Essays on the Supply-Side of School Choice

by

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Dissertation submitted in partial fulfillment of the requirements for the degree of
Doctor of Philosophy in the Department of Economics
in the Graduate School of Duke University
2017

Abstract

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Abstract

This dissertation studies the supply of charter schools, school alternatives introduced to education markets to expand choice for students. Drawing upon unique data gathered from Florida, the chapters examine the characteristics and behavior of charter schools and their implications for equilibrium sector outcomes and for policy. The first chapter investigates how non and for-profit managed charter schools differ in terms of where they locate, the composition of students they serve, and student performance. Regression estimates indicate that, among independent charters, for-profits spend less per pupil on instruction and achieve lower student proficiency gains. By contrast, among charter schools that belong to a network, for-profits spend significantly less per pupil, but expenses on student instruction are not being cut. These results thus provide empirical evidence concerning the trade-offs surrounding recent policies that restrict for-profit management of charter schools. The second chapter develops and estimates an empirical model of how charter schools decide where to locate in a school district. This is motivated by the possibility that flat funding formulas create an incentive for charter schools to spatially "skim" low-cost students. In the model, charter schools choose a location based on expected revenues, which depend on the per-pupil funding rate, and costs, which depend on the composition of students served. The equilibrium structure of the model, which embeds competition with public and other charter schools for students, facilitates the study of counterfactual funding policies, including a formula tying revenue to the characteristics of students a charter school serves. The estimation strategy consists of linking charter school effectiveness at raising student achievement, recovered from student test score data, with charter school expenditures to estimate the cost structure of charter schools and then leveraging revealed preference to uncover how charter schools respond to competitive and financial incentives. The results indicate that a cost-adjusted funding formula would significantly increase the share of charter schools serving disadvantaged students with little reduction in aggregate effectiveness. These findings are important in demonstrating that a mismatch between funding and costs may generate significant disparities in benefits from school choice through inequity in access. Together, the chapters suggest that supply-side incentives may provide an effective policy instrument for directing competition in education markets, which has broad implications for the design of school choice programs.

For Katie

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1

Introduction

School choice proponents and opponents alike frequently invoke the metaphor of an education market. Proponents contend that choice stimulates competition, driving schools to either raise student achievement or to go out of business. Opponents of choice, on the other hand, express skepticism at the belief that parents and households are consumers sensitive to school quality. Rather, critics argue that parents choose schools for other reasons, particularly the composition of peers, which raises equity concerns. Charter schools, which are privately-operated but funded out of public education revenues, remain on the front lines of this policy debate in the United States. Despite eliciting continued controversy in a number of states and districts, charter schools have become a permanent feature of the educational landscape over the past twenty years. The Obama Administration's 2009 Race to the Top initiative, for example, incentivized charter school support by including removing expansion barriers as a criterion for receiving federal dollars. As a result, improving the performance of the charter sector has become the relevant policy context for a large and growing number of jurisdictions embracing charter schools as an education reform.

Assessing the value of additional investment in charter schools and designing effective policies requires an understanding of the supply-side of the market, however – a dimension that remains neglected in both the considerable empirical literature studying school choice and work focusing on charter schools in particular. For instance, a dense supply of available and effective schools requires that the costs of opening and operating schools in a competitive education market (e.g. securing facilities, designing curricula, hiring and training faculty and staff, etc.) are not prohibitive for operators. Importantly, viewing school choice from this perspective modifies both the supportive and skeptical views of school choice. First, for cost-related reasons alone, choice may incentivize schools to engage in "spatial cream-skimming": if the cost of reaching a targeted achievement level varies by student type and students sort residentially across geographic areas, schools have an incentive to locate in some areas over others, potentially leading to inequity. In underserved areas where public schools may be failing, this incentive can work against competitive ones even if demand for education alternatives may be high. The "market" may thus devolve into geographically and competitively isolated schools that target relatively low-cost students. These incentives and their implications for efficiency and equity in the charter sector, as well as for policy design, have not previously been quantified.

At the same time, charter schools, as non-profit firms, may have internal incentives to raise student achievement even if parents are unresponsive to quality, an overlooked point in the invocation of the market metaphor. Absent strong competitive incentives, charter schools may supply quality for altruistic or non-profit seeking reasons alone, though the growing share of for-profit managed charter schools in many settings raises the concern that, alternatively, charters may cut costs to improve their bottom line. In this way, the education market is comparable to health care and similar markets, which feature mixed production by non and for-profit firms. The effects of this element of the market are important because for the aggregate supply of effective school alternatives in the education market, it is not demand as such, but demand relative to supply, which may respond to both external and internal incentives, that matters. Little to no work has examined difference between non and for profit managed charter schools, either in terms of the students they serve, their expenses, or ability to raise student learning or their sources, which may have significant implications for expansion of the charter sector.

This dissertation consists of two chapters examining supply-side elements of the charter sector. In addition to expanding understanding of education markets in order to inform school choice policy, the chapters draw upon a common data set assembled from existing and new sources from the state of Florida. The annual independent audits filed by all charter schools were individually scanned, read, and manually digitized to produce a unique and comprehensive database of charter school financials. These records facilitate analysis of both how much charter schools spend and why and what they allocate spending towards. In addition, a second new data source consists of annual survey responses by Florida charter schools, which provide information about schools' management including whether they contract with a for-profit management organization. These data then were merged with publicly-available data of public schools' characteristics, locations, and student test scores. Each chapter describes the respective data elements of principal importance in expanded detail. Beyond the rich data available, Floridas charter-friendly institutional environment, which generously funds and does not cap the number of charter schools, is particularly tailored to the dissertation's research questions.

The first chapter of the dissertation, titled "Putting Dollars Before Scholars? Evidence from For-Profit Charter Schools in Florida," compares for and non-profit management of charter schools in terms of student and location characteristics, allocation of financial resources, and student proficiency. In addition, the comparisons are stratified by whether a charter school belongs to a network to shed light on the sources of the differences. Comparisons reveal that independent for and non-profit charter schools locate in similar markets and serve similar student bodies, whereas for-profits belonging to a network locate in lower income, denser, and more Hispanic areas. Bearing out the concerns of parents and policymakers, regression estimates indicate that, among independent charters, for-profits spend less per pupil on instruction and achieve lower student proficiency gains. By contrast, among charter schools belonging to a network, for-profits spend over 11% less per pupil, but expenses on student instruction are not being cut. The estimates, which control for differences across schools in student composition and other characteristics, imply that an equivalent level of per pupil expenses purchases about 0.03σ higher student proficiency at network for-profit charter schools. These findings, which have important implications for policy and the development of the charter sector, provide evidence that for-profit charter schools are able to economize and expand without compromising student education.

Titled "Incentives and the Supply of Effective Charter Schools," the second chapter studies an under-recognized source of disparities in charter schooling: inequity in *access* to school choice. This inequity stems from two common features of charter school policy: First, charter school funding is typically set by formulas that provide the same amount for all students regardless of need or advantage. At the same time, while charter schools may not screen students, they choose where to locate and, due to travel costs, serve student populations that largely reflect local demographics. In the chapter, I present evidence from Florida that this creates perverse incentives that skew the distribution of students attending charter schools towards low-cost student populations. To do this, I develop and estimate an empirical model of charter school supply and competition. In the model, charter schools choose a location in a school district based (at least partly) on expected revenues, which depend on the per-pupil funding rate, and costs, which depend on the composition of students served. Due to competition with public and other charter schools for students, the location choices of charter schools are mutually dependent. I thus adapt the structure of an incomplete information entry game, which allows me to study counterfactual funding policies, including a formula tying revenue to the characteristics of students a charter school serves, in terms of equilibrium sector outcomes. I use the panel of student test scores to estimate effectiveness at raising student achievement, while the financial statements enable me to separate cost from demand-side reasons for a charter school's choice of location in the data. I study a counterfactual funding formula that removes the financial incentives to skim and find that this policy raises the share of subsidized students attending charter schools by nearly 8%. In addition, because the charter schools sustained in the market by this policy change are not relatively low effectiveness schools, the equity gain is associated with little to no change in the aggregate effectiveness of the charter sector. These findings are important as they demonstrate that a mismatch between funding and costs may generate significant inequities in benefits from school choice, while underscoring that funding policy, an element of both private school voucher and charter school programs, may provide an effective policy instrument for directing competition in education markets via supply-side incentives.

2

Putting Dollars Before Scholars? Evidence from For-Profit Charter Schools in Florida

2.1 Introduction

For-profit management of charter schools has elicited a great deal of recent controversy. Policymakers and parents worry that for-profit management orients schools toward the bottom-line rather than education, incentivizing for-profits to cut costs (Wang, 2014; Belfield and Levin, 2015; Abrams, 2016). This concern is particularly salient in the education market where quality may be difficult to observe (Glaeser and Shleifer, 2001). Legislation banning for-profit management of charter schools reached the Governor of California's desk in 2015, with similar bills under consideration or already enacted in Mississippi, New York, Ohio, and Tennessee, among other states.[1]

For all the debate engendered by for-profit management of charter schools, however, empirical analysis has lagged behind the public interest. While a substantial

[1] The California bill was vetoed partly out of concern that ambiguous language would also have restricted charter schools from contracting with (for-profit) vendors for food services and other operations.

literature studies the effectiveness of charter schools, the concerns over for-profit management have not received evaluation owing largely to lack of data on charter schools' management and allocation of financial resources. This neglect is doubly problematic because the effect of for-profit management on schools' behavior is theoretically ambiguous: a profit incentive may in fact lead charter schools to operate more efficiently – an advantage that may be all the more important for growing and expanding effective charter schools.

This chapter compares for and non-profit management of charter schools in Florida. This setting, featuring a charter-friendly environment in which for and non-profit charter schools compete for students, is particularly well-suited for this comparison. Since the 2004-5 school year, the for-profit share has grown by 80% to nearly half of all Florida charter schools. The unique dataset assembled contains information from the annual independent financial audits and accountability reports filed by all Florida charter schools. As a result, the data provide a rich portrait of schools' inputs and finances over time, including total expenses and expenses allocated toward student instruction. These resource allocations are then combined with enrollment and summaries of student performance of end-of-grade exams, facilitating the first analysis of how for-profit charter schools differ in their student composition, their use of taxpayer money, and their ability to raise student learning.

Three questions guide the research: First, do for and non-profit charter schools differ in their characteristics and behavior and, if so, along what dimensions? Second, given that many charters expand into networks of affiliated schools that share governance, mission, and marketing, are there important differences between for and non-profits among schools that belong to a network (as most for-profits in Florida do) and those that do not? Finally, are the observed differences in spending patterns, student achievement, and efficiency between for and non-profits explained by differences in school characteristics, such as location, student composition, and network size?

The data reveal robust differences between non and for-profit managed charter schools on average. Non-profits appear socioeconomically and demographically similar to traditional public schools in Florida. Further, whereas independent non and for-profit charter schools largely serve similar markets and student bodies, network for-profits locate in denser, more Hispanic areas, which is in turn reflected in their student composition. In terms of student proficiency on end-of-grade exams, students at independent for-profits perform below independent non-profit and public students. However, network for-profit charter schools display the highest student proficiency levels while also spending over $1,000 less per pupil annually.

Recognizing the many possible explanations for the observed differences between for and non-profit charter schools, the analysis then estimates regressions to control for differences in school characteristics, such as the subsidized lunch status and demographic composition of students, the age of the school, and location. This empirical approach, which is successfully validated against matching and fixed effect estimates of charter school effectiveness in Florida, is applied to evaluating differences between non and for-profit charters in the allocation of financial resources, student proficiency gains, and school efficiency.

Bearing out the concerns of parents and policymakers, the results indicate that independent for-profits spend about 6% less per pupil annually on student instruction than independent non-profit charter schools. Moreover, independent non-profits significantly outperform independent for-profits in terms of student proficiency gains. By contrast, among charter schools belonging to a network, the results reveal that for-profits spend over 11% less per pupil annually while students attending network for-profits achieve larger proficiency gains. Unlike among independent charters, however, expenses on student instruction are not being cut. Together, these differences represent a significant efficiency advantage: The estimates imply that an equivalent level of per pupil expenses buys about 0.03σ higher student proficiency in math and reading at network for-profit charter schools. Results that isolate within-school variation in network size suggest this premium stems from the most efficient for-profits expanding into networks. These findings, which have important implications for policy and the development of the charter sector, provide evidence that for-profit charter schools are able to economize and expand without compromising student education.

The remainder of the chapter is organized as follows. Section 2 describes the institutional environment of charter school operation in Florida. The data sources are described and initial comparisons of for and non-profit charter schools by network status are presented in Section 3. In Section 4, the empirical approach to evaluating the effects of for-profit charters is described and validated. The estimation results are presented in Section 5. Finally, Section 6 concludes with a discussion of the implications of the findings and directions for further research.

2.2 Background and Literature

Florida authorized the creation of charter schools in 1996 and the first schools opened for the 1996-7 school year. Since then, the Florida charter sector has grown into one of the largest nationwide both in terms of enrollments and the number of schools. In the 2013-14 school year, 625 charter schools served over 8% of all Florida public school students, including more than 13% of students in Broward and Miami-Dade counties. 2013-14 charter enrollment represents about a 100% increase over the prior 7 years. This vitality of the Florida charter sector reflects the state's comparatively charter-friendly environment. Florida charter schools receive the majority of their funding, per-pupil disbursements from the Florida Education Finance Program (FEFP), at par with districts. While the local school districts retain authorization authority, discretion is strictly limited and caps on charters or charter enrollment are not permitted. As in other settings, Florida charter schools may not apply any admissions criteria and participate fully in the state accountability programs.

Along with the rapid growth of charter schooling in Florida, the past 20 years has also witnessed the development of corporations that manage charter schools. Often termed either charter or education management organizations, these corporations provide a variety of services to charter schools that aim to take advantage of scale economies in school management. Such services potentially include human resources support, financial management, reporting requirements, facility maintenance and possibly acquisition, and legal compliance. For charter school operators, contracting with a management organization represents a division of labor in exchange for a fee (usually a percentage of enrollment).[2] While all charter schools themselves are 503(c)(3) non-profit entities by state statute, Florida charters may contract with a for-profit management organization.[3]

For-profit management of charter schools in Florida has grown substantially in recent years. As displayed in Figure 2.1, the share of all charter schools that were for-profit stood at a little over 25% in the 2004-5 school year. By contrast, the for-profit share of schools exceeded 45% in 2012-13, representing an 80% increase. The share of students attending for-profits consistently exceeds the school share, approaching 50% of all charter students in 2012-13. These trends, which contribute to the need for empirical analysis of for-profit charter school management, raise a number of questions.

First, given the "hybrid" organizational form wherein legally non-profit charter schools are managed by for-profit organizations, do such schools differ in characteristics or behavior from schools without or with non-profit management organizations?

[2] "Control" may also figure into the cost side of contracting. See Marsh Dalton and Warren (2016) for an analysis of hospitals' decision to outsource operations.

[3] A charter contract is held by school itself in Florida, not the management organization.

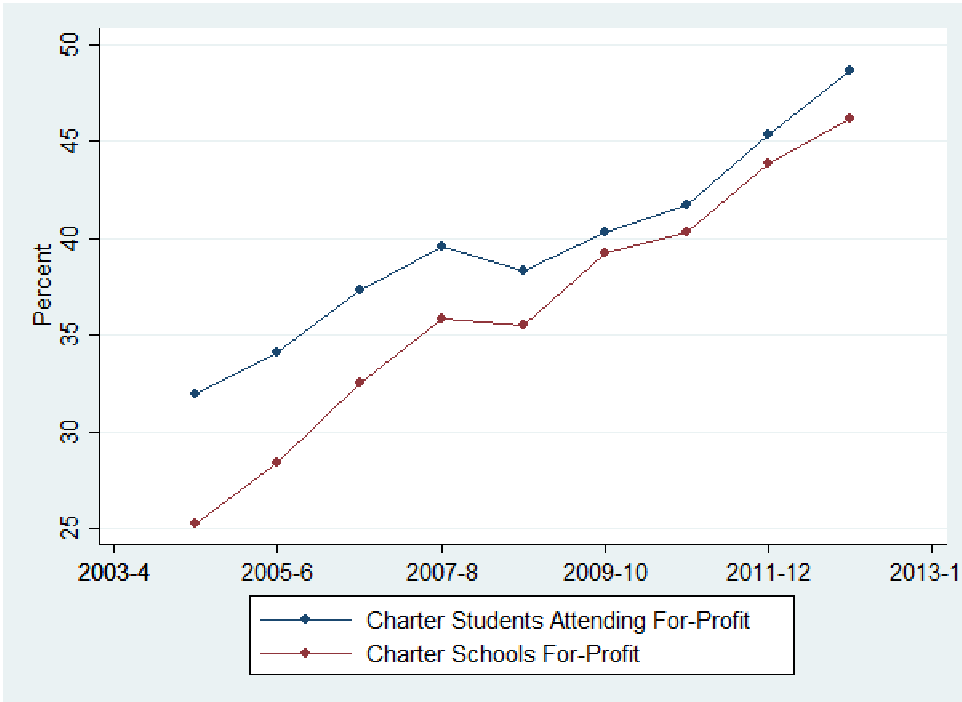

Figure 2.1: Growth of For-Profit Charter Schools and Schooling in Florida

If differences exist, a second set of questions then regards their meaning and importance. In a nutshell, economic theory predicts that for-profit charter schools should operate efficiently due to the profit motive. However, if output quality is difficult to ascertain and monitor, for-profits may have incentives to increase profits at the expense of education (Glaeser and Shleifer, 2001). For example, for-profits might cut costs on student instruction by hiring less qualified teachers – a possibility that is reflected in the concerns of parents and policymakers. An important added layer is that many charters belong to a network, characterized by shared governing board members and typically common mission, marketing, and curricular design and focus, that may contract with a management organization (for-profit or otherwise). The assembled data, described in detail the next section, allow for evaluating these predictions among both independent and network charter schools.

This chapter connects with two literatures. First, it contributes to the significant literature evaluating the performance of charter schools (Epple et al., 2015), particularly work examining the characteristics of successful charters (Zimmer and Buddin, 2007; Angrist et al., 2013a; Dobbie and Fryer, 2013a; Baude et al., 2014). Recent research in this area considers the organization and operation of charter schools by management companies, with special attention often placed on specifically non-profit organizations (Miron et al., 2010; Farrell et al., 2012). The profit status distinction is sometimes codified by distinct terms: charter management organizations (non-profits) vs. educational management organizations (for-profits).[4] Furgeson et al. (2012) present evidence of considerable variation in effectiveness across (non-profit) charter management organizations. The focus on non-profits, however, is not grounded in any established behavioral or outcome differences between non and for-profit managed schools. Indeed, both management types aim to leverage economies of scale in the management of schools. By linking measures of school effectiveness, characteristics, and spending allocations with the profit-status of Florida charter schools, this study investigates these differences. This work also extends analyses of charter school finances (Reed and Rose, 2015). Miron and Urschel (2010) show that for-profit managed schools spend less overall and less on instruction, but do not examine whether these differences are accounted for by variation in school characteristics or their association with school effectiveness.

Second, a literature analyzing non-profit organization and behavior evaluates for and non-profit operation across a number of industries that similarly feature mixed production (Malani et al., 2003; Steinberg, 2003; Lakdawalla and Philipson, 2006). The health care sector, especially hospitals and nursing homes, is the focus of numerous comparisons (McClellan and Staiger, 1999; Sloan, 2000; Sloan et al., 2001;

[4] For instance, Farrell et al. (2012) define a "charter management organization" as a non-profit that manages multiple schools with a "common mission/instructional design" and a "home office/management team that offers ongoing support." Miron et al. (2012) provide extensive profiles of management organizations.

Duggan, 2000; Deneffe and Masson, 2002; Farsi and Filippini, 2004).[5] Overall, the evidence from hospitals presents ambiguous, and sometimes contradictory, evidence about the relative quality and efficiency of for-profit management, concluding that non and for-profit hospitals are more similar than different. The health care setting shares two particularly salient commonalities with the education market: in both, quality may be difficult for consumers to observe and the effects of competitive forces may be muted. This invites empirical work to assess the importance of these factors for school behavior and student outcomes.

2.3 Data

The dataset assembled combines public data with unique financial records and survey responses of Florida charter schools. The data sources are merged to construct a school panel linking student achievement and school characteristics to spending patterns and management status. This enables comparing for and non-profit managed charter schools on a number of novel dimensions, including a measure of efficiency whose construction is described. The next subsection details the sources and sample in detail, while initial comparisons of the school types are presented in the following subsection.

2.3.1 Sources

By statute, all Florida charter schools must obtain and file an independent financial audit with the Florida Auditor General. Containing revenue, itemized expenses, assets, and capital investment, these records richly characterize the expenditure patterns and financial health of each charter school. As a source of financial data, two advantages of the audits are that they correspond to a school year (rather than fis-

[5] Other examples include daycares (Preston, 2013) and correctional facilities (Bayer and Pozen, 2005). For-profit colleges have also drawn attention recently (Deming et al., 2013).

cal year) and must be filed for each individual charter school.[6] For this study, all audits filed for the 2006-7 through 2012-13 school years were scanned and digitized, producing a comprehensive and detailed dataset of charter school financials.

A number of key variables are gathered from the audits. Conceptually, each school year a school must decide how to allocate its available financial resources, which include revenue and any accumulated income. These allocations are reported in the audits according to accounting conventions. Financial resources may either be allocated for investment (purchases or maintenance of capital assets, such as buildings, computers, and furniture) or toward operating the school in the current school year, which is termed expenses.[7] Revenue minus expenses represents a school's net income.[8] Total revenue, expenses, and investment are collected from the audits. For this study, expenses are then subdivided into either instructional or non-instructional. Instructional expenses include the salaries and benefits of teaching staff, instructional media services, and expenses on teacher training or curriculum development. Included in non-instructional expenses are the salaries of administrators and other staff and any management fee.

The financial records are then linked with publicly-available data for Florida public and charter schools. School enrollment, operating status, and student demographic characteristics are obtained from the National Center for Education Statistics' Common Core of Data through 2012-13. Demographic groups include students with free or reduced price lunch status as well as the racial and ethnic composition of the school. Enrollments by grade are used to define school grade levels, while

[6] There are some isolated exceptions. Where possible, the audits have been disambiguated.

[7] Note that expenses are distinct from expenditures, which represent total resources *paid out*, but not necessarily *used*, during a year. Thus, expenditure includes investment (but excludes depreciation).

[8] In accounting terms, this difference is defined as "profit" for for-profit entities. As the schools themselves are non-profits, any residual positive net income must remain in the school.

charter school openings and closings are constructed with total enrollments.[9] The Florida Department of Education's master database is used to gather schools' status and location, which is then merged with 2012 American Community Survey Census tract-level data.

Second, Florida School Grades reports are used to obtain measures of student achievement for each school. The School Grades program uses achievement levels and learning gains as demonstrated on the end-of-grade Florida Comprehensive Assessment Tests (FCAT) to assign letter grades to Florida public schools. The percentage of all test-taking students performing at a proficient level for their grade in each school is gathered for years 2003-4 through 2012-13 in reading and math. For the analysis, these percentages are then normalized by year and grade level.[10]

To measure the efficiency of each school, the merged dataset enables constructing "efficiency units." This is given by the ratio of a school's normalized proficiency rate to thousands of dollars in per pupil expenses:

$$\omega_{jt}^{k} = 1000 \times \frac{z_{jt}^{k}}{Exp/Pupil_{jt}}$$

where z_{jt}^{k} is the subject k normalized proficiency rate for charter school j in year t and $Exp/Pupil_{jt}$ is the school's per pupil expenses. Intuitively, the value represents how many standard deviations from the mean in student achievement one thousand dollars of per pupil spending purchases at a school. A high-performing school with low per pupil spending would therefore be very efficient, given by a large positive value for ω_{jt}. This variable facilitates evaluating competing explanations of for and non-profit differences in expenses and student proficiency.

[9] Schools are classified as primary if enrollment in K-5 is non-zero, middle if 6-8 is non-zero, and similarly for 9-12 (plus combinations). Schools are considered non-operational if total enrollment is zero

[10] Normalizing by year is important as the threshold for "proficiency" as reported in the School Grades reports shifts in some years. School Grades reports categorize schools as either elementary, middle, high, or a combination.

Finally, to classify schools as for or non-profit managed, management and governing board information for each charter school are obtained from the annual Accountability Reports collected by the Florida Office of Independent Education and Parental Choice. These reports, drawn from statutorily-mandated survey responses for 2006-7 through 2012-13, contain information on a wide variety of school characteristics and inputs, including management, curricular focus, and details regarding faculty and staff. The profit status of each charter school's reported management organization is the independent variable of interest.[11] To then link schools into affiliated networks, the survey responses regarding charter schools' governing board are used, supplemented by audit information and web searches. Schools are defined as belonging to a network if at least three other affiliated schools ever operate simultaneously. While network non and for-profit managed charter schools are of primary focus, non-network or independent schools also may contract with a management company. All Florida charter schools are thereby classified one of four ways: as either (1) a network charter school with a non-profit management organization; (2) a network for-profit managed charter school; (3) an independent school either without a management organization or with a non-profit management organization; or (4) an independent for-profit managed charter school.

The final sample tracks 542 Florida charter schools for up to 9 years (2004-5 through 2012-13), though financial information obtained from the audits are available for only the 7 most recent. The median panel length is 4 years, largely reflecting that many charter schools enter during the sample. 85 charter schools (about 16%) close at some point. At least one of math or reading student proficiency must be reported in Florida School Grades for inclusion.[12] Of the 542 charter schools in the

[11] Switches of management organization are rare in the survey. Because of missing responses in some years, a school is coded as for-profit managed if at least once its reported management organization is for-profit.

[12] This criterion removes schools that opt to receive a School Improvement Rating (formerly called

sample, 269 are classified as independent non-profits, while 43 are non-profits that belong to a network.[13] 84 schools are classified as independent for-profits, with the remaining 146 charter schools comprising network for-profits.[14]

2.3.2 Comparisons

To establish whether (and along which dimensions) non and for-profit managed charter schools differ, this section compares average school characteristics, inputs, and outcomes by charter school type. Comparison dimensions include location and student body characteristics along with schools' allocation of financial resources and student proficiency. As this section presents simple means of variables across school types, it must be emphasized that the comparisons do not account for selection (e.g. of schools by parents and students or of location by schools). The comparisons are stratified by network status with comparisons to traditional public schools presented for context.

Table 2.1 compares the locations and students of independent charter schools by profit status and with traditional public schools. The columns labeled Diff present the differences in averages between types (and their statistical significance). For instance, the third column of the table compares independent non-profit charter schools with traditional public schools in Florida. Independent non-profits serve relatively lower income areas than publics, represented by the difference of -$6,349 in household median income. As the fifth column shows, independent for-profits also serve lower income areas than traditional public schools. In fact, as the last

Academic Yearly Progress designation) rather than a School Grade from the sample. This option is only available to schools designated as "alternative" by focusing on dropout prevention and academic intervention or schools designed specifically to meet the needs of disabled students.

[13] For this study, Imagine Schools, which at one point was regarded the largest national for-profit management organization, is categorized as a non-profit. In 2012, Imagine Schools Non-Profit's application for non-profit status was approved by the IRS and applied retroactively to 2005.

[14] During the sample, 64 independent non-profits, 2 network non-profits, 15 independent for-profits, and 4 network for-profits close.

Table 2.1: Comparisons of Public Schools and Independent Charter Schools: Locations and Students

	Public	Non-Profit	Diff†	For-Profit	Diff‡	Diff⋆
A. Location Characteristics						
Income ($)	50,290	43,941	-6,349***	45,331	-4,959**	1,389
Density	2,388	2,612	223	3,956	1,569***	1,345**
% White	57.07	50.35	-6.72***	48.34	-8.73***	-2.01***
% Black	17.76	24.40	6.64***	20.45	2.66	-3.95
% Hispanic	20.73	21.18	0.45	27.40	6.67**	6.22*
% Asian	2.27	2.10	-0.17	1.88	-0.39	-0.22
Tract HHI	0.47	0.44	-0.04***	0.47	0.00	0.04
B. Student Characteristics						
Total Students	920.65	370.21	-550***	355.59	-565***	-14.62
% FRP Lunch	56.66	46.70	-9.96***	49.65	-7.01**	2.95
% White	46.01	44.82	-1.19	38.34	-7.67**	-6.48
% Black	24.58	27.80	3.22	28.37	3.79	0.57
% Hispanic	24.08	22.32	-1.76	26.85	2.77	4.53
% Asian	2.19	1.77	-0.43***	1.26	-0.93***	-0.51**
School HHI	0.41	0.46	0.05***	0.45	0.04	-0.01

Notes: † reports mean differences between non-profits and publics, ‡ between for-profits and publics, and ⋆ between for-profits and non-profits. *, **, and *** indicate statistically significant differences at the 10%, 5%, and 1% levels, respectively. Location variables correspond to Census tracts where schools are located. Income refers to median household income and density to population per square mile of land. Averages of location characteristics are over schools. Total students refers to grades K through 12. Averages of school characteristics are over 2004-5 through 2012-13 school-years.

column displays, independent for-profits serve higher income areas than independent non-profits, though the difference in not statistically significant. On the other hand, independent for-profits operate in much denser locations than either public schools or independent non-profit charter schools. Table 2.1 also shows that both types of independent charters serve less white areas that public schools. To quantify the diversity of a location and the school, a normalized HHI index is calculated for each by summing the squared shares of the four racial and ethnic groups (plus an other category).[15] By this measure, independent non-profits serve less diverse locations than

[15] The index takes values between 0 and 1 with larger values indicating more homogeneity. If shares are equal across groups, the index is equal to 0, while if one group constitutes 100% of a

publics, but the difference between non and for-profits is not statistically different from zero.

In terms of student characteristics, summarized in the bottom panel of Table 2.1, both types of charters (and charters more generally, as confirmed in the next table) have lower enrollment than traditional public schools. Independent charter schools also serve a lower share of students participating in subsidized lunch than publics, though there are participation and measurement issues at play comparing this variable across sectors (Harwell and LeBeau, 2010). While some difference with public schools appear (independent for-profits serve a lower share of white students than public schools and independent non-profits serve more homogenous student bodies), the last column shows that non and for-profits are largely more similar to one another in terms of the characteristics of students served than different.

Table 2.2 performs the same set of comparisons charter schools that belong to a network. As the third column reveals, network non-profits appear similar in location and student characteristics to public schools in Florida. While they serve somewhat higher income and less Hispanic areas (and, correspondingly, fewer subsidized lunch and Hispanic students), most differences with publics are not significant statistically. On the other hand, network for-profit charter schools differ sharply from public schools, locating in denser, less white, and more Hispanic areas. Further, these difference are reflected in terms of student characteristics. Hispanic students at network for-profits constitute a majority (56%) of students on average, for example. Consistent with this, the School HHI reveals that the student body of network for-profits is also less diverse on average. In sum, while independent non and for-profit charters appear to be largely similar in location and student characteristics, Table 2.2 portrays large differences between non and for-profit charter schools among those that belong to a network.

location or school, the index equals 1.

Table 2.2: Comparisons of Public Schools and Network Charter Schools: Locations and Students

	Public	Non-Profit	Diff†	For-Profit	Diff‡	Diff⋆
			A. Location Characteristics			
Income ($)	50,290	56,530	6,240*	49,397	-894	-7,133*
Density	2,389	2,375	-13.03	4,950	2,562***	2,575***
% White	57.07	62.16	5.09	32.65	-24.43***	-29.51***
% Black	17.76	17.58	-0.18	18.08	0.32	0.50
% Hispanic	20.73	16.02	-4.71**	45.44	24.71***	29.42***
% Asian	2.27	2.07	-0.20	2.08	-0.19	0.01
Tract HHI	0.47	0.45	-0.025	0.43	-0.04**	-0.02
			Student Characteristics			
Total Students	920.65	464.92	-456***	487.31	-433***	22.39
% FRP Lunch	56.66	36.77	-19.89***	45.16	-11.50***	8.39
% White	46.01	47.98	1.97	23.08	-22.93***	-24.90***
% Black	24.58	28.31	3.73	16.66	-7.92***	-11.65**
% Hispanic	24.08	17.76	-6.33***	56.83	32.75***	39.07***
% Asian	2.19	2.37	0.18	1.48	-0.71***	-0.89***
School HHI	0.41	0.41	0.00	0.52	0.11***	0.11***

Notes: † reports mean differences between non-profits and publics, ‡ between for-profits and publics, and ⋆ between for-profits and non-profist. *, **, and *** indicate statistically significant differences at the 10%, 5%, and 1% levels, respectively. Location variables correspond to Census tracts where schools are located. Income refers to median household income and density to population per square mile of land. Averages of location characteristics are over schools. Total students refers to grades K through 12. Averages of school characteristics are over 2004-5 through 2012-13 school-years.

Table 2.3: Comparisons of Public Schools and Independent Charter Schools: Student Proficiency

	Public	Non-Profit	Diff†	For-Profit	Diff‡	Diff⋆
Reading z	-0.01	0.04	0.05	-0.31	-0.30***	-0.35**
Reading Δz	-0.01	0.02	0.03	0.02	0.03	0.00
Math z	0.01	-0.14	-0.15	-0.47	-0.48***	-0.33**
Math Δz	-0.01	0.05	0.06	0.08	0.09***	0.03

Notes: † reports mean differences between non-profits and publics, ‡ between for-profits and publics, and ⋆ between for-profits and non-profits. *, **, and *** indicate statistically significant differences at the 10%, 5%, and 1% levels, respectively. Math and reading proficiency levels are normalized across all schools by year and grade level (elementary, middle, high, combination). Proficiency variables represent averages over 2004-5 through 2012-13 school-years.

Independent non and for-profit charter schools are compared by terms of student proficiency levels and year-over-year growth in math and reading in Table 2.3. Compared with students attending Florida public schools, independent non-profit charter school students are 0.05σ more proficient in reading and 0.15σ less proficient in math, though these differences are not significantly different from zero. In absolute terms, a 0.1σ difference represents about a 2 percentage point difference in the percentage of students who score as proficient at their grade level.[16] On the other hand, students attending independent for-profit charter schools are significantly less proficient on average as compared with both public and non-profit students. Student math proficiency in independent for-profits, for example, is 0.48σ below publics and 0.33σ below non-profits. Average proficiency growth is higher in independent for-profit charter schools.

Table 2.4: Comparisons of Public Schools and Network Charter Schools: Student Proficiency

	Public	Non-Profit	Diff†	For-Profit	Diff‡	Diff*
Reading z	-0.01	0.04	0.05	0.36	0.37***	0.32
Reading Δz	-0.01	0.05	0.06***	0.10	0.11***	0.05*
Math z	0.01	-0.26	-0.27	0.29	0.28***	0.55**
Math Δz	-0.01	0.10	0.11***	0.13	0.14***	0.03

Notes: † reports mean differences between non-profits and publics, ‡ between for-profits and publics, and * between for-profits and non-profits. *, **, and *** indicate statistically significant differences at the 10%, 5%, and 1% levels, respectively. Math and reading proficiency levels are normalized across all schools by year and grade level (elementary, middle, high, combination). Proficiency variables represent averages over 2004-5 through 2012-13 school-years.

Table 2.4 compares network charter schools in terms of student proficiency. Students attending network non-profit charter schools are not different statistically in proficiency levels than public students, though they display larger proficiency gains in both subjects. However, students attending network for-profits display much higher proficiency level. For instance, math proficiency is 0.28σ above publics and 0.55σ

[16] The school average proficiency in 2012-13 is about 57% for both math and reading.

above network non-profits for network for-profit charter schools. Average proficiency growth is also higher. Nonetheless, these differences in proficiency, including those summarized in the prior table among independent charter schools, may be fully accounted for by (observed and unobserved) differences in students served across charter types and sectors.

Table 2.5: Comparisons of Non and For-Profit Charter Schools by Network Status: Finances and Efficiency

	Independent			Network		
	Non-Profit	For-Profit	Diff†	Non-Profit	For-Profit	Diff‡
A. Finances ($ per pupil)						
Revenue	8,463	9,015	552	8,961	8,318	-643**
Expenses	8,314	8,857	543	8,801	7,740	-1,061***
Net Income	145	151	6.1	160	578	418***
Instructional	4,483	4,282	-201	3,901	3,533	-368**
Non-Instructional	3,845	4,488	643***	4,900	4,215	-685***
Investment	827	617	-210	501	1,731	1,230***
B. Efficiency Units						
Reading ω	0.02	-0.02	-0.04**	-0.00	0.06	0.06**
Math ω	-0.00	-0.05	-0.05***	-0.04	0.05	0.09***

Notes: † reports mean differences between independent for-profit and non-profits, ‡ between network for-profit and non-profits. *, **, and *** indicate statistically significant differences at the 10%, 5%, and 1% levels, respectively. Financial allocations represent per pupil amounts in 2012 dollars. All financial variables are averages over 2006-7 through 2012-13 school-years. Efficiency units are averages over 2006-7 through 2012-13 school years.

Table 2.5 compares charter schools by profit and network status in terms of finances and efficiency. On average, independent non-profits receive $8,463 in revenue and spend $8,314, which is modestly less (though not statistically so) from independent for-profits. For comparison, current expenditures of public schools in Florida per non-charter pupil for 2011-12 were $9,136 in total and $5,571 on instruction.[17] By these measures, the average Florida charter school spends both less overall and less on instruction on a per pupil basis than traditional public schools.[18] Traditional

[17] Figures gathered from the National Center for Education Statistics' Common Core of Data. In excluding expenditure on capital assets, the definition of current expenditure corresponds closely to expenses (though expenses also include depreciation).

[18] Note that the charter value represents an across school (and years) average rather than pupil-

public schools also allocate approximately 10% more of spending to instruction. This gap is commensurate with comparisons made in other contexts, including California where charters spend 8% less on instruction (Reed and Rose, 2015).[19]

Comparing among charter schools in Table 2.5, independent for and non-profits display generally similar financial allocations. The notable exception is that for-profits spend over $600 more per pupil per year on non-instructional expenses. On the other hand, network for and non-profit managed charters are significantly different in terms of finances. In particular, network for-profits spend over $1,000 less per pupil per year, which, despite lower revenues, translates into over $400 of net income per pupil on their balance sheets. It is important to keep in mind that this residuum is *net* of any management fee or payments to capital (ways a for-profit management organization might extract profits) and thereby represents network for-profits spending fewer resources over the school year. Network non-profits spend about $400 per pupil less on instruction and $700 less on non-instruction than network non-profits. The table also shows evidence that network for-profits invest more on average.

The lower panel of Table 2.5 compares charter schools in terms of efficiency, constructed by the normalized proficiency rate (for each subject) deflated by thousands of dollars in per pupil expenses. The comparisons highlight that the comparison between for and non-profit management depends considerably upon network status. For instance, as independent for-profit students attain much lower proficiency levels without significant differences in total expenses with non-profits, independent for-profits are relatively less efficient. The difference for math suggests that for the same level of per pupil expenses, independent for-profits achieve .05σ lower student proficiency. Among network charter schools, however, this association between efficiency

weighted.

[19] Likewise, 2006-7 National Public Education Financial Survey data show a 6% gap between charters and traditional public schools in the percentage of spending on instruction (Miron and Urschel, 2010).

and profit status is reversed: lower expenses combined with higher math proficiency levels indicate a significant efficiency premium in both subjects for network for-profit charter schools.

Nonetheless, numerous possible explanations – chiefly, the observed differences in student composition and other school characteristics – may account for the associations between outcomes, allocation of resources, and profit status. It may be, as an example, that differential student sorting across for and non-profit charters, perhaps stemming from locational differences, is associated with both proficiency levels and costs. The next section describes the empirical specification applied to net out the influence of these factors, which is then validated against matching and fixed effects estimates of charter school effectiveness.

2.4 Empirical Specification

While the comparisons presented in the prior section portray clear differences between charter school types, this section examines whether they remain unexplained by differences in observable characteristics. Allocation choices analyzed include expenses per pupil, *Exp/Pupil*, instructional expenses per pupil, *Instr/Pupil*, non-instructional expenses per pupil, *NonInstr/Pupil*, and investment per pupil, *Inv/Pupil*. The outcomes examined are gains in normalized proficiency levels, Δz, and reading and math efficiency, ω. Under assumptions discussed below, the results of this analysis evaluate predictions regarding the behavior of for and non-profit charters.

The empirical specification can be expressed as:

$$Y_{jt} = \alpha ForProfit_j + \gamma Network_j + \beta ForProfit_j \times Network_j + \theta X_{jt} + \upsilon_{jt} \qquad (2.1)$$

where Y_{jt} represents an outcome or allocation and X_{jt} the characteristics of school j at time t. As with the comparisons, the effect of for-profit status may differ by whether the school belongs to a network. X_{jt} includes the lunch status and demographic composition of students at school j, the HHI over the demographics groups, grade levels combinations offered, the logged age of the school, whether the school closes in year t, the percentage of eligible students taking the end-of-grade assessments, and whether the school reports specialization in ELL, dropout prevention, or vocational training. These latter characteristics are likely to capture important differences in costs and measured performance.

$ForProfit_j$ and $Network_j$ are indicators of for-profit and network status. Among charter schools not belonging to a network, α is the effect of for-profit management – the difference in Y_{jt} associated with for-profit as opposed to non-profit status for independent (non-network) charters. Similarly, $\alpha + \beta$ represents the effect of for-profit status for charter schools belonging to a network. The signs of these effects evaluate predictions about for-profit management: For example, if Y_{jt} is instructional expenses per pupil, then a negative sign provides evidence that for-profits cut costs on teaching and instruction. Likewise, when the dependent variable examined is efficiency units, a positive effect would suggest for-profits are more productive.

Estimation of (2.1) by ordinary least squares identifies the parameters on charter school type using residual average differences in the dependent variable. Applying a causal interpretation to the estimated effects, however, requires the assumption that any unobserved factors, subsumed into the error term υ_{jt}, are uncorrelated with both the treatment status and the outcome. This assumption is frequently referred to as "selection on observables." Proficiency gains provide an example why this may be unlikely to hold: while estimation of (2.1) might reveal that for-profit management is associated with higher achievement, this may be confounded by positive selection of students on ability, prior learning, or other unobserved dimensions into for-profit schools rather than differences in school quality. Similarly, charter schools may choose to locate near students who are efficient to educate.[20]

[20] In this regard, Singleton (2016a) presents evidence from Florida that charter schools underserve

This selection problem is ubiquitous to the literature evaluating charter school performance and has been addressed in a number of ways. For instance, lottery-based analyses compare students randomly lotteried-in to a charter school with those lotteried-out (Hoxby and Murarka, 2009; Abdulkadirolu et al., 2011; Tuttle et al., 2012; Angrist et al., 2013b). Other evaluation methods use matched student-school panels to apply either matching or fixed effect estimators (Bifulco and Ladd, 2006; Sass, 2006; Booker et al., 2007; CREDO, 2009; Ladd et al., 2015). Evaluations of for-profit operation of hospitals, on the other hand, have made use of ownership changes (Picone et al., 2002). As the data gathered for this project are school-level records where for-profit status remains fixed over the sample, these methods are unavailable.

Instead, to limit the influence of remaining unobservable factors, three modifications are made to (2.1). First, to proxy for unobserved student characteristics, the prior proficiency level, z_{jt-1}, is included in the estimation. This conditions the effects on proficiency gains on the prior level, while for expenses this absorbs additional variation in the cost of educating students due possibly to prior learning. Second, school district by year fixed effects, $\pi_d \times \lambda_t$, are inserted so that identification is based on within-district-year comparisons of schools.[21] Finally, using the Census tract data, the schools are binned into five quintiles based on the median household income of their Census tract and categorized as either above or below median density. These indicators, along with tract demographics and HHI, are also included as controls. The full specification can be written as:

$$Y_{jt} = \alpha ForProfit_j + \gamma Network_j + \beta ForProfit_j \times Network_j + \rho z_{jt-1} + \theta X_{jt} + \delta Z_j + \pi_d \times \lambda_t + \epsilon_{jt} \quad (2.2)$$

where Z_j represents the characteristics of j's location.

disadvantaged students for financial reasons through where they choose to locate.

[21] In the 2006-7 school year, 39 districts have at least one charter school in operation. Of those districts, the average number of charter schools is 5.5. For 2012-13, the average is about 10 charter schools each over 44 districts.

2.4.1 Validation

While the data prohibit applying student-level methods of evaluation to control for unobserved selection, estimates obtained from the empirical specification can be validated against them. As a result, this section uses the school-level panel assembled to evaluate charter school performance relative to traditional public schools. The results obtained are then compared with matching and fixed effects estimates from Florida for the same period. If the estimates of charter school effectiveness are commensurate, this validation test provides confidence in the empirical approach.

Davis and Raymond (2012) use student-level data from fourteen states and two districts to compare matching and fixed effects estimates of charter school quality. Matching and fixed effects deal with student selection in different ways. In matching, charter students are matched to a researcher-determined number of comparable public school students on observable dimensions, including prior test scores. The matched students then serve as controls for the charter school attendees, justifying causal inference if the matching procedure also eliminates unobservable differences.

By contrast, fixed effects estimators use students as their own control. The evaluation of charter school effectiveness is based on differences in learning gains when students switch between charter and traditional public schools. This method thus relies on students who transition, potentially compromising the generalizability of the estimates. Selection bias is eliminated, however, if the student unobservable is constant over time. Davis and Raymond (2012) find comparable effects across states using matching and fixed effects and present results from Florida for school years 2004-5 through 2007-8. For the same period in Florida, Ackerman and Egalite (2015) examine the matching methodology, also adopted in the CREDO (2009) evaluation, for robustness. The estimates from both papers are used for comparison.

To implement the validation, the equation specified in (2.2) is adapted to compare charters and traditional public schools in Florida in terms of gains in student proficiency:

$$\Delta z_{jt}^{k} = \beta Charter_j + \rho z_{jt-1}^{k} + \theta X_{jt} + \delta Z_j + \pi_d \times \lambda_t + \epsilon_{jt} \tag{2.3}$$

In this specification, β represents the treatment effect of attending a charter school on proficiency gains in subject k. This equation is estimated separately for math and reading for the same school years used by Davis and Raymond (2012) and Ackerman and Egalite (2015) (2004-5 through 2007-8). The sample for this estimation consists of 2,554 traditional public schools and 273 charters.[22]

The first columns of results Tables 2.6 and 2.7, labeled AE (2015), report the matching estimates of the charter school effect on math and reading respectively from Ackerman and Egalite (2015). Under heading DR (2012), the second two columns report the matching and fixed effect estimates obtained by Davis and Raymond (2012). The final four columns, labeled (1) through (4), present results of estimating variations of the empirical specification in (2.3) on the assembled school panel; (1) does not control for location characteristics or district by year fixed effects, while (3) includes both, and (4) adds years beyond those used for the validation.

For math achievement, displayed in Table 2.6, Ackerman and Egalite (2015) and Davis and Raymond (2012) report charter effects ranging from -0.038σ using student fixed effects to -.019σ by applying student matching. Estimating equation (2.3) on the school panel without district-year fixed effects or location characteristics produces an estimate, reported in column (1), of the effect of charter attendance of -0.058σ. While an underestimate of charter quality relative to the comparison estimates, this effect is of the same order of magnitude and direction. Further, even the larger matching estimates are well within the confidence interval. Controlling for location characteristics and district-year fixed effects attenuates the magnitude. Inserting

[22] Excluded from the sample are magnet, special education, and juvenile correction public schools.

Table 2.6: Comparing Estimates of Charter Effectiveness in Math

	AE (2015)	DR (2012)		(1)	(2)	(3)	(4)
Charter	-0.019***	-0.021***	-0.038***	-0.058***	-0.051**	-0.046**	0.003
	(0.002)	(0.002)	(0.002)	(0.021)	(0.021)	(0.021)	(0.016)
	Matching	Matching	FE	.	.	.	.
Sample Years			2005-08				2005-13
Loc. Char.	.	.	.	N	Y	Y	Y
District x Year FE	.	.	.	N	N	Y	Y
N	.	.	.	10,213	10,213	10,213	24,142

Notes: AE (2015) refers to Table 1 of Ackerman and Egalite (2015) and DR (2012) to Table 9 of Davis and Raymond (2012). Columns (1) through (4) report estimates and standard errors clustered by school from OLS regressions using changes in normalized math proficiency. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. All specifications control for student demographics, HHI, percentage of free or reduced-price lunch eligible students, grade level combinations, the percentage of students taking end-of-grade exams, and prior proficiency level. Location characteristics include the income quintile of the school location, an urban indicator, tract demographics, and HHI. (1) and (2) include district and year fixed effects.

both, as in (3), produces an estimate of -.046σ – very close to the Davis and Raymond (2012) fixed effect result. Lastly, the evidence from the full sample in column (4) suggests that charters have improved in effectiveness relative to traditional publics in recent years.

Table 2.7: Comparing Estimates of Charter Effectiveness in Reading

	AE (2015)	DR (2012)		(1)	(2)	(3)	(4)
Charter	-0.018***	-0.021***	-0.036***	-0.039*	-0.028	-0.028	0.015
	(0.002)	(0.002)	(0.003)	(0.020)	(0.020)	(0.020)	(0.012)
	Matching	Matching	FE	.	.	.	.
Sample Years			2005-08				2005-13
Loc. Char.	.	.	.	N	Y	Y	Y
District x Year FE	.	.	.	N	N	Y	Y
N	.	.	.	10,213	10,213	10,213	24,150

Notes: AE (2015) refers to Table 1 of Ackerman and Egalite (2015) and DR (2012) to Table 9 of Davis and Raymond (2012). Columns (1) through (4) report estimates and standard errors clustered by school from OLS regressions using changes in normalized reading proficiency. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. All specifications control for student demographics, HHI, percentage of free or reduced-price lunch eligible students, grade level combinations, the percentage of students taking end-of-grade exams, and prior proficiency level. Location characteristics include the income quintile of the school location, an urban indicator, tract demographics, and HHI. (1) and (2) include district and year fixed effects.

Table 2.7 repeats the validation exercise for reading achievement. Estimating equation (2.3) without the added controls yields an estimate of -0.039σ for the effect of charter attendance, shown in column (1). The causal effects obtained via matching and fixed effects are again within the confidence interval. This also holds when location characteristics and district by year fixed effects are included, as in (3). Like column (4) for math achievement, including all available years raises the estimate, suggesting recent improvement in charter performance relative to public schools in Florida.

Together, Tables 2.6 and 2.7 demonstrate that even with limited data, the estimation is able to reasonably reproduce causal effects of charter attendance in Florida on student achievement. As a result, the empirical specification can be applied with confidence to evaluating the performance of for and non-profit charters as well. Further, under the added assumption that the process of unobserved selection is the same, the specification can also be applied to charter schools' financial allocations choices and efficiency. These results are presented in the next subsection.

2.5 Results

This section presents the results obtained from estimating equation (2.2). The findings answer to what extent the differences between for and non-profit charters in allocation of expenses, student proficiency, and school efficiency documented in Section 3 can be explained by differences in school characteristics.

Three sets of dependent variables are of interest for this purpose. First, differences in spending allocations address whether for-profit charter schools operate at lower expenses per pupil, and whether they cut expenses on student instruction to do so. Second, differences in year-over-year gains in student proficiency address whether for or non-profits are more effective. In this case, the empirical approach validated for evaluating overall charter school effectiveness is simply applied to evaluating the relative effectiveness of for-profit (by network) charter schools. The third set of dependent variables examined are the "efficiency units," which represent quality given expenses. Differences in this measure enable separating competing explanations why for-profits spend less per pupil: greater efficiency or simply lower quality?

Using indicators, point estimates are obtained for independent non-profits, independent for-profits, and network for-profits, which are interpretable as differences from network non-profits (the excluded group). All models estimated include the same control variables: student body demographics and lunch status, HHI, grade levels served, the logged age of the charter school, the percentage of eligible students taking the end-of-grade assessments, self-reported specialties, and an indicator for closing. As discussed before, characteristics of each school's location (including income quantiles, an urban indicator, tract demographics and HHI), district by year fixed effects, and the prior year normalized student proficiency level are also included.[23]

2.5.1 Allocations

Table (2.8) presents estimates of the effects of for-profit management on schools' allocation of financial resources.[24] Turning first to a comparison among independent charter schools, as column (1) reports, for-profits' per pupil expenses do not differ statistically from independent non-profits. Column (2), however, reveals that, consistent with the raw comparisons, independent for-profits spend around 6% less per pupil on student instruction than independent non-profits. This implies, as (3) finds, that independent for-profits in turn spend more on non-instructional items. Moreover, independent for-profits invest less per pupil than independent non-profits.

While the results in Table (2.8) reveal that, among independents, for-profits spend roughly the same overall but less on student instruction, this finding is reversed when examining among network charter schools. As indicated by the results in column (1), network for-profits spend over 11% less per pupil than network non-profits. In other

[23] For the financial allocation variables, prior reading proficiency is conditioned on.

[24] All dollar amounts transformed to $\log(x+1)$.

Table 2.8: The Effect of For-Profit Management on the Allocation of Financial Resources by Network Status

	(1) log *Exp/Pupil*	(2) log *Instr/Pupil*	(3) log *NonInstr/Pupil*	(4) log *Inv/Pupil*
Independent Non-Profit	-0.043*	0.119***	-0.246***	0.433
	(0.025)	(0.032)	(0.065)	(0.306)
Independent For-Profit	-0.055*	0.055	-0.183***	-0.201
	(0.030)	(0.035)	(0.055)	(0.354)
Network For-Profit	-0.113***	-0.054	-0.191***	0.521
	(0.030)	(0.040)	(0.046)	(0.338)
Loc. Char.	Y	Y	Y	Y
District x Year FE	Y	Y	Y	Y
N	1,741	1,741	1,721	1,645

Notes: Each column reports estimates and standard errors clustered by school from OLS regressions using the variable in the column heading as the dependent variable. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. All specifications control for student demographics, HHI, percentage of free or reduced-price lunch eligible students, grade level combinations, the age of the school, the percentage of students taking end-of-grade exams, ELL, dropout, vocation, whether the school closes that year, prior reading proficiency level, the income quintile of the school location, an urban indicator, tract demographics and HHI, and district by year fixed effects. *Exp/Pupil* represents expenses per pupil, *Instr/Pupil* instructional expenses per pupil, *NonInstr/Pupil* non-instructional expenses per pupil, and *Exp/Pupil* investment per pupil. Dependent variables transformed to $\log(x + 1)$.

words, even after controlling for differences in school characteristics, network for-profits spend substantially less than network non-profits. While the results in (1) indicate that network for-profits in fact use fewer resources, (2) examines if those cuts are made on student instruction. The results reveal no statistically significant difference with network non-profits. As revealed in column (3), network for-profits spend substantially less (around 19%) on non-instructional expenses, such as school administration, than network non-profits. Finally, there is also some evidence in (4) that network for-profits invest more than network non-profits, but this difference is not statistically significant.

Table 2.9: The Effect of For-Profit Management on Student Proficiency and Efficiency by Network Status

	(1) Reading Δz	(2) Math Δz	(3) Reading ω	(4) Math ω
Independent Non-Profit	0.024	0.036	-0.002	0.001
	(0.047)	(0.067)	(0.008)	(0.011)
Independent For-Profit	-0.071	0.002	-0.001	0.003
	(0.054)	(0.080)	(0.008)	(0.012)
Network For-Profit	0.069	0.099	0.027***	0.029**
	(0.052)	(0.068)	(0.010)	(0.013)
Loc. Char.	Y	Y	Y	Y
District x Year FE	Y	Y	Y	Y
N	2,164	2,156	1,741	1,733

Notes: Each column reports estimates and standard errors clustered by school from OLS regressions using the variable in the column heading as the dependent variable. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. All specifications control for student demographics, HHI, percentage of free or reduced-price lunch eligible students, grade level combinations, the age of the school, the percentage of students taking end-of-grade exams, ELL, dropout, vocation, whether the school closes that year, prior proficiency level, the income quintile of the school location, an urban indicator, tract demographics and HHI, and district by year fixed effects.

2.5.2 Outcomes

The results in Table 2.9 compare charter school types in terms of student proficiency gains and efficiency. Columns (1) and (2) reveal that, relative to independent non-profits, independent for-profits raise student proficiency around 0.09σ less in reading, a statistically significant difference, and 0.03σ less in math. For comparison, these gaps meet or exceed the average effectiveness gap between all charter schools and traditional public schools in Florida, but recall even a 0.1σ increase in absolute terms represents about a modest 2 percentage point increase in the percentage of students who score as proficient at their grade level.[25] Thus, for independent for-profits, lower instructional spending appears to also be associated with lower gains in student performance after conditioning on school characteristics. Columns (3) and

[25] The school average proficiency in 2012-13 is about 57% for both math and reading.

(4) examine relative efficiency, measured by the ratio of student proficiency to total school expenses. Thus, these specifications also control for expenses per pupil. On this score, independent for-profits and non-profits are statistically indistinguishable, indicating that the relative gains in student proficiency for independent non-profits are not accompanied by savings in per pupil expenses.

By contrast, columns (1) and (2) reveal that, relative to network non-profits, network for-profits increase student proficiency around 0.069σ in reading and 0.099σ in math relative to network non-profits. However, these differences cannot be rejected as different from zero. Columns (3) and (4) examine differences in efficiency. For network charter schools, the large differences in expenses found in Table 2.8 translate into a considerable efficiency advantage: For an equivalent level of per pupil expenses, network for-profits are associated with 0.027σ and 0.029σ higher student proficiency in math and reading respectively after controlling for differences in school characteristics. Notably, this efficiency premium for network for-profits exists in comparison with independent – for or non-profit – charter schools as well.

2.5.3 Networks and Selection

The prior section presented findings that network for-profits are more efficient than other charter schools types even after conditioning on differences in school characteristics. This section examines the mechanism behind this result. In general terms, there are two reasons network for-profits may be more efficient. First, expansion of the charter school network may generate efficiency at existing schools in the network. Such a "treatment effect" would be due to the ability of the network to leverage greater scale economies with size by, for instance, sharing administrative costs across additional schools. On the other hand, the most efficient for-profit charter schools might simply expand into networks. In this case, it is not network economies that lead to the association with efficiency, but selection.

Examining within-charter school variation in efficiency associated with network expansion allows for evaluating these explanations. This is accomplished by constructing a variable for the size of the charter network and including charter school fixed effects in the empirical specification:

$$\omega_{jt} = \beta \log \mathit{Network\ Size}_{jt} + \gamma \mathit{ForProfit}_j \times \log \mathit{Network\ Size}_{jt} + \rho z_{jt-1} + \theta X_{jt} + \pi_d \times \lambda_t + \mu_j + \epsilon_{jt} \quad (2.4)$$

The dependent variable is efficiency. Note that while the charter school fixed effects, μ_j, absorb the profit status indicator (such that differences in efficiency levels are not identified), β and γ are identified by the association of within-school changes in network size with changes in efficiency.[26] One interpretation of this association is network economies, which may be different for non and for-profits. A complementary way to view this test is the inclusion of the charter school fixed effects controlling for schools' unobserved productivity. Thus, if apparent network economies vanish when the fixed effects are included, this provides evidence that the prior findings are driven by selection rather than treatment. The estimation is performed for math and reading efficiency.

The results of estimating (2.4) for math and reading efficiency are displayed in Tables 2.10 and 2.11 respectively. Column (1) applies OLS and does not include any interaction between profit status and network size. In column (2), the size of the network that a charter school belongs to is interacted with its profit status. For schools not affiliated with another charter school, the network size is by definition 1. The results are consistent with columns (3) and (4) of Table 2.9: the interaction between network size and for-profit is significant and positive, indicating higher efficiency (in the cross section) for those charter schools.

[26] One possible limitation of this test is that network size is defined only within Florida although some networks make operate in multiple states.

Table 2.10: The Effect of Network Size by Profit Status on Math ω

	(1)	(2)	(3)
For-Profit	0.012	-0.004	
	(0.008)	(0.009)	
Log Network Size	0.004		
	(0.004)		
Non-Profit * Log Network Size		-0.005	-0.040
		(0.004)	(0.025)
For-Profit * Log Network Size		0.011*	0.005
		(0.006)	(0.017)
Loc. Char.	Y	Y	Y
District x Year FE	Y	Y	Y
School FE	N	N	Y
N	1,733	1,733	1,733

Notes: Each column reports estimates and standard errors clustered by school from regressions using the variable in the column heading as the dependent variable. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. Specifications (1) and (2) control for student demographics, HHI, percentage of free or reduced-price lunch eligible students, grade level combinations, the age of the school, the percentage of students taking end-of-grade exams, ELL, dropout, vocation, whether the school closes that year, prior proficiency level, the income quintile of the school location, an urban indicator, tract demographics and HHI, and district by year fixed effects. Specification (3) includes school fixed effects, which absorb the location characteristics.

The test for selection or treatment is applied in column (3) with the inclusion of school fixed effects. For both math and reading efficiency, the results show that within-charter school changes in network size are not associated with any statistically significant changes in efficiency of for-profit managed charter schools. In other words, for-profits do not appear to become more efficient as they expand. The estimates support the interpretation of the significant cross sectional efficiency differences as stemming from selection by efficient for-profits into networks.

While the results in Tables 2.10 and 2.11 do not find evidence of network economies for for-profits, column (3) of Table 2.11 does display evidence of network

Table 2.11: The Effect of Network Size by Profit Status on Reading ω

	(1)	(2)	(3)
For-Profit	0.012**	-0.005	
	(0.006)	(0.007)	
Log Network Size	0.004		
	(0.003)		
Non-Profit * Log Network Size		-0.006**	-0.037**
		(0.003)	(0.018)
For-Profit * Log Network Size		0.011**	0.007
		(0.005)	(0.014)
Loc. Char.	Y	Y	Y
District x Year FE	Y	Y	Y
School FE	N	N	Y
N	1,741	1,741	1,741

Notes: Each column reports estimates and standard errors clustered by school from regressions using the variable in the column heading as the dependent variable. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. Specifications (1) and (2) control for student demographics, HHI, percentage of free or reduced-price lunch eligible students, grade level combinations, the age of the school, the percentage of students taking end-of-grade exams, ELL, dropout, vocation, whether the school closes that year, prior proficiency level, the income quintile of the school location, an urban indicator, tract demographics and HHI, and district by year fixed effects. Specification (3) includes school fixed effects, which absorb the location characteristics.

*dis*economies for non-profit managed charters. Non-profits network expansion is associated with lower efficiency in reading. The point estimate implies that expanding the non-profit network by 100% is associated with about a $.037\sigma$ reduction in math efficiency units at each of the network's pre-existing schools. Given that the cross sectional differences uncover little to no discernible efficiency differences between independent and network non-profits, these results suggest this is partly because the network non-profits expanded.

2.6 Discussion and Conclusions

As the charter school sector has evolved over the past 20 years, so has the organization and management of charter schools. Nowhere is this better represented than in Florida. One aspect of charter school management that has attracted recent attention is for-profit management. This chapter documents differences between non and for-profit managed charters and begins to provide empirical evidence on the effects of for-profit management on the allocation of schools' financial resources, student proficiency, and school efficiency.

The results portray a sharp contrast in the comparison of non and for-profit status that depends on whether the charter school belongs to a network of affiliated schools. Among independent or non-network charters, for-profit and non-profit schools look very similar in terms of their location and student characteristics. Moreover, this similarity extends to how much they spend per pupil. The regression results reveal, however, that there are clear differences in the way independent for and non-profits allocate their spending. For-profits spend about 6% less on instruction per pupil, representing 3% less of their total expenses. Further, students attending independent non-profits achieve larger gains in proficiency. As a result, these findings appear to bear out the concerns of parent and policymakers about for-profit management.

This conclusion is reversed among charter schools that belong to a network. Network non and for-profits serve markedly different student populations, with Hispanic students constituting the majority in network for-profits and a significantly higher percentage of students participating in subsidized lunch. The regression analysis reveals slight evidence that students attending network for-profits achieve larger proficiency gains. While the results indicate that network for-profit schools spend over 11% less overall per pupil, expenses on student instruction are not being cut relative to network non-profits. Together, these differences translate to a significant efficiency advantage that holds relative to all other charter school types. Even after controlling for differences in school characteristics, an equivalent level of per pupil expenses buys about 0.03σ higher student proficiency in math and reading at network for-profits. While some possibility remains that unobserved differences in the student populations may explain these residual premia, it is worth emphasizing that network for-profits appear to be negatively selected on observables.

To understand the mechanisms driving the cross-sectional differences, within-school variation is leveraged to examine the association between changes in network size and changes in efficiency. The results suggest that, rather than network economies, the efficiency premium stems from the most efficient for-profit charter schools expanding into networks. The findings therefore suggest that for-profit schools are able to economize without compromising student education. In turn, the recent growth of for-profit networks in Florida can be viewed as the product of efficient operation.

At the same time, the results show that network expansion is associated with declines in efficiency for non-profits, a diseconomy that may be due to how non-profit networks expand. If non-profits pull resources from existing schools, such as personnel or financial resources because of poorer access to capital, it might be difficult to maintain efficiency. Differences in organizational objectives could also explain the efficiency reduction. For instance, for-profit organizations often have a stronger or better defined set of goals, which may be accompanied by an orientation towards growth. Non-profits may instead expand their networks for reasons related to their organizational mission despite the costs.

This research suggests several avenues for future research. One is applying standard techniques for causal inference with student-level records, such as matching or fixed effects, to evaluate the effectiveness of for-profit charter schools. In states where recent policy changes have impacted for-profit management, before and after comparisons of spending and outcomes may also prove fruitful. Additionally, this study has focused on just a subset of the decisions made by charter schools. The results also highlight the need for improved understanding of charter school management structures and how charter schools networks grow and expand.

The challenges of charter school reforms can often be understood as balancing public accountability with private incentives. This tension is equally at play regarding the management of charter schools by for-profit organizations. Faced with the difficulty of monitoring how charter schools use taxpayer resources, many jurisdictions have responded by disallowing for-profit management. The immediate policy implication of these findings, however, is that for-profit management is not in and of itself problematic. In institutional environments where competition effectively disciplines behavior, a profit incentive may generate cost efficiencies that may be all the more important for replicating charter schools. One way policy can potentially foster this discipline is through tracking and publicly reporting charter schools' financial performance and allocation of resources.

3

Incentives and the Supply of Effective Charter Schools

3.1 Introduction

School choice reforms aim to improve school quality while expanding educational opportunity. In the United States, charter schools have become the primary vehicle for school choice, with a number of recent papers finding compelling evidence that charter schools are effective at improving student outcomes (Hoxby and Murarka, 2009; Abdulkadirolu et al., 2011; Angrist et al., 2013b; Dobbie and Fryer, 2013b). These findings have bolstered recent policy momentum behind charter schools, such as the Obama Administration's Race to the Top, which is based in part on the belief that removing barriers to expansion will lead new, high-performing charter schools to serve underserved student populations.

Two common institutional features of the charter sector call this belief into question, however. First, charter schools, which are publicly funded but privately run, are typically funded by formulas that provide the same amount for all students regardless of advantage or need. Second, although charter schools are unable to screen students, they are differentiated by where they choose to locate and, due to travel costs, serve student compositions that reflect local demographics. Taken together, these features raise the question whether the current approach to funding skews the distribution of students served by charters towards low-cost student populations.

To answer this question, I develop and estimate an empirical model of charter school supply and competition. The estimated model allows me to study counterfactual funding policies, in particular a formula that ties revenue to the characteristics of students, in terms of equilibrium sector outcomes. In the model, charter schools choose a location in a school district based at least partly on expected revenues, which depend on enrollment and the per-pupil funding rate, and costs. As variable costs depend on the composition of students served, the flat formula potentially presents a strategic incentive to spatially "cream skim." At the same time, due to competition with public and other charter schools for students, the location choices of charter schools are mutually dependent in the model. I thus adapt the structure of an incomplete information entry game.

This research design requires an institutional setting where the location choices of charter schools reflect their competitive and financial incentives and where those incentives can be measured. In this regard, Florida, which is characterized by limited authorization discretion for districts and an accordingly high charter penetration rate, is especially well-suited. I assemble a unique dataset that links detailed financial records gathered from independent audits filed by all Florida charter schools with student performance on end-of-grade exams and school characteristics. I estimate school effectiveness at raising student achievement from the panel of student test scores, while the financial statements enable me to separate cost from demand-side reasons for a charter school's choice of location in the data.

I use the empirical model to evaluate the effects of funding policies on the composition of students served and the aggregate effectiveness of the charter sector. This latter outcome, which is sensitive to competitive incentives, is important for capturing a key policy tradeoff: funding policies that raise equity may do so by sustaining ineffective charter schools in the market. Three policy simulations are of interest: First, a cost-adjusted funding formula that ties revenue to student characteristics corrects the financial incentives to skim. I use this counterfactual to answer whether the current funding approach has unintended consequences. Second, targeted grants for entry into underserved markets may also incentivize charters to serve disadvantaged student populations. Lastly, a general increase in the per-pupil funding rate quantifies the elasticities of charter school supply and effectiveness with respect to funding. The predictions thus shed light on the value of expanded social investment in charter schooling.

Estimation of the model presents a number of empirical challenges. In a first step, I estimate the incentive structure of charter school operation, shaped by demand and variable costs, from the data. To do so, I recover school effectiveness, which shifts household demand, from the test score panel. On the cost side, I link effectiveness with charter school expenditures, obtained from the audits, to estimate variable costs as a function of location and student characteristics. Finally, treating charter schools as not-for-profit maximizers, I leverage revealed preference with their location and operation choices in the entry game to uncover how charter schools respond to competitive and financial incentives. As the entry model contains a large state space due to heterogeneity in effectiveness and a large number of locations for entrants to choose from, I implement a computationally light, two-stage estimator that uses choice probabilities estimated semi-parametrically offline.

The policy simulations reveal evidence that the flat funding formula leads charter schools to underserve disadvantaged student populations. Implementing a cost-adjusted funding formula yields about an 8% increase in the share of subsidized lunch student and a 10% increase in the share of black students attending charter schools. In addition, because the charter schools sustained in the market by this policy change are not low effectiveness schools, this gain in equity is associated with little change in the aggregate effectiveness of the charter sector. By comparison, a location targeted start-up grant successfully shifts the location choices of new charter schools to underserved areas, but yields little net change in outcomes. Furthermore, though the total number of charter schools predictably increases, aggregate effectiveness responds only marginally due to an overall increase in charter school funding. This reinforces the general finding that gains in access to school choice do not appear costly in terms of the quality of charter schooling.

These findings are important as they are informative about school choice policy. In particular, a mismatch between funding and costs may generate significant inequities in access to and benefits from school choice. This point, which is largely unrecognized in both the existing literature on education markets and ongoing policy debate, has potentially broad implications for the design of school choice programs. The findings also underscore that funding policy, an element of both private school voucher and charter school programs, may provide an effective policy instrument for directing competition via supply-side incentives.

The remainder of this chapter is organized as follows. In the next section, I situate the chapter in the relevant literature. In Section 3, I describe the institutional setting of charter schooling in Florida and data sources in detail. I present the empirical model in Section 4. Section 5 then discusses estimation and identification of the model before I turn to the results, including estimates and counterfactual simulations, in Section 6. I conclude in Section 7.

3.2 Related Literature

School choice reforms embody two policy ambitions. The first is to enhance the quality of public education. Mechanisms supporting this include both direct access to better school alternatives for students and improvements in school quality stimulated by competition. The second ambition is to expand educational opportunities for underserved students. The growing empirical literature, which combines evidence from international and domestic school choice programs (often private school vouchers and charter schools, respectively), can be viewed as attempts to asses the ability and conditions under which school choice policies may fulfill these ambitions.

A major strand of literature evaluates the effectiveness at improving student outcomes of school alternatives supported by school choice. Examples include evaluations of private schools and voucher programs, which in general find positive effects of private school attendance.[1] Evaluations of charter schools typically rely on either student-level administrative data or on admissions lotteries. Papers that estimate charter school effects from changes in exam performance for students who switch between sectors find largely mixed results overall (Sass, 2006; Hanushek et al., 2007; Booker et al., 2007).[2] On the other hand, lottery findings provide compelling evidence of improvement in student outcomes (Hoxby and Murarka, 2009; Abdulkadirolu et al., 2011; Angrist et al., 2013b; Dobbie and Fryer, 2013b), and the benefits of charter school attendance appear highest for students from disadvantaged backgrounds (Angrist et al., 2012, 2013a).[3] These findings have motivated policy efforts to expand charter schooling.

Charter expansion, though, raises questions about the role of competition in education markets. To the degree that households value school quality, school choice

[1] In the U.S. context, a number of authors have examined the effectiveness of Catholic private schools (Neal, 1997; Altonji et al., 2005). International evidence, relying on lottery designs, finds largely positive impacts of attending private schools (Angrist et al., 2002, 2006; Muralidharan and Sundararaman, 2015).

[2] Similarly, CREDO (2009) uses matching techniques with student level-data from fifteen states and D.C., finding considerable heterogeneity in average charter quality.

[3] Beyond school outcomes, papers using both methods have also examined medium and longer term impacts, such as college completion and labor market returns. See Epple et al. (2015) for a recent review.

provides competitive incentives intended to enhance the quality of public education. This rationale, for instance, is explicitly written in to a number of charter laws, including Florida's. One mechanism for this may be that school choice induces government and public schools to improve. Neilson (2013), for example, studies an expansion of a private school voucher program in Chile, finding an increase in the quality of public schools in response. Papers examining the competitive effects of charters on public school quality, on the other hand, do not find unambiguous results.[4] Competition may nonetheless discipline the quality of school choice alternatives. Baude et al. (2014) present evidence of improvements in charter school quality in Texas over a ten-year period due to the exit and replacement of low-performing charter schools.

At the same time, scholars have long recognized the potential for school choice policies to generate inequities, compromising the second ambition. While households choosing schools based on characteristics other than school quality will tend to weaken competitive incentives, heterogeneity in prefereneces may also lead to stratification (Hastings et al., 2006; Bayer et al., 2007). Weiher and Tedin (2002) present evidence that racial composition predicts households' choice of charter school and Bifulco and Ladd (2007) attribute widening black-white achievement gaps to sorting along racial lines. Such patterns raise the question whether differences across households in the exercise of school choice enable resegregation of education.[5] Moreover, how households choose schools and the extent to which preferences for quality vary have supply-side implications that may cut against policy goals. Walters (2014) presents evidence from Boston that although disadvantaged students are most likely to benefit from charter schools, they are significantly less likely to apply and attend.

[4] For example, Sass (2006), Booker et al. (2008), and Winters (2012) report positive, if modest, effects, but Bettinger (2005), Bifulco and Ladd (2006), and Zimmer and Buddin (2009) find no competitive effects. Using an IV strategy to overcome endogenous charter location, Imberman (2011) finds mixed or even negative effects.

[5] More recently, Ladd et al. (2015) show that apparent improvements in charter school performance in North Carolina may be driven primarily by positive student selection.

The role of costs in shaping outcomes remains largely neglected by both of these strands of literature, however. Costs, which influence the supply of school choice alternatives, are important for two reasons: First, fixed costs of entry may undermine competitive incentives by, for instance, leading to excessive or insufficient entry (Spence, 1976; Dixit and Stiglitz, 1977; Mankiw and Whinston, 1986). School choice is only effective if school alternatives are available and underperforming schools face competitive pressure. Second, costs may be an independent source of disparities in education outcomes by generating inequities in access to school choice.[6] With differences in the cost of providing education to disadvantaged students (Duncombe and Yinger, 2005), such inequities may stem from program funding that provides the same amount for all students. In recognizing and quantifying the effects of this incentive, this chapter thus has parallels with the literature on cost-based cream skimming in health care markets (Ma, 1994; Currie and Fahr, 2005) and advances the literature on estimation of education costs by linking cost differentials to school behavior and the design of school choice policy (Downes and Pogue, 1994).[7]

In this chapter, I estimate the full cost structure of charter schools, which includes entry costs and cost differences across student populations. The empirical entry model I develop then allows me to connect education market equilibrium outcomes with funding policy through charter schools' strategic location choices. In adapting these methods to my setting, the chapter fits into the growing empirical literature using these methods to analyze policy questions (Berry and Reiss, 2007). Limited prior work has examined the determinants of charter school supply and location, such as Glomm et al. (2005) and Hoxby (2006), but these studies take a descriptive appro-

[6] On this point, Denice and Gross (2016) find that apparent differences across demographics in preferences for academic performance are explained by differences in nearby supply.

[7] Relatedly, targeted private school vouchers have been studied as a means of minimizing cream skimming due to peer-based externalities in education production (Nechyba, 2000; Epple and Romano, 2008).

ach that does not permit studying counterfactual policy changes. In work closest to my apporach, Ferreyra and Kosenok (2015) model demand for and entry of charter schools in Washington D.C., finding prospective welfare benefits of expansion, but do not model or consider the implications of strategic behavior by charter schools.[8]

3.3 Background and Data

I describe the institutional background of charter schooling in Florida in this section to highlight the features that make it well-suited to studying charter school supply and competition. In particular, Florida, by limiting the authorization discretion of school districts, provides a setting in which charter schools' entry and location choices reflect their competitive and financial incentives and where those incentives can be measured. This allows me to develop an empirical model that links the entry and location choices of charter schools observed in the data to study counterfactual funding policies.

The unique dataset I assemble combines detailed records gathered from financial audits filed by all Florida charter schools with student performance on end-of-grade exams and school characteristics. The merged panel facilitates estimating cost differentials across student populations from the relationship between expenditures, student composition, and gains in student achievement across charter schools. In addition, school locations are key as a choice variable for charters and for calculating the spatial distances between schools.

After describing the data sources for the panel, which tracks charter schools between the 2007-8 and 2012-13 school years, I present summary statistics. I focus the analysis on elementary schools where, due to transportation costs, cream-skimming incentives are likely to be particularly salient. The data reveal that charter schools

[8] Also related, Mehta (2012) models competition between charters and public schools in North Carolina, including strategic response by public schools, but does not incorporate student heterogeneity nor consider its supply-side implications for policy.

that exit the sample serve 21 percentage point higher subsidized lunch and 37 percentage point higher black student bodies than those that survive. At the same time, exiters also spend over $900 more per student per year and display much lower student achievement levels on end-of-grade exams. These stylized facts motivate the empirical model.

3.3.1 Charter Schooling in Florida

Laws authorizing charter schools aim to strike a balance between operational autonomy and accountability. For instance, charter schools are generally granted considerable independence in terms of curricular design and focus, human resources, and choice of location. To ensure equity, however, charter schools may not screen students or apply any admissions criteria, such as tuition or entrance exams. If a charter school is oversubscribed, an admissions lottery must be held to randomly allocate places in the school. Further, charter schools are not exempt from state accountability and reporting requirements. Florida charter schools, for example, must participate in the School Grades program which assigns letter grades to schools based on student performance on end-of-grade exams.[9] While accountability provisions require intervention in cases of persistently poor performing charters, instances of forced shutdown are relatively rare. A Center for Education Reform report, for example, found that just 18% of charter closures nationally were attributable to academic reasons (Consoletti, 2011).

Although the level varies by state or district, charter school funding typically provides the same amount for all students served by a school. For example, Florida charter schools receive per-pupil disbursements through the Florida Education Finance Program (FEFP) according to a statutory formula. A base funding rate for each full-time equivalent student is multiplied by a district cost differential and

[9] The School Grades program accounts for both achievement and learning gains.

totaled. While additional adjustments are made for disabled and English language learner students, charter school enrollment of these student populations is low.[10] This funding source may be supplemented by federal programs, such as Title 1, other state sources, or private contributions, but the FEFP program provides the vast majority of operating support for charter schools.[11] The implication of this is that two charter schools serving students with different educational needs or advantages, but located in the same school district, will receive largely the same per-pupil support.

Charter schools are authorized by public school officials. In this regard, Florida's distinctive institutional environment provides a number of advantages for studying charter school supply and competition. First, in contrast with a number of other settings such as Massachusetts and Washington D.C., caps on the number of schools are not permitted. Second, school districts, which are contiguous with Florida counties, retain sole authorization responsibility. This ensures that, for relatively large and reasonably well-defined education markets, authorization standards are uniform.[12] Finally, Florida statutes spell out the criteria that school districts may apply in reviewing applications. A prospective charter school must outline its guiding principles and objectives, an innovative curriculum plan that meets state requirements for reading instruction, and a financial plan. This authorization process thus differs dramatically from other settings. A prospective new charter school in Massachusetts, for example, competes with a number of other applicants for authorization and is vetted based upon perceived need and expected success. In contrast, Florida's insti-

[10] The median charter school's student body is around 9% disabled and just 3% English learners in my sample. This compares to 14% and 5% respectively for the median public school in Florida.

[11] Charter schools may receive capital funding in Florida and apply for state grants, but these account for little of operational revenues. Florida school districts are not required to share local revenues with charters and almost all do not. However, because Florida's school finance system is largely centralized through FEFP, charters are less disadvantaged in funding relative to public schools than in many other states.

[12] In general, students may only attend in-district charters. A limited number of conversion, municipal, and university-authorized lab charter schools operate in Florida.

tutional environment provides a setting in which charter schools' entry and location choices can be viewed as reflecting revealed preference.

The combined effect of Florida's charter-friendly environment is a vital charter sector, characterized by both rapid growth and significant turnover. The first Florida charter schools opened for the 1996-7 school year. Since then, the sector has expanded into one of the largest nationwide in both enrollment terms and the number of charter schools. For the 2014-15 school year, 646 charter schools served over 8% of all Florida public school students, including more than 13% in Broward and Miami-Dade counties. In addition to the high penetration rate of charter schooling in Florida, there is a great deal of entry and exit. For instance, 75 new charter schools schools opened just for the 2013-14 school year, while 38 shut down and closed.

3.3.2 Data Sources

I combine newly collected data financial records for Florida charter schools with existing data on all Florida public schools. Per Florida statute, all charter schools must file an independent financial audit with their district and the state for each year of operation. Containing revenue, itemized expenditures, assets, and capital investment, the audits richly characterize the spending patterns and financial health of each charter school. I gathered and digitized all audits on file with the Auditor General for the 2006-7 through 2012-13 schools years. As a source of financial data, the audits provide two added advantages (beyond their availability): (1) the audits correspond to an individual school year rather than a fiscal year; and (2) an audit must be filed for each individual school.

I use reported total expenditures to measure the variable costs of charter school operation in a given year.[13] These costs therefore include salaries paid to teachers, staff, and administrators, facility rent or mortgage payments, and any management

[13] I subtract out large capital purchases, such as outlays for buildings or facilities.

fee paid, among other expenses incurred during a school year. In using expenditures to measure variable costs, two points of clarification are important: First, these expenditures represent variable costs in that they reflect annually adjustable input purchases and exclude the opportunity costs of entering the market and of operation (which inherently cannot appear on an accounting statement). As explained later, such sunk or fixed "costs" are identified from the entry and continuation decisions of charter schools. Second, the expenditures reported in the audits are not necessarily costs at the frontier (i.e. the costs that would be incurred were a charter school fully efficient). Rather, the expenditures embed any allocative inefficiency, presenting a challenge for identification.

Three data sources provide information about the characteristics of Florida charter and public schools. First, I obtain enrollment, grade level, and student body characteristics for all schools from the National Center for Education Statistics' Common Core of Data for the 2006-7 through 2013-14 school years.[14] I define a school as open (i.e. operational) if enrollment in any primary grade (K through 5) is positive and calculate the number of years since opening for each charter school. Second, I merge these records with the Florida Department of Education's master school database. This database is used to identify schools as a charter school or not per state records and to obtain each school's exact address.[15] The last data source for school characteristics pertains to their locations and spatial relationship. I geocode the school addresses to 2000 Census tracts, for which I obtain American Community Survey estimates of the local demographics.[16] This is important as it allows me to

[14] For grade-level demographics, subsidized lunch, English language learner, and disabled status, I supplement these data with FCAT Demographic Reports.

[15] A limitation of this data source is that only the present address of charter schools is recorded, so I do not observe moves or model charter school location changes.

[16] I use 5-year Census tract estimates for 2005-9 through 2009-13, treating the middle year as corresponding to the spring of that school year. I impute data for 2012 and 2013. I then calculate location characteristics within a given distance of each Census tract using distances between

relate the composition of each school's student body to the composition of the tract where it is located. The spatial distances between tracts also allow me to identify each school's set of competitors.

Finally, in order to connect effectiveness at increasing student achievement with the expenditures and characteristics of charter schools, I obtain summaries of student achievement by school and grade on end-of-grade Florida Comprehensive Assessment Tests (FCAT) from the Florida Bureau of K-12 Assessment for years 2006-7 through 2013-14. Students attending charter and public elementary schools in grades 3 through 5 are examined in math and reading. For each tested grade in a given year, the data contain both the average current score and average prior year's score by grade and school for the set of students for whom records for both years are available.[17] Since testing begins in the third grade, I use only fourth and fifth grade performance to have a measure of prior learning for all grades. These score averages, which I normalize across schools within grade and year, allow me to estimate the effectiveness of each school at raising student achievement. I describe the specification and estimation of education production fully later.

My final merged panel tracks 341 charter elementary schools in Florida between the 2006-7 and 2012-13 school years. I restrict the sample to non-conversion and non-municipal charter schools, charter schools that are not a virtual school or laboratory school, and charter schools not specialized in serving disabled student populations. 193, or 57%, of the charter schools began operation during the 7 year sample period, while 67 (20%) exit at some point. The median charter school is tracked for 4 the school years.[18] Included in the sample are also traditional public elementary schools

centroids and population weights.

[17] Importantly, the prior scores may have been obtained at another public or charter school if a student switched schools.

[18] I am able to match expenditure data for 92% of charter school-year observations. The match rate is particularly low in the school year that a charter school closes, however.

in Florida.

3.3.3 Data Summaries

In this subsection, I present a series of stylized facts about charter schools in Florida drawn from the sample. To begin with, I compare public and charter schools in Florida in terms of location and student characteristics in Table 3.1. The literature indicates that charter schools in general tend to serve more urban areas and minority student populations (Epple et al., 2015), which suggests that concerns about charter schools underserving disadvantaged students may be largely misplaced. Rather than a simple cross-sectional summary, however, I focus the comparison on charter and public schools that are located in the same school district.[19] The comparisons in Table 3.1 paint a different picture: charter and public school demographics are nearly indistinguishable within school district. In fact, Florida charter schools actually operate in less dense locations and serve a slightly larger share of students who are non-minority on average than the public schools in the same district.[20]

To motivate the empirical model, I next use the assembled dataset to compare charter schools that exit during the sample with charter schools that persist (i.e. are either open in 2007-8 or open at some point after, but do not exit by 2012-13). To do this, I use the full panel to compute conditional averages for exiter and persister charter schools and test for statistical differences.[21] A first observation is that the summaries, presented in Table 3.2, show a close relationship between the characteristics of charter schools' locations and the characteristics of students they

[19] To do this, I regress each variable on district fixed effects, then use the residual (plus the constant for Palm Beach) for the comparisons. In the Appendix, I provide summaries for just charter schools in the 2012-13 school year.

[20] While charters also serve a lower share of students who are eligible for subsidized lunch, this likely reflects in part differences in participation and takeup across the two sectors.

[21] Specifically, I regress each variable on indicators for exiter, persister, and entrant, age, dummies for the year a school enters or exits, and year fixed effects.

Table 3.1: Within-District Comparison of Public and Charter School Characteristics, 2012-13

	Publics	Charters
Location Characteristics		
Density	3,092	2,613
Household Income	68,775	66,453
% White	47.01	45.62
% Black	27.13	25.63
% Hispanic	22.31	25.36
% Asian	2.10	2.10
Student Characteristics		
Enrollment	616.95	352.90
% FRP Lunch	64.22	46.91
% White	30.42	31.75
% Black	33.53	31.74
% Hispanic	29.32	29.80
% Asian	2.51	2.32

Notes: 288 schools and 1,933 public schools. Values computed after conditioning on school district using Palm Beach as reference group. Note that location characteristics represent area within one mile of a school's Census tract.

serve. This is indicative of the importance of location and travel costs as elements of household school choice.

Table 3.2 also reveals a number of striking differences between exiters and persisters in terms of student and location characteristics. In particular, the locations of charter schools that exit are higher density and much lower income on average (about $16,000 less mean household income). Accordingly, the average exiter charter school serves a 21 percentage point larger share subsidized lunch student composition. These differences also appear in terms of demographics, as exiters serve a 37 percentage point larger share black student composition on average. Combined with Table 3.1, these comparisons suggest that charter demographics match public school demographics in part because charter schools that do disproportionately serve

Table 3.2: Student and Location Characteristics of Exiters and Persisters, 2006-13

	Exiters	Persisters	Difference
Location Characteristics			
Density	4,468	4,039	429
Household Income	46,366	62,713	-16,347***
% White	37.46	47.56	-10.10***
% Black	24.87	12.18	12.69***
% Hispanic	34.06	36.54	-2.47
% Asian	1.65	2.11	-0.46*
Student Characteristics			
Enrollment	287.71	408.78	-121.10***
% FRP Lunch	66.23	45.27	20.97***
% White	15.93	39.00	-23.07***
% Black	53.86	17.08	36.78***
% Hispanic	28.52	39.93	-11.40***
% Asian	1.43	2.75	-1.32***

Notes: *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. Note that location characteristics represent area within one mile of a school's Census tract.

disadvantaged student populations are less likely to survive.

In Table 3.3, I compare exiter and persister charter schools in terms of expenditure per pupil and student performance on end-of-grade exams. The table reveals that charter schools that exit spend nearly $900 more per pupil (approximately 10% of total expenditure) than those that persist in the sample. In terms of achievement in math and reading performance, Table 3.3 also reveals that students attending exiter charter schools perform dramatically worse on average. The average math score for exiter charter schools, for example, is nearly 1 standard deviation on average below that of persister charter school. The reading gap is 0.62 standard deviations.

While these stylized facts are suggestive, they remain ambiguous about the mechanisms structuring the education market. For instance, though exiters both serve more disadvantaged student populations and spend more per pupil on average, this

Table 3.3: Expenditure and Student Performance of Exiters and Persisters, 2006-13

	Exiters	Persisters	Difference
Expenditure / Pupil	7,988	7,086	902***
Math z	-0.90	0.05	-0.96***
Reading z	-0.62	0.17	-0.79***

Notes: *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. Math and reading scores represent averages of within grade and year normalized 4th and 5th grade exam performance.

does not necessarily indicate that cost differentials associated with serving disadvantaged students drive exit. For one, exiter charter schools may be merely inefficient, in which case exit is symptomatic of competition. Similarly, the large differences in student test performance between exiters and persisters may be indicative of differences in effectiveness at raising student achievement and thereby consistent with market efficiency. On the other hand, the test score gaps may just reflect the socioeconomic and demographic differences of students attending exiter and persister charter schools. For these reasons, any empirical analysis of charter school supply must address the role of competition and successfully separate cost and demand-side reasons for charter school survival and failure. In the following section, I embed the location choices of charter schools in an incomplete information entry game that models these features of the education market.

3.4 Empirical Model

This section presents the empirical model of charter school supply and competition that I develop. The model links the competitive and financial incentives of charter schools with their location and operation choices to study the effects of funding policy on equilibrium sector outcomes. For this purpose, there are two key elements of the model: First, I allow charter schools to differ in effectiveness at raising student achievement (i.e. value-added), which is valued by households on the demand side.

This allows for a policy change that, for example, enhances competition to drive ineffective charter schools from business. Second, the variable costs of operation depend on the concentration of the characteristics of students served by a school. As a result, given a flat funding formula, charter schools may strategically locate in areas that attract fewer costly-to-serve students. This incentive, which may mute effects of competition, allows for a policy change that corrects this incentive to impact the composition of students served by the charter sector.

The basic building block of the model is an elementary education market, which I consider to be a school year and district. In each market, the following sequence occurs: First, incumbent charter schools – those in operation during the prior school year – decide whether or not to exit. Simultaneously, a pool of potential entrant charter schools decide whether to open for the school year and, if so, on a location in the school district. These choices, predicated in part on expected revenues (which depend on the per-pupil funding rate) and costs, define the set of active schools from which households may choose. Households then choose a school to attend at the beginning of the school year. Given enrollments and the effectivenesses of schools in operation, variable costs and student achievement are realized at the end of the school year,

Each market is fully described by a commonly observed state vector s_t. The vector includes the locations of active charter schools at time t, which I denote by a_t, and a vector of characteristics for each location, x_t. Public schools' locations and effectivenesses are included in x_t. Charter schools are characterized by their effectiveness at raising student achievement, listed in μ_t, their age, and incumbency status in the model.

Charter schools' entry and exit choices are made in an incomplete information setting. Given the payoff-relevant information summarized in the state vector, charter schools' choices constitute a Bayesian Nash equilibrium. The state vector then evolves between periods as a result of those choices. I adapt this basic entry game setup in a few ways for my setting. First, competition contains a spatial dimension and entering charter schools choose a location, which is characterized as a bundle of expected enrollments and costs. Second, I treat charter schools as not-for-profit maximizers that may behave as if they value output and effectiveness along with net income.

While the model endogenizes the composition of students served by charter schools (via location choices and demand) and the aggregate effectiveness of the charter sector (through differential survival), I abstract from other aspects of the education market. For instance, though they compete for students with charter schools, the locations and effectivenesses of public schools are treated as exogenous.[22] Additionally, while entry and exit dynamics may shift effectiveness in the aggregate, I do not model changes in effectiveness over time at the school level. Instead, effectiveness is an idiosyncratic characteristic drawn upon entry and evolves in a deterministic fashion.

This section is divided into three parts. In the first subsection, I define a school's effectiveness as its contribution to student learning in the context of a value-added education production function. In the second subsection, I detail the elements of the location choices of potential entrant charter schools and exit choices of incumbent charter schools, which are predicated on the "primitives" of demand and costs. I describe the equilibrium concept and evolution of states in the last subsection. Throughout, I suppress district-specific notation to simplify the exposition.

[22] There is weak to mixed evidence for competitive effects of charter schools on public school students. See Epple et al. (2015) for a summary.

3.4.1 Education Production

In the model, both public and charter schools combine their inputs with those of households to produce education outcomes, measured by student performance on end-of-grade exams. Performance also depends on accumulated impacts of inputs up to the present, which I assume are fully summarized by exam performance the prior year. As a result, education is produced in a value-added fashion:

$$A^k_{nit} = \rho^k A^k_{nt-1} + \beta^k Z_{nt} + \mu_{it} + \nu^k_{nit} \tag{3.1}$$

In this equation, A_{nit} is student n's achievement from attending school i during school year t, while A_{nt-1} represents prior learning. The k superscripts index subjects, e.g. math and reading. The contribution of household inputs to learning is represented by $\beta^k Z_{nt}$, while ν^k_{nit} is a mean-zero measurement error.

I term the contribution or value-added of school i to student learning gains, represented by μ_{it}, its effectiveness. This term summarizes the productive contribution of a school's inputs to student learning, including teacher quality, learning environment, infrastructure, management, etc., in a single index. In this way, effectiveness, which might equally be thought of as quality, vertically differentiates schools in the model.

3.4.2 Charter School Utility and Income

Based on their status in the prior period, charter schools in the model are either incumbents, who choose whether to exit, or potential entrants, who choose whether to enter and a location. While these choices are based in part on expected revenues and costs, I model charter schools as not-for-profit maximizers that potentially behave as if they value enrollment per se and their own effectiveness in addition to net income.

The utility for charter school i operating in location j at state s_t is given by:

$$U_{ij}(s_t) = U_i(\Pi_{ij}(s_t), D_{ij}(s_t), \mu_{it}) \tag{3.2}$$

$D_{ij}(s_t)$ is the total enrollment of i in location j. This formulation of not-for-profit utility, which shares commonalities with numerous health sector applications (Lakdawalla and Philipson, 2006), is intended to capture selection into charter operation for altruistic or mission-oriented reasons (Malani et al., 2003).[23] An implication of this utility is that the degree to which charter schools respond to financial incentives, such as a counterfactual change to the funding formula, is an empirical question.

Represented by $\Pi_{ij}(s_t)$, net income is determined by revenue, variable costs, and fixed costs operation, FC_{jt}:

$$\Pi_{ij}(s_t) = \tau_t D_{ij}(s_t) - VC_{ij}(s_t) - FC_{jt} \tag{3.3}$$

The product of the funding rate, τ_t, and enrollment yields revenue. Each location in a school district, j, is associated with a different enrollment level, $D_{ij}(s_t)$, and variable costs of operation, $VC_{ij}(s_t)$. Charter schools' choices of where to locate or whether to exit therefore depend on these "primitives." I describe the structure I place on these objects, from which competitive and strategic incentives derive, in turn next.

Demand

Households' school choice determines charter school enrollment in the model. By comparing effectiveness, which I assume is known to households, and travel distance to each school, households choose a school to attend from among the available alternatives in their district. As a result, the locations and effectiveness of public and competing charter schools have competitive implications for a charter school's enrollment.

[23] In addition, charter schools must be legally organized as non-profits, though many contract with a for-profit management organization for services. I examine for-profit management of charter schools in Florida in other work (Singleton, 2016b). In the estimation, I allow the utility parameters to vary with profit status.

I abstract from the household-level choice problem to model the enrollment of a given household type z at each charter school as a function of their effectiveness, location, and competition. Household types include both socioeconomic and demographic groups. The total enrollment of student group z in school i at time t is given by:

$$D^z_{ij}(s_t) = D^z(\mu_{it}, x^D_{j(i)t}, a_{-it}, \mu_{-it}) \tag{3.4}$$

Demand depends on the effectiveness, μ_{it}, of a charter school, the locations of public and competing charter schools, and characteristics of the local market. $x^D_{j(i)t}$ summarizes the exogenous characteristics of $i's$ location, among them the effectivenesses and distances to nearby public schools. Other location variables include measures of market size and composition.[24] a_{-it} and μ_{-it} represent the locations and effectivenesses of competing charter schools, respectively.

This formulation of demand parsimoniously captures three important features of education markets: First, the demand function incorporates competitive effects of nearby public and competing charter schools, which may be magnified by closer proximity. In this way, competition between schools is spatial in nature. Second, effectiveness differentiates schools in that, all things being equal, greater own effectiveness increases enrollment. These two features are important for modeling the horizontal and vertical aspects of competition. Lastly, the formulation allows for heterogeneity in how households, characterized by type, evaluate school alternatives.

From (3.4), the total enrollment for a charter school is given by summing demand over mutually-exclusive household types:

$$D_{it}(s_t) = \sum_z D^z_{it}(s_t) \tag{3.5}$$

Similarly, the vector of household type shares of students attending each charter school, which I denote by $\mathbf{Z}_{it}(s_t)$, is endogenized in the model by (3.4) and (3.5).

[24] I discuss the full list of variables I use in the estimation section.

Variable Costs

Operating a charter school incurs costs that can be conceptually separated into variable and fixed. Variable costs represent the minimum expenditure for a charter school in a given state. Unlike fixed, variable costs therefore depend on input prices, which may vary across locations and with student composition, and a charter school's outputs. These relationships are summarized by charter schools' variable cost function:

$$VC_{ij}(s_t) = VC(D_{it}(s_t), \mu_{it}, \mathbf{Z}_{it}(s_t), x^C_{j(i)t}) \tag{3.6}$$

Expressed in this way, each charter school is a "firm" that produces effectiveness μ_{it} for a given number, D_{it}, and composition of students, $\mathbf{Z}_{it}(s_t)$.[25] As effectiveness represents a combination of inputs, this formulation recognizes it as potentially costly to supply.

Since student composition is tied to a charter school's location through demand, a strategic incentive to "cream skim" potentially derives from the dependence of costs on the student composition served. While I do not model the mechanism through which they arise, such cost differentials may stem from two sources: the production surface or input prices. For instance, teaching assistants or non-classroom school inputs, such as social services, may be especially important for effectively serving disadvantaged students. This is consistent with recent evidence from school finance reforms that spending improves later life outcomes of low socioeconomic status students in part by increasing support services and staff Jackson et al. (2015).[26] As a result, the optimal mix of inputs (and thereby variable costs) may vary with the composition of students. To input prices, evidence from teacher sorting suggests that

[25] The variable cost function is derived from a cost-minimization problem over inputs conditional on effectiveness and enrollments.

[26] Relatedly, students in schools with concentrated low-income populations disproportionately benefit from non-instructional spending (Sorensen, 2016).

teachers view concentrations of disadvantaged students as a disamenity, necessitating compensating differentials (Lankford et al., 2002; Jackson, 2009; Clotfelter et al., 2011).[27] I assume that input prices are fully captured by the combination of a charter school's student composition and location-specific characteristics, $x^C_{j(i)t}$.

3.4.3 Entry Location and Exit

Charter schools decide where to locate (if a potential entrant) and whether to exit (if an incumbent) in the model. These choices are made simultaneously in an incomplete information setting. In other words, while state variables such as market location characteristics and effectiveness are commonly observed, the actions of competitor schools are stochastic from the point of view of a given charter school. As a result, charter schools evaluate the discrete choice alternatives in terms of expected utility.

For describing charter schools' choice problems in the game, it is useful to divide the state vector, s_t, into four sub-components. First, a_{-it} represents the actions of other charter schools, which may be either a location in the market or decision to exit/remain out. Second, s_{it} lists the characteristics of charter school i, which include its effectiveness, its age and incumbency (i.e. whether in operation the prior period), and its profit status. Vector s_{-it}, on the other hand, lists the characteristics of charter schools other than i, while x_t summarizes the exogenous characteristics of all market locations that shift demand and variable costs.[28]

Incumbent charter schools in state s_t make the choice of remaining in operation in their present location j or exiting the market. Operation yields expected utility $E[U_{ij}(s_t)] = E[U_j(a_{-it}, s_{it}, s_{-it}, x_t)]$, while I normalize the value of exiting to 0. Each choice alternative is associated with a corresponding choice shock that is known to

[27] Note that charter schools are not constrained by teacher salary schedules. Evidence indicates that hiring practices in charter schools are more market-based than traditional public schools (Podgursky, 2006). Differences across households in terms of parental involvement in the school may also translate to cost differences.

[28] Note that the per-pupil funding rate, τ_t, is also a commonly observed exogenous state variable.

the charter school, but unobserved to competitors and to the econometrician. Thus, incumbent i's choice problem can be expressed as to remain in operation (in location j) if:

$$E[U_j(a_{-it}, s_{it}, s_{-it}, x_t)] + \epsilon_{ijt} \geqslant \epsilon_{i0t} \tag{3.7}$$

and to close otherwise. The expectation in (3.7) is taken over competing charter schools' simultaneous entry and exit decisions. ϵ_{ijt} and ϵ_{i0t} are the choice shocks for continuing operation and exiting respectively.

For a charter school deciding to enter the market, the choice problem also contains a location decision. An entering charter school weighs the alternative locations in a school district, indexed by j, by computing the expected utility of each choice. Entering the market incurs entry costs that are denoted EC_t, which represent both monetary and nonmonetary costs associated with the application, authorization, and opening process, including organizing a board, curriculum, staffing, and securing facilities. The choice problem facing potential entrants can be written as:

$$\max\{E[U_j(a_{-it}, s_{it}, s_{-it}, x_t)] - EC_t + \epsilon_{ijt}, ..., E[U_J(a_{-it}, s_{it}, s_{-it}, x_t)] - EC_t + \epsilon_{iJt}, \epsilon_{i0t}\} \tag{3.8}$$

In addition to the set of locations in the district, potential entrants may choose to remain out of the market, which yields only the associated choice shock.

3.4.4 Equilibrium and State Evolution

Equations (3.7) and (3.8) map charter schools' expected utility, conditioned on their beliefs about the choices of other charter schools, into ex ante choice probabilities. Since the choice shocks are private information, each charter school's decision rule is a function of the common state variables and its own choice shocks, but not the private information of other charter schools. I denote by $\mathbf{P}_t$ the set of all charter schools' choice probabilities to re-express the expected utility for charter school i of location j as:

$$E[U_j(a_{-it}, s_{it}, s_{-it}, x_t)] = \tilde{u}_{ij}(s_t, \mathbf{P}_t) \tag{3.9}$$

Given this expected utility, (3.7) and (3.8) represent a system of best response probability functions that define the Bayesian Nash equilibrium of the game wherein strategies and beliefs are consistent.[29] Charter schools' choices determine the equilibrium outcomes in the current period and the state vector evolves as a result of those choices.

The vector of charter schools' effectivenesses, μ_t, is a state that influences choices and thereby outcomes. While competitive entry and exit dynamics endogenize the aggregate effectiveness of the charter sector in the model, I specify a deterministic law of motion for the evolution of a given school's effectiveness between periods:

$$\mu_{it} = \mu_{1i} + \mu_2 \log(a_{it} + 1) \tag{3.10}$$

In this process, μ_{1i} represents an idiosyncratic and permanent component of effectiveness that is drawn upon entry, while μ_2 scales the rate at which effectiveness accumulates with age, a_{it}, of a charter school. This process, which is similar to returns to teacher quality with experience, captures improvement over time within charter schools.

3.5 Estimation and Identification

Estimation of the empirical model broadly consists of three steps: (1) recovering effectiveness of schools from the panel of test score data; (2) estimating the incentive structure of charter school operation, shaped by demand and variable costs, from the data; and (3) plugging-in the "offline" estimates to leverage revealed preference with the entry game to uncover how charter schools respond to the incentive structure. In

[29] I focus on pure-strategy equilibria, with anonymous and symmetric strategies. Existence of equilibrium follows from Brouwer's fixed point theorem, but is not guaranteed to be unique. The two-step estimator I use conditions on the equilibrium in the data.

this section, I detail both steps and the identification assumptions made to estimate the model parameters.

3.5.1 *Offline Elements*

Effectiveness

I use the panel of end-of-grade exam scores by school and grade to estimate the effectiveness of each school at raising student achievement. Averaging (3.1) to the grade level and substituting in charter schools' law of motion for effectiveness (3.10) yields the equation that I take to the data:

$$A^k_{igt} = \rho^k_g A^k_{igt-1} + \beta^k \mathbf{Z}_{igt} + \mu_{1i} + \mu_2 \log(a_{it} + 1) + \delta^k_{gt} + \nu^k_{igt} \tag{3.11}$$

The dependent variable, A^k_{igt}, is the normalized average subject k score of grade g students in school j at time t, while A^k_{igt-1} is their average score the prior year.[30] I allow ρ to vary by grade and subject and β to vary by subject. Grade-level student characteristics, which include subsidized lunch status and demographics, are included in $\mathbf{Z}_{igt}$.[31] Net of subject-grade-year intercepts, δ^k_{gt}, I assume that effectiveness at raising student achievement is constant across subjects and grades.

I estimate (3.11) by school fixed effects pooling charter and public schools.[32] The fixed effects for charters schools are taken as estimates of μ_{1i}.[33] I assume that, conditional on students' average prior learning A^k_{igt-1} and observable characteristics

[30] Note that the averaging in both years is over the same students, but the prior score may have been received at a prior school if the student switched schools. I normalize current and prior scores separately.

[31] I also control for the share of special education, English language learner, and gifted students. Since I do not observe the characteristics of just the matched sample of students, I assume that the overall grade-level demographics are representative. To proxy for deviations, however, I also include a polynomial in the share of grade-level enrollment that the matched test score sample accounts for in the estimation.

[32] Note, however, that the effectiveness of public schools is assumed fixed over time. In the estimation, I also interact the household variables with a charter indicator.

[33] In the estimation, I weight each observation in the data by the number of students going into calculation of the achievement score averages.

$\mathbf{Z}_{igt}$, assignment of students to schools is as good as random. Residual average growth in student performance across grades and years therefore identifies the effectiveness of each school.

Demand

To estimate charter school demand, I pool the elementary enrollment of Asian, black, Hispanic, white, other demographic, and subsidized lunch students across charter schools and years. I then bin counts of nearby charter and public schools into mutually-exclusive distance bands centered around each school's location to capture spatial competition while conditioning on charter school effectiveness and detailed location characteristics.

The equation I take to the data is given by:

$$\log(D_{it}^z + 1) = \alpha\mu_{it} + \varrho^z x_{j(i)t}^D + \sum_d \gamma_c^d NC_{j(i)t}^d + \sum_d \gamma_p^d NP_{j(i)t}^d + \pi_{j(i)t}^z + \epsilon_{it}^z \qquad (3.12)$$

$NC_{j(i)t}^d$ and $NP_{j(i)t}^d$ represent the number of charter and public schools respectively in distance band d from charter school i at time t in this equation. The γ parameters are thus interpretable as semi-elasticities of enrollment with respect to an additional competitor (public or charter) in a given distance band. I use three distance bands in the estimation: within one mile, between one and three miles, and between three and five miles. α represents the return to effectiveness at raising student achievement. z indexes the household types.

To summarize the market size of each location, I use school aged populations and other variables, such as density and household income, of the surrounding area. In addition to controlling for the population of the "own" demographic nearby (e.g. the enrollment of Hispanic students depends on the population of Hispanics in the local area), the specification I estimate also allows for "cross" spillovers of populations on enrollments. This is intended to capture sorting across charter schools in a parsimonious way. In the case of subsidized lunch student enrollment, the specification captures correlation between demographics and socioeconomic status. I control for local populations within the one, three, and five mile distance bands. I also include urban-household income quintile intercepts. These location characteristics are summarized by $x^D_{j(i)t}$.

Conditional on charter school effectiveness, μ_{it}, I assume that the observed location characteristics fully account for the location-specific shifters of demand. I estimate (3.12) by OLS while including household type-district and type-year fixed effects, represented by $\pi^z_{j(i)t}$.[34] A validity check of the identifying assumption is that unobserved location characteristics would attenuate the estimates of γ towards zero (or even make them positive).

Variable Costs

To estimate the variable costs of charter school operation, I combine the recovered estimates of charter school effectiveness with the panel of expenditures, student compositions, and location characteristics. As described earlier, the variable cost function embeds cost differences across student populations.

The specification that I estimate is given by:

$$\log VC_{it} = \kappa T(\log D_{it}, \mu_{it}) + \lambda \mathbf{Z}_{it} + \eta x^C_{j(i)t} + \epsilon_{it} \tag{3.13}$$

The dependent variable in this equation is the reported total expenditure of charter school i during school year t, which depends on input prices through the location characteristics $x^C_{j(i)t}$, student composition $\mathbf{Z}_{it}$, and outputs.[35] The location characteristics I include in the estimation include density-income quintile and district-year

[34] Note that although α and γ are not household type-specific, the marginal effects on enrollments of changes in effectiveness or nearby competition will differ across types due to $\varrho^z x^z_{j(i)t}$ and $\pi^z_{j(i)t}$.

[35] In addition to the student compositions endogenized by the model (demographic and subsidized lunch status), I also control for the share of gifted, special education, and English language learner students in the estimation. Note that equation (3.13) implicitly assumes that the returns to scale do not vary with student composition.

intercepts. To allow for possible nonlinearities, such as a quantity-quality trade-off, I specifiy $T(\log D_{it}, \mu_{it})$ by a quadratic polynomial (akin to a translog) in log enrollment and effectiveness.

Cost estimation in education settings is subject to a number of endogeneity concerns (Costrell et al., 2008; Duncombe and Yinger, 2011; Gronberg et al., 2011). For example, a traditional concern is market power in setting teacher wages. In this setting, where charter schools are small players in the labor market, this is not a salient issue. In addition, effectiveness or quality is often difficult to measure due to non-random sorting of students across schools. By estimating the education production (3.11) in a first stage, however, I obtain a measure of effectiveness identified by residual student achievement growth. As a result, the cost estimates are implicitly conditioned on students' unobserved prior inputs.

Nonetheless, unobserved differences across schools in allocative efficiency may confound naive regressions of expenditure on measures of outcomes and student characteristics. In this case, the error term in (3.13) can be decomposed into efficiency and measurement error:

$$\epsilon_{it} = u_{it} + \zeta_{it}$$

If efficiency in input usage, represented by u_{it}, is correlated with effectiveness or enrollment, then ordinary least squares estimates will be subject to omitted variable bias. The cost estimation literature typically models unobserved u_{it} using parametric distributional assumptions.[36] While the more competitive charter school market may alleviate some of this worry, I also assume that any allocative inefficiency across charter schools is fully captured by the age and profit status of a charter school. I therefore include these as additional controls when estimating equation (3.13).

[36] See chapter 3 of Davis and Garcs (2009) and Greene (2008) for overviews.

3.5.2 Entry Game

Estimating how charter schools respond to incentives relies on pairing the offline estimates of demand and variable costs with the logic of revealed preference in the entry game. For estimation, this requires placing a functional form on the utility function of charter schools and a distributional assumption on the choice shocks. Given the computational burden required to solve the game, I implement a modified two-step approach for estimation, which is described below.

I specify charter schools' flow utility as quasi-linear in net income per pupil:

$$U_{ij}(s_t) = \theta_i \Pi_{ij}(s_t)/D_{ij}(s_t) + g_i(D_{ij}(s_t), \mu_{it}) \tag{3.14}$$

θ_i represents the marginal utility of net income per pupil and governs how charter schools respond to financial incentives. On the other hand, g_i represents how, whether for altruistic or other reasons, charter schools value enrollment and effectiveness. Because I do not directly observe the statutory funding rate, τ_t, in the data, I re-write (3.14) using (3.3) as follows for the estimation:

$$\begin{aligned} U_{ij}(s_t) &= \theta_i(\tau_t D_{ij}(s_t) - VC_{ij}(s_t) - FC_{jt})/D_{ij}(s_t) + g_i(D_{ij}(s_t), \mu_{it}) \\ &= -\theta_i VC_{ij}(s_t)/D_{ij}(s_t) + \tilde{g}_i(\tau_t, FC_{jt}, D_{ij}(s_t), \mu_{it}) \end{aligned} \tag{3.15}$$

While the estimation seeks to return θ_i (intuitively identified by variation in costs per pupil across locations) for purposes of conducting counterfactuals, the parameters comprising $\tilde{g}_i$, which includes the funding rate and fixed costs, are not of direct interest. I therefore flexibly specify this function in the estimation. As the statutory funding formula is set by a base amount that varies over time with district cost adjustments, I include year and district fixed effects. These capture unobserved heterogeneity at the market level. I also allow θ_i and $\tilde{g}_i$ to depend on whether a charter is for-profit managed.

I assume that the choice shocks in (3.7) and (3.8) are distributed i.i.d. type I extreme value. This assumption produces familiar closed-form solutions for the probability of continuing for incumbents (which I superscript by I) and for choosing a location for potential entrants (supercripted E). These are given by:

$$P^I_{ij}(s_t) = \frac{\exp\left(\tilde{u}_{ij}(s_t, \mathbf{P}_t)\right)}{1 + \exp\left(\tilde{u}_{ij}(s_t, \mathbf{P}_t)\right)} \tag{3.16}$$

$$P^E_{ij}(s_t) = \frac{\exp\left(-EC_t + \tilde{u}_{ij}(s_t, \mathbf{P}_t)\right)}{1 + \sum_j \exp\left(-EC_t + \tilde{u}_{ij}(s_t, \mathbf{P}_t)\right)} \tag{3.17}$$

These choice probability expressions form the basis for the likelihood, which involves a system of discrete choice equations satisfying a fixed point.

There are two primary approaches for dealing with the equilibrium structure of this system. The nested fixed point approach, adapted from Rust (1987), requires solving the game for every parameter guess to evaluate the likelihood. Due to heterogeneity across charter schools and the large set of locations available (for example, there are nearly 350 Census tracts in Miami-Dade), this approach is computationally prohibitive. For this reason, I adopt a two-step approach based on insights from Hotz and Miller (1993) that semi-parametrically recovers conditional choice probabilities of entry location and exit in a first step. The second step uses the choice probabilities as estimates of charter schools' beliefs regarding other charter schools' actions to calculate $\mathbf{P}_t$.[37] I modify this procedure to use simulation for this calculation.

I estimate the model pooling all school districts in Florida. A potential entrant's choice set thus consists of the Census tracts in their exogenously assigned district.[38] As the demand model (3.4) overidentifies total enrollment, I use the predicted enrollment of the five mutually exclusive demographic groups (Asian, black, Hispanic,

[37] Note that the two-step approach, which conditions on the equilibrium played in the data, is also more robust to multiplicity of equilibria. The contraction mapping approach, on the other hand, is difficult to apply when there are multiple equilibria.

[38] I populate the pool of potential entrants for each school district by setting the total to a third the amount of observed entries rounded up to the next integer. I also assign potential entrants a profit status.

other, white) to predict total enrollment in each location.[39] For the first stage, I estimate a multinomial logit with a flexible polynomial in the state variables that includes district and year fixed effects and interacts the state variables polynomial with district and year indicators. While I allow for heterogeneity in effectiveness in the model, I assume that each potential entrant's effectiveness is only known (to them and to rivals) post-entry. The initial effectiveness is drawn from the empirical distribution of μ_{1i}, which I discretize.

3.6 Results

This section presents the estimates of the empirical model and results of the counterfactual exercises. In the first subsection, I present the parameter estimates of the offline functions and from the entry game. I then simulate the empirical model to compare with the data to assess goodness-of-fit. Finally, I examine three counterfactual policy changes in the last subsection: (1) a cost-adjusted funding formula based on the estimated cost differentials; (2) start-up grants targeted by household income of the location; (3) and a general increase in the per-pupil funding rate for charter schools. I compare these simulations in terms of aggregate effectiveness and the demographic composition of students served by the sector.

3.6.1 Estimates

Effectiveness

Figure 3.1 summarizes the school effectiveness estimates recovered from (3.11) by comparing public and charter schools operating in Florida in the 2012-13 school year. I demean the effectiveness estimates over the entire sample to facilitate the comparisons and plot kernel densities for both school types. The figure illustrates that the average charter school was around 0.07 standard deviations (on the student

[39] I require predicted enrollment to be at least one and cap the subsidized lunch share at 1.

achievement distribution) worse than average, with public schools ever so slightly better than average. In addition, the figure reveals a wider dispersion in effectiveness across charter schools than across public schools. These distributions are summarized numerically in the upper panel of Table 3.4.

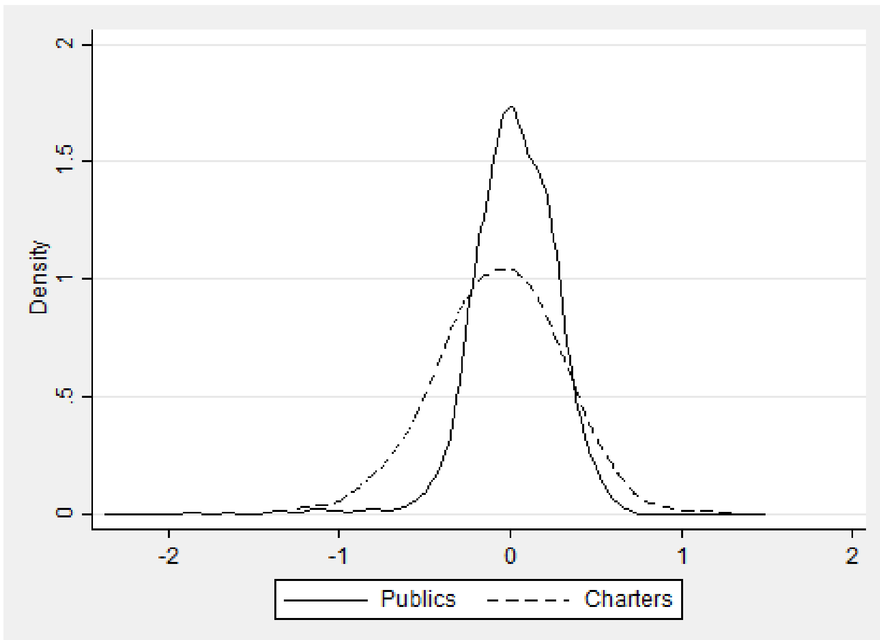

FIGURE 3.1: Effectiveness of Public and Charter Schools, 2012-2013

I compare charter schools that exit the sample with charter schools that persist in terms of effectiveness in Figure 3.2.[40] In contrast with the level test score difference of nearly 1 standard deviation on average (summarized earlier in Table 3.3), the density plots reveal a smaller average gap in effectiveness. As reported in the middle panel of Table 3.4, the average exiter charter school raises learning 0.47 standard deviations less than the average school. Nonetheless, the figure also shows considerable overlaps in the effectiveness distributions, such that some exiter charter schools are quite effective in absolute terms. For instance, the 75th percentile charter school that closes and exits the sample would be as effective as the average charter school in

[40] For purposes of this comparison, I construct effectiveness from the estimated school fixed effects from (3.11) and plug in the average charter school age in 2012-13.

2012-13 (if it survived to the same age). Conversely, even the 25th percentile charter school that survives during the sample lowers student performance by 0.25 standard deviations relative to the average school.

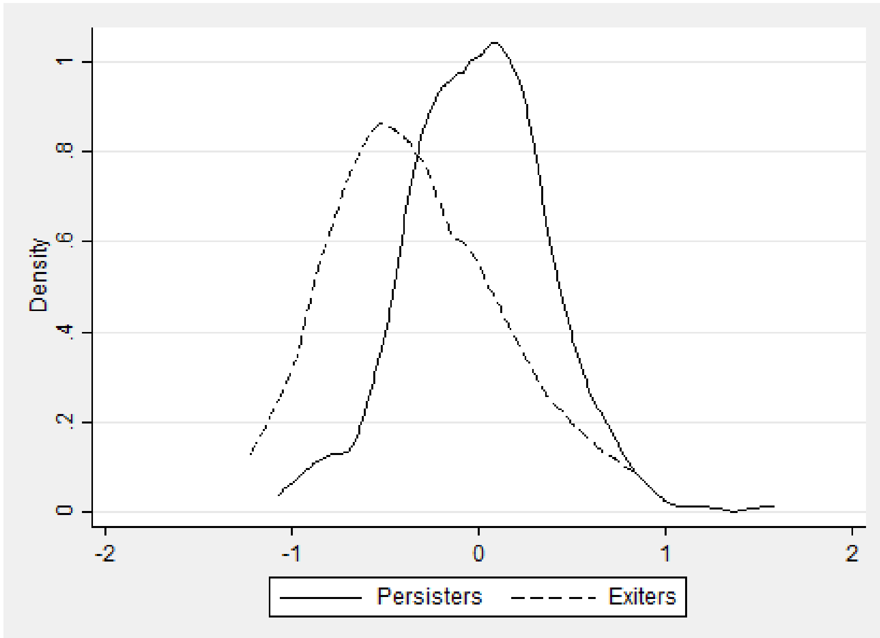

FIGURE 3.2: Effectiveness of Exiters and Persisters, 2006-2013

The bottom panel of Table 3.4 presents a final comparison of persisting and exiting charter schools in the sample. Using the estimates of public school effectiveness obtained from (3.11), I compute the average effectiveness of public schools within 3 miles of all charter schools and average over the sample period. This comparison produces the additional finding that exiters are located in more underserved areas, as measured by the quality of nearby public schools; the average effectiveness of public schools near exiters is also lower on average. This suggests that some fraction of the charter schools that close and exit the sample are better schools relative to immediate local public schools alternatives. Together, these estimated effectiveness distributions provide evidence that funding policies which exiter sustain charter schools may not necessarily imply "costs" in terms of aggregate effectiveness.

Table 3.4: Estimates of School Effectiveness

	Mean	SD	p5	p25	Median	p75	p95
				All Schools, 2012-13			
Publics	0.02	0.27	-0.36	-0.12	0.03	0.19	0.39
Charters	-0.07	0.38	-0.71	-0.31	-0.07	0.20	0.52
				Charter Schools, 2006-13			
Persisters	0.00	0.38	-0.62	-0.25	-0.01	0.23	0.59
Exiters	-0.47	0.76	-1.22	-0.65	-0.44	-0.07	0.48
				Nearby Public Schools, 2006-13			
Persisters	0.02	0.16	-0.23	-0.07	0.03	0.13	0.25
Exiters	-0.01	0.15	-0.29	-0.06	0.01	0.11	0.18

Notes: Top panel represents just 2012-13 school year. In the middle panel, I use the fixed effect estimates of μ_{1i} from (3.11) and predict effectiveness if each school were the average age of charter schools in 2012-13. In the bottom panel, mean effectiveness is calculated over all public schools within 3 miles of each charter and averaged over the sample.

Primitives

Demand estimates are presented in Table 3.5. As would be expected, the estimates indicate that greater effectiveness is associated with larger charter school enrollment. A one standard deviation increase in effectiveness, all things being equal, is associated with around a 35% increase in enrollment. The estimates also indicate that charter school competition is highly localized. For instance, an additional competitor charter school within one mile is associated with around an 11% drop in enrollment, but at further distances the competitive effect is not statistically different from zero. On the other hand, an additional public school within one mile is associated with around a 10% drop in enrollment and publics between one and three miles reduce enrollment around 4%. These negative effects of competition that attenuate with distance provide a validity check of the estimates against economic theory.

Table 3.6 presents estimates of the charter school variable cost function. The results indicate that the variable costs of charter school operation decrease with

Table 3.5: Estimates of Demand Function

	Log Enrollment
Effectiveness	0.352***
	(0.115)
# Charters < 1 Mi	-0.111**
	(0.050)
1 Mi ⩽ # Charters < 3 Mi	0.017
	(0.027)
3 Mi ⩽ # Charters < 5 Mi	0.002
	(0.022)
# Publics < 1 Mi	-0.100***
	(0.038)
1 Mi ⩽ # Publics < 3 Mi	-0.039***
	(0.013)
3 Mi ⩽ # Publics < 5 Mi	-0.023***
	(0.008)
District x Type FE	Y
Year x Type FE	Y
Observations	8,590
R^2	0.763

Notes: Standard errors clustered by school. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. Specification controls for log school-aged demographic populations by distance band, density-income quintile intercepts, and dummies for year of charter entry or exit.

enrollment. For a charter school of average size and effectiveness, a 10% increase in enrollment is associated with about an 8.6% increase in costs, all things being equal. In addition, effectiveness is costly to provide. A one standard deviation increase in effectiveness is associated with nearly 18% higher costs for the average sized charter school, with those costs increasing with additional effectiveness. The estimates also indicate the the costliness of effectiveness diminishes with scale, though this effect is small in magnitude.[41] For-profit managed schools are estimated to be more efficient,

[41] For a school at the 90th percentile of enrollment, a standard deviation increase in effectiveness raises costs 16%.

as represented by around 5% lower costs.

The results in Table 3.6 indicate cost differentials across student populations. In particular, holding effectiveness and enrollment constant, a 10 percentage point increase in the share of black students is associated with about a 2% increase in costs. For the share of Hispanic students, a 10 percentage point increase is associated with around a 1% increase, all else constant. As these characteristics proxy for differences in socioeconomic status, household wealth, and other sources of disadvantage, they are highly collinear with subsidized lunch status. I use these estimated cost differences to implement the counterfactual cost-adjusted funding formula, as described later.

Utility

The results from estimating the entry game are presented in Table 3.7. These parameters correspond to the utility function of charter schools in deciding whether and where to open or to close. From the point estimate on variable costs, the estimates reveal that charter schools are respond positively to net income per pupil. Although the estimates indicate somewhat counterintuitively that for-profits operated charters respond less to variable costs per pupil, the difference is not statistically significant.

Table 3.7 also presents estimates of entry costs. While the point estimates are not directly interpretable, they can be put in willingness-to-pay terms based on how charters value net income. The results indicate that the disutility of setting up a new charter school is worth approximately $30,000 per pupil in willingness to pay and somewhat more for for-profits.[42] This is suggestive evidence that barriers to entry into the market are considerable.

[42] This is the entry cost for the 2012-13 school year. The estimates of the entry by year fixed effects, not presented here, show entry costs declining over time.

Table 3.6: Estimates of Variable Cost Function

	Log Expenditure
Log Enrollment	0.771***
	(0.101)
Log Enrollment^2	0.018**
	(0.009)
Effectiveness	0.325*
	(0.175)
Effectiveness^2	0.039
	(0.047)
Effectiveness * Log Enrollment	-0.058*
	(0.031)
% FRP Lunch	-0.000
	(0.000)
% Black	0.002***
	(0.001)
% Hispanic	0.001*
	(0.001)
% Asian	-0.008*
	(0.005)
% Other	0.003
	(0.003)
For-Profit	-0.054***
	(0.018)
District x Year FE	Y
Observations	1,319
R^2	0.944

Notes: Standard errors clustered by school. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. Specification controls for density-income quintile intercepts, the percentages of ESE, ELL, and gifted students, grade levels, the percentage of enrollment above grade 5, dummies for year of charter entry or exit, and the logged age of the charter school.

Table 3.7: Estimates of Utility Function

	Utility
Variable Costs / Pupil	-3.28***
	(0.91)
Variable Costs / Pupil * For-Profit	0.72
	(1.28)
Entry	-8.78***
	(0.43)
Entry * For-Profit	-1.68***
	(0.62)
Entry * Year FE	Y
Year and District FE	Y

Notes: *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. Specification controls for own effectiveness, quadratic in enrollment, and interactions with for-profit. The excluded entry by year fixed effect is 2012-13. Variable costs per pupil are in tens of thousands of dollars.

3.6.2 Goodness-of-Fit

To assess the ability of the empirical model to fit the data, I compare selected moments to those generated by simulating the model. To perform the simulations, I begin with the state of the education market in Florida in the first year of the sample, the 2007-8 school year, and simulate forward the evolution of the sector using the estimated parameters. I then generate moments for a number of simulated paths and compare the averages with the data for 2012-13. Simulation requires solving the incomplete information entry game (i.e. finding the fixed point), so this exercise simplifies that requirement by only finding an equilibrium for states along each simulated path.

Table 3.8 presents the comparisons. 273 elementary charter schools were in operation in Florida in the 2012-13 school year for the estimation sample. Matching this moment closely, the model predicts 277 charter schools on average. Further, the

Table 3.8: Model Fit, 2012-13

	Data	Model
Number of Charters	273	276.73
Enrollment	329.73	321.44
% FRP Lunch	50.33	53.83
% Black	28.05	27.49
% Hispanic	32.89	33.05
% Asian	2.09	1.82
Effectiveness	0.00	-0.08

Note: 2012-13 averages over 30 simulated paths. Effectiveness weighted by enrollment.

predicted composition of students attending charter schools is close to the data: 50% of students in elementary charter schools participated in subsidized lunch, 28% were black and 34% were Hispanic in 2012-13. The model predicts 54%, 27% and 33% on average, respectively. Finally, aggregate charter school effectiveness, measured by the enrollment weighted average across schools, is 0.00 in the data, as compared with 0.08 standard deviations below the mean predicted by the model. In sum, although the model underpredicts the aggregate effectiveness of the charter sector slightly, these comparisons indicate that the model is able to reproduce important features of the data well.

3.6.3 Policy Counterfactuals

In this section, I study counterfactual changes to funding policy in terms of equilibrium sector outcomes. Using the estimates of cost differences across students, I examine a cost-adjusted funding formula designed to correct the strategic incentive to cream skim. These results thereby answer whether current funding policy has the perverse effect of skewing the distribution of students served by charters towards low-cost student populations.

To implement this policy, I consider a funding formula that attaches weights to the enrollment of each household type and denote this policy by $\hat{\tau}(\mathbf{D})$. I choose the weights to satisfy two conditions: First, that the marginal revenue of enrolling an additional student of a given type equals the marginal cost. This is where the variable cost estimates enter the calculation. The second condition is that the formula provides approximately the same amount of total revenue as the status quo: $\hat{\tau}(\mathbf{D}) \approx \tau D$. In other words, the counterfactual is intended to only reallocate funding across household types.[43] I use the average expenditure and student compositions in the data to calibrate the formula.

I also consider two additional policy counterfactuals. First, I study the effects of a targeted start-up grant that provides \$1,000 of additional support per pupil – on the order of existing federal and state grants – for charter schools locating in areas with average household income in the first quintile (below about \$45,000). This policy aims to capture the benefits of the cost-adjusted funding formula in a practicable fashion. Finally, I examine a general per-pupil funding increase to examine the elasticities of charter school supply and aggregate effectiveness.

I compare the counterfactuals in terms of two primary outcomes: the composition of students attending charter schools and the aggregate effectiveness of the charter sector. The first outcome is determined by demand and where charter schools decide to locate in equilibrium. As the first counterfactual removes the financial motive to cream skim, those results provide a benchmark for comparison with other policies on this dimension. Aggregate effectivenes depends on the effectivenesses of charter schools operating in the market. By affecting who is marginal via competition, this outcome is sensitive to a change in funding policy.

Table 3.9 presents the results of the counterfactual simulations. I report the equilibrium outcomes in terms of percentage changes from the base model predictions, reported in 3.8. Column (1) presents the predictions of a cost-adjusted funding for-

[43] To provide a sense of the magnitudes, the difference in funding for a fully Hispanic charter school and a fully white charter school is \$800 per pupil in the counterfactual.

mula. The cost-adjustment leads to a significant shift in the composition of students attending charter schools. In the counterfactual, the share of students attending charters that participate in subsidized lunch increases by nearly 8% and the share of black students attending charters increases by 10%. This provides positive evidence of cream skimming in the charter sector. At the same time, the cost-adjusted funding formula predicts a drop in aggregate effectiveness of the charter sector by 2.5%. As a result, the cost-adjusted formula increases the share of charter schools serving underserved populations with little reduction in aggregate effectiveness. As suggested in Table 3.4, this is in large part due to the fact that a number of the charter schools sustained in the market by this policy change serve disadvantaged students and are not ineffective schools.

Table 3.9: Counterfactual Results, 2012-13

	(1)	(2)	(3)
Number of Charters	0.16	2.15	11.74
Enroll	-3.08	-1.18	-0.67
% FRP Lunch	7.82	4.37	-0.19
% Black	10.19	6.29	-0.62
% Hispanic	0.09	0.33	-1.15
% Asian	-1.10	-0.55	1.10
Effectiveness	-2.47	3.70	4.94

Notes: Average percentage change from baseline predictions over 30 simulated paths, 2012-13 school year. (1) corresponds to cost-adjusted funding formula using estimates of variable cost differences calibrated to leave average revenue unchanged; (2) corresponds to start up grant for locations with mean household income in the 1st quintile (less than approx. $45,000) of $1,000 per pupil; (3) corresponds to additional $1,000 per pupil for all charters. Effectiveness weighted by enrollment.

The second counterfactual I study, presented in column (2), is a targeted start-up grant for charter schools that locate in areas with average household income in the 1st quintile. This policy moves the dial somewhat towards the cost-adjusted policy outcomes (e.g. the share of students attending charters who participate in subsidized lunch increases by 4%), though the magnitudes are lower. To see why this is, I present summaries of the characteristics of entrant and exiting charter schools in the counterfactuals in Table 3.10. The top panel shows that, in terms of the student composition of entrants, policies (1) and (2) look very similar: the targeted start-up grant appears equally effective at shifting where new charter schools locate. However, the bottom panel reveals that this policy fails to support charter schools as incumbents, leading to little difference with the baseline in terms of the characteristics of exiters.[44] This margin is important for the net impact of the cost-adjusted funding formula. In sum, the targeted start-up grant captures limited benefits of cost-adjusting.[45]

The final counterfactual I study is an increase of $1,000 per pupil in annual revenue for charter schools. This counterfactual is interesting given its two likely effects. First, the additional funding should expand the charter sector by attracting new schools into the market. Second, if the new entrants intensify competition, this effect may imply changes in the aggregate effectiveness of the sector. This is countervailed against the possibility that the additional funding subsidizes low-effectiveness schools. The results in column (3) of Tables 3.9 and 3.10 present the results. The additional funding significantly increases the number of charter schools by about 12%. Aggregate effectiveness also increases by 5%. To put the change in more easily interpreted value, a 10% increase in funding is associated with approximately a .005 standard deviation increase in the average effectiveness of the charter sector. This reinforces the general finding of weak competitive incentives, such that gains in

[44] In fact, Table 3.10 shows that exiters' shares of subsidized lunch and black students actually increase somewhat in the counterfactual, suggesting an increase in the exit rate that accompanies the reallocation of locations.

[45] Additional financial support on the entry margin may be able to make up at least some of the difference. In terms of a comparison along financial lines, recall that I calibrate the cost-adjusted formula to provide approximately the same total revenue to charter schools, whereas the start-up grant program is implemented as additional revenue.

Table 3.10: Entrants and Exiters in Counterfactuals

	Model	(1)	(2)	(3)
	Entrants			
% FRP Lunch	48.50	50.38	49.73	48.19
% Black	29.17	31.40	30.23	28.92
% Hispanic	32.14	32.06	32.18	31.49
% Asian	1.86	1.82	1.83	1.89
	Exiters			
% FRP Lunch	48.60	47.16	49.28	49.91
% Black	32.39	30.92	33.35	33.69
% Hispanic	24.79	24.02	24.47	24.71
% Asian	1.79	1.77	1.76	1.73

Notes: Averages over 30 simulated paths. (1) corresponds to cost-adjusted funding formula using estimates of variable cost differences calibrated to leave average revenue unchanged; (2) corresponds to start up grant for locations with mean household income in the 1st quintile (less than approx. $45,000) of $1,000 per pupil; (3) corresponds to additional $1,000 per pupil for all charters.

access to school choice do not appear costly in terms of quality of charter schooling.

3.7 Conclusion

This chapter uses unique data from Florida the study the effects of charter school funding policy on the composition of students served by charter schools and aggregate effectiveness. This is motivated by the possibility that, due to the flat statutory funding formula, charters schools face strategic incentives to underserve disadvantaged student populations through their choice of location. The data assembled present a number of suggestive differences between charter schools that exit and those that survive in the sample: Exiters serve 21 percentage point higher subsidized lunch and 37 percentage point higher black student bodies. At the same time, those that exit also spend over $900 more per student per year and display much lower student achievement levels on end-of-grade exams on average.

To understand the mechanisms behind these patterns, I develop and empirical model of charter school supply and competition that enables me to study the effects of counterfactual funding policies on equilibrium sector outcomes. In the model, charters consider competition and the cost of educating the expected student body composition in choosing where to locate. As a result, charter sector outcomes depend on whether and how charter schools strategically respond to the policy environment. To estimate the model, I first recover estimates of school effectiveness, demand, and variables costs, which embed cost differences across student populations, to plug these primitives in to an incomplete information entry game. I then leverage revealed preference to uncover how charter schools, which I treat as not-for-profit maximizers, respond to incentives.

I use the estimated model to study three policy changes in detail. First, I consider a cost-adjusted funding formula that aims to correct the strategic incentive to cream skim. The results indicate a significant increase in the share of charter schools serving students of disadvantaged backgrounds with little change in aggregate effectiveness. This result provides evidence that the current flat funding formula unintentionally skews the distribution of students served by charters towards low-cost populations. Second, I consider a location targeted start-up grant that provides support for charter schools serving lower income areas. While this policy shifts the location choices of new schools, it fails to support schools serving disadvantaged students and yields little overall change in outcomes. Finally, I examine the effect of a general funding rate increase for charters. This policy increases the size of the sector, but the benefits to aggregate effectiveness are small in absolute terms.

These findings are important as they are informative about school choice policy. In particular, a mismatch between funding and costs may generate significant disparities in access to and benefits from school choice. This point, while relevant to ongoing debates over the expansion of charter and voucher programs, is largely unrecognized in the existing literature on education markets. Further, the counterfactuals I study underscore that funding policy, an element common to both private school voucher and charter school programs, may provide an effective policy instrument for directing competition via supply-side incentives. This has implications for the design of school choice programs broadly.

The empirical model I develop makes several important simplifying assumptions that motivate future work. For instance, I abstract from incomplete information or preferences for peers in modeling how students choose schools. While these features influence how students sort across schools, they also have supply-side implications that remain unexamined and which I do not develop here. In addition, I do not analyze the sources of within-school changes in effectiveness. While on the one hand this may underestimate some quality effects of competition, it also suggests another margin which may inform the design of school choice policy, particularly school accountability regimes. Lastly, as the charter sector continue to mature, the roles of charter school networks and management organizations, which are beyond the scope of this work, are likely to take on added importance.

Appendix

Table 3.11: Location and Student Summary Statistics for Charter Schools, 2012-13

	Mean	SD	p10	Median	p90
		Location Characteristics			
Density	3,722	3,752	209	2,983	7,507
Household Income	59,206	21,536	37,554	53,836	89,680
% White	20.84	23.58	0.60	11.75	54.97
% Black	45.59	29.85	2.82	47.61	85.03
% Hispanic	29.84	27.21	3.67	20.27	72.30
% Asian	2.23	2.27	0.05	1.62	4.74
		Student Characteristics			
Enrollment	324.76	263.57	72	234	687
% FRP Lunch	50.05	27.16	13.64	49.77	87.52
% White	34.86	29.59	1.20	30.19	78.05
% Black	27.49	30.73	1.06	13.26	87.76
% Hispanic	31.91	29.03	3.85	21.50	84.38
% Asian	2.07	2.85	0	1.32	4.76

Notes: 288 charter schools. Note that location characteristics represent area within one mile of a school's Census tract.

Table 3.12: School Summary Statistics for Charter Schools, 2012-13

	Mean	SD	p10	Median	p90
Expenditure / Pupil	7,398	1,932	6,034	7,051	9,407
Math z	-0.05	1.11	-1.49	0.00	1.38
Reading z	0.14	1.05	-1.30	0.18	1.36
For-Profit	0.47	0.50	0	0	1

Notes: 288 charter schools. Expenditure missing for 13 schools.

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John D. Singleton was born December 25th, 1985 in Denver, Colorado. He received his BA with Honors in economics and in political science in 2008 from Calvin College, an MA in economics in 2010 from University of Colorado Denver, an MA in economics in 2012 from Duke University, and his PhD in economics in 2017 from Duke University. At the University of Colorado Denver, John twice received the George W. Zinke Award in Economics and was also named Outstanding Graduate Student in the College of Liberal Arts and Sciences. His thesis research at Duke University was supported by a National Academy of Education/Spencer Foundation dissertation completion fellowship. His work has been presented at the Allied Social Science Associations, Association for Education Finance and Policy, History of Economics Society, and Society of Labor Economists meetings and has appeared in *History of Political Economy*. With J. Daniel Hammond and Steven G. Medema, he co-edited *Chicago Price Theory* (Edward Elgar, 2013). John will begin an assistant professor position in the department of economics at the University of Rochester fall 2017.