O is for Oligopolies and Ordered Probit: An Industrial Organization Approach to Understanding the Effect of Universal Pre-Kindergarten Policies on Private Competition

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April 2023

Submitted to the Distinguished Majors Program
Department of Economics
University of Virginia
April 28th, 2023
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Abstract

I propose an empirical framework to understand the effects of Universal Pre-Kindergarten (UPK) policies on the decisions of private pre-Kindergarten providers to operate in a market. I derive a model for private pre-Kindergarten firms' entry decisions and estimate the effect of UPK using data from New York City that covers all childcare centers from 2010 to 2017. I find that the implementation of UPK in New York City is associated with a 25.27 percentage point increase in the likelihood of observing markets with zero private firms and a decrease in the likelihood of observing markets with more than zero private firms relative to before the policy was enacted. These results suggest that NYC's implementation of a UPK policy introduced enough new competition into the market to decrease private firms' profits enough that they choose to exit the market.

Acknowledgements

This paper was made possible only through the support of my wonderful friends, family, and advisors. First, I would like to thank Professor Federico Ciliberto and Professor Sarah Turner for nurturing my love of economics, helping me tackle the challenges of this semester with grace and patience, and providing me the opportunity to explore the intersection of the Economics of Education and Industrial Organization. Without your encouragement and kindness, I truly would not be in the position that I am today.

A thank you is owed to Professor Derek Wu, Diego Briones, and Professor Sebastian Tello Trillo for allowing me to come to their offices and ask questions about every econometric method under the sun.

I also wish to thank my friends inside and outside the Distinguished Major Cohort. I am particularly grateful for Avni Parthan and Quinn Ferguson. Your kindness, compassion, and patience this semester, especially during the weeks leading up to the submission of this paper, are things I will forever be grateful for. Words cannot express how much your support has meant to me.

Lastly, I would like to thank my mom and dad. Mom, thank you for always being the best cheerleader, editor, and listener I could ask for. Dad, thank you for encouraging me to take Introduction to Microeconomics first year, pushing me to ask questions about how the world works, and being the first person to foster my love of economics.

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Section 1: Introduction

At least 14 states were discussing Universal Pre-Kindergarten (UPK) programs in their legislative sessions as of February 2023 (Potts, 2023). If all 14 states were to pass legislation mandating that state-run pre-Kindergarten (pre-K) become universally accessible, the number of states with UPK policies would jump from 12 to 26, including the District of Columbia (Potts, 2023).

While New York is not one of the 12 states that currently offer UPK to residents, New York City (NYC) has operated a UPK program since 2014. As of 2019, more four-year-olds were enrolled in public pre-K programs in NYC than students of all ages in the entire Boston Public School System (Brown, 2019). Following the success of this program, as of 2022, the city is looking to expand the program to provide services to 3-year-olds (Fitzsimmons, 2022)

The increase in the popularity of UPK legislation among policymakers can be attributed to the recommendations of a sizable body of literature detailing large educational and psychosocial returns to participation in high-quality pre-K programs, as well as documentation that private pre-K costs can rival college tuition (Grunewald and Davies, 2011). These benefits include improved math and literacy skills, lower rates of juvenile incarceration, and increased college enrollment (Conger et al., 2019; Gray-Lobe et al., 2021; Weiland and Yoshikawa, 2013).

Despite the popularity of this policy intervention, the literature on the effect of UPK policies on private-firm behavior and market-level competition is small. Of the papers that study changes in the early childhood education market, most study changes in the number of available pre-K seats or the total number of pre-K providers in states (or cities) that implemented UPK policies. They find that UPK programs crowd out private provision, especially for children under

the age of two and in high-poverty areas (Bassok et al., 2014; Bassok et al., 2016; Brown, 2019). Although these papers quantify the effect of UPK on private provision at the state and city level, they do not analyze the effect of UPK within markets nor do they attempt to create or estimate a model of private providers' decisions to operate in a market.

This gap in the literature forms the motivation for my paper. In this paper, I attempt to model and estimate the effect of UPK on private firms' choices to serve a market. Specifically, I seek to answer the following question: does the introduction of a UPK policy decrease the likelihood of private pre-K providers choosing to serve a market?

To answer this question, I use administrative data from NYC's Department of Health and Mental Hygiene (DOHMH). This data set contains information on every pre-K provider between the years 2008 and 2017. Due to the limited availability of demographic data, which is imperative to my empirical strategy, I restrict the sample to the years 2010 to 2017. After restricting the data set, I observe the behavior of 2,856 unique pre-K firms across 2,168 unique census tracts, which constitutes a market for the purpose of this paper.

I assume that private pre-Ks maximize a function that is a weighted combination of educational quality and profit. This assumption is consistent with the existing literature at the intersection of Industrial Organization and the Economics of Education. I also assume that they provide a homogeneous product and are independent of one another. Because I do not have access to data on the costs of individual firms, I leverage market-level demographic data to assess the likelihood of a firm choosing to serve a market, following the methodologies of Bresnahan and Reiss (1991).

I find that the passage of UPK in NYC is associated with a 25.27 percentage point increase in the likelihood of observing markets with zero private firms and a decrease in the likelihood of

observing markets with more than zero private firms relative to before the policy was enacted. These results are robust to alternative specifications. My findings suggest that the implementation of UPK introduced enough new competition into the market to decrease private firms' profits enough that they choose to exit the market, even in the monopoly case.

I contribute to the existing literature on early childhood education by deriving and estimating a model of private pre-K entry decisions. To my knowledge, this paper is the first of its kind to create such a model in the context of early childhood education. This body of literature primarily consists of papers that implement quasi-experimental research designs to quantify the effect of UPK on the total private provision in areas with UPK policies. My work complements these papers by offering a novel model of firm behavior.

This paper is laid out as follows: Section 2 describes the industry and policy context, Section 3 summarizes the existing literature, Section 4 details the data I use, Section 5 outlines the theoretical framework for my analysis, Section 6 reviews the empirical strategies I have implemented, Section 7 contains the results of my analysis, and Section 8 offers a discussion of my results, their limitations, and directions for future work.

Section 2: Industry Description and Policy Context

2.1: Early Childhood Education in the United States

Market Structure: In the United States, the early childhood education industry is a mixed market, composed of firms that provide school-like lessons to children not yet eligible to attend Kindergarten, generally starting at the age of 4, although some will serve 3-year-olds. The existing literature on the industry divides it into formal and informal settings. The informal sector consists of home-based centers (centers outside the child's home in which the provider is paid a fee), nannies, babysitters, and unpaid family or friends. Within the formal sector, there are childcare centers (private preschools and nursery schools), Head Start (a federal program that provides services to families under a certain income level), and state-run pre-K programs which may or may not restrict enrollment by a state-set income threshold (Bassok et al., 2016).

Market Failures: The industry is thought to suffer from two market failures: positive externalities and liquidity constraints. Each has implications for the functioning of the market.

First, there exists a large body of literature suggesting that early childhood education has large, positive externalities ("The Economics of Child Care Supply in the United States," 2021). Economic theory suggests that in the case of positive externalities, private markets will provide less of a good or service than what is socially optimal. The Center for American Progress reports that 83 percent of families struggle to find high-quality childcare (Malik et al., 2018), providing evidence to suggest that the current provision of childcare services is less than the optimal amount.

Second, the consumers consist of parents of young children, who tend to have spent relatively little time in the labor force. Earnings generally increase as time in the labor force increases, which means that these young parents are likely earning relatively little compared to

their expected lifetime earnings. However, they are unlikely to be able to borrow against their future earnings to pay for their child to attend pre-K. Thus, the industry suffers from a liquidity constraint ("The Economics of Child Care Supply in the United States," 2021). This liquidity constraint often means that parents are forced to compare their earnings to the cost of childcare, placing an upper bound on consumers' willingness to pay. If childcare exceeds the expected earning of one parent, families may opt to forgo sending their child to pre-K and instead have one parent (typically the mother) exit the labor force to care for the child during the day, especially in two-parent households ("The Economics of Child Care Supply in the United States," 2021).

However, the production of childcare is extremely labor intensive. (See Figure A2 in the Appendix for a breakdown of the costs pre-K firms face, on average.) As a consequence of the upper bound on the price firms can charge, firms operate on "razor-thin" profit margins, even though pre-K tuition can rival that of some colleges (Grunewald and Davies, 2011; Workman, 2018).

Regulatory Environment: There exist sets of state- and city-level regulations that restrict entry into the industry. To open an early childcare education center, one must obtain proper licensure from the state and local jurisdictions. These requirements vary by location and often include inspections for health and safety ("The Economics of Child Care Supply in the United States," 2021).

2.2: Early Childhood Education in New York City

As of 2019, more four-year-olds were enrolled in public pre-K programs in NYC than students of all ages in the entire Boston Public School System (Brown, 2019). In 2014, Mayor Bill de Blasio successfully passed the city's UPK policy, which greatly expanded the public pre-K

program the city operated to guarantee all 4-year-olds in the city a spot in a public pre-K program. By the next school year, the number of students enrolled in public pre-K programs increased by over 170 percent.[1] By the 2015-16 school year, the city had completed its implementation of UPK, and there were 67,000 students enrolled in public pre-K programs across the city. Enrollment numbers stayed relatively stable until the pandemic.[2]

Public Pre-Kindergarten Programs: UPK in NYC guarantees all children who are NYC residents and who have turned or will turn four in the calendar year the option of attending a public pre-K at little or no cost (Brown, 2019; "3-K and Pre-K Programs – Enrollment," n.d.). To attend UPK, the parents of four-year-olds must fill out an application either online or by phone and rank their preferred schools ("3-K and Pre-K Programs – Enrollment," n.d.). Parents can apply anywhere, but preference is given to extending seats to students who have siblings who are attending or have attended the school and for public schools for which children are already zoned. Secondary preference is given to students in the same school district, and tertiary preference is given to students in the same county (Brown, 2019). There are three types of public pre-K programs parents can choose from. These include:

- **District Schools:** District Schools are run by the city's Department of Education (DOE) and operate pre-K classrooms in public elementary schools ("3-K and Pre-K Programs – Enrollment," n.d.).

[1] There were 52,000 students enrolled in public pre-K in the 2014-15 school year (Brown, 2019). In the 2013-14 school year, there were only 19,000 students enrolled in public pre-K programs.
[2] In 2022, there were 54,730 students enrolled in public pre-K programs. This decline in enrollment was most concentrated in high-poverty areas, which also had some of the highest rates of Covid-19 infection, pandemic-driven job loss, and death (Touré, 2022). Because the Covid-19 pandemic happened outside of the range of years I have data for, I do not attempt to study the pandemic's effect on private pre-Ks and refrain from any further discussion of enrollment changes due to Covid-19.

- **NYC Early Education Centers (NYCEEC):** NYCEECs are programs in community-based organizations (CBOs) that partner with the city to offer UPK ("3-K and Pre-K Programs – Enrollment," n.d.). The city partnered with CBOs to ensure that they could sufficiently expand public pre-K capacity when they originally implemented UPK (Brown, 2019).
- **Pre-K Centers:** Pre-K Centers are run by the DOE, but unlike District Schools, only offer grades before kindergarten ("3-K and Pre-K Programs – Enrollment," n.d.).

Moreover, there are three types of public pre-K seats. These are:

- **School Day:** School Day seats are free and provide services for 6 hours and 20 minutes a day during the regular school year ("3-K and Pre-K Programs – Enrollment," n.d.). This is the type of seat most children are enrolled in.
- **Head Start:** Head Start seats are free and guarantee service for ten hours a day, year-round. They are allotted to students based on their family's income ("3-K and Pre-K Programs – Enrollment," n.d.). Column 1 in Table A1 of the Appendix contains the details of Head Start eligibility in NYC in 2022.
- **Extended Day and Year:** Extended Day and Year seats are free or low-cost and guarantee service for ten hours a day, year-round. Much like Head Start seats, they are allotted to students based on their family's income ("3-K and Pre-K Programs – Enrollment," n.d.). Column 2 in Table A1 of the Appendix contains the details of Extended Day and Year eligibility in 2022.

Charter programs are also available but have a separate application.

Private Pre-K Programs: The city defines a daycare center as a facility that provides regular care to three or more children under the age of six. Private daycare centers in NYC are

licensed and regulated. They are inspected every year on a random, unannounced date by the DOHMH. At the time this data was collected, the maximum number of four-year-olds the DOHMH allowed in a classroom was 20 and there had to be at least one teacher for every 12 students. The city mandates that programs have an education director with a bachelor's degree and experience working with children, and, in general, most lead teachers are required to also have a bachelor's degree (Brown, 2019).

Section 3: Review of Existing Literature

3.1: Studies of the Benefits of Early Childhood Education

Over the past two decades, a large body of literature has emerged indicating that participation in high-quality early childhood education programs has massive benefits to individuals and society. The most famous and influential of these papers is likely James J. Heckman's research, which develops the Heckman curve. His findings suggest that preschool programs offer the greatest rate of return to human capital investment relative to schooling and job training. This finding is driven by the importance of environments and interactions in early childhood in shaping skill development and labor-market outcomes later in life (Heckman, 2006). A full depiction of the Heckman curve, which graphs the rate of return of investment in a person against age, is included in Figure A1 of the Appendix.

Since the publication of the Heckman curve, other studies have corroborated his results and found additional benefits. These other benefits of pre-K include improved math and literacy skills, better health outcomes, lower rates of juvenile incarceration and adult criminal behavior,

increased high school completion rates, and increased college enrollment and completion rates (Bailey et al., 2020; Carneiro and Ginja, 2014; Conger et al., 2019; Gray-Lobe et al., 2021; Weiland and Yoshikawa, 2013). Researchers have also linked the availability of affordable early childhood education to increases in the labor-force participation rate for mothers (Cascio and Schanzenbach, 2013).

3.2: Studies of Crowd Out in Early Childhood Education

The literature on the effects of UPK on private competition has mixed findings. In a study of the effects of Florida's UPK policy from 2003 to 2011, researchers found that industry capacity decreased by 83 slots per 1,000 students after the policy was put in place. The informal sector felt this most; they experienced a 28 percent contraction compared to an 8 percent contraction in the formal sector. However, there was still an estimated 13.3 percent increase in quantity in the industry relative to what there would have been in the absence of the policy, with this increase being entirely in the formal sector (15.4 percent increase), and a contraction of about 9 percent still occurring in the informal sector (Bassok et al., 2016).

In a separate study that looked at the number and size of early childhood education centers in Georgia and Oklahoma before and after the implementation of UPK policies, researchers found evidence that such policies increased the quantity of childcare supplied in the market. In Georgia, which adopted a voucher system, this growth was driven by an increase in the number and size of both public and private firms, while in Oklahoma, which concentrated its UPK expansion to be in existing public schools and new public pre-Ks, growth was only observed in the public sector (Bassok et al., 2014). A similar study was conducted in NYC, which found that the city's UPK

program reduced capacity in private firms, especially for children under 2 and in areas of high poverty (Brown, 2019).

3.3: The Industrial Organization Literature

To study entry and exit in concentrated markets when cost structures are not known to the researcher, Bresnahan and Reiss proposed an empirical framework for estimating the effects of entry by leveraging market size. They use an ordered probit model where the number of firms in a market is on the left-hand side of the regression. Outcomes are ordinal in the sense that the number of firms can be linked to the degree of competition in the market (Bresnahan and Reiss, 1991). I model my theoretical and empirical framework around their methodologies.

Few studies analyze crowd-out in education markets in cases of public entry. One such study uses methodologies based on the work of Bresnahan and Reiss to motivate a regression discontinuity to study competition between public and private K-12 schools. They find that increased public school funding diverts students from private schools to public schools, leading to a decline in the number of private schools in the market (Reigg Cellini, 2009).

Both studies of entry in concentrated markets assume that firms are profit-maximizing. However, other work at the intersection of Industrial Organization and the Economics of Education suggests that this assumption may not be appropriate in the context of educational markets. For example, in structural models of private not-for-profit universities, researchers assume that they maximize the quality of education they offer and face a revenue constraint (Epple et al., 2006).

Section 4: Data

4.1: New York City Pre-Kindergarten Data

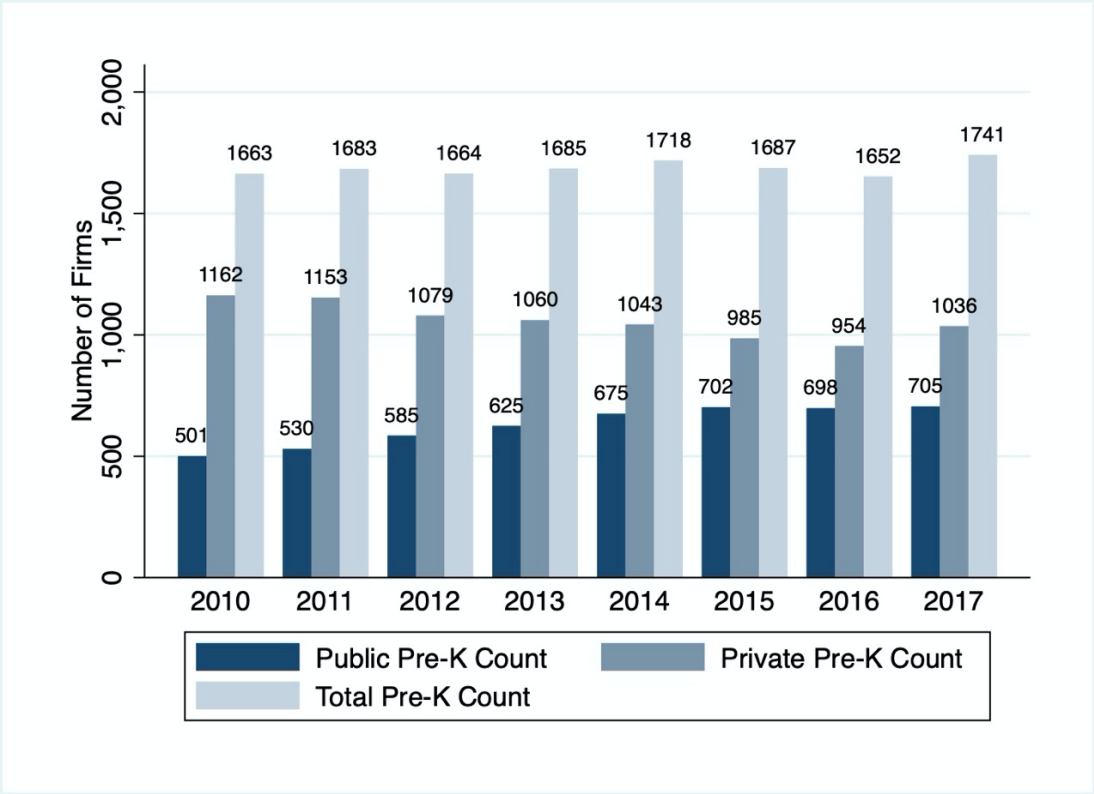
For this analysis, I used data on private pre-Ks in NYC covering the years between 2010 and 2017. This data was sent to me by Professor Jessica Brown at the University of South Carolina, who originally acquired the data after submitting a Freedom of Information Act Request to obtain records from the DOHMH's inspections of private daycare centers.

In this data, I can observe the school type, its location, entry dates, and inspection records, which include the date of the inspection. Using the last year that a school was inspected, I derived a proxy for the year a school closed. I assume a center closed the year it was last inspected.[3]

Figure 1 describes the total number of private and public pre-K firms by year in the sample. As is evident in the graph, the number of private pre-Ks declines over time, starting with 1,160 in 2010 and reaching 1,029 by 2017. In contrast, the number of public pre-Ks steadily increases across the sample. In 2010, there were 504 and in 2017, there were 712. Notably, there is no observable jump in the number of private or public pre-Ks in 2014. This is likely due to the city's implementation strategy, which took place throughout 2014 and 2015. Moreover, throughout the sample, private pre-Ks outnumber public pre-Ks. Additionally, the total number of pre-Ks does not appear to follow any consistent trends across the sampled timeframe. However, between the years of 2014 and 2016, when UPK was being implemented, the total number of pre-K providers in NYC declined.

[3] I made this assumption because centers must be inspected annually. This is a simplifying assumption; it is possible a firm shut down before it could be inspected that year.

Figure 1: Private and Public Pre-Kindergarten Firm Counts by Year



Note: This figure displays the number of public and private pre-Kindergarten providers in New York City, as well as the sum of private and public pre-Kindergarten providers by year.

To understand the data better, I conducted a Difference-in-Means test before and after the policy implementation. The results of this test can be found in Table 1. As would be expected, the average number of public pre-K providers in a market increased after UPK was introduced. Additionally, the mean number of private pre-Ks decreased. This test provides evidence that the introduction of UPK may have crowded out private competition. Noticeably, there was no

statistically significant difference in the total number of pre-K providers in markets. This result suggests that public entry into the market sufficiently offset the decrease in the number of private firms.[4]

Table 1: Difference-in-Means Test

	Pre-Treatment Mean	Post-Treatment Mean	Difference	T-statistic
Public Pre-K	.2585	.3207	0.0622	7.26
Private Pre-K	0.5138	.4635	-0.0502	-3.67
Total Pre-K	0.7723	0.7843	0.012	0.71

Note: N=17,337. This table presents the results of a Difference-in-Means test for the average number of public, private, and total pre-Kindergarten providers in a market before and after the introduction of the Universal Pre-Kindergarten policy in New York City.

I found the census tract for each firm by inputting the school's address into an online geocoder published by the Census Bureau.[5] After dropping observations where the geocoder could not match the address in my dataset to their database, I had a sample of 2,168 unique census tracts over eight years.

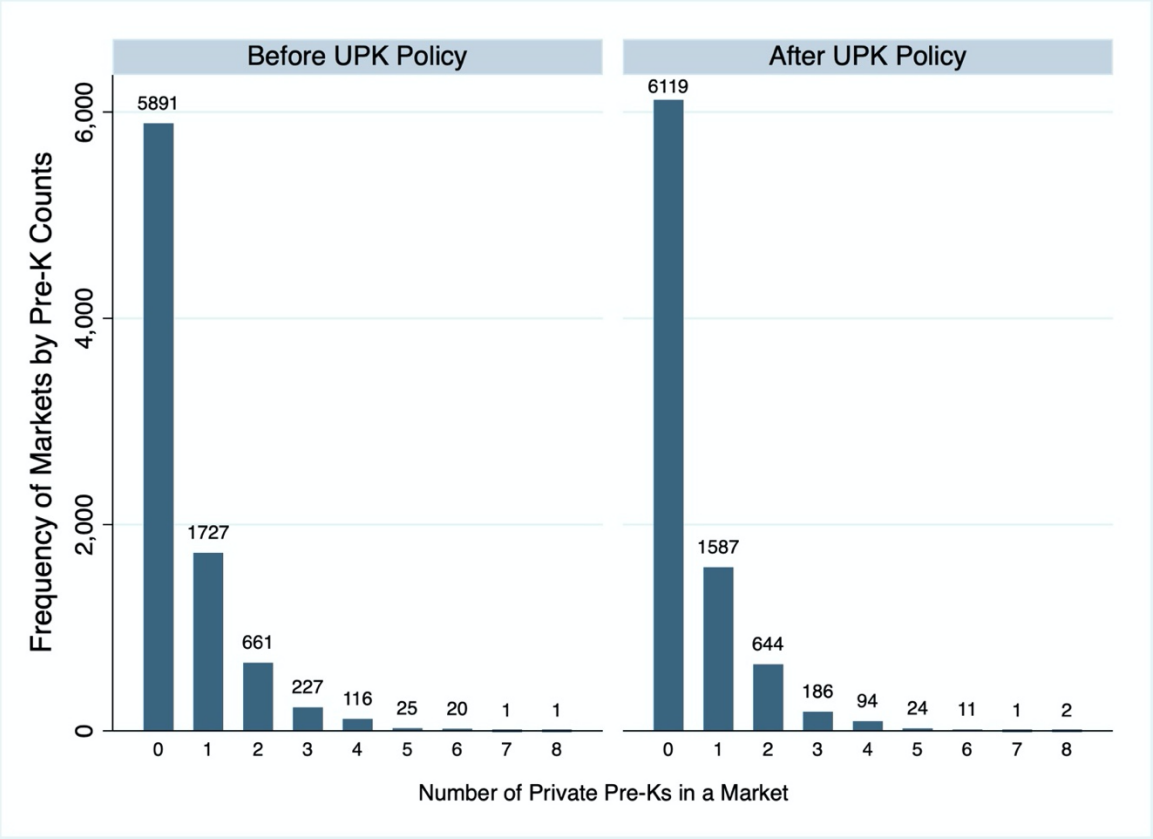
For my analysis, I define a market to be a census tract. The advantages of this are threefold. First, a census tract is relatively small in NYC, and it is plausible that if consumers prefer their child attend a pre-K near where they live, they will attend a pre-K within the census tract they live

[4] This statement is not equivalent to saying that total capacity stayed the same. If, for example, public pre-K firms provide significantly more seats than private pre-K providers, total capacity would increase, even if the total number of firms in the market stayed the same.
[5] The geocoder I used can be accessed at:
https://geocoding.geo.census.gov/geocoder/geographies/addressbatch?form

in. Second, I merge the NYC administrative data with demographic data from the American Community Survey (ACS), which allows me to observe demographic characteristics at the level of a census tract. Third, within census tracts, I never observe more than eight firms, which allows my empirical strategy, which is discussed in Section 6, to be viable. Limitations to this market definition are discussed in Section 8.

Figure 2 contains two histograms that display the distribution of markets by the number of private pre-Ks they have before and after the 2014 UPK policy was implemented. This figure shows that the number of markets with no private pre-K firms increased by 228 markets after the UPK policy was implemented. Moreover, the frequency of markets with more than zero private pre-K firms but less than seven decreased in the post-treatment period. In both the pre- and post-treatment periods, only one market had seven private firms. The number of markets with eight private firms rose from one to two after treatment.

Figure 2: Distribution of Markets by Private Pre-K Count



Note: These histograms display the frequency of markets with each observed number of private pre-Kindergarten providers before and after New York City implemented their Universal Pre-Kindergarten policy.

The major limitation of this dataset is that there is only one instance of a UPK policy being introduced. This means I can only leverage one point of variation to estimate the effect of the introduction of a UPK policy on the number of private firms in the market. Ideal data would span beyond NYC and allow me to conduct the same analysis on different geographic locations that implemented UPK policies at different times.

4.2: Demographic Data

I acquired data on demographic characteristics by census tract from the ACS 5-year estimates, which are published by the Census Bureau.[6] In this data, I observe the population by age, average household income, and educational attainment.

Table 2 contains summary statistics for this demographic data. The differing observation counts are due to missing data for some census tracts. There are a few very large outliers with each variable, explaining the big differences between estimates for the mean and median, as well as the relatively large standard deviations.

Table 2: Demographic Characteristics Summary Statistics

	Observations	Mean	Standard Deviation	Median
Population Under 5	17,051	38.42	109.88	6.6
Total Population	17,377	3,834.54	2,223.18	3,488
Average Household Income	16,866	78,756.38	44,865.11	69,576.5
Share with bachelor's degree	17,011	.145	.318	.022

Note: This table contains summary statistics for each demographic characteristic I use. Each observation corresponds to a census tract in New York City in a year between 2010 and 2017. The data used comes from the American Community Survey's 5-year estimates.

[6] The tables from which I pulled my data can be accessed here: https://data.census.gov/

The major limitation of this dataset is the presence of missing data and the types of data I can observe. I argue that none of these factors only affect the quality of a private pre-K firm. As I will elaborate on in Section 5, my analysis would be strengthened in the presence of factors that affect only quality.

Section 5: Theoretical Framework

5.1: Private Firms' Maximization Problem

I assume private firms maximize an additively separable combination of educational quality, s, and profit, π.[7] In the notation, I will refer to this combination as R. The relative weight firms place on quality in their maximization problem is referred to as λ, which I do not observe.[8] Thus, I can write R for firm i at time t as:

$$R_{it} = \lambda s_{it} + (1 - \lambda)\pi_{it}$$

I assume that educational quality has additively separable observed and unobserved components. The observed components include a set of variables that affect both quality and profit, here denoted by x for simplicity, and a set of variables that affect only quality, written as y. All unobserved components that affect the educational quality of a firm are represented by ϵ_{it}.

[7] This assumption that education firms are not strictly profit maximizing is consistent with Epple et al. (2006). They argue that private, not-for-profit colleges maximize quality and face a revenue constraint. Because private, not-for-profit universities are likely to be somewhat different from pre-K firms in their mission, I relax the assumptions that firms are strictly quality-maximizing and instead allow the possibility that they maximize a weighted combination of quality and profit.

[8] If firms are strictly quality-maximizing, $\lambda = 1$. If they are strictly profit-maximizing, $\lambda = 0$. Thus, both the quality-maximizing and profit-maximizing scenarios can be recovered from this analysis.

Therefore, I can express the quality of firm i at time t as:

$$s_{it} = ax_{it} + by_{it} + \epsilon_{it}$$

Similarly, I assume that profit is a function of additively separable observed and unobserved components. I can write profit as a function of a set of variables that affect both quality and profit, x, a set of variables that just affect profit, z, and a firm's fixed costs, F. Unobserved components that affect profits are denoted by ξ_{it}.

Profits also depend on a function of the number of other private firms in the market, $f(n_{it})$, where n_{it} is the number of other private firms in the market and $f(n_{it})$ is equal to the following:

$$f(n_{it}) = \delta_1 1(n_{it} = 1) + \delta_2 1(n_{it} = 2) + \delta_3 1(n_{it} = 3) + \delta_4 1(n_{it} = 4) + \delta_5 1(n_{it} = 5) + \delta_6 1(n_{it} = 6) + \delta_7 1(n_{it} = 7)$$

Here, δ_k is the effect of k private competitors on a firm *i*'s profit at time *t*.[9]

I assume that the implementation of a UPK policy in the market affects a private firm's profits but not its quality. I hypothesize that this effect is driven by the introduction of public competitors who can offer services at low or no cost to consumers. This increase in competitors who can charge lower prices leads consumers to switch from private firms to public firms, reducing the profits of private firms. In the notation, I use the variable w_t as an indicator for whether a UPK policy is in place at time t.

Taken together, we can write the profit function of firm *i* at time *t* as:

$$\pi_{it} = cx_{it} + dz_{it} + \theta w_t - F_{it} - f(n_{it}) + \xi_{it}$$

I can substitute the decomposed functions for profit and educational quality into the function for R. This gives rise to the following function:

[9] A monopolistic market would have $f(n_{it}) = 0$ because there are no private competitors in the market. A market with k private firms would have $f(n_{it}) = \delta_{k-1}$ because there are $k - 1$ private competitors in the market.

$$R_{it} = \lambda(ax_{it} + by_{it} + \epsilon_{it}) + (1-\lambda)(x_{it} + dz_{it} + \theta w_t - F_{it} - f(n_{it}) - \xi_{it})$$

Which can be written as:

$$R_{it} = (\lambda a + (1-\lambda)c)x_{it} + \lambda b y_{it} + \lambda\epsilon_{it} + (1-\lambda)dz_{it} + (1-\lambda)\theta w_t - (1-\lambda)F_{it} - (1-\lambda)f(n_{it}) + (1-\lambda)\xi_{it}$$

Because of the limited availability of demographic information in the ACS, I only observe variables that affect both quality and profit and variables that only affect profit. Thus, for the purpose of my analysis, R_{it} reduces to be only a function of x_{it}, z_{it}, w_t, F_{it}, and $f(n_{it})$. Specifically, R_{it} can be written as:

$$R_{it} = \alpha x_{it} + \gamma z_{it} + \beta w_t - (1-\lambda)[F_{it} - f(n_{it})] + \nu_{it}$$

Where $\alpha = (\lambda a + (1-\lambda)c)$,$\gamma = (1-\lambda)d$, $\beta = (1-\lambda)\theta$, and $\nu_{it} = \lambda\epsilon_{it} + (1-\lambda)\xi_{it}$.

It should be noted that estimates for α are the combined effect of the variable on both quality and profit. Thus, if the component leads to a decrease in profit or quality but an increase in the other, the coefficient could be either positive or negative, depending on the relative magnitudes of the effects.

5.2: Estimating the Likelihood of Observing Markets of Size *N*

Following the work of Bresnahan and Reiss (1991), I assume that ν_{it} is normally distributed with a mean of zero and a variance of one. Moreover, for all firms *i* in market *m*, I assume that $\nu_{it} = \nu_{mt}$, $(1-\lambda)F_{it} = F$, $(1-\lambda)f(n_{it}) = f(n_m)$[10], $x_{it} = x_{mt}$, and $z_{it} = z_{mt}$. These assumptions indicate that all firms face the same observable fixed cost and that firms are homogeneous within markets (Bresnahan and Reiss, 1991). The assumption that firms are

[10] Thus, all markets with *k* competitors have $f(n_m = k) = \delta_k$.

homogeneous within markets also means that all firms within a market have the same unobserved profit and educational quality. This assumption allows me to use an ordered probit regression to estimate entry thresholds of successive firms (Bresnahan and Reiss, 1991).

The probability of observing a market with no firms at time *t* can then be written as follows:

$$\Pr(N_{mt} = 0) = Pr(\alpha x_{mt} + \gamma z_{mt} + \beta w_t - F + \nu_{mt} < 0)$$

where $\alpha x_{mt} + \beta w_t - F$ is the monopolist's observed R.

Moreover, the probability of observing a market with one firm at time *t* can be written as:

$$Pr(N_{mt} = 1) = Pr(\alpha x_{mt} + \gamma z_{mt} + \beta w_t - F + \nu_{mt} \geq 0\ , \alpha x_{mt} + \gamma z_{mt} + \beta w_t - F - \delta_1 + \nu_{mt} < 0)$$

Generalizing this, the probability of observing a market with N firms at time t such that $N = 2, 3, 4, 5, 6,$ or 7 can be written as:

$$Pr(N_{mt} = N) = Pr(\alpha x_{mt} + \gamma z_{mt} + \beta w_t - F - \delta_{N-1} + \nu_{mt} \geq 0\ , \alpha x_{mt} + \gamma z_{mt} + \beta w_t - F - \delta_N + \nu_{mt} < 0)$$

The residual probability of observing a market with eight firms in the market can be written as:

$$Pr(N_{mt} = N) = Pr(\alpha x_{mt} + \gamma z_{mt} + \beta w_t - F - \delta_7 + \nu_{mt} \geq 0\ )$$

These probabilities can be estimated by an ordered probit regression with N_{mt} on the left-hand side, and x_{mt}, z_{mt}, and w_t on the right-hand side. The estimated first threshold is associated with the observed fixed cost, but not equal to F because it contains the constant and is a function of the variance. Henceforth, I will refer to the first threshold as $\tilde{F}$. After the first threshold, one can recover estimates for δ_k by subtracting $\tilde{F}$ from the $k + 1$ threshold.

Section 6: Empirical Framework

6.1: Baseline Specification

To estimate the effect of the introduction of a UPK policy on the number of private pre-Ks in a market, I use an ordered probit regression. The number of private pre-K providers is on the left-hand side of my regression. In my data, this never exceeds eight, so I treat each value between 0 and 8 as a distinct indicator. Because the market becomes increasingly more competitive as the number of firms in a market increases, the indicators are ordered, supporting my use of an ordered probit regression.

On the right-hand side of the regression, I have included an indicator for whether UPK was in place at the time of the observation and a set of covariates. In my main specification, the covariates I use are detailed below.

***Logged Average Household Income*:** The average household income in a market may affect both a firm's quality and its profit. This effect is mostly driven by the prices that the firm can charge; in higher income areas, they can charge higher prices that would allow them to both offer higher quality education and/or increase their profits, conditional on their market power. I log average household income in my specifications.

***Share of Population with a Bachelor's Degree or Higher*:** The share of the population with a bachelor's degree or higher could affect both firm quality and firm profit. Specifically, it may indicate the average level of educational attainment by pre-K teachers. While some researchers have found mostly null effects on the impact of college-educated pre-K teachers on student outcomes, in some instances, well-educated teachers are associated with better student outcomes (Early et al., 2007). For example, teachers with bachelor's degrees have been associated with gains

in math skills over the pre-K year (Early et al., 2006). Moreover, if firms expect teachers have college degrees, they will also need to pay teachers more to cover the cost of their college tuition for the degree to be worthwhile to pre-K instructors (Cain Miller, 2017). The former mechanism would indicate that larger shares of college-educated people likely lead to higher-quality pre-K. The latter indicates that firms that hire more educated instructors have lower profits, all else equal.

***Population Under 5*:** Because we cannot directly observe the count of children that turn four in a calendar year in the data, this is a proxy for the number of children who would be attending pre-K. The population under five in a census tract is therefore a proxy for the number of consumers in a market, which affect the profit of a firm.

***Number of Public Pre-K Firms*:** The number of public pre-K firms is a measure of the public competition that exists in a market. Therefore, it affects a firm's profits.

Year Fixed Effects: I include year fixed effects to control for all observable and unobservable time-variant characteristics that could affect both a firm's quality and profit. These year fixed effects treat 2010 as the base year.

6.2: Alternative Specifications

Because, likely, the number of public firms is closely correlated with market size, I run the analysis excluding the number of public firms from the specification to check the robustness of my main results. Further details of the results of this specification and my rationale for running it are given in Section 7.

It is likely to be the case that neighboring and nearby census tracts are not independent since a census tract may be roughly the size of a few city blocks. Due to limited data availability, I cannot increase the market size to account for these effects. Rather, to control for effects driven

by location in a wider area, I run an alternative specification that includes county-level fixed effects.[11]

Section 7: Results

7.1: Main Regression Results

NYC's UPK policy is associated with a statistically significant negative effect. Because the regression coefficients are hard to interpret alone, I computed the marginal effects of UPK to guide my interpretation. Regression results are included in Table 3, Column 1, and the marginal effects of UPK are included in Table 4, Column 1.

Marginal Effects of UPK: Being in the post-treatment period is associated with an increase in the likelihood of observing a market with no private pre-Kindergarten firms of 25.27 percentage points relative to before the UPK policy was implemented. For firm counts greater than zero, the UPK indicator has a negative marginal effect, meaning that the policy's implementation is associated with a decrease in the number of private pre-K firms at all levels of competition. In the monopoly case, that decrease is 11.14 percentage points relative to the pre-treatment period; for duopolies, it is 7.83 percentage points. The likelihood of observing oligopolies with three firms decreased by 3.34 percentage points. For markets with four firms, the decrease is roughly 2 percentage points.

[11] I refrain from including fixed effects for census tracts due to practical constraints. Because there are over 2,000 unique census tracts in my data, computing the maximum likelihood estimation of coefficients in ordered probit models becomes difficult and estimates of standard errors become questionable (Greene, 2004). I am not concerned about these constraints in my main specification due to the large sample size relative to the number of fixed effects included (Heckman, 1981).

As the number of markets exceeds four firms, the marginal effects fall below 1 percentage point. For markets with five firms, the decrease is 0.52 percentage points. The likelihood of observing a market with six firms decreases by 0.37 percentage points.

After six firms, the effects are no longer statistically significant at the 1 percent significance level and fall below 0.1 percentage points. This result is likely due to the small number of markets in both the pre- and the post-treatment periods with seven or eight private firms operating, as seen in Figure 2.

Analysis of Other Regression Coefficients: All other coefficients besides the indicator for UPK and year fixed effects before 2014 are positive. As average income and educational attainment increase, parents can likely better afford private pre-K for their children. Further, as the share of people with bachelor's degrees increases, there is a larger pool of college-educated pre-K instructors to work in classrooms, increasing the quality of education provided.

The estimates for year fixed effects capture the combined effect of all observed and unobserved year-variant characteristics that affect the likelihood of observing markets of different sizes. Explaining the sign and magnitude is therefore effectively impossible. The year 2017 was omitted from the regression; after accounting for observations that had missing demographic data, there was effectively no change in the number of private pre-K providers in markets between 2016 and 2017. This is a limitation of the demographic data I used.

Table 3: Regression Results – Estimated Coefficients

	(1) Main Specification	(2) Specification without Public Pre-K Count	(3) Specification with County Controls
UPK	-0.7478*** (0.0603)	-0.7191*** (0.0599)	-0.5691*** (0.0612)
Public Pre-K Count	0.3184*** (0.0161)		0.3233*** (0.0162)
Logged Average Income	0.4666*** (0.0240)	0.4033*** (0.0236)	.3973*** (0.0262)
Population Under Five	0.0009*** (0.0001)	0.0011*** (0.0001)	0.0008*** (0.0001)
Share with a BA or higher	0.7586*** (0.0812)	0.7358*** (0.0808)	0.3831*** (0.0832)
2011	-0.0322 (0.0375)	-0.0245 (0.0374)	-0.0307 (0.0377)
2012	-0.1080*** (0.0378)	-0.0882** (0.0377)	-0.1066*** (0.0381)
2013	-0.1403*** (0.0379)	-0.1121*** (0.0378)	-0.1391*** (0.0382)
2014	0.5789*** (0.0608)	0.5878*** (0.0604)	0.4017*** (0.0618)
2015	0.2743*** (0.0536)	0.2984*** (0.0533)	0.2239*** (0.0540)
2016	0.2307*** (0.0536)	0.2565*** (0.0533)	0.1854*** (0.0540)
King's County			0.2858*** (0.0316)
Manhattan County			0.5720*** (0.0405)
Queen's County			-0.1313*** (0.0340)
Richmond County			0.0415 (0.0521)
Psuedo-R^2	0.0363	0.0243	0.0546

Note: N=16,866. Each column presents the results for each specification detailed in Section 6. The dependent variable is the number of private pre-Kindergarten firms in a market. UPK, an indicator variable for if the observation was from a year after the city implemented Universal Pre-Kindergarten, is the focal explanatory variable. The base category for year fixed effects is 2010 and the base category for county-level fixed effects is Bronx County. Standard errors are in parentheses below the estimated coefficients. *** p>0.01, ** p>0.05, * p>0.1.

Table 4: Regression Results – Marginal Effects of UPK

Number of Firms in the Market	(1) Main Specification	(2) Specification without Public Pre-K Count	(3) Specification with County Controls
0	0.2527***	0.2474***	0.1871***
	(0.0202)	(0.0204)	(0.0200)
1	-0.1114***	-0.1089***	-0.0829***
	(0.0090)	(.0091)	(0.0089)
2	-0.0783***	-0.0769***	-0.0579***
	(0.0065)	(0.0066)	(0.0063)
3	-0.0334***	-0.0326***	-0.0245***
	(0.0031)	(0.0031)	(0.0029)
4	-0.0200***	-0.0196***	-0.0147***
	(0.0020)	(0.0021)	(0.0018)
5	-0.0052***	-0.0051***	-0.0038***
	(0.0008)	(0.0008)	(0.0007)
6	-0.0037***	-0.0036***	-0.0027***
	(0.0007)	(0.0007)	(0.0005)
7	-0.0003	-0.0003	-0.0002
	(0.0002)	(0.0002)	(0.0002)
8	-0.0005*	-0.0004*	-0.0004*
	(0.0003)	(0.0002)	(0.0002)

Note: N=16,866. Each column presents the marginal effects of the UPK policy indicator for specification detailed in Section 6. The dependent variable is the number of private pre-Kindergarten firms in a market. Standard errors are in parentheses below the estimated results. *** p>0.01, ** p>0.05, * p>0.1.

The results for the number of public pre-K firms are less intuitive; the coefficient is positive and relatively large in comparison to other coefficients from the regression. Moreover, the coefficient on the measure of market size, the number of children under the age of five in the market, is relatively small. I expect that these results may be due to the large correlation between public pre-K firms and my measure of market size. Intuitively, as the market size increases, the number of firms of either type should also increase. To better understand the effect of this potential covariance on my main regression results, I reran the regression but excluded the number of public pre-Ks.

Apart from the year fixed effect for 2011, all results were statistically significant at the one percent significance level. This is likely due to the size of the sample; I observed over 2,000 census tracts during a seven-year-long period. This may also explain why some of the results that are less intuitive are statistically significant.

Discussion of Thresholds: The thresholds for my main specification can be found in Column 1 of Table 5. The first threshold estimate is associated with but not equal to the observed fixed cost of firms because the estimated threshold is a function of the constant term and the variance. I refer to this estimate as $\tilde{F}$. For all successive estimates, the k threshold estimates is equal to $\tilde{F} + \delta_{k-1}$. Therefore, estimates for δ_{k-1}can be recovered by subtracting the estimate for the first threshold from the estimate for the k threshold. The recovered estimates for δ_k are graphed in Figure 3 (the exact values of δ_k can be found in Table A2 of the Appendix).

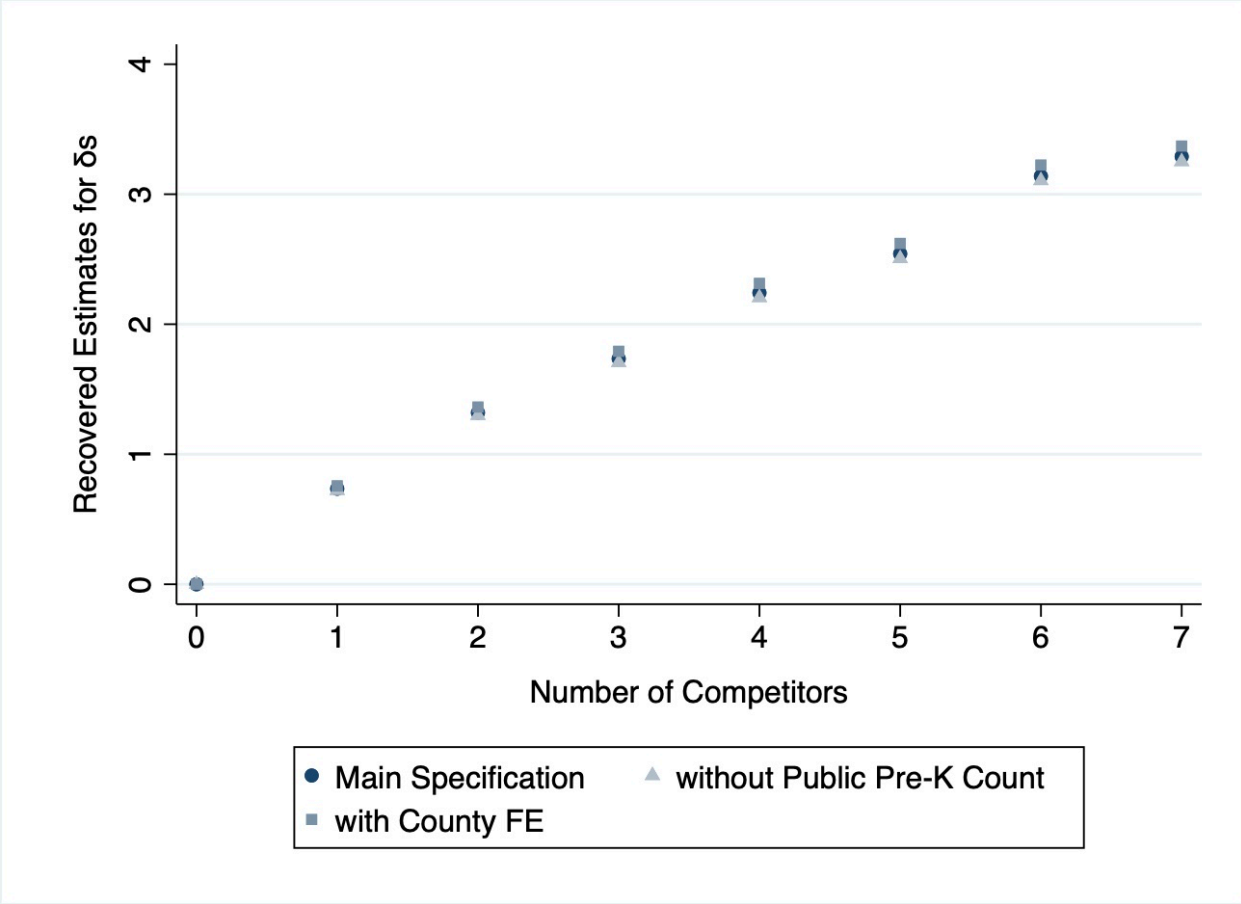
Table 5: Regression Results – Estimated Thresholds

	(1) Main Specification	(2) Specification without Public Pre-K Count	(3) Specification with County Controls
Threshold 1 ($\widetilde{F}$)	5.670 (0.2674)	4.890 (0.2631)	5.045 (0.2854)
Threshold 2 ($\widetilde{F}$+δ_1)	6.405 (0.2681)	5.612 (0.2637)	5.802 (0.2860)
Threshold 3 ($\widetilde{F}$+δ_2)	6.990 (0.2692)	6.189 (0.2647)	6.408 (0.2870)
Threshold 4 ($\widetilde{F}$+δ_3)	7.405 (0.2706)	6.596 (0.2660)	6.837 (0.2884)
Threshold 5 ($\widetilde{F}$+δ_4)	7.912 (0.2736)	7.095 (0.2689)	7.359 (0.2913)
Threshold 6 ($\widetilde{F}$+δ_5)	8.212 (0.2767)	7.395 (0.2721)	7.667 (0.2943)
Threshold 7 ($\widetilde{F}$+δ_6)	8.809 (0.2987)	7.995 (0.2945)	8.269 (0.3150)
Threshold 8 ($\widetilde{F}$+δ_7)	8.960 (0.3150)	8.141 (0.3099)	8.416 (0.3297)

Note: N=16,866. Each column presents the thresholds for each specification detailed in Section 6. The dependent variable is the number of private pre-Kindergarten firms in a market. Standard errors are in parentheses below the estimated results. The interpretation of the value in the model is in parentheses next to the threshold number.

As can be seen in Figure 3, as the number of competitors in a market increases, δ_k increases. Practically speaking, this means that an additional competitor in the market increases $\tilde{F} + \delta_k$ for all k. According to the model specified in Section 5, an increase in $\tilde{F} + \delta_k$ leads to a decrease in a firm's profits; thus, an additional firm entering the market always leads to a decrease in a firm's profits.

Figure 3: Estimated Values for δ_k

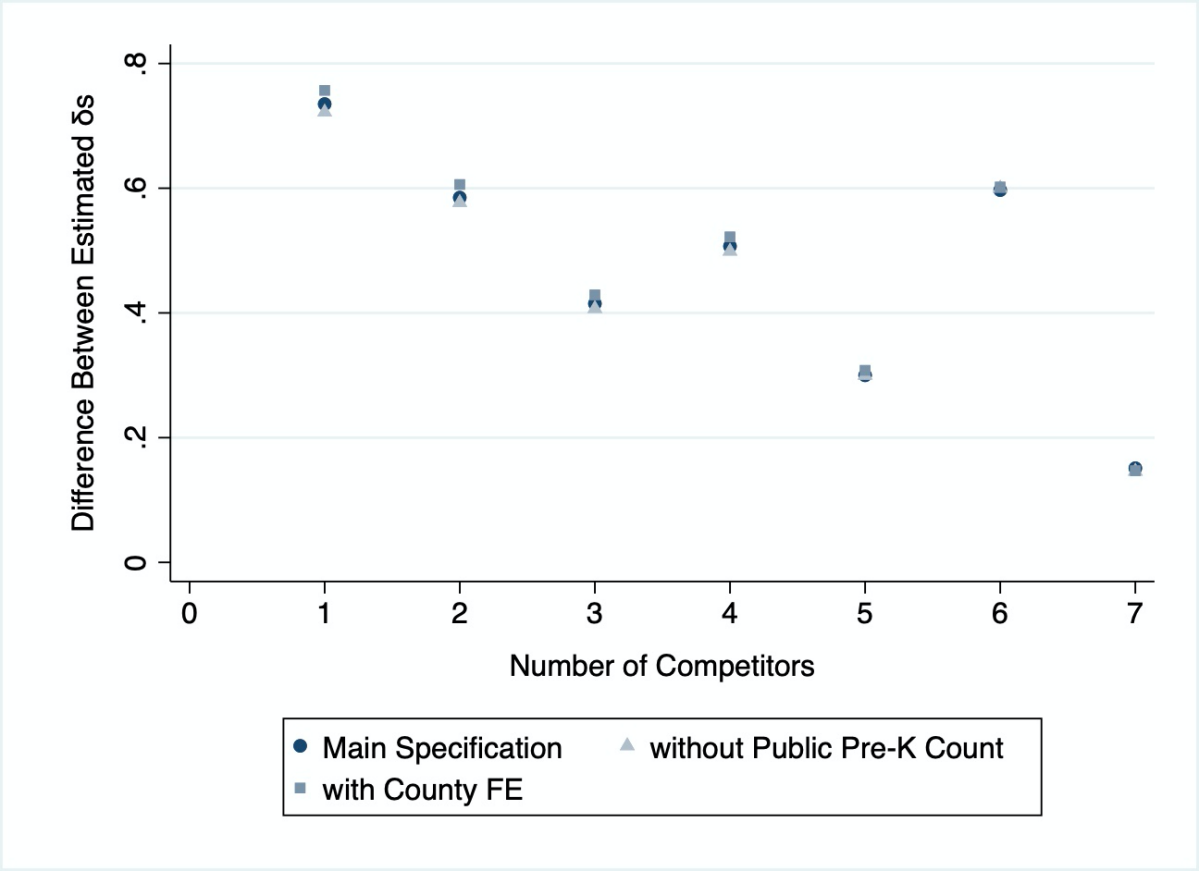


Note: This figure displays the recovered estimates for δ_k. These estimates were recovered by subtracting the estimate for the first threshold, which is associated with the observed fixed costs of firms, from each successive threshold.

It should be noted that the difference between the recovered estimates for each δ_k are mostly decreasing as the number of competitors increases. Figure 4 displays these differences. This result means that the effect of k competitors on R is greater than the effect of $k + 1$ competitors on R, which is consistent with the work of Bresnahan and Reiss (1991). There are

outliers from this relationship at 4 and 6 competitors, likely due to the small number of observations with 5 and 7 firms in a market.

Figure 4: Marginal Effect of an Additional Competitor



Note: This figure displays the marginal differences between estimates for δ_k. Thus, when there is one competitor, the difference is equal to $\delta_1 - 0$. When there are k competitors such that $k > 1$, the difference is equal to $\delta_k - \delta_{k-1}$.

As Figures 3 and 4 display, the estimated values of δ_k are relatively consistent across specifications. For this reason, I refrain from further discussing the estimated thresholds and recovered values of δ_k.

7.2: Alternative Specifications

Removing Public Pre-K Counts: As discussed above, my measure of market size and the number of public firms in the market are likely highly correlated. To understand how this collinearity affects my main regression results, I reran the regression, excluding the number of public firms in the market. Results from this specification can be found in Column 2 of Tables 3, 4, and 5.

Excluding the number of public pre-K firms from the analysis does not significantly change my main regression results. The coefficient on the UPK indicator is still negative and statistically significant. Additionally, the significance and signs of all other covariates do not change, except for the coefficient of the 2012 indicator, which is statistically significant at the five percent significance level, but not the one percent significance level.

Excluding the number of public pre-K firms in the market from the analysis slightly reduced the estimated marginal effects of the UPK policy. Being in the post-treatment period is associated with an increase in the likelihood of observing a market with no private pre-K firms of 24.74 percentage points. It is associated with a decrease in observing markets with monopolies of 10.89 percentage points and duopolies of 7.69 percentage points. For markets with three firms, that decrease is 3.26 percentage points and for four firms, the decrease is 1.69 percentage points.

As before, for five or more firms, the marginal effect falls below one percentage point, and after six firms, the effects are no longer statistically significant at the 1 percent significance level.

For this reason, I refrain from further discussing the results and conclude that my main specification is relatively robust to this alternative specification.

***With Geographic Controls*:** Regression results for the specification that included county fixed effects can be found in Column 3 of Tables 3, 4, and 5. Including county-level fixed effects does not drastically change the results from the main specification. The coefficient on the UPK indicator is still negative and statistically significant, and the sign and statistical significance of all other covariates does not change.

In this specification, Bronx County is the left-out category. Apart from Richmond County, all coefficients are statistically significant. Further, all coefficients besides that of Queen's County are positive. These results are likely due to unobservable preferences for private education in New York County (Manhattan), King's County (Brooklyn), and Richmond County (Staten Island). This is confirmed in existing explorations of K-12 school enrollment; over 20 percent of students in Manhattan, Brooklyn, and Staten Island were enrolled in private schools in 2014. Within parts of Manhattan and Brooklyn, that share was greater than 50 percent. This is contrasted by 9 percent of students in the Bronx and 13 percent of students in Queens being enrolled in private schools ("Private School Attendance in New York City– NYU Furman Center," 2016).

Including county-level fixed effects slightly reduced the marginal effect estimates. Being in the post-treatment period is associated with an increase in the likelihood of observing a market with no private pre-Kindergarten firms of 18.71 percentage points. It is associated with a decrease in the likelihood of observing markets with monopolies of 8.29 percentage points and duopolies of 5.79 percentage points relative to before the UPK policy was implemented. For markets with three firms, the decrease is 2.45 percentage points and for four firms, the decrease is 1.47 percentage points.

As before, for five or more firms, the marginal effect falls below one percentage point, and after six firms, the effects are no longer statistically significant at the 1 percent significance level. For this reason, I refrain from further discussing the results and conclude that my baseline specification is relatively robust to this alternative specification.

Section 8: Discussion

8.1: Discussion of Results

These results suggest that, on average, the introduction of UPK in NYC was associated with a reduction in the likelihood of private firms serving a market. The large, positive marginal effect associated with observing a market with zero firms and the negative marginal effects associated with markets with more than zero firms indicates that markets move from having one or a few firms prior to the policy's introduction to having no firms.

These results support the theoretical assumption made in Section 5 suggesting UPK expansion decreases private firms' profits. Because the marginal effect for every number of firms greater than zero is negative, we can assume that this reduction in profits is such that R is less than zero for all market types. In other terms, even if a firm is a monopoly, the cuts in profit due to the implementation of UPK are large enough that they more than cancel out educational quality in the firm's maximization problem, leading private firms to exit the market. My alternative specifications confirm that this effect is robust when excluding the number of public pre-K firms from the analysis and when considering county-level fixed.

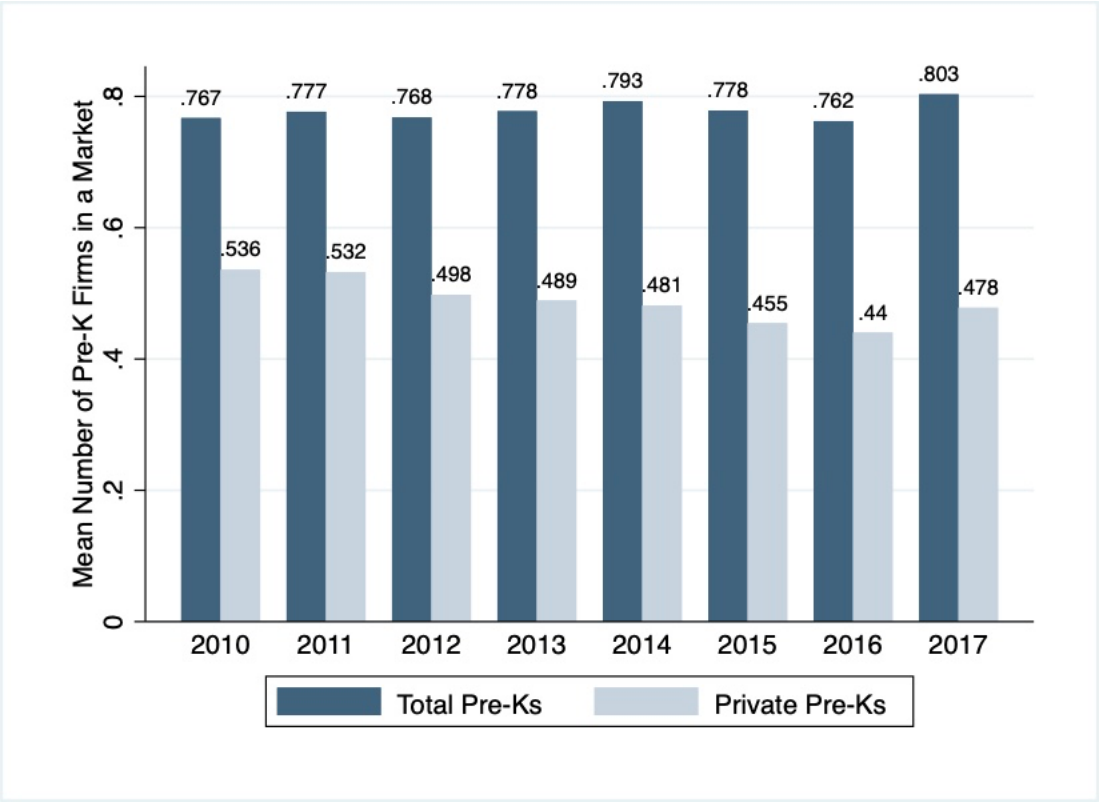
Policymakers may be concerned with these effects if the decline in private pre-K firms is not adequately offset by the public expansion or if the quality of private firms after the market consolidates drastically differs from that of public firms. This latter concern lies outside of the scope of my analysis.[12]

To better understand the impact of these results on total childcare supply, I compile descriptive evidence of the effects of UPK on the total number of pre-K firms in a market. Figure 2 displays the mean number of total firms and private firms in a market by year. While the mean number of private firms declines over time, the mean number of total firms in a market does not follow any consistent trends.

Referring to the results of the simple Difference-in-Means test included in Table 1, this difference between the average number of total childcare centers before and after the 2014 UPK expansion is small and not statistically significant at any conventional levels. These results suggest that the decline in private pre-K firms operating in a market was likely balanced by the entry of public firms. It should be noted that this does not factor in the capacity of each center, so I cannot comment on how these results relate to the total supply of childcare.

[12] The existing literature finds that most of the benefits conferred by participation in pre-K diminish as the quality of pre-K falls. Thus, high-quality pre-K is important (Workman and Ullrich, 2017).

Figure 5: Mean Number of Pre-K Firms in a Market by Year



Note: This figure displays the mean number of total pre-Kindergarten providers and private pre-Kindergarten providers in a market between 2010 and 2017.

8.3: Limitations

There are four noteworthy limitations of my analysis: the assumption that firms offer homogeneous products, the restrictive market definition, the generalizability of my work, and the availability of demographic data.

Heterogeneity: In this paper, I assume that pre-K providers offer homogeneous services within markets. While it is convenient for my empirical approach, it is not realistic. As was

documented in the industry description (Section 3), among public firms, there exists heterogeneity in provision. Moreover, in an analysis of how parents search for and select a pre-K provider to send their child to, researchers documented differences in program characteristics. These include whether centers operated a waitlist, the provision of summer care, and the hours of operation, among other characteristics (Bassok et al., 2018). Thus, the assumption that all firms in a market offer homogeneous products does not accurately model real-world phenomena. In future work, I plan to allow for heterogeneous products within markets.

Market Definition: The market definition is likely too restrictive for the analysis. It is reasonable to assume that what happens in one census tract is greatly related to what happens in neighboring or nearby census tracts.

To account for this, I include county-level fixed effects in an alternative specification. However, county-level effects may have the opposite problem in that they are too big; your average New Yorker would likely tell you that going from Washington Heights to China Town to send your child to daycare is infeasible unless a parent works nearby.

Unfortunately, data availability does not allow me to define a market in more moderate terms. While I can observe a firm's zip code, zip codes in the city can vary drastically in size and private firm counts within zip-codes can range from zero to hundreds. Moreover, controlling for zip-code-level fixed effects would not work with my data because zip codes cut through census tracts in ways that county lines do not.

Generalizability: My data for this paper only allows me to leverage one instance of UPK expansion, limiting the extent to which I can generalize my results to other policy contexts. Ideally, future work would replicate my analysis across different jurisdictions that have enacted UPK policies.

Data Availability: The data I used in this paper was beholden to two primary issues. First, the covariates I included had some missing data points. Consequently, observations in 2017 were closely related to 2016, and the year fixed effect for 2017 was omitted from the analysis. Moreover, I could not observe characteristics that only affected a firm's quality, which limits the extent to which I can estimate the theoretical model developed in Section 5.1.

8.4: Directions for Future Research

To fully disentangle the relationship between the UPK implementation and private pre-K firms' decisions to serve a market, more work is needed.

First, better covariates are needed. It may also be useful to know more about factors that affect profit like the rent and utility costs firms pay.[13] Moreover, this paper lacks information on factors that only affect the quality of firms, which could be problematic because quality is likely an important part of an education firm's maximization problem (Epple et al., 2006). Ideal data would contain information on the amount of training teachers receive, program structures, and curriculum used, among other factors that are common indicators of pre-K quality (Weiland and Guerrero Rosada, 2022).

Second, I plan to continue this work by complicating the model to describe firms that provide heterogeneous products. Models that allow for vertical product differentiation more closely represent real-world phenomena. Specifically, this analysis would allow me to learn about the effect of UPK on high-quality private providers. These providers are likely of greater

[13] The ACS contains information on housing costs. This housing data is unlikely to be a good proxy for the rent and utility costs paid by businesses due to differences in private residences and businesses. For example, while a household may need to have lights on throughout the day and night, a private pre-K is unlikely to be using as much electricity during the hours when they are not providing care. This differing electricity use would naturally lead to different utility costs.

importance to policymakers than private providers in general due to the sizable literature suggesting that high-quality pre-K offers the greatest return on investment (Workman and Ullrich, 2017).

While more work is needed to fully estimate the effect of UPK policies on private firms' entry decisions, this paper is still a valuable contribution to the literature on the effect of UPK policies on private-firm behavior. This paper offers researchers and policymakers a novel framework to understand the effects of UPK on market-level competition within the early childhood education industry.

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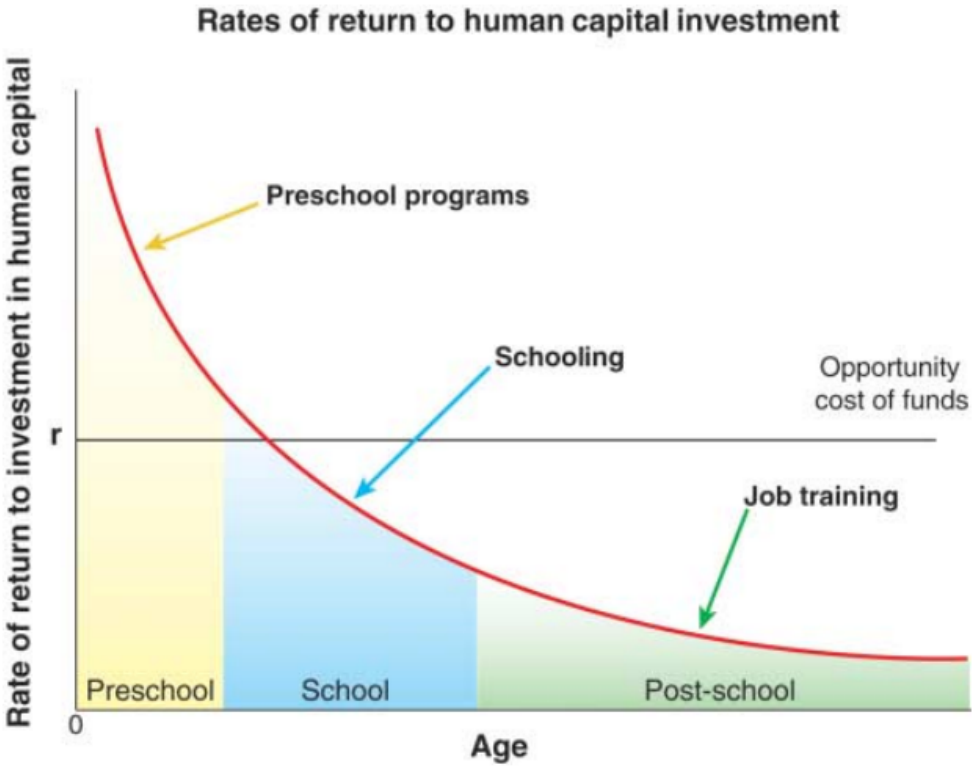
Appendix

Table A1: Eligibility Requirements

Persons in Family/Household	(1) Head Start Income Eligibility	(2) Extended Day and Year Income Eligibility
1	$13,590	$25,760
2	$18,310	$34,840
3	$23,030	$43,920
4	$27,750	$53,000
5	$32,470	$62,080
6	$37,190	$71,160
7	$41,910	$80,240
8	$46,630	$89,320

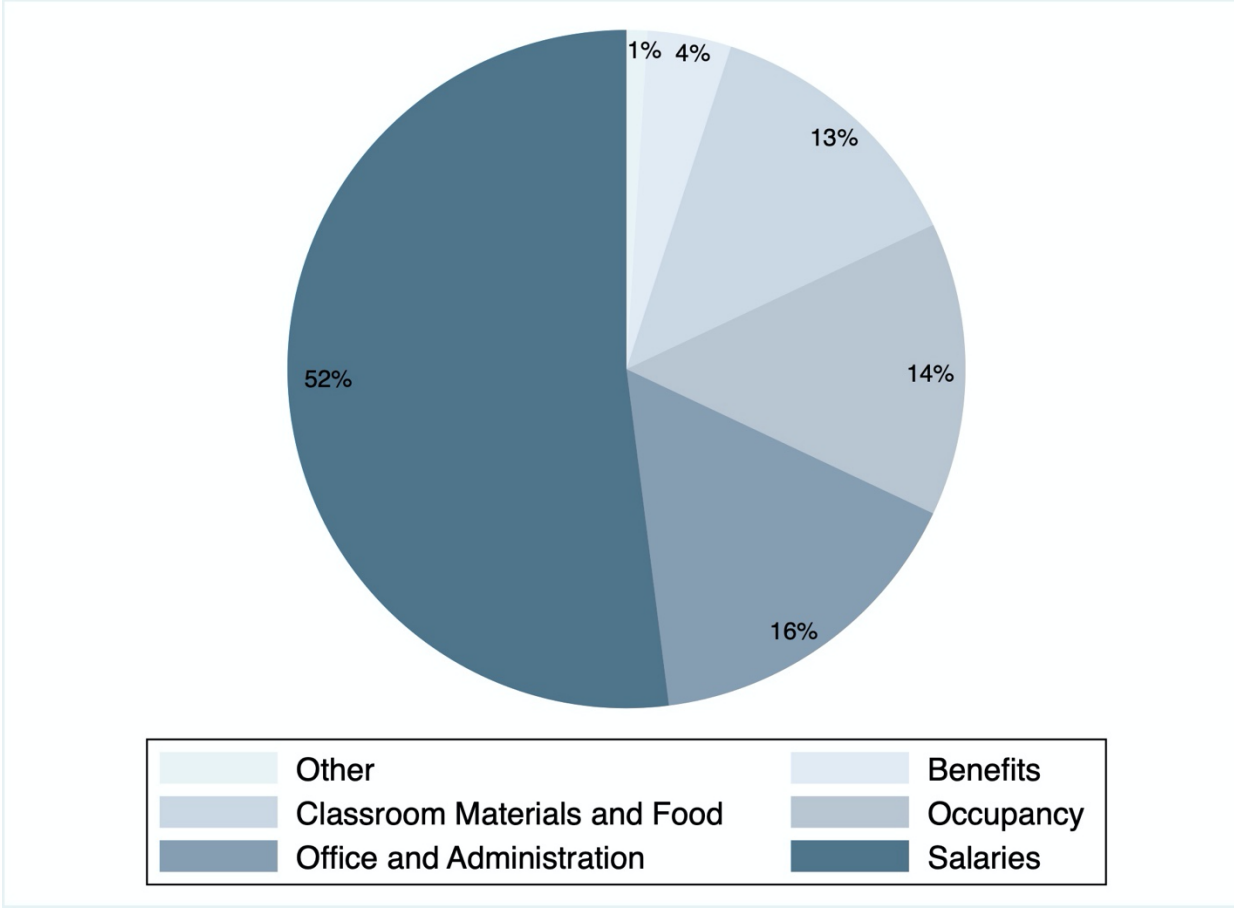
Note: This table displays the income thresholds for eligibility for Head Start and Extended Day and Year seats in 2022 ("Extended Day and Year Early Childhood Programs," n.d.; "Head Start," n.d.).

Figure A1: Heckman Curve



Note: The Heckman Curve displays the relationship between age and the return of investment in human capital. This figure suggests that investment in human capital has the highest return for younger children. Further, after the first few years of schooling, the opportunity cost of funds exceeds the expected return on investment. This relationship has been used to justify the expansion of public pre-K programs. (Heckman, 2006).

Figure A2: Cost Breakdown of Pre-Kindergarten Provision



Note: This figure displays the estimated cost breakdown of pre-K provision. Production of early childhood education is extremely labor intensive with over 50 percent of the cost's firms pay being in the form of wages to workers. The second largest cost comes from administration costs, followed by occupancy, then classroom materials, and finally benefits. (Workman, 2018).

Table A2: Recovered Estimates for δ_ks

	(1) Main Specification	(2) Specification without Public Pre-K Count	(3) Specification with County Controls
δ_1	0.735	0.722	0.757
δ_2	1.32	1.299	1.363
δ_3	1.735	1.706	1.792
δ_4	2.242	2.205	2.314
δ_5	2.542	2.505	2.622
δ_6	3.139	3.105	3.224
δ_7	3.29	3.251	3.371

Note: This table displays the recovered estimates for each δ_k. These estimates were found by subtracting the first estimated threshold from each successive threshold. Hence, δ_k is equal to the estimate for the kth threshold minus the first estimated threshold.