Identifying Presence of Brain Drain Effects of Public Chartered Schools on Other Local Public Schools

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Sohil Kollipara

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I. Introduction

Public charter schools have been growing in the past decade from an enrollment of 1.6 million students in 2009 to 3.4 million students in 2019. Public charter schools are schools that are government funded, but do not necessarily have to follow local or state regulations. Instead, they create a charter with goals that is agreed upon with the state funding the school. If the school fails to meet the expectations outlined in the charter, the state can revoke funding. Additionally, this charter is approved for a specified amount of time (generally several years) (Annual Reports).

The inequalities in education in the United States are a long-standing and contentious topic. (Mullen and Bartlett). One of the major concerns is the quality of public schools versus public charter schools. Public charter schools are particularly controversial as they are sometimes seen as the cause of "brain drain" – or the relocation of highly gifted or academically talented students away from local public schools and state regulations. High performing students may leave due to curriculum better suited to them, preferred peer group composition, or other factors. The result of this is a potential for lower percentages of students performing proficiently on state examinations (Leonard).

Hillsborough county in New Hampshire is in the southmost portion of New Hampshire. With a population of 415,305 as of 2020, the county was the most populous in New Hampshire (United States Census Bureau). Of the population 89.3% are white, 3.4% Black, 4.6% Asian, and 7.9% Hispanic or Latino. There are two cities: Manchester and Nashua, and 29 towns. The county also has a set of 14 public school districts with middle schools, some of which serve multiple towns at once. Additionally, the county contains one blue-ribbon

school[1] – The Academy of Science and Design (ASD) – a public chartered, STEM-focused[2], school currently located in Nashua, New Hampshire. Opened in 2007-2008 for grades 7-12, the school quickly gained reputation in the state for high performance (National Blue Ribbon Schools Program). The school does not provide transportation and admits students using a lottery system with no location, grade, or test preference for students within New Hampshire (Merhalski). The lottery system is only applicable if more students apply than capacity for the school. According to admissions procedures, the only admission criteria is verification of competition of the previous year of schooling and parent/guardian acknowledgment of the school mission. This paper will explore the effect of ASD on the overall percentage of proficient students at nearby schools, percentage of proficient students in science, and percentage of proficient students in math. It is hypothesized that the growth of the number of ASD students will cause a drop in the percentile of proficient students nearby due to brain drain. Additionally, since ASD is a STEM school, it will have the greatest effect on science and math. This will be measured using regression to view the relationships between various independent variables and several dependent variables.

II. Sample

The sample used for this study are school reports of distribution of student's skill levels from the New Hampshire Department of Education Bureau of Education Statistics for the 22 non-chartered, public middle schools that have 8th grade students inside the Hillsborough County from the 2008-2009 school year to the 2014-2015 school year (Assessment Data). Due to missing data, the 2013-2014 was not included, leading to 132 samples. Only schools within Hillsborough County are considered to limit the schools being affected to the same

[1] Blue-ribbon schools are schools that the United States Department of Education has awarded the distinction to recognize academic excellence or reducing educational inequalities between student subgroups (National Blue Ribbon Schools Program)
[2] STEM-focused schools are schools that specialize in science, technology, engineering, and mathematics. They promote these subjects to their students by emphasizing curriculum around these fields.

region. The data available includes demographics (Enrollments - Demographic Categories) and percentage of students who are eligible for free/reduced lunch (Free and Reduced School Lunch Eligibility). The locations of each school are available through the school district's websites. Schools and areas outside Hillsborough County are not being considered due to the wide-ranging possible effects of other school systems. For example, the neighboring county (and closest county to ASD in both new and old locations) Rockingham County has several other chartered schools like The Birches Academy of Academics & Art.

III. Dependent Variables

Percentile of Proficient Students in Public Non-Chartered School (Overall, Math, Science)

The dependent variable is the percentile of proficient students. Since there are three different exams: science, math, and ELA (English and Language Arts), the overall percentage of proficient students will be determined by averaging the percentage of proficient students in each of the categories. Additionally, science and math will be separately analyzed since ASD specializes in STEM. The percentage of proficient students in each school is an indicator of the skill level of students at these middle schools as the goal of the statewide exam is to provide a measure of proficiency. While it is not a perfect system, it provides a comprehensive, analytical survey of each school's student population. The examinations used for the analysis may vary and the scoring scale is not consistent between each year (i.e., the actual score cannot be compared across years). However, since the New Hampshire Board of Education also categorizes every student in 4 categories based on these exam results, the categorical data can be used. For every subject, students have the following possible categories: 1 – Not Proficient, 2 – Approaching Proficiency, 3 – Proficient, 4 – Above Proficient. The categories 1 and 2 are considered not proficient, while the categories of 3 and 4 are both considered proficient. If there are not enough students in a particular category, that category is given a value of <10 rather than a specific percentage to maintain privacy of

students. In this case, it will be considered as 0 (Assessment Data). Additionally, in the 2013-2014 school year, the science examination was not conducted, so that year was removed from the dataset.

IV. Independent Variables

Number of 8th Grade Students in ASD

The number of 8th grade students in ASD is used as a proxy variable to represent the amount of brain drain nearby schools are experiencing. The number of students is used because there is only data available for ASD one year prior to the forming of the school and would make it difficult to measure any jump. Additionally, the school began with a small population so it may not have a drastic effect until it grew. Consequently, the number of students is used to account for the small initial size and rapid growth. For a graph of change in ASD population, see Figure 1 in the Appendix.

I expect that there will be a negative relationship between ASD's 8th grade population and other middle school's percentile of proficient students since the smartest students are picked up by ASD assuming brain drain. If the relationship between this variable and the dependent variable are significant, this will indicate that there is a potential for ASD to cause brain drain from other local schools.

Distance to ASD

Schools that are further from ASD may experience a lower loss of academically gifted students. All public schools outside of ASD provide their own form of transportation, enabling students to go to their local district school. However, ASD does not provide transportation potentially making it difficult for students who live far to go to the school. Additionally, if the schools are very far apart, parents may prefer to send their child to the school in their local district (so that their children are not far apart from them or to keep siblings close by). Since schools serve their own local district and not students from outside

the district, this variable can represent how far students at these schools are from ASD. This fails to account for students who live near the edge of district boundaries or far from the district middle school as they may be particularly further or closer to ASD. However, it does provide insight and an approximation into how far students will need to travel to go to ASD.

The distance used will be direct distance (in miles). This may be slightly inaccurate as the distances between schools is not a perfect representation of travel difficulty. The terrain in New England is hilly and there are not many grid-like road patterns but rather an archaic road pattern reminiscent of the original settler's plans[3].

ASD also moved from Merrimack, New Hampshire to Nashua, New Hampshire. While the change may cause a conflicting effect on this variable, it will not be considered here but with a different dummy variable. The original address and newest address are both available so the distance will change between two schools for different years. For a map of the locations and Hillsborough County within New Hampshire see Figure 2 in the Appendix.

The distance to ASD is expected to have a negative relationship with percentile proficient students. Schools and students that are closer to ASD will have easier access to ASD and will have a stronger brain drain effect.

ASD Facility

This will be a dummy variable to represent whether ASD is in its older Merrimack, NH facility or newer Nashua, NH facility. 0 will represent Merrimack and 1 will represent Nashua. This variable represents the changing of ASD's facilities and the move from Merrimack to Nashua. The school gained additional land and facilities, becoming larger and more able to serve students. Due to the improved facilities, a more academically gifted group

[3] Roads are reminiscent of farms and planning from the 1700s when the towns and areas were originally settled. Roads were improved over time but some of the structure and planning remains the same. Consequently, roads are not optimal for minimal time to travel but are present in an older style.

of students may decide to join the school (Lavy and Nixon). Consequently, I expect a negative relationship between this dummy variable and the dependent variable.

Free/Reduced Lunch Eligibility Percentile (Abbreviated F/R)

The percentage of students who are eligible for free/reduced lunch will also be considered. This variable will be used to identify students who have a lower economic status and consequently may not have as many tools available to improve their academic proficiency as their higher economic status peers (Jones). Because of having lower opportunities available to grow academically, I predict a negative relationship with the dependent variables.

School (Dummy Variables)

To account for other differences between schools, a school dummy variable will be considered. This is because schools fundamentally have differences including classroom size, teacher retention rate, and other factors which directly affect student performance. There are 22 schools in this variable set, leading to 21 variables to account for them. For the statistics and regression variables associated with these dummy variables, see Link 1 in the Appendix.

Discluded Variable: Percentage Asian/Black/Hispanic/Multi-race

Due to the low number of minorities and high homogeneity of the schools being studied, this variable was not included. While previous work such as (Quinn) indicate that race is important to consider when gauging percentile of student success, the low diversity in data makes it difficult to include.

V. Summary Statistics

Table 1: Summary Statistics

	N	MEAN	MEDIAN	MODE	ST. DEV	MIN	MAX
Overall Proficiency	132	52.3409	54.5	58.3333	13.0175	17	78

Science Proficiency	132	24.7879	24	10	10.7944	10	55
Math Proficiency	132	60.2803	64.5	74	16.3050	15	89
Free/Reduced Eligible	132	27.7257	23.7049	44.1558	17.3601	2.4752	69.9237
Distance	132	15.1515	13	12.6	8.7860	3.3	33.9
ASD Population	132	61.6667	62	-	29.8435	18	111
Facility	132	0.3333	0	0	0.4732	0	1

Note: Dummy Variable Data in Appendix Link 1, ASD population is unique every year making the mode all values.

VI. Regressions and Results

Table 2: Correlation Matrix

	Overall Proficiency	*Science Proficiency*	*Math Proficiency*	*F/R*	*ASD Population*	*Facility*	*Distance*
Overall Proficiency	1						
Science Proficiency	0.3908	1					
Math Proficiency	0.3865	0.6766	1				
F/R	-0.6049	-0.1359	-0.0071	1			
ASD Population	-0.2305	-0.0010	-0.3467	0.1212	1		
Facility	-0.2061	-0.0040	-0.2892	0.0800	0.8047	1	
Distances	-0.1806	0.0783	0.2981	0.1881	0.0085	0.0105	1

Note: Dummy Variable Data in Appendix Link 1

From Table 2, a negative correlation between ASD's population and the percentage of overall and math proficient students in a school was discovered. The percentage of free/reduced eligible students and the percentage of proficient students has a negative correlation (-0.59) as supported by literature (Jones). There is a strong positive correlation between ASD's population and facility (0.8047), which is expected since the upgraded facilities would be capable of a greater number of students. To account for multicollinearity, two sets of regressions were performed for each of the three proficiency metrics.

(1) Regression with all independent variables

(2) Regression without the Facility variable

(3)

Table 3: Regression Results with All Independent Variables

	Dependent variable:		
	Percentile Proficient		
Regression	Overall	Science	Math
Free/Reduced Eligible	0.6018**	0.6504***	-0.0218
	(0.2447)	(0.1701)	(0.0759)
Distance	-0.2461	-0.1114	0.5670***
	(0.5383)	(0.3742)	(0.1489)
ASD Population	-0.1364***	-0.0587*	-0.1746**
	(0.0494)	(0.0343)	(0.0729)
Facility	-0.4653	1.0026	-1.1536
	(2.8017)	(1.9476)	(4.5749)
Intercept	41.4613***	3.0192	63.4330***
	(9.2397)	(6.4230)	(4.4068)
Observations	132	132	132
R^2	0.624	0.736	0.730
Adjusted R^2	0.536	0.674	0.667
Residual Std. Error	8.8706	6.1665	9.4123
F Statistic	7.04	11.82	11.48

Note: standard error in parentheses,
School variable results in Appendix Link 1

*p<0.1; **p<0.05; ***p<0.01

With all independent variables included, ASD's facility did not have a statistically significant effect on the percentile of proficient students. Free/reduced eligibility did have a significant effect on overall and science proficiency ($p < 0.05$ and $p < 0.01$ respectively). However, both had a unexpected positive slope, which may be due to free/reduced lunch eligibility giving students access to nutrition and meals to help improve their proficiency. The distance to ASD only had a statistically significant effect on math proficiency. For every mile further from ASD, schools experience a 0.5670 percentile increase in math proficiency ($p < 0.01$). ASD's population had a statistically significant negative effect on overall, science, and math proficiency. With a growth of 1 student in ASD's population, a -0.1364 percentile drop in overall proficiency, -0.0587 percentile drop in science proficiency, -0.1746 percentile drop

in math proficiency is seen schools around the county ($p < 0.01$, $p < 0.1$, $p < 0.05$ respectively).

Table 4: Regression Results without Facility Variable

	Dependent variable:		
	Percentile Proficient		
Regression	Overall	Science	Math
Free/Reduced Eligible	0.6087** (0.2400)	0.6355*** (0.1670)	0.7950*** (0.2547)
Distance	-0.2538 (0.5338)	-0.0947 (0.3715)	-0.9202 (0.5664)
ASD Population	-0.1428*** (0.0307)	-0.0449** (0.0214)	-0.2432*** (0.0326)
Intercept	41.6434*** (9.1326)	2.6267 (6.3557)	60.1976*** (9.6911)
Observations	132	132	132
R^2	0.624	0.735	0.730
Adjusted R^2	0.540	0.676	0.670
Residual Std. Error	8.8302	6.1453	9.3703
F Statistic	7.40	12.38	12.07

Note: standard error in parentheses *p<0.1; **p<0.05; ***p<0.01
School variable results in Appendix Link 1

When the facility variable is removed distance to ASD did not have statistically significant effects on the overall percentile of proficient students and percentile of proficient students at science at other public schools within the county. Only free/reduced lunch eligibility had significant positive relationships, like the original regression ($p < 0.05$, $p < 0.01$, $p < 0.01$ for overall, science, and math).

ASD's population had a statistically significant negative effect on overall, science, and math proficiency. With a growth of 1 student in ASD's population, a -0.1428 percentile drop in overall proficiency, -0.0449 percentile drop in science proficiency, -0.2432 percentile drop in math proficiency is seen schools around the county ($p < 0.01$, $p < 0.1$, $p < 0.01$ respectively).

The results of the regressions partially support the hypothesis. Proficiency dropped as ASD's population increased. The statistically significant relationship between ASD's population and proficiency indicates that ASD could be cream skimming highly proficient students from other schools. However, this study does not control for several factors such as: parental education level, teacher experience, examination modifications, other counties. Parental education level data was not readily available at a school level, but rather a percentage of education level per district level. While this education data could be used per school, this may cause inaccuracies as that may not be representative of the average parent. However, parental education level can be an important determinant of student success (Woolley, Kol and Bowen). Additionally, teaching experience was also only available on a district level rather than on a school level. Teachers with greater experience could have better performing students as they have seen the examinations many times or are generally more experienced. The exam used to categorize students is changed yearly. While the proficiency ratings are standardized, exams may favor students who have seen similar examples in their curriculum over other students, favoring some schools. The biggest potential issue is that ASD does not only accept students from Hillsborough County. Consequently, ASD students could come from any county and ASD could be cream skimming from other public schools not considered.

VII. Conclusion

This study found that the Academy for Science and Design, a renowned public charter school, had a statistically significant relationship with exam proficiency of other public schools in the same county. These results suggests that this specific school could be cream skimming providing evidence on whether charter schools are cream skimming. The significant effects of ASD's population on percentile of proficient students potentially indicates that charter schools do not cause a decrease in skilled students at nearby schools by

taking them out of normal public-school systems. However, the unique conditions of Hillsborough County and New Hampshire may also have led to cream skimming. As a consequence, more schools must be analyzed.

Moving forward, I intend to expand this study to other high performing charter schools across New Hampshire to identify if this lack of effect can be seen across the entirety of the state. I also plan to add consideration of different types of schools such as private schools and privately endowed public schools.

VIII. Appendix

Link With Data and Analysis Scripts and more information:
https://github.com/skllpr/EconomicsHonorsThesis

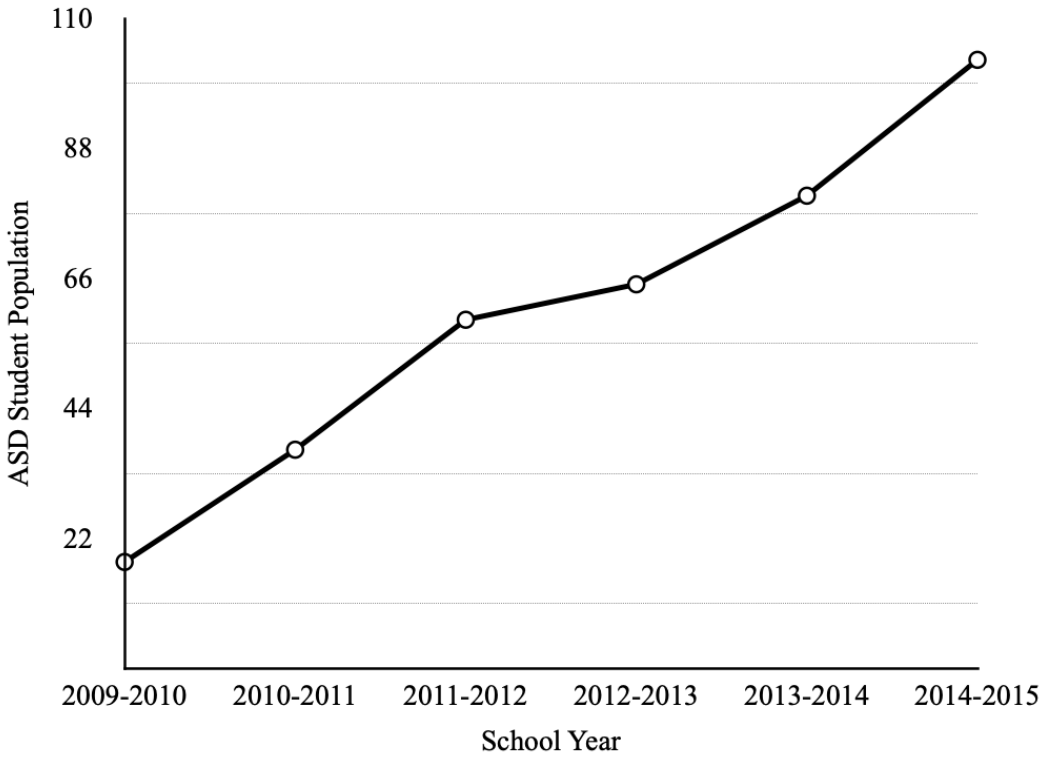

Figure 1: Yearly population of ASD from 2009-2010 school year to 2014-2015 school year.

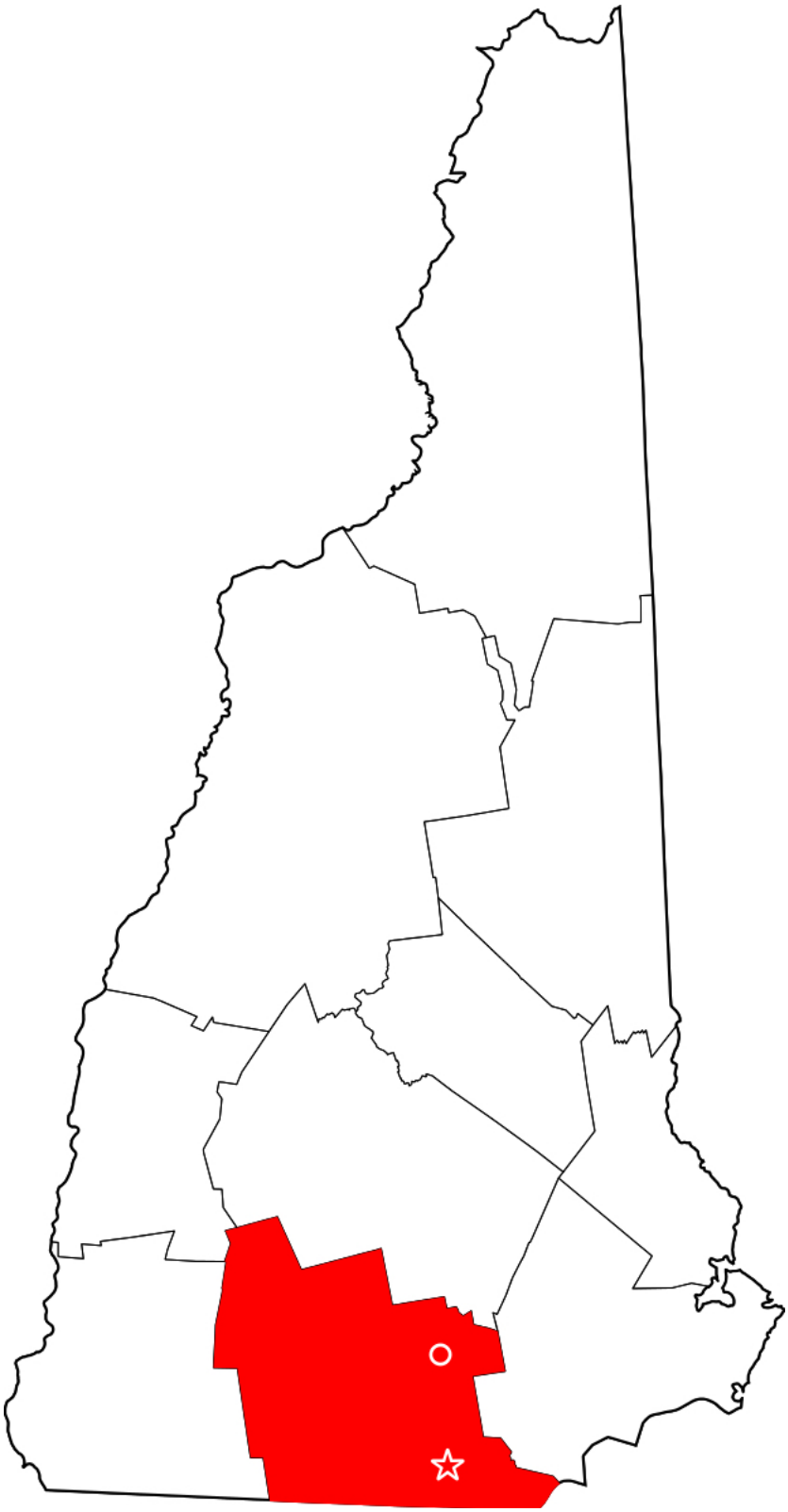

Figure 2: Map of Hillsborough County with Merrimack (circle) and Nashua (star) ASD locations marked (New Hampshire GRANIT GIS Clearinghouse).

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