

Understanding the STEM Pipeline

2015 CALDER Research Conference
Washington, DC

Motivation

- Stylized facts
 - Inadequate supply of Americans in STEM fields
 - Women and minorities are underrepresented
- Hypothesized Mechanisms and Policy Options
 - Lack of role models
 - Enhance hiring and support of female and minority college faculty in STEM fields
 - Negative peer effects
 - Single-sex schools

Literature

- Persistence in STEM among college students
 - Multi-campus studies
 - Bettinger and Long (2005), Bettinger (2010), Price (2010), Griffith (2010), Arcidiacono, et al. (2013)
 - Single-university studies
 - Hoffman and Oreopoulos (2009), Kokkelenberg and Sinha (2010), Carrell, Page and West (2010), Fairlie, Hoffman and Oreopoulos (2014)
 - Findings
 - Generally mixed evidence on gender role model effects, but strong positive effects in Carrell, Page and West (2010)
 - Some positive evidence on racial matching of minority students and instructors
 - First-year coursework predictive of eventual major choice

Literature

- Effects of Pre-College Experiences on Educational Attainment in STEM
 - Dee (2005, 2007)
 - racial matching at the elementary level boosts tests scores, but zero or negative effects of gender matching in middle on math and science achievement
 - Park, Behrman and Choi (2012)
 - same-sex high schools in Korea boost math entrance exam scores but have no effect on choice of a STEM major
 - Anelli and Peri (2013)
 - Increases in the proportion of women in high school classes in Milan associated with increased likelihood of selecting a STEM major in college

Contribution

- First U.S.-based study to link pre-college experiences to STEM major completion in college
- Only study to consider effects of gender/racial matching of students and teachers in middle and high school on STEM coursework and major completion in college
- Only study to evaluate influence of high school teachers' credentials on STEM college coursework and degree attainment

Data

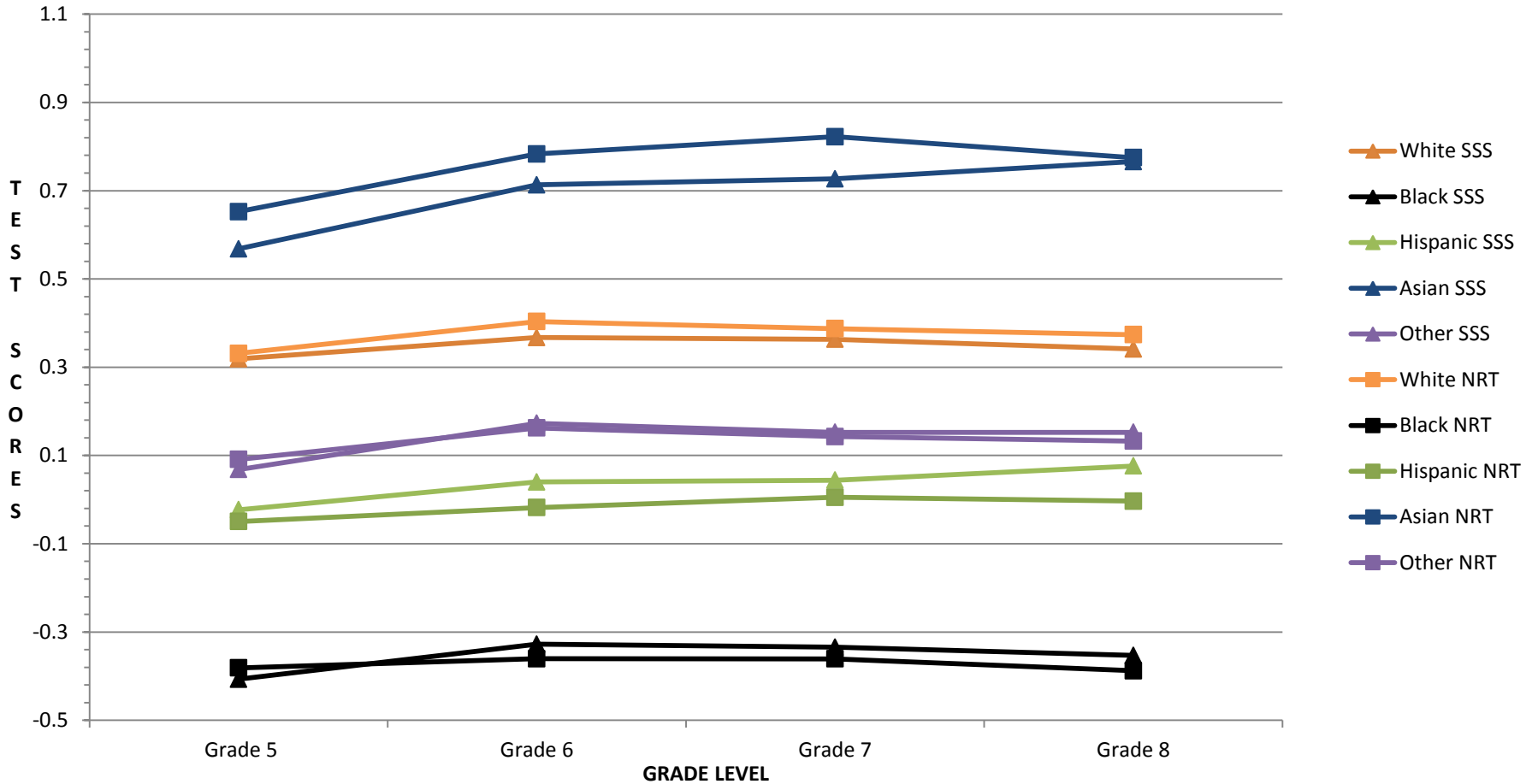
- Statewide administrative data from Florida
 - Four cohorts of students who began 5th grade in 1997-2000, took the 5th-grade math achievement test and enrolled in a Florida public school in grade 9
 - Can track progress in high school if they remain in a public school in Florida
 - Can determine post-secondary enrollment whether or not they remain in Florida (2 cohorts)
 - Can determine first-year coursework, college graduation and major if they attend a public university in Florida

Evidence

- Investigate the following outcomes by race, gender and family income (lunch status)
 - Pre-high school achievement
 - Dropout and achievement in high school
 - High school diploma receipt
 - Post-secondary schooling choices
 - First-Year college coursework (conditional on attending a public university)
 - College completion and major choice (conditional on attending a public university)

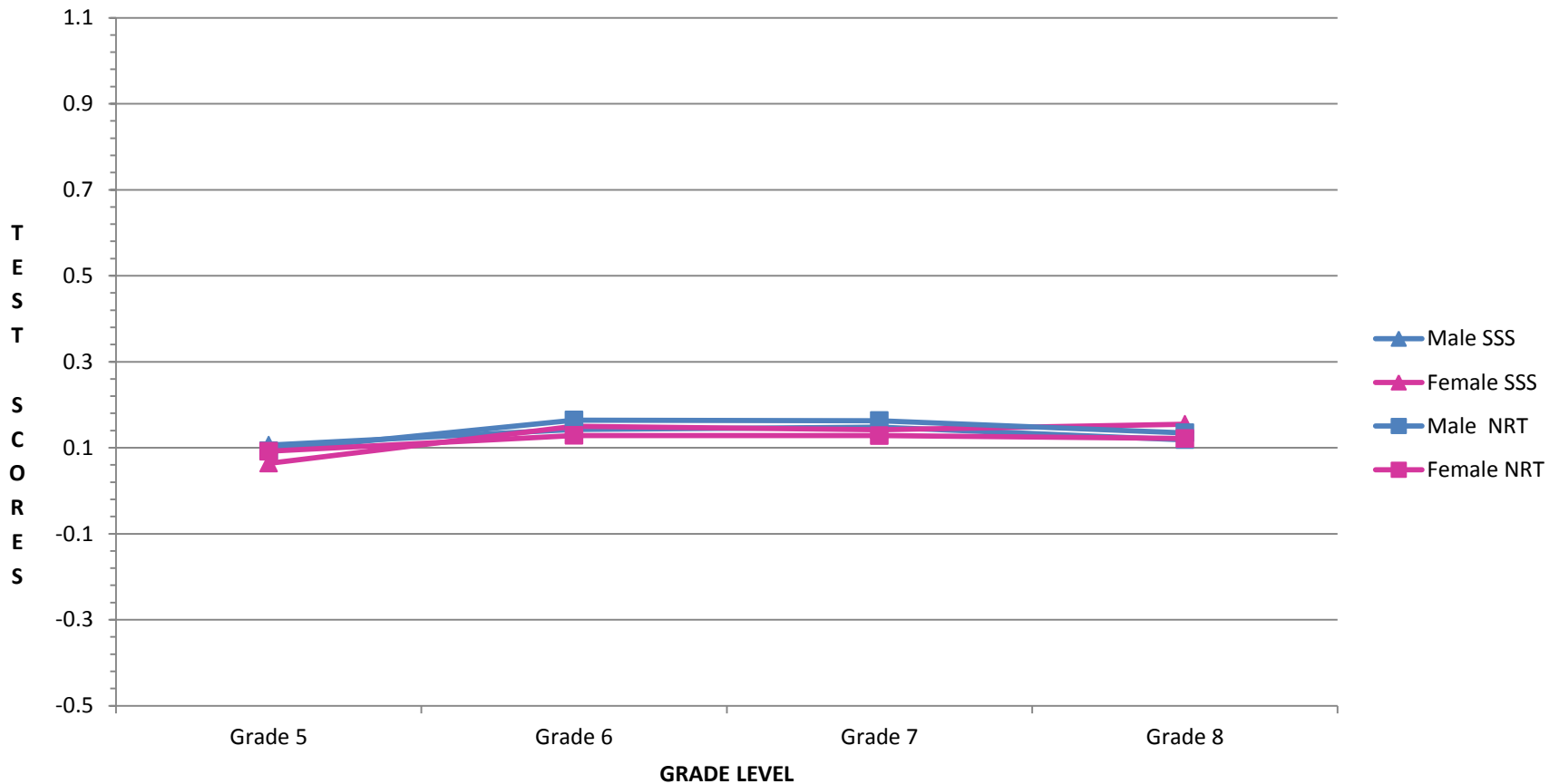
Normed Math Scores in Grades 5-8 by Race

(Students with a test score in grade 5 in 2000/01 who are enrolled four years later in a public school in Grade 9)



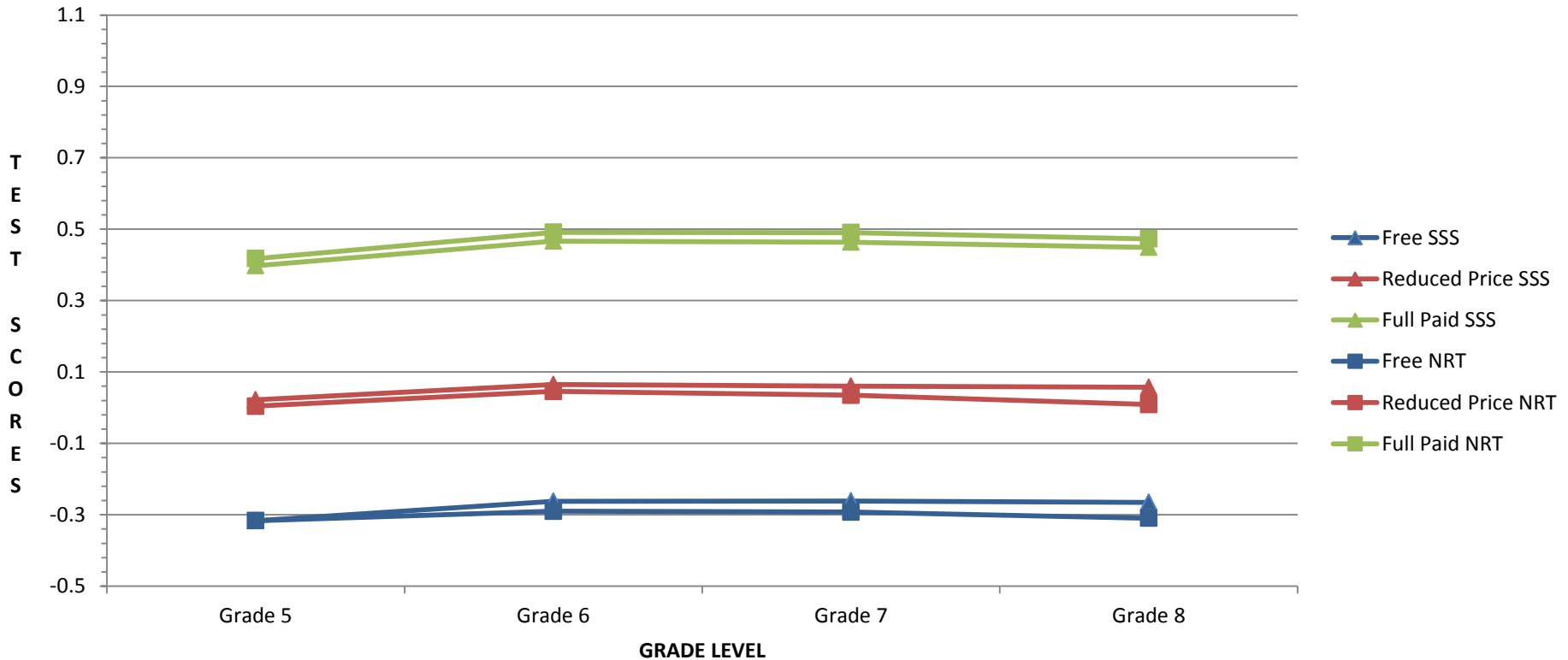
Normed Math Scores in Grades 5-8 by Gender

(Students with a test score in grade 5 in 2000/01 who are enrolled four years later in a public school in Grade 9)



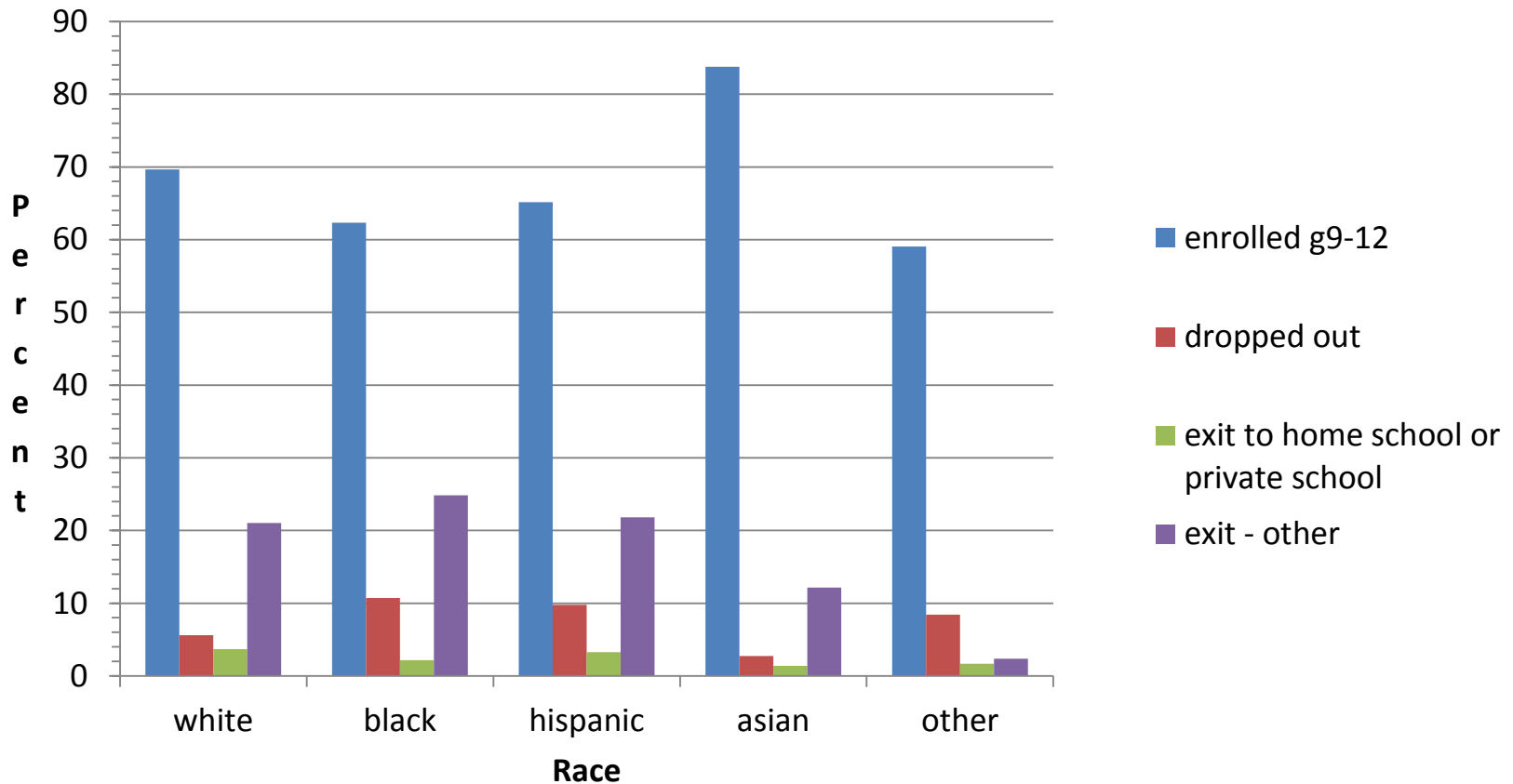
Normed Math Scores in Grades 5-8 by Lunch Status

(Students with a test score in grade 5 in 2000/01 who are enrolled four years later in a public school in Grade 9)



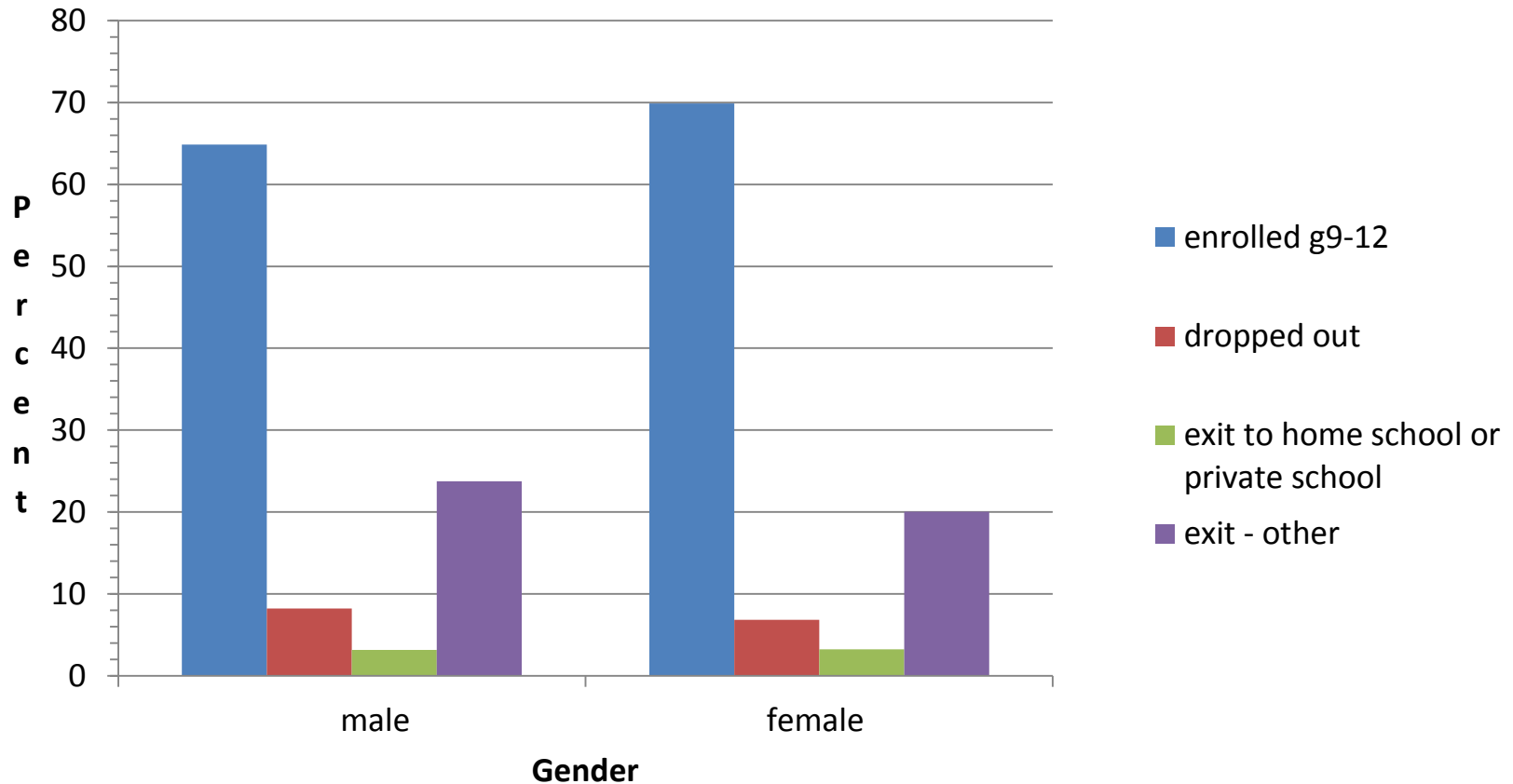
High School Exit by Race

(Students with a test score in grade 5 in 1997/98-2000/01 who are enrolled four years later in a public school in grade 9)



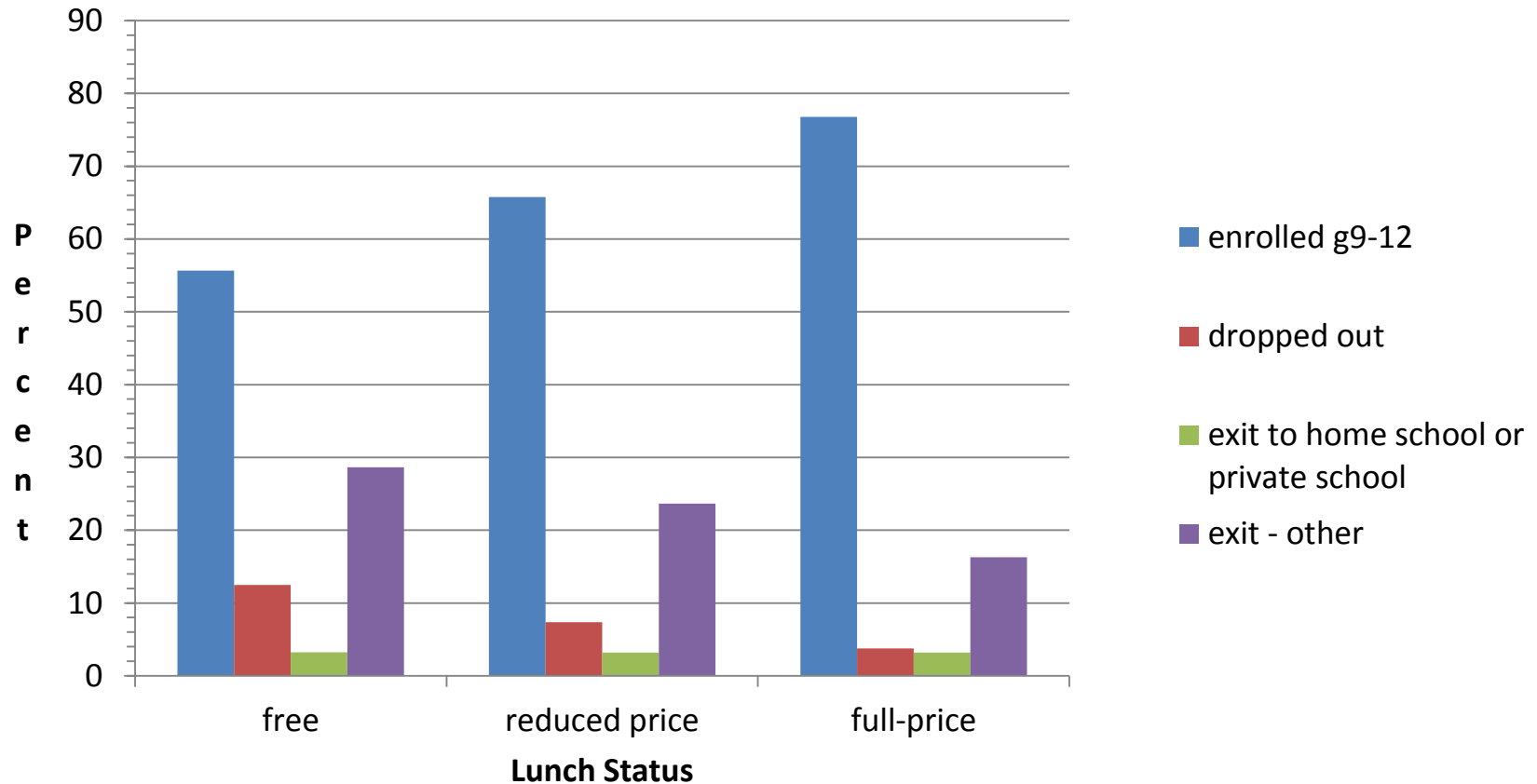
High School Exit by Gender

(Students with a test score in grade 5 in 1997/98-2000/01 who are enrolled four years later in a public school in Grade 9)



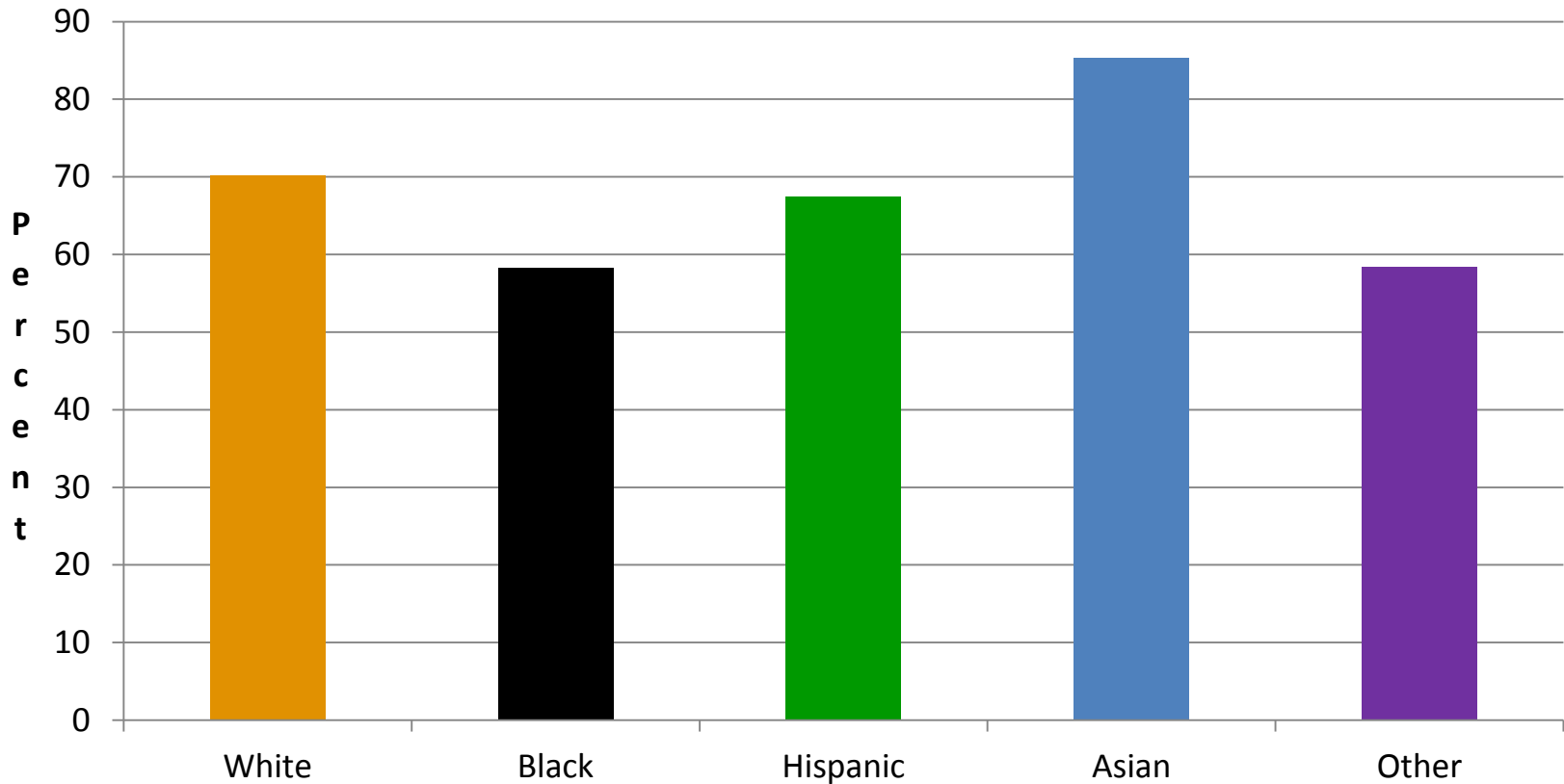
High School Exit by Lunch Status

(Students with a test score in grade 5 in 1997/98-2000/01 who are enrolled four years later in a public school in Grade 9)



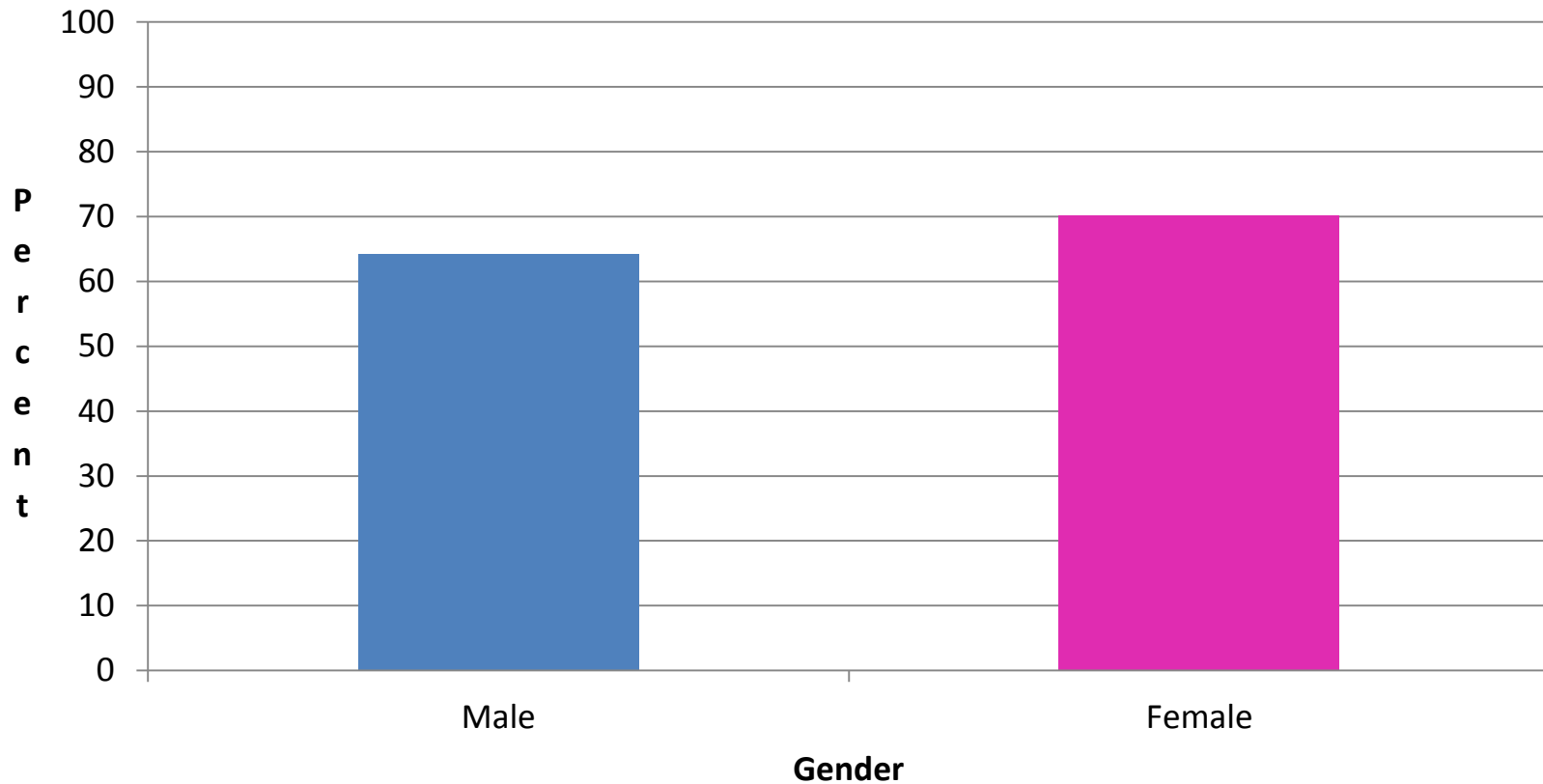
Regular High School Diploma Receipt Within 5 Years of Entering Grade 9 by Race

(Students with a test score in grade 5 in 1997/98-2000/01 who are enrolled
four years later in a public school in Grade 9)



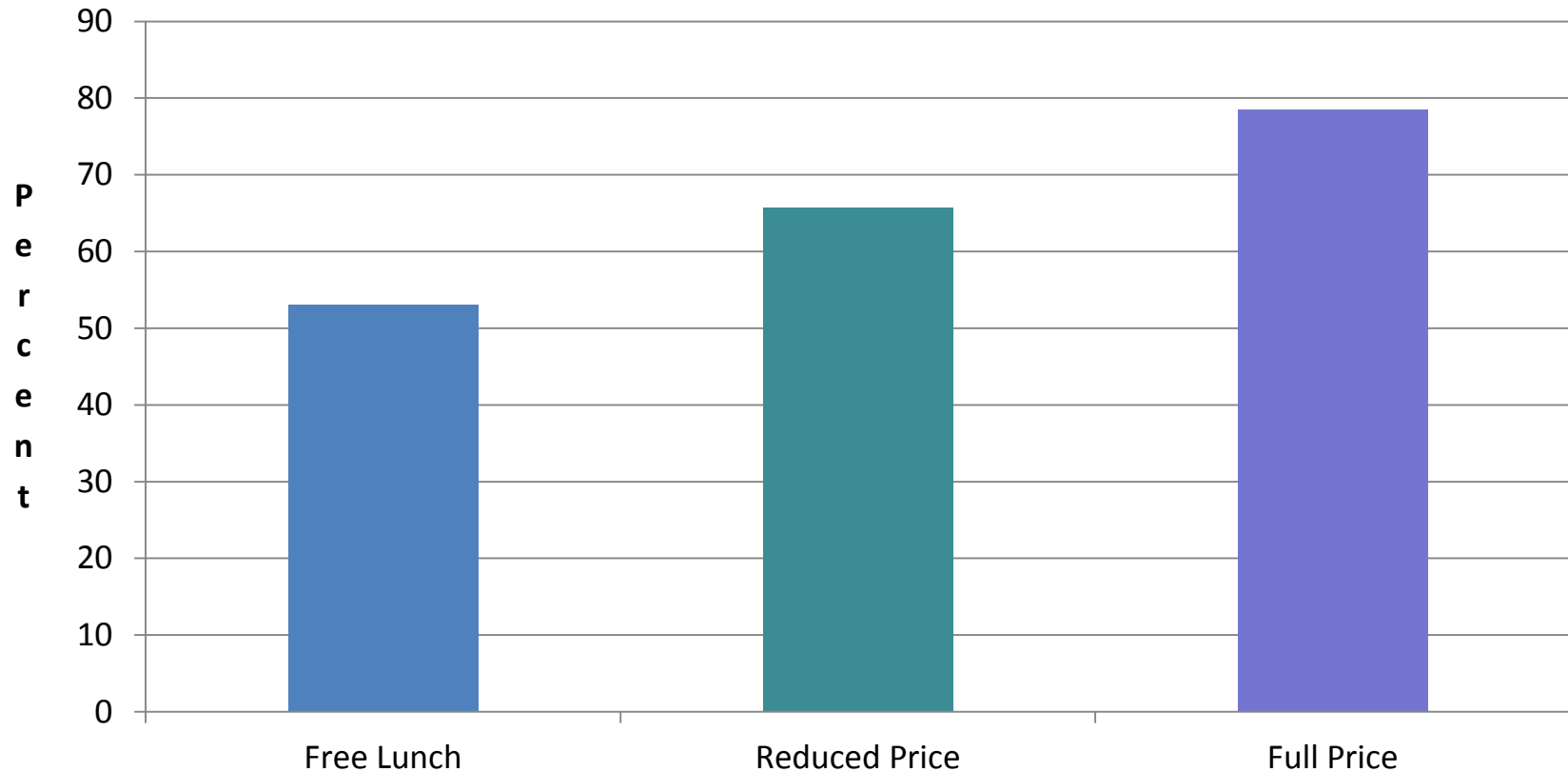
Regular High School Diploma Receipt Within 5 Years of Entering Grade 9 by Gender

(Students with a test score in grade 5 in 1997/98-2000/01 who are enrolled
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Regular High School Diploma Receipt Within 5 Year of Entering Grade 9 by Lunch Status

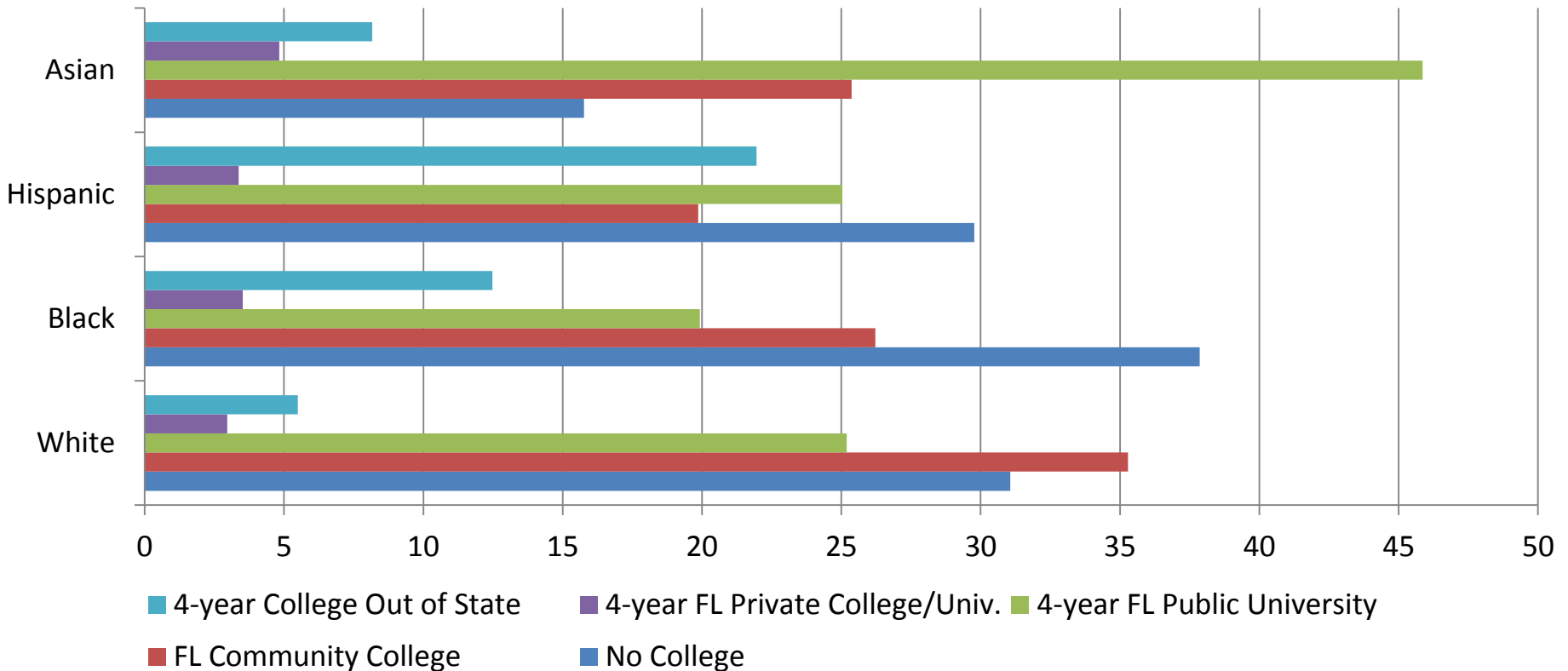
(Students with a test score in grade 5 in 1997/98-2000/01 who are enrolled
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College Attendance in Year Immediately

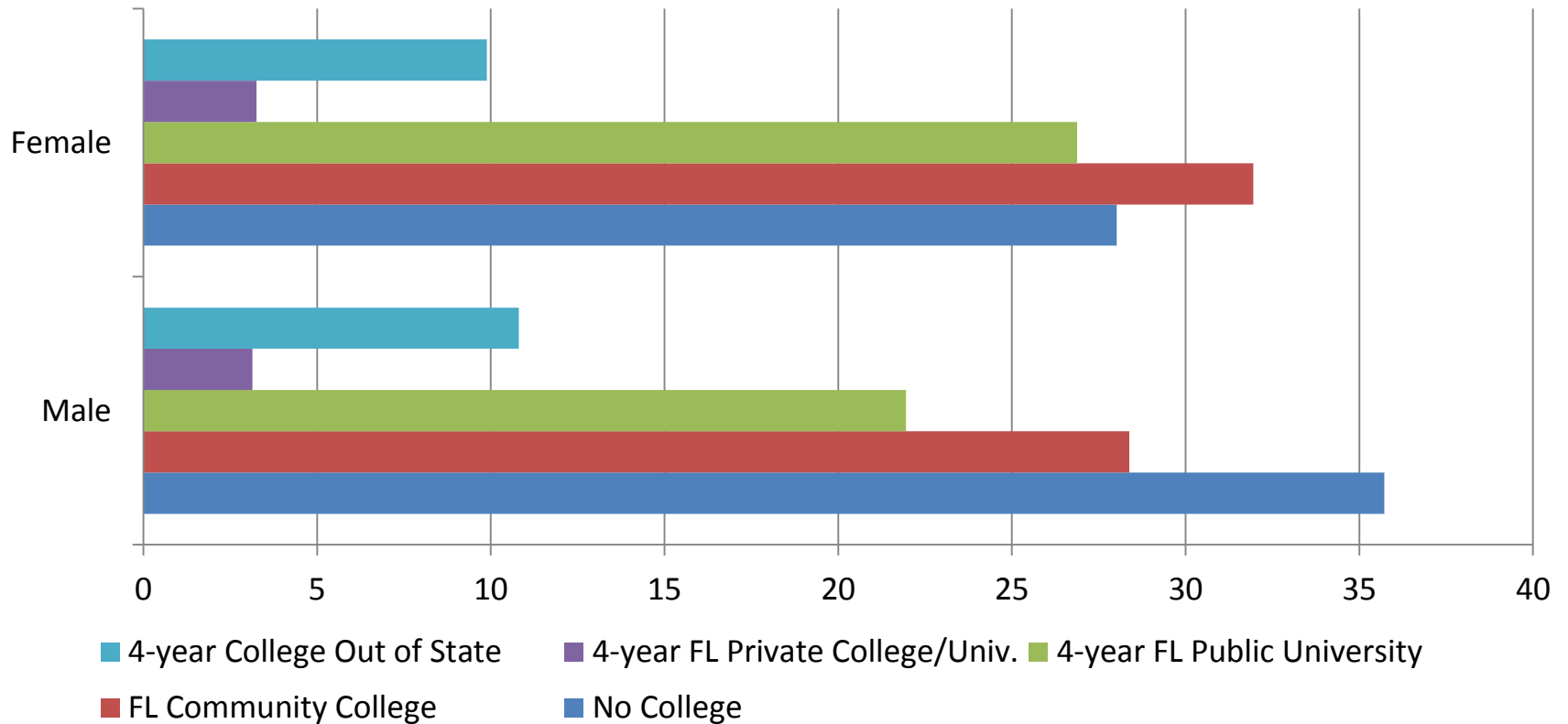
Following Receipt of High School Diploma by Race

(Students with a test score in grade 5 in 1997/98 who are enrolled four years later in a public school in grade 9 and graduate within 5 years with a regular diploma)



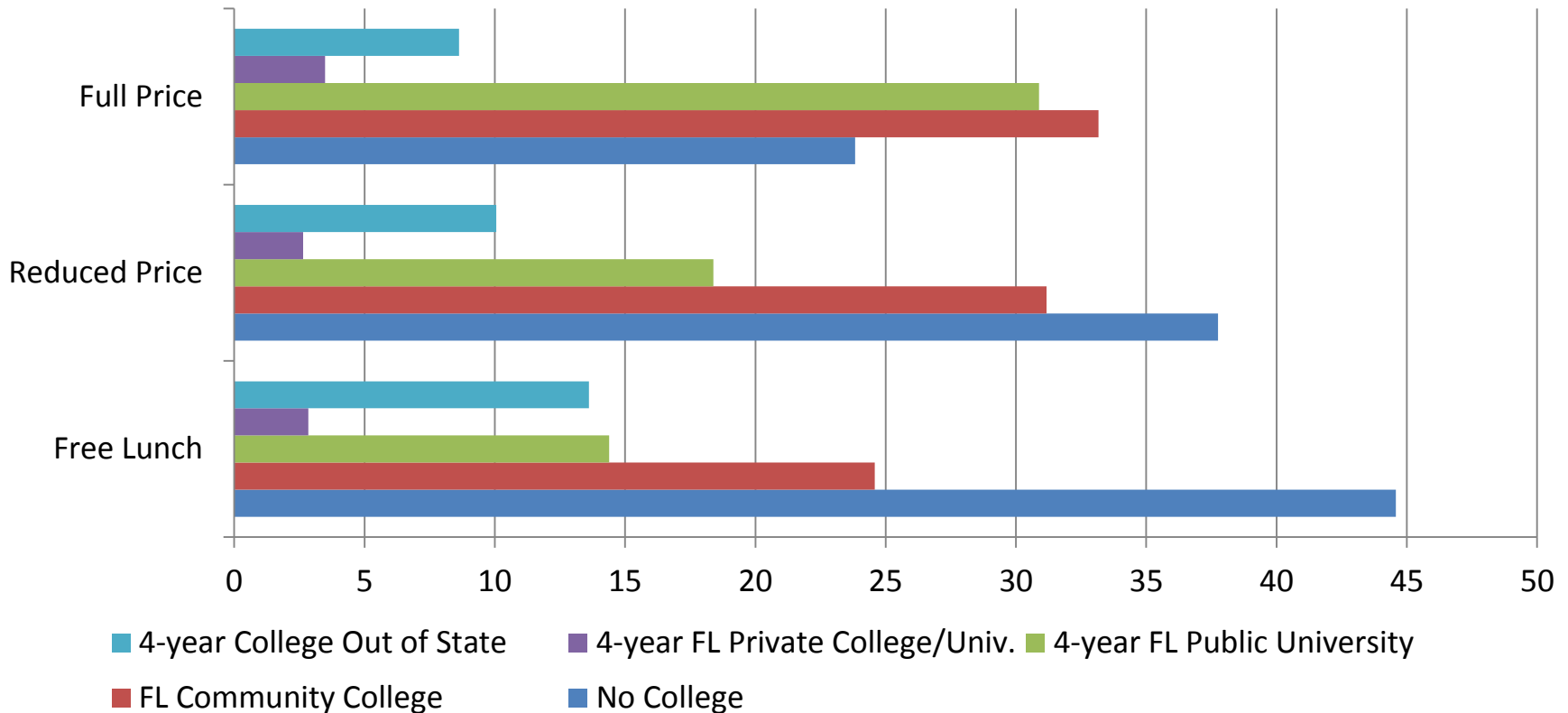
College Attendance in Year Immediately Following Receipt of High School Diploma by Gender

(Students with a test score in grade 5 in 1997/98 who are enrolled four years later in a public school in grade 9 and graduate within 5 years with a regular diploma)



College Attendance in Year Immediately Following Receipt of High School Diploma by Lunch Status

(Students with a test score in grade 5 in 1997/98 who are enrolled four years later in a public school in grade 9 and graduate within 5 years with a regular diploma)



Determinants of Taking One or More Courses in a STEM Field in the First Year of College

(Students with a test score in grade 5 in 1997/98-2000/01, enrolled 4 years later in a public school in grade 9, receive HS diploma within 5 years and attend a Florida public university within one year)

VARIABLES	(1)	(2)	(3)	(4)
Black	0.0320** (0.0036)	0.0338** (0.0039)	0.0323** (0.0042)	0.0324** (0.0046)
Hispanic	0.0540** (0.0033)	0.0553** (0.0034)	0.0557** (0.0035)	0.0570** (0.0037)
Asian	0.0293** (0.0056)	0.0301** (0.0057)	0.0283** (0.0058)	0.0267** (0.0060)
Other Race	0.0172 (0.0177)	0.0177 (0.0177)	0.0096 (0.0189)	0.0109 (0.0195)
Female	-0.0370** (0.0027)	-0.0369** (0.0028)	-0.0368** (0.0029)	-0.0360** (0.0030)
Control for Lunch Status		✓	✓	✓
Control for HS Math Scores			✓	✓
Control for MS Math Scores				✓
Observations	74,528	74,528	71,113	67,424
Pseudo R ²	0.0090	0.0090	0.0091	0.0090

Determinants of Taking One or More Courses in Specific Science Subjects in the First Year of College

(Students with a test score in grade 5 in 1997/98-2000/01, enrolled 4 years later in a public school in grade 9, receive HS diploma within 5 years and attend a Florida public university within one year)

VARIABLES	Any Science	Biology	Chemistry	Physics
Black	0.0527** (0.0061)	0.0208** (0.0055)	0.1212** (0.0061)	-0.0032 (0.0020)
Hispanic	0.0982** (0.0052)	0.0304** (0.0049)	0.1177** (0.0052)	0.0054** (0.0017)
Asian	0.0721** (0.0082)	0.0749** (0.0081)	0.1626** (0.0084)	0.0097** (0.0027)
Other Race	0.0000 (0.0267)	-0.0231 (0.0229)	0.0398 (0.0251)	-0.0024 (0.0074)
Female	-0.0110** (0.0040)	0.0616** (0.0034)	-0.0048 (0.0034)	-0.0312** (0.0014)
Control for Lunch Status	✓	✓	✓	✓
Control for MS Math Scores	✓	✓	✓	✓
Control for HS Math Scores	✓	✓	✓	✓
Observations	67,424	67,424	67,424	67,424
Pseudo R ²	0.0060	0.0144	0.0294	0.1401

Determinants of Taking One or More Courses in a STEM Field in the First Year of College

(Students with a test score in grade 5 in 1997/98-2000/01, enrolled 4 years later in a public school in grade 9, receive HS diploma within 5 years and attend a Florida public university within one year)

VARIABLES	(1)	(2)	(3)
Female x Prop. MS/HS Math & Sci. Courses Taught by a Female Teacher	0.0653** (0.0116)		0.0514** (0.0142)
Black x Prop. MS/HS Math & Sci. Courses Taught by a Black Teacher	-0.0648** (0.0206)		-0.0692** (0.0234)
Hispanic x Prop. MS/HS Math & Sci. Courses Taught by a Hispanic Teacher	0.1560** (0.0185)		0.1640** (0.0123)
Enrolled in at Least One HS Biology Course Taught by a Teacher with a BA in Biology		0.0132* (0.0059)	0.0124* (0.0059)
Enrolled in at Least One HS Chemistry Course Taught by a Teacher with a BA in Chemistry		0.0236** (0.0073)	0.0214** (0.0074)
Enrolled in at Least One HS Physics Course Taught by a Teacher with a BA in Physics		-0.0104 (0.0121)	-0.0118 (0.0122)
Enrolled in at Least One HS Math Course Taught by a Teacher with a BA in Math		0.0134** (0.0051)	0.0144** (0.0050)
Controls for Race/Ethnicity & Gender	✓	✓	✓
Control for Lunch Status	✓	✓	✓
Control for Grade 5 and MS Math Scores	✓	✓	✓
Observations	69,978	49,639	49,634
Pseudo R ²	0.0108	0.0103	0.0121

Determinants of Earning a Bachelor's Degree in a STEM Major Within 9 Years of Starting Grade 9

(Students with a test score in grade 5 in 1997/98-2000/01, enrolled 4 years later in a public school in grade 9, receive HS diploma within 5 years and attend a Florida public university within one year)

VARIABLES	(1)	(2)
Black	-0.0377** (0.0020)	0.00079 (0.0031)
Hispanic	-0.0097** (0.0022)	0.0072** (0.0025)
Asian	0.0491** (0.0049)	0.0405** (0.0046)
Other Race	-0.0110 (0.0107)	0.0016 (0.0121)
Female	-0.0497** (0.0020)	-0.0262 (0.0018)
Control for Lunch Status		✓
Control for MS/HS Math Scores		✓
Observations	75,292	68,093
Pseudo R ²	0.0335	0.1093

Relationship Between First-Year-in-College STEM Instructors and Earning a Bachelor's Degree in Specific STEM Majors Within 9 Years of Starting Grade 9

(Students with a test score in grade 5 in 1997/98-2000/01, enrolled 4 years later in a public school in grade 9, receive HS diploma within 5 years and attend a Florida public university within one year)

VARIABLES	STEM	Math	Chemistry	Physics	Bio. Sci.	Engineering
Female x Proportion of First-Year College STEM Courses Taught by a Female Instructor	-0.0190** (0.0039)	-0.0010 (0.0005)	-0.0009 (0.0008)	0.0002 (0.0003)	-0.0033** (0.0010)	-0.0068** (0.0019)
Black x Proportion of First-Year College Courses Taught by a Black by a Black Instructor	-0.0662** (0.0154)	-0.0011 (0.0020)	-0.0037 (0.0032)		-0.0018 (0.0033)	-0.0132 (0.0071)
Hispanic x Proportion of First-Year College Courses Taught by an Hispanic Instructor	-0.0210** (0.0080)	-0.0001 (0.0012)	0.0001 (0.0015)	0.0009* (0.0004)	-0.0002 (0.0027)	-0.0068* (0.0031)
Controls for MS/HS Math & Sci. Teacher-Student Match	✓	✓	✓	✓	✓	✓
Controls for Race/Ethnicity & Gender	✓	✓	✓	✓	✓	✓
Control for Lunch Status	✓	✓	✓	✓	✓	✓
Control for MS/HS Math Scores	✓	✓	✓	✓	✓	✓
Observations	65,458	65,458	65,458	54,715	65,458	65,458
Psuedo R ²	0.1727	0.1594	0.1388	0.2046	0.0692	0.2781

Conclusions

- For blacks and Hispanics, significant “leakage” before college
 - need to tackle achievement gaps that occur as early as elementary school
- For those who make it to college, ability/willingness of blacks and Hispanics to take STEM courses in college does not appear to be a problem
- Female freshman college students less likely to take courses in physical sciences
 - STEM course-taking is higher the greater the exposure to female math and science teachers in middle/high school

Conclusions

- Having a high school math or science teacher with a degree in the relevant subject appears to boost the likelihood of taking STEM courses as a college freshman
- First-year college coursework is predictive of eventual attainment of a BA in a STEM field
- Black and Hispanic college students are less likely than whites to earn a BA in a STEM field, but differential is eliminated if account for prior achievement and family income
- Female freshman college students less likely to take courses in physical sciences
 - STEM course-taking is higher the greater the exposure to female math and science teachers in middle/high school

Next Steps

- Address possible endogeneity of teacher characteristics
 - Use faculty composition as an instrument
 - Include HS fixed effects
- Include classroom composition data to analyze peer effects
- Expand sample to include students who start their post-secondary careers in community colleges