What factors affect students' learning through *Carbon TIME*?

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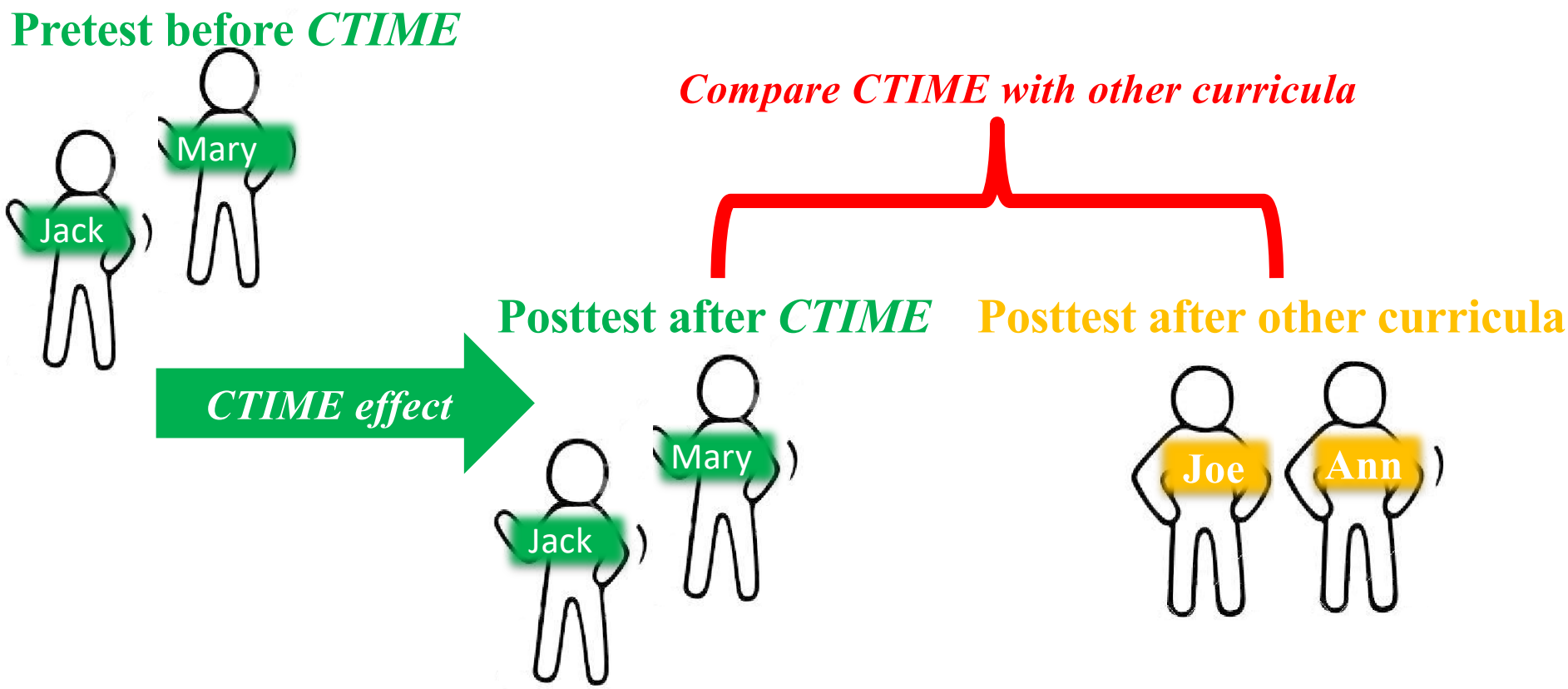
Outline

1. How successful is *CTIME?*
2. What factors affect students' learning about *CTIME?*
3. How do student and teacher success change over time?
4. How do students learn from first unit to third unit in *CTIME?*
5. How can we use these data to construct value-added models that provide evidence about the success of individual teachers?

1. HOW SUCCESSFUL IS *CTIME?*

Two-ways to think about how well *CTIME* works

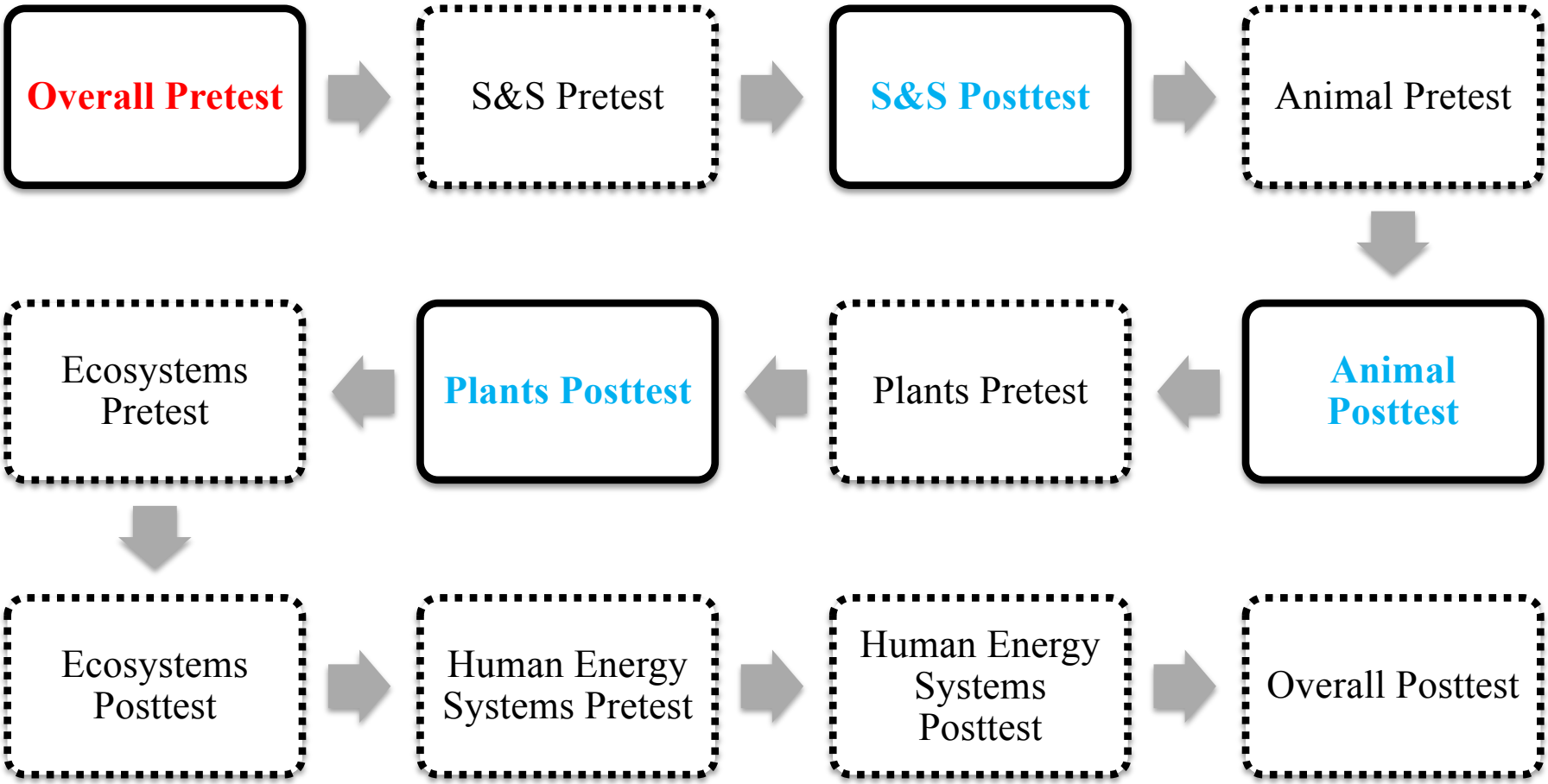
- ***Approach 1 (Pre vs. Post)***: Compare pre and post from same students taught by same teachers with *CTIME*
- ***Approach 2 (CTIME vs. non-CTIME):*** Compare posttest from two groups of students taught by same teachers with *CTIME* and other curricula



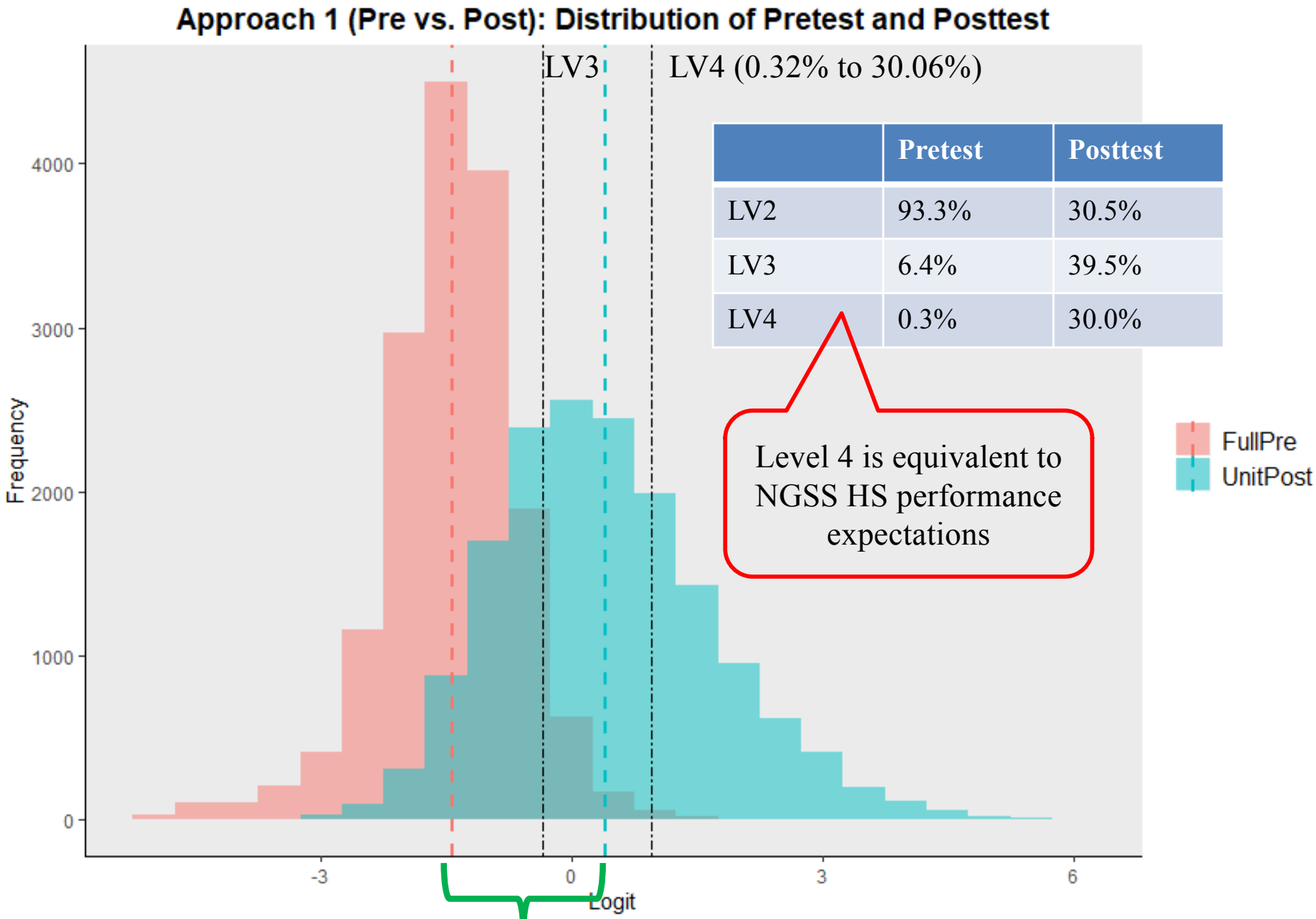
- ***Approach 1 (Pre vs. Post)***:
  - can check the gain score for each student since we can match pretest and posttest
  - *Students' prior knowledge* can be controlled by pretest
  - We report results over a four-year period, from 2015-16 to 2018-19 students from classrooms, taught by 133 teachers
- ***Approach 2 (CTIME vs. non-CTIME):***
  - can only compare at the mean level because we can NOT match pretest and posttest
  - *Students' prior knowledge* controlled by assuming the two groups of students have similar prior knowledge on average
  - We report results over a 2-year period, from 2016-17 to 2017-18, 3,191 students for other curriculum and 3,615 students for *CTIME* from 57 teachers

- All student learning levels are results generated by IRT analyses.
  - Focus on Carbon Dimension/macroscopic scale explanations
  - Overlapping items made it possible to calibrate items and test difficulties across years and across tests on the same scale
  - Measures: calculated proficiencies in logits
    - *0 represents the overall student mean across all tests*
    - Thresholds for translating to learning progression levels:
      - Below -0.34: most likely at level 2
      - Between -0.34 and 0.96: most likely at level 3
      - Above 0.96: most likely at level 4, this is expectation of NGSS

- Pretest: Overall Pretest
- Posttest: Average Unit Post
  - Near transfer
  - Better validity



Approach 1 (Pre vs. Post):

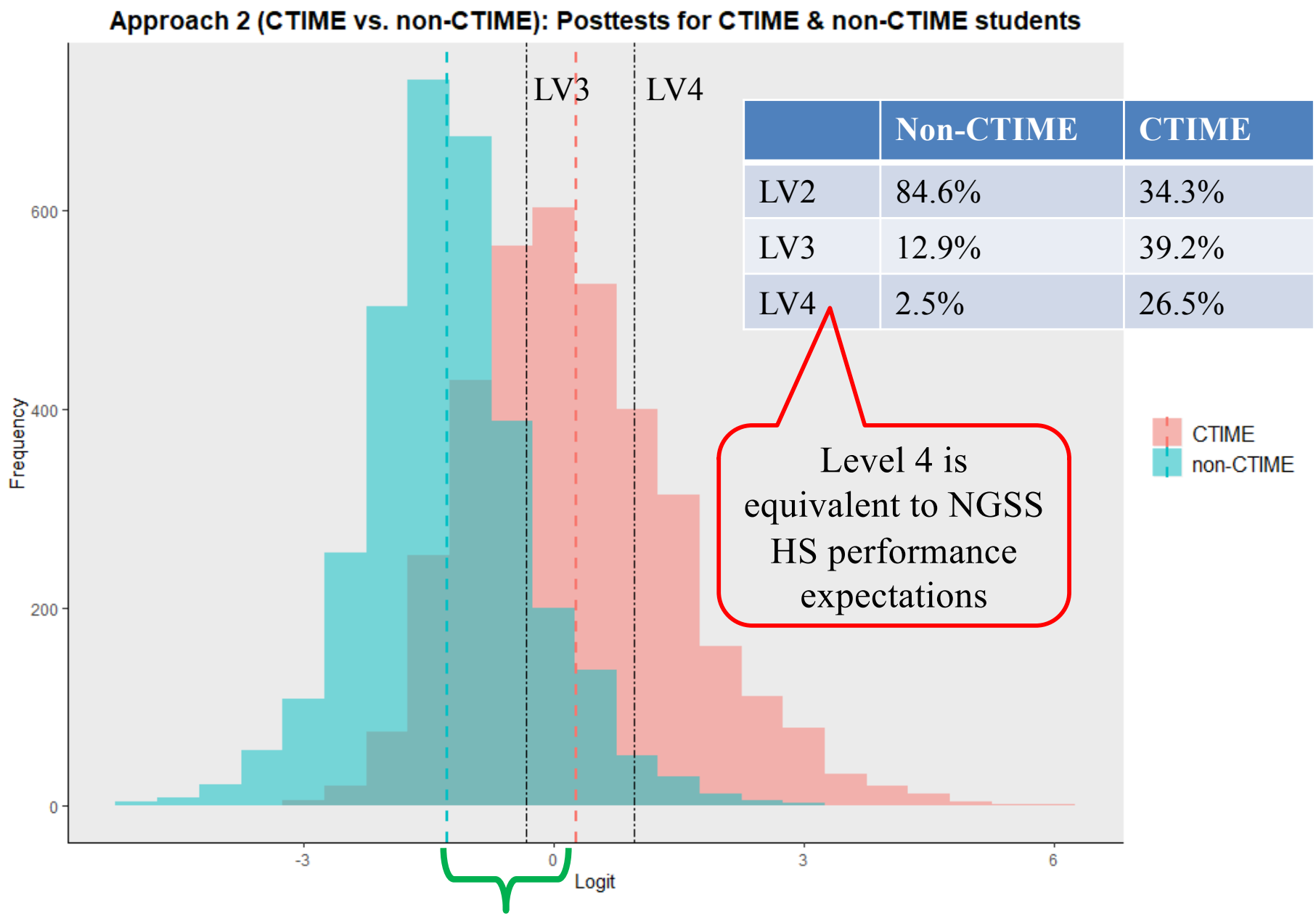


	Pretest	Posttest
LV2	93.3%	30.5%
LV3	6.4%	39.5%
LV4	0.3%	30.0%

Level 4 is equivalent to NGSS HS performance expectations

Average increased from -1.435 to 0.396

Approach 2 (CTIME vs. non-CTIME):



	Non-CTIME	CTIME
LV2	84.6%	34.3%
LV3	12.9%	39.2%
LV4	2.5%	26.5%

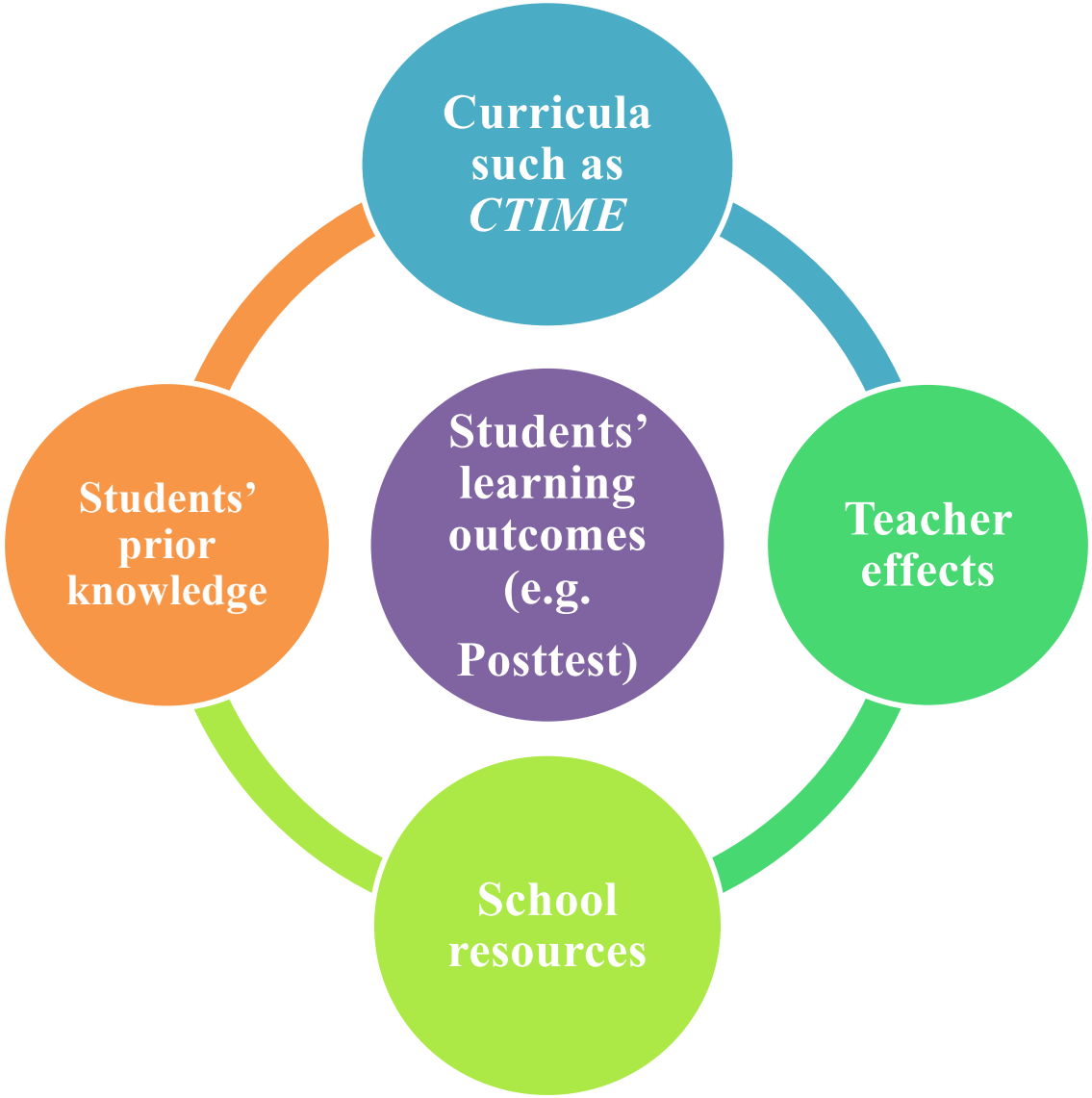
Level 4 is equivalent to NGSS HS performance expectations

The two averages are -1.274 and 0.264

2. HOW DO VARIOUS FACTORS AFFECT STUDENTS' LEARNING THROUGH *CTIME*?

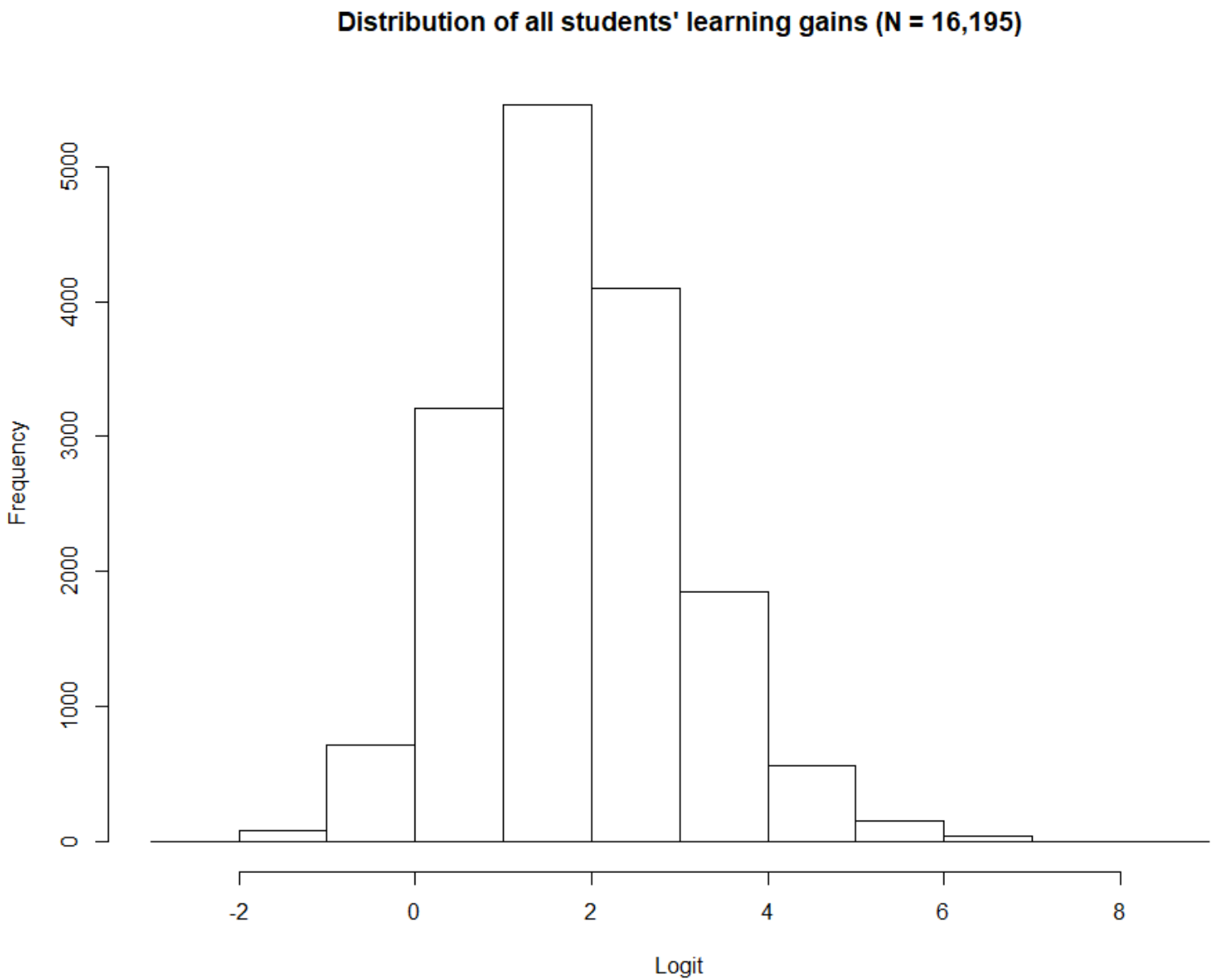
How to figure out the effects of these factors on students' learning through *CTIME?*

- *We know there are many factors that may affect students' learning outcomes in general.*
- *Question is: how these factors affect students' learning through CTIME?*



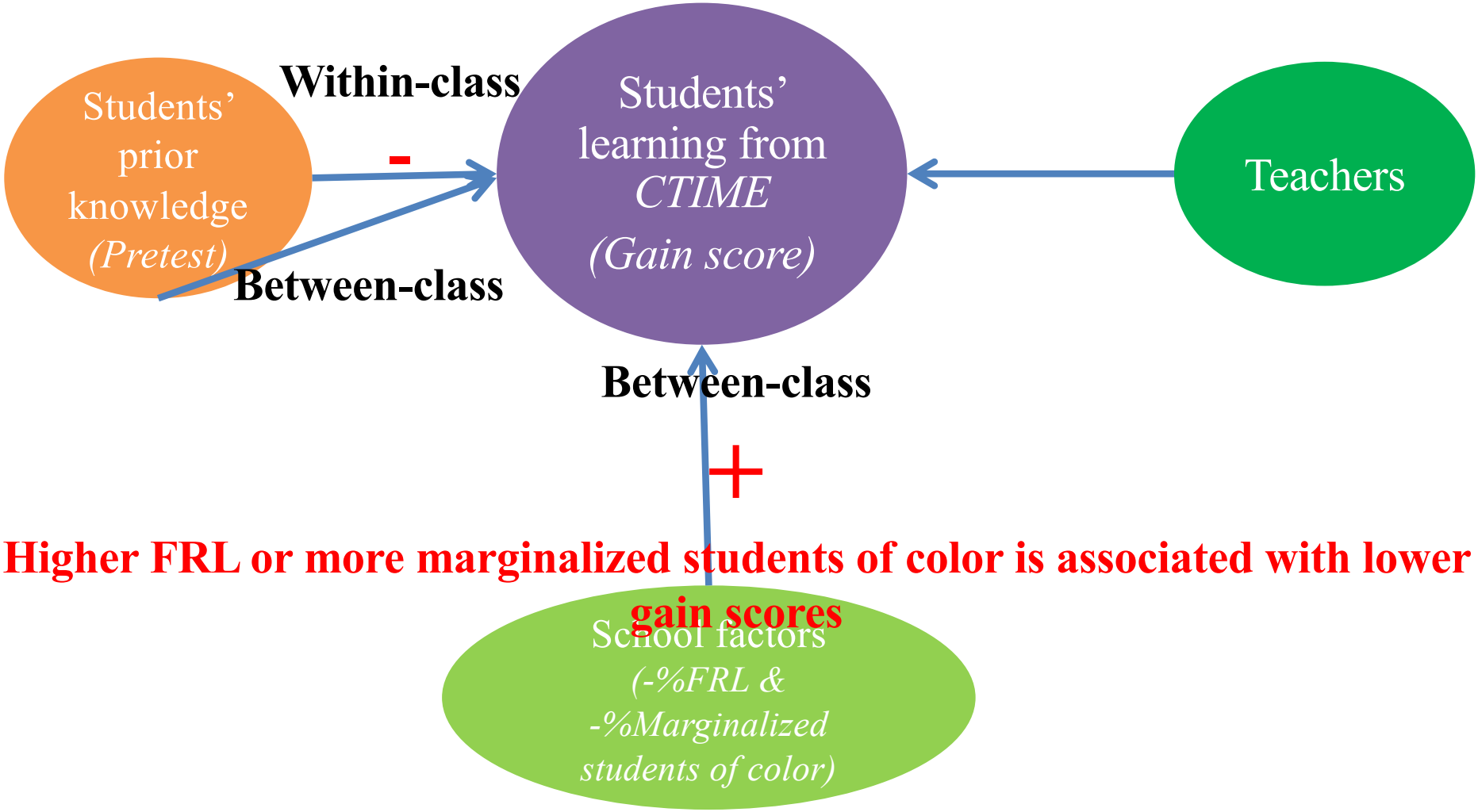
***Approach 1 (Pre vs. Post)*:**

Distribution of gain scores (Average Unit Post – Full Pre)



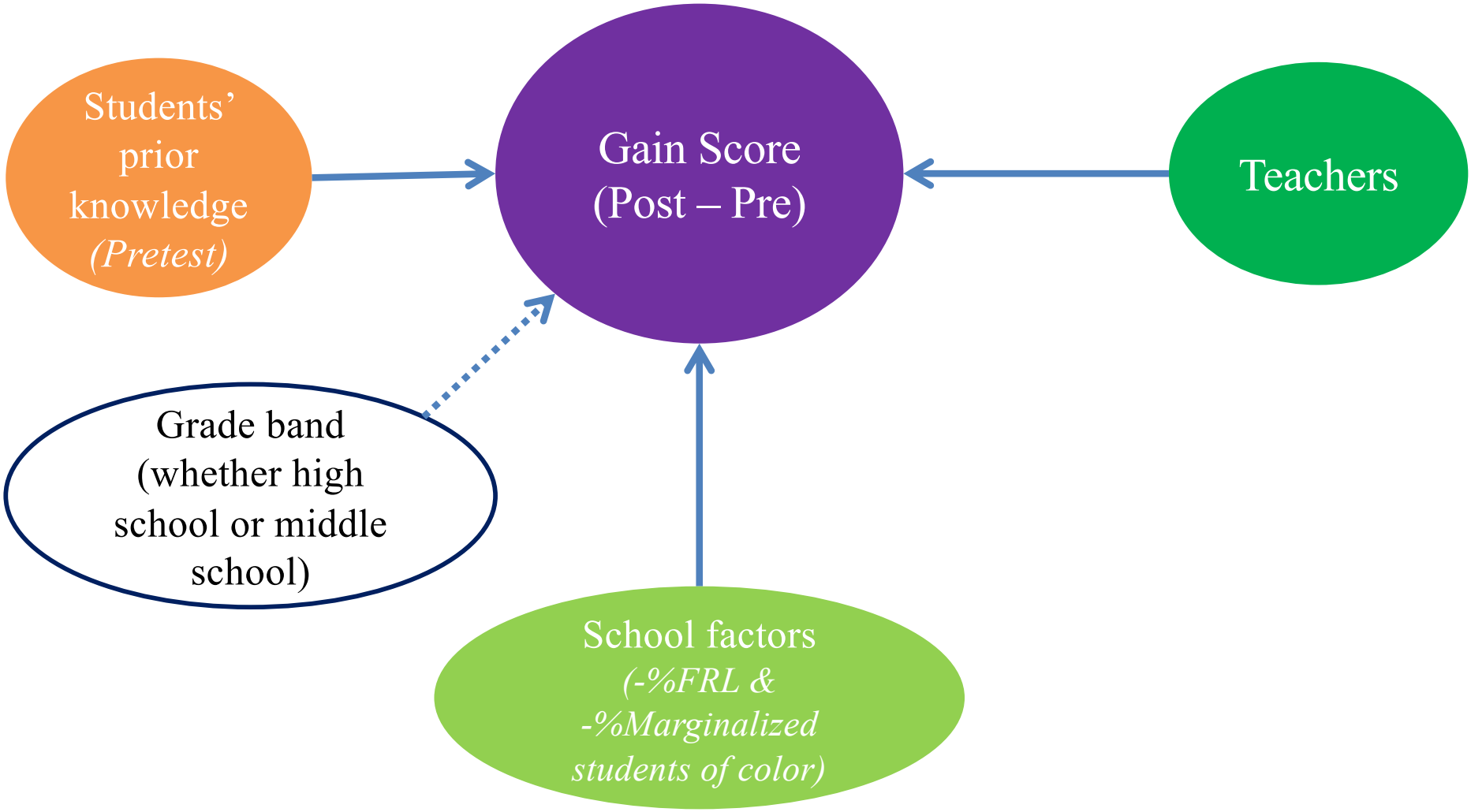
Important factors that affect students' *learning from CTIME*

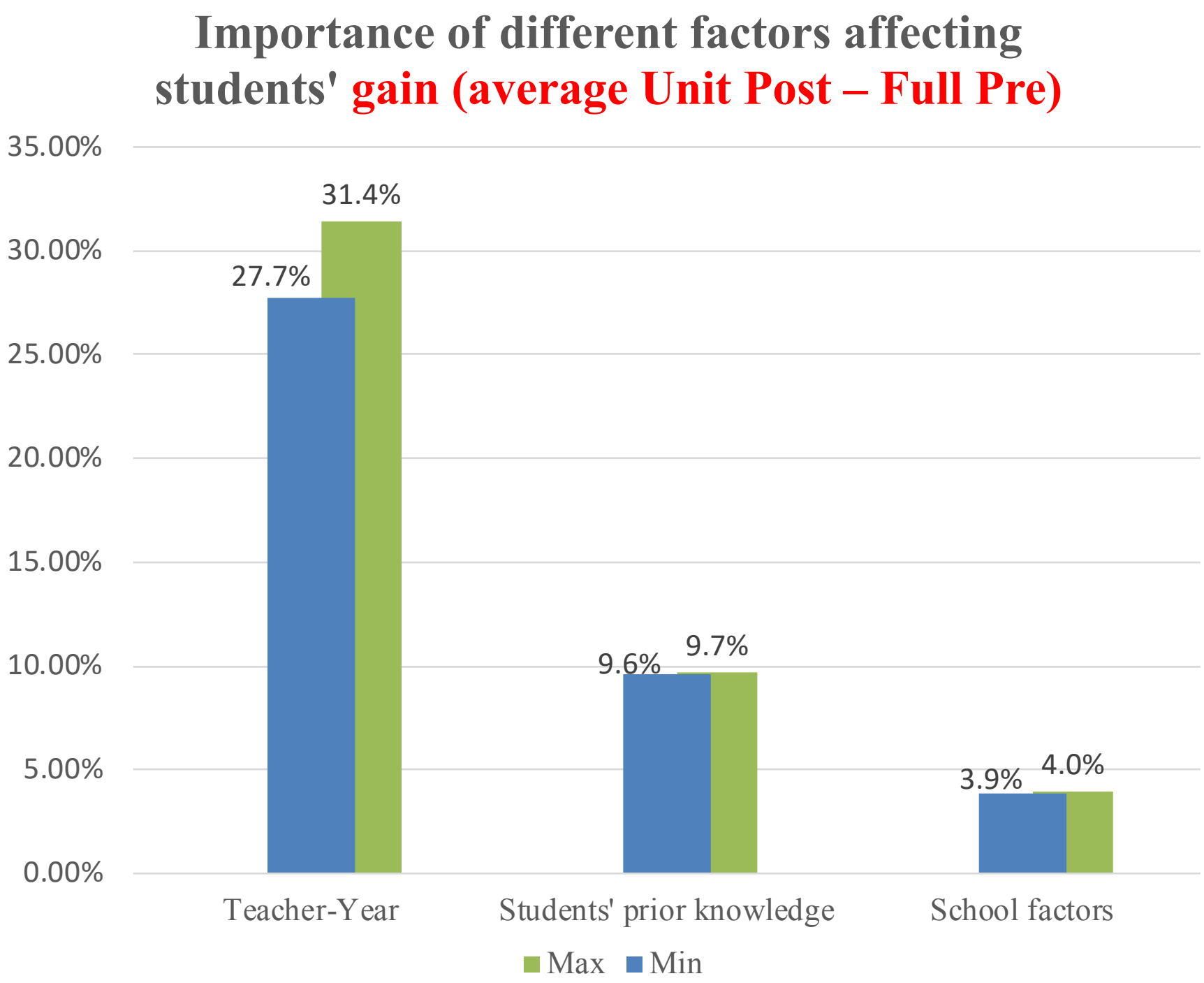
Lower pretest scores are associated with higher gain scores



Higher FRL or more marginalized students of color is associated with lower gain scores

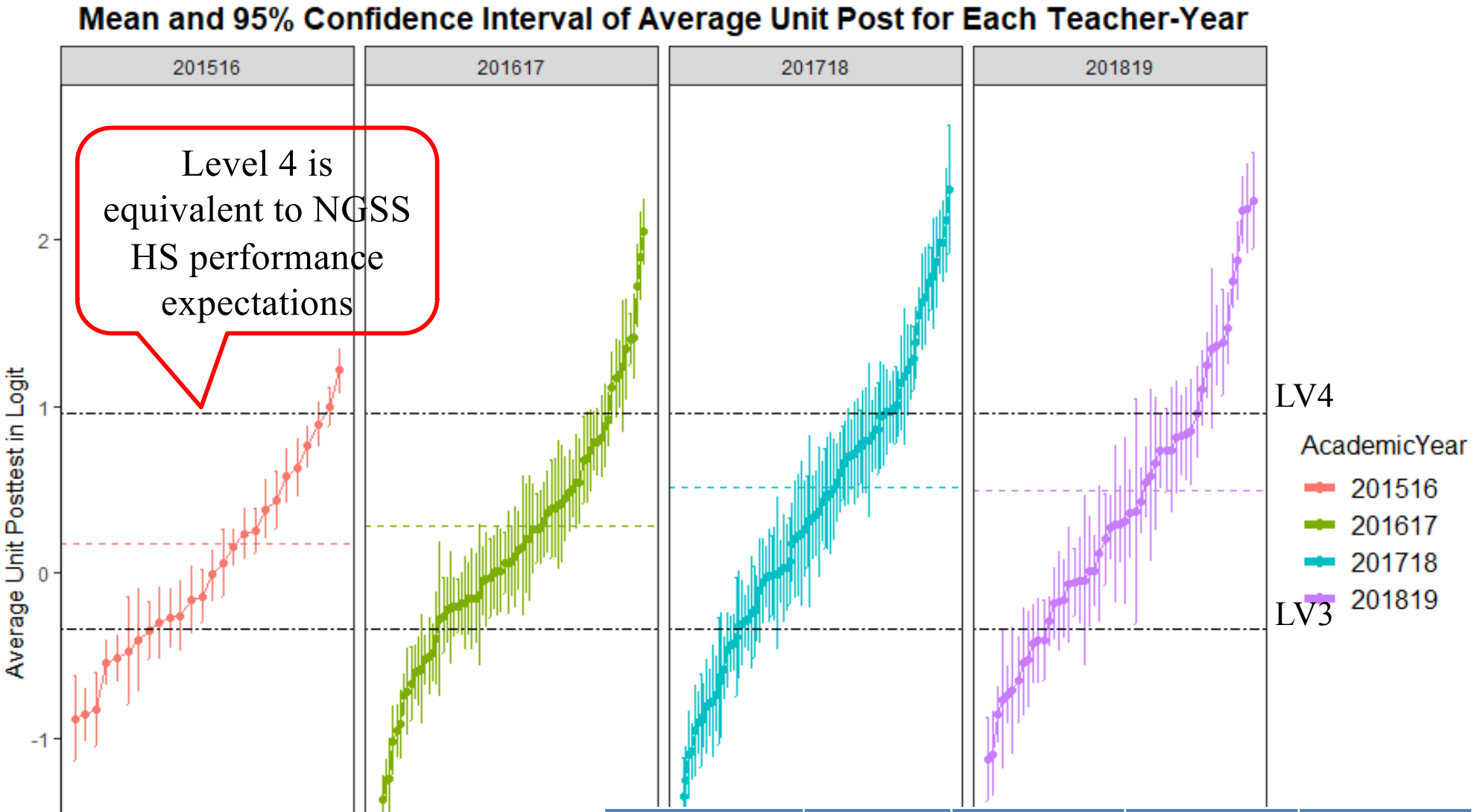
The other factors that we have excluded because they do not have significant unique contributions




Importance of different factors affecting students' gain (average Unit Post – Full Pre)
35.00%
30.00%
25.00%
20.00%
15.00%
10.00%
5.00%
0.00%
31.4%
27.7%
9.6%
9.7%
3.9%
4.0%
Teacher-Year
Students' prior knowledge
School factors
Max
Min

3. HOW DO STUDENT AND TEACHER SUCCESS CHANGE OVER TIME?

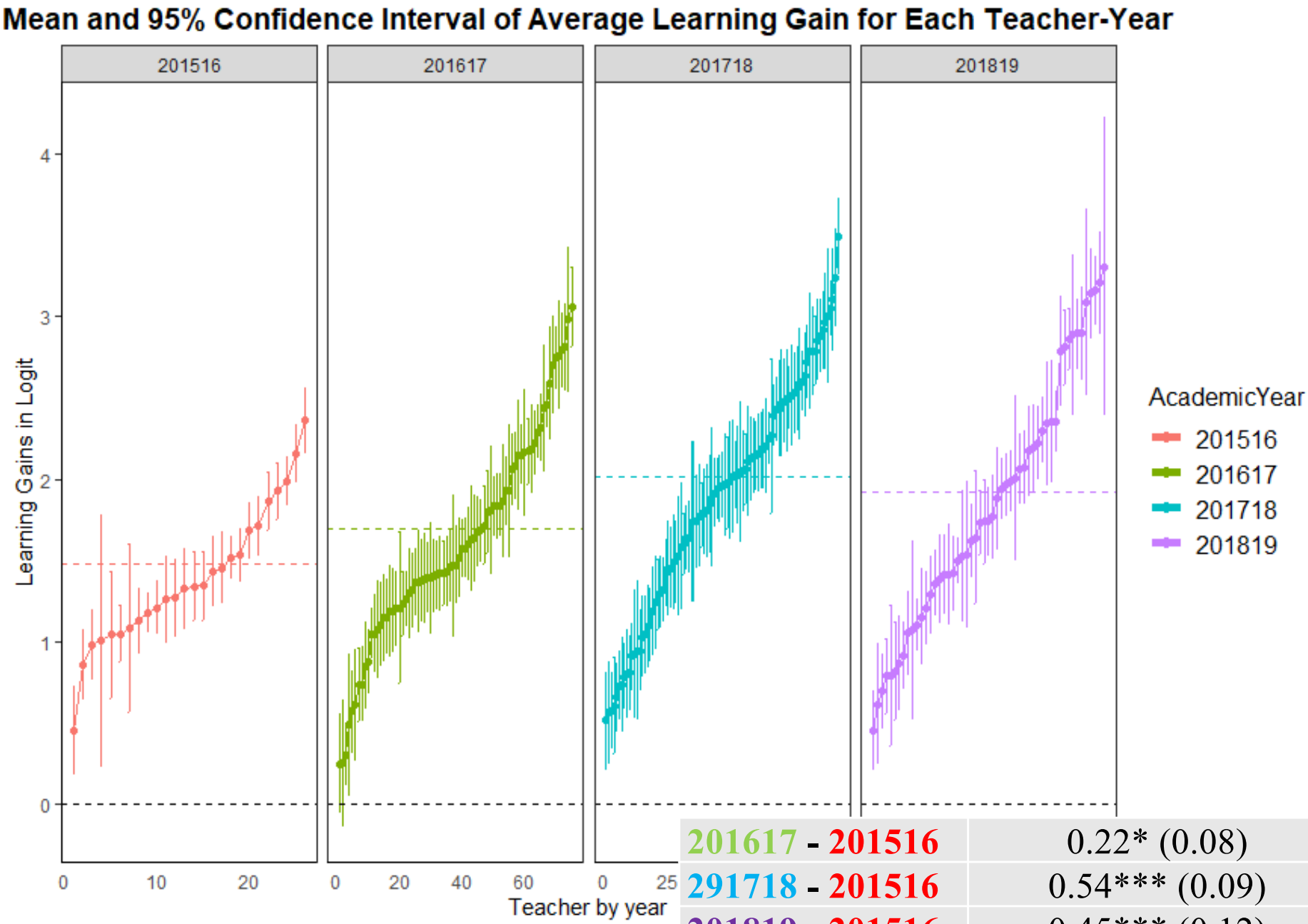
More teachers achieved Level 4 class averages over time



Units (classrooms)	2015-16	2016-17	2017-18	2018-19
LV2	30.8%	22.7%	20.9%	22.6%
LV3	61.5%	64.0%	54.9%	54.7%
LV4	7.7%	13.3%	24.2%	22.6%

The overall success of *CTIME* increased over time

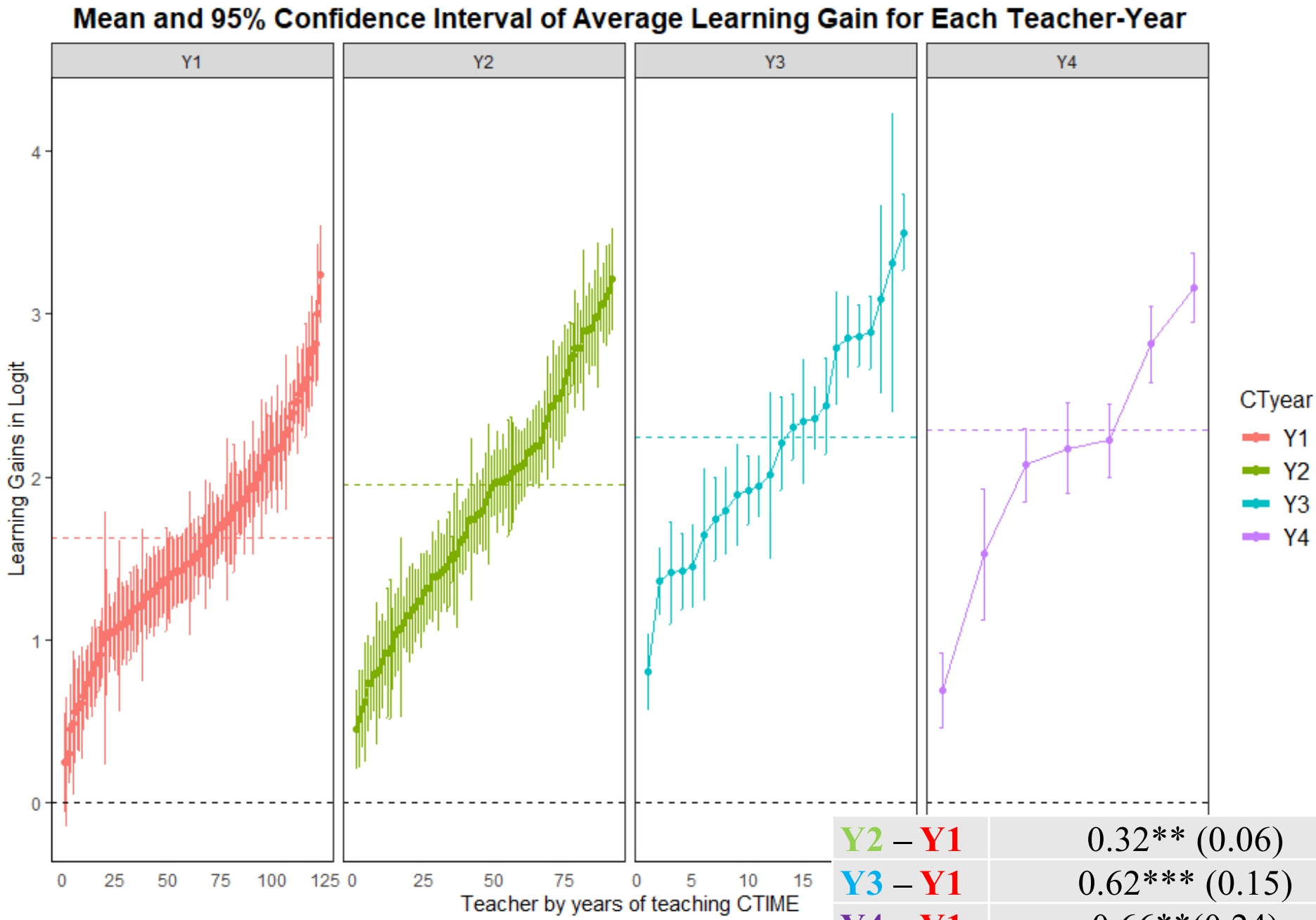
(Gain = average Unit Post – Full Pre)



201617 - 201516	0.22* (0.08)
291718 - 201516	0.54*** (0.09)
201819 - 201516	0.45*** (0.12)

Class average gain increased as teachers gained more experience in teaching *CTIME*.

(Gain = average Unit Post – Full Pre)



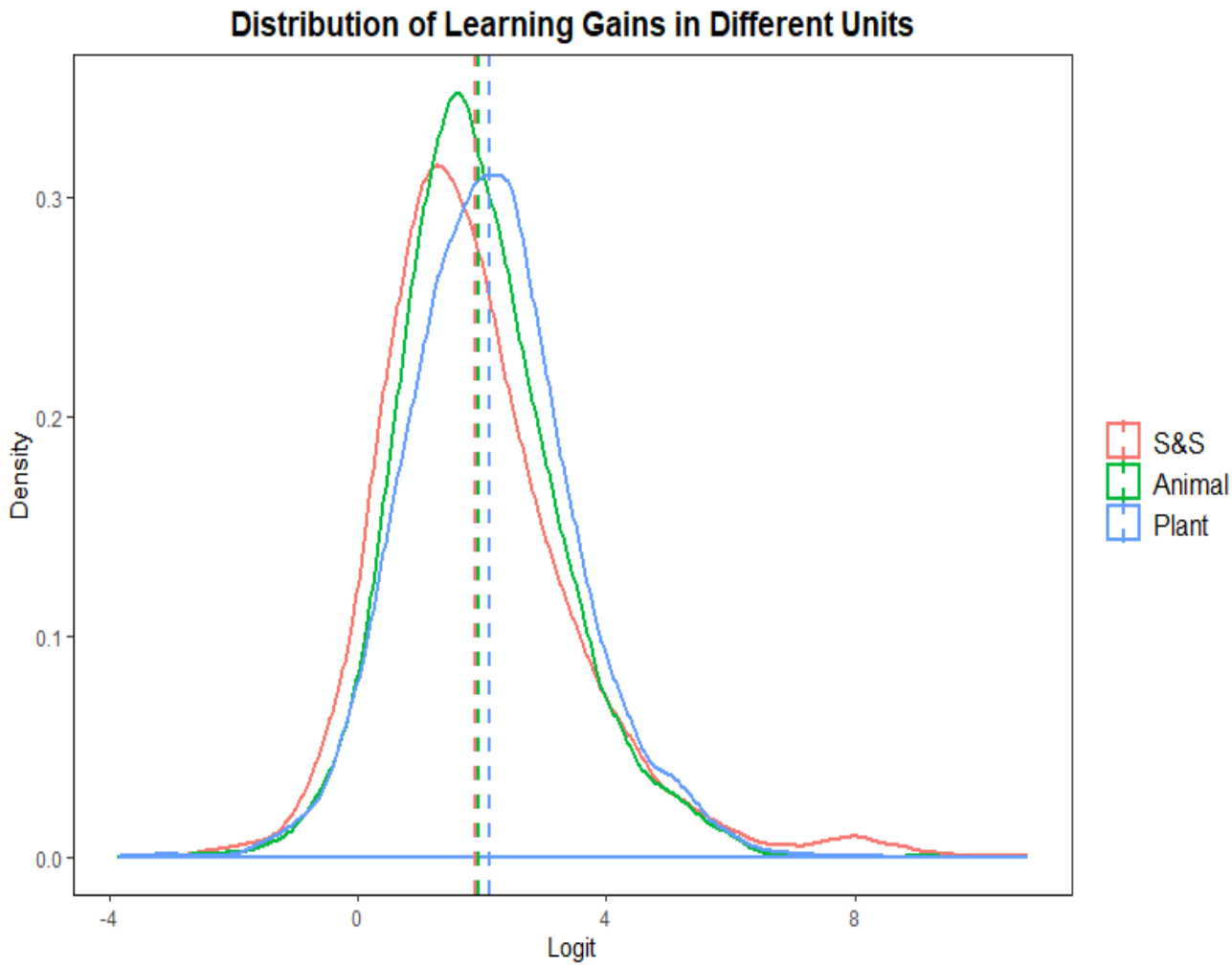
Y2 – Y1	0.32** (0.06)
Y3 – Y1	0.62*** (0.15)
Y4 – Y1	0.66**(0.24)

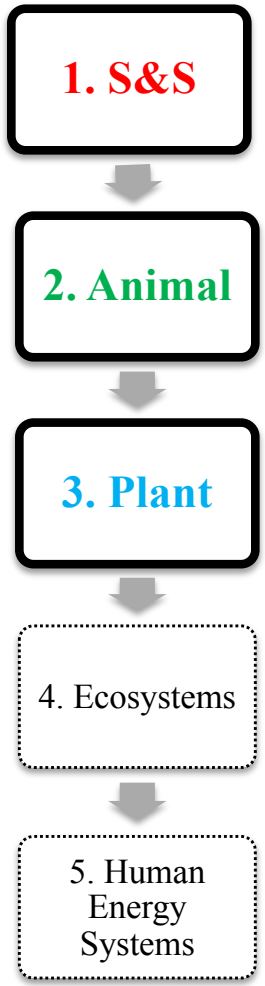
Interpret the increasing overall success over time.

- *Explanation 1: The effect of Carbon TIME increased during the 4-year period, from 2015-16 to 2018-19.*
- *Explanation 2: Teacher effectiveness also increased as they gained more experience in teaching Carbon TIME.*
- *However, we cannot statistically distinguish between (a) teachers gaining experience and learning from professional development, and (b) improvements in Carbon TIME units and professional development.*

	Y1	**Y2**	**Y3**	**Y4**
2015-16	26			
2016-17	56	19		
2017-18	40	42	9	
2018-19		31	15	7

4. HOW DO STUDENTS LEARN FROM FIRST UNIT TO THIRD UNIT IN *CTIME?*



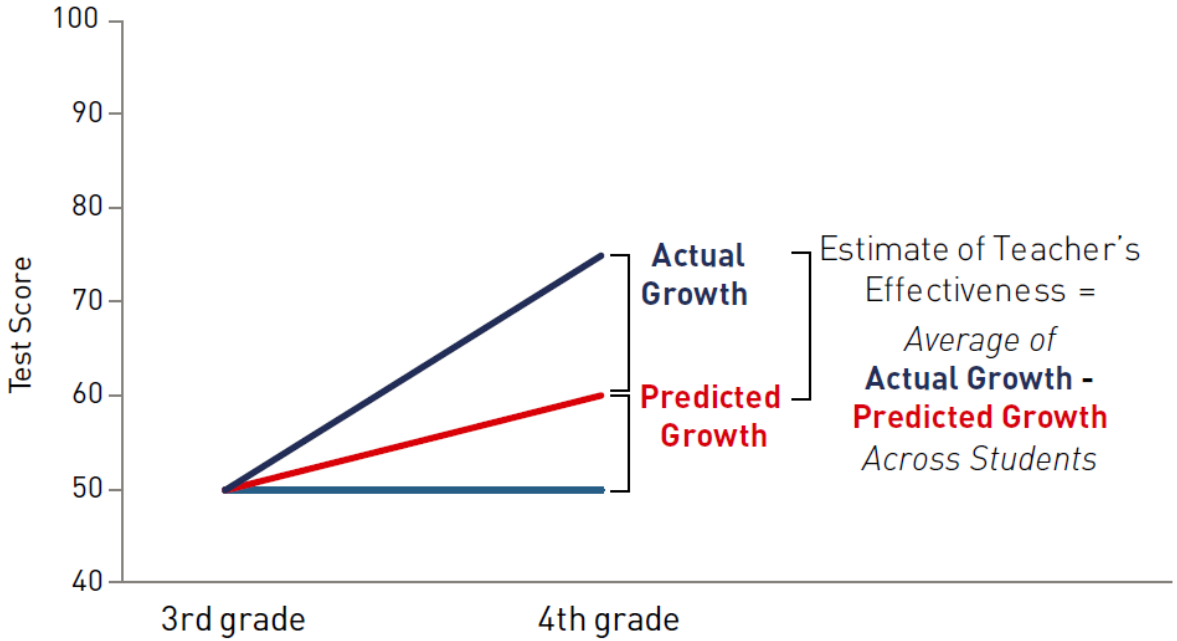


	N	Mean	Std. Dev.	Min	Max
S&S gain	10,832	1.90	1.60	-3.68	10.75
Animal gain	10,832	1.95	1.30	-3.84	9.07
Plant gain	10,832	2.13	1.35	-3.51	8.14
Paired t test between S&S and Animal: difference = 0.06, SE = 0.01, $p < 0.001$.					
Paired t test between Animal and Plant: difference = 0.18, SE = 0.01, $p < 0.001$.					
Paired t test between S&S and Plant: difference = 0.23, SE = 0.01, $p < 0.001$.					

5. HOW CAN WE USE THESE DATA TO CONSTRUCT VALUE-ADDED MODELS THAT PROVIDE EVIDENCE ABOUT THE SUCCESS OF INDIVIDUAL TEACHERS?

What is value-added?

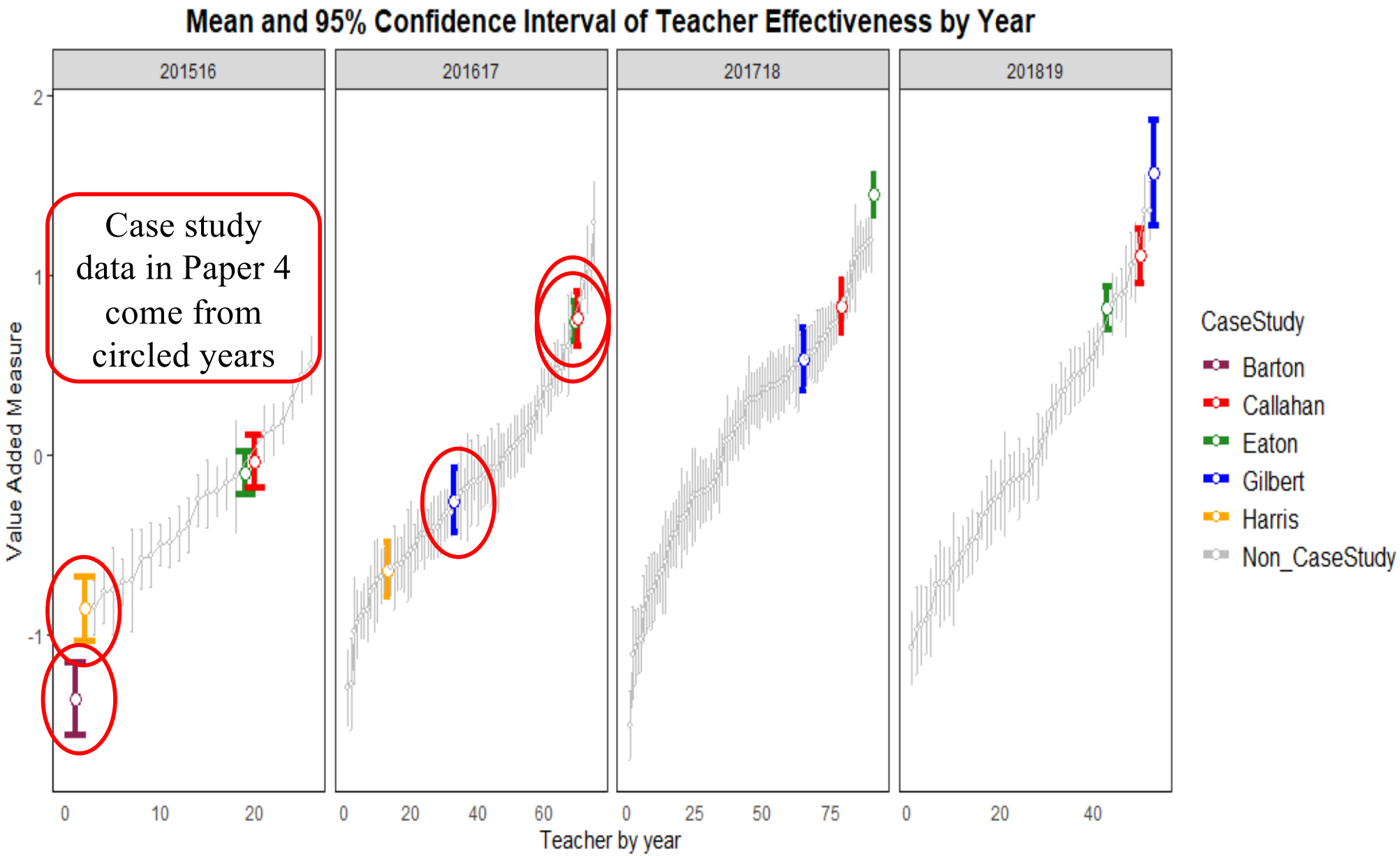
- "Gain score"
  - adjust for other covariates (remove the effects from factors other than the teacher: free/reduced lunch and percent minorities)
  - the "deflection" between expected and observed score is assumed to be the effect of teacher



  - Each teacher's value-added score is the average "estimate of teacher effectiveness" of all her students

Value-Added Measures: How and Why the Strategic Data Project Uses Them to Study Teacher Effectiveness, Harvard University, 2011, p. 3. Available online: https://sdp.cepr.harvard.edu/files/cepr-sdp/files/sdp-va-memo_0.pdf.

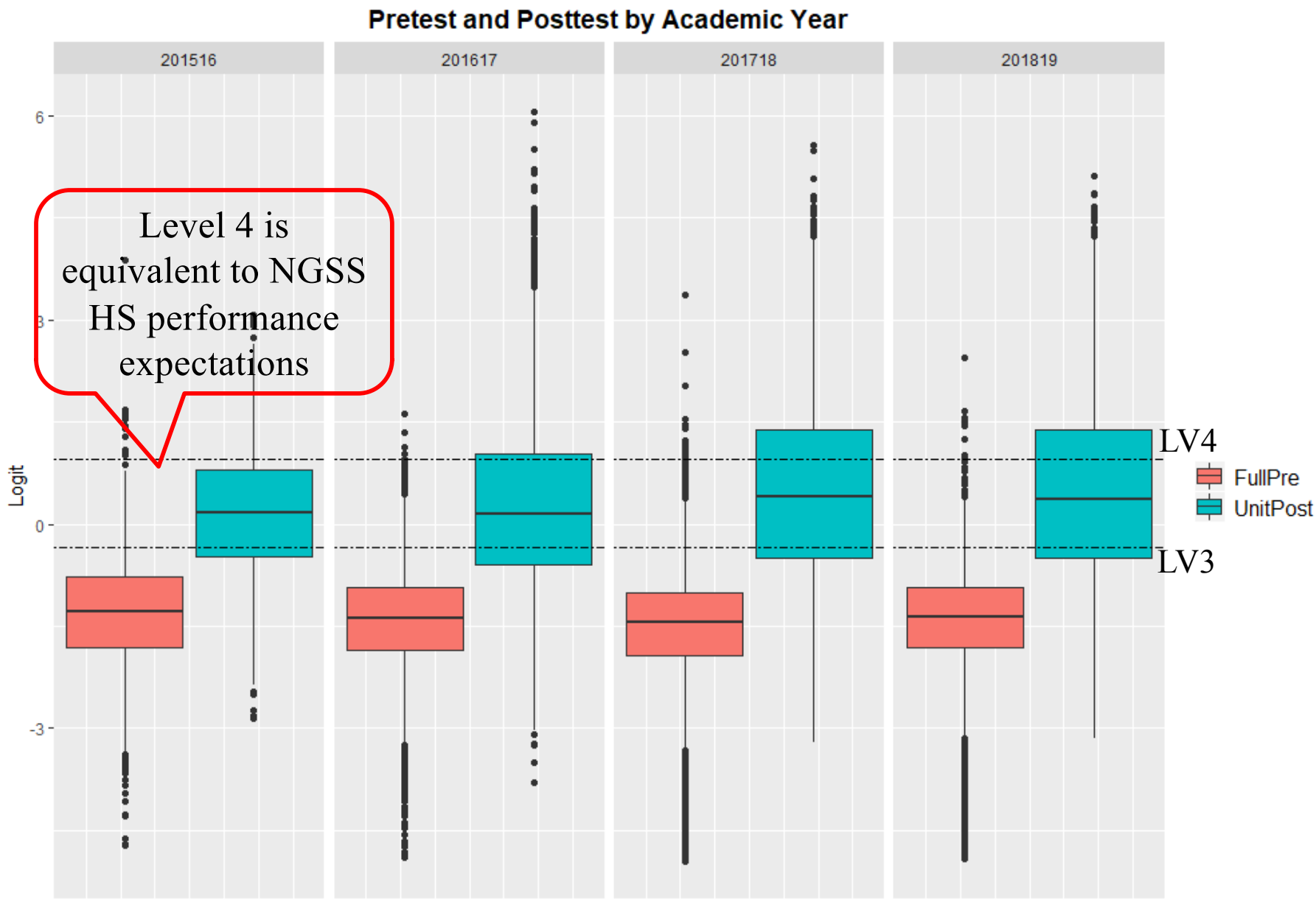
After removing the effect from school factors & students' prior knowledge – estimate for teachers' effectiveness…



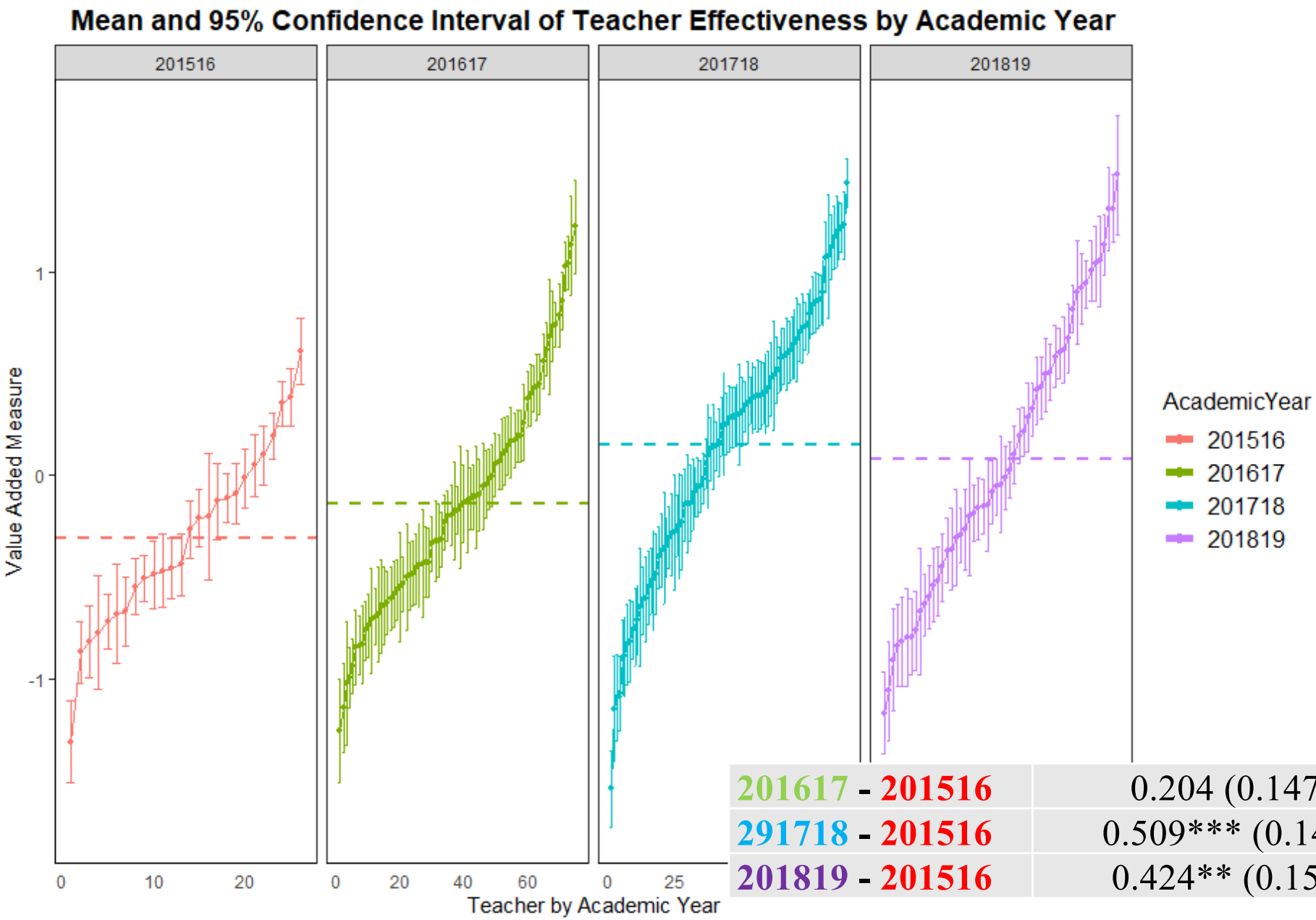
Thank you!

(Back-up slides from here.)

More teachers achieved Level 4 class averages over time

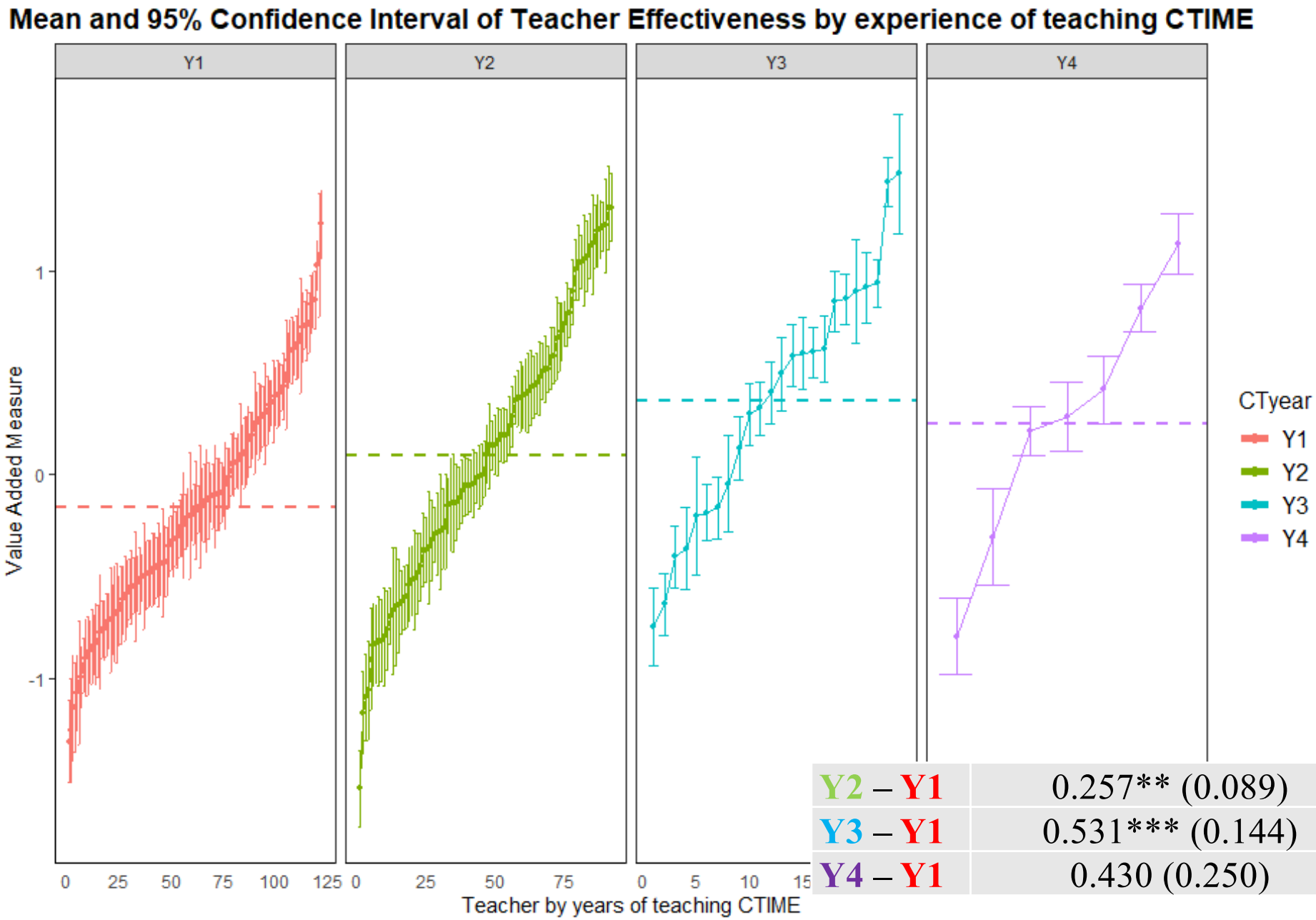


- ***The effect of Carbon TIME increased during the 4-year period, from 2015-16 to 2018-19.***

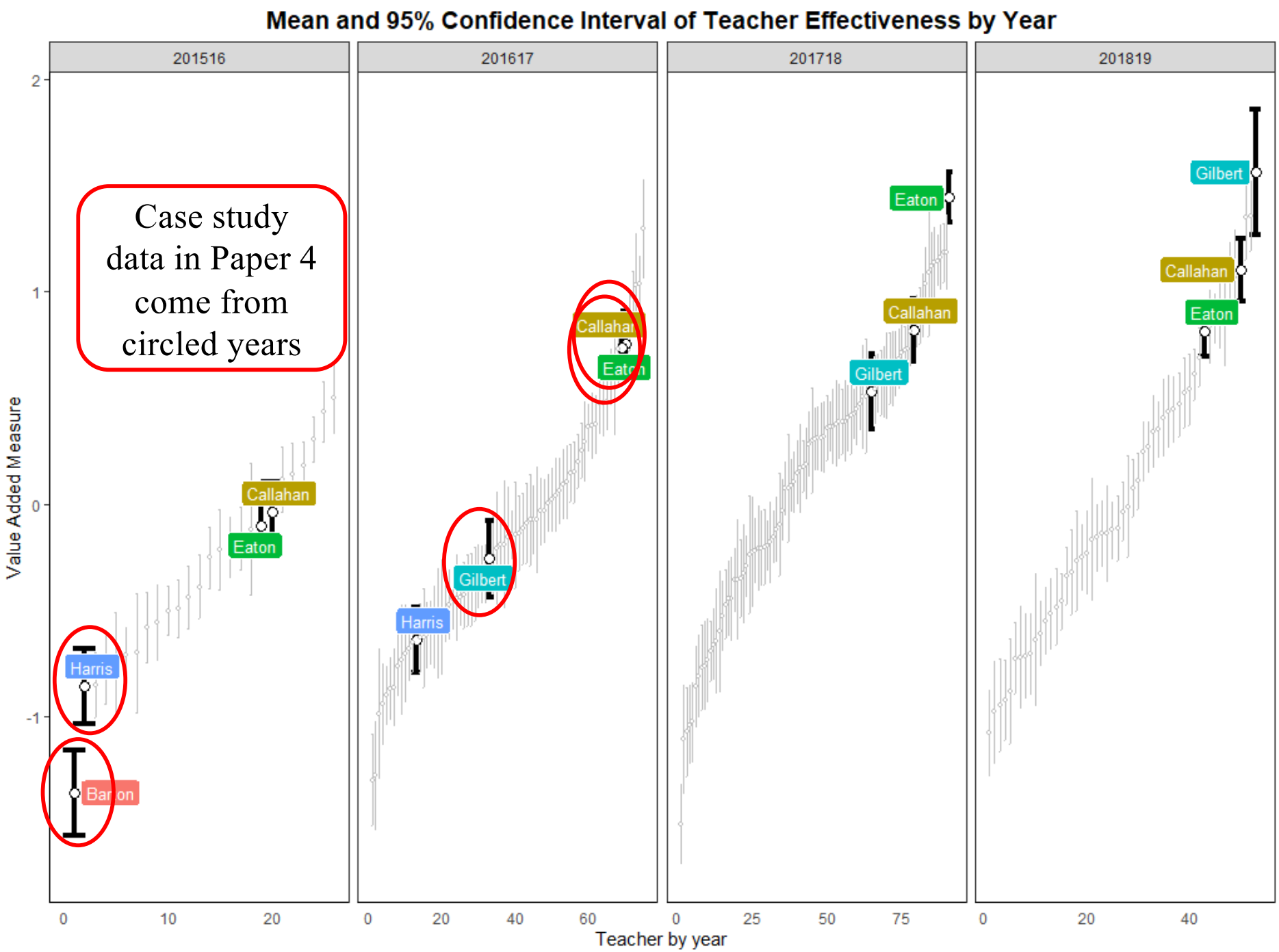


201617 - 201516	0.204 (0.147)
291718 - 201516	0.509*** (0.144)
201819 - 201516	0.424** (0.154)

- *Teacher effectiveness also increased as they gained more experience in teaching Carbon TIME.*



Y2 – Y1	0.257** (0.089)
Y3 – Y1	0.531*** (0.144)
Y4 – Y1	0.430 (0.250)


Mean and 95% Confidence Interval of Teacher Effectiveness by Year
201516
201617
201718
201819
Case study data in Paper 4 come from circled years
Value Added Measure
Teacher by year
Harris
Barton
Eaton
Callahan
Gilbert
2
1
0
-1
0
10
20
40
60
25
50
75