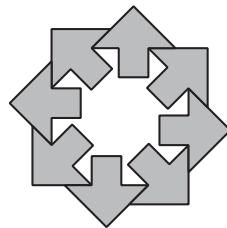


# **Value-Added Analysis in Chicago and Methodological Issues in this Work**

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Stanford University**



**Consortium on  
Chicago School Research**

# Why?

- Determine how much students benefit from their schools, and how much schools differ from each other
- Improve on earlier work – model the movement of students across schools, with grades nested within schools
  - Old model used trends within grades over time, in a cross-sectional analysis
- Resist emphasis on one-time snapshots of student performance or simple test score trends

# Value Added Analysis of the Chicago Public Schools

- Analysis is performed with the acknowledgement that outcomes besides test scores should be examined when making determinations about student performance.
- If test scores are used in these analyses, one must use models that are defensible.

# Value Added Analysis of the Chicago Public Schools

- Measure impact of schools on student learning gains at level of grade-within-school.
- No link of individual teachers to students, but this is possible in the near future. At that point, we will move to a teacher-level analysis.
- Use ITBS results in Chicago from 1995 to 2001 for grades 2 through 8.
- Developmental metric is necessary to do value-added analysis, so Rasch analysis was used to equate levels and forms of ITBS.

# Data Summary

	<b>Reading</b>	<b>Math</b>
<b>Observations</b>	1,263,035	1,266,730
<b>Students</b>	388,127	389,083
<b>School-grades</b>	3,265	3,264
<b>Schools</b>	515	515
<b>Years of data</b>	7	7
<b>Grades</b>	7	7

# Organization of School-entry Cohorts from Seven Waves of Annual Test Scores

	<b>Year</b>						
<b>Grade</b>	<b>1995</b>	<b>1996</b>	<b>1997</b>	<b>1998</b>	<b>1999</b>	<b>2000</b>	<b>2001</b>
<b>2</b>	C7	C8	C9	C10	C11	C12	(C13)
<b>3</b>	C6	C7	C8	C9	C10	C11	C12
<b>4</b>	C5	C6	C7	C8	C9	C10	C11
<b>5</b>	C4	C5	C6	C7	C8	C9	C10
<b>6</b>	C3	C4	C5	C6	C7	C8	C9
<b>7</b>	C2	C3	C4	C5	C6	C7	C8
<b>8</b>	C1	C2	C3	C4	C5	C6	C7

## Number of Students with Math Score

			<b>Year</b>						
<b>Cohort</b>	<b>First year</b>	<b>First grade</b>	<b>1995</b>	<b>1996</b>	<b>1997</b>	<b>1998</b>	<b>1999</b>	<b>2000</b>	<b>2001</b>
<b>6</b>	<b>1995</b>	<b>3</b>	<b>24,824</b>	<b>22,000</b>	<b>20,379</b>	<b>19,174</b>	<b>18,046</b>	<b>16,888</b>	<b>1,588</b>
	<b>1996</b>	<b>4</b>		<b>5,061</b>	<b>4,255</b>	<b>3,990</b>	<b>3,737</b>	<b>3,406</b>	<b>354</b>
	<b>1997</b>	<b>5</b>			<b>1,936</b>	<b>1,526</b>	<b>1,336</b>	<b>1,198</b>	<b>105</b>
	<b>1998</b>	<b>6</b>				<b>1,540</b>	<b>1,185</b>	<b>978</b>	<b>50</b>
	<b>1999</b>	<b>7</b>					<b>1,375</b>	<b>1,032</b>	<b>25</b>
	<b>2000</b>	<b>8</b>						<b>881</b>	

**Number of Students with Math Score**

Cohort	First year	First grade	Year						
			1995	1996	1997	1998	1999	2000	2001
1	1995	8	25,668						
2	1995	7	24,965	22,519	169				
	1996	8		1,942					
3	1995	6	24,245	21,643	20,044	414			
	1996	7		2,080	1,476	32			
	1997	8			1,361				
4	1995	5	26,225	23,523	21,842	20,447	913		
	1996	6		2,061	1,539	1,338	62		
	1997	7			1,476	1,109	33		
	1998	8				1,190			
5	1995	4	27,316	24,475	22,832	21,307	19,991	1,979	
	1996	5		2,428	1,825	1,675	1,523	145	
	1997	6			1,631	1,265	1,127	75	
	1998	7				1,432	1,126	28	
	1999	8					1,198		
6	1995	3	24,824	22,000	20,379	19,174	18,046	16,888	1,588
	1996	4		5,061	4,255	3,990	3,737	3,406	354
	1997	5			1,936	1,526	1,336	1,198	105
	1998	6				1,540	1,185	978	50
	1999	7					1,375	1,032	25
	2000	8						881	

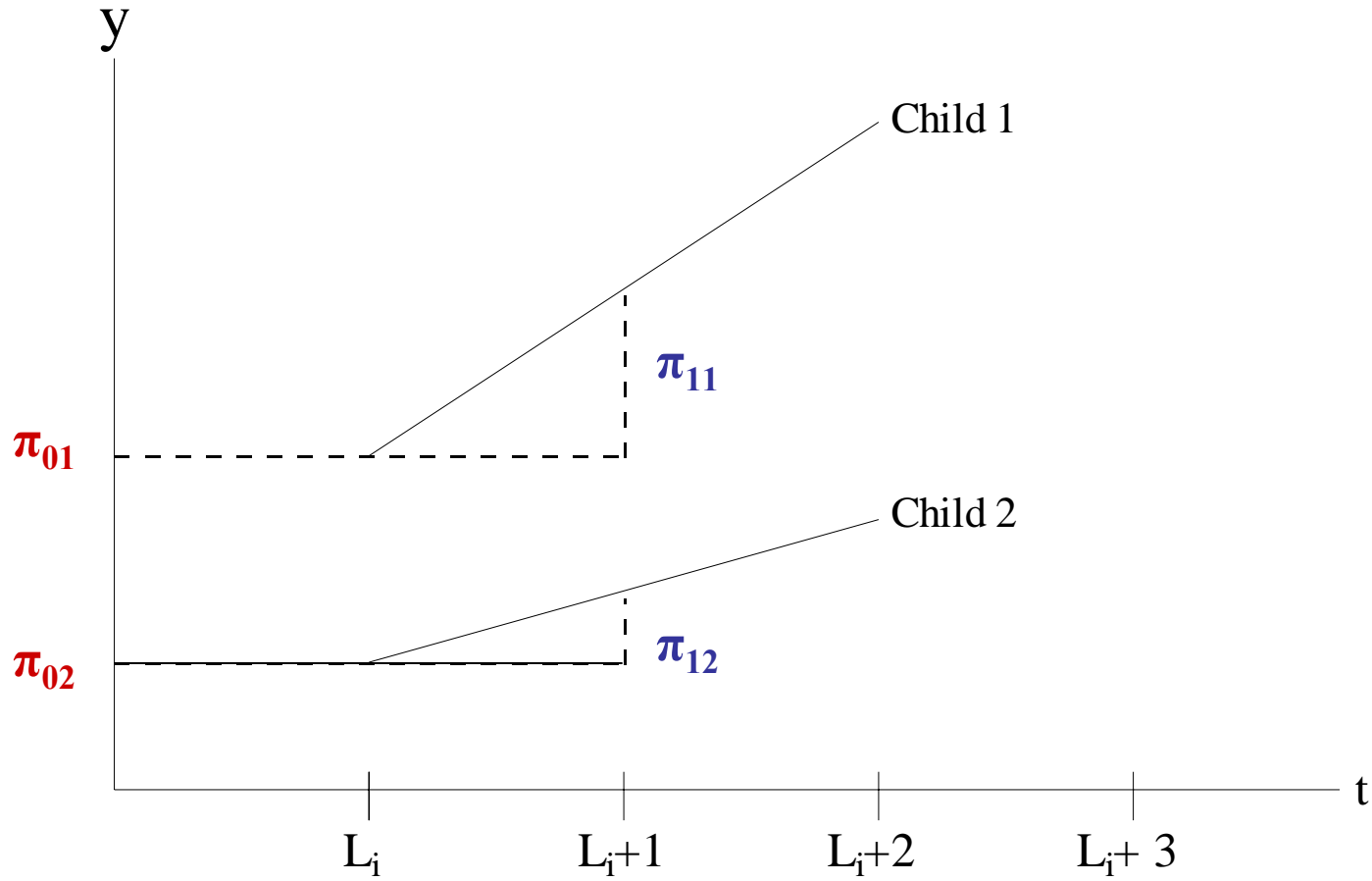


**Number of Students with Math Score**

Cohort	First year	First grade	Year						
			1995	1996	1997	1998	1999	2000	2001
7	1995	2	24,239	21,360	19,703	18,398	17,451	16,309	15,370
	1996	3		3,727	3,038	2,780	2,537	2,370	2,187
	1997	4			4,807	4,171	3,854	3,516	3,269
	1998	5				1,790	1,447	1,306	1,158
	1999	6					1,518	1,166	1,022
	2000	7						1,041	789
8	1996	2		23,937	21,035	19,357	18,056	16,880	16,019
	1997	3			4,782	3,991	3,669	3,381	3,145
	1998	4				5,285	4,602	4,238	3,918
	1999	5					1,929	1,530	1,336
	2000	6						1,177	848
9	1997	2			25,103	22,178	20,590	18,884	17,781
	1998	3				4,509	3,773	3,423	3,139
	1999	4					5,380	4,650	4,221
	2000	5						1,415	1,086
10	1998	2				25,695	22,829	20,870	19,522
	1999	3					9,328	8,090	7,447
	2000	4						1,820	1,357
11	1999	2					26,499	23,250	21,418
	2000	3						9,050	7,900
12	2000	2						25,203	22,319

# Model Description

- Three-level hierarchical cross-classified model.
- Repeated measures, cross-classified by students and schools.
- Combine two simpler models:
  - Two-level model for student growth in achievement over time
  - Three-level model for the value each school and school-grade adds to student learning over time.
  - Include separate effects on initial value added and improvement in value added for each grade in each school as deflections from an overall school effect.
  - Include school-level selection effect
  - Assume effects of school and school-grade are cumulative, so, for example, the effect of a student's school in first grade remains with the student in second grade and beyond.
    - This is a strong hypothesis, but it did not affect results in earlier work.



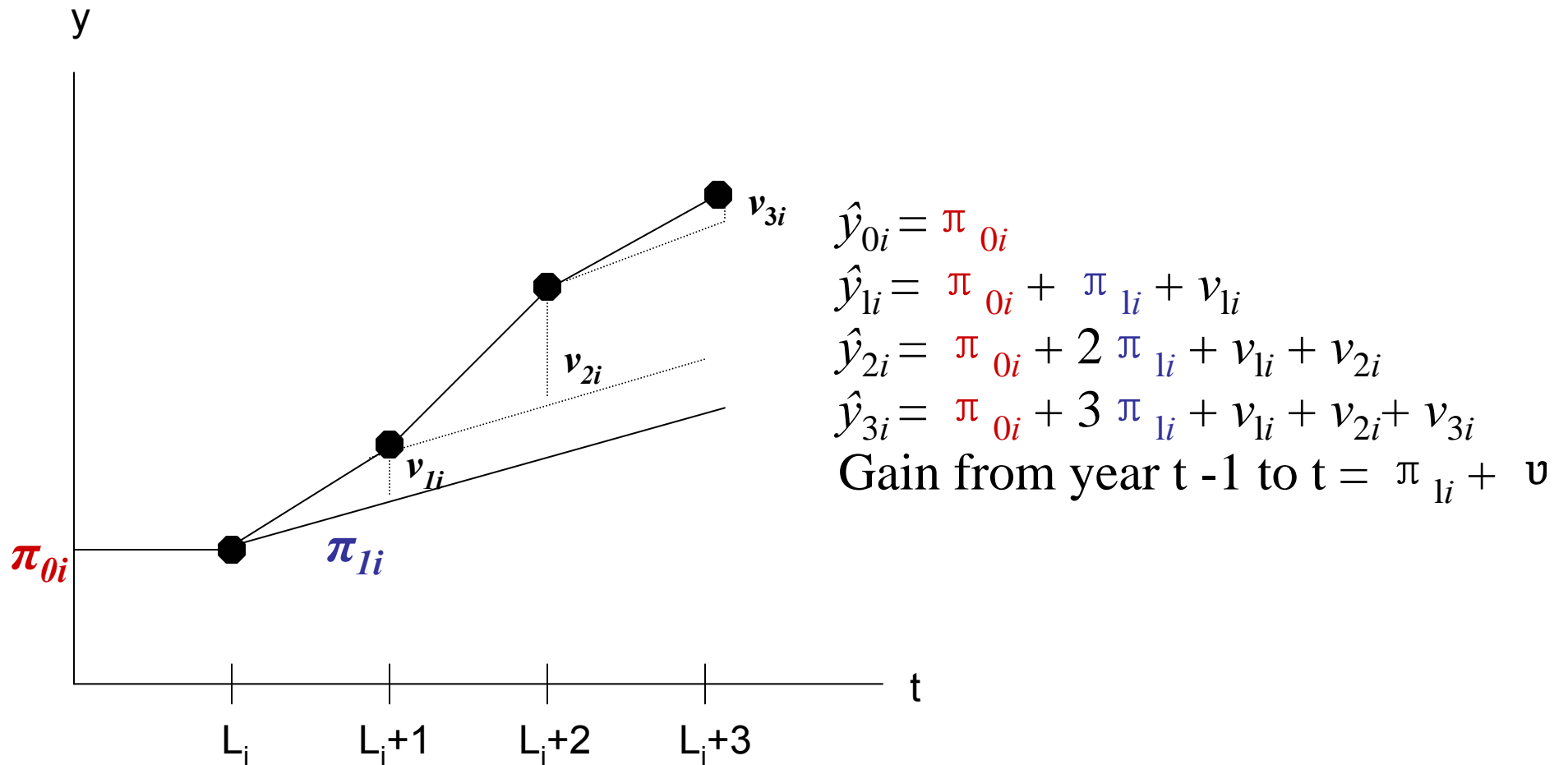
- **Figure 1. Selection Model**

- $\pi_{0i}$  = initial status of student  $i$

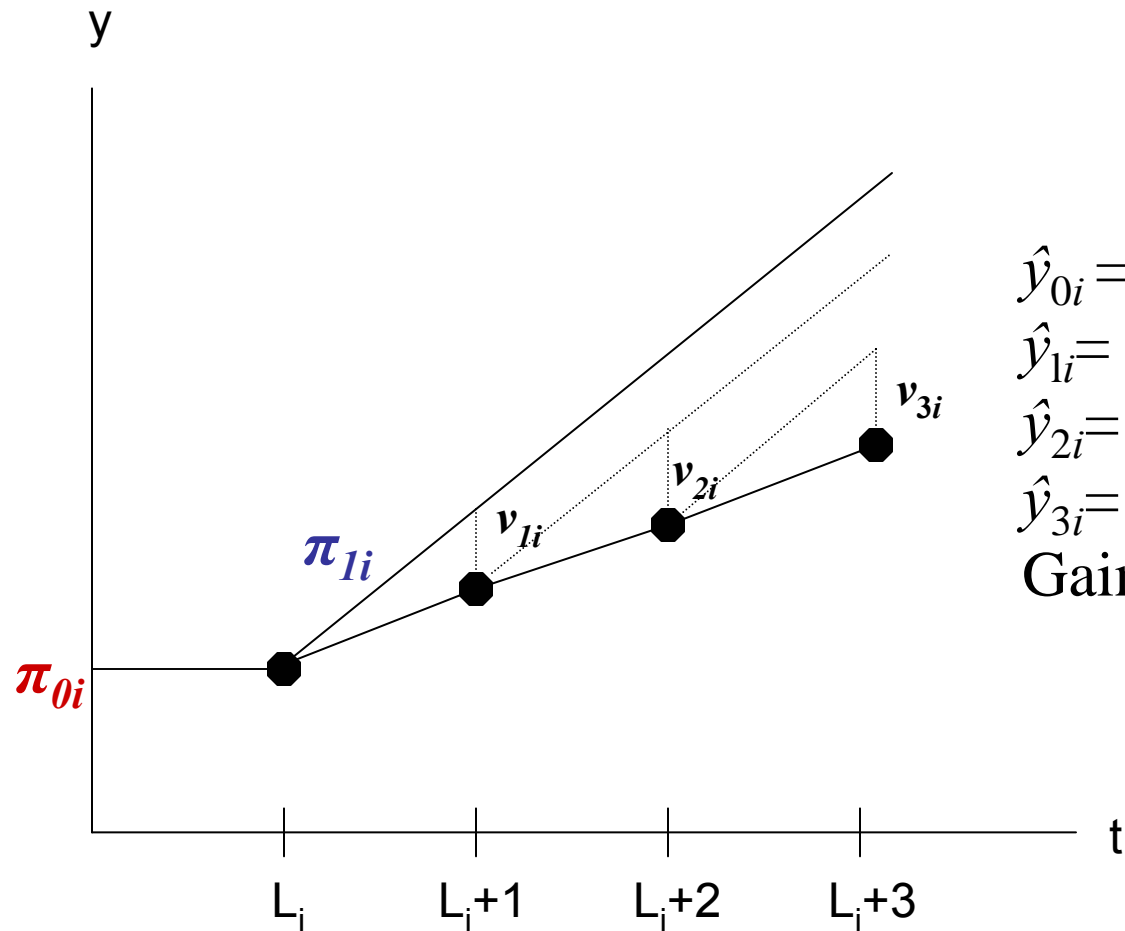
- $\pi_{1i}$  = annual growth rate given “average” schools i.e.  $v_{1i} = v_{2i} = v_{3i} = 0$

- So  $\pi_{0i}$ ,  $\pi_{1i}$  are governed by selection, not value added.

**Figure 2.** Value Added Model: An Example of a Fortunate Student



**Figure 3.** Value Added Model: An Example of an Unfortunate Student



$$\hat{y}_{0i} = \pi_{0i}$$

$$\hat{y}_{1i} = \pi_{0i} + \pi_{1i} + v_{1i}$$

$$\hat{y}_{2i} = \pi_{0i} + 2\pi_{1i} + v_{1i} + v_{2i}$$

$$\hat{y}_{3i} = \pi_{0i} + 3\pi_{1i} + v_{1i} + v_{2i} + v_{3i}$$

$$\text{Gain from year } t-1 \text{ to } t = \pi_{1i} + v$$

# Random Effects

- Two per student – initial status and growth rate
- Two per grade-within-school – base value added and value added trend
- Three per school – base value added, value added trend, initial status/selection effect

# Notation

- $v_{0k}$  = Base value added for school  $k$
- $v_{1k}$  = Value added trend for school  $k$
- $w_{g0k}$  = Addition to base value added for grade  $g$  in school  $k$
- $w_{g1k}$  = Addition to value added trend for grade  $g$  in school  $k$

# Value Added Calculation

- Example with students in Cohort 7 (data in grades 2 to 8):

			Contribution to Value added	
Year	Grade	$v_{ti}$	School	Grade-Within-School
1995	2	0	0	0
1996	3	$v_{1i} =$	$V_{0k} +$	$W_{30k}$
1997	4	$v_{2i} =$	$V_{0k} + V_{1k} +$	$W_{40k} + W_{41k}$
1998	5	$v_{3i} =$	$V_{0k} + 2V_{1k} +$	$W_{50k} + 2W_{51k}$
1999	6	$v_{4i} =$	$V_{0k} + 3V_{1k} +$	$W_{60k} + 3W_{60k}$
2000	7	$v_{5i} =$	$V_{0k} + 4V_{1k} +$	$W_{70k} + 4W_{70k}$
2001	8	$v_{6i} =$	$V_{0k} + 5V_{1k} +$	$W_{80k} + 5W_{80k}$



# School Effects

- Correlation of school-level effects:

	Base	Trend	Selection
Base	1.000	-0.345	0.363
Trend	-0.345	1.000	0.085
Selection	0.363	0.085	1.000

# School-grade Effects

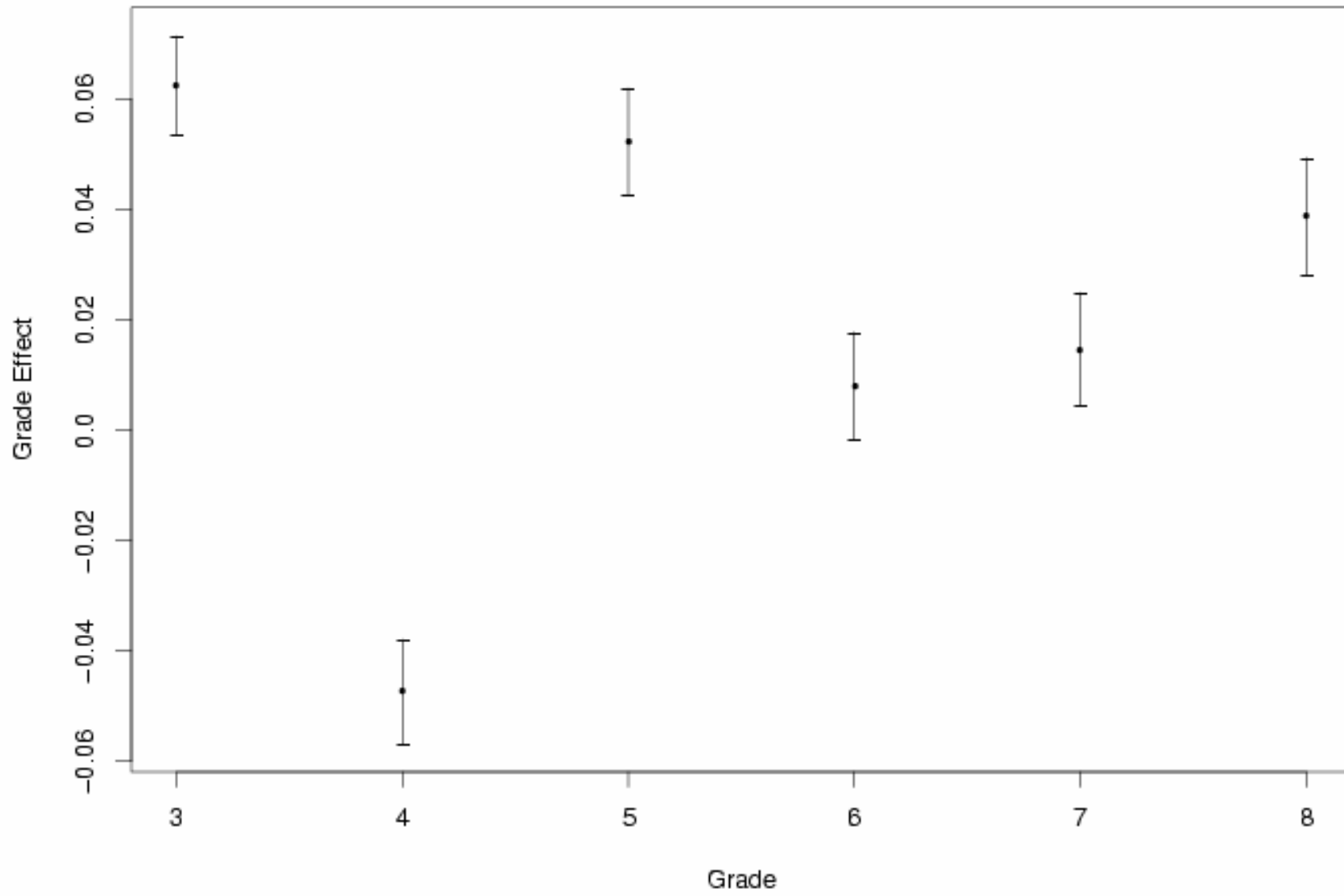
- Correlation of grade-within-school base value added and value added trend: **-0.43**
- These effects are not highly correlated across grades – base value added correlation ranges from -0.37 to 0.16; value added trend from -0.30 to 0.10

# School Profiles

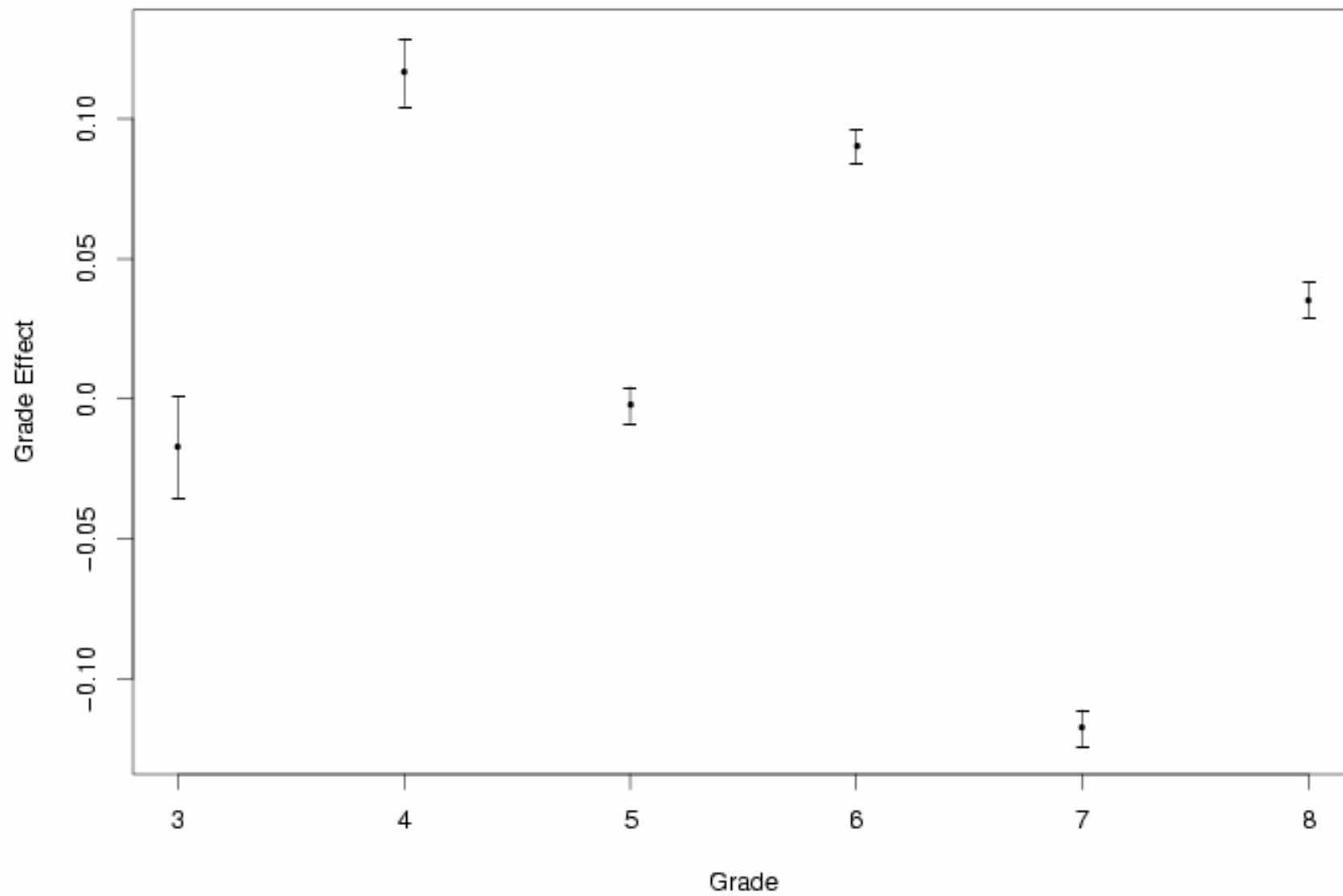
- In the following graphs, the effects shown are added to the school's average value added to yield the total effect of that grade in that school per year
- Variability in school effects exists as well, but is not shown
- Grade-within-school contribution to average value added =

$$\frac{\sum_{i=2}^7 (\text{Number of gains in year } i * \text{Grade - within - school contribution to value added in year } i)}{\text{Number of gains}}$$

Grade-Within-School Contribution to Average Value Added, School 423



Grade-Within-School Contribution to Average Value Added, School 211



# Results

- Results are similar to earlier work, but some important differences exist.
  - Current model uses all available data; earlier models were limited to students with consecutive test scores.
  - In previous years, the computational time required to perform analyses at any level smaller than the school made such work impossible.
  - Earlier models did not include assumptions about the form of the trend in learning gains
    - We can now include such assumptions and estimate the relevant growth parameters, or use a functionally simpler (but more computationally intensive) model with no assumption about the form of the growth.

# Results

- Different results than NCLB-based measures of student proficiency relative to the state learning standards.
- When examining output, we are most interested in two values for each school – the average value added per year, and the trend in value added (one possible measure of school improvement).
- Average value added (school level) =

$$\frac{\sum_{i=2}^7 (\text{Number of gains in year } i * \text{School Value added in year } i)}{\text{Number of gains}}$$

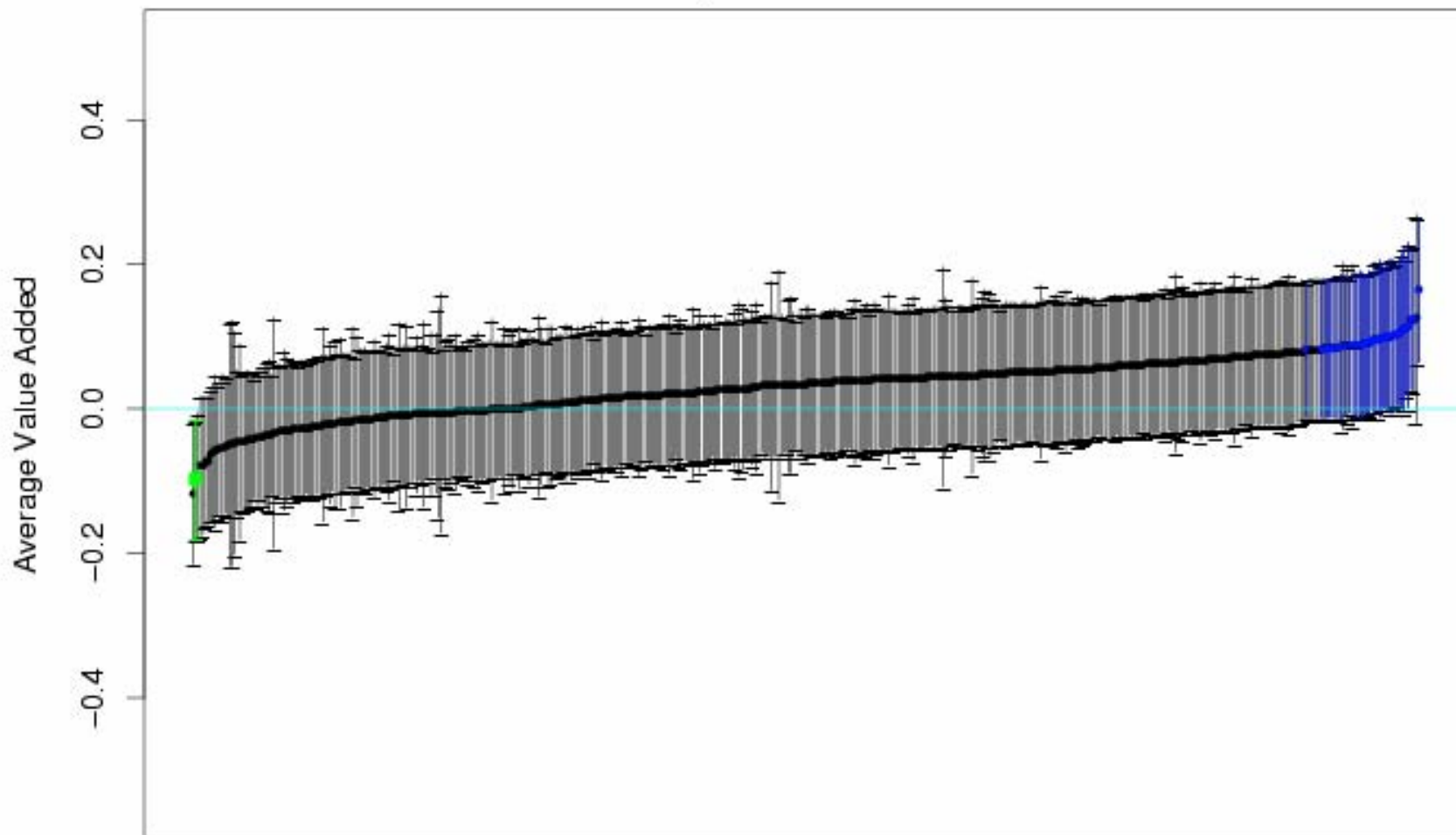
# Results

- Some schools look good on one measure, but not the other:

	Low Average	Moderate Average	High Average
Low Trend	58	51	56
Moderate Trend	57	53	59
High Trend	50	65	52

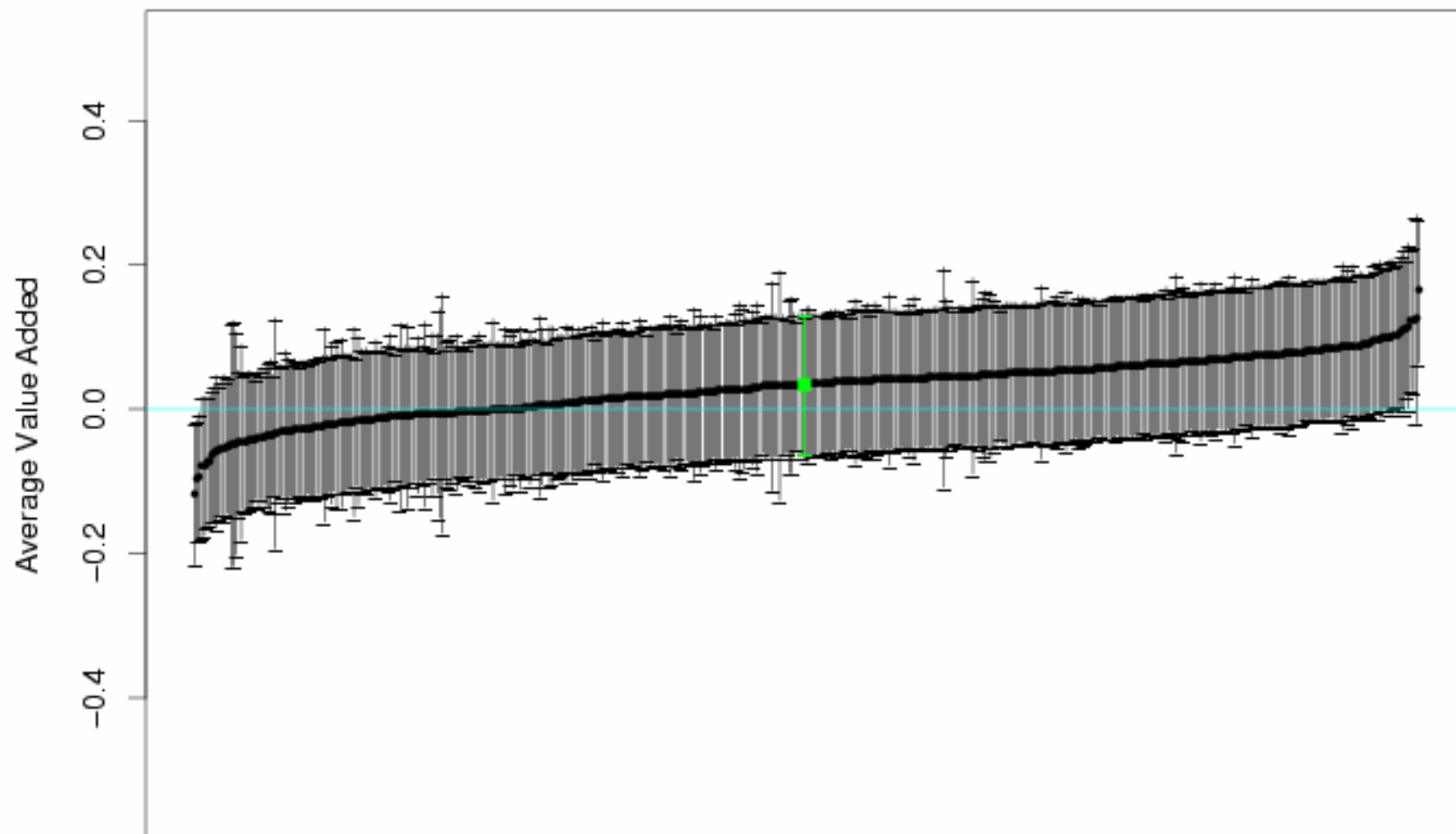
- Our results allow us to place schools in three groups:
  - those that a school has out-performed
  - those to which the school's performance is comparable
  - those to which the school is inferior.
- The sensitivity of these results to the amount of data present is a focus of ongoing work.

# Average Value Added, Low-Performing School Rasch Scoring of ITBS, 3-Level Model

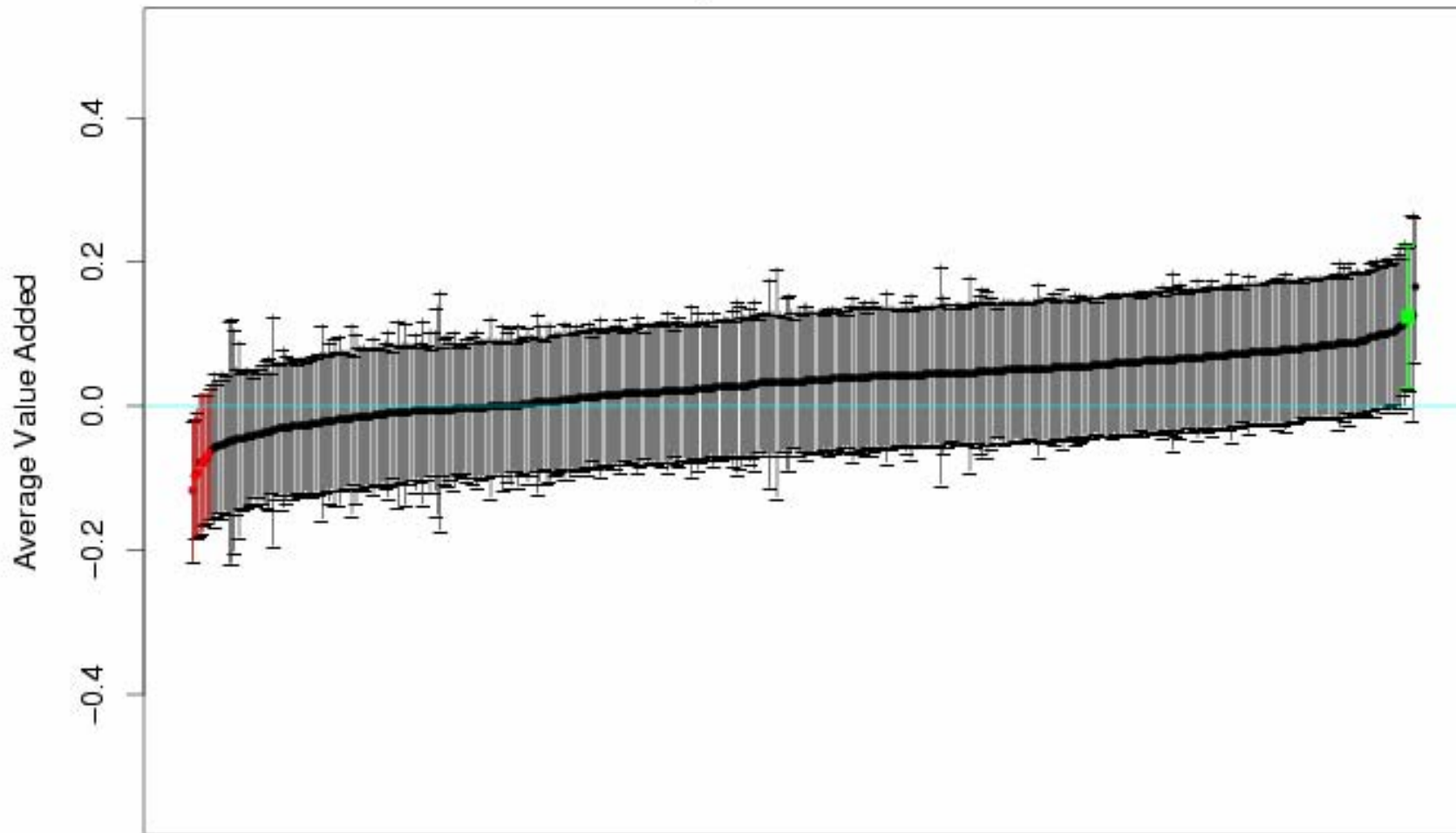




# Average Value Added, Moderately-Performing School Rasch Scoring of ITBS, 3-Level Model

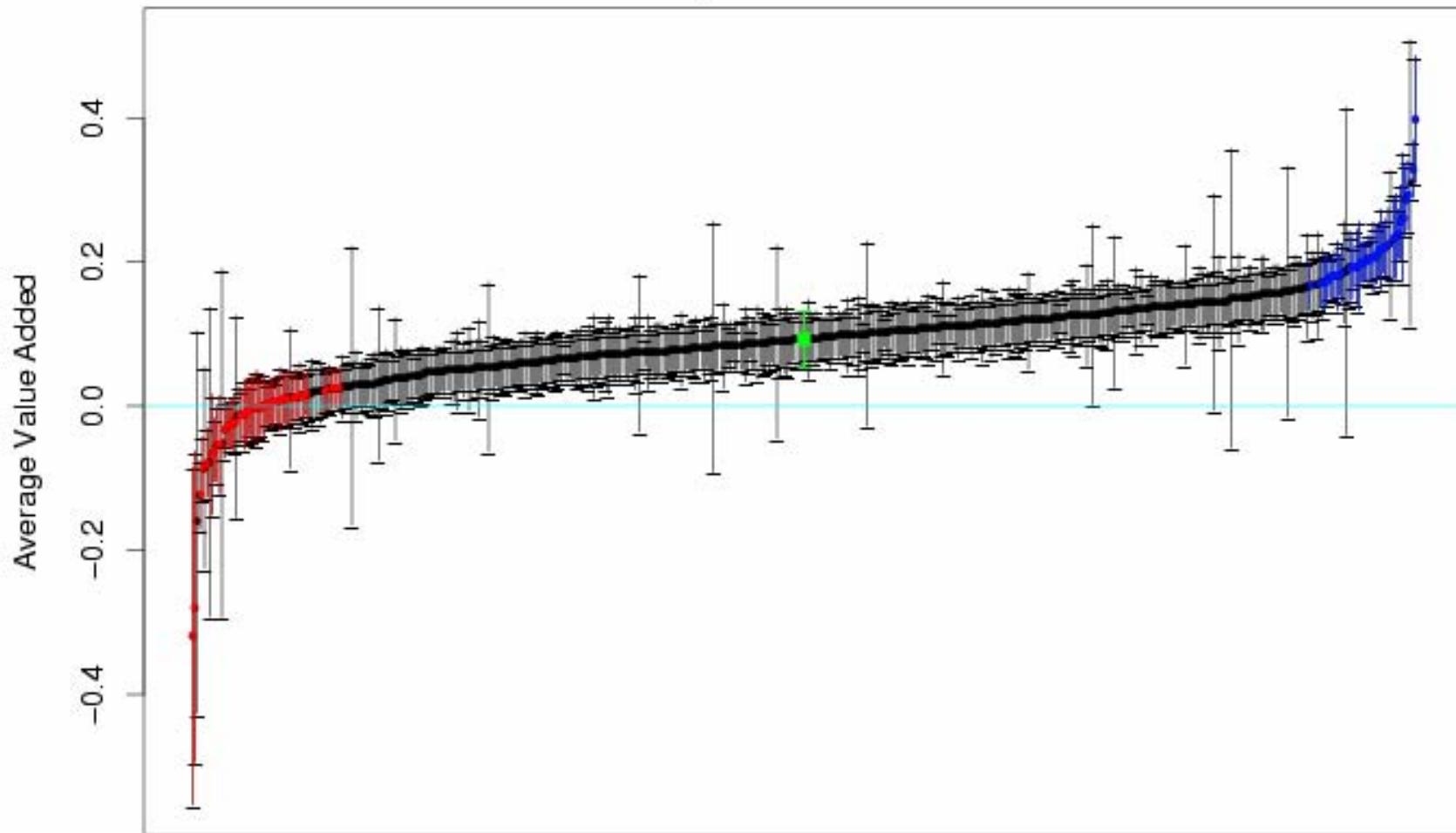


# Average Value Added, High-Performing School Rasch Scoring of ITBS, 3-Level Model



# Comparison with Earlier Models

# Average Value Added, Moderately-Performing School Rasch Scoring of ITBS, 2-Level Model

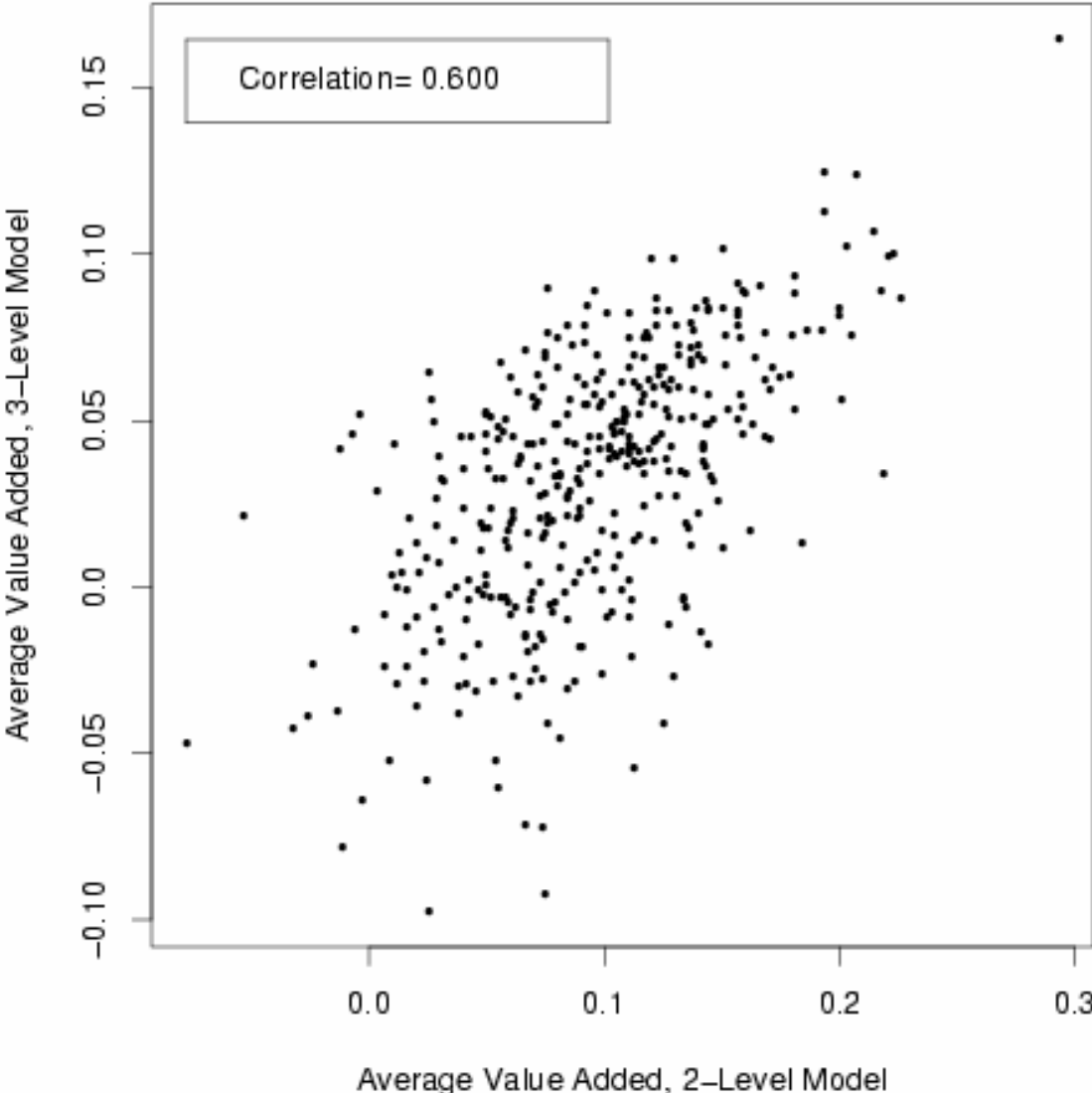


# Impact of Adding a Level to the Model on Schools' Average Value Added

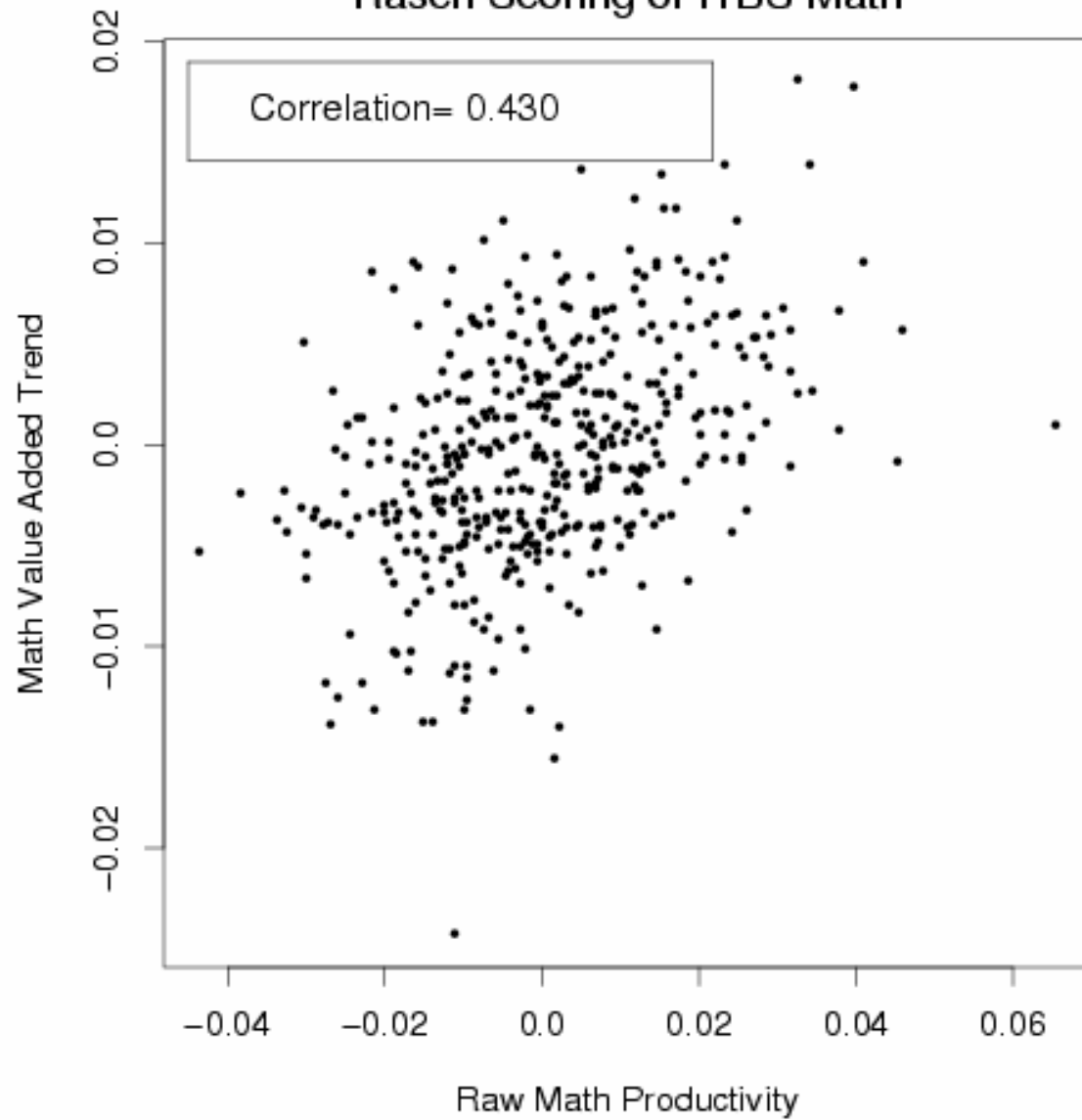
- Smaller range of effects, and less precision, in 3-level results

	Percentile				
	10	25	50	75	90
2-Level Mean	0.020	0.056	0.093	0.131	0.161
3-Level Mean	-0.024	-0.001	0.035	0.058	0.079
2-Level SD	0.014	0.014	0.017	0.022	0.026
3-Level SD	0.047	0.048	0.050	0.051	0.057

# Average Value Added Comparison – 3-Level vs. 2-Level Model



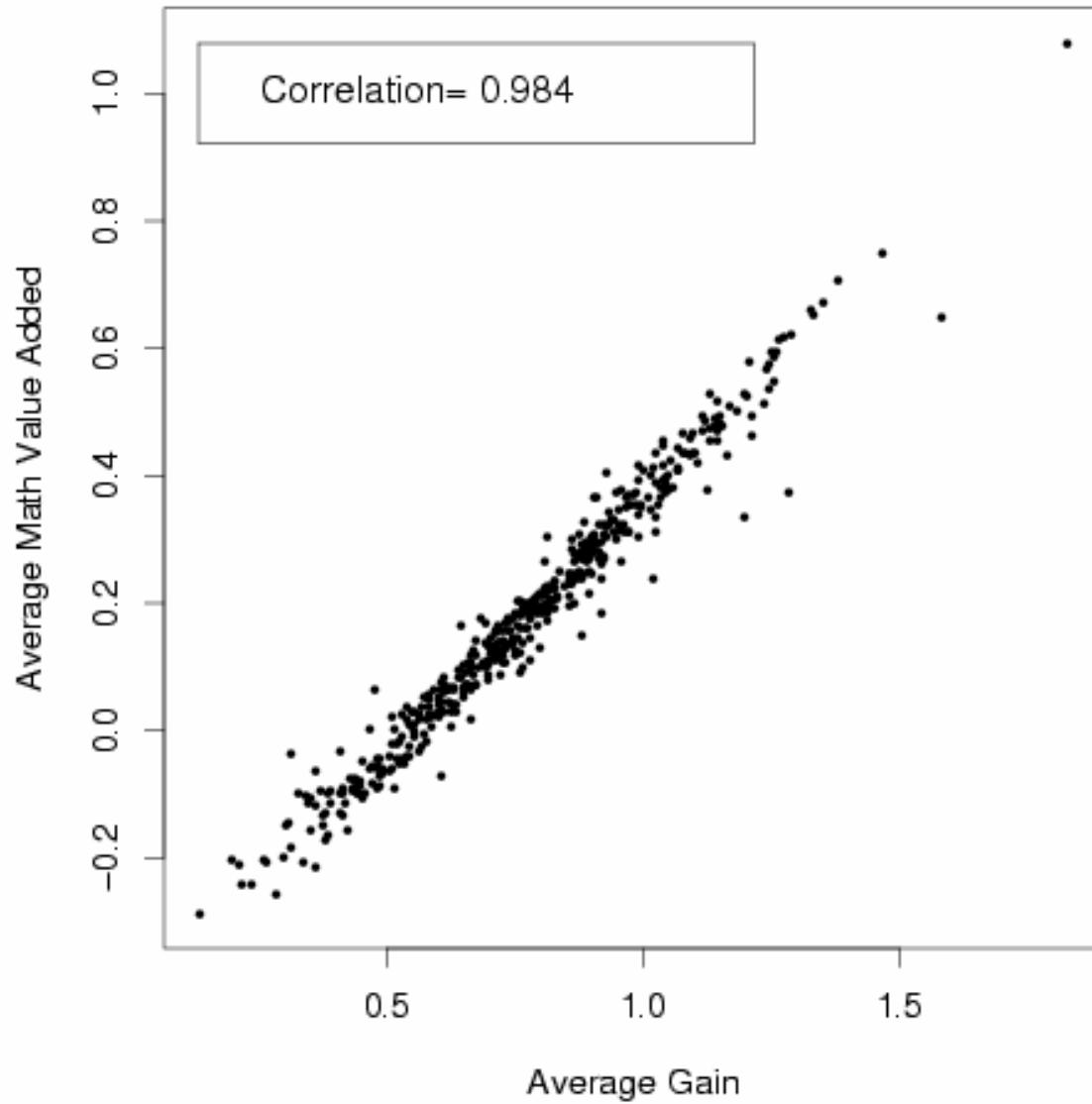
Value Added Trend vs. Raw Productivity  
Rasch Scoring of ITBS Math



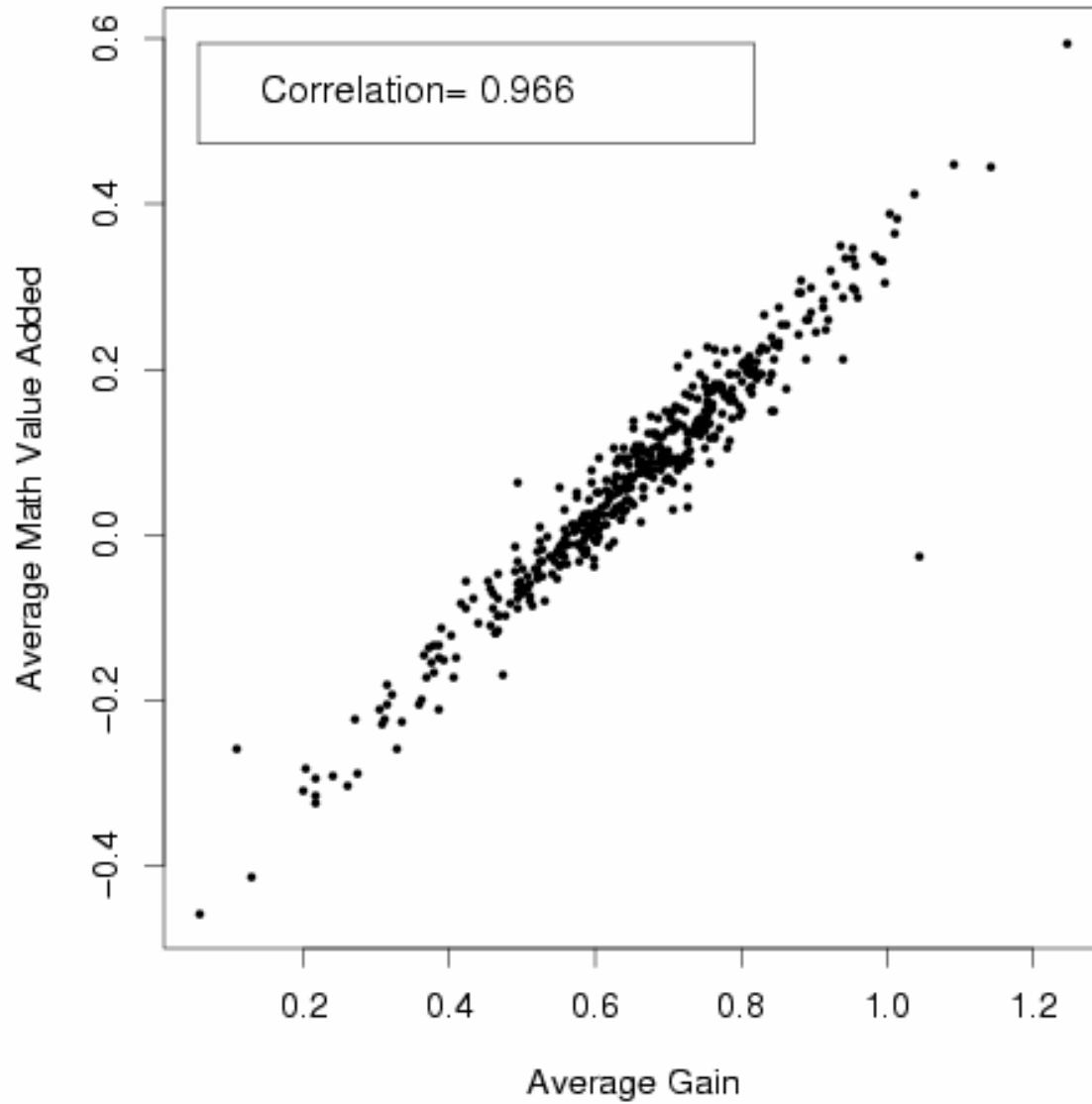
# Comparison with Raw Gains



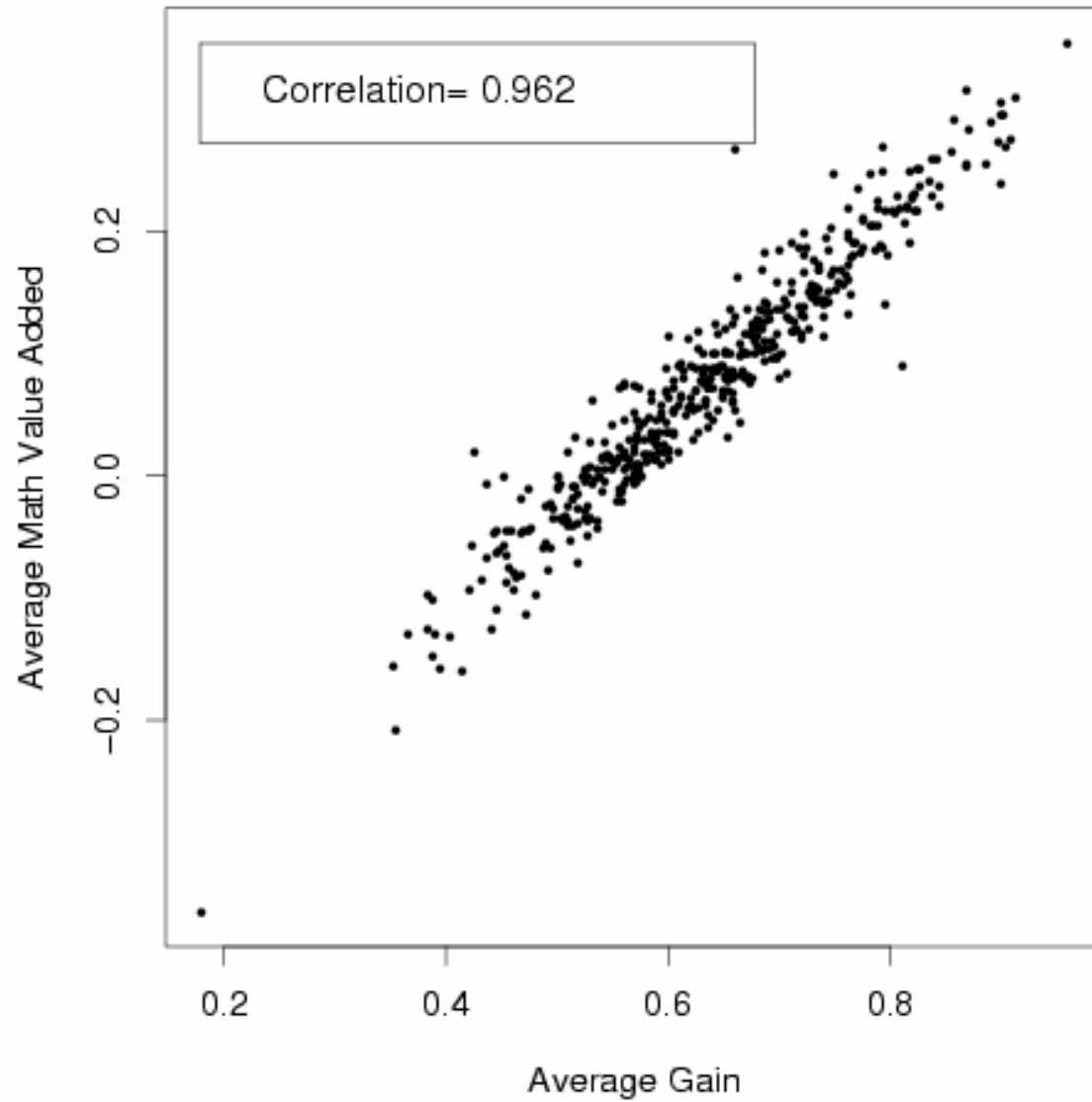
Average Value Added vs. Average Gain  
ITBS Grade 3, 1995–2001



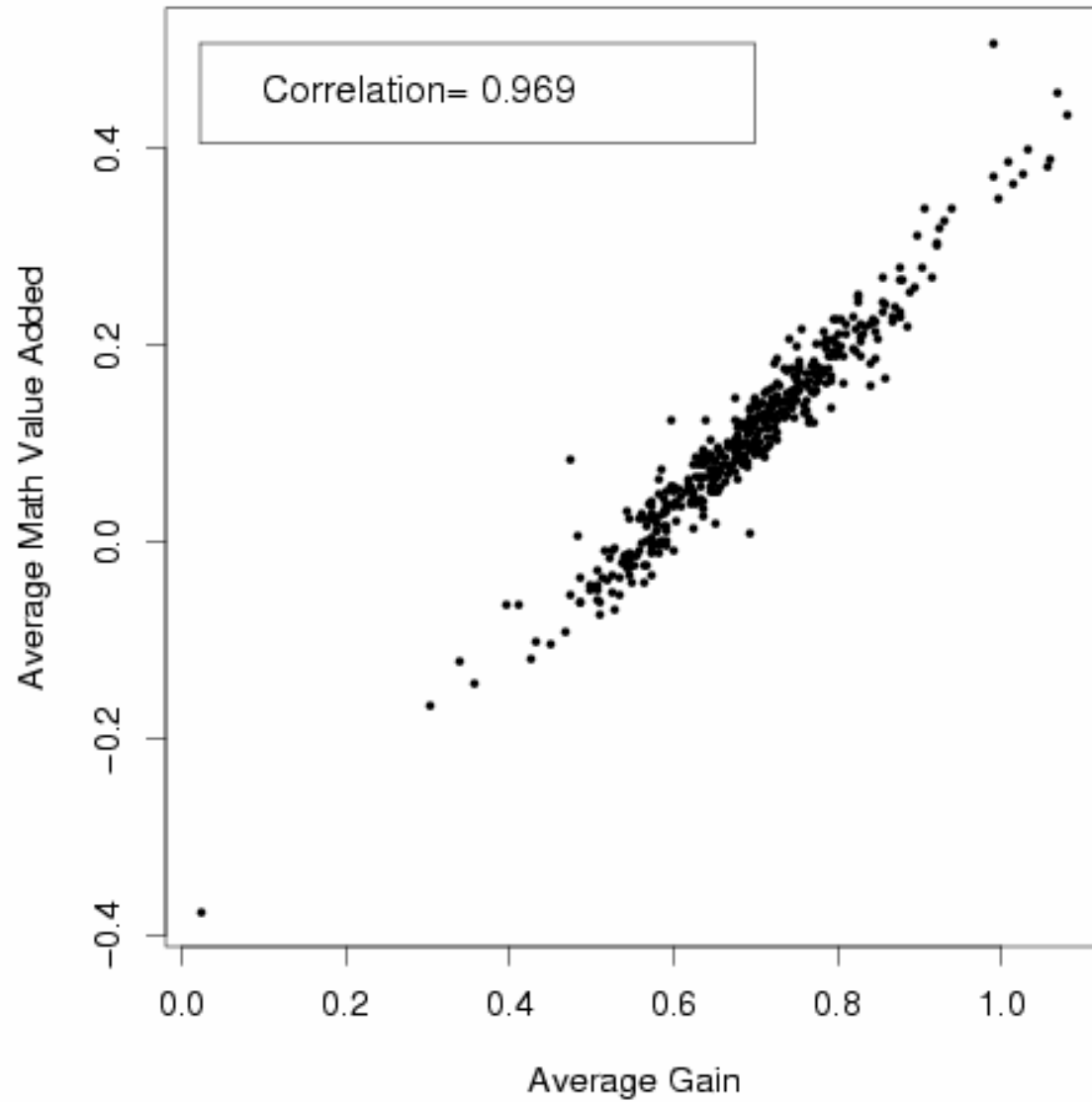
Average Value Added vs. Average Gain  
ITBS Grade 4, 1995–2001



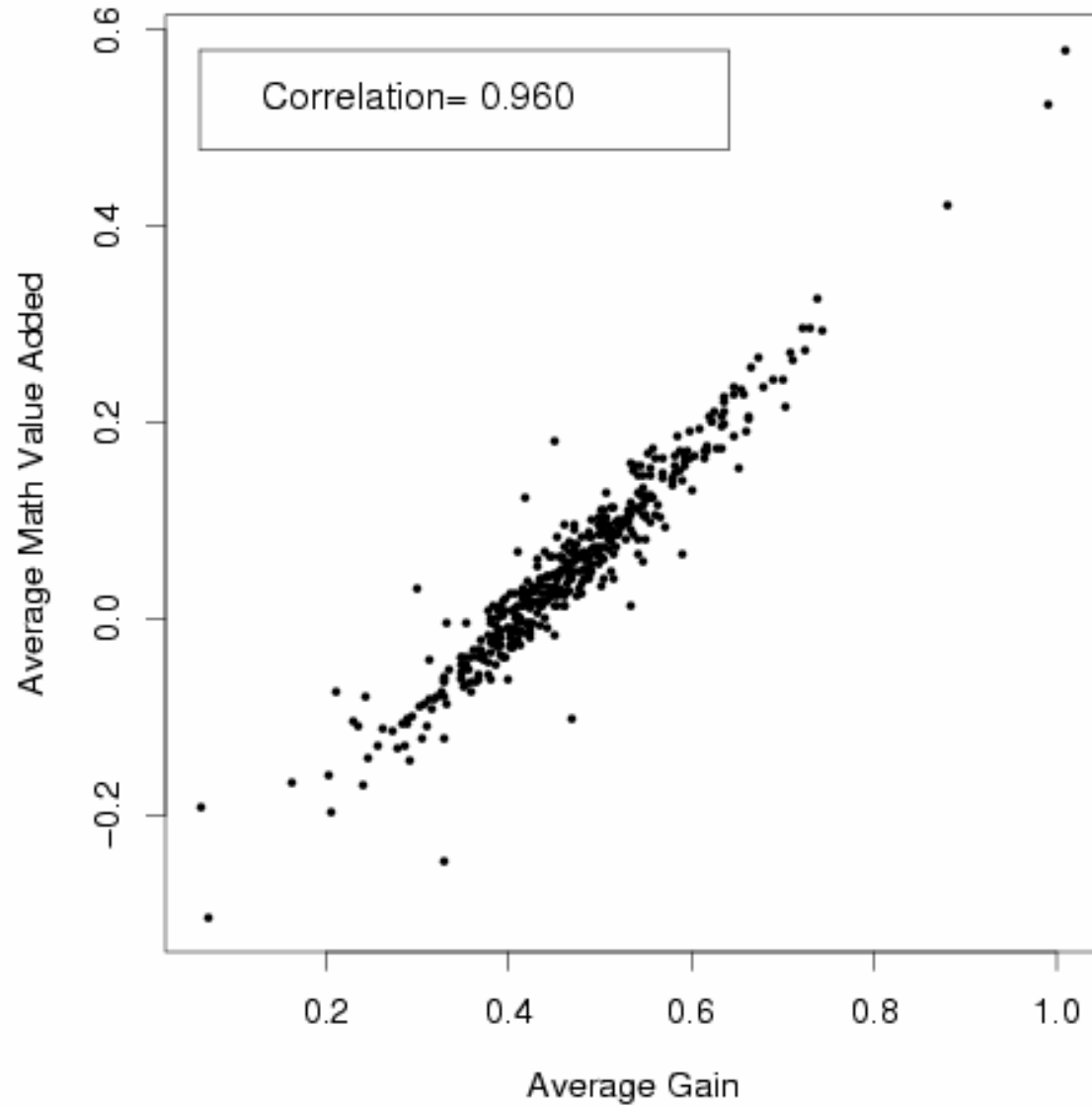
Average Value Added vs. Average Gain  
ITBS Grade 5, 1995–2001



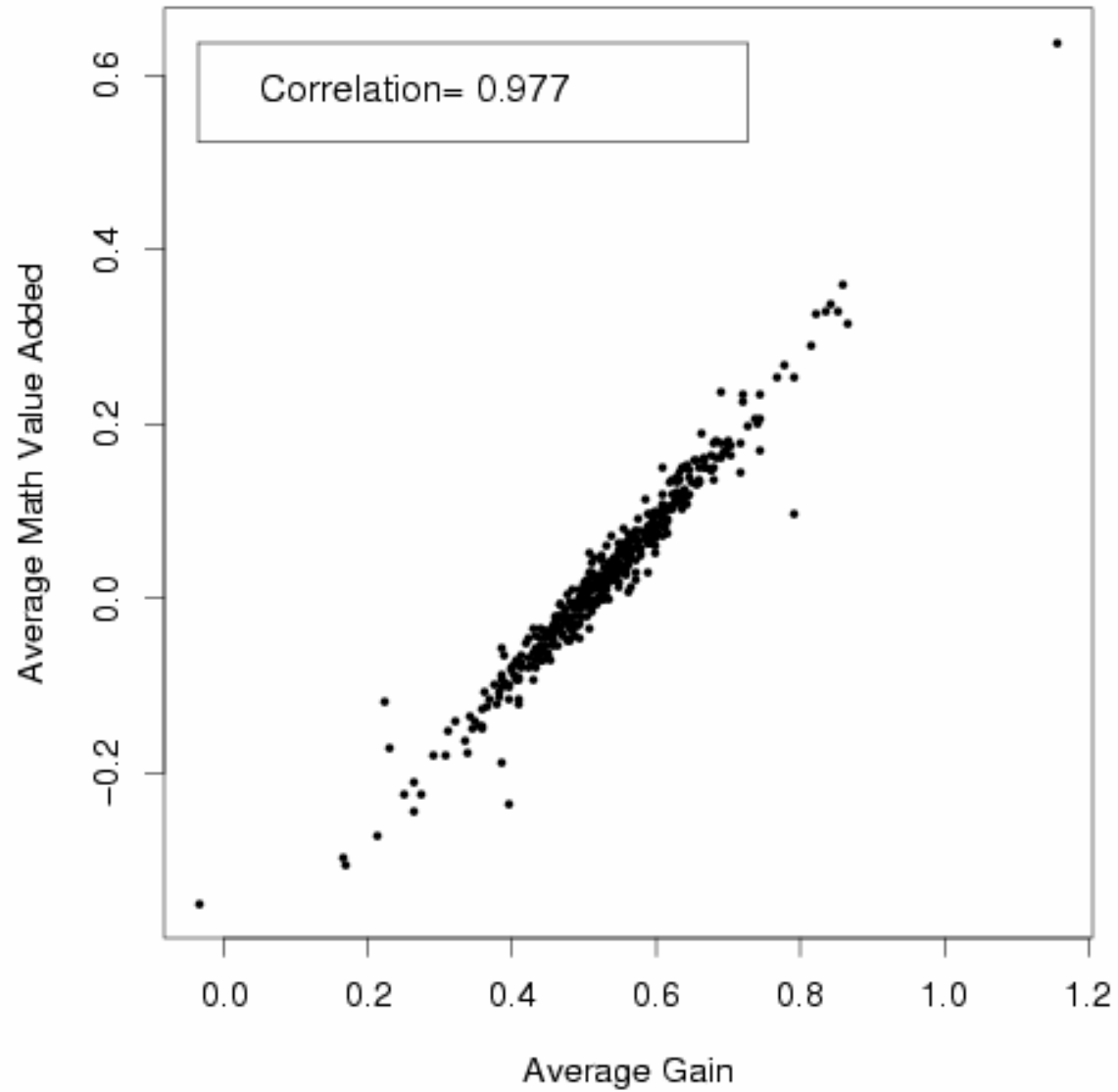
Average Value Added vs. Average Gain  
ITBS Grade 6, 1995–2001



Average Value Added vs. Average Gain  
ITBS Grade 7, 1995–2001



Average Value Added vs. Average Gain  
ITBS Grade 8, 1995–2001



# Comparison with NCLB Outcomes

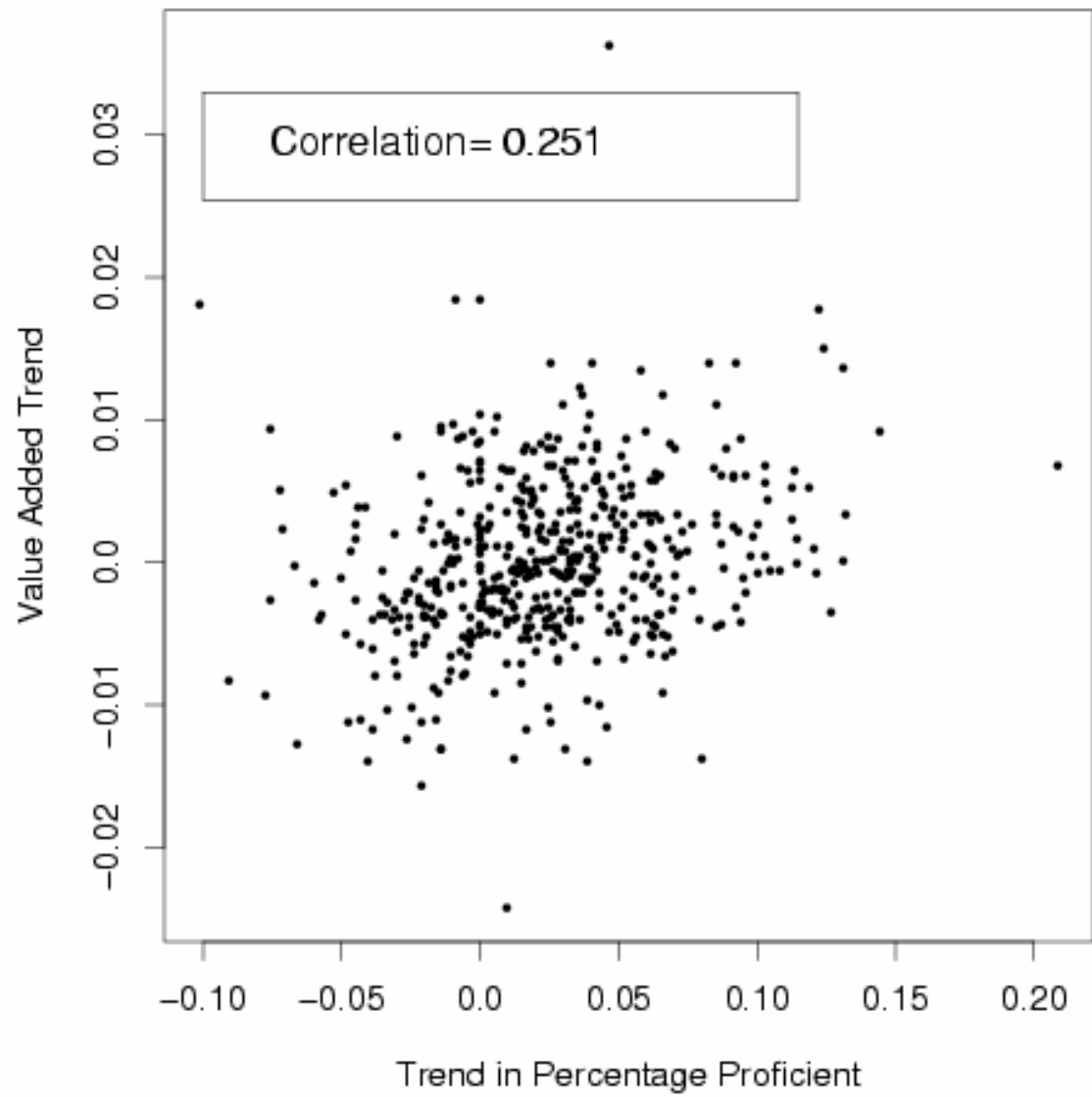
# Status Compared With Gains

- Percentage proficient is highly correlated with average gain at the school-grade level

	<b>Correlation</b>		
<b>Year/Subject</b>	<b>Grade 3</b>	<b>Grade 5</b>	<b>Grade 8</b>
<b>1999 Reading</b>	<b>0.87</b>	<b>0.90</b>	<b>0.80</b>
<b>2000 Reading</b>	<b>0.87</b>	<b>0.86</b>	<b>0.79</b>
<b>2001 Reading</b>	<b>0.88</b>	<b>0.92</b>	<b>0.84</b>
<b>1999 Math</b>	<b>0.87</b>	<b>0.88</b>	<b>0.83</b>
<b>2000 Math</b>	<b>0.87</b>	<b>0.82</b>	<b>0.83</b>
<b>2001 Math</b>	<b>0.87</b>	<b>0.88</b>	<b>0.79</b>

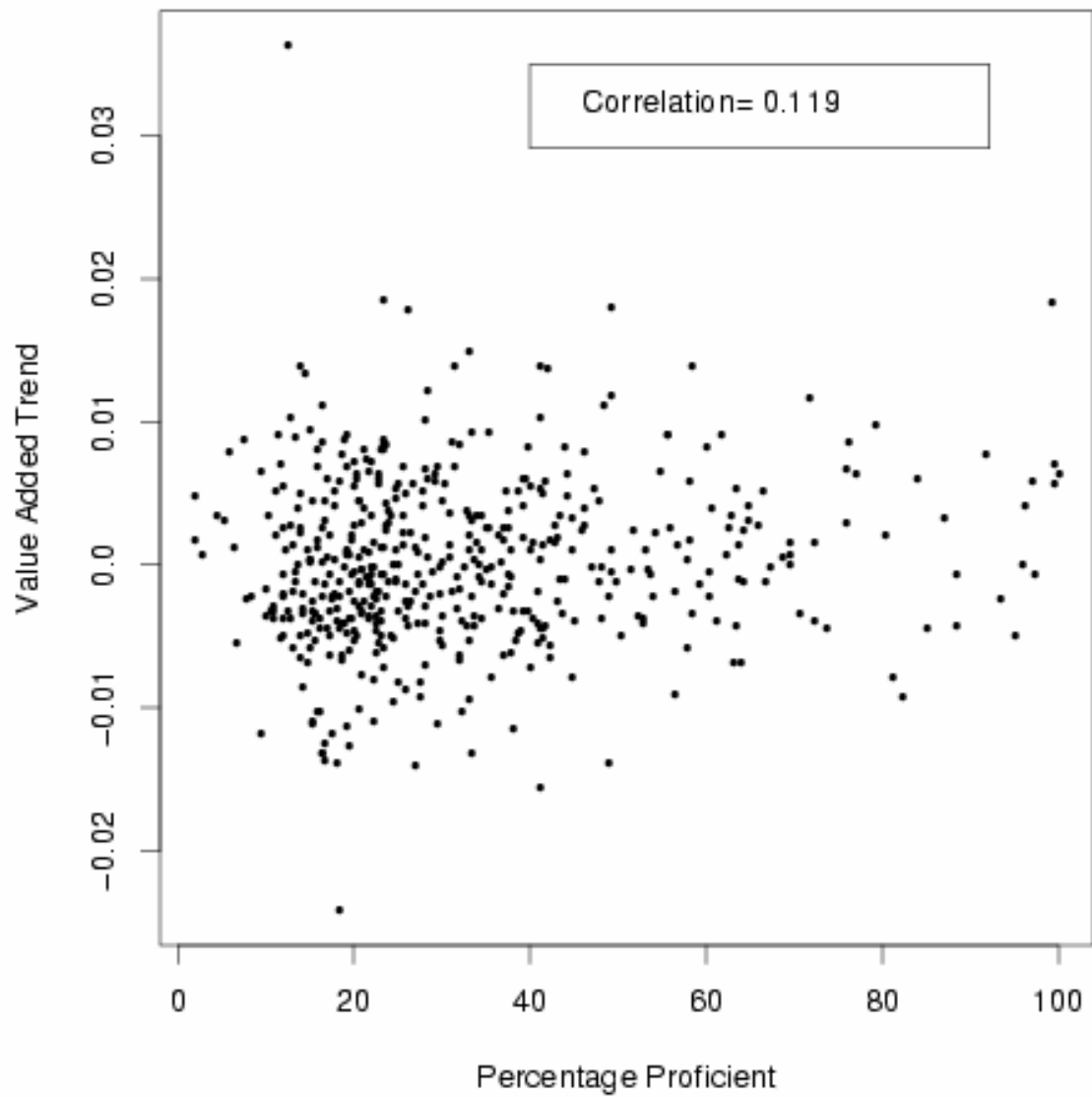


Percentage Proficient Trend vs. Value Added Trend  
Rasch Scoring of ITBS Math



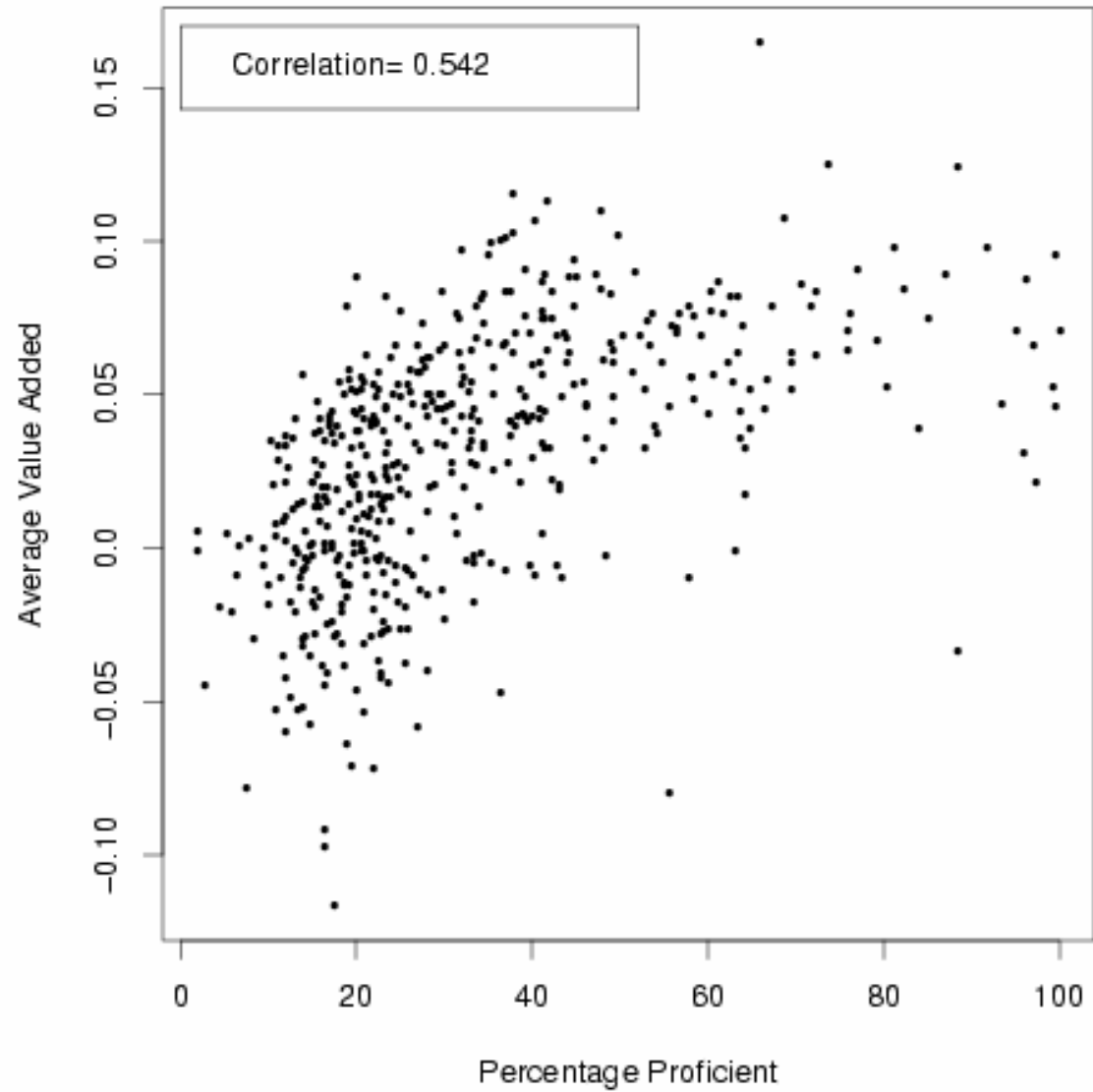
# Percentage Proficient vs. Value Added Trend

Rasch Scoring of ITBS Math

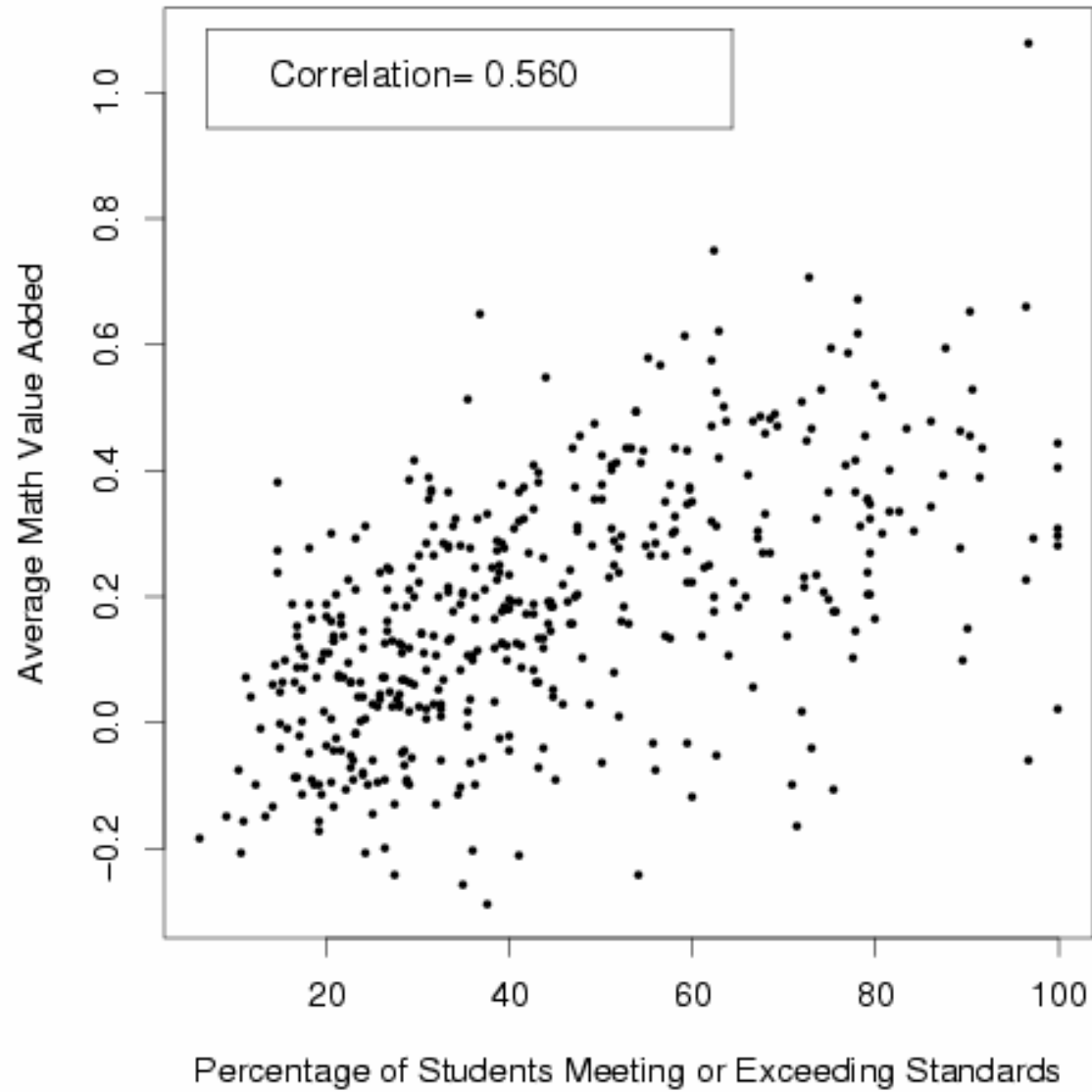


# Percentage Proficient vs. Average Value Added

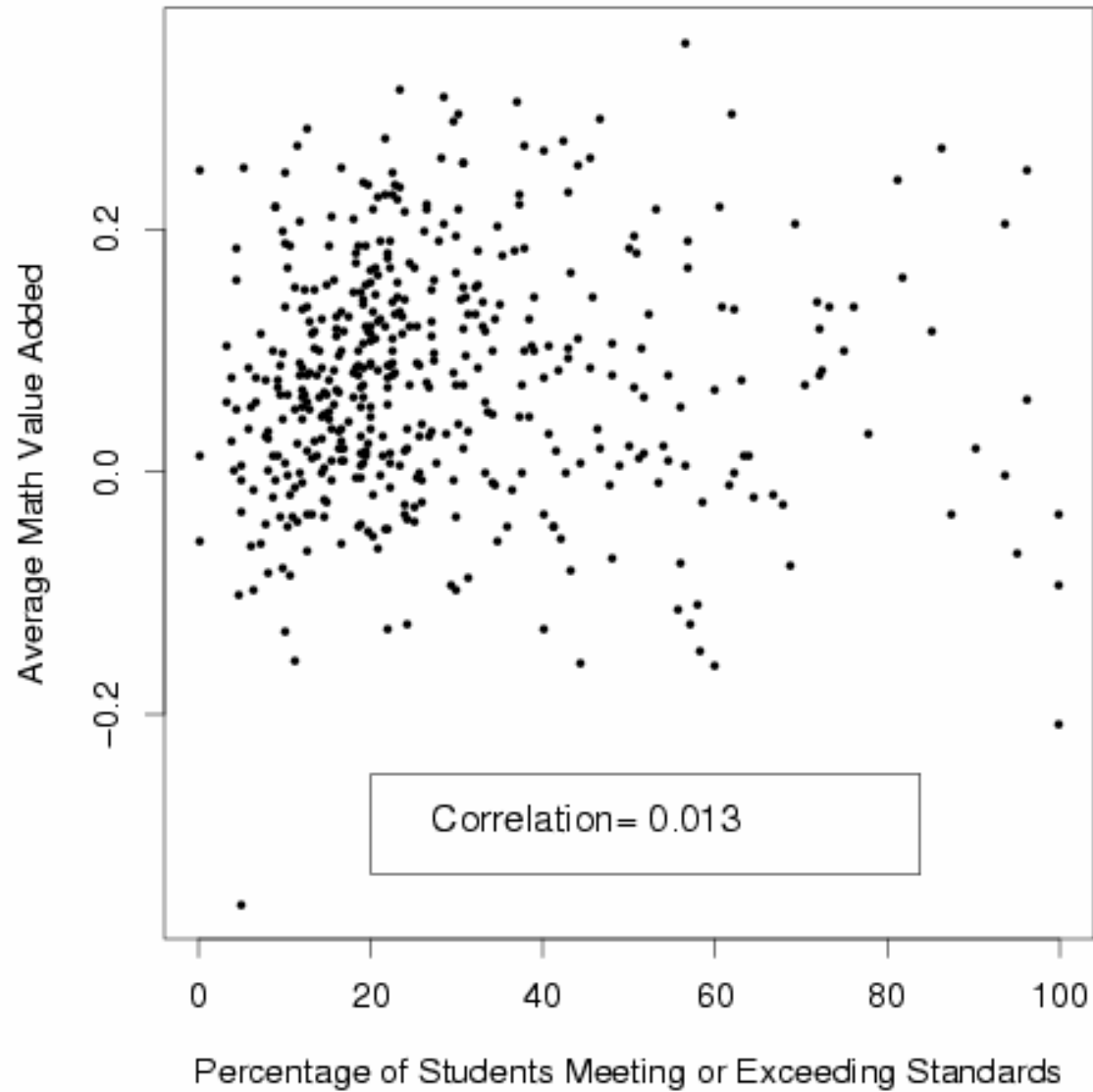
Rasch Scoring of ITBS Math



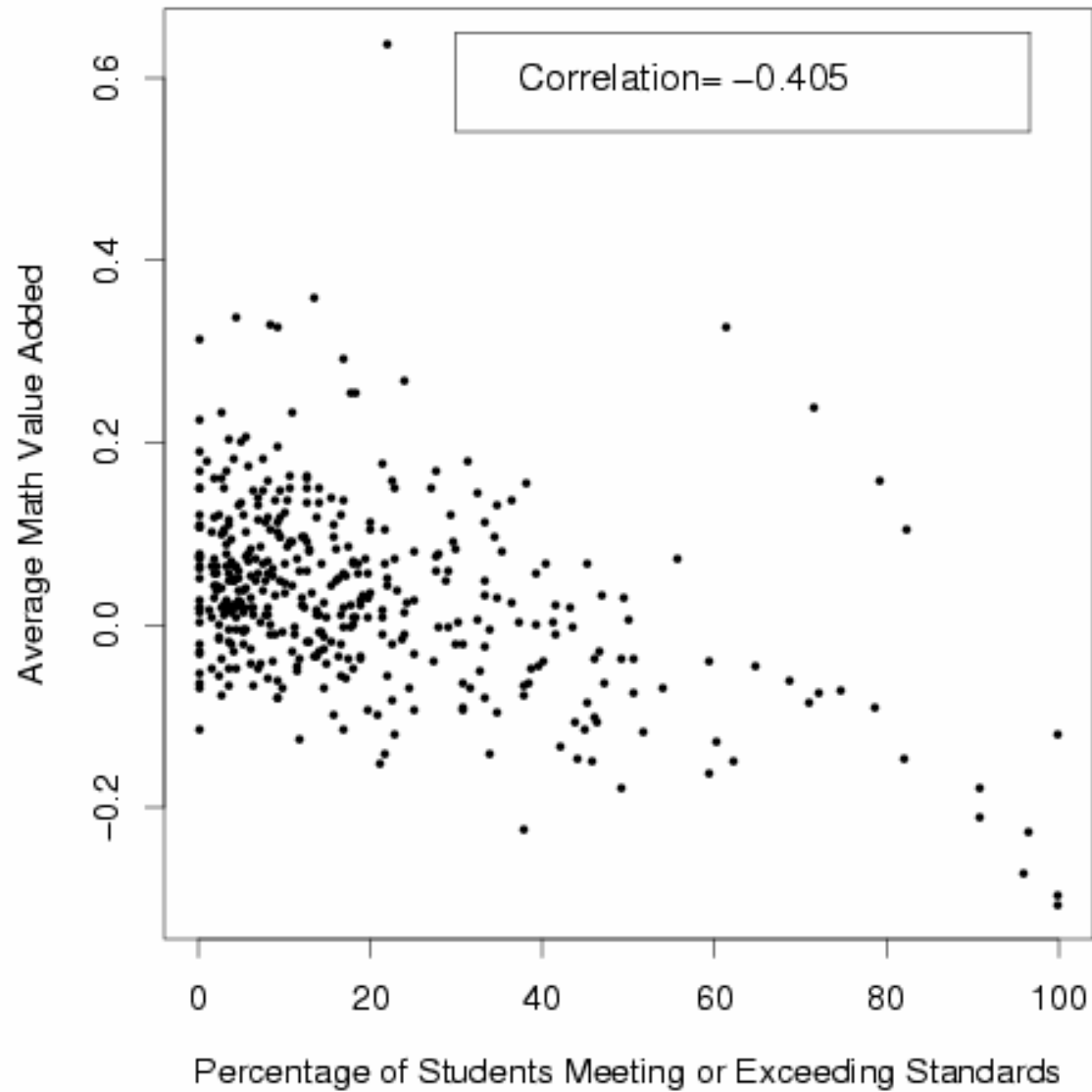
Percentage Meeting or Exceeding ISAT Standards  
Compared with Average ITBS Value Added  
Grade 3, 1999–2001



Percentage Meeting or Exceeding ISAT Standards  
Compared with Average ITBS Value Added  
Grade 5, 1999–2001



Percentage Meeting or Exceeding ISAT Standards  
Compared with Average ITBS Value Added  
Grade 8, 1999–2001



# Preliminary Conclusions

- Results similar to earlier work
- Different from NCLB results
  - Relationship different in each grade
- Our model can distinguish the top from the bottom, but “average” schools are most of the population
- Less variability at the school level than earlier models (due to variability between grades within a school)