

# School value-added models for multivariate academic and non-academic outcomes

A more rounded approach to using student data to inform school accountability

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Statistics > Applications

# School value-added models for multivariate academic and non-academic outcomes: A more rounded approach to using student data to inform school accountability

Lucy Prior, Harvey Goldstein, George Leckie

(Submitted on 7 Jan 2020)

Education systems around the world increasingly rely on school value-added models to hold schools to account. These models typically focus on a limited number of academic outcomes, failing to recognise the broader range of non-academic student outcomes, attitudes and behaviours to which schools contribute. We explore how the traditional multilevel modelling approach to school value-added models can be extended to simultaneously analyse multiple academic and non-academic outcomes and thereby can potentially provide a more rounded approach to using student data to inform school accountability. We jointly model student attainment, absence and exclusion data for schools in England. We find different results across the three outcomes, in terms of the size and consistency of school effects, and the importance of adjusting for student and school characteristics. The results suggest the three outcomes are capturing fundamentally distinct aspects of school performance, recommending the consideration of non-academic outcomes in systems of school accountability.

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Subjects: **Applications (stat.AP)**

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# Motivation

- Typical focus on a limited range of attainment measures in systems of school accountability
- High stakes accountability systems and their deleterious consequences
- Aspire to more holistic and sensitive judgements of schools
- Basing school summaries of student performance on a wider range of academic and non-academic outcomes as potential way to address these concerns

# Data

- National Pupil Database
- Mainstream schools, KS4 (age 15/16): 2017/2018
- Sample of 300 schools: 45,103 students

## Outcomes

- Attainment  
Summary score of qualifications across 8 subjects (Attainment 8)
- Absences:  
Log of total absence sessions in secondary school
- Exclusions:  
Ever excluded in secondary school

# Absences

## School attendance and absence: The facts

7 December 2017



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## Green Bay schools received deductions for chronic absenteeism

DECEMBER 18, 2019

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## Reducing Chronic Absenteeism under the Every Student Succeeds Act

Lauren Bauer, Patrick Liu, Diane Whitmore Schanzenbach, and Jay Shambaugh



## Article

### Chronic Absenteeism in the Classroom Context: Effects on Achievement

2019  
Article  
sagepub.com/journals.sage

**Michael A. Gottfried<sup>1</sup>**

**Abstract**  
Although educational policy makers uphold that chronic

### Albion Park High School, Albion Park, NSW

School profile | NAPLAN | Attendance | Finances | VET in schools | Senior secondary | Schools map

The table below shows the student attendance rate and student attendance level for students from Year 1 to Year 10 at this school, by Indigenous status. Student attendance level information is collected by schools and reported on My School twice yearly by Indigenous status for Semester 1 (Terms 1 and 2) and Term 3.

Year	2012	2013	2014	2015	2016	2017	2018	2019
Student attendance rate	Percent <sup>1</sup>							
All students	89%							
Indigenous students	84%							
Non-Indigenous students	89%							
Student attendance level (proportion of students attending 90% or more of the time) <sup>2</sup>	Percent <sup>1</sup>							

### All schools and colleges in Bristol City of

View on map

- Primary performance (138 schools)
- Secondary performance (50 schools)
- 16 to 18 performance (41 schools/colleges)
- Ofsted ratings
- Absence and pupil population
- Workforce and finance

Looking at:

Show filters

#### Pupil absence in schools in 2017 to 2018

Showing 1 - 50 of 168 schools and colleges

School name	Type of school	Overall rate of absence	Persistent absence
Elmlea Junior School <a href="#">Create Myschools list</a>	Academy	2.5%	1.4%
Elmlea Infant School <a href="#">Create Myschools list</a>	Maintained School	2.6%	1.6%
Henleaze Infant School <a href="#">Create Myschools list</a>	Maintained School	3%	3.8%
Henleaze Junior School <a href="#">Create Myschools list</a>	Academy	3%	2.8%
St Teresa's Catholic Primary School	Academy	3%	4.9%

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Asia | China | India

## Why so many Japanese children refuse to go to school

By Alessia Cerantola  
BBC World Service



## Student absenteeism

Who misses school and how missing school matters for performance

Report • By Emma Garcia and Elaine Weiss • September 25, 2018

# Exclusions

## Schools told to stop using exclusions to boost their results

Review will call for heads to be accountable for the exam records of children 'off-rolled'



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England Local News Regions

## Schools' pupil exclusion rate rise concerns inspectors

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Universities Students

## Dozens of secondary schools exclude at least 20% of pupils

Call for government to act after Guardian investigation reveals high suspension rates in England



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## SCHOOL EXCLUSIONS ARE A SOCIAL JUSTICE ISSUE, NEW DATA SHOWS

6th August 2019

Written by:

Laure Pertridge

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Family & Education Young Reporter Global Education

## Knife crime: Excluded pupils 'sucked into criminality'

By Hannah Richardson  
BBC News education and social affairs reporter

© 7 March 2019

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# TIMPSON REVIEW OF SCHOOL EXCLUSION

May 2019

# MAKING THE DIFFERENCE

## BREAKING THE LINK BETWEEN SCHOOL EXCLUSION AND SOCIAL EXCLUSION

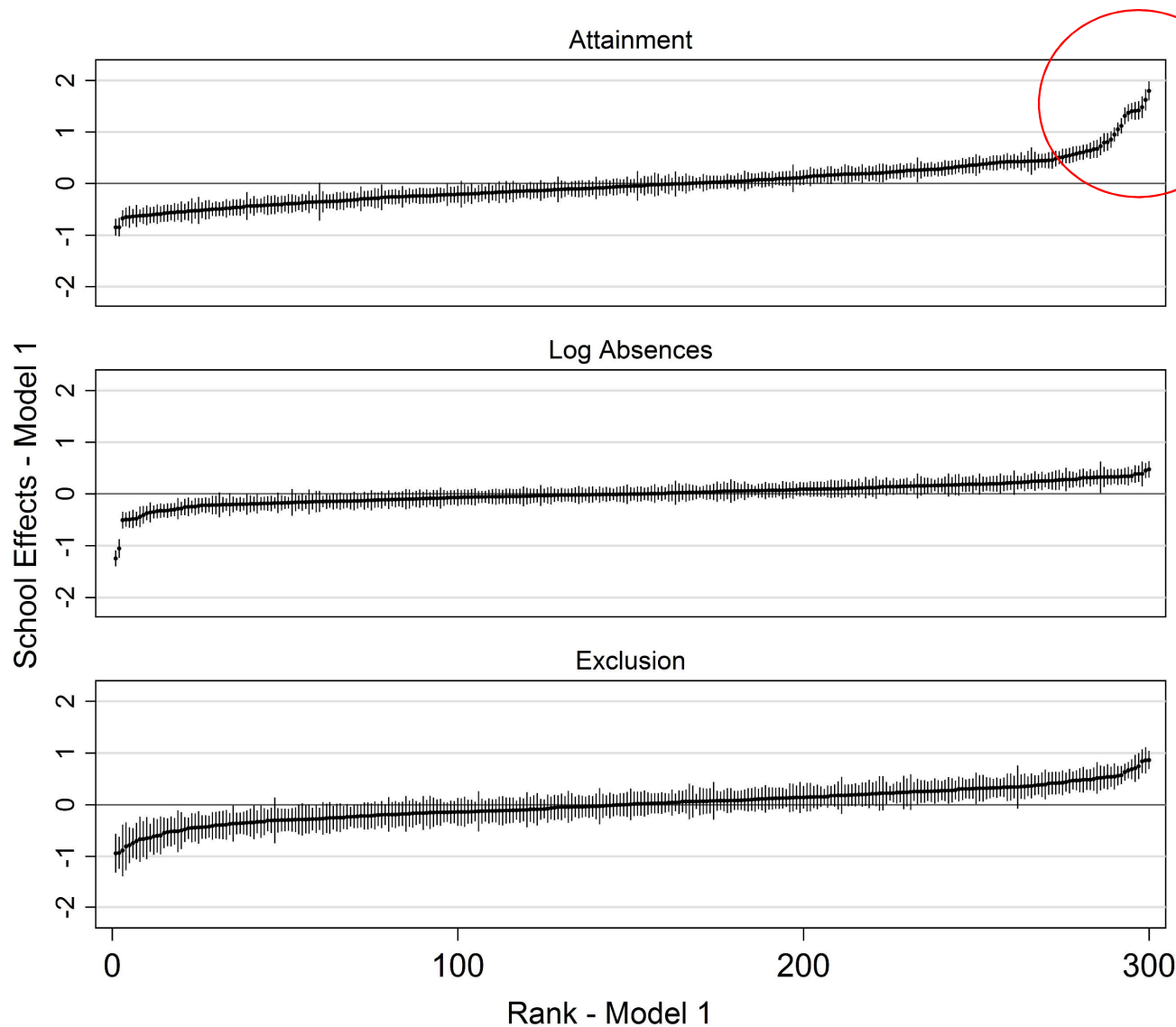
# Methods

- Multivariate, mixed-response, multilevel model
- Two-level: students (level 1) nested within schools (level 2)
- Four models:
  - 1 - Unadjusted model
  - 2 - Value-added model
  - 3 - Contextual value-added model
  - 4 - Contextual value-added model with school characteristics

# Model 1: unadjusted model

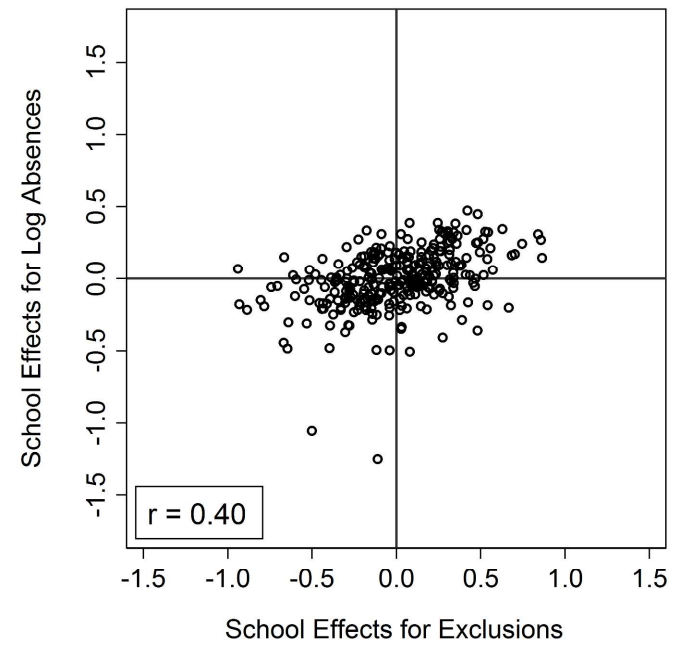
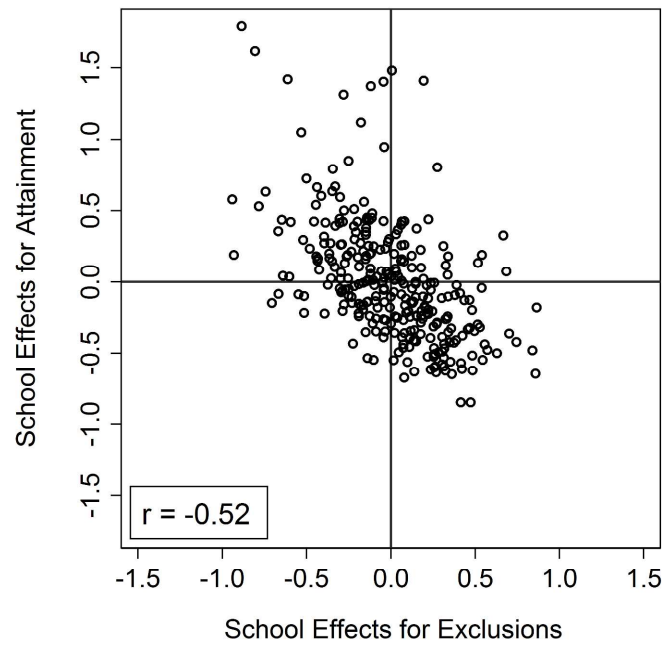
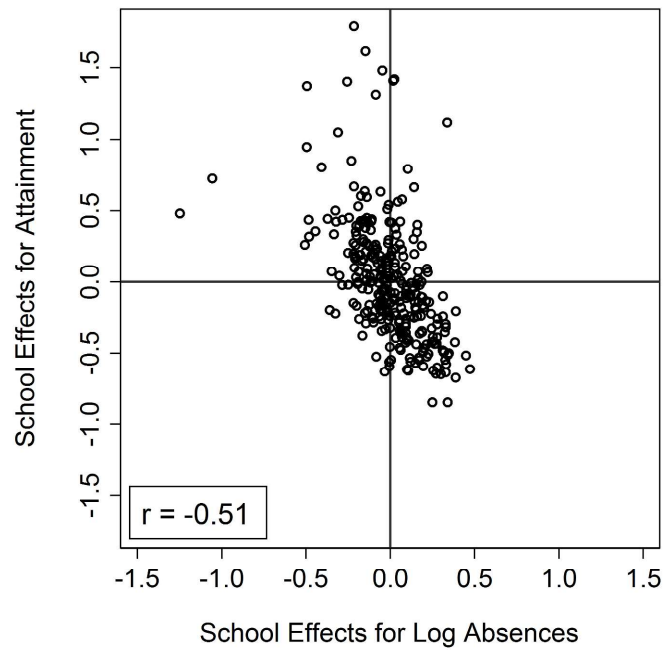
Variance Partitioning  
Coefficient (VPC)

Attainment: 19%  
Log Absences: 5%  
Exclusions: 12%

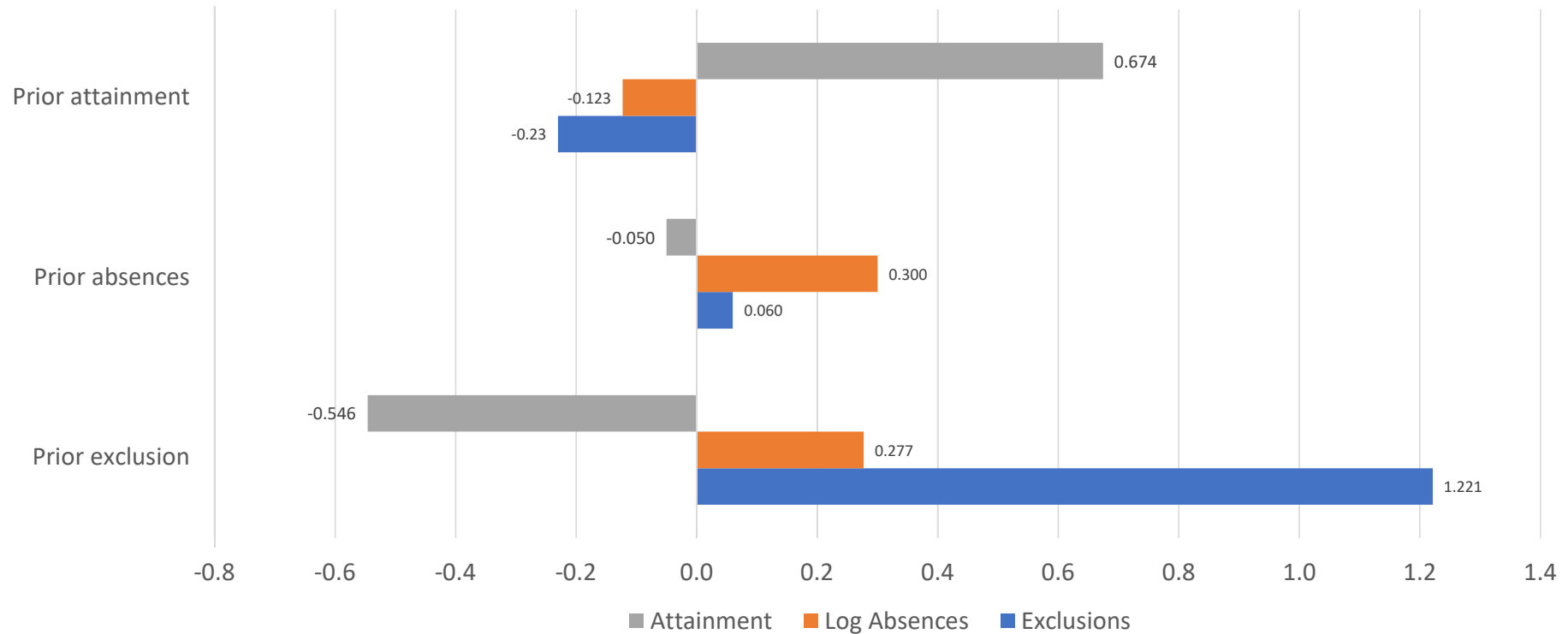




# Model 1: unadjusted model



# Model 2: value-added



- Prior attainment is standardised KS2 score, with mean 0 and SD 1
- Prior absences is total number of absence sessions in final year of primary school – here coefficient is multiplied by 10 to indicate effect of missing an extra week of schooling
- Prior exclusion is binary indicator of whether the student was excluded in the final year of primary school

## Model 2: value-added

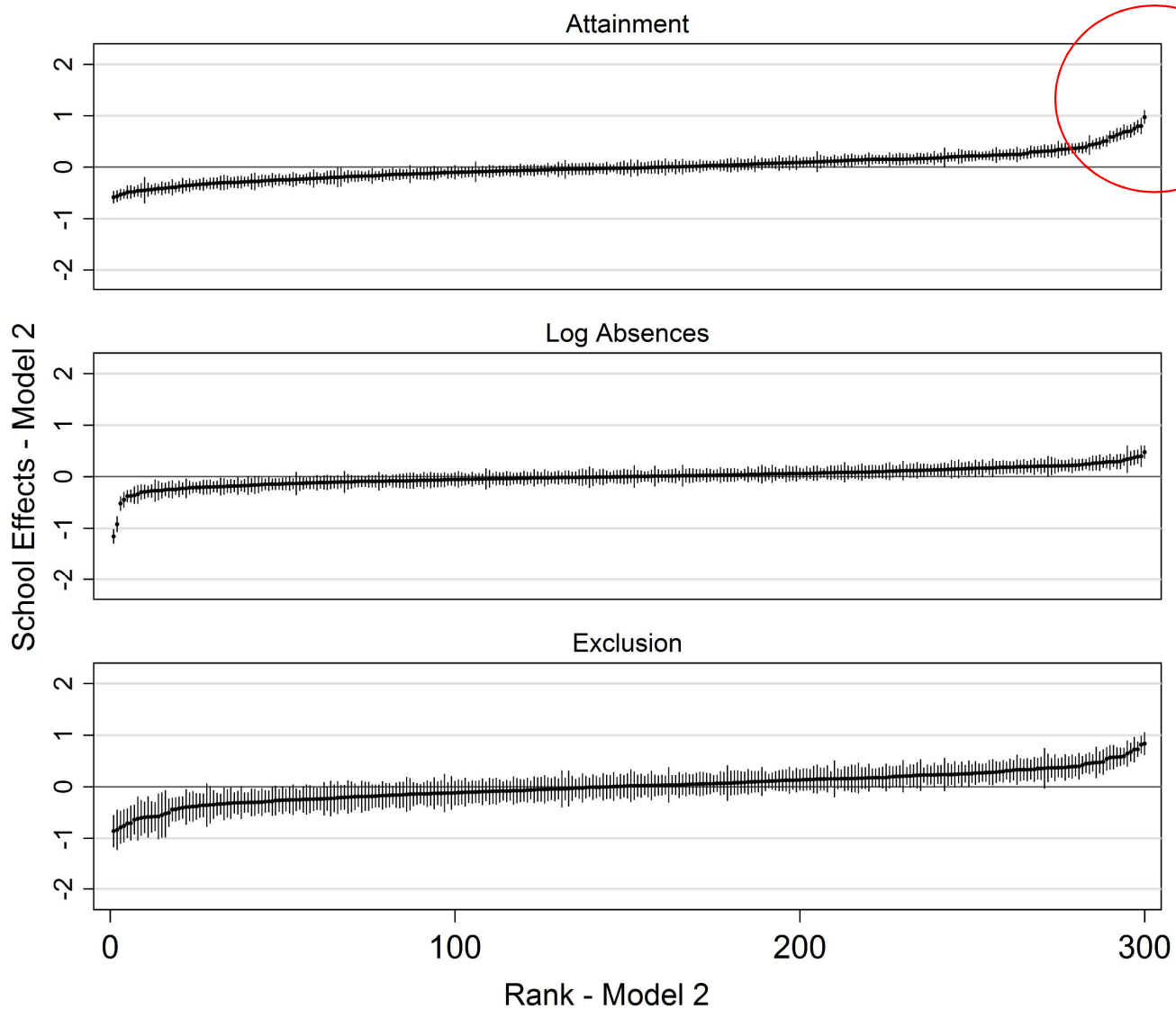
Model 1				Model 2			
	Attainment	Log Absences	Exclusions		Attainment	Log Absences	Exclusions
VPC	19%	5%	12%	VPC	14%	5%	11%
R Squared	0.00	0.00	0.00	R Squared	0.48	0.24	0.08
Model 3				Model 4			
	Attainment	Log Absences	Exclusions		Attainment	Log Absences	Exclusions
VPC	12%	5%	10%	VPC	9%	5%	9%
R Squared	0.53	0.28	0.15	R Squared	0.56	0.28	0.17

- VPC (Variance Partitioning Coefficient) shows percentage of variation that lies between schools
- R Squared is the proportion of total variation explained by the fixed portion of the model

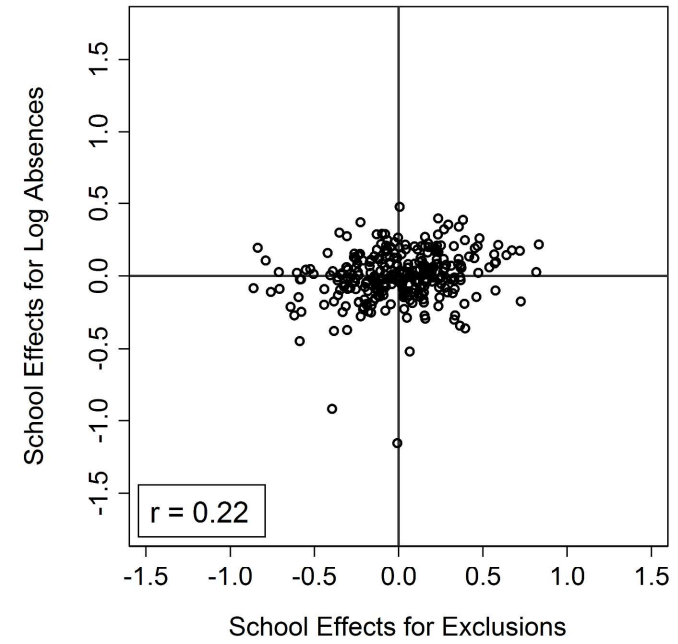
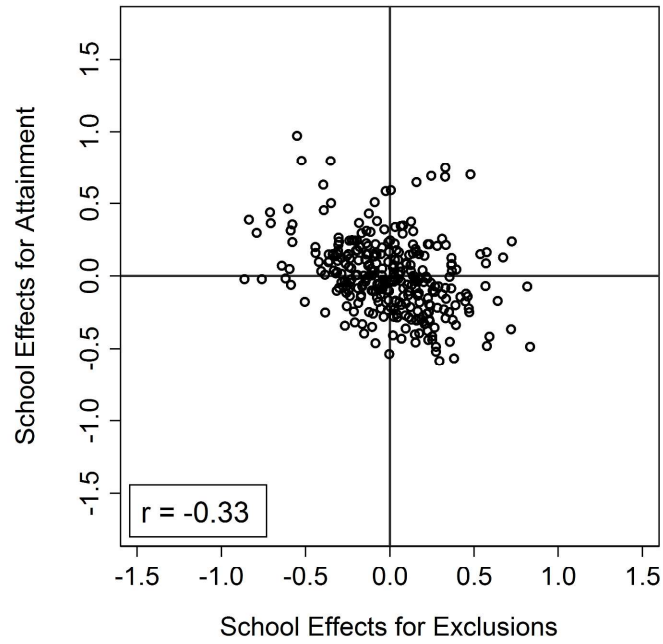
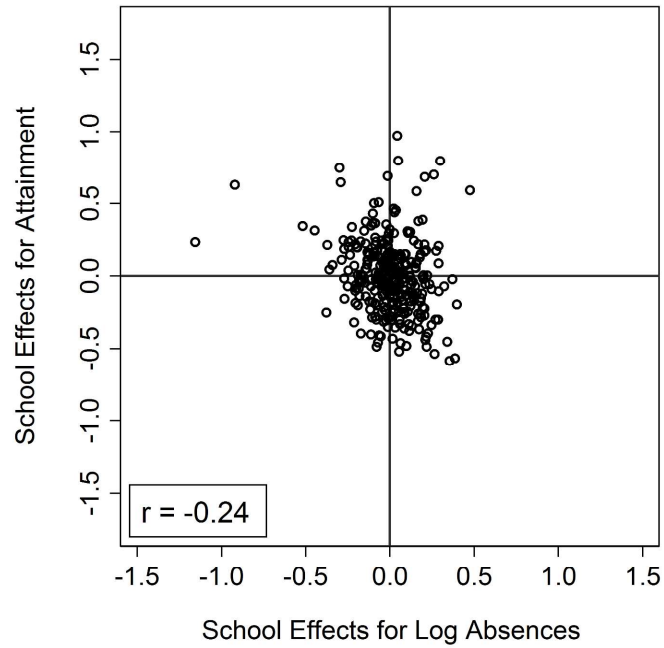
# Model 2: value- added

Variance Partitioning  
Coefficient (VPC)

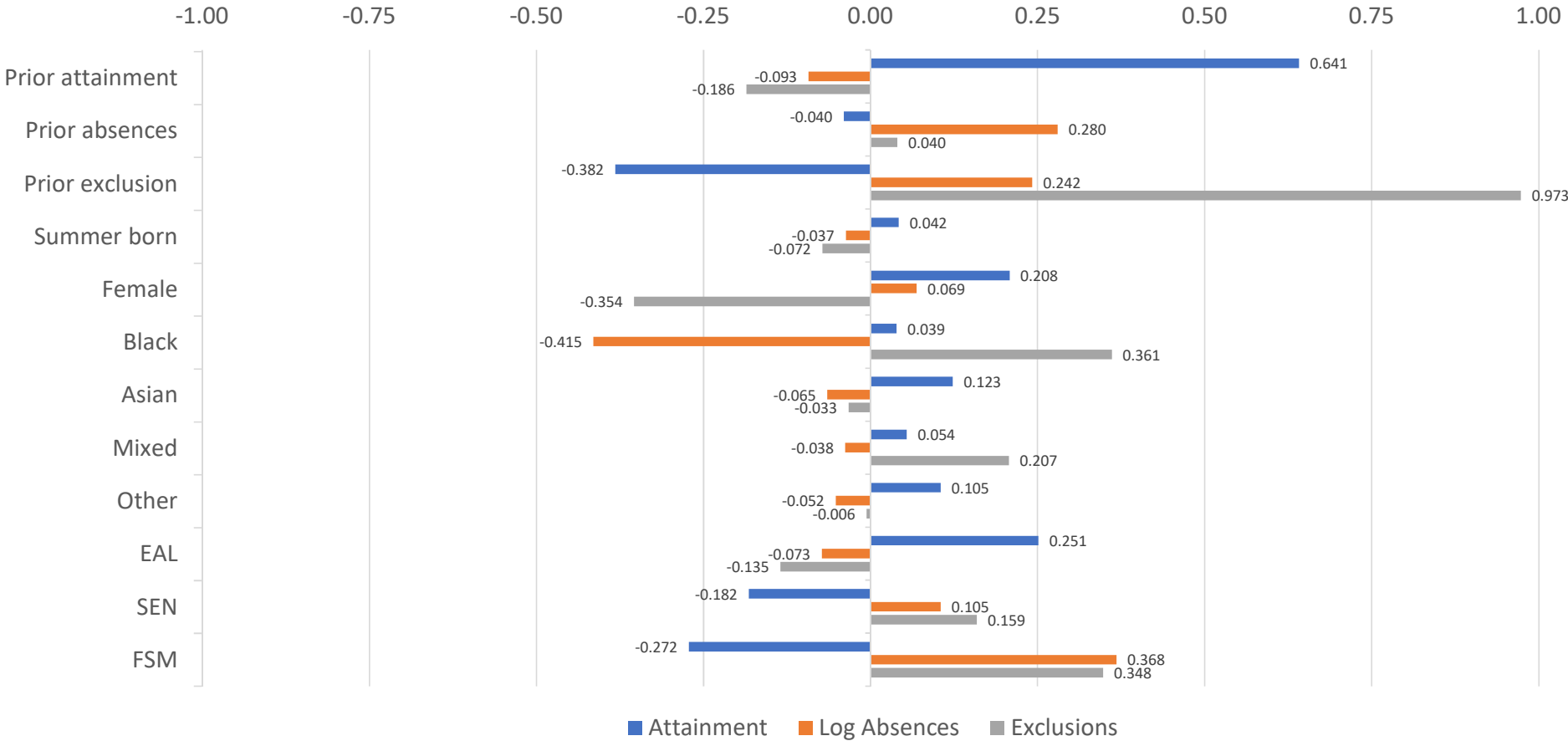
Attainment: 14%  
Log Absences: 5%  
Exclusions: 11%



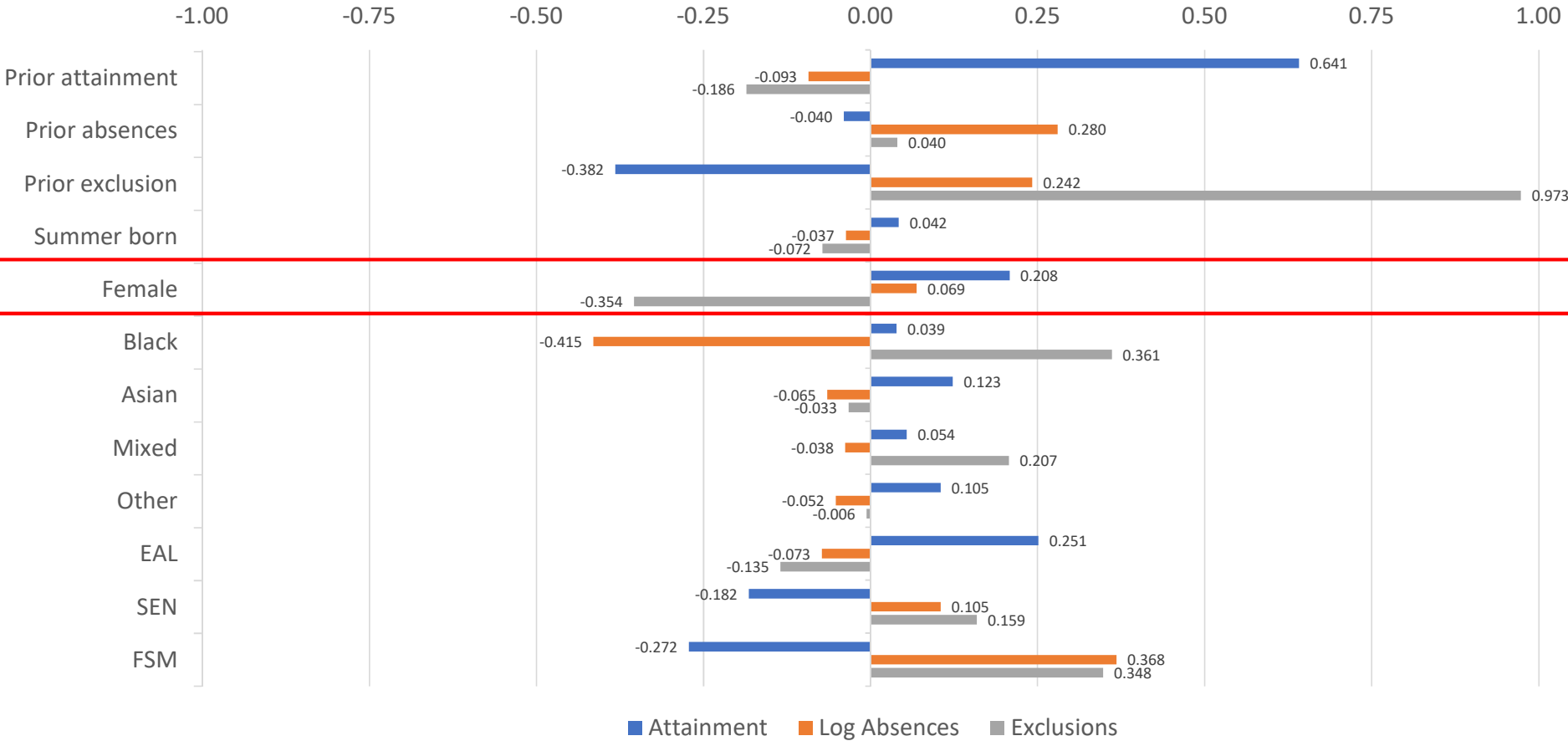
# Model 2: value-added



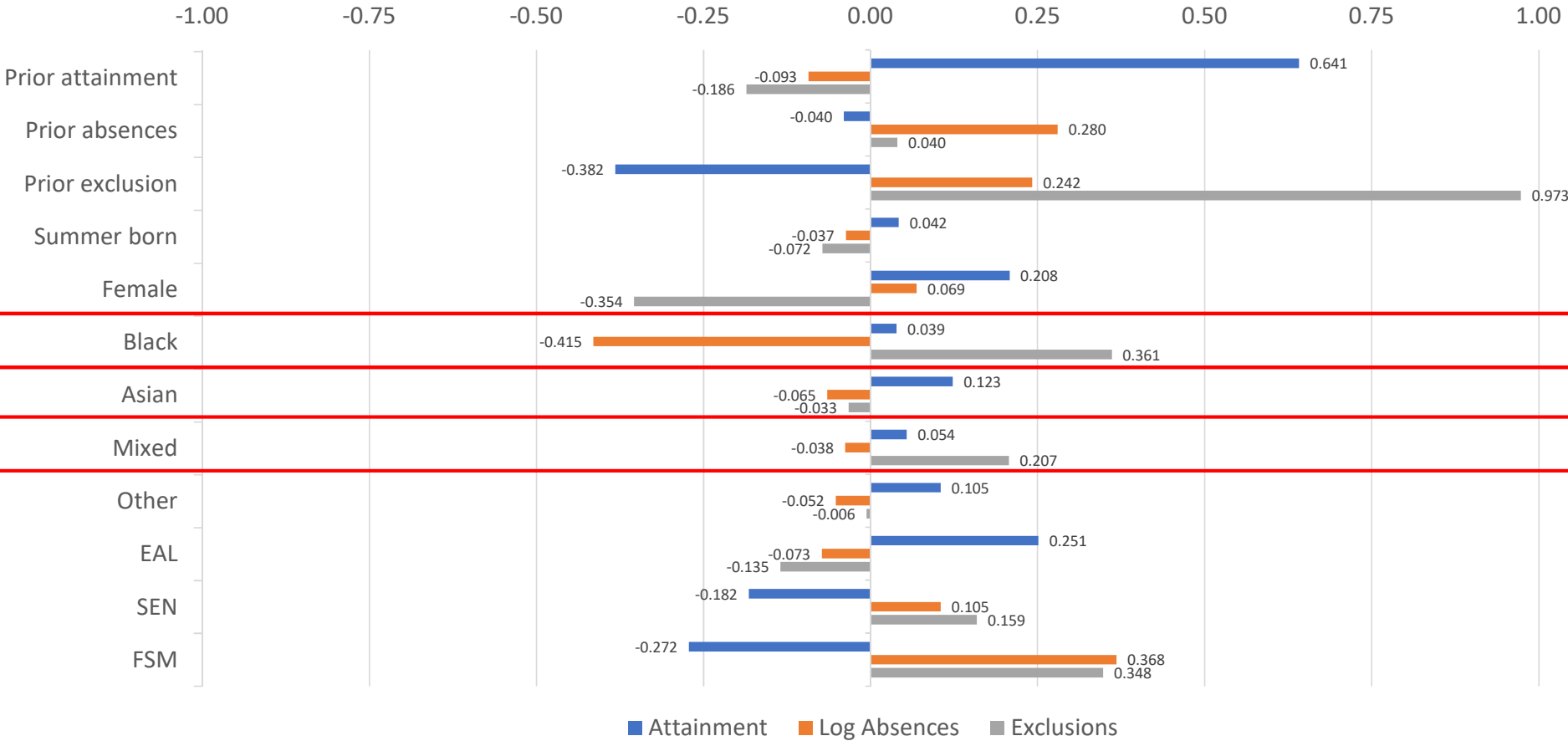
# Model 3: contextual value-added



# Model 3: contextual value-added

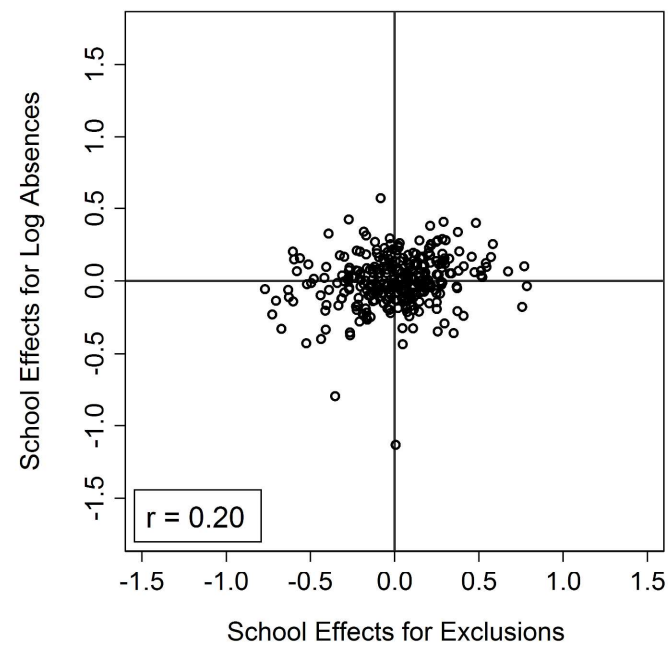
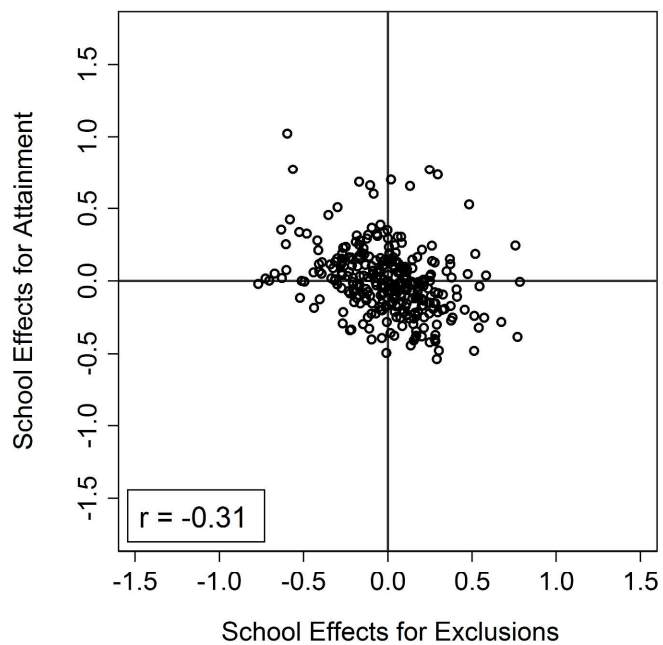
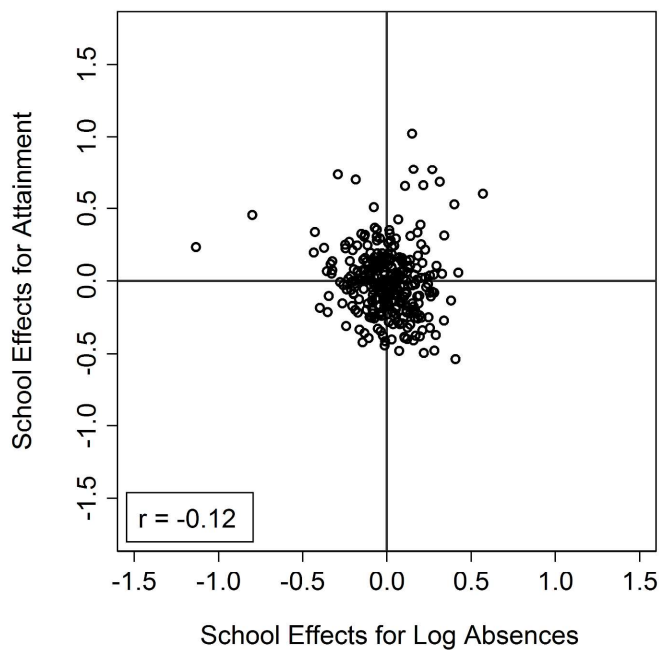


# Model 3: contextual value-added





# Model 3: contextual value-added



# Model 3: contextual value-added

Model 1				Model 2			
	Attainment	Log Absences	Exclusions		Attainment	Log Absences	Exclusions
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R Squared	0.00	0.00	0.00	R Squared	0.48	0.24	0.08
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	Attainment	Log Absences	Exclusions		Attainment	Log Absences	Exclusions
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R Squared	0.53	0.28	0.15	R Squared	0.56	0.28	0.17

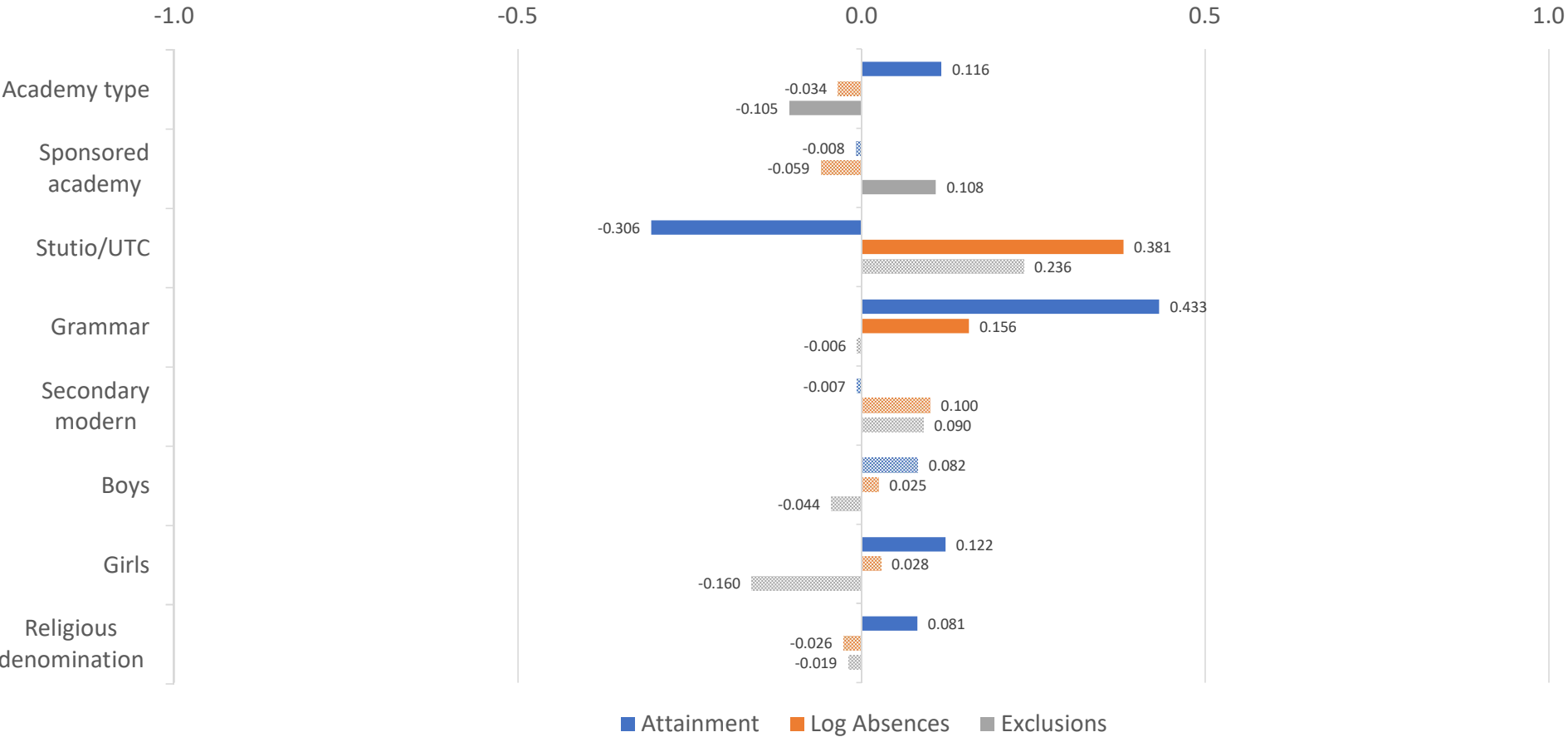
- VPC (Variance Partitioning Coefficient) shows percentage of variation that lies between schools
- R Squared is the proportion of total variation explained by the fixed portion of the model

# Model 4: school characteristics

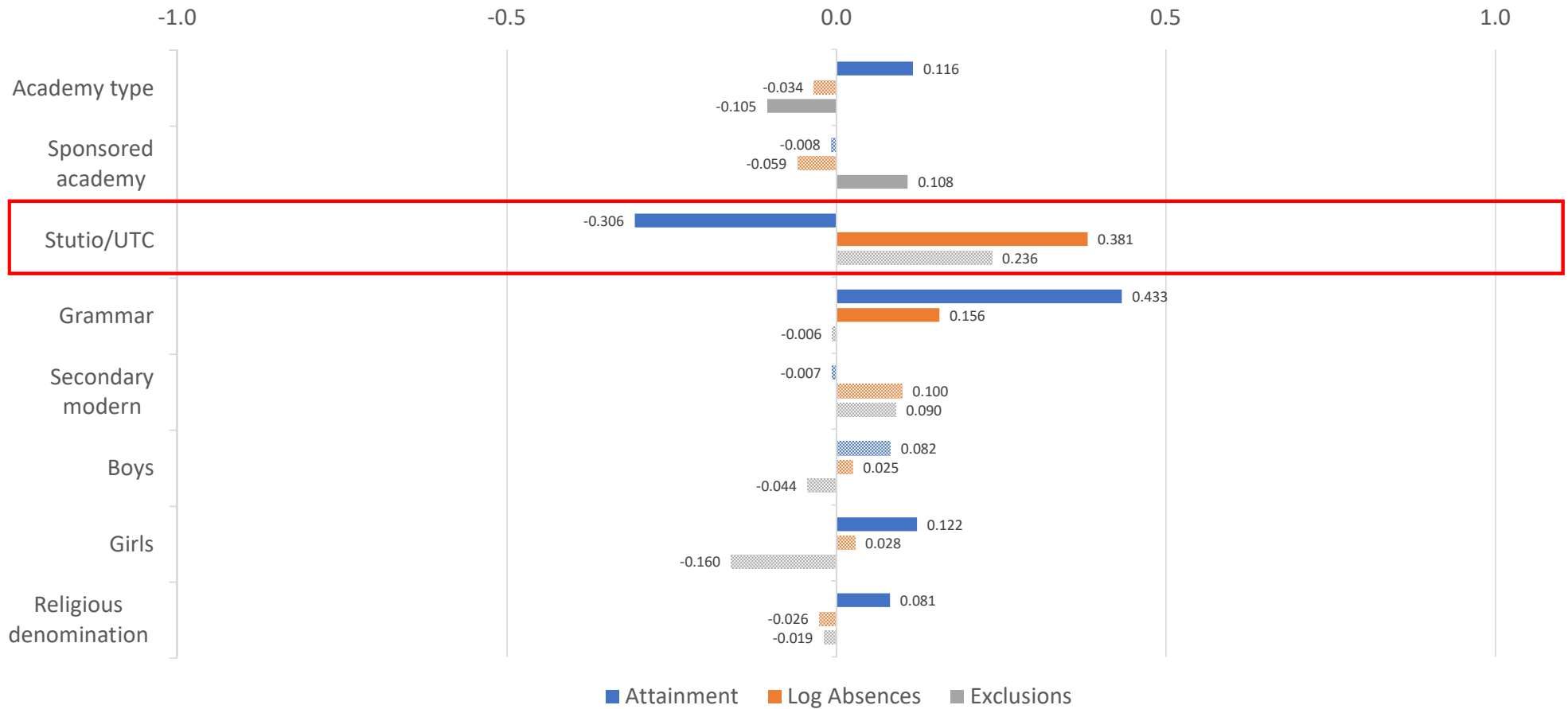
Model 1				Model 2			
	Attainment	Log Absences	Exclusions		Attainment	Log Absences	Exclusions
VPC	19%	5%	12%	VPC	14%	5%	11%
R Squared	0.00	0.00	0.00	R Squared	0.48	0.24	0.08
Model 3				Model 4			
	Attainment	Log Absences	Exclusions		Attainment	Log Absences	Exclusions
VPC	12%	5%	10%	VPC	9%	5%	9%
R Squared	0.53	0.28	0.15	R Squared	0.56	0.28	0.17

- VPC (Variance Partitioning Coefficient) shows percentage of variation that lies between schools
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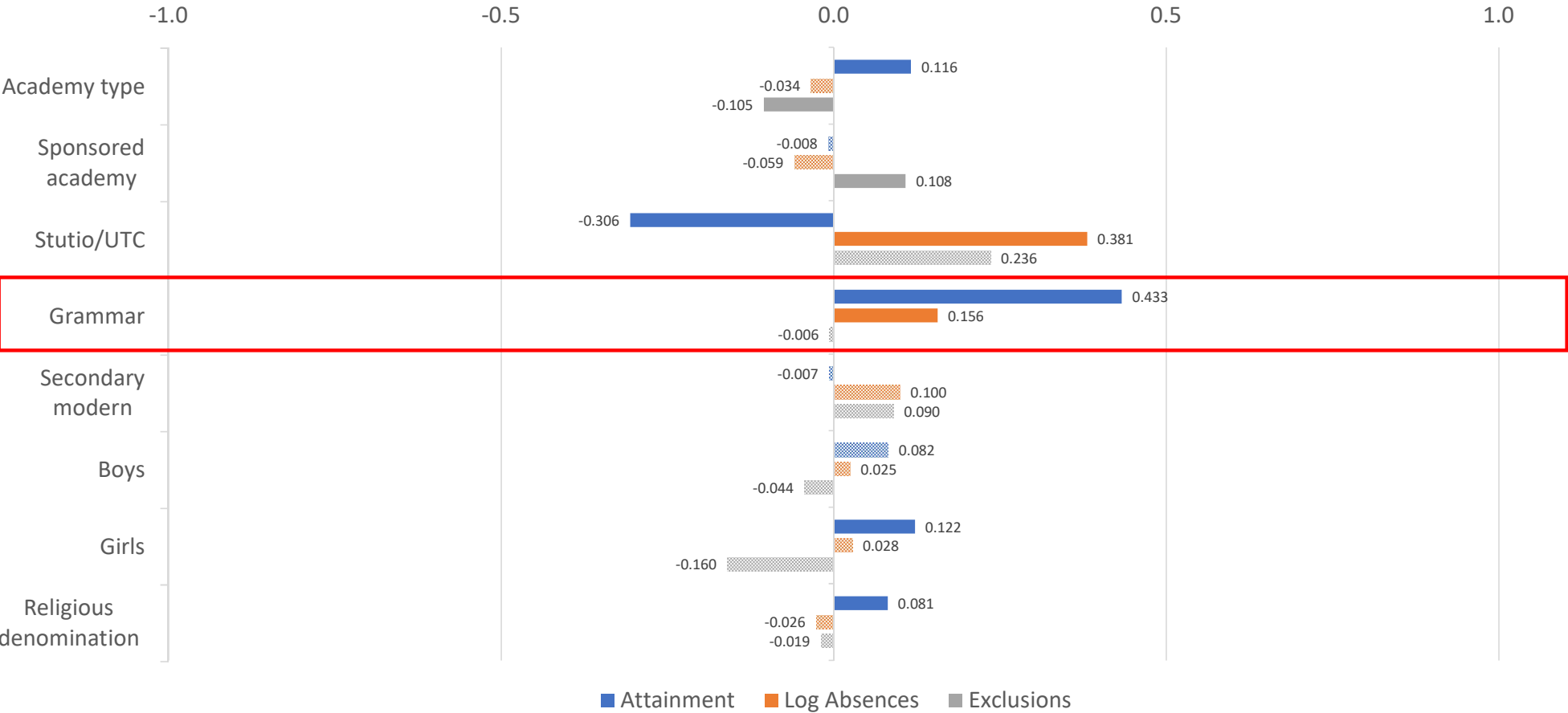
# Model 4: school characteristics



# Model 4: school characteristics



# Model 4: school characteristics



# Discussion

- Attainment, absences and exclusions appear to be capturing different aspects of school effectiveness
- School accountability systems could potentially benefit from considering academic and non-academic outcomes simultaneously
- Potential use of multiple outcomes as part of informed screening tools
  - % of tail ends of caterpillar plots
  - Scatterplots to help reveal schools unusual in combination of effects

## Limitations/Further work

- How to enact value-added models for continuously recorded student data?
  - Total variance explained much lower for absences (28%) and exclusions (17%) than attainment (56%)
  - Limitations to prior absence and prior exclusions measures
  - Final schooling attainment versus continuously recorded absences and exclusion
- What are the school effects on the different dimensions of absences and exclusions and how to these relate to attainment?
  - Focused on overall summaries of absences (authorized and unauthorized) and exclusions (fixed and permanent)



## Limitations/Further work

- What is the impact of student mobility, particularly in relation to modelling exclusions?
  - Student mobility not considered in current analyses, including moves related to permanent exclusions
- What other outcomes could be incorporated into systems of school accountability and how can such systems better reflect the harder to measure aspects of school effectiveness?
  - Absences and exclusions chosen as the non-academic outcomes as routinely recorded in NPD and both having relationships to attainment

# Thanks – Questions?

<https://arxiv.org/abs/2001.01996>

Prior L, Goldstein H, and Leckie G (2019). School value-added models for multivariate academic and non-academic outcomes: A more rounded approach to using student data to inform school accountability. ArXiv:2001.01996 [stat.AP]

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# Appendix: Methods

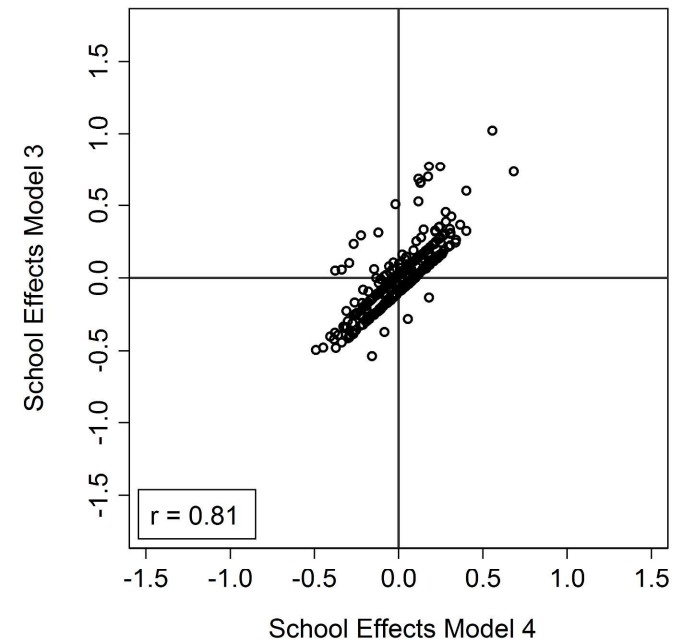
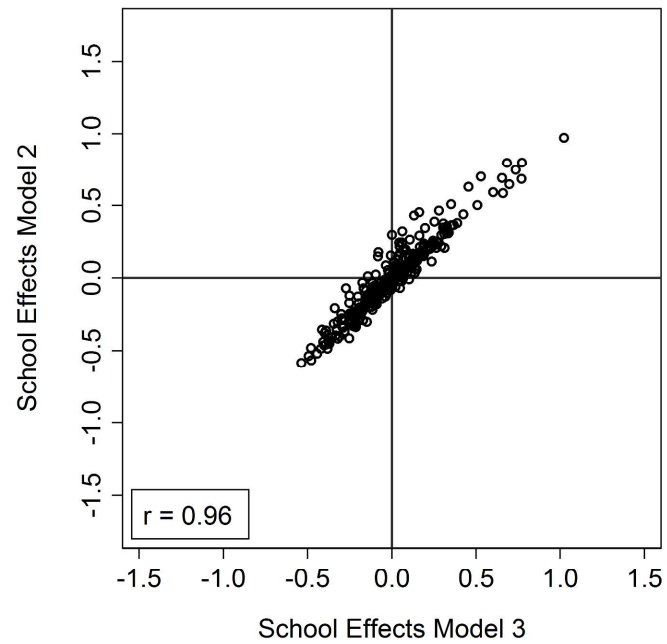
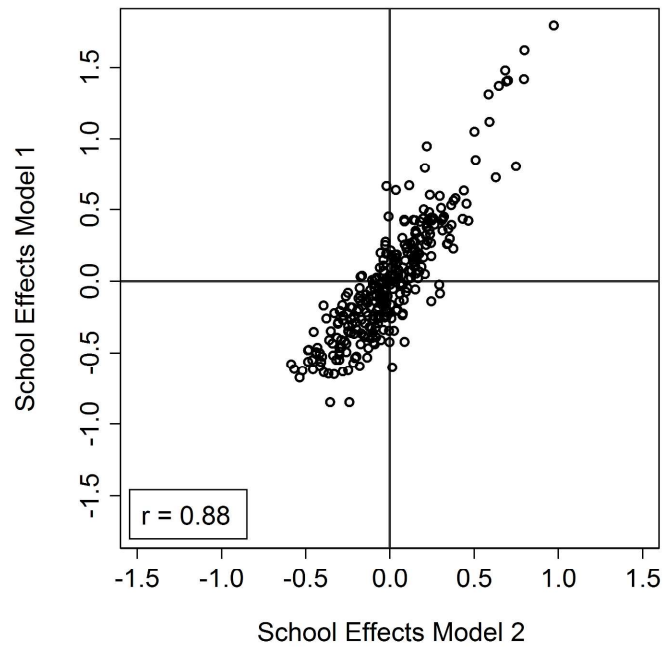
- Appeal to an unobserved continuous outcome variable ( $y_{3ij}^*$ ) underlying observed binary exclusion outcome ( $y_{3ij}$ )
- $y_{3ij} = 1$  when  $y_{3ij}^* \geq 0$  and  $y_{3ij} = 0$  when  $y_{3ij}^* < 0$
- Model for three continuous outcomes (attainment, log absences, and propensity of exclusion:  $y_{1ij}$ ,  $y_{2ij}$ , and  $y_{3ij}^*$ ):

$$\begin{aligned}y_{1ij} &= \mathbf{x}'_{1ij}\boldsymbol{\beta}_1 + u_{1j} + e_{1ij} \\y_{2ij} &= \mathbf{x}'_{2ij}\boldsymbol{\beta}_2 + u_{2j} + e_{2ij} \\y_{3ij}^* &= \mathbf{x}'_{3ij}\boldsymbol{\beta}_2 + u_{3j} + e_{3ij}\end{aligned}$$

- School effects and student residuals assumed to be independent and multivariate normally distributed with zero mean vectors and unstructured covariance matrices:

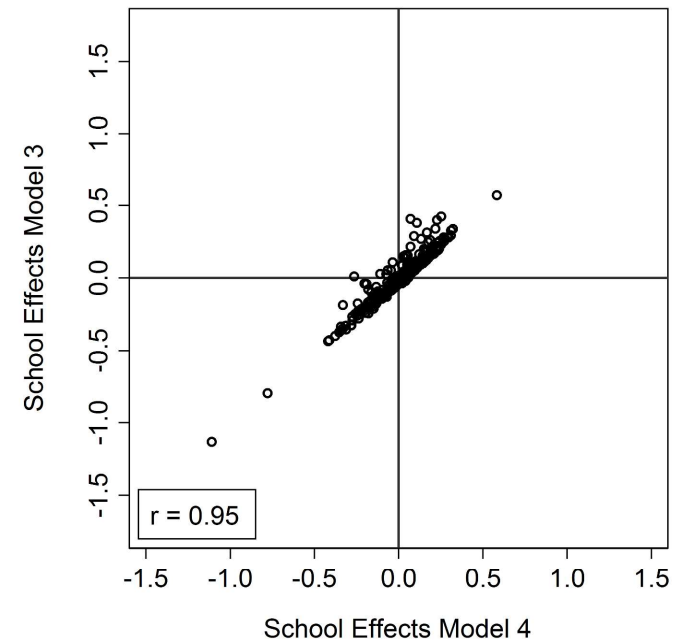
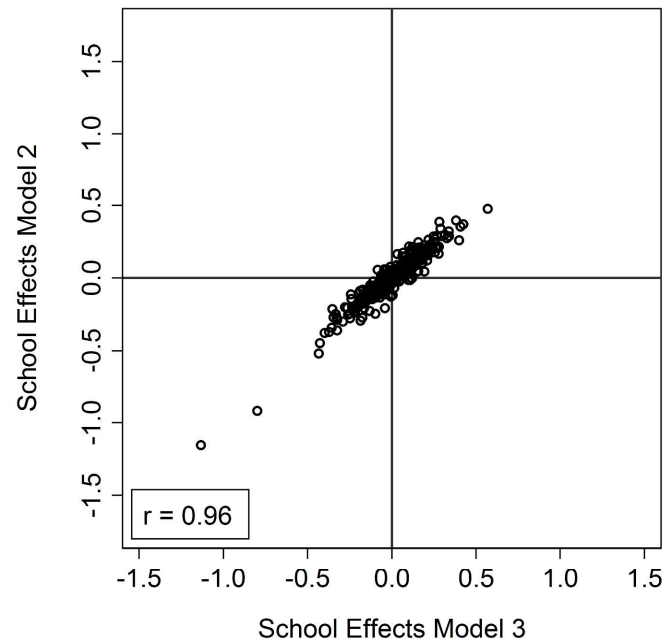
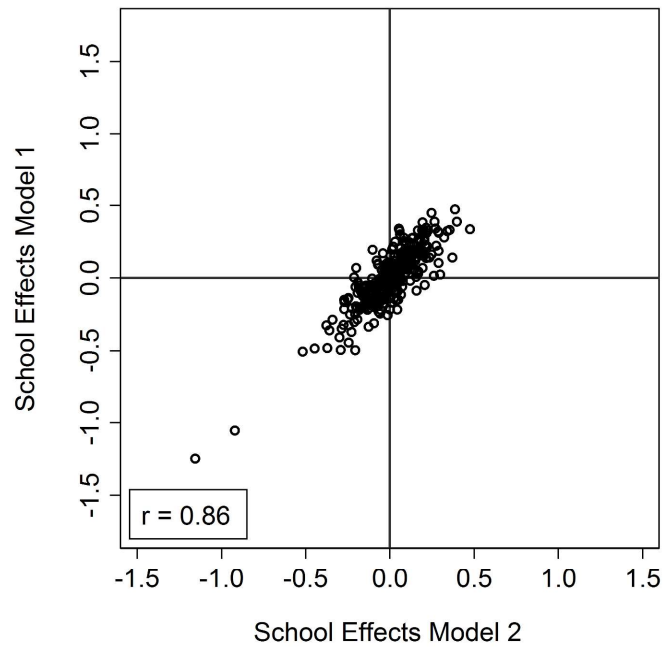
$$\begin{aligned}\begin{pmatrix} u_{1ij} \\ u_{2ij} \\ u_{3ij} \end{pmatrix} &\sim N \left\{ \begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma_{u_1}^2 & & \\ \sigma_{u_{12}} & \sigma_{u_2}^2 & \\ \sigma_{u_{13}} & \sigma_{u_{23}} & \sigma_{u_3}^2 \end{pmatrix} \right\} \\ \begin{pmatrix} e_{1ij} \\ e_{2ij} \\ e_{3ij} \end{pmatrix} &\sim N \left\{ \begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma_{e_1}^2 & & \\ \sigma_{e_{12}} & \sigma_{e_2}^2 & \\ \sigma_{e_{13}} & \sigma_{e_{23}} & 1 \end{pmatrix} \right\}\end{aligned}$$

# Appendix: Attainment results



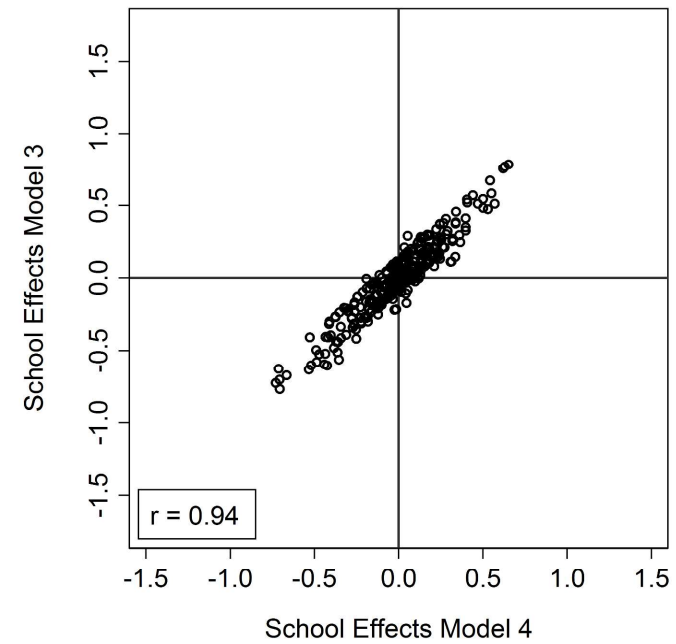
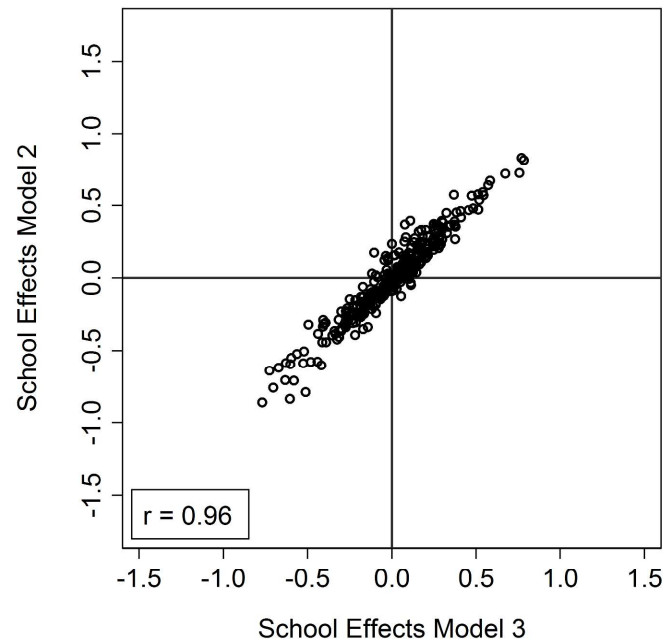
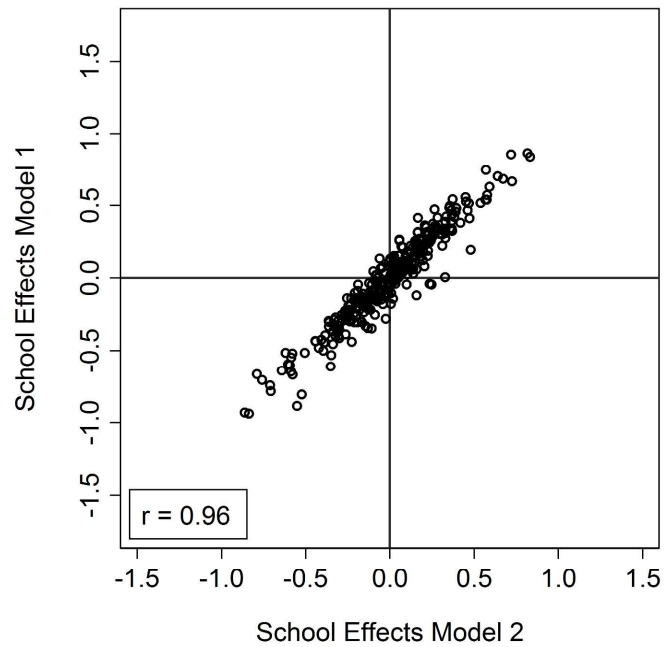
- Scatterplots and correlation between school effects for attainment across the model series

# Appendix: Log Absences results



- Scatterplots and correlation between school effects for log absences across the model series

# Appendix: Exclusion results



- Scatterplots and correlation between school effects for exclusions across the model series