DISSERTATION

THREE ESSAYS IN CULTIVATING REGIONAL GROWTH: BROWNFIELDS AND CHARTER SCHOOLS

Submitted by

Michael Frans Trouw

Department of Economics

In partial fulfillment of the requirements

For the Degree of Doctor of Philosophy

Colorado State University

Fort Collins, Colorado

Fall 2023

Doctoral Committee:

Advisor: Stephan Weiler

Anita Alves Pena
Sammy Zahran
Tobin Lopes

ABSTRACT

THREE ESSAYS IN CULTIVATING REGIONAL GROWTH: BROWNFIELDS AND CHARTER SCHOOLS

This dissertation is comprised of three chapters focused on two important factors in cultivating regional growth. The first factor considered in chapter one is potential barriers to contaminated land reuse. As cities and towns grow, over time the stock of land within an area can be impacted by prior land use. A property which currently has a contamination issue from prior use which must be remedied before the land may be used in the future, whether for production or settlement, is called a brownfield. In this chapter we employ a survey of real estate professionals, and find developers require an additional risk premium on top of their normal rate of return on investment to incentivize them to invest in a brownfield. Importantly, this risk premium is found to be in excess of cleanup costs. Informed by the results of the survey analysis, a theoretical framework is used to explore the implications of this risk premium. We show this risk premium generated by information asymmetries potentially leads to inefficiency in the market for real estate and can perpetuate a cycle of underdevelopment due to a first mover problem. The redevelopment of this land is important, as these brownfield properties are typically located in the urban core of cities and towns and if not remediated can leave potentially productive swaths of land fenced off while expansion occurs in a sprawling manner on the fringes.

The second factor in cultivating regional growth considered in chapters two and three of this dissertation is the role of educational alternatives. Specifically, I focus on the determinants of charter

school formation and growth. Education quality and availability has been shown to be important in determining economic growth and migration patterns. Specifically, a strong education system can be viewed as an amenity to households and firms debating moving to a particular locale. Charter schools are publicly funded, privately run institutions crafted first as a pilot program for innovation, and more recently as a substitute or competitor for public schools. While the efficacy of charter schools has been heavily researched and remains controversial, little work has focused on the determinants of demand for the schools themselves. Chapter two builds on a small existing literature to provide light on what factors outside of direct measures of educational quality affect the creation rate of charter schools. Using a panel of core based statistical areas over the period 2006-2015, this analysis finds evidence that the composition of industry within a Core Based Statistical Area is related to the rate at which new charter schools are created, with more technical employment associated with a greater demand for alternative school options. The connection between industry and charter school creation is further explored by measuring the impact of intra-industry entrepreneurship on charter school proliferation, where findings suggest that higher levels of entrepreneurship within an CBSA is correlated with a higher charter school formation rate.

Chapter three further explores the connection between charter schools and their interconnectivity with the broader economy. Posed as a method of returning education to the private market, charter schools are considered to be more exposed to market conditions, potentially more nimble to changing conditions and methodologies, but also potentially functioning in a more volatile

market where school closings can occur more easily. This chapter uses the impact of the 2007 financial crisis to determine if charter schools were impacted differently than public schools. Using a nationally representative sample and aggregating to the Core Based Statistical Area, I find both traditional public and charter schools experienced small decreases in revenue but were largely sheltered from recessionary forces due to Federal intervention. Using a difference-in-differences approach I find that charter schools experienced both an increased rate of openings and an increase in the stock during the Great Recession. I attribute this effect to the decreased opportunity cost of charter school entrepreneurship. However, areas most affected by the Great Recession experienced a decrease in the stock of charter schools, as the challenges associated with opening a new school likely increased and lowered the viability relative to education entrepreneur's next best venture.

ACKNOWLEDGEMENTS

This dissertation would not have been possible without the immense support provided by my family, friends, and members of the economics department at Colorado State University. I would like to thank Leah for being the best partner I could ask for. Thank you, Leah, for your endless patience and for providing both the mental and physical means to complete this research. I would like to thank my parents Frans and Deborah for their truly enormous support and encouragement. Thank you for always pushing me to be myself. Thank you, Stephan, for always reaching out and keeping me on track to accomplish what I set out to do. Without Stephan’s dedication to supporting me and maintaining scientific rigor this research would have been little more than cave paintings.

I would like to thank my colleagues in the department who were sources of encouragement, knowledge, and friendship. Thank you to Anil, Arpan, Nick, Kevin, and Alex. Without your help, I would never have been able to navigate these waters.

Lastly, I would like to thank my friends for always being there for me and for understanding when I couldn’t reciprocate. Thank you to Will, Tom, Bryan, Kris, Dennis, and Lane. Thank you for all the laughs and adventures.

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Introduction

Recent economic development has provided economists with many interesting and challenging problems to analyze. The shift in manufacturing to countries with lower wages and input prices, the impact of greater global trade, tumultuous energy prices, and large demographic shifts such as the greater integration of women in the workforce has changed the economic prospects and lifestyle of the average household. Time has also revealed the persistence of certain economic trends, whether desirable or problematic.

For regional economists, one of the central challenges has been how to identify, explain, and tackle the unevenness of growth in places that are geographically similar or physically close. Pueblo, Colorado is located just 45 miles south of Colorado Springs, but in 2022 had one quarter the population and a median household income of $46,766 compared to Colorado Spring's median household income of $71,957 (U.S Census Bureau, 2021). There are some obvious differences, such as Colorado Springs being home to several military bases and an Air Force academy, but this likely does not fully explain the large spread between these two cities.

Economists have identified several different factors which can generate large economic and demographic disparities, such as institutional structure (both current and historical), industry and agglomeration economies, transportation structure, natural resource endowment, land availability, the weather, and amenities. While some of these factors, such as natural resource endowment are likely to be static, others such as institutions and amenities can be changed given enough people are willing to do so, and the right opportunity either presents itself or is created. This dissertation focuses on two factors that can impact a city's ability to grow, maintain itself, and directly affects the general welfare of resident households. Chapter 1 focuses on land availability in the context of contaminated land reuse, while chapters 2 and 3 focus on educational alternatives through the lens of amenities.

Efficient land use within a city is subject to several competing factors. The typical firm needs access to workers, capital, and land to produce a good or service. Workers employed by these firms need access to housing, services, and transportation. As a city becomes more developed and populated, it will naturally increase the price of land in the urbanized core, leading firms and households to locate themselves in areas that balance cost versus amenities offered. There are many challenges associated with this changing land use that affects both efficiency and the welfare of residents.

One of the challenges cities face is many production methods and services offered use or generate chemicals in their production. These are harmful to both the natural environment and the people who work and reside in these areas. When these firms cease production and vacate the property, this land is now contaminated and cannot be safely used by firms or households until it has been cleaned. In chapter 1 novel survey data of Colorado real estate professionals is used to show these contaminated sites are not remediated and reused efficiently due to the presence of a stigma effect. Land redevelopers worry the level of contamination will be greater than expected or more difficult to clean than anticipated. Specifically, even when told they will be fully compensated for the cost of cleanup, these real estate professionals still require an additional premium on their rate of return compared to working with a non-contaminated property.

Additionally, potential purchasers or users of remediated property are unsure of whether the property has been properly cleaned of all contamination, which leads those who are willing to remediate these properties to potentially experience difficulties selling. This first-mover problem disincentivizes developers from being the first party to deal with the property, and these sites will be cleaned up at a lower rate than what would be socially optimal. In chapter 1 I contribute to existing literature by statistically identifying and quantifying this stigma effect and showing that cities will experience inefficient land reuse from contaminated properties. To efficiently grow and best accommodate both firms and residents, cities will need to tackle their growing stocks of contaminated land through incentives, increasing information available to potential developers, or by providing better structure to the remediation process.

Along with maintaining and efficiently allocating land, cities must offer services and amenities which attract and retain residents. Better educational establishments improve the quality of workers available to firms through the direct education of residents and by attracting migrants who will need schools for their children. In this dissertation, chapter 2 explores supply and demand factors for charter schools, which are an educational alternative to the traditional public school system. In the United States, a charter school is a privately ran, publicly funded school which has greater flexibility in determining their curriculum relative to the traditional public school system. While most existing research on charter schools has focused on educational outcomes relative to traditional public schools, a much smaller body of research exists on determining what factors influence the demand for charters.

In chapter 2 I contribute to this literature by analyzing the link between specific industry employment and the formation rate of charter schools in a core-based statistical area. Using data from the North American Classification System (NAICS), I find core-based statistical areas with a higher concentration of establishments in professional, scientific and technical services have more charter schools and a higher rate of openings. This result suggests cities and towns who wish to grow and maintain their workforce of skilled, technical workers can offer charter schools as an attractive amenity. Due to the heterogenous nature of charter school design and curriculum better educational outcomes are not guaranteed, but it appears households are interested in the ability to choose between schools without being tied to school district zoning dependent on living in a specific neighborhood.

Chapter 3 asks the question of whether charter schools are more exposed to market conditions than their traditional public school counterparts. If cities and towns choose to grow their stock of charter schools, are they exposing their education system to greater turbulence during economic downtowns? Previous research has focused on the impact of the Great Recession on traditional public schools, but little work has focused on its impact on charter schools. I contribute to the literature by comparing changes to the stock of charter schools relative to traditional public schools during the Great Recession.

I find that the overall effect of the Great Recession was an increase in the number of charter schools and the rate of charter openings in the typical core-based statistical area. I attribute this to the opportunity cost decreasing for potential educational entrepreneurs, and charter schools' lack of reliance on state funding. However, for areas most affected by the Great Recession the rate of charter openings decreases. This is likely due to the increased difficulties in opening a charter school from a funding and capital perspective. Overall, it appears charter schools were resilient to a greater market shock, and while these schools are technically more market integrated due being privately ran, their access to public funding helps shelter these institutions.

These findings suggest cities and towns may improve their competitiveness and satisfaction of residents by both actively tackling their growing stock of contaminated land and increasing their provision of education amenities. Economic research has been unable to find a "magic bullet" for closing the economic gaps between geographically similar or physically close cities and towns, but instead there are many small, important ways policy can be used to help raise places which need it the most.

Chapter 1: Brownfield Development: Uncertainty, Asymmetric Information, and Risk Premia[1]

1.1 Introduction

Due to differences in regulation, production techniques, and heavy industrial use in the past (Collaton & Bartsch, 1996), communities have found themselves left with sites which the redevelopment of is desirable due to its location and attributes, but is difficult to attract individuals willing to tackle the uncertainty and obstacles associated with the potential clean up (De Sousa, 2000; Howland, 2010; McCarthy, 2002; Meyer & Lyons, 2000; Slutzky & Frey, 2010; Wernstedt et al., 2006). As defined by the House of Representatives (2002), "… The term 'brownfield site' means real property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant".

While there are numerous benefits to the redevelopment and reuse of brownfield sites (De Sousa et al., 2009; Gayer & Viscusi, 2001; Haninger et al., 2017; Kiel & Williams, 2007; McClusky & Rausser, 2003a; Jackson, 2003), these redevelopment efforts are undertaken at a much lower rate than is socially desirable, even when there are government incentives operating in the market. Brownfield redevelopment occurs at low rates due to several different factors. Developers tend to fear the legal liability for contamination, face uncertain cleanup standards, have difficulty finding funding for redevelopment, and deal with complicated regulatory requirements (Boyd et al., 1996; De Sousa, 2000; Howland, 2010; McCarthy, 2002; Meyer & Lyons, 2000).

[1] This chapter has co-authors: Michael Trouw, Stephan Weiler, & Jesse Silverstein contributed to this work.

The fundamental issues driving these complications are the uncertainty associated with the level of contamination for the site which determines the cost of cleanup and future liability concerns. Specifically, the market for brownfields suffers from a form of Akerlof's lemons problem (Akerlof, 1970; Boyd et al., 1996). There exists an information asymmetry between the buyers and sellers of potentially contaminated property. The seller of the site knows significantly more about the potential contamination level than the prospective buyer, generating an information asymmetry. Due to the uncertainty surrounding the status of the property, a buyer will offer a lower price than the seller is willing to accept, leading the mutually beneficial transaction to fail. This information asymmetry leads many buyers and sellers to drop out of the market, which consequently becomes thin (Weiler, 2000a; Weiler et al., 2000). We argue the effects of this information asymmetry persist even when more information about the property has been revealed in the form of a stigma associated with being a brownfield. As with the "Market for Lemons", this thinning of the market lowers the average quality of brownfield sites on the market.

Additionally, we argue the market for brownfields also suffers from a first-mover problem (Weiler, 2000a), where socially beneficial actions are not undertaken due to the private benefit to the individual actor being too low to act as an incentive. The developer is the "first-mover" in tackling the contamination problem and bringing the property back into use. Due to the perceived risk associated with brownfield sites, developers cannot expect to receive the full value of their property when they go to sell it even after remediation. These effects contribute to a lower level of brownfield remediation and therefore fewer transactions on which to base expectations and beliefs on. This situation leads to profitable transactions and remediations not being undertaken, as potential buyers rely on noisy market data to estimate profitability and cleanup costs (Lang & Nakamura, 1993; Weiler et al., 2006). We model this asymmetry formally, incorporating the results from survey evidence.

Using a survey of real estate development professionals in the Denver metro area, this chapter statistically quantifies the risk premia associated with brownfield redevelopment. We find private sector buyers require additional compensation in the form of a higher rate of return above cleanup costs to consider a brownfield redevelopment project. We additionally find that attitudes and previous experience with contaminated site remediation are significant determinants of willingness to invest in a contaminated site, while general characteristics such as property type, and typical role played by the survey respondent are also important. The survey results also suggest that different types of contamination lead to different risk premia, which we argue is associated with the familiarity of and difficulty of dealing with different contaminants.

Section 1.2 of this chapter reviews the challenges of brownfield redevelopment and introduces the theoretical framework, and Section 1.3 presents the hypotheses. Section 1.4 details the survey data, and Section 1.5 contains the two-tier analytical results. Section 1.6 details the implications of the survey results using the theoretical framework. Section 1.7 concludes.

1.2 Brownfield Remediation: Informational Asymmetry

Common potential brownfield sites may be an old gas station, industrial site, dry cleaner, or abandoned residential site with asbestos (U.S. Conference of Mayors, 2010). It is difficult to find exact numbers on how many brownfield sites are within an area, as contamination levels vary, and locals may be unsure about how to classify a specific property. Another difficulty arises from property owners who would rather not report potential contamination unless required to do so. Brownfield sites are generally only reported as such when a developer or site-owner applies for a federal grant to help remediate the property or participates in a voluntary cleanup program held at the state level. The EPA estimates there are more than 450,000 brownfield sites in the United States. The U.S. Conference of Mayors in their 2008 survey found that 188 cities in the U.S. reported 24,896 brownfield sites totaling conservatively 83,949 acres of land. At the federal level, the EPA has received grant applications for 1,383 brownfield properties since 2002, while Colorado alone has seen 1,162 applications for its voluntary cleanup program (VCUP) since 1994 (Haninger et al., 2017; CDPHE, 2017).

Considering these statistics, it is apparent that brownfield remediation is occurring at a much lower rate than necessary to significantly reduce the growing stock of identified contaminated sites. Additionally, sites may be added to the pool as existing but unknown pollutants are identified and designated as serious enough to require cleanup. For example, perfluoroalkyl and polyfluoroalkyl substances (PFAS) used in firefighting and the production of items such as Teflon cooking tools have been designated as an emerging contaminant of concern (Sauve & Desrosiers, 2014; Wells et al., 2022).

Numerous benefits to brownfield remediation have been identified and are typically quantified via their effect on housing prices and tax revenue for the local government. McCluskey & Rausser (2003a) found that property owners near hazardous waste sites experience lower housing appreciation rates after the EPA identified the site, and this reduction in housing values relative to other non-contaminated areas may be reversed if the brownfield site is cleaned. Using a hedonic pricing model paired with high resolution and high frequency data, it has been found that a cleaned brownfield site increases nearby property values by 5 to 11.5% (Haninger et al., 2017). Importantly, this impact on housing prices is sensitive to the perception of the risk itself, and the uncertainty of the level of contamination.

In recognition of a growing environmental problem, in 1980 the United States passed the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). This act created some issues for brownfield remediation, as it allows the government to assign liability to current owners of sites even if they were not the original polluting party. To reduce the uncertainty involved with the potential liability for future developers of smaller scale projects, the Small Business Liability and Brownfields Revitalization Act (Brownfields Act) was passed in 2002. The goal of the Brownfields Act was to primarily reduce the associated liability risk that developers and investors face when considering a contaminated property. State level governments in the U.S. have also implemented their own grants and methods to reduce the uncertainty associated with contamination and liability of these properties, such as Voluntary Cleanup Programs (VCPs). VCPs help private parties navigate the cleanup process by introducing state oversight and coordination, which in turn reduces the perceived risk of liability (Meyer & Lyons, 2000). This liability relief from both cleanup costs and claims by third parties is of relatively high value to developers when surveyed (Wernstedt et al., 2006). However, these programs have fees associated with them for the private developer, who essentially pays the government to perform oversight (Blackman et al., 2010). Additionally, states such as Michigan have begun creating programs which invest in brownfield redevelopment, with the idea that increased future tax revenues will cover the costs of the program. However, Bendor et al. (2011) found that a simulated investment of $500,000 per year will take six years for the benefits to outweigh the costs.

Even with these programs created by state and federal governments, the private developers fear of liability, the uncertainty surrounding potential contamination, and the associated costs of information gathering create a general market condition much like George Akerlof's market for lemons (Akerlof, 1970; Boyd, Harrington, and Macauley, 1996). The market for lemons refers to a product market where the buyer of the good has less information about quality than the seller, which leads the information-lacking potential buyer to offer an average price for the good regardless of quality. The developer will not know the true extent of the contamination until they purchase the property and have begun the remediation assessment process. Because of this, the developer requires an additional return on their investment to compensate them for the higher risk associated with potentially contaminated properties. We argue this risk premium is directly connected with the stigma associated with brownfield sites, since it persists even when the developer knows and will be compensated for the cost of cleanup.

Stigma in this context refers to the general fear of liability, potential costs, and difficulty selling properties which have been identified as brownfields by those involved in both the redevelopment and purchasing of these properties (McClusky & Rausser, 2003b).

This leads higher quality properties to trade for less than their value or not at all, while lower quality properties will trade for higher prices than their true value. This affects the developer's perceptions of the true quality of properties in the brownfield market, which lowers the average price and further suppresses transactions. This self-reinforcing cycle of low development in the market for brownfields is the result of rational decision making by individuals but is not socially optimal as the level of redevelopment is too low.

Lang and Nakamura in their 1993 work on redlining describe a similar situation with banks. Neighborhoods with lower levels of development do not have enough transactional data to provide banks with good estimates on lending risk, so they underprovide credit by offering too high of interest rates or not disbursing loans at all. This combination of low development activity and inefficient market pricing generates a first-mover problem, where transactions which would be beneficial to the community from both a redevelopment and informational perspective are not undertaken because the benefit to the developer only stems from the post-remediation value of the site (Weiler, 2000a). By removing the contamination, the developer is the "first-mover", and their return on investment is impacted by the lingering stigma effect in the form of a lower post-remediation sale price. The social benefit of remediating the brownfield property outweighs the private benefit, and these remediations are undertaken at a rate lower than what is socially optimal.

A further potential complication arises from the possibility of having an economically significant stigma effect associated with a property post remediation, as buyers of remediated properties may be worried the cleanup was not sufficient and they will be liable in the future. This makes the initial transaction before cleanup less likely, due to the potentially lower returns to a developer interested in remediating the property to sell it.

There are further potential complications for brownfield remediation beyond the contamination. Tureckova et al. (2018) using factor analysis on a general set of brownfields in the Czech Republic found that the property ownership, size, and distance from the local governing body are significant determining factors in remediation potential. Ownership in this case refers to public, private, or a public-private partnership. Given these potential market frictions in redeveloping brownfield properties, we turn to the empirical analysis to understand what affects the discrepancy in valuation for brownfield properties and the magnitudes of these effects.

1.3 Hypotheses: From Theory to Empirical Testing

There are several testable hypotheses that arise from the literature, which we divide into two sets. Our first set of hypotheses shown in Table 1.1 concerns the binary choice of ***whether*** to invest in a representative contaminated property net of cleanup costs. A priori, we expect those who have experience in dealing with contaminated properties and related services such as voluntary cleanup programs in the past will be more willing to invest in future contaminated land redevelopment, as their own experience provides them with greater market information. We also expect the role in which the developer specializes will affect their willingness to invest, as brokers may inherently have a different level of risk than a developer who focuses on the actual cleanup. Finally, we expect to find differences in willingness to invest based on property type, as residential and commercial properties require different standards of cleanup compared to industrial properties. We address these hypotheses using Probit analysis, which we detail in Section 5.

Table 1.1: Hypotheses Based on Investment Choice

Hypothesis	Empirical Implication
Experience with contaminated land remediation and programs leads to a greater willingness to invest in contaminated property.	The coefficients on experience with voluntary cleanup programs and prior accidental purchases of contaminated land will be positive, indicating greater willingness to invest.
Transaction role affects their willingness to invest.	Significant coefficients on dummy variables representing different roles such as broker and developer, indicating different willingness to invest.
Typical transaction type affects their willingness to invest.	Significant coefficients on dummy variables representing different property types, indicating different willingness to invest.

Our second set of hypotheses shown in Table 1.2 concern the ***requirements*** of developers who indicate they are willing to invest in contaminated properties. We expect there is a significant stigma effect present in the market for contaminated land, even after accounting for cleanup costs. We expect this stigma effect will present itself as an increase in the capitalization rate developers require for contaminated properties relative to clean properties, even when told they will be compensated for cleanup costs. We further expect there will be a greater variance in required capitalization rates across our sample of developers, due to the lack of representative market transactions upon which to base their expectations of profitability and cleanup costs. This variance reflects widely varying individual perspectives on the exact same property proposition. We address these hypotheses using differences in means testing in Section 5.

Table 1.2: Hypotheses Based on the Requirements of Those Willing to Invest

Hypothesis	Empirical Implication
Investors require a risk premium to incentivize them to invest in contaminated properties even when cleanup costs are known and compensated.	Positive and significant coefficients on capitalization/terminal rates for gasoline, dry-cleaning, and solvent contaminated properties relative to clean properties.
Due to poor market information, developers have widely different expectations of profitability and cleanup costs.	The variance for the contaminated property capitalization/terminal rates will be significantly greater than for clean properties.

1.4 Survey Data

A four-page survey conducted in 2002 by the Center for Research on the Colorado Economy and Development Research Partners Inc. was sent to 900 real estate development professionals in the Metro Denver area (Appendix A). The mailing list was developed from the membership of professional associations including Certified Commercial Investment Member, Counselors of Real Estate, the Society of Industrial and Office Realtors, and the Denver Metro Commercial Association of Realtors, supplemented by the commercial real estate developer directory maintained by the Colorado Real Estate Journal. These individuals were chosen to generate a representative real estate development professional's required rate of return.

The survey had a response rate of 17.2%, with a total of 155 surveys returned. 149 contained sufficient information to be used for analysis. Not all respondents answered all questions, so restricted-subsamples were used to analyze certain questions. The survey gathered background information on the respondent's development roles, the typical types of properties they develop and invest in, their attitude toward and experience with contaminated properties. Summary statistics for the survey data are shown in Appendix B.

The first question asked the respondent to categorize themselves into any of the following roles which applied: broker, developer, financier, and investor. A broker would be defined as an intermediary in the sale or transaction who receives a fee for their services. A developer takes on the actual development by improving the site by adding or replacing buildings. Investors and financiers contribute capital to use in the transactions. 82% identified themselves as brokers, with 30% being solely brokers, while 52% of respondents categorized themselves as brokers among other roles.

The second question asked respondents about the types of property with which they typically deal. The choices available were single-family residential, multi-family residential, retail, office, and industrial. They were asked to indicate all categories that applied. Responses were spread evenly between all five property types, with respondents not showing a high level of specialization in any specific development. The survey then asked the respondents to indicate the typical transaction sizes that they deal with, where we find respondents tend to cluster around medium size transactions of $1,000,000 to $5,000,000, with even tails into smaller and larger transactions.

The next set of questions assess the risk-tolerance level of the respondents. Respondents were asked whether they had ever purchased property with environmental contamination issues, of which 64% indicated they had not, 8% unintentionally bought contaminated property, and 28% had purchased contaminated sites intentionally. It was then asked whether they purchase contaminated property, and if they would consider doing so. 15% said they will never willingly purchase contaminated property, 69% indicated they try to avoid it but will purchase contaminated property if the economics makes sense, and 16% specified they would invest in both clean and contaminated properties. Combining these two sets of responses, this suggests that while most respondents would consider purchasing contaminated property if the economics makes sense, the majority had not done so.

Similarly, survey respondents were asked if they would continue with a project when the initial phase I environmental site assessment shows on-site environmental issues. 86.6% indicated they would further investigate and continue to pursue the investment. However, when a follow up question was asked suggesting that the phase II investigation reflected on-site contamination, those who would be willing to continue pursuing the investment dropped to 42.9%. This finding shows an aversion to dealing with a contamination issue.

The remainder of the survey asked respondents to consider a well-defined property type that was typical for them, and to tell what rates and other parameters they would set as criteria for the investment decision if the property was clear of contamination. They noted their overall capitalization rate, reversion or terminal capitalization rate, discount rate, and anticipated investment holding period.

The capitalization rate is a commonly used measure in real estate which allows for the comparison of the rate of return for different properties:

$$\text{Capitalization Rate} = \frac{\text{Net Operating Income}}{\text{Market Price}} \tag{1.1}$$

By taking the revenue (realized or potential) of a property and dividing by the market value, individuals can compare the rate of return on the asset versus other potential investments (Wincott, 2016). The terminal (reversion) rate for a property is the expected capitalization rate at the time of sale.

Then, the same property respondents were asked to revise their criteria if the property had known cleanup costs equal to 15% of the clean property purchase price. Three types of contamination were posed: Gasoline contamination, dry cleaning contamination, and degreasing/solvent contamination. They were asked whether they would still consider investing, what their required capitalization rates and discount rate would be, what their expected holding rate would be compared to their typical, and whether these responses already considered a purchase price lowered by the expected amount of cleanup cost.

We focus on differences in capitalization rates for most of the empirical and theoretical analysis. This formulation is useful because it may be easily parameterized with the survey. In focusing on the capitalization rate (Equation 1.1) and net operating income (NOI) we are excluding loan principal/interest, capital expenditures, and depreciation/amortization. This takes the debt, access to equity capital, and other financial aspects of a project out of the analysis and focuses on the direct relationship of market price per income dollar generated, allowing a direct comparison across projects, and is a common metric in the real estate industry.

1.5 Empirical Analysis

We evaluate our first set of hypotheses addressing what factors influence these individuals' willingness to invest with a Probit analysis of the survey data. We consider three types of potential contamination: gasoline, dry cleaning chemicals, and solvent contamination. Survey data on the respondent's familiarity with voluntary cleanup programs, attitudes toward contamination screening, typical transaction roles, property types and transaction sizes are employed to estimate the willingness to invest in contaminated properties:

$$\mathrm{P}(\mathrm{Invest_i} = 1|\mathbf{X}) = \phi(\beta_0 + \boldsymbol{\beta}\mathbf{X}) = \phi(\beta_0 + \beta_1\mathrm{Role_i} + \beta_2\mathrm{Type_i} + \beta_3\mathrm{Size_i} + \beta_4\mathrm{VCP_i} + \beta_5\mathrm{Screen_i}) \quad (1.2)$$

All variables are binary, with summary statistics for the variables of interest reported in Table 1.3. As multicollinearity is likely a concern, Appendix B3 contains a correlation matrix of all variables employed in the analysis and shows the independent variables are only mildly related. Those choosing to invest are assigned a value of 1 while not investing is assigned a value of 0. The effect of role type is explored with Broker as the reference category. The reference category for property type contains single family and multi-family properties. The reference category for transaction size is $1-5 million, as most individuals fell into this category. The VCP reference category contains those who have never dealt with a VCP program. Never purchased is an indicator variable capturing if an individual has not purchased a contaminated property. Screen Phase1 refers to those who always choose to check for contamination when making a purchase. The “Contam” variables capture whether individuals are willing to continue with the transaction if contamination is found onsite or offsite during a Phase 1 or Phase 2 assessment.

Table 1.3: Summary Statistics of the Sample

	N	Mean	St.Dev
Gas Invest	135	.726	.448
Dry Invest	130	.508	.502
Solvent Invest	128	.547	.5
Avoid Maybe	149	.691	.464
Buy Both	149	.161	.369
Accidental Purchase	149	.081	.273
Broker	149	.826	.381
Developer	149	.463	.5
Investor	149	.477	.501
Financier	149	.074	.262
Office & Retail	155	.645	.48
Industrial	149	.584	.495
Less 1mil	155	.652	.478
BT 1mil 5mil	149	.604	.491
Greater 5mil	149	.248	.433
VCP Helpful	149	.282	.451
VCP NoHelp	149	.168	.375
Screen Phase1	149	.537	.5
P1 Contam Onsite	147	.857	.351
P1 Contam Offsite	144	.542	.5
P2 Contam Onsite	137	.467	.501

The results of the Probit analysis are displayed in Table 1.4, which reports marginal effects for ease of interpretation. The full Probit results can be found in Appendix B4. The coefficients reported in Table 1.4 can be interpreted as the change in the probability an individual will invest. For example, in regression (1) an individual who have used a voluntary cleanup program (VCP) before and found it helpful are 27.5% more likely to invest compared to those who signaled they do not purchase contaminated properties.

In terms of individual attributes, those who operate as investors are less likely to invest in contaminated properties compared to brokers. This could be capturing a perceived higher financial risk, which is interesting considering that those who signaled the role of Developer do not show the same hesitation. Those who indicated they deal with Office and Retail properties are more likely to invest in a contaminated property. This may be due to the ease of cleanup compared to homes, which may have more stringent requirements for use. Transaction size is not significant in determining their likelihood to invest.

Table 1.4: Investment Choice Probit Marginal Effects

VARIABLES	(1) Gas	(2) Dry	(3) Solvent
Accidental Purchase	-0.145	-0.047	-0.175
	(0.099)	(0.136)	(0.130)
Developer	0.004	0.070	0.110
	(0.061)	(0.083)	(0.081)
Investor	-0.103*	-0.128	-0.102
	(0.057)	(0.079)	(0.079)
Financier	0.067	-0.000	0.093
	(0.150)	(0.146)	(0.167)
Office & Retail	0.159***	0.095	-0.096
	(0.056)	(0.086)	(0.082)
Industrial	-0.091	-0.059	0.059
	(0.063)	(0.087)	(0.082)
Less 1mil	-0.116	-0.073	-0.015
	(0.072)	(0.095)	(0.092)
Greater 5mil	0.008	-0.012	0.057
	(0.077)	(0.099)	(0.097)
VCP Helpful	0.275***	0.132	0.234**
	(0.088)	(0.091)	(0.092)
VCP NoHelp	0.210**	0.026	-0.009
	(0.088)	(0.103)	(0.102)
Screen Phase1	-0.076	-0.063	-0.047
	(0.061)	(0.081)	(0.080)
P1 Contam Onsite	0.273***	0.234*	0.235**
	(0.069)	(0.128)	(0.115)
P1 Contam Offsite	0.146**	0.227***	0.191***

	(0.060)	(0.076)	(0.074)
P2 Contam Onsite	0.181***	0.221***	0.195***
	(0.060)	(0.076)	(0.072)
Observations	126	121	119

Standard errors in parentheses

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Individuals who indicated they always screen for contamination when considering a property were no more likely to invest than those who only screen at the lenders request, or if contamination was suspected. The "Contam" variables show generally that those who indicated they would continue an investment even after finding potential contamination during a screening are more likely to invest. Those that indicated they would consider an investment even after the more in-depth Phase 2 screening found contamination were approximately 18-22% more likely to invest.

Looking at previous experience with contaminated land, the empirical analysis shows that an accidental purchase of a contaminated property in the past does not significantly affect their present willingness to invest in contaminated properties. However, it should be noted the coefficient on accidental purchase is non-zero and negative. This means that while a potentially negative or positive experience has not decreased their willingness to invest in these properties, a study with more statistical power may find a stronger relationship. Additionally, we find that both a positive or negative experience with a Voluntary Cleanup Program increases their willingness to invest in gasoline contaminated properties, and a positive experience increases willingness to deal with solvent contamination. This result indicates that regardless of success, more experience in dealing in these properties is likely to adjust expectations positively, as individuals begin to overcome the lack of information in the market through their own experiences.

We now turn to our second set of hypotheses focused on the stigma effect and market information. Difference-in-means tests the hypothesis of whether there is a risk premium required to entice real estate development professionals to engage in brownfield transactions, even after accounting for cleanup costs. The initial test examines whether the overall capitalization rate, reversion/terminal rate, discount rate, and holding period are statistically different between the cases of clean versus contaminated properties. The results are shown in Table 1.5.

Judged at a 5% significance level, the tests indicate statistically significant differences between the two cases for all the rates used in our study, supporting the hypothesis that investors do require a premium in the rate of return required when investing in contaminated property as compared to investing in a clean property. The existence of this risk premium is compelling, as respondents were told that the cleanup costs associated with the contaminated properties were both known and compensated. This premium therefore represents additional uncertainty that remains purely as the stigma surrounding these properties. We find a capitalization rate premium of 2.3% for gasoline contamination, 2.5% for dry cleaning, and 2.96% for degreasing/solvent as compared to a clean property investment. This difference in the premium and holding periods between the different types of contamination could also stem from the information differentials concerning the difficulty of cleanup. Gasoline contamination may be dealt with more frequently, and therefore investors while still uncertain about the property, may have more information resources available to them as compared with dry cleaning and degreasing/solvent contamination.

Additionally, the variance in capitalization rates ranges from two to four times higher when considering contaminated properties when compared to clean properties. This wide range of estimates lends support to the hypothesis that the lack of information in the market leads potential investors to have high uncertainty about the potential returns, reflected in the much greater capitalization rates despite the fact that cleanup is fully funded. Potentially profitable investments thus may not be undertaken. We also see that the average holding period for contaminated properties is lower and statistically significant, implying respondents who are willing to invest in these properties are more concerned with immediate value recovery, as they see less long-term value in holding and/or using the property.

Table 1.5: Difference in Means of Clean and Contaminated Property Responses

Capitalization Rate (%)	**Clean**	**Gas**	**Clean[1]**	**Dry-Clean**	**Clean[1]**	**Solvent/Degreaser**
Mean	10.44	12.37	10.5	12.89	10.69	13.91
Variance	6.47	18.77	7.28	25.05	7.55	24.44
Observations	71		51		55	
T-Statistic	5.489		4.622		5.233	
P-Value	P<0.0000		P<0.0000		P<0.0000	
Terminal Rate (%)	**Clean**	**Gas**	**Clean**	**Dry-Clean**	**Clean**	**Solvent/Degreaser**
Mean	11.17	13.18	11.08	13.1	11.19	13.59
Variance	11.34	22.73	11.36	19.73	11.43	25.85
Observations	46		33		35	
T-Statistic	5.388		4.353		3.749	
P-Value	P<0.0000		0.0001		0.0007	
Discount Rate	**Clean**	**Gas**	**Clean**	**Dry-**	**Clean**	**Solvent/Degreaser**

				Clean		
Mean	10.67	12.65	10.91	13.82	10.91	13.91
Variance	29.61	40.95	39.32	68.35	39.32	73.13
Observations	30		22		22	
T-Statistic	3.579		3.362		3.224	
P-Value	P<0.0000		0.0029		0.0041	
Holding Period (Years)	**Clean**	**Gas**	**Clean**	**Dry-Clean**	**Clean**	**Solvent/Degreaser**
Mean	8.30	7.48	8.97	8.04	8.83	8
Variance	28.58	25.90	35.46	30.98	32.68	28.81
Observations	76		54		60	
T-Statistic	2.456		2.251		2.141	
P-Value	0.0164		0.0285		0.0364	

1: Mean values for clean properties differ as we directly compare responses of those who indicated they would invest given that type of contamination with their clean property values, as opposed to the entire sample.

The results of the empirical analysis provide support for the hypotheses. Information and general attitudes towards contaminated investment appear to be the most significant factors in developers' willingness to invest, as opposed to their typical roles and transaction types. Furthermore, developers working in the market for contaminated properties require a risk premium to incentivize them to invest above and beyond cleanup costs, and high variance in required returns highlights widely varying perceptions of identical property propositions. These results imply increasing the remediation of brownfield properties could benefit from the provision of additional information about contamination characteristics and typical returns, which are usually provided by existing market transactions but are underprovided within the typical brownfield market relative to the broader social optimum.

1.6 Theoretical Implications

In this section we use a hypothetical transaction to explore the implications of the stigma effect found with the empirical analysis. As a comparison, the market result achieved by real estate development professionals is contrasted with that of a social optimum (SO). The SO does not suffer from the stigma effect, because under the SO condition market participants have perfect information about the quality of the site.

For simplicity, we consider two different types of sites: clean and contaminated. Clean sites have never been environmentally contaminated. Contaminated sites are known to be currently impaired from previous use and require cleanup for future use. There are two forms of impairment associated with a contaminated site: the actual physical contamination of the site, and the stigma associated with a brownfield property. We assume both site types have the same dimensions and characteristics in the absence of contamination. Both parcels are assumed to have a vacant building, which in the absence of contamination could be used to generate rental income. The net operating income (NOI) for both properties will be the same once the contamination is remediated, which we assume to be $100,000.

We first compare the market result with that of the SO for a clean property, where referencing the survey results, developers expect a capitalization rate of approximately 10%. Plugging this into equation 1 with our assumed NOI shows developers in the market are willing to purchase a clean property with these characteristics for $1MM. This price is competitive, as any developer who offers a lower price will be supplanted by another willing to offer a higher price, until the capitalization rate is reduced to the minimum of 10%. Since the developers know that the site is not contaminated, the SP result will be identical for clean sites.

For contaminated sites, we assume cleanup costs equivalent to 15% of the market price in accordance with the survey. Specifically, the survey asks developers to consider a contaminated site where cleanup costs are known and compensated. This enters into the formulation as a reduction of the market price that the developers pay:

$$\text{Contaminated Market Price} = \text{Market Price} - \text{Cleanup Costs} = \$1\text{MM} - \$150\text{K} = \$850\text{K} \qquad (1.3)$$

In the absence of the stigma effect, the contaminated site will sell for $850K, which allows the developer to maintain their 10% capitalization rate as found by the survey results for a clean property. However, using the survey results, developers require an additional risk premium to invest willingly in brownfield properties. Being the first mover and responsible for the cleanup, the developer views the transaction as being inherently riskier. A risk premium of 3% over the capitalization rate for a clean property for a total of 13% decreases the maximum price they are willing to pay for the property:

$$\text{Stigmatized Market Price} = \frac{\$100\text{K}}{13\%} - \$150\text{K} = \$619{,}200 \qquad (1.4)$$

Under the SO, market participants do not suffer from the stigma effect, since they have perfect information about the quality of the contaminated site. The SO recognizes the cleanup costs of 15% and nets this directly from the purchase price, setting the market price to $850K. This large discrepancy between the SO and market result leads to fewer transactions occurring in the market. This initial state of low redevelopment may continue in perpetuity, due to the lack of remediations available for potential developers to base their expectations on. This is similar to Lang and Nakamura (1993), where they show banks may systematically overestimate the riskiness of providing loans to perpetually disadvantaged communities due to a lack of market transactions upon which to base appraisals, effectively underfunding the community and keeping it in a perpetual state of low development and decline. While private actors may be practicing rational decision-making based on the information available to them, Lang and Nakamura showed the overall market may be operating inefficiently, with credit being underprovided and mutually beneficial loans not being dispersed. In this case, our market imperfection is the low rate of brownfield remediation.

Therefore, it is potentially important to incentivize these developers to begin redeveloping these properties to increase the level of information within the market. Specifically, we can quantify the value of increased information to the developer:

$$V(I) = E[P_P|I] - E[P_A] = P \tag{1.5}$$

Equation 1.5 represents the value to the developer of the gap generated by this informational asymmetry between buyer and seller (Weiler, Hoag, & Fan, 2006). P_A represents the value of the property ex-ante when the buyer considers all information they have available, while P_P represents the valuation of the property post transaction where the buyer is now able to glean more information about the true contamination level of the property. Subtracting the ex-ante valuation from the post valuation gives us the true value of information (P) about the property to the buyer. Using our developer's private market valuation of $619,200 for the contaminated property versus the true value of $850,000, we can see that the property is undervalued by $230,800.

An additional problem which presents itself is that the developer cannot rely on attaining the clean property price if they sell the remediated property. As noted in the survey results, developers typically expect to hold the contaminated property for a shorter period than a clean property, most likely engaging in value recovery (fix and flip). After cleanup, the contaminated site price over time will trend towards the clean price as opposed to immediately. The sale price will be lower than the true market value if the parcel is brought to market quickly, as the prospective buyer of the cleaned brownfield is unsure about the adequacy of the cleanup and the stigma effect lingers (McClusky & Rausser, 2003b). The market price (x) over time will fall between the range:

$$\text{Market Price} = \text{Clean} \geq x \geq \text{Stigmatized} = \$1MM \geq x \geq \$769{,}200 \tag{1.6}$$

The first mover problem for our site that has been recently remediated is modeled in the game tree below (Figure 1.1) with 2 stages:

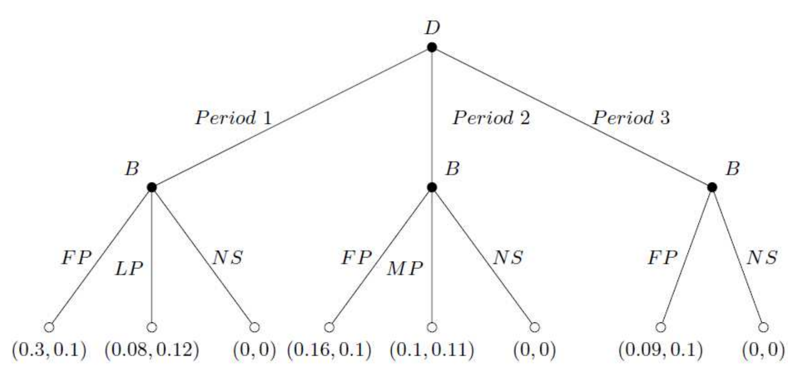

Figure 1.1: The Developer's Post Remediation Sale Choice: Timing & Sale Price

Focusing on the resale of the property, the game tree has two players: The Developer (D) who owns the recently remediated property and the Buyer (B) of the remediated property. The Developer goes first, and the Buyer responds in stage two of the game. The Developer is modeled as having three choices; sell the property immediately after cleanup (period 1), sell the property in period two (a five year hold), or sell the property in period 3 (a ten year hold). In each period, the developer has three payoff options: the full price (FP), low price (LP), and no sale (NS). Payoffs for the Developer are generated by calculating the Net Present Value (NPV) of all cash flows and costs (R) to the property over time:

$$NPV_i = \sum_{t=0}^{n} \frac{R}{(1+r)^t} \tag{1.7}$$

For example, if the Developer sells the property immediately for the full price (FP) of $1MM, then they gain a 30% return on their initial investment of $769,200. This value of 30% is represented by 0.3 on the far-left side of the game tree. However, it is unlikely that the Developer will ever receive such an offer because the buyer questions the quality of cleanup. Considering the stigma effect, it is assumed that the Buyer will require a higher capitalization rate depending on how quickly the property is brought to market in order to incentivize the perceived risk (assumed to be 12%), but lower than the initial 13% required by the developer who purchased the property in a non-remediated state:

$$\text{Period 1 Low Price Offer} = 12\% \text{ Cap Rate} = \text{LP} = \frac{\$100\text{K}}{12\%} = \$833{,}300 \tag{1.8}$$

The Buyer is always going to offer the lowest price possible since they are trying to compensate for the perceived additional risk of dealing with a previously contaminated property. The Developer will only receive low price (LP) offers in period 1 due to the persistent stigma associated with the property, medium price (MP) offers in period 2 due to the decreased stigma associated with the property, and finally the full price (FP) offer in period 3 when the stigma effect is no longer present. If the Developer accepts LP then they would only receive an 8% return on cost. The value of the period 2 and 3 payoffs depends on the Developer's discount rate, which our survey finds to be approximately 13%. Therefore, the Developer faces 10% and 9% returns in periods 2 and 3 respectively and should choose to sell the property in period 2.

Overall, this may decrease the willingness of Developers to participate in value recovery as they will have to increase their holding period to recover the most value possible. To further understand the loss of efficiency in the market we can consider the case in which the developer receives the full price for the remediated property. Ceteris paribus, it would be in the Developers best interest to immediately sell the property after remediation as we still discount their payoffs over time.

Table 1.6: Stigma Pricing Effects and Efficiency Loss (r=13%)

Time of Sale	Stigmatized Price	Full Price	Difference in return
Period 1 (t = 0)	8.3%	30%	-21.7%
Period 2 (t = 5)	9.9%	16.3%	-6.4%
Period 3 (t = 10)	8.8%	8.8%	0

Based on this assumed discount rate, the private market result gives the Developer a 21.7% lower return on cost if they sell their property in the first period, and a 6.4% lower return if they sell in the second period. In period 3 the returns are equivalent, as the stigma effect has dissipated over the ten-year waiting period.

These results are sensitive to the rate of stigma decay. For example, if instead the stigma effect reduces 50% instantly after remediation (boosting sale price) and in each period after, the developer will be interested in selling the property immediately. However, it is still inefficient as compared to the social optimum. Additionally, not every developer will be affected by the first mover problem to the same degree. For example, if the developer is interested in redeveloping the site to rent or plans to occupy the building themselves then they are less concerned with the extended holding period. It primarily makes it difficult for companies or individuals who specialize in remediating these properties, as they must find additional ways to maintain their capitalization rate and may not be interested in managing the property while the value recovers. These developers may require an even lower original purchase price for the contaminated property, or depending on the costs associated with cleanup, may expect to be paid to take the property and remediate it due to the large negative value of the site itself.

1.7 Conclusion

The results of the survey clearly show the main driving factor in developers' willingness to invest in contaminated properties is not their role or typical transaction type, but rather their attitudes and previous experience with contaminated properties. This finding already indicates the importance of information within such a thin transactional market. Furthermore, even among those willing to invest in such properties, there is a risk premium associated with redeveloping brownfield when compared to clean property. Real estate development professionals require a two to three percent risk premium in this market when considering potentially contaminated sites, even after being compensated for remediation costs with a reduced purchase price. This implies the risk premium is influenced by nonpecuniary factors which do not represent actual resource costs. The stigma associated with potentially contaminated properties drives the risk premium, as the lack of information in the market leads participants to have highly variable perceptions of the post-sale prospects for the representative property.

The brownfield situation yields a process remarkably parallel to Akerlof's classic lemons model, where many potential sellers drop out due to a dissatisfaction in their potential sale price, which then potentially leads the average quality of property in the market to decrease along with a thinning of the market. Fewer transactions within this market provide little information to potential buyers, who then base their expectations on noisy market data, biasing profitability and cleanup cost estimates as they are unable to properly assess the true market probabilities. This context creates a first-mover problem, further compounding the entrenched difficulty associated with remediating a contaminated property.

Based on these results, the market for brownfield sites is operating inefficiently relative to the social optimum due to asymmetric information. This has many implications, such as inefficient resource use and pollution as greenfield land further from the urban core is substituted for these stigmatized properties, depressed housing and neighborhood values, and decreased tax revenues. Local and state governments can help bridge this informational gap by maintaining easily accessible databases containing information on brownfield properties and expanding incentives for developers in order to minimize the stigma effect for both the initial purchase and the potential sale post cleanup.

Beyond providing information there are many ways governments can help redevelop brownfield properties. Recent work published on brownfields has focused on sustainable redevelopment, as both a potential upside of remediation and to incentivize (Koutra et al, 2023; Zang et al, 2021). For example, the redevelopment of an old industrial site into a solar farm (brightfield) both reduces health risks from the existing soil contamination and provides an energy source that does not emit harmful pollutants (Koutra et al, 2023). With the market for brownfields operating inefficiently, government subsidies or targeted projects can help mitigate the negative market externalities while also generating additional benefit beyond contamination removal.

Chapter 2: The Regional Determinants of Charter School Formation and Growth

2.1 Introduction

The efficacy of charter schooling has been heavily researched since the first charter school law was created by Minnesota in 1991. Charter schools were introduced as a method to increase school quality within the United States, and as of the 2021-22 school year there were approximately 7800 individual charters making up 8% of all public schools (NCES, 2023). Prior research has focused largely on measuring academic performance and the student body characteristics of these charters to assess their inclusiveness and ability to educate (Epple et al, 2015).

Beyond educational outcomes, a much smaller body of work has identified several different factors which influence a community's supply and demand for charter schools (Glomm et al., 2005; Hoxby, 2006; Ferreyra & Kosenok, 2018). Existing educational alternatives, public school characteristics, and increased heterogeneity in income, ethnicity, and parental education have been identified as influencing the demand for charter schools (Glomm et al., 2005; Ferreyra & Kosenok, 2018). Educational alternatives refers to the number of available private and magnet schools, which parents may choose instead of the traditional public school (TPS) system. The quality of existing public schools may also influence their decision, as a dissatisfaction with test scores and curriculum design can lead parents to search for an alternative.

Glomm et al. (2005) breaks down theoretical charter school demand into two types: vertical and horizontal innovation. The demand for vertical innovation is characterized by increases in education quality within the existing curriculum, while horizontal innovation demand refers to broadening the curriculum to contain material or methods not typically taught in public schools. In their paper, Glomm et al. do not separate these two different avenues of demand empirically.

Upon thorough review of the literature, previous analyses do not fully capture the determinants of demand for these schools, as they focus on general population heterogeneity as opposed to focused channels. As an example, previous work has not included industrial composition or employment types when considering the demand for charter schools. While it has been found charter school demand is higher in communities with higher education levels, no work has been done to identify if charter school demand differs across the degree subject matter (Epple et al, 2015; Glomm et al., 2005; Ferreyra & Kosenok, 2018). This work seeks to refine our understanding of the demand for alternative schools by considering if charter school creation is dependent on the types of industry and employment available within an area. For example, areas with a greater concentration of science and technology related firms (STEM) may employ individuals who are more interested in vertical schooling innovation, as they would prefer their children receive a higher quality education, putting students on track to learn the skills which they employ at work (Dustman, 2004; Pablo-Lerchundi et al, 2015). Alternatively, a greater relative concentration of the arts within an area may employ individuals who are interested in charter schools due to a desire for horizontal innovation, as they may prefer an alternative approach to education from that provided by TPS.

I contribute to this literature by considering the effect of community employment types and concentration on the demand for charter schools. Parental and community exposure to unique challenges, skills, and opportunities in their career may influence what they consider to be important aspects of education. For example, a career scientist who regularly relies on complex math and scientific knowledge may wish that their children are exposed to a curriculum which focuses more heavily on math and science than the local public schools (Dustman, 2004; Pablo-Lerchundi et al, 2015). Alternatively, an artist or graphic designer may desire more exposure to creative activities than the current public curriculum offers. Using a panel of 286 Core-Based Statistical Areas (CBSA) over the period of 2005-15, I find evidence of vertical innovation, where communities with a higher concentration of science and technology related firms is associated with a higher charter school formation rate. This work does not find evidence of horizontal innovation, with the concentration of the arts and recreation industry not being a significant determining factor in the demand for charter schools.

This industry linkage to the proliferation of charter schools may also be influenced by market characteristics beyond just the relative industrial composition. The formation of charter schools relies not only on an interested student body whose preferences are not fulfilled by a TPS, but a set of willing individuals who necessarily must create a curriculum, secure funding, teachers, and the physical provisions for opening a school. These willing individuals are entrepreneurs in the education market and will choose to open a charter school if they believe the benefits of doing so outweigh the opportunity cost. I further contribute to the existing literature on the supply of charter schools by examining the entrepreneurial nature of the proliferation of charter schools. The formation of these schools not only requires a willing entrepreneur, but also an entrepreneurial ecosystem conducive to the opening of potentially innovative and competitive schools. Specifically, I focus on the impact of firm openings and closures within a community (industry dynamism) on the formation of new charter schools. Firm openings and closures have been used as an indicator of entrepreneurship to examine entrepreneurship's contribution to employment growth (Bunten et al., 2015; Conroy & Weiler, 2019; Fritsch & Mueller, 2004). I find that lagged industry specific dynamism (yearly firm births and deaths as a percentage of existing industry) is not correlated with the charter school creation rate, but total dynamism within a CBSA is associated with an increase in the charter formation rate. Breaking this effect into firm births and deaths, I find that the charter formation rate is positively associated with firm deaths in the previous year, and no significant relationship to firm openings. This finding implies that general economic conditions within a CBSA may impact the education entrepreneur's decision making, with worsening market conditions reducing the opportunity cost of choosing to open a school.

Section 2.2 contains the motivation and a review of the relevant literature. In Section 2.3 a theoretical framework of charter demand and supply factors is presented. In Section 2.4 the hypotheses are stated, with Section 2.5 detailing the data and methodology used. Section 2.6 presents the empirical results, and Section 2.7 concludes.

2.2 Motivation & Literature Review

To understand the reasoning behind the demand for, and funding of an educational alternative that eight percent of all primary and secondary school students now attend, one must consider both the specifics of the US school system and the shifting value placed on education (NCES, 2023). The first charter school was formed in the United States (US) in 1992, one year after Minnesota had passed legislation allowing for their creation. Since then, 45 States have some form of charter school law and subsequently schools (Education Commission of the States, 2020). The role of government in funding and shaping education within the US is frequently debated, centering on several key issues: The public funding of education itself, mandatory attendance, common curriculum, standardized testing, and the choice of what school a child attends.

In the 21st century, the distinction between the public funding of schooling and a mandatory curriculum designed by the government is where most of the debate takes place. Much research has been done on the benefits to increased educational access for citizens, with the benefits accruing to households, firms, and governments alike (Sianisi & Reenen, 2003). For example, Barro (1996) found the economic growth rate of a country is influenced by "higher initial schooling and life expectancy, lower fertility, lower government consumption, better maintenance of the rule of law, lower inflation, and improvements in the terms of trade" (2). Additionally, the concept of human capital as a factor of production gained prominence in the 1980s, as it became apparent within macroeconomic models that the growth rate of output could not be explained by the growth of the labor force or physical capital stock alone (Mincer, 1984). These growth models further pushed on this idea by positing that economic growth could potentially be sustained indefinitely in the long run via increases in the human capital stock (Romer, 1986).

While the public funding of schooling has benefits to all parties involved, especially those who would be considered more vulnerable in the population such as minorities and the poorest households, there has been much debate about the shaping of the curriculum and teaching methods themselves by the US federal government. For example, in 1962 Milton Friedman argued that the American school system would benefit from operating in a free market setting, where students could attend schools which maximized their utility rather than assigned schools based on a standardized curriculum. Breaking it down, there are two main pieces to this argument. The first argument posits that the government cannot be as efficient as a free market setting and could therefore stifle innovation, and the second piece being that the government may try to change the curriculum toward the administration's particular world view.

Focusing on the former, the concept of efficiency in education is interesting as there are several different measures one might consider: The overall level of knowledge being produced, the distribution of educational knowledge among students with different demographic backgrounds, and the educational value generated per dollar spent. If the efficiency of the US school system based on these measures is deemed to be high, then the role of educational alternatives is harder to justify. However, if US school efficiency is low across one of these metrics, then one must ask why it is so, and what steps can be taken to increase it. Furthermore, there are several implications for the US economically if educational efficiency is deemed to be low.

First, sustained economic growth is in part affected by increases in human capital which can be generated by increased education of the population. Raising the level of human capital within the US economy will lead to a higher quantity of output per capita (Sianisi & Reenen, 2003). The second implication has to do with the high capital and skill intensity associated with the production of goods and services within the US economy. It is possible for other countries to experience conditional convergence to “catch up” to developed nations such as the US, who are sitting on the frontier of economic development (Barro & Sala-i-Martin, 1997; Barro, 2012). As these countries develop, competition increases within markets which require high levels of human capital. Therefore, for the US to maintain its comparative advantage in producing in these markets it must maintain higher relative levels of human capital. If educational efficiency is too low, then this edge could be potentially lost. Alternatively, any increase to educational efficiency could benefit the US economy.

The next logical step is to consider whether the US has been maintaining this competitive edge, and what measure is most useful in determining the strength of the US school system. Quantifying school effectiveness can be challenging, as there are many different aspects which must be considered when attempting to connect education with meaningful human capital increases within an economy. When a country is developing, it is easier to judge the strength of an education system by looking at the quantity of overall average years of education received per individual. However, once we are considering countries which are sitting on the frontier of growth, the quality and focus of education becomes a greater consideration as opposed to quantity. While a developing country may be able to boost economic growth quickly by focusing on literacy, a country sitting at the frontier must anticipate what skills will be needed in the future to remain competitive and adjust accordingly. One general argument for the creation of these charter schools is decentralizing education will allow the education system to adapt to current needs and new methods more quickly.

One of the simplest ways we can compare education systems at any level is through student scores from standardized testing. While there are many reasons why standardized tests may not be a great measure of overall education system quality (For example, how well do the tests measure high demand skills?), they can provide us with a general comparison. The Programme for International Student Assessment (PISA) by the Organization for Economic Co-operation and Development (OECD) allows us to compare student's performance across countries in mathematics, science, and reading. Figure 2.1 shows how the US compares to the OECD average over time.

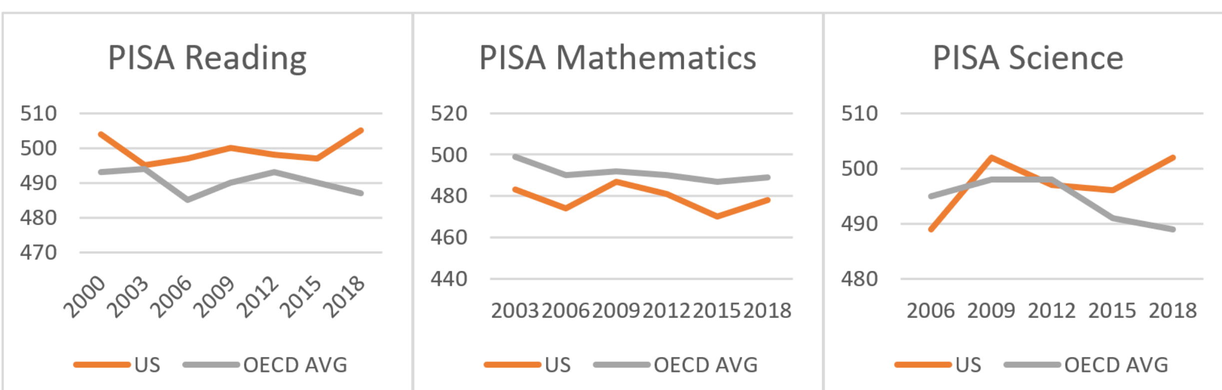

Figure 2.1: PISA Reading, Mathematics, and Sciences Scores for the U.S. vs OECD Average

The typical US student has scored slightly higher on reading, lower for mathematics, and recently better with science. Overall, a US student is similar to the representative OECD student. Sitting firmly in the middle of the pack is not ideal for a country specializing in human capital-intensive goods and services.

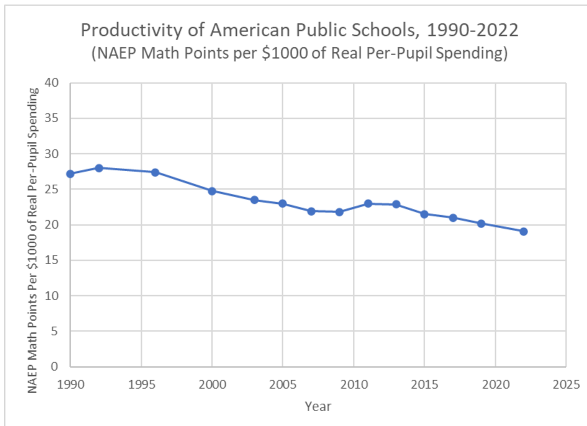

Figure 2.2: Productivity of American Public Schools 1990-2022

There are other aspects to consider beyond average test scores, such as productivity within the education system itself. Not only are the scores themselves relevant, but the level of resources committed to earn those scores is of concern. Additionally, we want to consider potentially changing demographics within the school system. The lower scores could be a result of an influx of students who are starting at a disadvantage, and average test scores will mask the overall improvement of student outcomes. Caroline Hoxby (2002) used data from the North American Educational Progress (NAEP) exam along with per-pupil expenditure to show that overall productivity within the US education system had fallen since 1970. This reduction in productivity is the product of flat test scores during the 1970-2003 period along with a two-fold increase in per-pupil spending. Hoxby also addressed the potential question of shifting demographics by adjusting scores to reflect different demographic compositions and found that it has essentially no effect on test scores, with the overall trend remaining flat. Figure 2.2 replicates Hoxby's 1970-2000 education productivity graph using recent data, which shows school productivity has continued to decline. As a comparison, Caroline Hoxby's original 1970-2000 graph can be found in Appendix C1.

The combination of the decidedly similar performance between a US student and the representative OECD student paired with the decreasing productivity of the American school system is an issue that U.S. residents may find concerning. Putting the shortcomings of standardized testing aside, if per-pupil spending is increasing but educational outcomes are not improving, then there is room for potential improvement. In the United States, one potential innovation which has gained traction is the liberalization of the school system.

In response, two different educational reforms have arisen from this shift in approach: vouchers and charter schools. Educational vouchers are designed to increase household freedom of choice between existing schools. Being assigned a voucher gives a student the ability to attend schools other than the school assigned by the traditional system. Typically, this also includes access to some private schools with tuition being at least partially covered by the voucher. In comparison, charter schools are an innovation regarding the supply of schools. Generally, a charter school is run by a non-governmental agency or group which has come together and created a custom curriculum which differs from the traditional public school (TPS) system policy on academic or disciplinary methodology. Additionally, the charter schools are not subject to zoning rules, theoretically allowing students from anywhere within reasonable commuting distance to attend[2]. Curriculum autonomy paired with the lack of zoning should allow students to attend schools which better fit their household educational preferences.

The efficacy of voucher programs and charter schools are still a subject of debate within academic research, where some studies found positive effects on student performance, while others found negative or no effect at all (Epple et al, 2015; Rouse & Barrow, 2009; Angrist et al., 2010; Imberman, 2011; CREDO, 2016). This is likely due to the heterogeneous nature of the voucher programs and the charter schools themselves. Research focusing on one particular school district or state may find positive effects, negative in another, and a national study will show no effect at all. Walters (2018) found charter schools provide the most academic gains for disadvantaged students, but advantaged students are more likely to apply, creating an additional challenge for education policy. The complex legal environment in which these schools operate, paired with potential large differences in student body composition and curricula means researchers must closely identify what aspect of a school makes it successful. For example, Angrist et al. (2010) recognize that charters in Massachusetts which have longer school days and years (along with some other features) relative to traditional public schools generates positive academic effects. Based on current research, it appears that charter schools can be beneficial to the community but they must have appropriate characteristics.

During the time researchers have been working to fully understand and quantify the effects of charter schools, they have evolved from what was envisioned as a relatively small pilot program to

[2] There may be restrictions concerning schools which are close to a student but technically across a state border.

educating approximately 8% of all school children in the United States as of the 2021-22 school year (NCES, 2023). Interestingly, the total (net) number of charter schools has grown in a relatively stable manner throughout the 2005-2015 period without being slowed down by the 2007 recession, as shown in Figure 2.3. This continued steady growth is especially interesting considering the lack of consensus on academic performance.

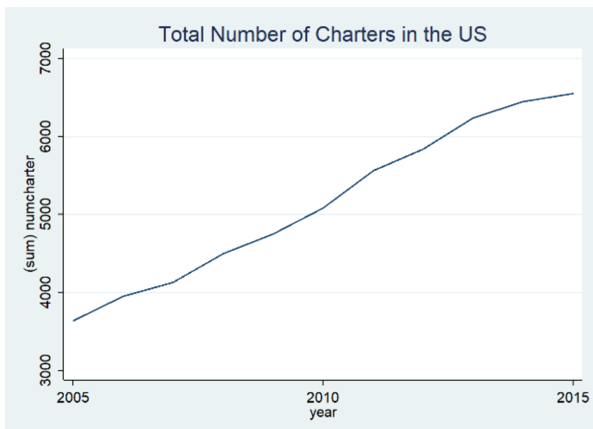

Figure 2.3: The Total Number of Charter Schools in the U.S. 2005-2015

Most research on charter schools continues to focus on questions regarding the efficacy of charter schools versus TPS, while less work has been done on exploring the determinants of charter school entry, which is the focus of this work. There are both supply and demand factors to consider. On the supply side, there needs to be a legal environment which is conducive to charter school creation, individuals who are willing to start and run charter schools, suitable real estate, and appropriate funding. Caroline Hoxby in her 2003 study of charter supply determinants found that the legal environment plays a significant role, where states which have the most generous charter laws have higher charter entry. A generous charter law provides equal funding to charter schools relative to TPS, allows greater autonomy in the chartering process, and does not impose a cap on the number of schools created. There is a great deal of heterogeneity in state laws, as some states impose caps, restrictions on funding, or do not have a law at all (6 states as of 2021) which prevents charters from being created.

Building on the importance of the legal environment, Singleton (2019) shows that the design of funding formulas for charter schools, which may vary at the state and district level, influence where charter schools choose to locate and subsequently the supply of available schools. Given a set level of funding, a charter school may choose to locate in a neighborhood which contains a less challenging potential student population, since their likelihood of positive test scores and therefore success will be higher than if they chose to target a disadvantaged and potentially expensive population to educate (Bifulco & Buerger, 2015; Singleton, 2019). It is often the case that a charter law does not offer the same level of funding per pupil for a charter school compared to a TPS.

Given the heterogeneous nature of charter schools, there are several different dimensions of note when considering the demand for charters. Glomm et al. (2005) identify two general categories which a proposed charter school can fall into. Schools created with the goal of increasing educational quality (vertical innovation) and schools which are created with the intent of widening the curriculum to include topics and perspectives not usually covered in traditional public schools (horizontal innovation). This distinction is typically captured by introducing demographic information about the residents in the relevant school district or other geographic level of analysis. Previous work has found that the more heterogeneous the population within a geographic area, the more charters are likely to enter as the existing TPS do not adequately match population preferences. Racial diversity, high community education levels, and a larger proportion of low-income households within a population leads to a greater amount of charter schools created (Glomm et al., 2005; Koller & Welsch, 2016; Bifulco & Buerger, 2015).

Building on this body of literature, this chapter seeks to further explore the idea of vertical and horizontal innovation in schooling using the occupational characteristics of the population and composition of industry. For example, if a household seeks a higher quality schooling option in math than what is offered by the public schools, then their demand fits the concept of charters being vertically innovative. If, however the household prefers a setting which teaches a particular skill or aspect of the curriculum which cannot be directly measured by standardized testing, such as learning languages, to paint or dance, then this demand being satisfied by their choice of charter school would be horizontally innovative. Ferreyra and Kosenok (2018) found in their analysis on charter school entry and choice that "…some households prefer non-Core over Core curricula. According to these estimates, households prefer Arts over Core, and non-whites prefer Core over Vocational" (176). Parental occupation is assumed to be an indicator of parental preferences for their children's education, as a household may place additional value on skills which they use and build daily (Dustman, 2004; Pablo-Lerchundi et al, 2015; Abdulkadiroglu et al., 2020). Dustman (2004) found German students were more likely to attend more academically focused high schools if their parents worked white collar jobs as opposed to blue collar professions. A scientist by profession may place a higher value on their children receiving a higher quality science curriculum, a banker may believe that their child needs a stronger background in math, and an artist may seek a curriculum which allows their child to create regularly. The first two would be identified as vertical innovation, while the third would be horizontal innovation demand.

Identifying this aspect of preferences and demand could be useful for several reasons. If the main component of demand for charter schooling can be attributed to horizontal innovation, then the relative focus on test scores and whether the schools themselves can “beat” the TPS could be misplaced. If, however the demand is determined to be vertically innovative, then school performance relative to TPS is of relatively high importance and the government and schools themselves should increase their efforts to generate educational quality improvements. Another implication of identifying linkages between occupation and charter school demand is their potential use as an amenity and place making policies. Communities which wish to incubate and support specific industries within their locale may choose to partner with or make it easier to open a charter school in order to maintain or attract workers and businesses, much like building parks or offering tax advantages to certain industries.

I further explore this connection between industry and charter school demand through impacts on the supply side. A unique piece of the puzzle which appears to be absent in the literature is the motivations of those who start charter schools themselves. Interestingly, the concept of charter schools was initially introduced as a pilot for testing alternative school methods which would then be introduced to the TPS. Unlike in a conventional model of technological change such as Romer 1990, these innovations in teaching and instruction are a non-rival and non-excludable good, as schools are not patenting a particular teaching method. However, as seen by the number of charters being created and the potential competition TPS face for students and subsequently funding, it is apparent charter schools are a strong competitor to TPS, private, and other charter schools (Epple et al, 2015).

In this newly formed market for education those who start a charter school must: believe they can do a better job of educating children than what the current schools offer and have the desire to start offering a service within a competitive market. As such, these individuals are educational entrepreneurs, who "… must amass, combine, and filter large amounts of information at each stage of the entrepreneurial process. Identifying a viable business idea requires some insights on an innovative new good or service or a valuable variation on a product already on the market" (Conroy & Weiler, 2019). These charter entrepreneurs may be a large for-profit organization, a group of teachers, or simply individuals who have identified a need for schooling alternatives and wish to either provide this service or capitalize on it.

I explore this entrepreneurial aspect of supplying charter schools by measuring the degree of entrepreneurship within all industries in a community via industrial dynamism, and then break it down by industry. Dynamism is measured via the births and deaths of firms within a CBSA, as this firm turnover represents both the benefits of individuals starting up new firms, and the market informational benefits accrued to the community from seeing both successful and unsuccessful businesses (Bunten et al., 2015). I focus on overall dynamism in a CBSA to capture the entrepreneurial environment, with the hypothesis that a higher degree of firm births and deaths shows both the potential ease of starting a business and the potential information gained from observing others.

Market turnover can also be an indicator of the overall quality of the entrepreneurial ecosystem within a community. Ceteris paribus, if a CBSA has a relatively higher rate of entrepreneurship compared to another of identical size, then it is likely the environment and institutions within that CBSA are more conducive to the propagation of new firms. As stated by Cavallo et al (2019), “In particular, the ecosystem approach draws attention to the fact that entrepreneurship takes place in a community of interdependent actors, individuals, entities and regulatory bodies within a given geographic area” (1300). Opening a charter school has many of the same characteristics as the typical business opening in the private sector. Access to physical and human capital, financing, land, and a conducive legal environment are just as important as having a potential student body (Hoxby, 2006).

The entrepreneurial ecosystem can be difficult to capture, as some models tend toward having many indicators that are difficult to measure and form a complete and representative dataset, such as the innovativeness of new firms and methods. Additionally, “The phenomenon at first appears rather tautological: entrepreneurial ecosystems are systems that produce successful entrepreneurship, and where there is a lot of successful entrepreneurship, there is apparently a good entrepreneurial ecosystem" (Stam & van de Ven, 2021). However, economic research on the importance of institutions such as property rights and their effect on growth provides some clarity.

Entrepreneurs operate within an economic environment built over time, which varies from place to place and can provide very different outcomes. For example, research has found African colonies in which historic European settler mortality was relatively higher were set up to be more extractive, and presently have lower income per capita than those with lower mortality rates in which Europeans settled and instituted different laws (Acemoglu et al., 2001). The entrepreneurial ecosystem is a combination of people, places, and the institutions built over time within places, such as the legal system. Therefore, each CBSA will have different combinations of people, resources, and institutions, which will affect the overall ease of entrepreneurship. The impact of this ecosystem can be found in the rate of new firm openings/closures, with a more conducive ecosystem leading to higher rates of entrepreneurship, which in turn is hypothesized to increase the rate of new charter openings. In order to test this hypothesis, this chapter captures the informational effects, supply of entrepreneurs, and the quality of the entrepreneurial ecosystem by measuring the impact of total CBSA firm openings and closures on charter formation.

I further break down the relationship by focusing on dynamism within individual sectors associated with vertical and horizontal innovation in schooling. For example, the more dynamism in STEM type industries implies the existence of individuals who use a certain skillset which they may believe is not produced currently in schools. If a potential entrepreneur believes they can better facilitate the learning of these skills, they could choose to start a charter school as opposed to another venture. Additionally, teachers who work in TPS could have ideas on how to innovate in the classroom in ways that are untenable in TPS. These teachers could recognize the importance of a particular industry type in an area, and as such believe that they may be able to capture a particular group of students that would not be present if that industry were not growing or dominant.

Alternatively, the supply of horizontally innovative charter schools could be reliant on a dynamic market for the arts and other industries which typically use skills or knowledge that is not obtained in a TPS environment. Teachers who have students with parents which work in these industries could see a potential benefit of building a school curriculum which would appeal to those parents, and in turn they know there is a potential pool of students who would be interested in attending. In both cases, these entrepreneurs may be able to gather greater community support to help attain the necessary provisions for starting the school, including pulling some of those who may work in the industries to help build the curriculum itself or contribute by teaching within the school as opposed to working in their current industry.

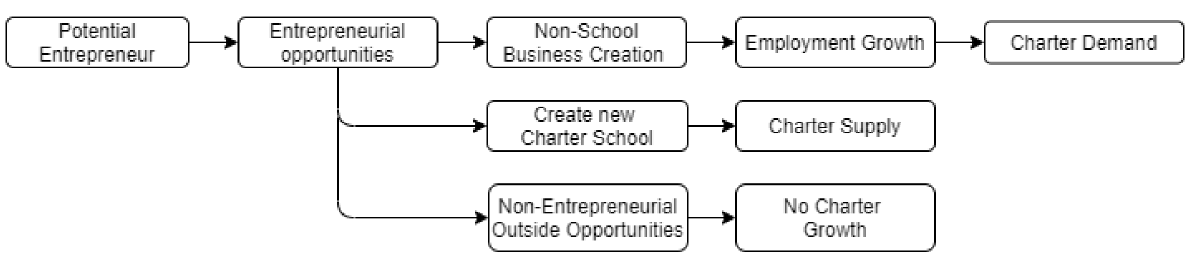

Figure 2.4: Diagram of the Direct and Indirect Effects of Entrepreneurship on Charter Demand

Finally, there may be indirect pathways through which entrepreneurship and subsequent firm dynamism affects the formation rate of charter schooling. Previous research has shown entrepreneurship leads to greater levels of employment growth (Bunten et al., 2015; Conroy & Weiler, 2019; Fritsch & Mueller, 2004). This greater employment growth further attracts individuals who work in these types of industries who may desire to send their children to charter schools which provide the vertically and horizontally innovative curricula that more closely matches their preferences. Both the direct and indirect pathways of entrepreneurship affecting the growth are detailed in Figure 2.4.

2.3 Theoretical Framework

I begin by providing a model of household demand factors for charter schools, and then provide a framework for the entrepreneurial supply effects. Modeling the connection between occupation, preferences, and the demand for charter schooling begins at the household level. Generally, there are three different schooling alternatives available to households: public schools (P), private schools (V), and charter schools (C). For simplicity, homeschooling is not considered as the household motivations for opting out of community education options are most likely different than those of choosing between existing options. School choice for the household is a discrete choice problem, as a student cannot fractionally consume a schooling option. The probability the household chooses school type *i* is defined as a function (Z) of household and school attributes:

$$P_{ni} \equiv \mathrm{z}\,(X_i, X_j, S_n) \tag{2.1}$$

where:

X_i : Attributes of school type *i*
X_j : Attributes of alternative school options
S_n: Attributes of the individual household *n*

The attributes of school types (X_i) a household considers includes common metrics such as pupil-teacher ratio, expenditure per student, test scores, extracurricular programs, location, school demographics, and cost in the case of private schooling[3]. For example, a household will have a higher probability of choosing a schooling option which has higher test scores, ceteris paribus. The probability of choosing charter schooling also depends on the characteristics of the household itself, S_n (Dustman, 2004; Pablo-Lerchundi et al, 2015; Abdulkadiroglu et al., 2020). These characteristics include parental education level, household income, ethnicity, and occupation. This work hypothesizes a household which contains a parent who works in a scientific or technical industry may prefer a schooling option which they believe delivers a higher quality math or science curriculum. A household with high levels of income may be more likely to choose private over charter or public schooling due to the relatively smaller impact tuition costs would have on overall household consumption. Modeling school choice at the primary and secondary level differs from the typical consumer choice problem in economics due to TPS and charter schools not directly collecting tuition from parents (Argarwal & Somaini, 2020). The framework presented below models the household's individual decision making, which I then aggregate to the Core Based Statistical Area for the empirical analysis.

[3] This analysis does not consider the cost of private schools specifically, but rather just the overall public school expenditure per student within the CBSA.

Framing this choice in terms of utility, household n will maximize their utility by choosing school type *i*:

$$Max\ U(Z,\varepsilon) = Z + \varepsilon_n \tag{2.2}$$

where:

$Z = z(X_i, X_j, S_n)$

ε_{ni}: Unobserved preferences & characteristics of households, schools

If the household chooses to send their child to a charter school, it is assumed X_C provides the highest utility for the set *Z.* The formulation presented in equation 2.2 is particularly meaningful due to the inclusion of the unobserved term ε_{ni} (Greene, 2012). There are many aspects of households which will influence their utility gained from a specific schooling option. For example, if a household values competitive sports, it may be the case a household which would otherwise choose a charter school based on academics will choose a public school with a strong football team. Additionally, a household with religious beliefs may choose a private school option with religious instruction which would otherwise not be chosen due to cost. Due to data limitations and the choice to aggregate to Core Based Statistical Areas (CBSAs), in this analysis there are aspects of the schools themselves which are not observed, such as proximity to the household and test scores due to the difficulty of obtaining them for an analysis spanning all CBSAs. Having weighed their options, a household would select charter schooling as their preferred education method if the utility gained from sending their child to a charter school (X_{nC}) is greater than the utility gained from a public (X_P) or private ($X_V - C_V$) school:

$$P_{nC}(y_{nC} = 1) = [X_C > \ X_P > X_V - C_V] \tag{2.3}$$

This household choice will match the one based on observed characteristics of the data if the observed characteristics outweigh the unobserved:

$$P_{nC}(y_{nC} = 1) = [X_C - (X_P, X_V - C_V) > \varepsilon_{nC} - (\varepsilon_{nP}, \varepsilon_{nV})] \tag{2.4}$$

The number of potential charter school students in a community *m* will be the sum of all HHs where the utility gained from charter schooling outweighs the alternatives:

$$C_{Nm} = \sum_{n=1}^{N} P_{nC}(y_{nC} = 1) = \ \sum_{n=1}^{N}[X_{nC} - (X_{nP}, X_{nV} - C_V) > \varepsilon_{nC} - (\varepsilon_{nP}, \varepsilon_{nV})] \tag{2.5}$$

At the community level, the demand for charter schools (D_C) is expressed simply as a function of the number of potential students, as the cost of attending an equidistant charter or TPS is assumed to be zero:

$$D_{Cm} = f(C_{Nm}) \tag{2.6}$$

Modeling the relationship between entrepreneurship and the rate of charter entry requires us to consider the supply side of the market for charter schools. Building on existing literature, the supply of charter schools depends on the strength of charter school laws (Φ), funding (F), availability of real estate (R), existing TPS per capita (P_{st}), private school cost (ψ), TPS quality (γ), and this analysis adds the supply of entrepreneurs (λ):

$$S_{Cm} = f(\Phi, \mathrm{F}, \mathrm{R}, \mathrm{P}, \psi, \gamma, \lambda) \tag{2.7}$$

where:

$$\frac{\partial S_{Cm}}{\partial \Phi} > 0, \frac{\partial S_{Cm}}{\partial \mathrm{F}} > 0, \frac{\partial S_{Cm}}{\partial \mathrm{R}} > 0, \frac{\partial S_{Cm}}{\partial \mathrm{P}_{st}} < 0, \frac{\partial S_{Cm}}{\partial \psi_{st}} > 0, \frac{\partial S_{Cm}}{\partial \gamma} < 0, \frac{\partial S_{Cm}}{\partial \lambda} > 0$$

Based on the Center for Education reforms charter law index, a strong charter law imposes minimal restrictions on new charter schools, such as no cap on the number of schools that can open in a year (CER). A stronger charter law is assumed to be associated with an increase in the supply of charters. Increased funding and available real estate for charter schools is assumed to increase the supply of charters. An increase in the number of existing TPS per capita is assumed to be associated with a decrease in the charter school supply, as competition is higher. The number of charter schools is a decreasing function of TPS quality, as this implies a greater level of competition within the market. Finally, the degree of entrepreneurship is assumed to be positively associated with the number of charter schools, and quantified using several different measures in the empirical analysis. Following the basic entry decision model posited in Wu & Knott (2006), the number of potential entrepreneurs λ depends on the expected profitability of forming a charter school relative to other entrepreneurial ventures and the outside wage option:

$$\lambda_C = \int_{i=1}^{N} [E(\pi_{ic}) > E(\pi_{io}) \geq E(\pi_{iw})] dF(i) \tag{2.8}$$

The expected profitability of opening a charter school is defined as:

$$E(\pi_{ic}) = \int_0^{c_0} q_s (M - C) dF(c) \tag{2.9}$$

where:

q_s= Number of potential students

M = Available funding

C = marginal cost of educating a student

C_0 = largest solution to M – C = 0

The charter entrepreneurs are revealed empirically by the number of new charter schools opened in an area, while the non-charter entrepreneurs are captured by firm births and deaths. Both the number of educational entrepreneurs and general entrepreneurship within an CBSA are hypothesized to increase the number of charters created, as discussed in Section 2.2.

2.4 Hypotheses

This chapter considers four hypotheses in testing the link between industrial composition and charter schools. The first hypothesis is areas with a relatively higher concentration of science and technology firms or the arts will experience a greater charter school formation rate over time. This explores the idea that charter schools can be formed as a vertical or horizontal innovation response to community's demand for alternatives to the public-school curriculum. The second hypothesis is greater concentrations of individuals in an CBSA who work in STEM or arts specific jobs will increase the charter formation rate. Hypothesis one focuses on the influence working for a STEM or arts focused firm has on household wage earners, while hypothesis two targets individuals who work specifically on STEM or arts related tasks. A worker in a firm which specializes in a STEM related output may find themselves immersed in an environment which highlights the need for certain skills, while a worker who has a specialized job in a firm which provides a completely different product or service may not encounter this pressure. The third hypothesis considers industry dynamism within the CBSAs: Greater overall establishment turnover (births & deaths) will generate higher levels of charter school formation. Charter school creation relies on entrepreneurs willing to open these schools, which is more likely to occur in areas experiencing greater firm turnover. The fourth hypothesis poses that greater dynamism within *specific* industries connected to STEM and the arts generates greater rates of charter formation. This combines the hypothesized industry concentration effects with the general impact of entrepreneurship from market dynamism. The hypotheses and their expected effects are summarized in Table 2.1. The specifics of the data used and methodology described in the expected effect column are detailed in the following section.

Table 2.1: Hypotheses, Effects, and Results

Hypothesis	**Expected Effect (DV: New Charter Schools Per Year)**	**Reported in:**
A greater relative concentration of STEM and arts focused firms within an CBSA leads to a greater rate of charter formation.	Positive and significant coefficients on establishments for NAICS sectors 54 & 71.	Table 2.6
A greater relative concentration of STEM and arts focused individuals within an CBSA leads to a greater rate of charter formation.	Positive and significant coefficients on establishments for NAICS sector employment 54 & 71.	Table 2.7 Table 2.8
Greater business dynamism within an CBSA leads to a greater rate of charter formation.	Positive and significant coefficients on total establishment births, deaths, and births interacted with deaths.	Table 2.9
Greater STEM & Arts industry dynamism influences charter school creation relative to other industry.	Positive and significant coefficients on NAICS 54 & 71 firm births, deaths, and births interacted with deaths.	Table 2.10

2.5 Data and Methodology

Aggregating at the Core Based Statistical Area, (CBSA), this analysis employs a panel dataset spanning 2005-2015. A Core Based Statistical Area is a specific way to define a metropolitan statistical area, created by the Office of Management and Budget. A CBSA consists of one or more counties anchored by an urban area of at least 50,000 people. This analysis is further restricted to areas of at least 65,000 residents to make use of 1-year American Community Survey data. CBSAs in states which do not have laws which allow charter schools in 2005 are also excluded (7 in total). CBSAs which straddle state lines are removed, leaving 286 CBSAs for analysis. The panel is composed of data on industry using the North American Industrial Classification System (NAICS), school data and characteristics from the National Center for Education Statistics (NCES), along with demographic and housing information from the American Community Survey (ACS) to perform a nationally representative analysis. Focusing on CBSAs is both convenient from a data perspective and useful as most charter schools operate within an urban setting. Rural areas face unique barriers to growth and education quality which may dominate and obscure the industry linkages explored within this chapter.

Aggregating at the CBSA level avoids problems such as charters locating just outside of school districts or on county lines, while still retaining enough regional granularity which would be hidden if aggregated to the state level. It also helps avoid data problems stemming from the mismatch between school districts and counties while performing a nationwide analysis. The major shortcoming of this approach is the lack of data on educational outcomes since there is no readily available source for nationally inclusive individual school or district test scores.

Using 2-digit NAICS data, industry concentration is measured by the number of establishments per one thousand residents within the CBSA:

$$Sector_i = \frac{Establishments_i}{Population\_CBSA_i}(1000) \tag{2.10}$$

Alternatives such as location quotients were considered, but when CBSA size becomes relatively small a single firm entry or exit can have a large effect, and fluctuations at the national level can lead to a change in the location quotient for a CBSA when the proportion of firms in $CBSA_i$ has remained unchanged. The 2-digit NAICS separates businesses into general categories such as agriculture, manufacturing, retail, information, and groupings such as professional, scientific and technical services. For the purposes of this analysis, the hypothesized vertical innovation driving STEM industries are captured using NAICS code 54, which represents Professional, Scientific and Technical services. Potential horizontal innovation demand is measured using NAICS 71 which encompasses arts, recreation, and entertainment. The NAICS industry categories are not perfect as they typically pull in several slightly different types of firms within the same industry code. NAICS 54 contains many science and technology firms, but also captures professional services, such as law firms and accounting. These could be considered too broad, but data censoring at the more detailed NAICS 3-digit and 4-digit level is highly prevalent in the sample and does not allow for a nationally representative analysis. However, the categorization of these industries still allows for general interpretation, as they are in line with the overall concept of vertical and horizontal innovation in schooling. To test hypothesis 2, NAICS data on the average number of employed individuals within an industry is used in place of establishments.

Hypotheses 3 and 4 use firm turnover data obtained from the Statistics of U.S. Businesses (SUSB), and provides information on the number of firm births, deaths, and employment changes for 2-

digit NAICS sectors over the 2007-2014 time period. Births and death rates are measured as a percentage of yearly initial establishments.

American Community Survey (ACS) 1-year estimates are employed to capture demographic characteristics of the CBSAs. Data on the percentage of individuals at or below 150% of the poverty line are used. Measures of parental educational attainment are not used as they are highly correlated with the industry data, which is of primary interest. The ACS 1-year estimates are available for CBSAs with a population of 65,000 individuals or greater which decreases the number of CBSAs in the sample. The public-use data is censored for regions below that population level but using the 5-year estimates would greatly reduce the explanatory power of the analysis.

The NCES Public Elementary/Secondary School Universe Survey gathers information from every public school in the United States on a yearly basis and is reported at school level. It contains information regarding demographic composition of the student body, and school characteristics such as the pupil-teacher ratio, charter status, and provides information about school openings and closures. Individual schools are aggregated to the CBSA level as averages for demographic information and counts for the number of public schools and charter openings/closures. NCES data on magnet and private schools is also utilized, as they are a potential substitute for the existing options and therefore in competition with charter schools. It should be the case that a greater number of magnet, private, and even public schools should provide larger amounts of competition through expanded school choice options in an CBSA. The NCES data on expenditure per student has been adjusted for inflation to real 2007 dollars.

Using this panel dataset, I estimate several negative binomial regressions of the following form to address the four hypotheses:

$$E(N_{Cjt}|X) = exp\ (\beta X + P_{it} + e_{it}) \tag{2.11}$$

where:

$$X = \{I_{j(t-5)} D_{j(t-1)}, S_{j(t-1)}, M_{j(t-1)}, Z_{jt}\} \tag{2.12}$$

$$var[N_{Cijt}] = \mu_{ijt} + \alpha\mu_{ijt}^2 \tag{2.13}$$

N_{Cjt} represents the set of charter school dependent variables: The stock of charter schools, rate of new charter openings, and the rate of charter closures. $I_{j(t-5)}$ represents a vector of NAICS industry characteristics for CBSA j in time t – 5. Measures of industry are lagged by 5 years to better isolate the direction of the relationship between industry composition and the number of charters created. $D_{j(t-1)}$ represents a vector of demographic variables, such as the median age and the poverty rate in the previous year. $S_{j(t-1)}$ is a vector of school variables, such as the number of traditional public schools per 100 students, and the average minority percentage for schools within that CBSA for the previous year. Z_{jt} represents a vector of time and state dummies to account for fixed differences not captured by the independent variables. To explore firm dynamism I add an additional vector $M_{j(t-1)}$, which contains CBSA data on industry firm births and deaths in the previous year. Negative binomial regression is used as the dependent variable is a yearly count variable of the number of newly formed charter schools (NC), and as such does not follow a normal distribution. The Poisson estimator is typically more robust and allows for better fixed effects but assumes the mean of the regressand is equal to its variance. This charter school data suffers from dispersion, and the variance is more than two times the mean as shown in Table 2.2.

Table 2.2: Overall, Between, and Within Variation for New Charters per CBSA per Year

Variable	Variation	Mean	Std. Dev.	Min	Max	Observations
newcharter	Overall	1.183	3.455	0.000	42.000	N = 3146
	Between		3.116	0.000	27.909	n = 286
	Within		1.502	-19.635	17.092	T = 11

Excess dispersion would potentially bias the standard errors downward. The negative binomial estimator is more flexible and does not assume the mean is equal to the variance, as shown in equation (13). In order to account for unobserved differences between CBSAs, time and geographical dummy variables are employed. Additionally, negative binomial allows us to use an exposure variable, which is typically employed to adjust the time periods over which the dependent variable was measured (exposed). In this case, the exposure variable is population, as the number of new charters is directly correlated with the number of individuals within an CBSA. This enters the analysis as an offset variable: The natural log of the population (P_{it}) with a coefficient of 1.

The negative binomial estimator is a typical choice for count data but comes with several challenges when dummy variables are employed to capture unobserved differences. Many of the variables of interest have significantly smaller within CBSA variation over time as opposed to the variation between CBSAs. For example, the relative size of the NAICS 54 (Sci/Tech) varies significantly between CBSAs, but is quite stable within an CBSA over the available 11 years of NAICS data as shown in Table 2.3:

Table 2.3: Overall, Between, and Within Variation for Sci/Tech

Variable	Variation	Mean	Std. Dev.	Min	Max	Observations
NAICS Sci/Tech	Overall	2.521	1.303	0.613	12.232	N = 3124
	Between		1.298	0.676	11.159	n = 284
	Within		0.138	1.217	3.823	T = 11

An estimator which uses fixed effects and relies purely on time variation is unable to capture most of the variation within the dataset. However, not employing fixed effects would put this analysis at risk of omitted variable bias. Therefore, time and state dummy variables are used to account for unobserved differences between CBSAs. Geographical fixed effects at the state level were chosen due to the critical role the state plays in the determination of charter school finances and legal environment they operate within. Table 2.4 reports summary statistics for the variables used in hypothesis testing.

Table 2.4: Pooled Descriptive Statistics of the Full Sample 2005-15

Variable	Obs	Mean	Std. Dev.	Min	Max
Newcharter	3146	1.183	3.455	0	42
Agriculture	3124	.396	.524	0	4.128
Mining	3124	.129	.394	0	5.216
Manufacturing	3124	1.125	.498	.217	4.328
Science and Tech	3124	2.521	1.303	.613	12.232
Arts and Rec	3124	.368	.176	.013	1.606
Agr. Empl	3145	1.642	3.956	0	32.05
Min. Empl	3101	1.303	4.025	0	47.245
Manuf. Empl	3146	1.224	.769	.08	5.54
SciTech Empl	3146	.564	.434	0	6
ArtsRec Empl	3146	.912	.671	0	5.38
LQ Under 18	2881	.822	.158	.231	1.484
TPS per 100 stud	2881	.179	.052	.071	.514
Mag per 100 stud	2881	.006	.011	0	.084
Pvt per 100 stud	2881	.048	.029	.007	.315

Pupil-Teacher Ratio	3039	16.141	4.441	8.999	94.909
Expenditure per student	3146	10.145	2.469	3.607	20.241
TPS minority	3099	.365	.218	.028	.992
poverty rate	3057	.252	.064	.095	.557

Within this sample, the average number of new charter schools per year is 1.183. There is quite a bit of variation between CBSAs, with some such as those based in California adding many schools each year, while others may add none in a given year. We can also see the average number of Sci/Tech firms per 1000 individuals within our sample is 2.521, compared with 0.368 for Arts/Rec. The highest concentration of Sci/Tech in the sample is 12.232 in Charlottesville, Virginia. An example of a place with zero firms in Sci/Tech would be Odessa, Texas in the year 2000, where industry is largely mining and manufacturing based. Each of the four hypotheses are tested using slightly different sub-samples of this dataset (the number of observations vary), as some of the variables of interest have fewer data points available. Data availability for this chosen sample do not vary systematically, so the impact of this variability on the results of the empirical analysis is minimal.

Table 2.5: Descriptive Statistics: Industry Turnover & Entrepreneurship

Variable	Obs	Mean	Std. Dev.	Min	Max
Gross Turnover	2288	19.6	3.5	11	34.1
Births %	2288	9.7	2	5	22.3
Deaths %	2288	9.9	2	5.4	21.7
Agriculture Opening %	2246	14.3	20.7	0	300
Agriculture Closure %	2246	12.4	13.3	0	100
Mining Opening %	2231	9.9	18.1	0	400
Mining Closure %	2231	9	12.7	0	100
Sci/Tech Opening %	2288	10.9	3.2	2.3	30.1
Sci/Tech Closure %	2288	10.7	2.5	2.2	24.3
Arts/Rec Opening %	2287	11.3	5.4	0	60
Arts/Rec Closure %	2287	10.8	4.5	0	32.4

Table 2.5 reports summary statistics for the industry turnover variables used to explore hypotheses 3 and 4. The measure of industry gross turnover is the sum of firm births and deaths, representing on average 19.6% of existing industry. Of this, openings and closures are approximately an even percentage. Hypothesis 4 explores the impact of specific industry turnover, and as shown above the average turnover within each industry is relatively similar in both openings and closures. For example, the average CBSA had 10.9% new firms open in Sci/Tech for a given year, with 10.7% of existing firms closing. This percentage can be greater than 100%, as shown by looking at mining openings. This would be due to a few firms entering what is potentially a very small market to begin with. Due to data availability and censoring, observation counts vary among the variables in Table 2.5.

2.6 Empirical Results

The hypotheses posited in Section 2 are tested using the panel dataset and negative binomial method described in Section 3. To address hypothesis 1, analyzing the connection between industry concentration and charter formation is considered using industry establishment counts, with the dependent variable being the number of new charter schools opened in an CBSA for a particular year.

Table 2.6 reports the results of the establishments regression. 284 CBSAs are included, with state and year dummy variables which control for unobserved differences such as the legal environment in which these schools operate. The independent variable of charter formation is measured as the count of new charter schools opened in a given year. The independent variables of interest are lagged establishment counts per one thousand residents within a CBSA. The results in Table 2.6 show the relationship between the number of establishments in the Sci/Tech industry five years earlier and an increase in the number of new charter schools created in a given year. As a test of robustness, this same analysis was performed with a 10-year lag for establishment counts. The results are similar and are reported in Table C1 (Appendix C).

Table 2.6: The Impact of Industry Establishments on the Rate of Charter Openings

IRR Reported	(1) newcharter	(2) newcharter	(3) newcharter
Agriculture	1.253**	1.233**	1.100
	(0.116)	(0.113)	(0.084)
Mining	1.019	0.925	0.822
	(0.168)	(0.154)	(0.126)
Manufacturing	0.922	0.864	0.734***
	(0.118)	(0.113)	(0.079)
Sci/Tech	1.287***	1.254***	1.204***
	(0.072)	(0.071)	(0.052)
Arts/Rec	0.444*	0.577	1.225
	(0.208)	(0.276)	(0.391)
LQ Under 18	1.643**	5.618***	4.513***
	(0.367)	(3.108)	(2.292)
TPS per 100 stud	0.291	0.423	0.045***
	(0.349)	(0.515)	(0.051)
MAG per 100 stud	0.049	0.498	0.251
	(0.213)	(2.167)	(0.995)
PVT per 100 stud	0.642	0.860	0.626
	(1.509)	(2.165)	(1.381)
TPS Pupil/Teacher	1.002	0.997	0.990*
	(0.005)	(0.005)	(0.005)
Exp/Student	1.011	0.995	1.081***
	(0.010)	(0.022)	(0.032)
Minority TPS	0.979	1.142	0.614*
	(0.278)	(0.330)	(0.177)
Poverty rate	16.212***	1.799	1.642
	(13.573)	(1.756)	(1.338)
Observations	2,841	2,841	2,841
Time Fixed Effects	No	Yes	Yes
State Fixed Effects	No	No	Yes

Standard errors are in parentheses
**** p<.01, ** p<.05, * p<.1*

Column (1) reports the results of the impact of industry establishments on the rate of charter openings without time or state controls. Column (2) reports the results with time fixed effects, and column (3) shows the results with both time and state fixed effects. Controlling for unobserved differences is important, as more agriculture heavy CBSAs and the poverty rate appear to have a strong correlation with a greater charter school formation rate until both time and location are controlled for in column (3).

For ease of interpretation, incidence rate ratios (IRR) are reported for all regressions involving count data. The standard coefficients reported from negative binomial regression are the difference in the log of expected counts. The incidence rate ratio reports the log of their quotient which is a simple transformation of the original coefficients. Once transformed, the IRR can be interpreted as the change in the rate for the dependent variable holding all other factors constant.

An incident rate ratio of 1.204 on Sci/Tech would imply that as a CBSA gains 1 firm per one thousand people, the rate of new charter openings increases by approximately 20% per year. Evaluated at the mean value of 2.52 Sci/Tech firms, the typical CBSA experiences 1.6 new charters per year. Therefore, a CBSA with a Sci/Tech sector two standard deviations above the norm would gain an additional 0.96 schools per year. This effect compounds to be non-trivial over the ten-year period. These results do not find any significant relationship between the number of Arts/Rec firms and the creation of new charter schools.

The control variable for the proportion of the population that is school aged is significant, as expected. As the proportion of school aged children increases, the creation rate of new charter schools increases. Additionally, these results show a significant negative relationship between the number of traditional public schools serving an CBSA and the charter formation rate, suggesting higher competition for students. However, magnet and private schools are not significant and therefore do not affect charter school entry. This could be because the number of magnet and private schools are relatively low, and private schools require tuition. The TPS pupil-teacher ratio negatively impacts the rate at which new charters open but is economically insignificant as one student increase in the pupil-teacher ratio decreases the rate of charter openings by one percent.

Interestingly, the proportion of minority students and the poverty rate do not influence the creation rate of new charter schools, but the expenditure per student matters. As per-student spending goes up within an CBSA it is more likely for a charter school to enter the market. A one thousand dollar increase in per pupil expenditure is associated with an eight percent increase in the rate of charter openings. This aligns with previous research which found that charters will choose to locate in areas which give them a higher chance of success, with one dimension of that success relying on higher funding (Singleton, 2019).

To address hypothesis two, the effects of employment occupation type on charter formation are shown in Table 2.7. Column (1) reports the results of the impact of industry employment on the rate of charter openings without time or state controls. Column (2) reports the results with time fixed effects, and column (3) shows the results with both time and state fixed effects. The same control variables are used in Table 2.6 and 2.7, but industry concentration is measured with employment as opposed to establishments. For ease of interpretation incidence rate ratios are reported. The control variables maintain similar significance and magnitudes, but the employment location quotients for Sci/Tech and Arts/Rec are not significant. This is an interesting and somewhat curious result since at the industry level the number of firms in Sci/Tech is positively correlated with the charter formation rate.

Table 2.7: The Impact of Industry Employment on the Rate of Charter Openings

IRR Reported	(1) newcharter	(2) newcharter	(3) newcharter
LQ Agriculture Emp	1.008	1.007	0.989
	(0.014)	(0.014)	(0.010)
LQ Mining Emp	1.005	0.993	0.974*
	(0.016)	(0.016)	(0.015)
LQ Manuf. Emp	0.908	0.850*	0.823**
	(0.081)	(0.079)	(0.072)
LQ Sci/Tech Emp	1.282**	1.206	0.992
	(0.161)	(0.151)	(0.104)
LQ Arts/Rec Emp	1.009	1.011	0.962
	(0.063)	(0.064)	(0.050)
LQ_Younger_18	1.422*	6.379***	4.303***
	(0.290)	(3.430)	(2.188)
TPS per 100 Stud	0.160	0.286	0.025***
	(0.190)	(0.346)	(0.028)
MAG per 100 Stud	0.058	0.772	0.521
	(0.258)	(3.395)	(2.150)
PVT per 100 Stud	0.753	2.036	2.996
	(1.722)	(5.125)	(6.128)
TPS Pupil/Teacher	1.001	0.996	0.990*
	(0.005)	(0.005)	(0.005)
Exp/Student	1.005	0.986	1.108***
	(0.010)	(0.022)	(0.033)
Minority TPS	1.054	1.203	0.689
	(0.298)	(0.350)	(0.207)
Poverty rate	14.385***	1.160	0.755
	(12.179)	(1.140)	(0.625)
Observations	2,814	2,814	2,814
Time Fixed Effects	No	Yes	Yes
State Fixed Effects	No	No	Yes

Standard errors are in parentheses
***** p<.01, ** p<.05, * p<.1**

This implies there is a potential difference in the impact a business has on the charter formation rate versus employment. Establishments that focus on STEM related production of goods and services may provide a stronger signal to households within their communities of what types of knowledge is required for employment versus the signal created by individual employment. It should also be kept in mind the employment data in Table 2.7 are location quotients, which can be highly variable when the size of a market is relatively small, as a small change in either direction of the number employed will lead to a large location quotient change. Additionally, if STEM employers view charter schools as an amenity they can use to help attract workers, they may be surprised to find out that STEM employees don't possess a higher demand by themselves.

Interestingly, there is a significant negative relationship with mining employment on the charter school formation rate. The magnitude of this relationship may not be economically significant however, as increasing the location quotient by one decreases the charter formation rate by less than three percent. Industries such as mining may engender a lower emphasis on education as the main source of skill building and future employment, though it is recognized in this work that there are many aspects of mining that requires individuals with extensive education backgrounds, such as engineers.

The analysis covering the hypothesized role of firm and employee demand effects on charter school creation is further expanded by considering both overall and industry specific firm turnover. Hypothesis three states that increased dynamism within a CBSA will lead to a greater rate of charter formation. The regression analysis for establishments is extended to include general firm births and deaths for the CBSAs, with the results reported in Table 2.8 as incident rate ratios.

Table 2.8: Overall Industry Turnover Effects on the Rate of Charter Openings

	(1)	(4)	(7)
IRR Reported	newcharter	newcharter	newcharter
Gross Turnover	1.049***		

	(0.019)		
Births %		1.046	
		(0.030)	
Deaths %			1.078**
			(0.032)
LQ_Younger_18	2.678*	3.013**	2.765*
	(1.438)	(1.614)	(1.486)
TPS per 100 Stud	0.035***	0.026***	0.023***
	(0.038)	(0.028)	(0.025)
MAG per 100 Stud	1.187	0.848	0.863
	(4.996)	(3.570)	(3.625)
PVT per 100 Stud	11.946	8.223	14.726
	(25.477)	(17.539)	(31.452)
TPS Pupil/Teacher	0.991*	0.991	0.991*
	(0.005)	(0.005)	(0.005)
Exp/Student	1.044	1.061**	1.037
	(0.033)	(0.032)	(0.033)
Minority TPS	0.865	0.844	0.883
	(0.300)	(0.292)	(0.306)
Poverty rate	1.135	0.827	0.987
	(1.025)	(0.738)	(0.881)
Observations	2,395	2,395	2,395
Time Fixed Effects	Yes	Yes	Yes
State Fixed Effects	Yes	Yes	Yes

Standard errors are in parentheses
**** p<.01, ** p<.05, * p<.1*

Dynamism in this case is measured in three different ways. "Gross Turnover", which is the yearly sum of all firm births and deaths as a percentage of existing firms, firm openings, and closures. Using the Gross Turnover measure finds a significant positive relationship between dynamism in the previous year and charter school formation. Interestingly, decomposing the measure into firm births (2) or deaths (3) shows that firm births are not significant, but finds a positive relationship with deaths. This implies the general entrepreneurial conditions is correlated with the rate of charter formation, but certain market signals are more important than others. This positive relationship between general firm closures in a CBSA and charter openings may imply a change in opportunity costs for entrepreneurs and is further explored in Chapter 3.

Table 2.9: : Specific Industry Openings & Closures on the Rate of Charter Openings

IRR Reported	(1) newcharter	(2) newcharter
Open Agriculture.	0.997	
	(0.002)	
Open Mining	0.999	
	(0.002)	
Open Sci/Tech	1.008	
	(0.016)	
Open Arts/Rec	1.000	
	(0.008)	
Close Agriculture		1.000
		(0.003)
Close Mining		0.999
		(0.003)
Close Sci/Tech		1.035*
		(0.020)
Close Arts/Rec		0.993
		(0.010)
LQ_Younger_18	2.600*	2.521*
	(1.363)	(1.327)
TPS per 100 Stud	0.018***	0.019***
	(0.019)	(0.020)
TPS Pupil/Teacher	0.992	0.992
	(0.005)	(0.005)
Exp/Student	1.065**	1.057*
	(0.032)	(0.033)
Minority TPS	0.929	0.920
	(0.320)	(0.319)
Poverty rate	0.592	0.774
	(0.528)	(0.691)
Observations	2,299	2,299
Time Fixed Effects	Yes	Yes
State Fixed Effects	Yes	Yes

Standard errors are in parentheses
**** p<.01, ** p<.05, * p<.1*

Having found a connection between overall establishment turnover and charter formation, hypothesis 4 considers whether dynamism matters at the individual industry level. The results are reported in Table 2.9 as incidence rate ratios, which showcases two regressions that individually consider firm births (1) and deaths (2). Contrary to the industry establishment concentration analysis, individual industry turnover in Sci/Tech and Arts/Rec does not have a relationship with the rate of charter formation. This implies the overall economic conditions is positively associated with charter creation, but individual industry health does not. Additionally, if alternative specifications are considered such as gross industry specific turnover or increasing returns (multiplicative) no significant results are found, as shown in Table C2 (Appendix C). It could be the case that any changes in an individual industry are small relative to the combined industry of the typical CBSA, and therefore the impact would be small. However, it can be seen from the results in Table 2.6 that the relative concentration and composition of industry within a CBSA matters.

2.7 Conclusion

This work contributes to the existing literature surrounding charter school demand by considering what factors lead households to seek alternatives to traditional public schools beyond test scores. Previous work found that charter school demand increases as the school districts population is more heterogeneous across incomes and education levels but did not explore specific employment and establishment differences (Epple et al, 2015; Glomm et al., 2005; Ferreyra & Kosenok, 2018). Employing a panel dataset spanning 2005-2015 of 286 Core Based Statistical Areas, I find some evidence of vertical innovation demand for charter schooling in the form of a positive relationship between lagged NAICS sector 54 establishments per one thousand CBSA residents (scientific and professional services) and the number of new charter schools formed per year. A CBSA with a sector 54 industry two standard deviations above the mean in size is correlated with the number of charter schools formed increasing by 0.96 per year.

Using NAICS industry employment LQs, I find no evidence of vertical or horizontal innovation demand from either industry of interest. The contradictory results between establishments and employment could be indicative of either the NAICS categories being too broad, or that firms themselves affect markets differently than individuals. For example, a firm which specializes in a particular industry may immerse workers in an environment which focuses on specific skills, which further emphasizes the need for either sharpening or broadening their children's education. Working a specialized job in a firm which provides a more general service may not provide the same experience and immersion to the worker, which decreases the employee's and therefore the household's value on a particular skillset.

Further exploring the impact of industry on charter demand, I use firm births and deaths as a proxy for market dynamism, with the expectation that greater turnover and therefore greater rates of entrepreneurship is correlated with a higher number of charter schools being formed per year on average. Overall economic conditions and the entrepreneurial ecosystem within an CBSA is related to on the rate of charter formation and appears to be positively correlated with the death rate of businesses. This is interesting for several reasons. Firstly, there could be some competition for entrepreneurs, and the higher rate of business openings (closures) in a CBSA may be indicative that market conditions look appealing (poor) for starting a business and less (more) so for starting a school. Secondly, individuals typically turn to education as a method of escaping or dealing with harsh market conditions during situations such as recessions or creative destruction. Because of this, potential entrepreneurs and households may both increase their attention and perceived utility of schooling during a period of higher business turnover.

However, focusing on individual industry level measures of entrepreneurship shows no significant connection between specific industry firm turnover and charter school creation. This suggests the proposed linkage above between high rates of activity within a particular industry and education entrepreneurs could be weak. It may be the case that an individual industry does not have a great enough impact relative to the CBSA's economy for it to affect the level of educational entrepreneurship. Overall CBSA dynamism may be a better measure of overall market response to poor economic conditions, which is addressed in the third chapter of this dissertation. It could be the case that the entrepreneurial process for creating charter schools is fundamentally different than the typical business environment, due to funding differences and potential insulation from economic shocks.

This analysis further contributes to the existing literature by employing a nationally representative sample of CBSAs as opposed to focusing on a subsample of schools within one state or urban center. Most analyses rely on smaller geographies to employ school district level educational outcomes as a dataset aggregating individual school test scores for a nationwide analysis does not exist at the time of writing. Comparing charter demand and supply at the CBSA level allows for comparisons which are not possible at the district level such as the questions this work addresses regarding industry, employment, and entrepreneurship.

Potential future extensions of this work include changing the geography of interest to commuting zones, which impacts the feasibility of a household sending their student to a specific school. As data availability improves, comparing the relationship between establishments/employment on for-profit versus non-profit charter schools will become possible, as this is a relatively recent question that has been added to the public school universe data employed within this work. A qualitative extension of this work that would be of high value is a case-study of charter school founders. Interviews with these individuals would help shed light on their motivations and their experiences with being a “charter entrepreneur” outside of the typical question of educational outcomes.

Chapter 3: A Competition Conundrum: Are Charter Schools More Exposed to Economic Shocks?

3.1 Introduction

Charter schools are typically described as a market-oriented solution for improving educational outcomes. By opening the door to education entrepreneurs, individual school level innovation in educational methods and environments could lead to rapid improvements in education quality. While the efficacy of any individual charter school varies due to the heterogeneity of location, legal environment, student demographics, teacher quality, and the goals of the charter itself, charters are at their core viewed as more market integrated than their traditional public school (TPS) counterparts. Previous work has largely focused on educational outcomes, while few have considered supply and demand factors for charter schools (Rouse & Barrow, 2009; Angrist et al., 2010; Imberman, 2011; CREDO, 2016; Glomm et al., 2005; Hoxby, 2006).

This work explores the interconnectedness of charter schools with the broader economy by measuring their sensitivity to economic shocks and comparing their response to that of traditional public schools. Specifically, this work seeks to answer the question of whether charter schools are more exposed to general economic shocks than TPS due to the market-oriented nature of their creation, and whether they adjust more quickly to these economic shocks than TPS. Previous work has analyzed the impact of the Great Recession (GR) on TPS and student outcomes but does not focus specifically on the impact of the GR on supply outcomes for charter schools versus TPS (Chakrabarti & Livingston, 2015; Evans et al., 2019, Maloney et al, 2013, Shores & Steinberg, 2019a & 2019b).

To do so, it must be first asked what market forces charter and traditional public schools are exposed to. If the overall economy experiences a negative shock such as the Great Recession, what aspects of the schools themselves are affected by recessionary forces? There are many different direct and indirect avenues through which schools can be affected by negative economic shocks. This work first explores the direct impact of changes in school financing during the GR, and then considers the potential indirect impact of changes in local industry on the supply of schools.

School financing is composed of federal, state, and local sources which underwent changes during the GR. Federal, state, and local funding fluctuate due to policy changes and tax revenues. For example, while local funding tends to be tied to real estate taxes and therefore will naturally fluctuate (such as in the case of a collapsing housing bubble), there tends to be policy adjustments to the property tax rate to mitigate decreases in revenue (Lutz et al., 2010). However, policy response can be uneven, and the three different levels of government can provide additional complexity to maintaining school funding. Shores and Steinberg (2019b) found "…recession-induced declines in spending are driven not by changes in state revenues, but instead by significant and substantive recession-induced declines in local revenues" (125).

Using Common Core of Data (CCD) gathered on school finances, this work compares school districts composed of only charter schools against school districts composed of only TPS for Core-Based Statistical Areas (CBSAs) in the United States. Specifically, I compare 214 CBSAs charter school only school districts aggregated to the CBSA level against a pool of 270 public school only districts aggregated to CBSAs. I find total revenue per student for charter school districts in the typical CBSA did not decrease during the GR, as increased Federal revenue outweighed decreases in state and local revenues. Charter school districts relatively higher reliance on state funding and lower reliance on local revenues compared to TPS only districts positioned them to be less impacted by falling property taxes and other local revenue shortcomings. TPS only school districts experienced a decrease in total revenue for 2010, as increased federal funding was unable to outweigh the decrease in state and local funding. This implies charter schools were fiscally sheltered from the GR due to their low reliance on local revenues, but as seen in the analysis provided in this work charter schools were operating with less revenue in the pre-recessionary period due to lower local funding than TPS districts received.

Having explored the direct impacts of education funding sources on charter schools, the impact of changes in local industry due to the GR are considered. Charter schools require educational entrepreneurs who weigh the opportunity cost and choose to open or maintain existing charter schools. A potential education entrepreneur will compare the perceived benefit to opening a charter school with their next best alternative (the opportunity cost). This alternative could be education related, starting a business offering a completely different product/service, or wage income. Overall market conditions may affect the entrepreneur’s real and perceived benefits to opening a school, and potentially bring additional challenges to overcome. For example, it may be more difficult to garner support to start a charter school during a recessionary period, but higher rates of unemployment and lower demand in other industries may make charter entrepreneurship relatively more lucrative.

Using a panel dataset spanning 2006-18 of Core-Based Statistical Area (CBSAs), I take these changing local industry conditions and examine whether this impacts the number of TPS and charter schools within a CBSA (overall stock, openings, and closures). CBSAs are grouped based on their overall exposure to the GR to test whether charter school only districts are more vulnerable to a large economic shock than TPS only districts. Using difference-in-differences analysis, I find the typical charter school only district experienced an increase in the school creation rate, a greater stock of schools, and no effect on the closure rate during the GR. This implies the overall opportunity cost of starting a charter school during the GR decreased, as it became more lucrative relative to the entrepreneur's next best option. However, using industry employment as a measure of exposure to the GR, I find that charter only school districts located in the top 20% of CBSAs for relative employment in STEM (NAICS 54) or finance (NAICS 52) had fewer charter schools because of the GR. The industry specific measure of exposure to the GR captures two nuances of charter school's interconnectivity with the broader market. As shown in Chapter 2, charter schools are sensitive to the relative size of the STEM industry, and the top 20% of CBSAs by relative size of the STEM industry had on average four fewer charter schools due to the Great Recession. Secondly, CBSAs in the top 20% for the relative size of the finance sector had a decrease in their stock of charter schools. The finance industry was heavily impacted by the GR, and the overall economy for these CBSAs was likely more heavily impacted than the bottom 80%. The combination of the overall impact of the GR with the industry specific effects shows that while charter schools in the average CBSA experienced a proliferation due to the potential decrease in opportunity costs for entrepreneurs. Some areas experienced more difficult conditions for potential charter entrepreneurs due to the impact of the GR on specific industries.

In comparison, I find the typical TPS only district experienced a decrease in the yearly school closure rate, no effect on the opening rate of new TPS, with an overall decrease in the stock of schools. The number of TPS has been decreasing in number over time, due to competition from charter schools and consolidation. The injection of federal funding during the GR and other forms of policy likely slowed the decrease in the number of TPS.

Using relative industry employment as a measure of exposure to the GR, I largely find no specific industry effect on TPS only school districts, but ones located in CBSAs who are in the top 20% of relative employment in finance experienced a lower yearly closure rate. Much like the overall effect of the GR, the injection of funding during this period likely slowed down the rate of closures in areas most heavily affected, such as those in the top 20% of finance by relative size.

The organization of this chapter is as follows: Section 3.2 provides a literature review and motivation for the analysis. Section 3.3 presents the hypotheses explored in this work, with Section 3.4 providing a theoretical framework. Section 3.5 states the empirical specifications employed and describes the dataset used in the analysis. Section 3.6 presents empirical results for the hypotheses regarding the direct impact of school funding, and Section 3.7 presents empirical results for the indirect impacts of the broader local economy on the market for charter schools. Section 3.8 concludes.

3.2 Motivation & Literature Review

The Great Recession (GR) is defined as starting in December 2007 and officially ending in June 2009 (NBER). This was the first major economic event most charter schools experienced since their inception in 1991. The GR was a financial crisis which originated from a lack of solvency in the sub-prime mortgage industry (Mian & Sufi, 2009). The collapse of this real estate market exposed how leveraged large financial institutions were, and subsequently generated a credit-supply shock which spilled over and affected most aspects of the global economy. For the United States, Rohwedder and Hurd (2010) found “between 2008 and April 2010 about 39 percent of households had either been unemployed, had negative equity in their house or had been in arrears in their house payments”. As shown in Figure 3.1, the financial crisis had a strong negative impact on the United States’ economy with a lasting decrease in real domestic product. Furthermore, as shown in Figure 3.2, the unemployment rate in the United States increased dramatically from a low of 4.4 percent in 2007 to a high of 10 percent in 2009, decreasing only gradually over time.

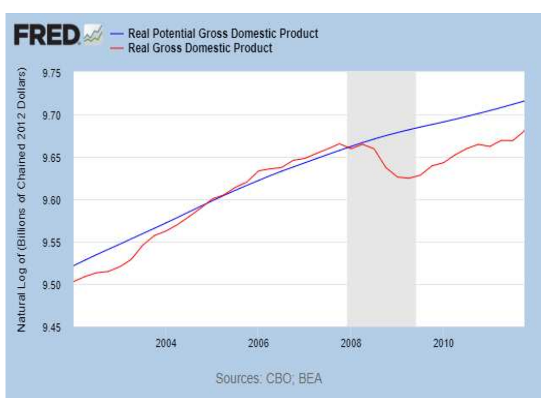

Figure 3.1: U.S. Real Domestic Product Versus Potential Real Domestic Product

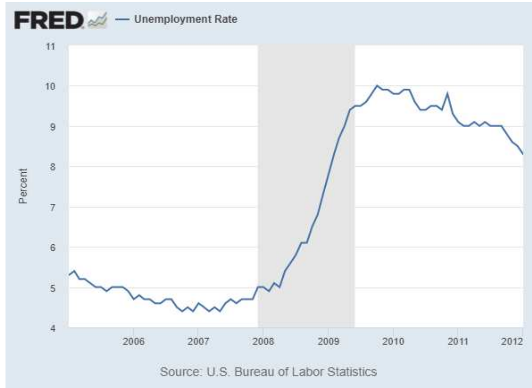

Figure 3.2: The United States Unemployment Rate 2005-2012

There are two avenues through which the GR potentially impacted TPS and charter schools. The first avenue is direct school funding. In expectation of revenue shortfalls, the federal government increased their education expenditures, which “through the American Recovery and Reinvestment Act (ARRA) allocated $100 billion to states for education in an effort to lessen the impact of decreased state and local funding and stave off serious budget cuts” (Chakrabarti et al., 2015). The education spending in ARRA was part of a larger bundle of government expenditure focused on mitigating the impact of the recession and providing counter-cyclical stimulus. Crucini et al. (2020) found the grants provided through ARRA reduced the effects of the GR on county level private wages by 7.5%, and 13% in the public sector. However, state and local funding comprises the majority of school budgets, with federal funding typically accounting for less than 10% of overall revenue (Jackson et al., 2021). Previous research on the impact of the GR on education in the United States found that nearly 300,000 school employees lost their jobs and inequality in school spending rose sharply (Evans et al., 2019).

The second avenue through which the GR potentially impacted TPS and charter schools is indirect industry effects. Outside of education, the GR caused many industries to contract with individual firms thinning their workforce and potentially exiting the market completely. For example, the real estate industry (where the GR originated) experienced a decline in establishments and job losses for several years post crisis. Figure 3.3 shows both establishment counts and net job creation at the CBSA level using the Business Dynamics Statistics (BDS) dataset and the North American Classification System (NAICS) for real estate (NAICS 53), construction (NAICS 23), finance (NAICS 52), and scientific and professional services (NAICS 54). These industries experienced varying degrees of establishment loss and job destruction and had not returned to pre-GR establishment counts by 2018.

The empirical analysis in Chapter 2 found the number of charter schools formed in a CBSA is correlated with the composition of industry. The larger the relative size of the STEM industry within a CBSA (NAICS 54), the more charter schools were formed. As such, a decline in firms and individuals working within this industry may change their demand for charter schooling, as they may no longer work in an environment which leads them to seek vertical innovation in schooling. Vertical innovation refers to the idea of improving the quality of core classes, such as science and math, while horizontal innovation refers to curriculum widening (Glomm et al., 2005). However, as all industries were declining during the GR, it is important to consider that most employment changes for STEM workers were involuntary and the relative decline of establishments in this industry is smaller (as shown in Figure 3.3).

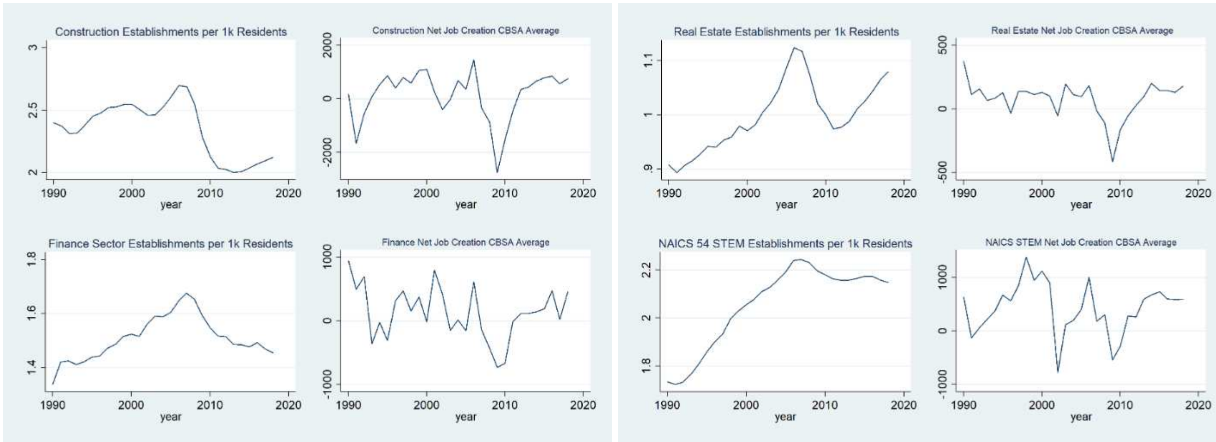

Figure 3.3: CBSA Industry Establishments & Net Job Creation

As shown in Chapter 2, the formation rate of charter schools is related to general market conditions and potential education entrepreneurs. Using establishment openings and closures as a measure of industry dynamism, I found the formation rate of charter schools is positively correlated with the number of overall firm deaths in a CBSA increased in the prior year. This relationship is hypothesized to be indicative of the supply of education entrepreneurs, as the relative opportunity cost of opening a charter school decreases as general market conditions worsen. Caroline Hoxby (2019) found that "…when the unemployment rate for recent college graduates rises, the quality of teachers, measured by their value added for students, rises" (5). Just as a potential teacher's options change due to recessionary forces, a potential education entrepreneur may find the option of opening a new charter school more enticing.

This work seeks to shed light on the relationship between charter schools, entrepreneurship, and the greater economy. There exists a substantial body of work focused on the impact of the GR with

TPS, but an exhaustive search of the literature found none that focus on charter schools (Chakrabarti & Livingston, 2015; Evans et al., 2019, Shores & Steinberg, 2013). As shown above, the GR had a large impact on overall economic output and had differing degrees of impact on specific industries and employment. This economic shock allows for several testable hypotheses to be generated and explored to better understand what drives the proliferation of charter schools and their potential risk/resilience to the broader economy.

3.3 Hypotheses

This work seeks to address two sets of hypotheses: Those associated with the direct effects of school funding the GR on charter schools, and a second set focused on the indirect effects of the broader economy on charter schools. Table 3.1 lists the hypotheses tested.

Focusing first on the direct effects, hypothesis one posits that charter schools are more exposed to negative market shocks due to differences in funding levels relative to TPS. Given that charter schools are not subject to the relatively more rigid administrative environment of a typical TPS, they are able to adjust their educational expenditures more rapidly and potentially through different avenues. However, since both TPS districts and charter only districts both operate from an essentially balanced budget approach the expenditure changes may be made at the same pace, but they may change different costs (i.e. capital expenditures versus instruction). It is hypothesized that charter schools will experience greater funding losses than TPS in areas more heavily affected by the GR due to the usually weaker finance formulas they are subject to.

Table 3.1: Hypotheses

GR Direct Effects: Funding	GR Indirect Effects: Economy
1. Charter schools are more exposed to negative market shocks due to differences in funding levels relative to TPS.	4. Holding school funding constant, charter schools are affected by greater market shocks such as the real estate market collapse during the GR.
2. CBSAs which experience greater decreases in per pupil funding have slower charter growth & more school closures.	5. Due to a decrease in opportunity costs, CBSAs more heavily affected by the GR will have more charter openings.
3. Charter Schools adjust spending differently compared to TPS when per pupil funding increases/decreases.	

Hypothesis two states charter only school districts located in CBSAs relatively more affected by the GR will experience slower charter growth and a decrease in the stock of charter schools due to funding challenges. As funding decreases, entrepreneurs will view opening a new school as more challenging, and existing schools may struggle to educate their current students using less funds. Following from this, hypothesis three posits charter schools who experience funding challenges will adjust their spending differently compared to TPS. Due to the less rigid nature of charter schools and lack of staff unionization, it should be possible for charter schools to change their expenditures in ways that are not feasible for TPS.

The second set of hypotheses focuses on the indirect impact of the broader economic environment on the proliferation and stock of charter schools within a CBSA. Hypothesis four states ceteris paribus, charter schools are affected by greater market shocks such as the collapse of the real estate market during the GR. At the onset of the GR, the collapse of the real estate market led to banks suffering from solvency issues. Given this, it is expected that charter schools will have a harder time opening in areas with deeper negative shocks to the real estate and finance sectors, as schools need both locations and loans to afford these locations. While real estate prices and rents became cheaper due to the market collapse, they may suffer difficulties attaining loans from banks during this period. A charter school has to compete with bank's next best alternative and does not have the perceived stability of the public school system, so it is expected that charters will struggle relative to TPS as the severity of the negative shock to these industries increases.

Hypothesis 5 states that as the overall economic condition within a CBSA will have an inverse relationship with the number of charter schools opened, as educational entrepreneurs will be more likely to choose to open a charter school as opposed to another venture as the opportunity cost decreases. However, it should be noted that if a CBSA were to experience lower direct funding levels (hypothesis two) for schools, then this effect may be minimized.

3.4 Theoretical Framework

To better understand the relationships explored between charter schools, the broader economy, and education entrepreneurs a simple theoretical framework is presented below. The supply of charter schools depends on the strength of charter school laws (Φ), funding (F), availability of real estate financing (R), existing TPS per capita (P_{st}), private school cost (ψ), TPS quality (γ), and the supply of entrepreneurs (λ):

$$S_{Cm} = f(\Phi, \mathrm{F}, \mathrm{R}, \mathrm{P}, \psi, \gamma, \lambda) \tag{3.1}$$

where:

$$\frac{\partial S_{Cm}}{\partial \Phi} > 0, \frac{\partial S_{Cm}}{\partial \mathrm{F}} > 0, \frac{\partial S_{Cm}}{\partial \mathrm{R}} > 0, \frac{\partial S_{Cm}}{\partial \mathrm{P}_{st}} < 0, \frac{\partial S_{Cm}}{\partial \psi_{st}} > 0, \frac{\partial S_{Cm}}{\partial \gamma} < 0, \frac{\partial S_{Cm}}{\partial \lambda} > 0$$

Based on the Center for Education reforms charter law index, a strong charter law imposes minimal restrictions on new charter schools, such as no cap on the number of schools that can open in a year (CER). A stronger charter law is assumed to be associated with an increase in the supply of charters. If a state does not have a charter law, then charter schools are not an approved educational establishment and are unable to open. Increased funding and available real estate for charter schools is assumed to increase the supply of charters, as both of these lower the difficulty associated with opening and maintaining a charter school. An increase in the number of existing TPS per capita is assumed to be associated with a decrease in the charter school supply, as competition is higher. The number of charter schools is a decreasing function of TPS quality, as this also implies a greater level of competition within the market. Finally, the higher levels of entrepreneurship within a CBSA is assumed to be positively associated with the number of charter schools, and quantified using several different measures in the empirical analysis.

Focusing specifically on entrepreneurship, the basic entry decision model in Wu & Knott (2006) is presented in equations (3.2) and (3.3). The number of potential entrepreneurs λ depends on the expected profitability of forming a charter school relative to other entrepreneurial ventures and the outside wage option:

$$\lambda_C = \int_{i=1}^{N} [E(\pi_{ic}) > E(\pi_{io}) \geq E(\pi_{iw})] dF(i) \tag{3.2}$$

The expected profitability of opening a charter school is defined as:

$$E(\pi_{ic}) = \int_0^{C_0} q_s(M - C)dF(c) \tag{3.3}$$

where:

q_s= Number of potential students

M = Available funding per student

C = marginal cost of educating a student

C_0 = largest solution to M – C = 0

Equation (3.3) states a charter entrepreneur will choose to open a charter school if the expected profitability of doing so (π_{ic}) is greater than their next best alternative, which could be another entrepreneurial endeavor (π_{io}) or earning a wage (π_{iw}). Charter entrepreneurs are revealed empirically by the number of new charter schools opened in an area, while the non-charter entrepreneurs are captured by firm births and deaths. The expected profitability of opening a charter school is shown in equation (11). An entrepreneur weighs the available funding (M) per student against the marginal cost (C) of educating a student, and multiplies this by the potential quantity of students (q_s). In the context of this analysis, it is expected that the GR will decrease available funding (M), which would decrease the expected profitability of opening a charter school. However, if the expected value of the entrepreneurs' other ventures (π_{io}) and potential outside wage option (π_{iw}) decrease, then entrepreneurs are more likely to open and maintain charter schools during the recessionary period.

3.5 Empirical Framework

Aggregating to the Core Based Statistical Area (CBSA), this analysis employs a panel dataset spanning the years 2006-2018. A CBSA consists of one or more counties which are anchored by an urban area of at least 50,000 people. This analysis further restricts the sample to CBSAs of more than 65,000 residents to make use of the 1-year American Community Survey (ACS) demographic data. Additionally, states which did not have a charter law in 2006 are excluded (seven). CBSAs which straddle state lines are removed due to state level differences in charter laws. In total, this generates a panel of 281 CBSAs nationwide. The panel is composed of school finance and characteristics data from the National Center for Education Statistics (NCES), demographics and housing information from the ACS, and industry employment data from the 2018 Business Dynamics Datasets (BDS). Focusing on CBSAs of 65,000 is convenient from a data perspective, and rural areas typically face different challenges, barriers, and pathways to education growth and quality increases.

The NCES finance data allows us to separate school districts within a CBSA into three categories: charter only districts (1), mixed districts (2), and TPS only (3). This analysis focuses on categories (1) and (3), allowing for comparison between pure charter and TPS districts. The industry data from BDS contains the number of new, closed, and existing firms in each two-digit NAICS industries. The North American Industry Classification System (NAICS) groups industries by output type and services offered. The NAICS sectors employed in this analysis are shown in Table 3.2.

Table 3.2: NAICS Industries Under Analysis

NAICS 2 Digit Sector Code	Category
Sector 23	Construction
Sector 52	Finance and Insurance
Sector 53	Real Estate and Rental and Leasing
Sector 54	Professional, Scientific, and Technical Services

Table 3.3 reports summary statistics of the variables employed in the empirical analysis. In total, 281 CBSAs are observed over the period 2006-2018, with a possible 3,520 observations for each variable. Due to data availability and the nature of the school district variables some have less observations but does not systematically bias the results. For example, some CBSAs do not have charter only school districts, and would not have any observations for those categories. Taking into account these restrictions, the difference-in-differences analysis in section 3.7 is based upon 2724 observations.

The NAICS sector employment variables in Table 3.3 are transformed before use in the empirical analysis to be a relative measure of employment. The number of establishments in an industry per one thousand CBSA residents is calculated for the 1995-2005 period, and then assigned into quantiles. This analysis uses the top 20% of CBSAs in terms of relative industry employment as an indicator for exposure to the GR. Net job creation is calculated as the number of jobs added within an industry in a particular year, less jobs destroyed. Newcharter is the number of new charter schools opened in a CBSA in a particular year, while numcharter is the total number of charter schools within a CBSA.

Revenue totals for federal, state, and local government are adjusted per pupil to allow for a direct comparison of differently sized school districts. For example, the average CBSA has 15 charter schools in charter only districts, while the average CBSA has 148.46 schools in TPS only school districts.

This almost tenfold difference in school numbers should be kept in mind when considering the empirical analysis that follows.

Table 3.3: Descriptive Statistics of the CBSA Sample

Variable	Obs	Mean	Std. Dev.	Min	Max
Total Rev Charter	1558	8845.09	3782.73	299.97	88001.02
Total Rev TPS	3251	10923.01	3705.29	5554.84	112725.13
Fed Rev Charter	1558	922.28	713.04	0	7455.56
Fed Rev TPS	3251	1028.19	1067.84	132.1	52265.15
State Rev Charter	1558	5839.82	3137.56	0	58066.69
State Rev TPS	3251	5207.52	1810.5	278.93	17361.57
Local Rev Charter	1558	2083	3381.9	0	26656.62
Local Rev TPS	3251	4687.31	2731.42	20.65	44219.44
newcharter	2724	1.17	3.32	0	36
numcharter	2724	15	38.22	0	433
closedcharter	2724	.5	1.91	0	37
numTPS	2724	148.46	233.69	10	2274
newTPS	2724	1.52	3.57	0	53
closedTPS	2724	.27	1.3	0	19
NAICS 54 Employment	2724	14786.41	35702.27	348	505645
NAICS 52 Employment	2724	11098.97	23980.33	364	248288
NAICS 23 Employment	2724	12546.3	24786.53	492	217891
NAICS 53 Employment	2724	3963.32	9083.24	133	127136
Minority TPS	2724	.37	.22	0	.99
Poverty rate	2724	.26	.06	.1	.53
Rent2BR	2724	40.78	8.13	24.45	94.45
Expenditure/pupil	2724	9.27	3.37	0	20.24

Several control variables are employed to capture differences between CBSAs and isolate the effects of interest: Minority TPS is a measure on the non-white population in a CBSA's traditional public schools and is employed as a control for CBSA demographics. Poverty Rate is the proportion of people in a CBSA who are at 150% of the poverty line or below. Rent2BR is a measure of what percentage of the median income CBSA resident would be spent on renting a two-bedroom apartment within that CBSA. Expenditure per pupil is employed to control for the school fiscal environment and is measured in thousands of dollars.

The impact of a negative market shock on charter schools is measured using two different econometric methodologies. The impact on the stock of charter schools is measured using a difference-in-differences approach, with geographic (state-level and CBSA) and time fixed effects:

$$Charter_{it} = \propto_0 + \propto_1 Treatment_{it} + \propto_2 GR_t + \propto_3 (Treatment_{it} \times GR_t) + X_{it}^T\beta + \tau_t + \delta_g + e_{it} \quad (3.4)$$

Charter represents the stock of charters within CBSA i and year t. Treatment captures whether a CBSA is classified as being heavily exposed to the GR, and several different measures are employed. GR is an indicator variable for the period after the Great Recession begins (2008-2011). Coefficient $\propto_3$ provides the treatment effect of the GR on CBSAs more exposed to recessionary conditions, and X_{it}^T is a vector of CBSA controls, such as the poverty rate. τ_t and δ_g represent time and geographic fixed effects, with e_{it} being the error term.

Several different measures of the treatment group are employed to capture CBSAs which are disproportionately affected by the GR. For example, a CBSA with a relatively large finance sector is disproportionately affected by the GR, and the treatment group is identified as the top 20% of CBSAs in terms of relative size of their financial industry as compared to the rest of the CBSAs in the sample. In this analysis, I use the top 20% of the construction (NAICS 23), Finance (52), Real Estate (53), and Scientific and Professional Services (54) in separate estimations to identify the treatment group. The choice of top 20% is convenient from a data perspective, as it assures there are at least 43 charter only school district CBSAs represented in the treatment group. As a robustness check, the statistical analysis was tested using top 10%, 30%, and 40% of CBSAs by industry concentration. The empirical results are robust to changing the cutoff, and for comparison Appendix D contains a replication of the empirical analysis using the top 30% of CBSAs by industry concentration.

Negative binomial regression is used when the dependent variable is a yearly count, which does not follow a normal distribution. The Poisson estimator is considered to be more robust but assumes the mean of the regressand is equal to its variance. The rate of charter openings suffers from dispersion where the variance is two times the mean, making Poisson inappropriate. The formation and closure rate of charters and TPS are count data, so negative binomial regressions are employed when necessary:

$$E(N|X) = exp\ (\beta X + P_{it} + e_{it}) \tag{3.5}$$

where:

$$X = \{\beta I_{j(t-1)} D_{j(t-1)}, S_{j(t-1)}, N_{j(t-1)}, Z_{jt}\} \tag{3.6}$$

$$var[N_{Cijt}] = \mu_{ijt} + \alpha\mu_{ijt}^2 \tag{3.7}$$

N represents the set of six school dependent variables: The stock, opening, and closure rate for TPS and charter schools. $I_{j(t-1)}$ represents a vector of NAICS industry turnover and employment data for CBSA j in time t – 1. Measures of industry are lagged by 1 year to isolate the direction of the relationship between industry composition and the count of charters created. $D_{j(t-1)}$ represents a vector of demographic variables, such as CBSA resident median age and the poverty rate in the previous year. $S_{j(t-1)}$ is a vector of school variables, such as the average minority percentage for schools within that CBSA for the previous year. Z_{jt} represents a vector of time and state dummies to account for fixed differences not captured by the independent variables. $N_{j(t-1)}$ is a vector of school finance variables, such as total federal, state, and local revenue.

3.6 Direct Effects: School Funding and the Great Recession

The direct impact of funding changes on charter and traditional public schools can be challenging to analyze due to the structure of the U.S. school systems. Due to the individual state approach to the provision of education, school systems were heterogeneous in their response to potential funding shocks. For example, New Jersey schools experienced declines of 12% in per pupil funding, while New York schools remained largely on trend (Bhallas et al., 2017). This is partially explained by New York's heavier reliance on federal funding prior to and during the GR, as New Jersey experienced a much smaller increase in federal funding based on the demographic criteria entering the federal funding formula. Keeping it in mind that an individual school or system may have unique challenges, this analysis takes individual school district financials and aggregates to the CBSA level. Using this aggregation, I consider the "typical" environment that a charter or traditional public school operated within during the 2006-18 time period.

Starting with hypothesis (1), I compare charter school only district financials against those of TPS only school districts across CBSAs to determine if charter schools are more or less exposed to negative market shocks. Understanding how school funding revenues change during the GR first requires considering the differences in funding for charter and TPS only districts in the pre-recessionary period. In 2006-07 per pupil funding in a charter only school district was $2,067.24 less than per pupil funding in

TPS only school districts (Table 3.4). While charter and TPS districts receive essentially equal Federal funding, charter schools receive significantly less local revenue than TPS. The majority of charter school funding comes from state government. Using a basic paired t test confirms significantly different state, local, and total revenue for charter school only districts. A paired t test compares the average charter only school district against the average TPS only school district within the same CBSA and excludes any CBSA district averages that do not have a corresponding pair. In total, there are 195 pairs in the 2006-07 pre-recessionary period.

Table 3.4: Charter Versus TPS Pre-Recession Funding Paired T-Test Results

T-Test Funding Comparison	obs	Charter Mean	TPS Mean	Diff	St Err	t value	p value
Charter Total Revenue Per Pupil vs TPS	195	8550.65	10618.17	-2067.52	148.96	-13.88	0.00
Charter Fed Revenue Per Pupil vs TPS	195	901.71	930.44	-28.73	59.61	-0.48	0.63
Charter State Revenue Per Pupil vs TPS	195	6081.81	5079.57	1002.24	160.87	6.23	0.00
Charter Local Revenue Per Pupil vs TPS	195	1567.13	4608.16	-3041.03	185.12	-16.43	0.00

Figure 3.4 shows revenue per pupil over time for Federal, state, and local sources. Local and state revenues decrease in 2010 and then continue to climb. The Federal government increased expenditures, peaking in 2010. Local revenues did not decrease as much as they potentially could have, due to an increase in the property tax by most local governments to compensate for decreased home values, and in some cases more than compensated for the reduced home values that typically determine educational revenues (Evans et al., 2019).

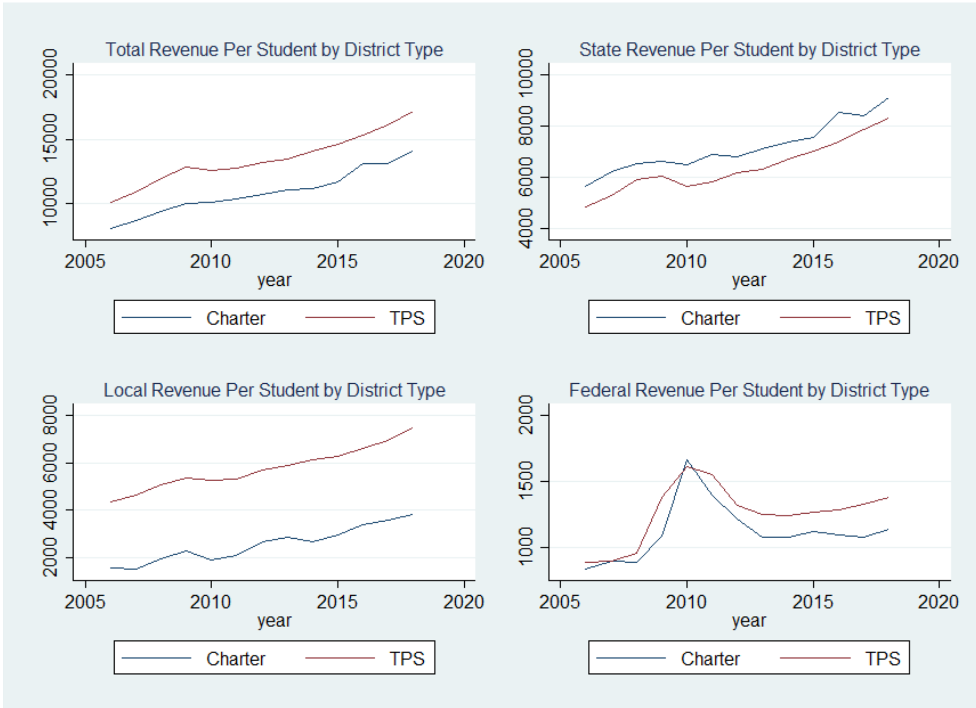

Figure 3.4: Charter & TPS District Revenues by Source 2006-18

Interestingly, Figure 3.4a shows that the average school steadily gained funding per pupil relative to pre-recession levels, albeit slowly. The average TPS experienced a small decrease in funding per pupil during 2010, due to the decrease in both state and local revenues. Based on this graphical analysis, charter schools were no more exposed to the GR than TPS, and we can reject hypothesis (1) that the market orientation of charter schools makes them more susceptible to market shocks than TPS. While charter schools saw a decrease in their local revenue, it comprises a relatively small proportion of their total revenue per student. This would imply they are less likely to experience a decline in their revenues due to a negative real estate market shock in the absence of policy to raise tax rates.

Turning to hypothesis (2), the number of charters across all CBSAs over the 2005-2015 period shows a relatively steady increase with no indication of an exogenous shock or structured break, shown in Figure 3.5. This is interesting when contrasted with the small decrease in total revenue per student in 2010 shown above. The steady increase in the number of charters over this time period could be indicative of the “new” nature of charter schooling, where markets have yet to be competitively saturated.

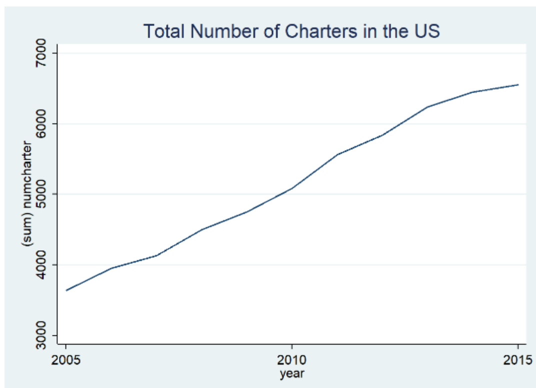

Figure 3.5: The Total Number of Charter Schools in the U.S. 2005-2015

Figure 3.6 shows the number of new charters and closed charters by year over the same time period. Openings experience a dip during the GR but recover quickly. Interestingly, openings decrease in the post-recession recovery period. Charter closures are relatively noisy and affects a smaller proportion of schools, with slightly less than one school closure for every two openings.

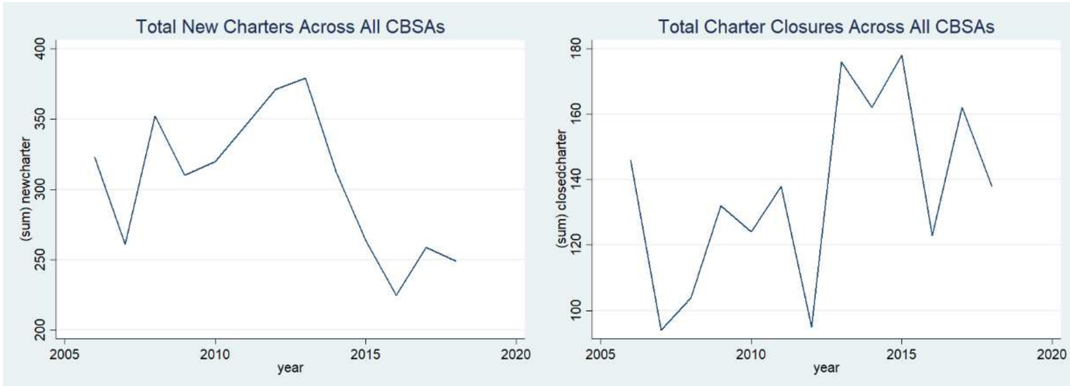

Figure 3.6: Charter Openings and Closures For Sample CBSAs 2006-2018

Traditional public schools over this same period have experienced a steady decline in number, but still experience new openings as shown in Figure 3.7. In total, CBSAs experienced a net loss of 216 TPS over the 2006-18 period. In comparison, charters experienced a net gain of almost 5000 schools over the same period.

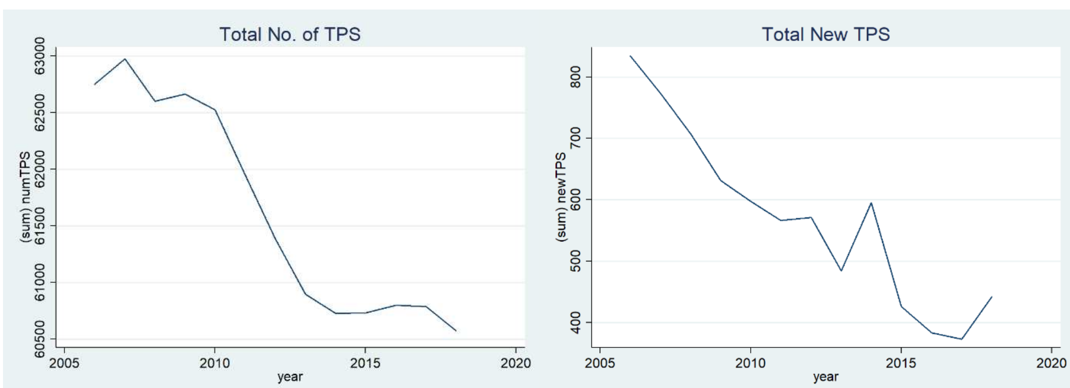

Figure 3.7: The Stock of Traditional Public Schools & Openings 2006-18

Having looked at the experience of the average charter school district, I find no evidence of a decrease in charter growth or an increase in school closures. However, the average can often mask changes at different parts of a spectrum. To further explore this relationship, I calculate the percentage change in total revenue during the sample period and group the bottom 20% of CBSAs which experienced the largest decrease in revenue.

Reported in Table 3.5, I find a statistically significant difference in the number of charters created or closed per year. The bottom 20% of charter schools by change in revenue experienced a 3.4 percent decrease in their total revenue per pupil during the sample period compared to an increase of 5.61% for the remaining 80%. The rate of new charter openings for the bottom 20% has decreased by more than half a school per year, but the rate of charter closures has decreased by a quarter of a school per year on average. This implies charter growth during the 2006-18 period was affected by these decreases in revenue, but by a relatively small margin.

Table 3.5: Charter Growth & Closures for the Bottom 20% in Total Revenue

Variable	Bottom 20%	Remaining 80%	Diff	t value	p value
% Change Total Revenue Per Pupil	-3.40%	5.61%	9.01%	2.49	0.0130
New Charters Per Year	1.04	1.69	0.64	2.69	0.0073
Charter Closures Per Year	0.50	0.75	0.25	1.85	0.0644
Observations	362	1439			

Hypothesis (2) stated charter school districts which experienced greater decreases in revenue per pupil would have a lower rate of charter openings and an increase in closures. Interestingly, the results of Table 3.5 show that while the rate of openings decreased, the rate of closures decreased as well. Charter entrepreneurs may be less likely to open schools in an environment with decreased funding, but it appears that the more distressed charter school districts have lower overall turnover. As a robustness check, Tables D1 and D2 in Appendix D report the same analysis as Table 3.5 but using the bottom 30% and 10% respectively. Using a 10% cutoff shows a continuation of the shown relationship, with charter openings decreased further while the rate of charter closings also decreased.

Having found that charter school districts are surprisingly resilient to decreases in total revenue, I consider whether charter schools are responding to these decreases by adjusting their spending differently than TPS. The typical school has several different categories of expenditure, and in this analysis I focus on four: Teaching staff, administration, maintenance, and students. Figure 3.8 plots these different spending categories over the 2006-18 period for both charter only districts and TPS only.

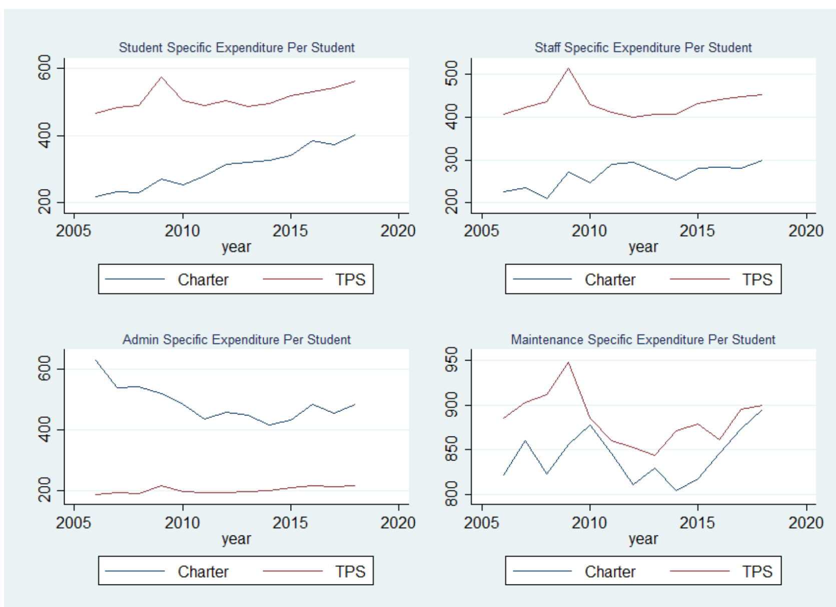

Figure 3.8: Changes in Four School Expenditure Categories Over 2006-18

These graphs showcase the drastic difference in what a typical charter school spends their funding on as compared to TPS. At the beginning of the sample, charter schools spent much less of their funding on staff and students, and significantly more on administration and maintenance. Understandably, since charter schools are largely independent institutions with smaller student bodies, they will have to spend more on administration per student than a comparable TPS due to economies of scale. Due to the significant difference in total revenue per student, convergence between charter school expenditures and TPS is not expected. The greatest change for the typical charter school was a decrease in maintenance expenditure, which by the end of the sample period has returned to pre-recession levels. Overall, charter schools clearly allocate their funding differently than TPS, but this is likely a function of their scale and not a response to funding shocks.

3.7 Indirect Impacts: Charter Entrepreneurship

Having considered the direct impacts of funding changes on charter schools, I now consider the hypothesized indirect effects. Hypothesis (4) states ceteris paribus, charter schools are affected by greater market shocks, and hypothesis (5) states CBSAs most heavily affected by the GR recession will have more charter openings. Because charter school openings require an education entrepreneur, we would expect that the opportunity cost of opening a school would change during a market shock. Table 3.6 reports four difference-in-differences regressions for the number of charter schools in a CBSA. The top 20th percentile of CBSA NAICS sector employment in construction (23), finance (52), real estate (53), and STEM (54) are used as identifiers for CBSAs which may be more greatly affected by the GR. As shown in Section 3.2, these industries experienced establishment and employment losses during the recessionary period, and this metric separates out the CBSAs which will have experienced the largest impact of the GR, and therefore will apply the largest indirect effect on potential charter entrepreneurs.

Table 3.5: Industry Impacts on the Number of Charters

	(1) numcharter	(2) numcharter	(3) numcharter	(4) numcharter
crisis	5.215***	4.872***	4.358***	4.639***
	(.692)	(.7)	(.697)	(.695)
Top 20% Stem	35.488***			
	(6.2)			
STEM*crisis	-4.138***			
	(.699)			
Top 20% Finance		25.227***		
		(6.103)		
Finance*crisis		-1.718**		
		(.694)		
Top 20% Construction			-17.779**	
			(7.437)	
Construction*crisis			.912	
			(.683)	
Top 20% Real Estate				16.173**
				(6.573)
RealEstate*crisis				-.732
				(.695)
Minority TPS	5.326*	4.584	4.786*	5.063*
	(2.871)	(2.892)	(2.894)	(2.89)
Expenditure/pupil	-.573***	-.61***	-.616***	-.598***
	(.159)	(.159)	(.16)	(.16)
Poverty rate	-9.546	-10.764	-10.57	-10.134
	(7.185)	(7.222)	(7.231)	(7.232)
Rent2BR	.029	.028	.021	.028
	(.053)	(.054)	(.054)	(.054)
Constant	71.739***	74.281***	93.066***	70.552***
	(14.524)	(14.957)	(16.479)	(15.511)
Observations	2724	2724	2724	2724
Time Fixed Effects	YES	YES	YES	YES
State Fixed Effects	YES	YES	YES	YES

Standard errors are in parentheses
**** p<.01, ** p<.05, * p<.1*

Across all four regressions the indicator variable crisis is significant, with CBSA charter only school districts having on average 4.4 – 5.2 more charter schools operating within the CBSA during the crisis period. Charter only school districts in the top 20% of CBSAs based on the relative size of their real estate industry have approximately 16.17 more charter schools than the bottom 80%. The difference-in-differences coefficient for real estate is not significant, which is interesting for two reasons. Firstly, the top 20 percent of CBSAs in real estate employment prior to the great recession were likely more greatly affected by the collapse of the real estate market. Secondly, this is opposite to the a priori expectations for hypothesis 4. Areas that are likely most distressed by the GR (top 20% in relative size of the real estate sector) have greater numbers of charter schools post-recession, even in the face of potential challenges with securing real estate.

When the treatment group is selected based on the top 20% of CBSAs in finance employment, different results are found. Being in the top 20% of CBSAs by employment in finance is associated with a school district having 25.2 more charters. However, the difference-in-difference coefficient is negative and significant, which means areas most heavily invested in finance had fewer charter schools during the GR. With the finance industry being heavily impacted by the GR, it is not surprising that the top 20% of CBSAs by finance employment would see a decrease in their charter stock due to these CBSAs being more economically distressed. Being in the top 20% of CBSAs for STEM employment is associated with a school district having 35.5 more charters. The difference-in-difference coefficient is negative and significant, which means areas more heavily invested in STEM had fewer charter schools during the GR.

This is expected, as the STEM industry was itself indirectly affected by the GR and experienced greater changes in employment. CBSAs in the top 20% of construction employment is associated with a charter stock 17.8 schools smaller. Interestingly, while the construction industry was heavily affected by the GR, the top 20% of CBSAs in terms of construction employment did not experience any change due to the GR. This could be due to the relatively smaller size of the stock of charter schools in construction industry heavy CBSAs.

Table 3.6: Industry Impacts on the Creation Rate of Charters

IRR reported	(1) newcharter	(2) Newcharter	(3) Newcharter	(4) newcharter
crisis	1.338**	1.392***	1.364**	1.306**
	(0.173)	(0.177)	(0.170)	(0.165)
Top 20% Stem	3.998***			
	(0.790)			
STEM*crisis	1.000			
	(0.098)			
Top 20% Finance		2.548***		
		(0.546)		
Finance*crisis		0.959		
		(0.097)		
Top 20% Construction			0.676	
			(0.173)	
Construction*crisis			1.243*	
			(0.141)	
Top 20% Real Estate				1.059
				(0.282)
RealEstate*crisis				1.341***
				(0.143)
Minority TPS	5.280***	5.194***	4.400***	4.780***
	(2.418)	(2.478)	(2.177)	(2.365)
Expenditure/pupil	1.038	1.041	1.036	1.036
	(0.036)	(0.037)	(0.037)	(0.037)
Poverty rate	0.010***	0.002***	0.001***	0.002***
	(0.013)	(0.002)	(0.002)	(0.002)
Rent2BR	1.012	1.025***	1.017*	1.015
	(0.009)	(0.009)	(0.009)	(0.009)
Observations	2,724	2,724	2,724	2,724
Time Fixed Effects	YES	YES	YES	YES
State Fixed Effects	YES	YES	YES	YES

Standard errors are in parentheses
**** p<.01, ** p<.05, * p<.1*

Looking at the rate as opposed to the stock, Table 3.7 shows the relationship between these four NAICS industries on the creation rate of new schools with four negative binomial difference-in-difference regressions. Table 3.7 reports incidence rate ratios in place of standard negative binomial coefficients. The standard coefficients reported from negative binomial regression are the difference in the log of expected counts. The incidence rate ratio reports the log of their quotient which is a simple transformation of the original coefficients. Once transformed, the IRR can be interpreted as the change in the rate for the dependent variable holding all other factors constant. For example, in column (1) of table 3.7 the crisis variable has an IRR of 1.338, which means ceteris paribus the rate of new charter school openings was 1.338 times higher during the crisis period.

CBSAs in the top 20% for STEM and finance have a significantly higher rate of charter formation, but there is no significant effect when interacted with the GR (D-I-D coefficient). CBSAs with a relatively larger NAICS 54 industry experienced greater charter growth, with one more establishment per 1,000 residents leading to an increase of 3.998 in the rate of charter openings per year. This implies that CBSAs more heavily affected by the GR did not experience a change in their rate of charter formation, but overall during this period there was an increased charter formation rate. CBSAs in the top 20% for real estate do not have a significant relationship with charter school creation rate, but the D-I-D coefficient is positive and significant. The GR originated in the real estate industry, and it is expected that CBSAs with a relatively large real estate industry would be heavily affected by the GR.

Based on these results, charter schools are affected by greater market shocks, and we can reject the null for hypothesis (4). The overall effect of the GR negative market shock lowered the opportunity cost of opening a new school, as funding levels were maintained and entrepreneur's next best options worsened. However, the results in Table 3.6 show us that areas most affected by the GR had fewer schools on average. It is likely that while the average CBSA had a lower opportunity cost for starting a charter school during the GR, if the negative shock was deep enough it increased the challenges with education entrepreneurship. Based on these results, we fail to reject the null on hypothesis (5).

Table 3.7: Industry Employment Impacts on the Closure Rate of Charters

	(1)	(2)	(3)	(4)
IRR reported	closedcharter	closedcharter	closedcharter	closedcharter
crisis	0.987	1.061	1.026	1.006
	(0.209)	(0.224)	(0.209)	(0.207)
Top 20% Stem	4.584***			
	(1.145)			
STEM*crisis	0.968			
	(0.152)			
Top 20% Finance		2.285***		
		(0.593)		
Finance*crisis		0.687**		
		(0.117)		
Top 20% Construction			0.563*	
			(0.186)	
Construction*crisis			0.798	
			(0.177)	
Top 20% Real Estate				1.292
				(0.416)
RealEstate*crisis				0.913
				(0.167)
Minority TPS	2.501	4.274**	3.920**	4.137**
	(1.506)	(2.643)	(2.461)	(2.627)
Expenditure/pupil	1.024	1.016	1.010	1.017
	(0.055)	(0.056)	(0.055)	(0.056)
Poverty rate	0.183	0.010**	0.006**	0.007**
	(0.357)	(0.019)	(0.012)	(0.014)
Rent2BR	1.013	1.023*	1.017	1.021
	(0.013)	(0.014)	(0.014)	(0.014)
Observations	2,724	2,724	2,724	2,724
Time Fixed Effects	YES	YES	YES	YES
State Fixed Effects	YES	YES	YES	YES

Standard errors are in parentheses
**** p<.01, ** p<.05, * p<.1*

For completeness, Table 3.8 considers the impact of the GR on the rate of charter closures in charter only school districts using four negative binomial difference-in-difference regressions. Incidence rate ratios are reported for ease of interpretation. The crisis dummy variable is not significant, which implies the overall rate of charter closures by itself did not significantly increase or decrease. The rate of closures is significantly higher in CBSAs in the top 20% of relative employment in STEM and finance. This is expected, as the number of charter openings is also higher in these CBSAs and a higher school turnover rate is feasible. Interestingly, the top 20% of CBSAs in relative finance employment experienced a lower rate of charter closures during the GR period, as the (D-I-D) variable is negative and significant. This could be due to the impact of federal intervention and policy response to the GR, as large financial institutions received aid to prevent their collapse and subsequently mitigated some of the recessionary impacts.

Turning to traditional public schools, Table 3.9 shows reports four difference-in-differences regressions for the number of TPS in a CBSA. The top 20th percentile of CBSA NAICS sector employment in construction (23), finance (52), real estate (53), and STEM (54) are again used as identifiers for CBSAs which may be more greatly affected by the GR and allows for a comparison with the charter results in Table 3.6. In all four regressions, the indicator variable crisis for the start of the GR is negative and significant, implying on average TPS only school districts lost 2.7-3.5 schools during the recessionary period. A priori expectations were TPS are not likely to be affected by the specific composition of industry within a CBSA, but a positive and significant relationship is found between the concentration of the STEM and finance industries and the number of traditional public schools. Looking at the D-I-D coefficients, TPS only school districts located in the top 20% of CBSAs in terms of relative STEM employment gained 4 more schools on average. This is surprising, as the number of TPS declined overall across the sample period.

Table 3.8: Industry Impacts on the Number of TPS

	(1) numTPS	(2) numTPS	(3) numTPS	(4) numTPS
crisis	-3.512***	-2.659**	-2.669**	-2.717**
	(1.196)	(1.205)	(1.199)	(1.195)
Top 20% Stem	238.023***			
	(36.177)			
STEM*crisis	3.834***			
	(1.207)			
Top 20% Finance		176.851***		
		(35.73)		
Finance*crisis		-.786		
		(1.194)		
Top 20% Construction			-94.645**	
			(44.271)	
Construction*crisis			-.789	
			(1.173)	
Top 20% Real Estate				47.634
				(39.225)
RealEstate*crisis				-.622
				(1.194)
Minority TPS	.678	.624	.949	.856
	(5.008)	(5.024)	(5.021)	(5.015)
Expenditure/pupil	.755***	.794***	.803***	.805***
	(.274)	(.274)	(.274)	(.275)
Poverty rate	-17.77	-18.441	-18.405	-18.139
	(12.491)	(12.511)	(12.511)	(12.511)
Rent2BR	.304***	.31***	.313***	.313***
	(.092)	(.093)	(.093)	(.093)
Constant	167.719**	175.992**	282.307***	180.554**
	(82.735)	(85.558)	(96.119)	(90.572)
Observations	2724	2724	2724	2724
Time Fixed Effects	YES	YES	YES	YES
State Fixed Effects	YES	YES	YES	YES

Standard errors are in parentheses
**** p<.01, ** p<.05, * p<.1*

Table 3.10 shows negative binomial difference-in-difference regression results for the creation rate of new traditional public schools. Incidence rate ratios are reported. The dummy variable denoting the recessionary period is not significant, which implies the rate of new TPS openings was not affected by the GR. CBSAs in the top 20% in relative employment for STEM and Finance have increased rates of TPS openings, but there is no interaction effect between being in the top 20% of these industries and the GR period. Overall, the GR did not affect the creation rate for TPS. Due to the mature nature of TPS, it is less likely for new TPS to be opening. Table 3.10 shows the creation rate for TPS relies on existing funding, percentage of existing pupils who are a minority, and the poverty rate. Areas and individuals who are underserved by TPS are likely being targeted for school expansions.

Measuring the impact of the GR on the stock of TPS is where the 20% cutoff for being in the treatment group can make a difference on the results. Comparing Table 3.8 with Table D6 in the appendix, using a 30% cutoff for industry concentration removes the significance in the construction industry, but finds a negative D-I-D coefficient for construction. Additionally, increasing the size of the treatment group to 30% finds a significant positive correlation between the size of the real estate industry and the stock of TPS. Since the construction and finance industries were heavily affected by the GR, we would expect to see a negative relationship between the stock of TPS and the recessionary period.

Table 3.9: Industry Impacts on the Creation Rate of TPS

	(1)	(2)	(3)	(4)
IRR reported	newTPS	newTPS	newTPS	newTPS
crisis	1.011	1.024	1.056	1.046
	(0.122)	(0.121)	(0.124)	(0.123)

Top 20% Stem	1.450***			
	(0.205)			
STEM*crisis	1.102			
	(0.114)			
Top 20% Finance		1.313*		
		(0.189)		
Finance*crisis		1.110		
		(0.123)		
Top 20% Construction			0.681**	
			(0.119)	
Construction*crisis			1.146	
			(0.142)	
Top 20% Real Estate				0.866
				(0.147)
RealEstate*crisis				1.068
				(0.126)
Minority TPS	3.675***	3.769***	3.594***	3.788***
	(1.250)	(1.294)	(1.245)	(1.312)
Expenditure/pupil	1.224***	1.233***	1.227***	1.232***
	(0.037)	(0.037)	(0.037)	(0.037)
Poverty rate	0.166*	0.090**	0.070***	0.069***
	(0.166)	(0.088)	(0.068)	(0.068)
Rent2BR	0.993	0.998	0.994	0.996
	(0.008)	(0.008)	(0.008)	(0.008)
Observations	2,724	2,724	2,724	2,724
Time Fixed Effects	YES	YES	YES	YES
State Fixed Effects	YES	YES	YES	YES

Standard errors are in parentheses
**** p<.01, ** p<.05, * p<.1*

Table 3.11 shows incident rate ratios for negative binomial difference-in-difference regression results for the closure rate of traditional public schools. Looking across all four, the dummy variable denoting the recessionary period is less than one and significant. The rate of TPS closures fell by approximately two thirds during the recessionary period.

Table 3.10: Industry Employment Impacts on the Closure Rate of TPS

	(1)	(2)	(3)	(4)
IRR reported	closedTPS	closedTPS	closedTPS	closedTPS
crisis	0.335***	0.390***	0.310***	0.331***
	(0.104)	(0.123)	(0.092)	(0.099)
Top 20% Stem	5.648***			
	(1.596)			
STEM*crisis	0.802			
	(0.203)			
Top 20% Finance		2.348***		
		(0.641)		

Finance*crisis		0.595**		
		(0.156)		
Top 20% Construction			0.286***	
			(0.104)	
Construction*crisis			1.989*	
			(0.721)	
Top 20% Real Estate				0.829
				(0.266)
RealEstate*crisis				1.155
				(0.382)
Minority TPS	2.565	3.439*	3.779*	3.728*
	(1.705)	(2.337)	(2.586)	(2.571)
Expenditure/pupil	1.022	1.054	1.042	1.048
	(0.073)	(0.078)	(0.076)	(0.078)
Poverty rate	0.302	0.010**	0.007**	0.004**
	(0.654)	(0.021)	(0.015)	(0.009)
Rent2BR	0.984	1.001	0.989	1.000
	(0.017)	(0.017)	(0.017)	(0.018)
Constant	0.739	0.424	3.066	0.906
	(0.750)	(0.444)	(3.444)	(0.952)
Observations	2,724	2,724	2,724	2,724
Time Fixed Effects	YES	YES	YES	YES
State Fixed Effects	YES	YES	YES	YES

Standard errors are in parentheses
**** p<.01, ** p<.05, * p<.1*

On average, a TPS only school district experienced one fewer TPS closure per year during the GR. This could be attributed to the increase of federal funding during the recessionary period. Looking at the individual regressions, TPS only school districts located in CBSAs in the top 20% of relative employment in STEM and finance experience higher rates of TPS closures per year. These school districts may be experiencing greater competition from charter schools and would have higher rates of school closures in the absence of any recessionary effect. TPS only school districts located in CBSAs in the top 20% of relative employment in construction experience a reduction in yearly school closures.

However, the D-I-D interaction variable for finance is positive and less than one. This means the rate of TPS closures decreased significantly for CBSAs in the top 20% of relative size for the finance industry. Interestingly, the rate of charter closures was also lower as shown in Table 3.8. As hypothesized earlier, this could be due to federal response and support of large financial institutions during the GR. Combining these results with the school opening results displayed in Table 3.10, there are fewer school openings but also fewer school closures.

3.8 Discussion & Conclusion

The stock of charter schools has been steadily rising since their introduction in 1991, and much research has been done on the relationship between charter school attendance and educational outcomes. While there is a large body of work that has focused on the impact of the GR on public schools, this is the first work that has considered the specific impacts on charter schools. This work has shown charter schools have unique features to their funding sources and relationship with the broader economy. This changes their exposure to recessionary forces in comparison to traditional public schools. As charter schools continue to expand and educate a larger proportion of American children, it is pertinent to understand a charter schools systems' different strengths and challenges.

Charter schools are typically seen as a more market-oriented approach to schooling, and this analysis finds that both the stock and rate of charter school openings are affected by shocks to the broader economy. As the difference-in-differences analysis showed, the rate of charter school creation was higher during the Great Recession, but CBSAs more exposed to the GR experienced a decrease in their stock of charter schools. A priori expectations were that charter schools would be more exposed to the GR due to differences in their funding formulas, but as shown in Figure 3.4, the average charter only school district experienced minimal funding losses. While state and local revenue was reduced, charter school districts did not experience funding losses due to the increased Federal aid available due to the American Recovery and Reinvestment Act (ARRA). The government mitigated most funding shortfalls for charter school districts, and traditional public school systems had a similar experience. However, charter schools in the pre-recession period on average received $2,006.24 less funding per pupil than traditional public schools.

The total stock of traditional public schools decreases steadily during the sample period. The GR reduced the yearly school closure rate, which can likely be attributed to the injection of funding from the Federal government. While there are openings of new traditional public schools during the sample period, it was not affected by the GR. Using relative industry employment composition as a measure for exposure to the GR, I do not find any significantly different effects on the traditional public school system. While individual school systems may have experienced difficulties because of the GR, the average school district in this sample was only minorly affected (Evans et al., 2019).

The hypothesized ability for charter schools to respond differently to funding challenges was not found, as charter schools and TPS adjusted their spending in a similar manner by reducing spending across the board and shrinking maintenance expenditure. Somewhat interesting is the revealed systemic difference in expenditures between charter schools and TPS. The scale and design of charter schools leads to greater spending on administration, and lower spending on staff and the students themselves.

The general trend found in this analysis aligns with theoretical expectations for education entrepreneurs and their decision-making process. As general market conditions deteriorate, potential education entrepreneurs are more likely to choose to open a school, as their outside options have potentially worsened and decreased the opportunity cost of opening a school. However, the CBSAs most affected by the GR had fewer charter schools, which could be due to potential challenges that will arise when recessionary forces are stronger in a particular community. For example, a mild recession may push an entrepreneur to choose opening a school as their best option, but as the recession deepens it becomes more difficult to get the funding and physical capital required for opening a school. Additionally, community support for a new school may be lower when households are pre-occupied with their own employment outcomes and budgetary stress.

Overall, this analysis reveals that charter schools were fairly insulated from the direct impacts of the GR, and experienced steady and continuous growth during the recessionary period. Policy wise, the ARRA was successful in mitigating funding shocks to both TPS and charter schools. While charter schools may be viewed as a market-oriented approach to education, their funding was safely protected by the government during the GR which likely contributed to the increase in the charter growth rate. The indirect impact of a negative market shock made charter entrepreneurship generally more appealing, with limitations. A negative market shock without government stimulus would likely lead to lower levels of charter entrepreneurship, as their funding is already reduced relative to TPS.

This work provides insight on the interconnectivity between charter schools and the broader economy but provides just part of the picture. The primary challenge of performing research on charter schools is data availability and granularity, as charter schools and their founders are heterogeneous in nature. This work could be extended by performing a similar analysis on the post GR economic expansion to further identify the relationship between education entrepreneurs and school openings. Additionally, once the data become available, an analysis of the impact of covid-19 on charter schools versus traditional public schools would further shed light on their strengths and weaknesses.

Conclusion

This work focuses on two different avenues cities and towns can use to better their economic outcomes. In turn, these improved economic outcomes can help ease hardship for residents and potentially create a positively reinforced cycle of development. Increasing efficiency in land use is crucial for providing business locations that improve their ability to generate goods and services, but also provides residents desirable locations to live and raise their families. Providing amenities such as improved schooling options can both strengthen residents' productivity and incentivize skilled migrants to relocate in these areas which helps build a strong labor force and subsequently greater revenues for further city development.

As shown in chapter 1, contaminated land is difficult to bring back into use and suffers from several different problems. The stigma effect stemming from the developer's uncertainty of cleanup difficulty increases the relative price of remediation, leaving centrally located but contaminated properties effectively out of the market while pushing development to the outskirts which contributes to urban sprawl. The first-mover problem further adds to the difficulty of remediation, as developers may not receive the full value of the remediated property due to a lingering stigma effect where buyers do not trust the property has been properly cleaned.

The common thread in both this stigma effect and the first-mover problem is a very real information asymmetry. Unless provided with a detailed third-party analysis, a developer will always worry about the extent of the contamination and the buyer of the redeveloped property will always worry about whether the remediation had been performed properly. To increase efficiency in the market for brownfields, governments and organizations need to close this information gap, increase incentives, or provide some type of insurance to developers and buyers. Individual states within the U.S. have employed various forms of all three. Colorado's Brownfields Program provides environmental assessments of sites, tax credits and loans, and participation in the "Voluntary Cleanup Program" can mitigate developer's future risk of liability (CDPHE 2023). Each part of this brownfields program reduces the stigma effect and helps to fiscally close the risk premium gap developers require to work with these properties.

Just like increasing land use efficiency, offering quality education institutions is important for growing and maintaining a high-quality labor force. Chapter 2 explores the role of charter schools outside the lens of direct educational outcomes. Previous research has shown the number of charter schools is positively related to increased heterogeneity in income, race, and education levels, but has not focused on specific avenues or demographics that contribute to the supply and demand for these schools. Whether a particular charter school or system will offer a better education than traditional public schools varies, but I find the demand for these schools is correlated with the relative size and employment in professional, scientific, and technical services (NAICS 54). The growing importance of capturing high skill occupations and the increasing role of technology in today's economy implies high quality education options will be necessary for growing an increasingly skilled workforce. The results in chapter 2 show a city or town looking to grow their output in science, technology, engineering, and math (STEM) may want to incentivize the creation of charter schools, either through direct incentives, stronger charter school laws that provide equal funding compared to traditional public schools, and refrain from creating a cap on the number of charters allowed or placing them under the supervision of traditional public-school systems.

Chapter 3 works to answer the question of whether charter schools are more exposed to economic shocks relative to traditional public schools. Research on the impact of the Great Recession on education focuses on outcomes for traditional public schools, with little information on the impact it had on the growing set of charter schools that many students in the U.S. attend. A city or town interested in growing their stock of charter schools may worry about the impact of market downturns on charters, as they are typically understood as a form of education privatization that has access to public funding. I contribute to this literature by comparing changes in the number of charter schools during the recessionary period and comparing this with traditional public-school systems.

Aggregating to the core-based statistical area, I find both charter and traditional public schools experienced decreased revenues during the recessionary period but were largely sheltered from recessionary forces due to federal intervention. However, during this period the rate of charter school openings and the stock of charter schools increased for the typical CBSA. I attribute this to the decrease in opportunity cost for potential education entrepreneurs, as their outside options will worsen during a recession. In areas most deeply impacted by the Great Recession the stock of charter schools decreased, which is likely due to increasing challenges related to local and state education funding, and increased difficulties in attaining the physical capital required to open a school. These findings suggest cities and towns which are interested in using charter schools as an amenity for helping attract and retain skilled workers can do so without worrying about exposing their school system to more fiscal vulnerability in times of economic downturns.

These three chapters help shed light on important challenges associated with contaminated land reuse and a better understanding of the charter school market. As with all economic research, there are opportunities for further research and new questions that arise as a natural byproduct of the initial work. Governments can help reduce the informational gap in the market for contaminated land by employing many different strategies, but little research has been undertaken to validate the quality of these programs and rate their effectiveness. The greatest challenge in the analysis of the charter school market undertaken here is data quality and availability. Charter schools are a relatively new phenomenon, and the U.S. government has been slowly adding questions to their Public School Universe Survey which help shed light on the different types of charter schools. For example, a question on whether a charter school is “for-profit” was introduced near the end of the sample period, and as such cannot be used in this analysis. As the data for charter schools mature, it will be possible to perform detailed analyses that separate charter schools by their different characteristics.

Additionally, while the analyses contained within this dissertation are quantitative, there are several qualitative studies that would heavily benefit the literature. Surveying and interviewing real estate development professionals on their experiences dealing with contaminated land reuse and the government programs built to help deal with these market failures would be invaluable in both knowing the right empirical questions to ask and the public perceptions of these programs. In a similar vein, due to the heterogeneous nature of charter schools, a survey and interview of charter school founders would provide great insight into their motivations, challenges, and background.

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Appendix A

Survey Cover Letter

Dear Participant,

As a real estate professional, you have been selected to participate in a research study regarding the impacts of environmental conditions on real estate transactions. This study intends to sample a cross-section of the real estate investment community. We are therefore interested in your response regardless of your specific experience and regardless whether you seek, avoid, or are neutral to such "Brownfield" investments.

This survey is completely voluntary; all we ask is that you complete and return the enclosed survey, which should take only 5 minutes for your time. There is no risk to this survey and all individual responses will remain confidential. The overall survey results should benefit the broader real estate community by clarifying possibly overlooked opportunities for redevelopment at Brownfield sites.

Enclosed in the survey is a separate sheet for you to provide optional contact information, which can be returned in the same stamped envelope as the survey. This information will allow us to mail you an advance copy of the summary results shortly after the survey is tabulated. We will also solicit a few follow-up phone calls or in-person interviews expected to take approximately 10–15 minutes. Only participants who indicate an interest in such a conversation will be interviewed, and any comments will remain completely confidential. Finally, you can also opt to be entered in a random drawing for a round of golf for four at the Englewood Golf Course on the same sheet.

This study is being jointly conducted by the Center for Research on the Colorado Economy (CRCE) at the Economics Department at Colorado State University, and Development Research Partners Inc. of Littleton, Colorado. The study is funded with a grant from the U.S. Economic Development Administration to study urban opportunities with regard to Brownfield sites, as part of a larger "Matching Retail Gaps with Brownfield Opportunities" project. At the conclusion of the research project in late 2003, research reports on Brownfield redevelopment opportunities and impacts will be available to all participants and the wider public at the CSU's Center for Research on the Colorado Economy website (http://www.colostate.edu/programs/CRCE/).

If you have any questions regarding the survey questions, intent, confidentiality, or any other related issue, please contact Jesse Silverstein, Development Research Partners, 303-991-0074, jesse@DevelopmentResearch.net. Questions about participant rights may be directed to Celia S. Walker (CSU) at (970) 491-1563.

Thank you very much for your help in completing this important project.

Sincerely,

Stephan Weiler, Robert Kling, and Jesse Silverstein

Stephan Weiler—CSU Economics Department

Robert Kling—CSU Economics Department

Jesse D. Silverstein—Development Research Partners

Contaminated Property Investment Survey

Thank you for participating in this research effort. Your professional experience and judgement are important to us. Please answer the following questions as thoughtfully as possible; be as specific as possible, even if you see ambiguities in a question, and please answer from your own personal perspective as a real estate professional.

- Would you describe yourself as a …? (check all that apply)
- Broker
- Developer
- Financier
- Investor
- What types of property do you typically deal in? (choose all that apply)
- Single-family residential
- Multi-family residential
- Retail
- Office
- Industrial
- Which transaction size do you typically seek? (choose all that apply)
- Smaller than $250,000
- $250,000 to $1 million
- $1 million to $5 million
- Larger than $5 million
- Have you ever purchased a property with environmental contamination issues (excluding asbestos and lead-based paint)?
- No
- Yes, bought it unknowingly
- Yes, bought it intentionally
- Which best describes you? (answer one)
- Will not ever buy contaminated property
- Try to avoid contamination, but will invest if the economics makes sense
- Invest in contaminated ("Brownfield") properties as well as "clean" properties
- Only invest in contaminated ("Brownfield") properties
- Do you intentionally seek contaminated property as an investment?
- Yes
- No
- Have you ever walked away from a potential deal solely because environmental contamination was present?
- Not always; I will gladly evaluate the potential cost of remediation

- No, but I have a limited tolerance for such issues
- Yes, immediately upon the appearance or disclosure of environmental issues
- Yes, after further investigating the extent of environmental problems
- Yes, but only after I determined that remediation cost made the deal infeasible
- Have you ever dealt with a property that had a "No Further Action" letter from a state Voluntary Cleanup program?
- I don't know what a "Voluntary Cleanup program" is
- No, have never been in that situation
- No, I don't deal with contaminated properties
- Yes, it lowered my risk and my required rate of return
- Yes, but it did not lower my risk or my required rate of return
- Have you ever used environmental insurance for a property transaction? (choose all that apply)
- No, I don't deal with contaminated properties
- No, have never been in a situation that warranted it
- No, it's not worth the cost
- Yes, but at someone else's request, i.e., a lender
- Yes, it lowered my risk and my required rate of return
- Yes, but it did not lower my risk or my required rate of return
- Yes, but it increased my required rate of return.
- I don't know what "environmental insurance" covers, never dealt with it
- When initially evaluating an investment, do you screen for onsite environmental issues (choose the most fitting answer)
- As part of initial property inspection
- A Phase I environmental investigation is always done prior to seeking funding
- Only if requested by lender or other financial partner
- Only invest in contaminated property
- If a Phase I environmental investigation shows potential problems onsite, do you further investigate and continue to pursue the investment?
- Yes
- No
- If a Phase I environmental investigation shows potential offsite contamination originating from the property, do you continue to pursue the investment?
- Yes
- No
- If a Phase II environmental investigation shows potential onsite contamination, do you typically continue to pursue the investment?

- Yes
- No
- Considering again your answer or answers to Question 2, please mark the one type of investment that you most often deal in:
- Multi-family residential
- Retail
- Office
- Industrial

Please consider a completely typical property that you would consider for investment in this category in terms of property characteristics, price, intended holding period, etc., assuming no contamination problems.

Now, what if an environmental investigation finds a hazardous materials problem contained onsite, with a cleanup cost equal to 15%* of what the initial purchase price would be if the property were clean? Please tell us how this would affect your decision-making, depending on whether the contamination is related to gasoline, dry cleaning, or degreasing solvents. Using a **single point value**, or a **range of values**, please indicate your investment criteria under each condition (write **NA** if the question or criterion does not relate to your decision process):

	If the property is CLEAN	If there is a GASOLINE contamination problem	If there is a DRY CLEANING contamination problem	If there is a DEGREASING/ SOLVENT contamination problem
Would you still consider investing?	• Yes • No	• Yes • No	• Yes • No	• Yes • No
Your overall cap rate	___%	___%	___%	___%
Your reversion/terminal cap rate	___%	___%	___%	___%
The discount rate you would apply	___%	___%	___%	___%
Investment holding period?	___ years	___ years	___ years	___ years
Would you also deduct the cleanup costs directly from the resulting purchase price?	N A	• Yes • No	• Yes • No	• Yes • No

* For example, 15% equates to a $37,500 cleanup cost on a $250,000 investment; $150,000 on $1 million investment; $750,000 on $5 million investment.

If you marked more than one investment type in Question 2, now please indicate the second most common type that you deal in:

- Multi-family residential
- Retail

- Office
- Industrial

Please consider a completely typical property that you would consider for investment in this <u>second</u> category, in terms of property characteristics, price, intended holding period, etc., assuming no contamination problems.

Now, what if an environmental investigation finds a hazardous materials problem contained onsite with a cleanup cost equal to 15%* of what the initial purchase price would be if the property were clean? Please tell us how this would affect your decision-making, depending on whether the contamination is related to gasoline, dry cleaning, or degreasing solvents. Using a **single point value**, or a **range of values**, please indicate your investment criteria under each condition (write **NA** if the question or criterion does not relate to your decision process):

	If the property is CLEAN	If there is a GASOLINE contamination problem	If there is a DRY CLEANING contamination problem	If there is a DEGREASING/ SOLVENT contamination problem
Would you still consider investing?	• Yes • No	• Yes • No	• Yes • No	• Yes • No
Your overall cap rate	___%	___%	___%	___%
Your reversion/terminal cap rate	___%	___%	___%	___%
The discount rate you would apply	___%	___%	___%	___%
Investment holding period?	___ years	___ years	___ years	___ years
In addition to the above, Would you also deduct the cleanup costs directly from the resulting purchase price?	N A	• Yes • No	• Yes • No	• Yes • No

* For example, 15% equates to a $37,500 cleanup cost on a $250,000 investment; $150,000 on $1 million investment; $750,000 on $5 million investment.

This is the end of the survey. Please return it to us in the postage-paid envelope provided. Thank you!

Are you interested in the results of this survey?

If you would like to receive a summary of the results of this survey, we would be happy to send it to you when ready. Please provide the information requested below and include this sheet with your survey or in a separately mailed envelope. If you return this results request sheet with your survey, the sheet will be immediately and permanently separated from the survey booklet and the anonymity of your survey answers will be fully protected.

On this sheet, please also indicate whether you would be willing to participate in a brief follow-up interview to gain further information on the issues we are studying. If such a follow-up conversation occurs, the confidentiality of your responses will be completely protected.

Finally, please let us know if you wish to be entered in a drawing for a round of golf (for 4) at Englewood Golf Course. If you were to win, please note that the winner's name is potentially public information. However, your survey responses will obviously remain confidential.

- ☐ YES, I would like to receive a summary of the results of this survey,
- ☐ YES, I am willing to participate in a brief, confidential follow-up personal interview.
- ☐ YES, I am willing to be entered in a drawing for a round of golf for 4 at Englewood Golf Course.

Name: ________________________________

Company: ________________________________

Address: ________________________________

____

Phone: ________________________________

E-mail: ________________________________

Appendix B

Table B1. Developer Survey—Summary of Risk Tolerance and Experience Responses.

Q4: Have you ever purchased a property with environmental contamination issues (excluding asbestos and lead-based paint)	**Count**	**Percentage**
No experience	95	64.19%
Yes, bought unknowingly	12	8.1%
Yes, bought intentionally	41	27.7%
	148	
Q5: Which best describes you?	**Count**	**Percentage**
Will never purchase contaminated property	22	14.66%
Avoid unless economics make sense	103	68.66%
Invest in both types of properties	24	16%
Only invest in Brownfield	1	0.66%
	150	
Q7: **Have you ever dealt with a property that had a "No Further Action" letter from a state Voluntary Cleanup program?**	**Count**	**Percentage**
I don't know what a VCP is	21	13.82%
No	63	41.45%
No, I don't deal with contaminated properties	1	0.66%
Yes, lowered my risk and required rate of return	42	27.63%
Yes, did not lower my risk or required rate of return	25	16.45%
	152	
Q10: When initially evaluating an investment, do you screen for onsite environmental issues	**Count**	**Percentage**
As part of initial inspection	75	46.01%
Always done prior to seeking funding	80	49.08%
Only if requested by lender	8	4.91%
Only invest in contaminated property	0	0%
	163	
Q11: If a Phase I environmental investigation shows potential problems onsite, do you further investigate and continue to pursue the investment?	**Count**	**Percentage**
Yes	126	85.71%
No	21	14.29%
	147	
Q12: If a Phase I environmental investigation shows potential offsite contamination originating property, do you continue to pursue the investment?	**Count**	**Percentage**
Yes	78	54.17%
No	66	45.83%
	144	

Q13: If a Phase II environmental investigation shows potential onsite contamination, do you typically continue to pursue the investment?		
Yes	64	46.72%
No	73	53.28%
	137	

Table B2. Matrix of correlations.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)
(1) Gas Invest	1.00																				
(2) Dry Invest	0.63	1.00																			
(3) Solv Invest	0.62	0.78	1.00																		
(4) Avoid Maybe	0.20	0.01	−0.03	1.00																	
(5) Buy Both	0.25	0.29	0.34	−0.54	1.00																
(6) Accidental Purchase	−0.05	0.03	−0.05	0.11	−0.07	1.00															
(7) Broker	−0.12	−0.22	−0.18	0.11	−0.12	−0.07	1.00														
(8) Developer	0.19	0.20	0.22	0.08	0.14	0.11	−0.29	1.00													
(9) Investor	−0.07	−0.13	−0.07	0.06	0.04	−0.02	0.07	0.23	1.00												
(10) Financier	0.11	0.03	0.14	0.08	0.03	0.02	0.06	0.18	0.30	1.00											
(11) Office & Retail	0.25	0.12	−0.00	0.08	0.03	−0.03	−0.09	0.12	0.14	0.06	1.00										
(12) Industrial	0.12	0.08	0.22	0.04	0.10	−0.07	0.11	0.03	0.05	0.19	0.11	1.00									
(13) Less 1mil	−0.17	−0.17	−0.08	−0.13	0.06	−0.11	0.45	−0.32	0.03	−0.16	−0.16	0.10	1.00								
(14) Between 1mil 5mil	0.13	0.01	−0.06	0.09	0.07	0.08	0.01	0.11	0.12	0.11	0.23	0.16	−0.31	1.00							
(15) Greater 5mil	0.19	0.14	0.21	0.09	0.20	−0.05	−0.28	0.21	0.00	0.28	0.13	0.19	−0.27	0.19	1.00						
(16) VCP Helpful	0.28	0.22	0.33	−0.12	0.30	−0.05	−0.13	0.17	0.04	0.13	0.09	0.23	0.03	−0.05	0.17	1.00					
(17) VCP NoHelp	0.16	0.00	0.01	0.08	0.06	−0.01	−0.05	0.07	0.02	0.19	0.19	0.11	−0.12	0.22	0.23	−0.12	1.00				
(18) Screen Phase1	0.08	−0.03	−0.01	0.03	−0.01	−0.05	0.12	0.03	0.08	0.01	0.17	−0.14	−0.09	0.14	0.06	0.06	0.06	1.00			
(19) P1 Contam Onsite	0.51	0.33	0.37	0.18	0.20	0.06	0.10	0.26	0.12	0.12	0.17	0.20	−0.02	0.04	0.14	0.19	0.08	0.12	1.00		
(20) P1 Contam Offsite	0.35	0.40	0.38	−0.07	0.25	0.06	−0.09	0.01	−0.14	−0.05	0.07	0.26	−0.01	0.12	0.13	0.13	−0.04	0.12	0.22	1.00	
(21) P2 Contam Onsite	0.49	0.44	0.46	0.08	0.18	0.05	−0.25	0.28	0.06	0.24	0.01	0.10	−0.24	0.00	0.21	0.25	0.03	−0.07	0.35	0.32	1.00

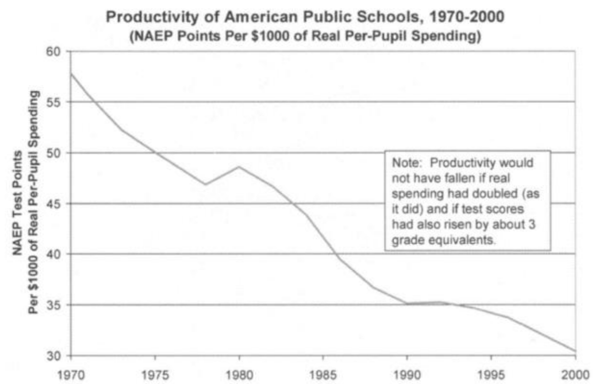
Table B3. Investment Choice Probit Analysis.

	(1)	(2)	(3)
Variables	Gas	Dry	Solvent
Avoid Maybe	1.83 ***	0.46	0.15
	(0.59)	(0.42)	(0.43)
Buy Both	2.31 ***	1.01 *	1.22 **
	(0.86)	(0.52)	(0.61)
Accidental Purchase	−1.17	−0.12	−0.63
	(0.78)	(0.50)	(0.54)
Developer	−0.27	0.18	0.44
	(0.46)	(0.31)	(0.33)
Investor	−1.07 **	−0.52 *	−0.55 *
	(0.48)	(0.30)	(0.33)
Financier	1.42	0.11	0.61
	(1.95)	(0.55)	(0.67)
Office & Retail	1.48 ***	0.36	−0.34
	(0.55)	(0.32)	(0.34)
Industrial	−0.89 *	−0.19	0.28
	(0.49)	(0.32)	(0.34)
Less 1mil	−0.53	−0.31	−0.09
	(0.53)	(0.35)	(0.37)
Greater 5mil	−0.23	−0.18	0.09
	(0.54)	(0.37)	(0.39)
VCP Helpful	1.93 **	0.37	0.77 *
	(0.75)	(0.34)	(0.40)
VCP NoHelp	2.06 **	0.04	−0.11
	(0.83)	(0.38)	(0.41)
Screen Phase1	−0.67	−0.17	−0.14
	(0.48)	(0.30)	(0.32)
p1 Contam Onsite	1.98 ***	0.67	0.69
	(0.71)	(0.50)	(0.50)
P1 Contam Offsite	1.24 **	0.73 **	0.69 **
	(0.51)	(0.31)	(0.32)
P2 Contam Onsite	1.24 **	0.78 **	0.77 **
	(0.51)	(0.30)	(0.32)
Constant	−3.11 ***	−1.58 **	−1.35 **
	(1.11)	(0.65)	(0.59)
Observations	126	121	119

Standard errors in parentheses and *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Appendix C

Figure C1: Productivity of American Public Schools 1970-2000.



Hoxby, C. 2002. School Choice and School Productivity (or Could School Choice Be a Tide that Lifts All Boats?). *National Bureau of Economic Research*, Working Papers: No. 8873.

Table C1: Establishments 10 Year Lag

IRR Reported	(1) newcharter	(2) newcharter	(3) newcharter
Agriculture	1.022	1.018	0.970
	(0.073)	(0.073)	(0.063)
Mining	0.958	0.871	0.770
	(0.179)	(0.163)	(0.138)
Manufacturing	1.053	0.978	0.811**
	(0.124)	(0.114)	(0.081)
Sci/Tech	1.237***	1.239***	1.190***
	(0.070)	(0.070)	(0.054)
Arts/Rec	0.250***	0.420*	0.926
	(0.117)	(0.198)	(0.314)
LQ Under 18	1.454	5.564***	4.784***
	(0.337)	(3.005)	(2.453)
TPS per 100 stud	0.376	0.606	0.068**
	(0.442)	(0.721)	(0.077)
MAG per 100 stud	0.084	0.563	0.339
	(0.373)	(2.460)	(1.382)
PVT per 100 stud	0.641	0.549	0.496
	(1.504)	(1.369)	(1.111)
TPS Pupil/Teacher	1.002	0.998	0.992
	(0.005)	(0.005)	(0.005)
Exp/Student	1.011	0.994	1.092***
	(0.010)	(0.022)	(0.032)
Minority TPS	1.225	1.411	0.646
	(0.341)	(0.398)	(0.191)
Poverty rate	12.419***	1.562	1.680
	(10.646)	(1.515)	(1.386)
Observations	2,841	2,841	2,841
Time Fixed Effects	No	Yes	Yes
State Fixed Effects	No	No	Yes

Standard errors are in parentheses
**** p<.01, ** p<.05, * p<.1*

Table C2: Industry Gross Turnover (1) and IRS Turnover (2)

	(1) newcharter	(2) newcharter
Agri. Gr. Turnover	-.148	
	(.172)	
Min. Gr. Turnover	-.099	
	(.183)	
Sci/Tech Gr. Turnover	1.553	
	(1.114)	
Arts/Rec Gr. Turnover	-.268	
	(.583)	
Agri. IRS Turnover		-.033
		(.04)
Min. IRS Turnover		.009
		(.012)
Sci/Tech IRS Turnover		0
		(.001)
Arts/Rec IRS Turnover		0
		(.002)
LQ_Younger_18	.905*	.978*
	(.527)	(.532)
Poverty Rate	-.269	-.509
	(.91)	(.898)
TPS per 100 Stud	-3.928***	-4.088***
	(1.067)	(1.098)
TPS Pupil/Teacher	-.008	-.008
	(.005)	(.006)
Exp/Student	.059*	.065**
	(.031)	(.031)
TPS Minority	-.084	-.039
	(.347)	(.355)
Constant	-12.298***	-12.06***
	(.705)	(.645)
Observations	2299	2299

Standard errors are in parentheses
***** p<.01, ** p<.05, * p<.1**

Appendix D

Table D1: Charter Growth & Closures for the Bottom 30% in Total Revenue Revised

Variable	Bottom 30%	Remaining 70%	Diff	t value	p value
% Change Total Revenue Per Pupil	-2.39%	6.48%	8.88%	2.81	0.0051
New Charters Per Year	1.78	1.46	-0.32	-1.52	0.1280
Charter Closures Per Year	0.99	0.57	0.12	-3.57	0.0004
Observations	550	1251			

Table D2: Charter Growth & Closures for the Bottom 10% in Total Revenue

Variable	Bottom 10%	Remaining 90%	Diff	t value	p value
% Change Total Revenue Per Pupil	-5.80%	4.79%	4.90%	2.09	0.0365
New Charters Per Year	0.99	1.62	0.63	2.05	0.0405
Charter Closures Per Year	0.35	0.74	0.39	2.19	0.0283
Observations	193	1608			

Table D3: Top 30% CBSAs in Industry Employment Impacts on the Number of Charters

	(1)	(2)	(3)	(4)
	numcharter	numcharter	numcharter	numcharter
crisis	5.49***	5.442***	4.531***	4.808***
	(.698)	(.709)	(.705)	(.703)
Top 20% Stem	34.714***			
	(5.507)			
STEM*crisis	-3.694***			
	(.607)			
Top 20% Finance		28.802***		
		(5.295)		
Finance*crisis		-2.924***		
		(.608)		
Top 20% Construction			-9.818	
			(6.615)	
Construction*crisis			.01	
			(.602)	
Top 20% Real Estate				13.631**
				(6.127)
RealEstate*crisis				-1.108*
				(.61)
Minority TPS	4.719*	4.322	4.917*	5.112*
	(2.862)	(2.877)	(2.897)	(2.892)
Expenditure/pupil	-.595***	-.614***	-.609***	-.591***
	(.158)	(.159)	(.16)	(.16)
Poverty rate	-9.394	-11.206	-10.837	-10.223
	(7.162)	(7.19)	(7.24)	(7.234)
Rent2BR	.043	.019	.026	.033
	(.053)	(.053)	(.054)	(.054)
Constant	62.063***	74.283***	86.252***	65.742***
	(14.905)	(14.808)	(16.302)	(16.039)
Observations	2724	2724	2724	2724
Time Fixed Effects	YES	YES	YES	YES
State Fixed Effects	YES	YES	YES	YES

Standard errors are in parentheses
**** p<.01, ** p<.05, * p<.1*

Table D4: Top 30% CBSAs in Industry Employment on the Creation Rate of Charters

IRR Reported	(1) newcharter	(2) newcharter	(3) Newcharter	(4) newcharter
crisis	1.275*	1.434***	1.254*	1.250*
	(0.178)	(0.187)	(0.160)	(0.164)
Top 20% Stem	4.092***			
	(0.735)			
STEM*crisis	1.014			
	(0.108)			
Top 20% Finance		3.640***		
		(0.654)		
Finance*crisis		0.909		
		(0.090)		
Top 20% Construction			0.752	
			(0.173)	
Construction*crisis			1.435***	
			(0.145)	
Top 20% Real Estate				1.490*
				(0.321)
RealEstate*crisis				1.289**
				(0.129)
Minority TPS	4.335***	4.801***	4.142***	4.919***
	(1.947)	(2.223)	(2.072)	(2.413)
Expenditure/pupil	1.036	1.039	1.035	1.031
	(0.035)	(0.036)	(0.036)	(0.036)
Poverty rate	0.022***	0.004***	0.001***	0.002***
	(0.029)	(0.005)	(0.001)	(0.003)
Rent2BR	1.013	1.021**	1.019**	1.014
	(0.009)	(0.009)	(0.009)	(0.009)
Observations	2,724	2,724	2,724	2,724
Time Fixed Effects	YES	YES	YES	YES
State Fixed Effects	YES	YES	YES	YES

Standard errors are in parentheses
**** p<.01, ** p<.05, * p<.1*

Table D5: Top 30% CBSAs in Industry Employment Impacts on the Closure Rate of Charters

IRR Reported	(1) closedcharter	(4) closedcharter	(7) closedcharter	(10) closedcharter
crisis	1.147	1.063	0.972	1.015
	(0.254)	(0.228)	(0.201)	(0.213)
Top 20% Stem	5.123***			
	(1.211)			
STEM*crisis	0.703**			
	(0.117)			
Top 20% Finance		3.720***		
		(0.870)		
Finance*crisis		0.672**		
		(0.107)		
Top 20% Construction			0.744	
			(0.212)	
Construction*crisis			1.079	
			(0.191)	
Top 20% Real Estate				1.755**
				(0.471)
RealEstate*crisis				0.973
				(0.160)
Minority TPS	2.484	3.178*	3.948**	3.928**
	(1.472)	(1.929)	(2.497)	(2.475)
Expenditure/pupil	1.013	1.023	1.016	1.012
	(0.054)	(0.055)	(0.056)	(0.056)
Poverty rate	0.488	0.047	0.006***	0.009**
	(0.961)	(0.091)	(0.012)	(0.018)
Rent2BR	1.011	1.018	1.019	1.018
	(0.013)	(0.013)	(0.014)	(0.014)
Observations	2,724	2,724	2,724	2,724
Time Fixed Effects	YES	YES	YES	YES
State Fixed Effects	YES	YES	YES	YES

Standard errors are in parentheses
**** p<.01, ** p<.05, * p<.1*

Table D6: Top 30% CBSAs in Industry Employment Impacts on the Number of TPS

	(1) numTPS	(2) numTPS	(3) numTPS	(4) numTPS
crisis	-3.591***	-3.157***	-2.25*	-2.85**
	(1.208)	(1.224)	(1.212)	(1.211)
Top 20% Stem	219.761***			
	(32.182)			
STEM*crisis	2.768***			
	(1.048)			
Top 20% Finance		194.914***		
		(31.05)		
Finance*crisis		1		
		(1.048)		
Top 20% Construction			-58.877	
			(39.314)	
Construction*crisis			-2.046**	
			(1.033)	
Top 20% Real Estate				89.225**
				(36.191)
RealEstate*crisis				.113
				(1.048)
Minority TPS	1.049	1.075	1.234	.842
	(4.996)	(5.011)	(5.018)	(5.021)
Expenditure/pupil	.778***	.796***	.815***	.792***
	(.273)	(.274)	(.274)	(.275)
Poverty rate	-17.362	-17.881	-17.534	-18.307
	(12.462)	(12.488)	(12.511)	(12.525)
Rent2BR	.29***	.317***	.313***	.308***
	(.092)	(.092)	(.093)	(.093)
Constant	107.421	172.824**	251.464***	124.724
	(85.152)	(84.799)	(94.826)	(92.818)
Observations	2724	2724	2724	2724
Time Fixed Effects	YES	YES	YES	YES
State Fixed Effects	YES	YES	YES	YES

Standard errors are in parentheses
**** p<.01, ** p<.05, * p<.1*

Table D7: Top 30% CBSAs in Industry Employment Impacts on the Creation Rate of TPS

	(1)	(2)	(3)	(4)
IRR Reported	newTPS	newTPS	newTPS	newTPS
crisis	0.978	1.030	1.047	1.054
	(0.121)	(0.126)	(0.124)	(0.126)
Top 20% Stem	1.494***			
	(0.194)			
STEM*crisis	1.131			
	(0.112)			
Top 20% Finance		1.873***		
		(0.226)		
Finance*crisis		0.989		
		(0.098)		
Top 20% Construction			0.693**	
			(0.104)	
Construction*crisis			1.082	
			(0.115)	
Top 20% Real Estate				0.990
				(0.136)
RealEstate*crisis				1.027
				(0.107)
Minority TPS	3.552***	3.494***	3.599***	3.788***
	(1.205)	(1.166)	(1.252)	(1.314)
Expenditure/pupil	1.217***	1.226***	1.233***	1.232***
	(0.037)	(0.037)	(0.037)	(0.037)
Poverty rate	0.207	0.143**	0.069***	0.073***
	(0.209)	(0.137)	(0.067)	(0.071)
Rent2BR	0.993	0.999	0.994	0.996
	(0.008)	(0.008)	(0.008)	(0.008)
Observations	2,724	2,724	2,724	2,724
Time Fixed Effects	YES	YES	YES	YES
State Fixed Effects	YES	YES	YES	YES

Standard errors are in parentheses
**** p<.01, ** p<.05, * p<.1*

Table D8: Top 30% CBSAs in Industry Employment Impacts on the Closure Rate of TPS

IRR Reported	(1) closedTPS	(2) closedTPS	(3) closedTPS	(4) closedTPS
crisis	0.329***	0.370***	0.266***	0.306***
	(0.112)	(0.117)	(0.081)	(0.093)
Top 20% Stem	6.078***			
	(1.515)			
STEM*crisis	0.777			
	(0.203)			
Top 20% Finance		3.658***		
		(0.930)		
Finance*crisis		0.581**		
		(0.146)		
Top 20% Construction			0.682	
			(0.204)	
Construction*crisis			2.493***	
			(0.662)	
Top 20% Real Estate				1.456
				(0.412)
RealEstate*crisis				1.389
				(0.363)
Minority TPS	2.679	2.942	3.350*	3.478*
	(1.723)	(1.971)	(2.335)	(2.400)
Expenditure/pupil	1.023	1.059	1.049	1.037
	(0.073)	(0.077)	(0.077)	(0.077)
Poverty rate	1.238	0.059	0.004***	0.008**
	(2.629)	(0.126)	(0.008)	(0.018)
Rent2BR	0.989	1.000	0.998	0.992
	(0.016)	(0.017)	(0.017)	(0.017)
Observations	2,724	2,724	2,724	2,724
Time Fixed Effects	YES	YES	YES	YES
State Fixed Effects	YES	YES	YES	YES

Standard errors are in parentheses
**** p<.01, ** p<.05, * p<.1*