How Does Teachers' Salary Influence Students' Performance?
——Evidence from two high schools in Henan

Summary

This paper discussed the common phenomena in China that high schools' qualities are experiencing major changes after the Great Reform and Opening. The author used data from two high schools in Luoyang Area as a typical case of this wave. Year 2005 proved to be a turning point where the relative positions of two schools have changed significantly. However, it can't be proven that the rise in salary in not the main reason for the rise and fall of two schools. There is a better chance that the rise in salary and larger salary gap are both affecting the academic performance of students. Teaching experience has proved to be a significant factor influencing the academic performance of students. In addition, it is observed that female teachers are less capable in both teaching students and making money in public schools.

I. Introduction

The Great Reform & Opening in China at 1978 has immensely influenced Chinese people's life on every possible level. Full-scale marketization has been and is still affecting social fields including job market, education, health, etc. In this large wave of transformation, it is worthwhile to mention that many high schools' situation has changed dramatically in almost all provinces and areas of China. In the short 30 years after 1978, some former prevailing high schools have experienced descending of school quality, reflected by drop of college entrance rate and decreasing in student quality. On the other hand, some high schools that were not performing well in the past have taken off and attracted people's attention with their noticeable achievements.

Two high schools named A and B in Luoyang Area, Henan Province, are the typical

examples of this kind of transformation. High School A and High School B are adjacent in a normal area in Henan Province. In 2002, School A was a famous high school in people's memory. Young people have to study hard and be lucky enough to get into School A, as students in School A are supposed to have a promising future of entering a good university. However, in 10 years between 2002 and 2011, School B has launched off swiftly with its average "Gaokao" (Chinese version of SAT exam served as a criterion for entering college) scores rising in a stable and rapid way. The reason for the rise and fall of high school quality is undoubtedly a question worth to be explored.

II. Literature review

According to the papers of past research about education, the academic performance of student is influenced by multiple factors. First of all, family background is a considerable factor. The education level of parents, especially of mother, has significant positive influence on the return of education (Altonji & Dunn, 1995). Secondly, education resource received by students can affect their academic performance, while economic research has various definitions about education resources. The decline of student-teacher ratio has increased education expenditure but harmed the quality of teachers, and lessened students' education resources as a result (Hanushek & Rivkin, 1996). However, trade-off does exist between student-teacher ratio and teacher quality (Jepsen& Rivkin, 2009). Some researchers have focused on teacher quality as a main role of education resources, and show variation in teacher quality account for a large percentage of the total variation in student achievement (Hanushek et al, 1998). Besides teacher quality, reducing rates of employee absence may also be an effective way to improve productivity (Miller et al, 2007). What's more, the effects of features of teachers' preparation on teachers' value-added to student test score has been estimated (Boyd et al, 2008). Another research also proves that teachers an innovative practice-based preparation program is likely to improve student achievement in the district over the long run (Papay et al,

2011).

On the other hand, teacher's motivation is as important as their original quality according to some research. Higher salaries keep teachers in high-poverty schools and reduce mean turnover rates significantly in a government founded bonus program (Clotfelter et al, 2008). Opposing opinions believe students learn more in schools in which individual teachers are given financial incentives to do a better job, though researchers cannot discern whether this relationship is due to the incentives themselves or to better schools also choosing to implement merit pay programs (Figlio & Kenny, 2007).

Many researches have been conducted notwithstanding, debates over effectiveness of teacher's incentive is yet unsettled. Advocates of teacher incentive programs provide little evidence of more teacher effort aimed at increasing long-run learning. However, there is evidence that teachers increased effort to raise short-run test scores by conducting more test preparation sessions (Glewwe et al, 2003). Some researchers find no evidence that teacher incentives increase student performance, attendance, or graduation, or any evidence that the incentives change student or teacher behavior (Fryer, 2011). The third voice says that a quality classroom-observation-based evaluation and performance measures can improve mid-career teacher performance both during the period of evaluation, consistent with the traditional predictions, but evaluation system needs to be considered (Taylor and Tyler, 2011).

III. Data and Empirical Methodology

I. Data

In this paper, the author tries to dig into the real reason for transformation of School A and School B, and especially examine the factors influencing teacher's incentive. My data directly came from local ministry of education and archives department of the two schools, which means it is first-handed, but also requires large workload of sorting. The data included two main parts. One is teacher's information from

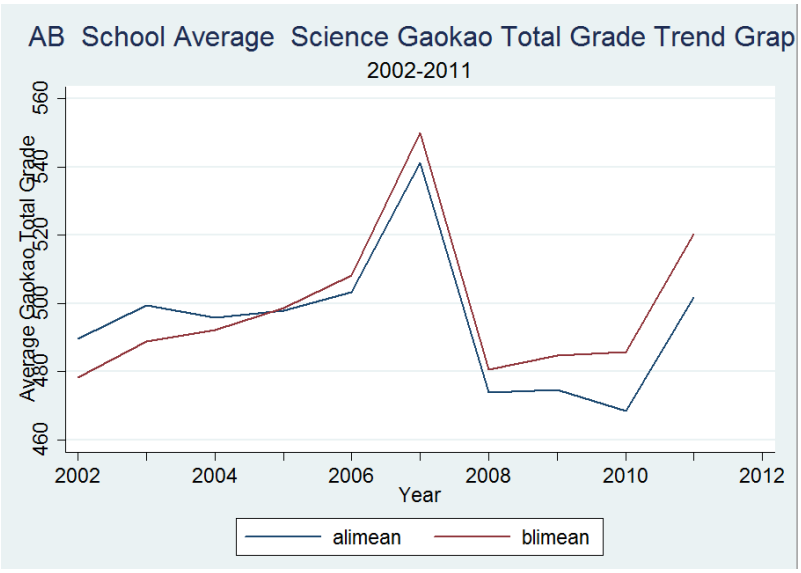
2002-2011, which includes teacher s' number, age, gender, education background, teaching age, salary (recorded by year), the course he/she is teaching, number of class he/she has taught. The other one is student information from 2002-2011, which includes students' number, gender, high school entrance grade, Gaokao grade on all six subjects, whether he or she studies science or sociology (a separate system of Chinese education), if he or she is participating Gaokao for the first time or not. The case for School A and School B are on some level simplified, as these two schools are both public schools with lots of similarities. Their location is so near that there is no economic development difference between these two schools. They have similar daily routine and rest schedule, which is six days a week and eight hours a day. Most of these similarities result from Chinese government regulations of education. These factors can serve as the controlled factors in the regression, and thus largely simplified the case.

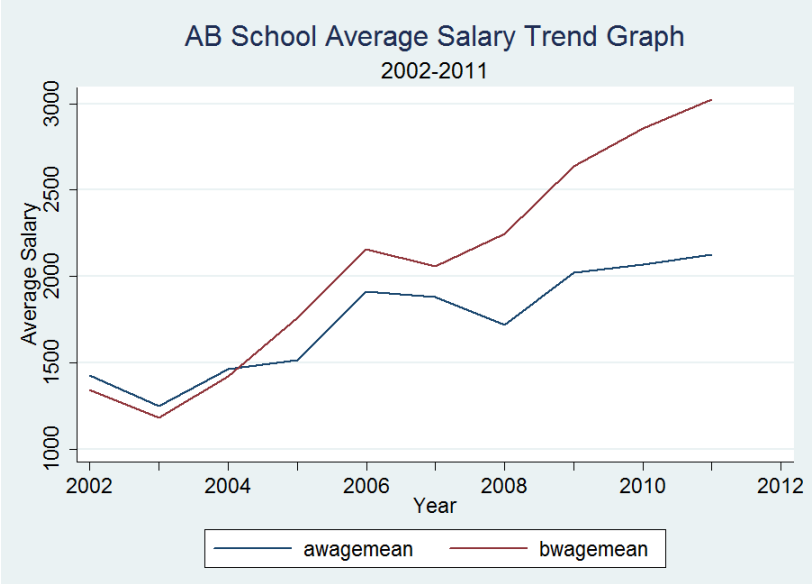
This paper has carefully dealt with variables that may cause multi-collinearity. For instance, the age and teaching age of a teacher are mostly correlated. If both of these two variables are put into regression, it can cause bias in regression outcome. The author has chosen teaching age over age, as teaching age can better reflect the "ability of experience" of a teacher.

Moreover, this paper has neglected a seemingly important variable, teacher's education background. This is because teachers in China have mostly graduated from "Educational Schools or Colleges", and their education backgrounds have very subtle variation.

Graph of data description of all variables concerned in this paper can be found in the annex. It can be observed that factors like sex ratio of students and teachers, proportion of non-first students, and proportion of sociology and science students are very close. Thus, the effect of these socioeconomic factors can be neglected for the regression model. However, it is very interesting that the salaries of School A and

School B has experienced and is still experiencing significant changes. From the graph below, we can find that Year 2005 can be seen as a turning point. Before 2005, the average salary and Gaokao total graph were both doing better than School B. But things have changed after 2005, where the salary level of School B has sharply taken the superior position. The gap of two school's teacher salary is in direct proportion to the gap of two school's student academic performance. It is very likely that the salary situation is the main factor for the rise and fall for School A and School B, as salary can serve as an important incentive for teacher's devotion into their work. If the outcome proved to be significant, it will come to a very important conclusion that teachers with the same education background and teaching experience will perform differently for different incentive, and result in different student academic performance.





We use regression to test if School A & B performs differently with time, and use the same variables to see if the salary gap of School A & B is changing with time.

$$\text{TotalGrade}_{ijt} = \beta_1 * School_j + \beta_2 * \text{After}_t + \beta_4 * \text{Female}_{it} + \beta_5 * \text{Teachingtime}_{it} + \gamma_1 * (School_j \times \text{After}_t) + \varepsilon_{ijt}$$

$$\text{Salary}_{it} = \beta_1 * School_j + \beta_2 * \text{After}_t + \beta_4 * \text{Female}_{it} + \beta_5 * \text{Teachingtime}_{it} + \gamma_1 * (School_j \times \text{After}_t) + \varepsilon_{ijt}$$

From Table 2 in Annex I, we can observe that the total grade of school B is higher than School A after 2005. The coefficient of $School_j \times \text{After}_t$ for both regression were significant and showed the trend of rise and fall clearly.

Interestingly, we notice that the female teacher group as a whole showed a weaker capability in promoting academic performance and got less salary than the male teacher group. The reason for this difference is worthy of exploring, as it may show the inequality of gender in the market of education.

Without doubt, the coefficients of teaching time (teaching experience) of both

regressions were significantly above zero, which means teachers with more teaching experience can teach students to perform better in academic fields, and also earn more money. The salary system in China is pretty fixed generally, because teachers in public rural high schools are regarded as government officials, and their income depends mostly on national funding. The effect of this regulation has been long discussed. On the one hand, a fixed salary from government can guarantee enough education resources for undeveloped rural areas (otherwise rural schools will lose most of their teachers). On the other hand, teachers receive little incentive to work harder in this fixed income system, as they receive same pay no matter how they perform in school. This kind of job is called "steel food plate" in China, showing both its stability and its inflexibility.

II. Methodology

To illustrate the basic methodology, use the two school panel and consider the triple-difference method.

$$\begin{aligned}\text{TotalGrade}_{ijt} = {} & \beta_1 * School_j + \beta_2 * \text{After}_t + \beta_3 * \text{Salary}_{it} + \beta_4 * \text{Female}_{it} + \beta_5 \\ & * \text{Teachingtime}_{it} \\ & + \gamma_1 * (School_j \times \text{After}_t) + \gamma_2 * (School_j \times \text{Salary}_{it}) + \gamma_3 * (\text{Salary}_{it} \times \text{After}_t) + \\ & \theta * (School_j \times \text{After}_t \times \text{Salary}_{it}) + \varepsilon_{ijt},\end{aligned}$$

where TotalGrade_{ijt} is the continuous variable indicating the average total Gaokao grade of a class taught by teacher *i* in year *t* in school *j*; $School_j$ is a dummy variable indicating whether the teacher was from School A or School B; After_t is a dummy variable indicating whether the average Gaokao grade was got before 2005 or after 2005 (as 2005 was a turning point of the treatment group and control group); Salary is the average month salary got by teacher *i* in year *t*; Female_{it} is a dummy variable suggesting the gender of the teacher; and Teachingtime_{it} is a variable indicating the teaching time of teacher *i* in year *t*.

Table 3 in Annex I shows the regression on the question "Does School A & B perform differently on academics with time due to salary change". The coefficient of the $School_j \times$ After $_t \times \text{Salary}_{it}$ was below zero and insignificant, which means that School A & B may not perform differently on academics with time due to salary change. Contrary to the presumption, the rise in salary gap may not be the main reason for the relative change of both schools. The factor of gender and teaching experience were consistent with the former regressions, that male teachers are more capable in encouraging academically better students than female teachers. In the whole China society, male shows more advantage in almost all jobs than female, due to the long history of concept that female should concentrate more on family.

So, if the rise in salary in not the main reason for the rise and fall of two schools, what is the reason becomes a question worthy of more consideration. It is highly possible that the variance of salary can influence deeper and stronger on teacher's incentive. School B is exceeding School A because (or partly because) the variance of its salary is larger than School A. It might be inequality that can encourage people to work harder. It can be observed from Annex II that School A has a more fixed salary system. Moreover, it is even more possible that the rise in salary and larger salary gap are both affecting the academic performance of students. Yet, the influence of these two factors is not easy to be separated. In this case, there is limited access to the data of salary change, and this question leaves us large space of the true incentive for education.

IV. Conclusion

This paper discussed the common phenomena in China that high schools' qualities are experiencing major changes after the Great Reform & Opening. The author used data from two high schools in Luoyang Area as a typical case of this wave. Year 2005 proved to be a turning point where the relative positions of two schools have changed

significantly. However, it can't be proven that the rise in salary in not the main reason for the rise and fall of two schools. It is more possible that the rise in salary and larger salary gap are both affecting the academic performance of students. Teaching experience has shown to be a significant factor influencing the academic performance of students. In addition, it is observed that female teachers are less capable in both teaching students and making money in public schools. However, it is still worthy of consideration that salary, no matter the amount or the variance of it, can truly affect teachers' performance.

Reference

J.G. Altonji, and T.A. Dunn, "The Effects of School and Family Characteristics on the Return to Education", NBER Working Paper No. 5072, 1995

E.A. Hanushek, and S.G. Rivkin, "Understanding the 20th Century Growth in U.S. School Spending", NBER Working Paper No. 5547, 1996

Christopher Jepsen, and Steven Rivkin, "Class Size Reduction and Student Achievement——The Potential Tradeoff between Teacher Quality and Class Size", Journal of Human Resources, 2009

Eric A. Hanushek, John F. Kain, Steven G. Rivkin, "Teachers, Schools, and Academic Achievement", Econometrica, Vol. 73, No. 2 (March, 2005), 417–458

Raegen T. Miller, Richard J. Murnane, and John B. Willett, "Do Teacher Absences Impact Student Achievement? Longitudinal Evidence from One Urban School District", Educational Evaluation And Policy Analysis, vol. 30, no. 2 ,

pp181-200 ,June 2008

Donald Boyd, Pamela Grossman, Hamilton Lankford, Susanna Loeb, and James Wyckoff, "Teacher Preparation and Student Achievement", *Educational Evaluation And Policy Analysis*, vol. 31, no. 4, pp.416-440, December 2009

John P. Papay, Martin R. West, Jon B. Fullerton, and Thomas J. Kane, "Does Practice-Based Teacher Preparation Increase Student Achievement? Early Evidence from the Boston Teacher Residency", NBER Working Paper No. 17646, December 2011

Charles Clotfelter, Elizabeth Glennie, Helen Ladd and Jacob Vigdor, "Would Higher Salaries Keep Teachers in High-Poverty Schools? Evidence from a Policy Intervention in North Carolina", *Journal of Public Economics*, 92, 1352–1370, 2008

David N. Figlio and Lawrence Kenny, "David N. Figlio and Lawrence Kenny", Journal of Public Economics, vol.91, iss.5-6, pp.901-914, 2007

Paul Glewwe, Nauman Ilias, Michael Kremer, "Teacher Incentives", *American Economic Journal: Applied Economics 2*, 1–25, July 2010

Roland G. Fryer, "Teacher Incentives and Student Achievement: Evidence from New York City Public Schools", *Journal of Labor Economics*, November 2011

Eric S. Taylor and John H. Tyler, "The Effect of Evaluation on Performance: Evidence from Longitudinal Student Achievement Data of Mid-career Teachers", NBER Working Paper No. 16877, March 2011

Annex I

Table 1 Data Description of Two Schools Academic Grade in 2002

Variable	Obs	Mean	Std. Dev.	Min	Max
Nonfresh	1050	0.387	0.487	0	1
Sociology	1050	0	0	0	0
Female	1050	0.379	0.566	0	10
Chinese	1050	98.2	13.44	0	123
Maths	1050	85.8	21.91	0	137
English	1050	107.9	20.85	0	142
Combine	1050	192.2	43.22	0	280
Total	1050	484.2	87.22	0	652
Entrance	1050	469.3	59.93	0	575
Class	1050	11.02	5.71	1	20

Table 2

Does A & B Act Differently with Time on the Aspect of Gaokao Grade and Salary?

	TotalGrade	Salary
School	-1.05	-69.5
	(.46)	(17.1)
After	-0.554	613.2
	(.38)	(14.4)
School*After	1.989	604.9
	(.55)	(23.0)
Female	-0.637	-32.04
	(.26)	(12.3)
Teaching	0.279	32.98
	(.01)	(.782)

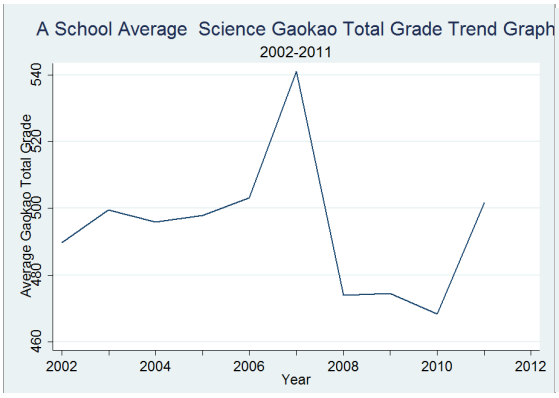
Table 3

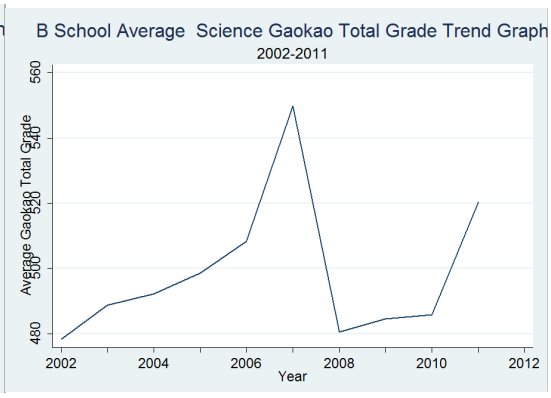
Does School A & B perform differently on academics with time due to salary change?

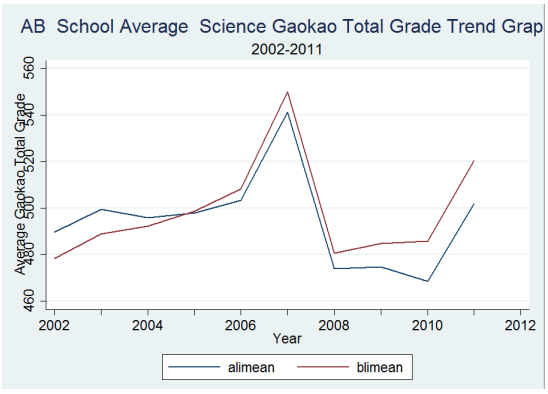
Total Grade	Coefficient

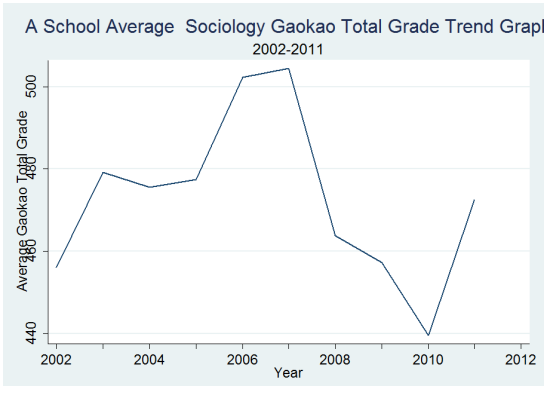
School	-1.485
	(2.08)
After	-.892
	(1.67)
Salary	.008
	(.0014)
School*After	5.142
	(2.41)
School*Salary	.000750
	(.0015)
After*Salary	-.00222
	(.0011)
School*After*Salary	-.00313
	(.00166)
Female	-.485
	(.262)
Teaching Time	.116
	(.0173)

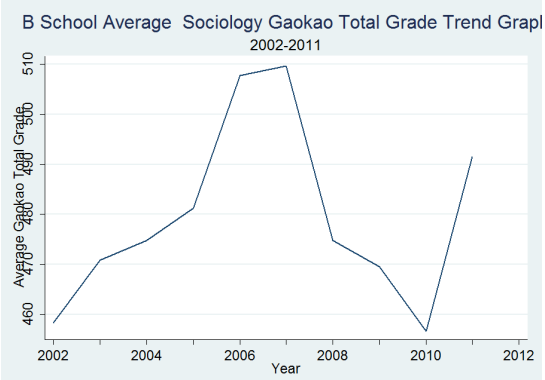
Annex II










B School Average Sociology Gaokao Total Grade Trend Graph
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Average Gaokao Total Grade
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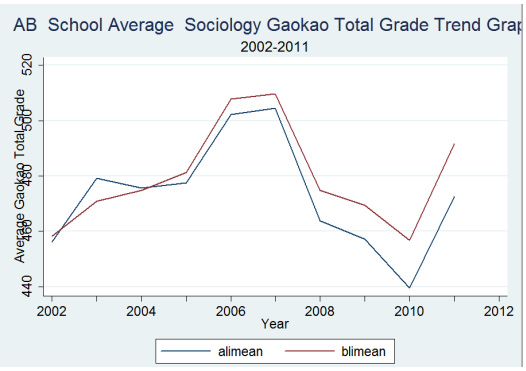
AB School Average Sociology Gaokao Total Grade Trend Graph
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Average Gaokao Total Grade
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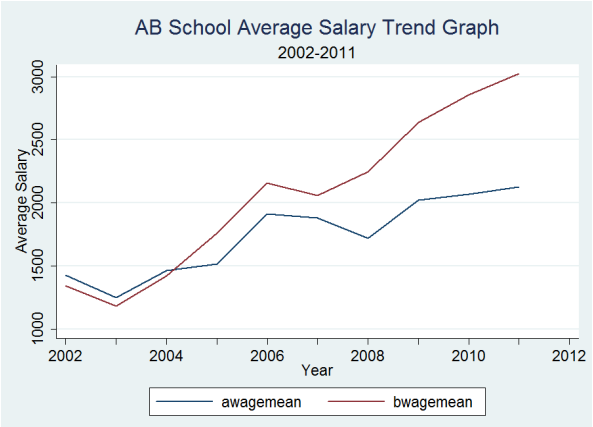
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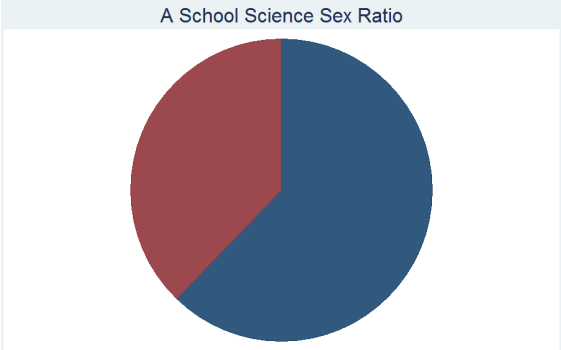
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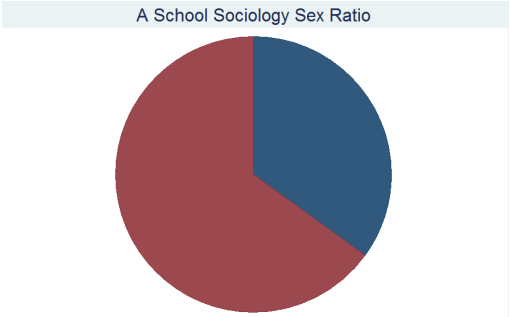
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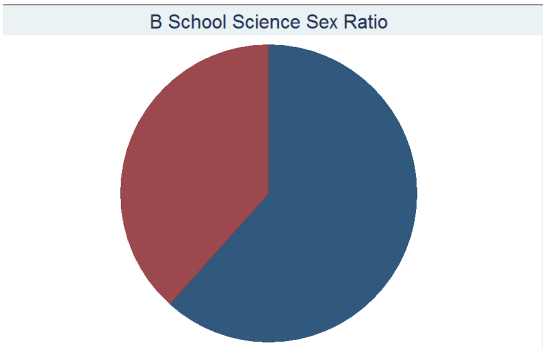
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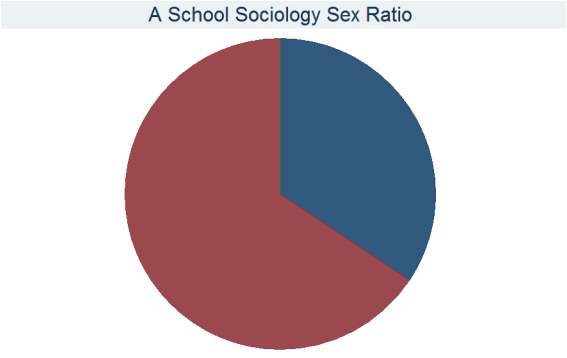
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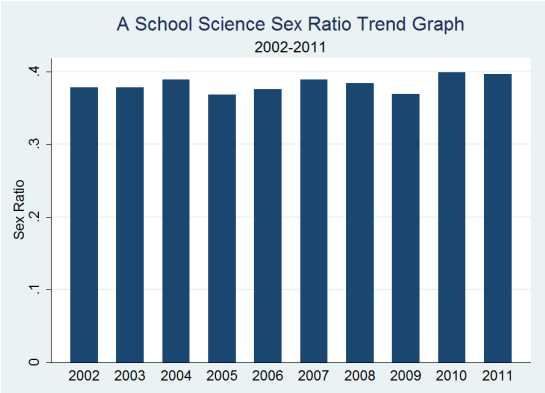
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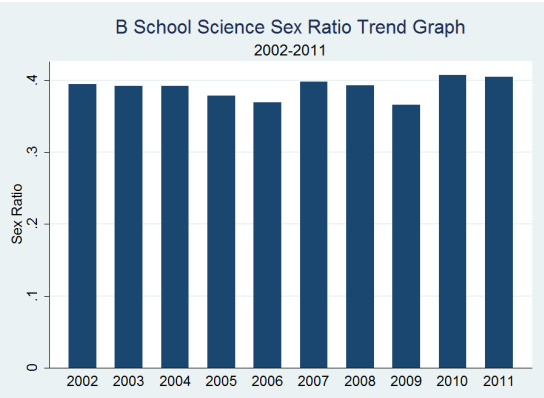
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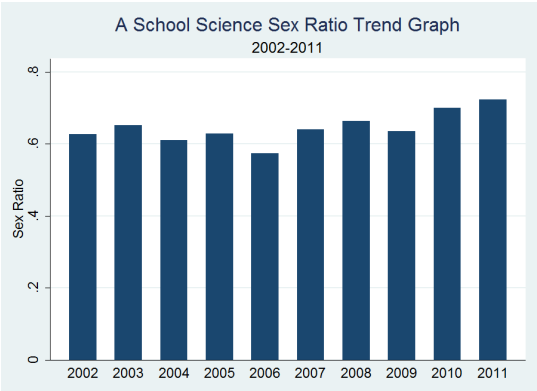
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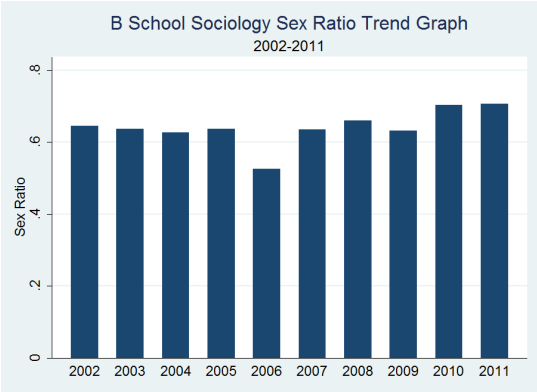
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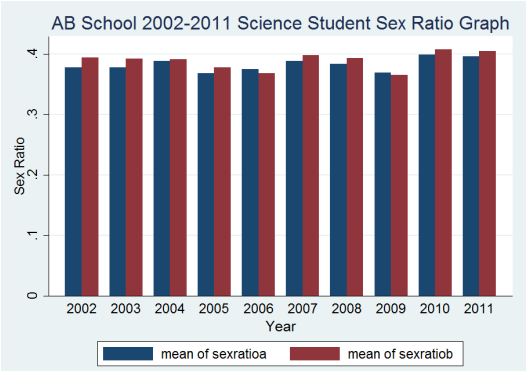
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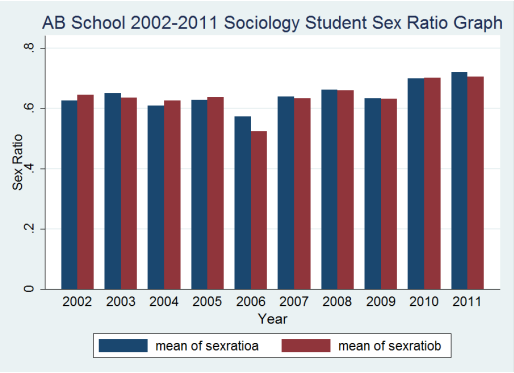
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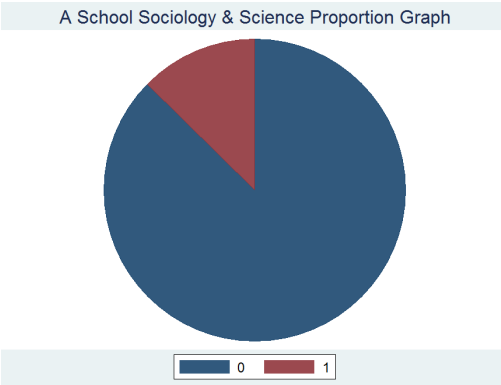
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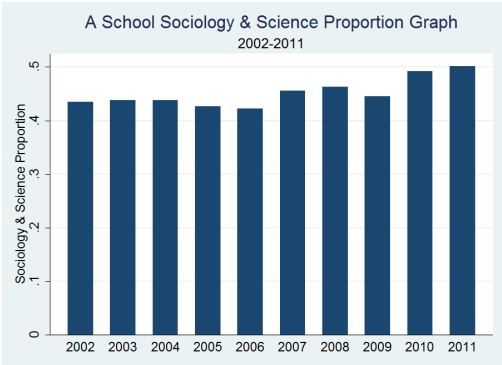
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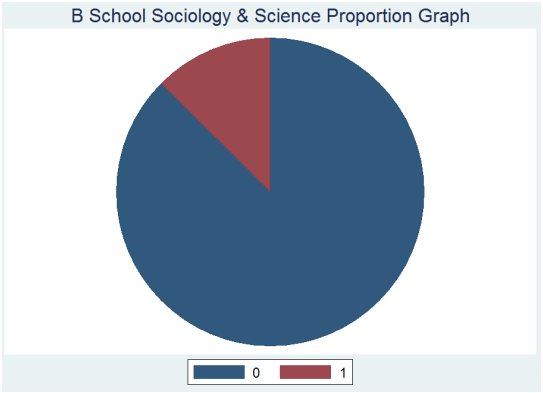
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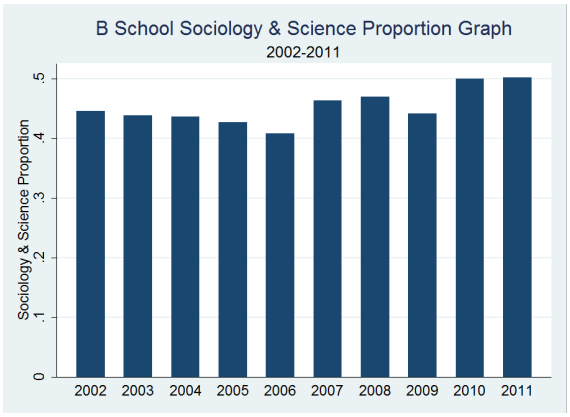
B School Sociology & Science Proportion Graph
2002-2011
Sociology & Science Proportion
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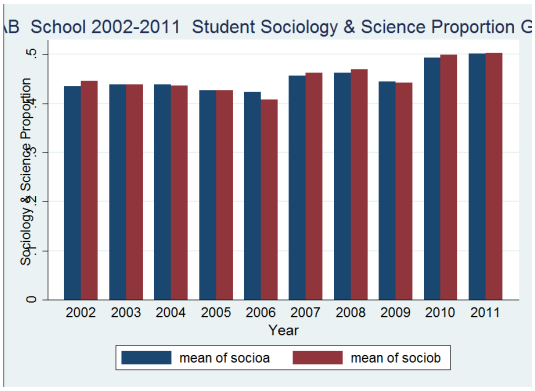
2011


B School 2002-2011 Student Sociology & Science Proportion G
Sociology & Science Proportion
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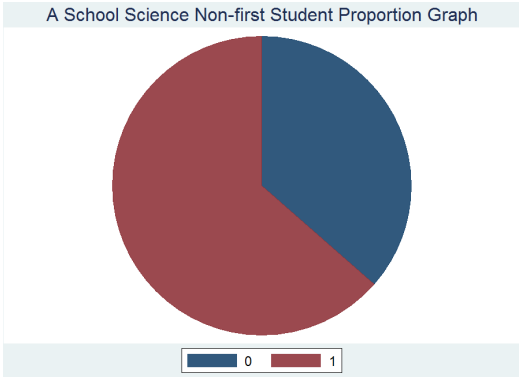
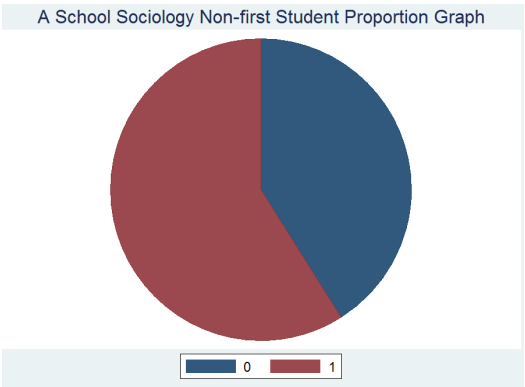

A School Science Non-first Student Proportion Graph
0
1


A School Sociology Non-first Student Proportion Graph
0
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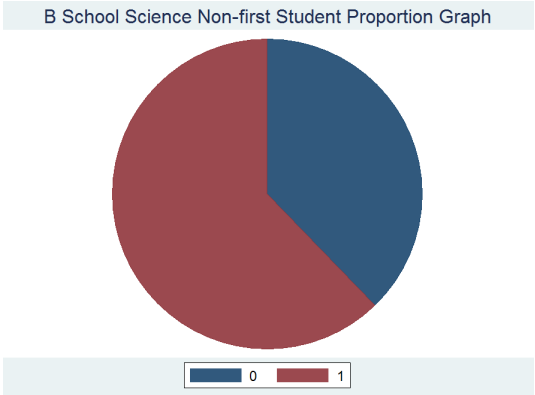
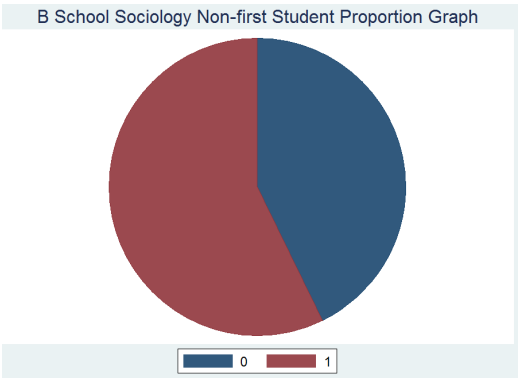
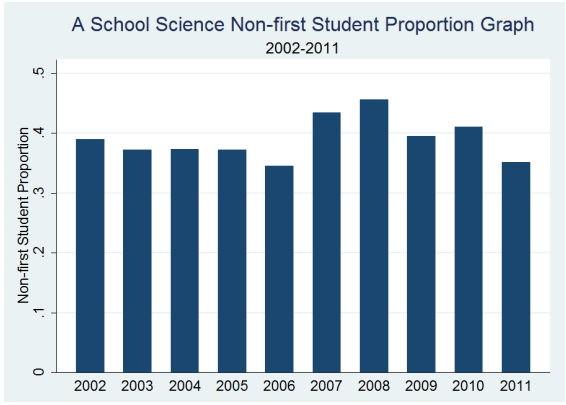

B School Science Non-first Student Proportion Graph
0
1


B School Sociology Non-first Student Proportion Graph
0
1


A School Science Non-first Student Proportion Graph
2002-2011
Non-first Student Proportion
0
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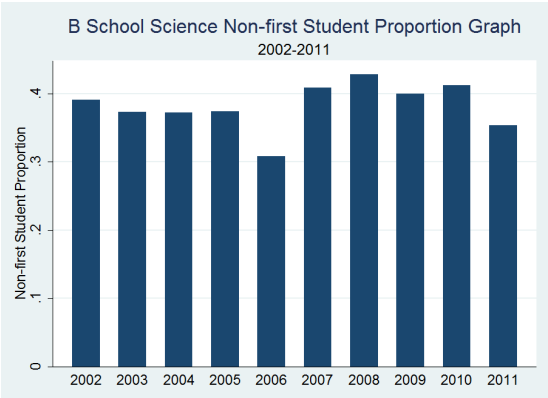
B School Science Non-first Student Proportion Graph
2002-2011
Non-first Student Proportion
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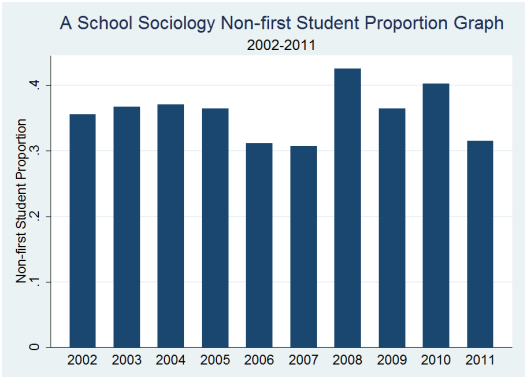
2002 2003 2004 2005 2006 2007 2008 2009 2010 2011


A School Sociology Non-first Student Proportion Graph
2002-2011
Non-first Student Proportion
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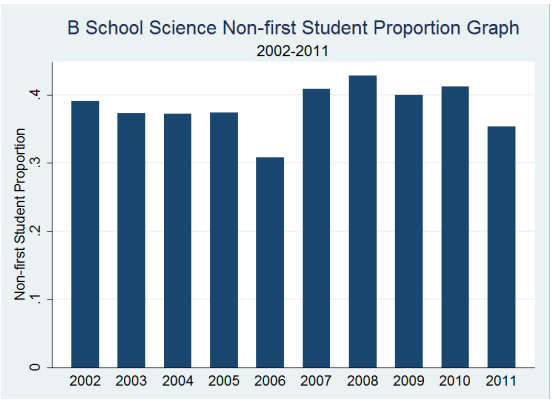
B School Science Non-first Student Proportion Graph
2002-2011
Non-first Student Proportion
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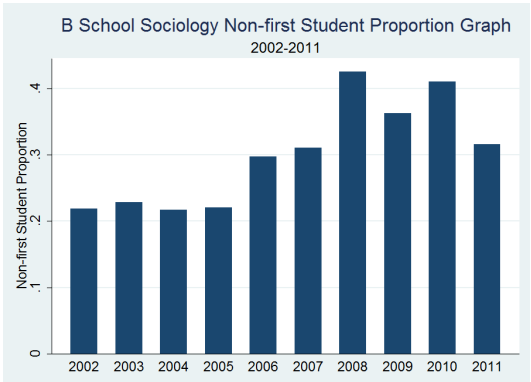
2002 2003 2004 2005 2006 2007 2008 2009 2010 2011


B School Sociology Non-first Student Proportion Graph
2002-2011
Non-first Student Proportion
0
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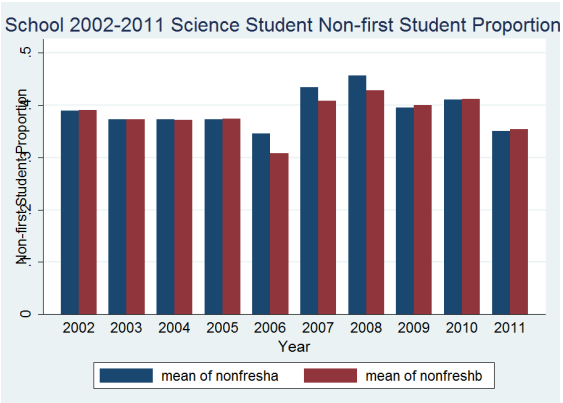
2002 2003 2004 2005 2006 2007 2008 2009 2010 2011


School 2002-2011 Science Student Non-first Student Proportion
Non-first Student Proportion
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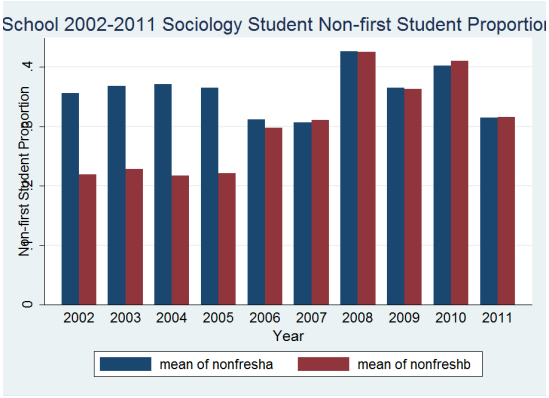
2002 2003 2004 2005 2006 2007 2008 2009 2010 2011
Year
mean of nonfresha
mean of nonfreshb


School 2002-2011 Sociology Student Non-first Student Proportion
Non-first Student Proportion
0
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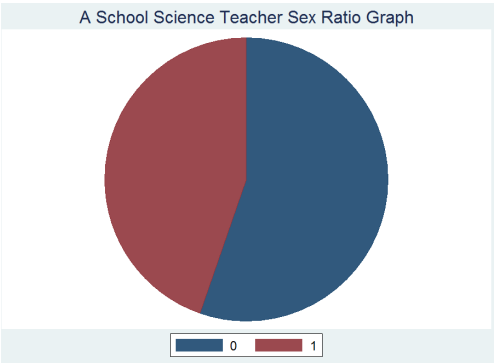
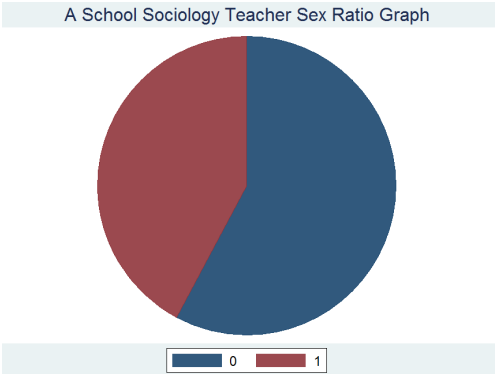
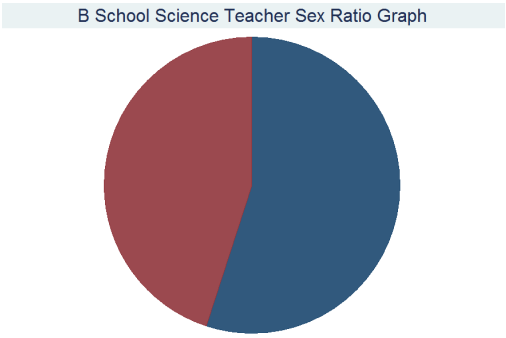
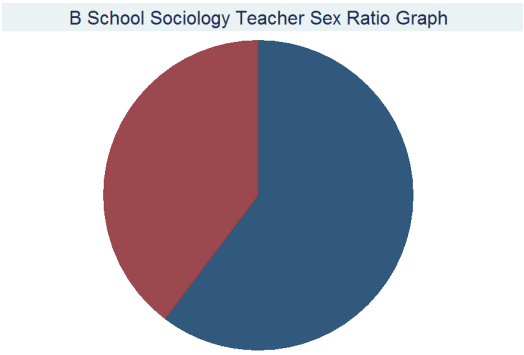
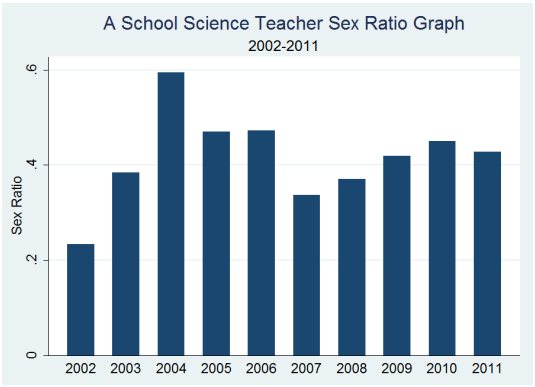
2002 2003 2004 2005 2006 2007 2008 2009 2010 2011
Year
mean of nonfresha
mean of nonfreshb

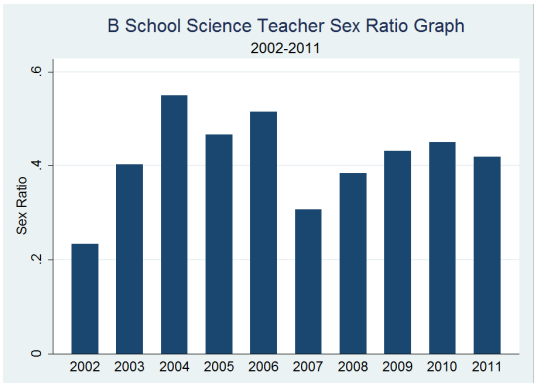

A School Science Teacher Sex Ratio Graph
0
1


A School Sociology Teacher Sex Ratio Graph
0
1


B School Science Teacher Sex Ratio Graph


B School Sociology Teacher Sex Ratio Graph


A School Science Teacher Sex Ratio Graph
2002-2011
Sex Ratio
0
.2
.4
.6
2002 2003 2004 2005 2006 2007 2008 2009 2010 2011


B School Science Teacher Sex Ratio Graph
2002-2011
Sex Ratio
0
.2
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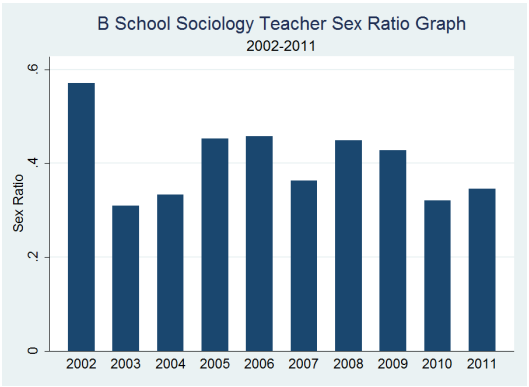
2002 2003 2004 2005 2006 2007 2008 2009 2010 2011


B School Sociology Teacher Sex Ratio Graph
2002-2011
Sex Ratio
0
.2
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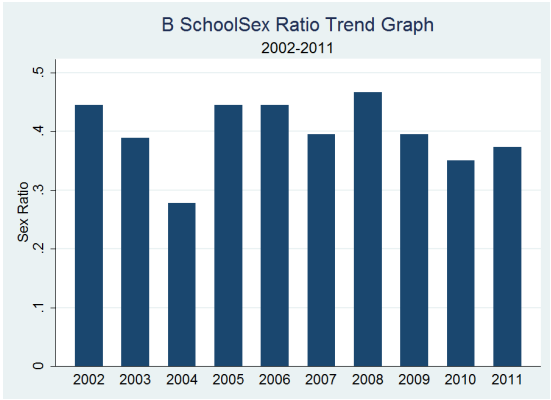
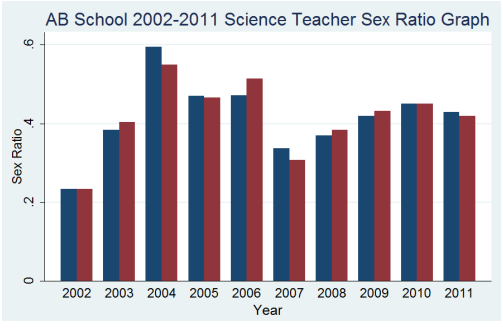
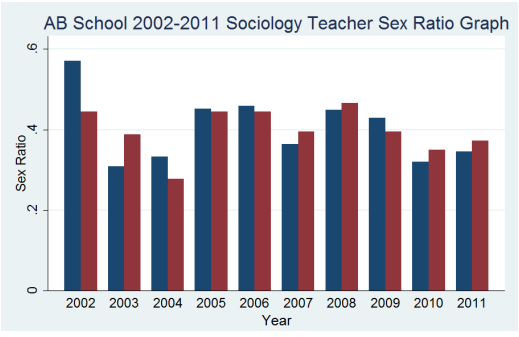
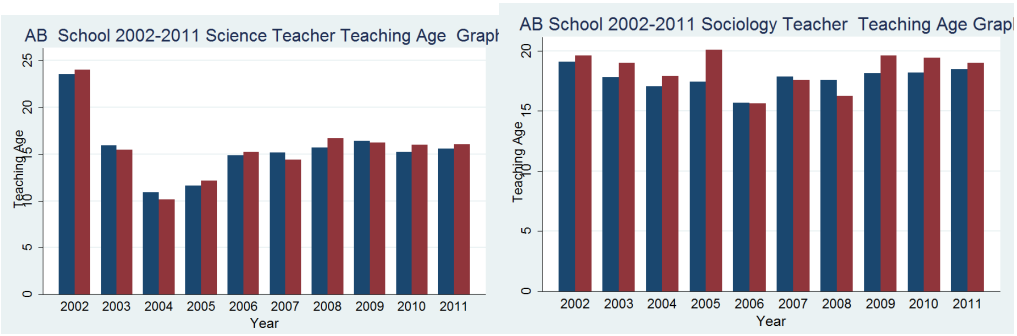
.6
2002 2003 2004 2005 2006 2007 2008 2009 2010 2011


B SchoolSex Ratio Trend Graph
2002-2011
Sex Ratio
0
.1
.2
.3
.4
.5
2002 2003 2004 2005 2006 2007 2008 2009 2010 2011


AB School 2002-2011 Science Teacher Sex Ratio Graph
Sex Ratio
0
.2
.4
.6
2002 2003 2004 2005 2006 2007 2008 2009 2010 2011
Year


AB School 2002-2011 Sociology Teacher Sex Ratio Graph
Sex Ratio
0
.2
.4
.6
2002 2003 2004 2005 2006 2007 2008 2009 2010 2011
Year


AB School 2002-2011 Science Teacher Teaching Age Graph
Teaching Age
0
5
10
15
20
25
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
Year
AB School 2002-2011 Sociology Teacher Teaching Age Graph
Teaching Age
0
5
10
15
20
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
Year