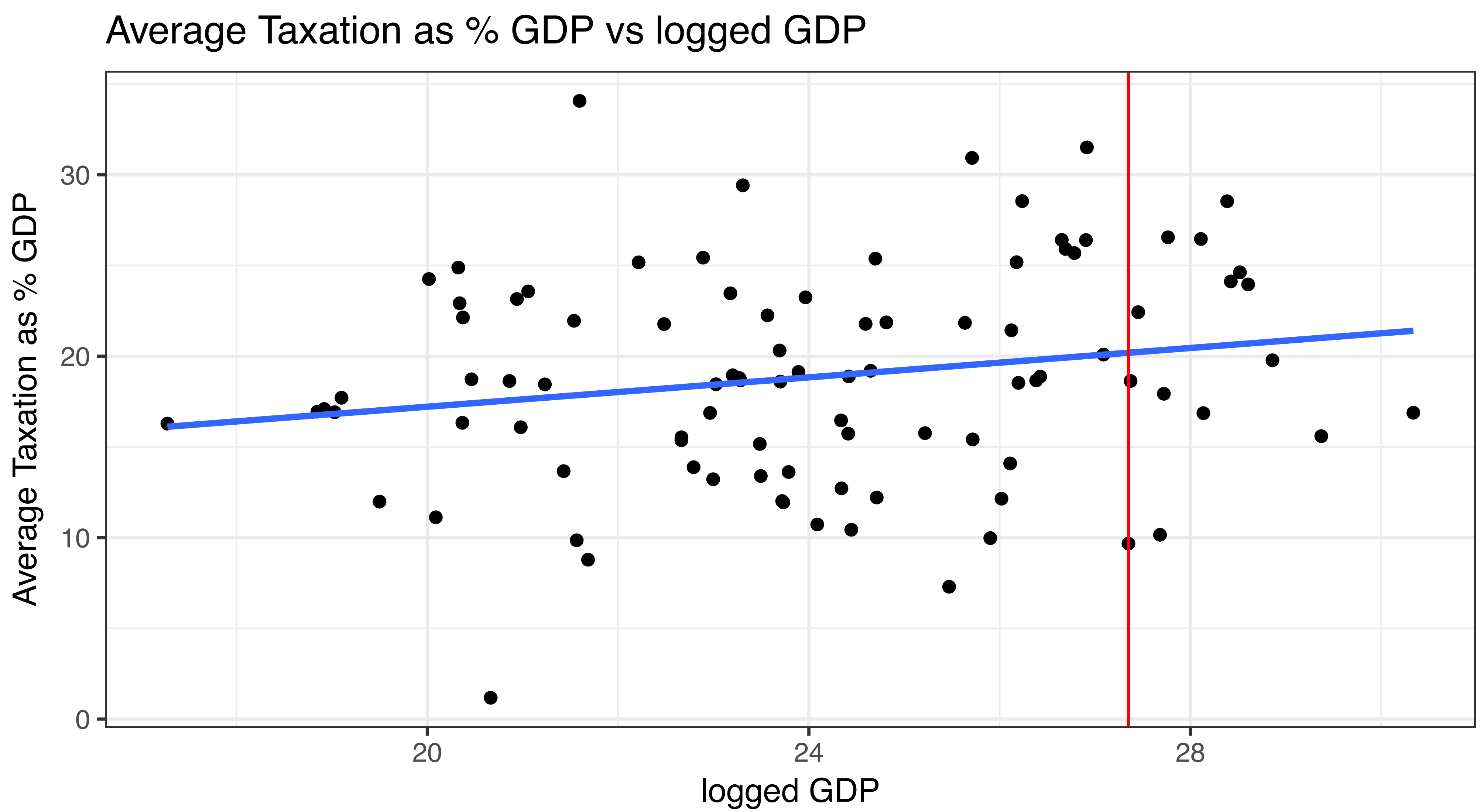
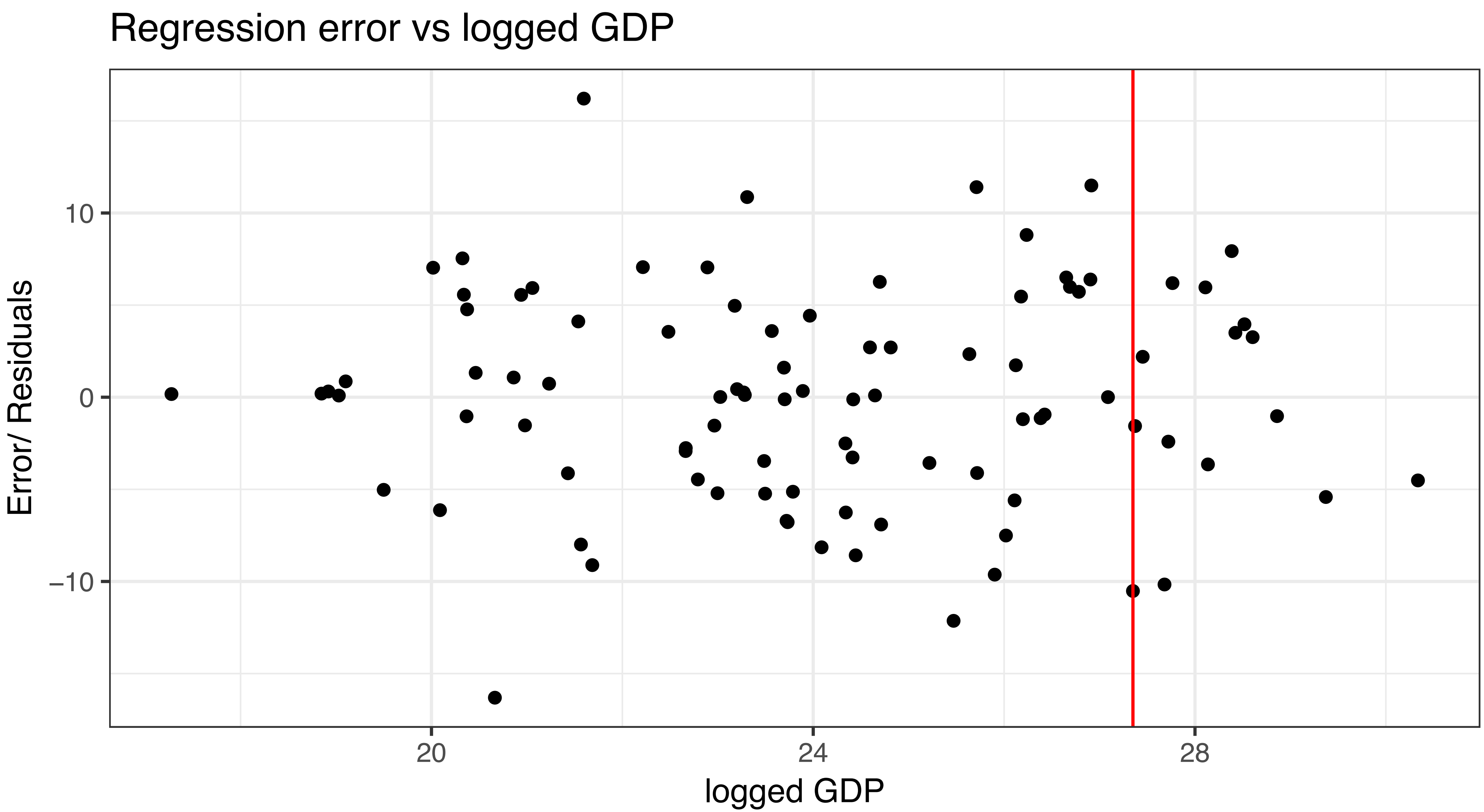
- What is the root mean squared error of using the average of y to predict y?
- The standard deviation!

# Computing the rms for the regression

- In theory, we could calculate the rms by doing the calculation for every point in our data
- Luckily, we have a formula that makes calculation much simpler: rms_regression = SD_y * sqrt(1 - r^2)
- Again:  rms is in the same units as the dependent variable
- In earlier example, rms would be in tax as % of GDP




# Plotting Errors or Residuals




# Plotting Errors or Residuals

# Often the error is also called the residuals

- We can plot the error/residuals against the x-axis
- The residuals should average out to zero
- Regression line through residuals should be flat
- If residuals look funnel shaped, things are problematic

# Homoscedasiticity

- Spread around the regression line is similar (the same) along the whole line

- The accuracy of predictions given the regression line should be the same along the whole line

- Football-shaped scatter plot

- If this condition is violated, we say the regression suffers from heteroscadasticity

# Normal approximation in vertical strips

- What is the new average?
- What is the new SD?
- Everything else stays the same

# Exercise

- Law school finds the following relationship btw. LSAT scores and first-year scores:
  - Average LSAT: 162, SD = 6
  - Average first-year score: 68, SD = 10,
  - R = 0.6

A. What is the percentage of students with first-year scores above 75?

B. Of students who scored 165 on LSAT, what percentage had first-year score greater than 75?

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# Exercise

- Correlation in height for 66 boys:
  - Average height at 6, 3 feet and 10 inches, SD = 1.7 inches
  - Average height at 18, 5 feet and 10 inches, SD= 2.5
  - R = 0.8

A. RMS for regression predicting height at 18 from height at 6

B. RMS for regression predicting height at 6 from height at 18