Unintended Consequences of Expanding Pre-Kindergarten: The Effects of North Carolina's Pre-K Program on the Childcare Market

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Abstract

Child care in the United States is usually described as a fragmented system, where federal, state, and local level programs interact with private organizations to supply child care services. In this paper, I analyze the effects of a program that expanded subsidized early education for low-income 4-year-old children - the state-based North Carolina Pre-Kindergarten program (NCPK) - on the enrollment of children from age 0 to 4 in centers that offered the program as well as those who did not. To do this, I combine rich data from administrative records with a difference-in-differences design that exploits geographical and temporal variation in the NCPK rollout between 2012 and 2018. The main findings are three-fold. First, when joining the program, NCPK centers enrolled more children and reorganized their structure in order to serve more eligible four-year-old children. Second, nearby childcare facilities also grew the enrollment of four-year-old children by about 30% and three-year-old children by 17%. This is most likely explained by a displacement of ineligible children from NCPK to non-NCPK centers. Third, the increase in age-4 enrollment in nearby facilities is mostly driven by centers in lower-income areas. The results suggest that this targeted pre-k expansion increased childcare access for low-income families that would not access formal childcare arrangements otherwise. Additionally, it led to a reallocation of children to centers, increasing economic segregation across centers.

Keywords: Early Childhood, Pre-Kindergarten Programs, Child Care, Spillovers
JEL Classification: J13, H75, I38, I24

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1 Introduction

State-funded pre-kindergarten programs (pre-k) have been growing constantly for the last two decades in the United States. They currently enroll about one-third of all 4-year-old children and constitute a financial investment of more than $9.5 billion in 2021-2022 (Friedman-Krauss et al., 2023). Current policy discussions suggest that these investments will continue to grow in the following years.[1] Despite their recent growth, state-funded pre-k centers are only one of several key actors in the broader early childhood education system, which includes a wide range of public and private childcare providers serving infants to preschoolers.[2] Hence, one natural question that follows its expansion is: how does an increase in state provision of pre-k education affect enrollment structures of all (state-funded or not) local providers?

The incorporation of state-funded pre-k slots may affect all childcare providers in the local market. Understanding how is an empirical matter. Intuitively, state-funded provision of pre-k education can be thought of as a subsidy that increases the number of free slots for four-year-old eligible children in centers that offer the program. This can attract eligible children who would not attend these centers otherwise. To accommodate such increased demand, pre-k providers that offer subsidized slots may increase their capacity and serve more children. Moreover, under optimization frictions such as capacity constraints, they might also respond by changing the classroom composition, depending on their preferences for subsidized versus non-subsidized slots and how pre-k eligible children are assigned to centers offering the program. Centers that do not offer subsidized slots might also be indirectly affected by the increase in state-funded pre-k slots near them. On the one hand, they could lose enrollment if eligible children switch to other local providers offering subsidized slots. On the other hand, they might face increased demand from ineligible children displaced from other pre-k centers that now offer subsidized slots and accommodate more eligible children. Ultimately, the overall effect is not theoretically clear.

This study provides empirical evidence to answer this question in the context of the

[1] Friedman-Krauss et al. (2023) state that four states passed laws to provide universal preschool in 2022 (California, Colorado, Hawaii, and New Mexico); two state governors have announced their support and increased funding (Michigan and New Jersey); while other states are increasing their enrollment and funding to improve its quality (e.g., Alabama and Rhode Island).

[2] In 2002, 32% of four-year-old children attended a state-funded pre-k program; 6% were in a Head Start program, 3% in a special education program, 2% in another public program, and 57% were in either a private setting or not enrolled in any early childhood education program (Friedman-Krauss et al., 2023). On the other hand, the federal government offers funding to states in the form of Child Care Development Funds to subsidize childcare for low-income children contingent on parental work, as well as Social Services Block Grants and Temporary Assistance for Needy Families (TANF), which could also be used by states to subsidize childcare for low-income children.

North Carolina Pre-Kindergarten (NCPK) program, which offers subsidized pre-k education slots for children from low-income families. There is variation in how states design their pre-k programs. The NCPK is a program with a mixed-delivery system, i.e., state-funded pre-k slots can be offered both in public and private childcare centers (a.k.a., community-based organizations). For simplicity, from now on, I will refer to centers offering subsidized NCPK slots as NCPK centers. The NCPK program started in 2001 as a pilot program in 100 classrooms and quickly expanded to all counties in the state. By 2012, even though the total number of NCPK centers at the state level had stabilized, there were still several underserved areas, and new providers continued joining the program every year across all North Carolina counties. The typical case in the NCPK expansion constitutes an already existing center that starts offering subsidized NCPK slots. Alternatively, there are also some new center openings under the NCPK program. North Carolina is an ideal context to study this question, given that its state-funded pre-k program has been in place for over two decades, it serves around one-fourth of all four-year-old children in the state, it has been recognized for its positive effects on child outcomes, and it has a high-quality data system.

To answer how NCPK might affect enrollment structures of NCPK and non-NCPK child-care providers, I exploit geographical and time variation in the rollout of the NCPK program, jointly with a rich combination of administrative childcare provider-year-level records. There are two main sources of data. First, enrollment data and provider-level characteristics were obtained from the North Carolina Department of Health and Human Services (NCDHHS). For monitoring purposes, NCDHHS collects information on all licensed child-care providers in North Carolina through unannounced visits made at least once per year by government officials. Second, specific information corresponding to NCPK centers was collected and provided by the University of North Carolina at Chapel Hill, which was in charge of the monitoring of the NCPK program. Finally, I also rely on data from the American Community Survey 5-year estimates at the census block level for socio-demographic characteristics of the relevant areas.

The research design is based on a difference-in-differences design that exploits the staggered and geographically heterogeneous incorporation of childcare centers to the NCPK program between 2012 and 2018 - the period for which the most detailed data is available. More specifically, I combine an event study via two-way-fixed effect strategy with a ring design to define treatment and control areas (Currie and Walker, 2011). In short, this research design compares enrollment in childcare centers that had an NCPK center within a radius of 0.5 miles with presumably similar centers located a bit further away from an NCPK center (between 0.5 and 1 mile), before and after the center began offering NCPK slots. While I discuss this in detail in Section 5, the chosen size of the ring is consistent with recent related

work that shows that childcare spillovers happen at a very local level (Brown, 2018). The key identification assumption is, therefore, that the timing of NCPK establishment is uncorrelated with other determinants of changes in enrollment in the area. Importantly, given recent developments in the TWFE literature (de Chaisemartin and D'Haultfœuille, 2023; Roth et al., 2023; Wooldridge, 2023; Sun and Abraham, 2021), it is important to note that all estimates are heterogeneity-robust.

The empirical analysis leads to three main sets of results. First, when joining the program, NCPK centers concentrated more on serving eligible four-year-old children. On the one hand, they significantly increased the enrollment of four-year-old children by about 10 slots. On the other hand, the share of four-year-olds among all the children served in their centers also increased, by about 10 percentage points. Furthermore, for centers that were already operating when joined NCPK, there is evidence of a slight decrease in the absolute number of 0-3 year-old children enrolled. Overall, these results indicate that when joining the program, NCPK centers not only started serving more four-year-old children but also reformulated their enrollment structure towards a larger share of the eligible population to the detriment of the ineligible population (either non-eligible four-year-old or 0-3-year-old children that are not covered by the program).

Second, when NCPK centers began offering the program, other non-NCPK childcare providers in their vicinity were also affected. Specifically, non-NCPK childcare centers within half a mile of an opening NCPK center increased the enrollment of four-year-old children by 30%, and three-year-old children by almost 20%. These results are robust to several specifications such as changes in the sample definition, model specification, and control/treatment ring size definition. Moreover, the effects are negatively associated with the distance: facilities that are located within shorter distances of the NCPK center had larger increases in enrollment, and these effects quickly diminished and disappeared by about a 0.75-mile distance. Put together, the first and second sets of main results suggest that ineligible three- and four-year-old children were crowded out from NCPK centers to non-NCPK centers in the local area.

Third, the growth in four-year-old enrollments in nearby facilities is explained almost exclusively by centers in lower-income areas. In other words, in lower-income areas, the increased demand from ineligible NCPK children faced by non-NCPK centers more than offsets what they lose in NCPK-eligible children who are switching to NCPK centers. This is not true for higher-income areas, where both forces seem to offset each other, meaning that overall enrollment remains unchanged. These results are consistent with the fact that low-income children are less likely to be in center-based childcare arrangements than their higher-income counterparts (U.S. Department of Education, National Center for Education

Statistics, 2021; U.S. Department of the Treasury, 2021). It suggests that, in higher-income areas, NCPK is more likely to be substituting childcare from another provider, as opposed to home-based or informal arrangements, which are more prevalent in low-income families.

Finally, an important implication of these findings is that, unintentionally, NCPK might have increased income segregation across childcare centers. While, unfortunately, I cannot observe the characteristics of the children enrolled in each center, the changes in enrollment counts imply that centers are altering the composition of their classrooms, in a way that NCPK centers serve four-year-olds from eligible low-income families almost exclusively, while higher-income ineligible children are displaced to non-NCPK centers.

This study contributes to three strands of literature. First, I contribute to the literature evaluating childcare market responses to pre-k program expansions, and more specifically, an emerging literature looking at how they affect the availability of childcare for ineligible children. Two studies of universal pre-k programs —in Florida and New York City— showed that increasing pre-k slots for four-year-olds can unintentionally decrease the availability of care for three-year-olds (Bassok et al., 2016) and children younger than two (Brown, 2018). Brown (2018)'s findings also suggest that these unintended effects on younger children may happen because pre-k centers crowd out four-year-old children from other facilities, who are the more profitable group for childcare providers. On the other hand, Bassok (2012) found that, as a response to state pre-k expansions, Head Start centers have been able to adapt and switch to serve younger children.[3]

In contrast to these studies, North Carolina's high-quality data system allows me to provide a more complete picture of the childcare market across all ages and childcare settings, which can help illustrate the mechanisms behind these responses. For instance, Bassok et al. (2014) found that the universal pre-k programs in Georgia and Oklahoma increased the number of childcare centers, and showed that in Oklahoma, where pre-k was expanded only through public schools, there was crowd-out from private centers. However, they do not have information on the number of children in each childcare setting. Additionally, high-quality administrative records also allow me to measure effects on enrollment counts as opposed to facilities' licensed capacity, which may be a more relevant margin of response. Licensed capacity is usually defined by the monitoring agency and it is defined as the number of children for which the childcare facility is authorized to care for. It is computed based on the facility infrastructure (e.g., characteristics of the primary space, outdoor space, toilets, etc.), the age group composition, and staff-to-child ratios. Hence, it will be less sensitive to

[3]The federal Head Start program, which started in the 1960s, has been the primary preschool provider for low-income families in the US for a long time. However, in the last decade, funding for state-based pre-k programs has substantially increased and surpassed investments in Head Start.

changes in childcare demand and might fail to capture responses in actual enrollment when facilities are not operating at full capacity.

An additional advantage of focusing on the NCPK setting is that, to my knowledge, all the existing evidence on pre-k crowd-out effects comes from universal pre-k programs. Despite its relevance, these effects might not generalize to targeted programs, which are most common across the nation (Friedman-Krauss et al., 2023). For instance, crowd-out concerns between providers should not be as relevant if pre-k is enrolling children who would not participate in any formal childcare arrangement in the absence of the program. In fact, crowd-out between private and public providers is more likely to happen among higher-income families (Cascio and Schanzenbach, 2013); however, low-income families are less likely to attend formal childcare centers (Herbst, 2022), and therefore, a pre-k program targeted at low-income families could potentially lead to different market dynamics. This study shows that in the context of a targeted program, adding pre-k slots did not come at the expense of infant and toddler slots. Additionally, I show that the program increased childcare access, and this increase was larger in low-income areas due to a response in both pre-k centers and non-pre-k centers.

Second, I contribute to the literature on optimal design and effectiveness of state-funded pre-k programs. There is growing concern about why current early education programs are yielding smaller or more conflicting results than early preschool demonstration studies, such as the successful Perry preschool study (Whitaker et al., 2023). One likely explanation is that counterfactual conditions have changed over time: preschool programs are now serving children who would otherwise be in a fairly similar arrangement. My results support the hypothesis that, at least in higher-income areas, NCPK is serving children who would otherwise be served in formal childcare centers. The results are also in line with Kline and Walters (2016), who show that the Head Start program also crowds out children from other similar arrangements ("close substitutes"). They show that while Head Start did not have positive overall effects on child outcomes, it did generate positive effects for children who would otherwise not attend any preschool. Consistently, Watts et al. (2023) found that NCPK had larger effects on the academic achievement of low-income children. Combining the results with those in this study, I suggest that a likely explanation for this income heterogeneity is that higher-income children who attend the program but who are still under the income eligibility threshold, in the absence of NCPK, would have been served by closely substitute childcare providers.

Finally, I also contribute to the literature on education systems and economic segregation. While school segregation in K-12 education has been widely studied (Owens et al., 2016), less is known about economic segregation in preschool. Similarly to later grades, and given

that proximity is a primary factor for childcare decisions, it is expected that neighborhood segregation leads to high economic segregation in childcare centers. However, this study highlights an institutional factor, a targeted pre-k policy, that can unintentionally increase economic segregation in an educational context. This is driven by the fact that providers that joined the NCPK program shift their enrollment structures disproportionately towards low-income eligible children to the detriment of ineligible children. It is noteworthy that, given that lower-income children are being concentrated in a high-quality setting (because of the NCPK high-quality standards), this segregation does not necessarily lead to a difference in the quality of services received. However, there are other reasons why preschool segregation may still be problematic. Attending a more diverse education setting can increase the likelihood of having diversified social networks, alter perceptions around social differences, and affect social preferences (Londoño-Vélez, 2022), even as early as the preschool years (Cappelen et al., 2020).

The results in this paper are not only academically relevant but have strong policy implications. As many states are passing legislation and showing efforts to expand their pre-kindergarten programs (Friedman-Krauss et al., 2023), many have concerns about how these policies are going to be implemented and how childcare providers are going to respond. Given the fragmented nature of the early childhood education systems in the United States, the reliance on private centers, and the combination of private and public funding streams (Duer and Jenkins, 2023), this study suggests that when states decide to expand childcare and education for four-year-olds, they should also contemplate the changes that these programs may trigger in the whole childcare market and how certain spillover effects might be associated with the program design features. This study shows that concentrating subsidized pre-k through slots in existing facilities can lead to increased access to childcare but also to an enrollment reshuffle between centers that increases economic segregation.

In particular, this paper sheds light on two policy decisions in the context of targeted pre-k programs: (1) in which areas should subsidized slots be allocated, and (2) within an area, which centers should provide them. As to the first point, results support the hypothesis that in higher-income areas, pre-k slots are more likely to substitute other formal arrangements and increase economic segregation across childcare centers. As to the second point, even in low-income areas, concentrating many subsidized slots in the same providers, while increasing access, might also come at the expense of increased segregation. However, it is noteworthy that relying on centers that already participate in the program can facilitate its administration and make it easier to serve more children since it does not require finding more high-quality centers that meet the program requirements. Hence, when making slot allocation decisions, policymakers should consider these trade-offs.

The rest of the paper is organized as follows. The conceptual framework is presented in Section 2; in Section 3, I describe the NCPK program's main characteristics; Sections 4 and 5 describe the data and analytical strategy, respectively; in Section 6 I present the main results, which are further analyzed in Section 7, and conclude in Section 8.

2 Conceptual Framework

The introduction of state-funded pre-k slots can affect both state- and non-state-funded pre-k centers. In this section, I discuss a conceptual framework based on the potential mechanisms that might operate in a setting where a targeted state-funded pre-k program for low-income children is introduced in a local pre-existing childcare market. The state-funded pre-k program offers free childcare slots to four-year-old children in childcare facilities that were already serving 0- to 4-year-old children before joining the program. This is how most pre-k programs operate in the United States (Friedman-Krauss et al., 2023). For simplicity and without loss of generality, in what follows I will refer to centers that offer fully-subsidized state-funded pre-k slots as NCPK, and centers that do not offer these subsidized slots as non-NCPK.

2.1 Expected Transformations of NCPK Centers

One intuitive way to think of this type of policy is the introduction of a subsidy that reduces the price paid for daycare services by the eligible population. Participating NCPK centers will, by definition, offer free slots. If NCPK centers can accommodate as many children as they want, they are expected to increase the overall enrollment of the eligible four-year-old population.

Under optimization frictions (e.g., capacity constraints), NCPK centers might respond by changing the classroom composition. This restructure will depend on NCPKs' relative preferences for subsidized versus non-subsidized slots and/or the NCPK allocation system (i.e., how NCPK-eligible children are assigned to centers offering the program). For instance, centers offering NCPK slots might prefer enrolling NCPK-eligible children compared to non-NCPK children because it is easier to collect tuition and fees from the government than collecting them from each family individually. Alternatively, from a policy-administration perspective, NCPK officials might prefer to concentrate the NCPK slots in specific centers. In both cases, NCPK centers will tend to increase their share of NCPK-eligible children. In other words, to accommodate more NCPK-eligible population, **NCPK centers will reduce the enrollment of children who are not eligible either because of their age (i.e.,**

younger children) or other individual characteristics (e.g., in targeted programs, higher-income 4-year-old-children).

2.2 Expected Transformations of non-NCPK Centers in the Local Market

Non-NCPK centers might be indirectly affected by NCPK expansions. On the one hand, non-NCPK centers might face increased childcare demand from ineligible families who are displaced from centers that now offer the NCPK program. On the other hand, they could also lose 4-year-old enrollments from eligible families who are now switching to NCPK providers. Theoretically, the overall effect could go in either direction, depending on which force predominates.

Scenario A: Increased demand from non-NCPK children < Loss of NCPK children

This could be the case if non-NCPK providers used to enroll many four-year-old NCPK-eligible children who are now being served by NCPK centers. In this scenario, the loss of NCPK-eligible children could be higher than the increased demand from displaced ineligible children coming from NCPK providers, leading to a **net decrease in the enrollment of four-year-old children in non-NCPK centers in the local market**.

However, in this scenario, **the expected effect on the enrollment of younger children is ambiguous**. Because the provision of childcare is more costly when children are younger (Brown, 2018), childcare centers typically cross-subsidize care for infants and toddlers with the revenue obtained from their enrollment of older children. Therefore, when they lose the enrollment of four-year-old children (the more profitable group) centers might be financially affected and might need to either decrease the quality, increase the price charged for younger children, or run out of business. If providers are running out of business, the available seats for younger children in the area would be reduced. However, if there are still families willing to pay a higher price, the enrollments of younger children might be unaffected or increase. In fact, if NCPK centers decide to enroll NCPK-eligible children at the expense of younger children (i.e., changing the age structure of the population they serve), local non-NCPK providers might experience an increased demand for younger children seats from families who lost their slots in the newly established NCPK centers.

Scenario B: Increased demand from non-NCPK children > Loss of NCPK children

This could be the case if new NCPK centers used to enroll many ineligible NCPK children and shifted strongly their focus to serving NCPK children who were not enrolled in other childcare arrangements before the program. If this is the case, the loss of NCPK children faced by non-NCPK centers might be more than offset by the increased demand driven by children whom new NCPK centers are letting go after joining the program. Under this scenario, the introduction of a new NCPK center is expected to **increase the enrollment of 4-year-old children in non-NCPK providers**.[4]

As to the enrollment of younger children, as long as NCPK centers are changing the age structure of the population they serve, local non-NCPK providers will experience an increased demand for younger children seats. As opposed to scenario A, since there is a positive net gain of 4-year-old enrolled children, **the predicted effect on the enrollment of 0- to 3-year-old children is positive**.

Scenario C: Increased demand = Loss of pre-k eligible children

Finally, the effects on age-4 enrollment in nearby non-NCPK facilities may be null when both the increased demand from NCPK-ineligible children and the loss of NCPK-eligible children are similar in size. Regarding younger slots, and similar to Scenario B, if NCPK centers are not enrolling as many 0- to 3-year-old children as they would otherwise, non-NCPK centers are facing an increased demand for younger slots. Then, the expected outcome would be an increase in the enrollment of younger children.

Summary and additional considerations on socio-economic segregation

In the end, the effect of a new NCPK center on enrollment structures in other local non-NCPK centers is theoretically ambiguous and depends on several factors, such as how well NCPK providers can adapt to increased demand, what would have been the childcare arrangements of the NCPK population in the absence of NCPK slots, and the characteristics of the childcare market before the NCPK program. These materialize into two competing forces: the loss of NCPK-eligible children, and the gain of non-NCPK-eligible children. For instance, age-4 enrollment in non-NCPK centers will increase if the increased demand driven by displaced ineligible NCPK children more than offsets the loss of NCPK-eligible children who are now shifting to NCPK centers. For younger-age enrollment, the effect will also

[4]This increased demand coming from ineligible NCPK children might also lead to an increase in the price charged by local private childcare centers. However, this is out of the scope of this paper.

be determined by how well childcare facilities might adapt their financial structures to the increase in operational costs associated with serving younger children.

An additional consideration on the potential effects of newly introduced NCPK centers regards the potential effects on socio-economic segregation across centers. Since NCPK eligibility is based on income, the reallocation of children into different childcare centers is expected to change socio-economic diversity within the provider. In particular, if NCPK centers concentrate on serving eligible children, they will serve more lower-income children, while the opposite is true for non-NCPK centers which now will receive more ineligible children. This represents an additional layer of economic segregation in education driven by institutional factors, on top of the one caused by neighborhood segregation.

3 The North Carolina Pre-Kindergarten Program

States across the United States have followed different approaches to designing their pre-k programs. In this section, I provide more details about North Carolina's approach.

Program Overview. NCPK is a state-funded program that offers subsidized early education to four-year-old children from low-income families. The main goal of the program is to better prepare children for their transition to kindergarten in terms of their overall well-being and academic readiness. Any licensed childcare center that meets a series of requirements described below can offer NCPK slots in its center and get reimbursed for the eligible children that they serve. Hence, NCPK slots are offered in private centers (a.k.a., community-based organizations; including non-profit, for-profit, Head Start centers, religious childcare centers, private schools, etc.) as well as public school buildings (as long as they have preschool classrooms for four-year-old children).

Program History. NCPK launched in 2001 as a pilot program in 100 classrooms under the name of More at Four and was gradually expanded until today (Appendix A1 shows the number of centers joining and leaving the NCPK program between 2005 and 2018). Looking at the first two decades, funding and enrollment in the program grew substantially during the first ten years and remained mostly stable during the 2010s. Despite the stability in the total number of NCPK centers in the post-2010 period, the expansion dynamics of NCPK still implied that many underserved areas faced NCPK openings for the first time during this period. One figure that illustrates the importance of NCPK at the state level is that by the end of this study period, about 25% of all four-year-old children in North Carolina attended NCPK.

Existing Evaluations. Several studies have demonstrated that NCPK is effective, not only in improving children's school readiness at the beginning of kindergarten (Peisner-

Feinberg et al., 2019; Peisner-Feinberg and Schaaf, 2011) but also in boosting academic skills through the elementary school grades (Dodge et al., 2017; Ladd et al., 2014; Watts et al., 2023).

Child Eligibility. A key characteristic of the NCPK program is that it funds slots that should be filled with eligible children, as opposed to funding entire classrooms or centers. NCPK is targeted at four-year-old children from low-income families, i.e., with a household income below 75% of the state median income. In addition, up to 20% of slots could be filled with children who do not meet the income requirement but present developmental disabilities, have limited English proficiency, have educational needs, have chronic health conditions, or belong to military families. Roughly, half of the four-year-old children in NC are eligible to participate in the program; however, only around 50% of them do it. This is still below the goal of the program, which aims to serve at least 75% eligible children.[5]

NCPK Administration. NCPK is administered by "contractors", who receive funding from the state and oversee the program under their jurisdiction. Typically, there is one contractor per county, and each of them must have a committee representing relevant members of the early childhood education community (e.g., public schools, Head Start, private childcare providers, and referral agencies). While there is flexibility and variation in how contractors implement the program, in most cases, program application and placement of children in centers is handled centrally, at the contractor (county) level.

NCPK Providers. To receive NCPK funds, participating centers should meet a list of requirements that guarantee the high quality of the program. These include having a 4- or 5-star rating in the Quality Rating and Improvement System (QRIS), licensure requirements for administrators and teachers (e.g., Birth-through-Kindergarten or Preschool add-on standard licensures for lead teachers), providing at least two meals, following an approved preschool curriculum, implementing formative assessments, and meeting a 1:9 class ratio, among others. Currently, there are more than 1,000 centers that offer NCPK. 48% of them are public schools, 38% are private child care centers, and 14% are Head Start centers. These numbers vary considerably between counties (e.g., some contractors may choose to locate all their slots in public schools).

[5]A possible explanation for the slowdown in the NCPK expansion is about costs. NCPK contractors and providers who are willing to participate in the NCPK program usually need to find additional funding. In 2018, participating centers received approximately $5,500 for each NCPK slot. This amount represents about 60% of the actual cost; hence, this amount is complemented with funds from other sources such as Smart Start, Head Start, Title I, or others (Barnett, 2018). The low share of the cost reimbursed by the state, coupled with the high standards required to participate, the shortage of qualified teachers, and the physical space needed to serve more children, are some of the main difficulties to continue expanding the program.

4 Data

To conduct this analysis, I use data at the childcare provider-year level. In short, I created and geo-coded a panel dataset of all licensed childcare providers in North Carolina. I located centers that joined the NCPK program between 2012 and 2018, and observed childcare centers around them. In this section, I describe the data sources, how the sample is defined and constructed, and an initial overview of the analytic sample.

4.1 Data sources

Enrollment data and provider characteristics. Information on all licensed childcare providers in North Carolina is collected by the North Carolina Department of Health and Human Services (NCDHHS) for monitoring purposes. For this analysis, I extracted provider-level data from Statistical Reports that are publicly available on the NCDHHS website. These reports are available starting in 2005 and include license ID, facility name, facility type, and the number of enrolled children by age. While reports are generated and posted monthly, the data only changes when enrollment information is collected during a visit and data is entered into the facility record. Following North Carolina's Child Care Rules, the Division of Child Development and Early Education makes at least one unannounced visit annually and additional unannounced visits when there is a complaint.[6] Even when no complaints are received, there is usually a second monitoring visit scheduled midway through the cycle. Hence, typically, visits are conducted a minimum of 1-2 times each year. Given this pattern of monitoring visits, I use data from one report per year.[7] These records are used to create the outcome variables used in the analyses.

NCPK centers. Participation in the NCPK program is derived from NCPK program monitoring data (MAFREPS, which stands for More at Four Reporting System). These data were collected at the University of North Carolina at Chapel Hill and made available for this study for the years 2005-2006 to 2018-2019. These records are used to identify the treatment "shocks" used for the identification, i.e., the moment when an NCPK center begins offering NCPK slots. This is defined as the year in which the center is observed in the MAFREPS data for the first time.

Childcare provider addresses. A key piece of information for a geographic analysis is being able to map out the facilities. Addresses for all childcare providers were requested and provided by the NCDHHS for the years 2012 to 2022. Addresses for NCPK centers were

[6]For more information, see "Chapter 9- Child Care Rules" from the North Carolina Department of Health and Human Services: https://ncchildcare.ncdhhs.gov/services/licensing/getting-a-license

[7]Data was extracted from the September report each year.

also included in the MAFREPS data for all available years (2005-2018). After geocoding both sources, I merged them based on their spatial location.

Socio-economic environment. In addition to provider-level information, in some cases the empirical analysis relies on characteristics of the local area which I obtained from the American Community Survey 5-year estimates at the Census Block level.[8]

4.2 Sample construction and Definition of Treatment and Control Areas

Data Cleaning and Geocoding. Childcare providers were geocoded using the US Census Batch Geocoding Tool and ArcGIS. Data from the two main sources (NCDHHS and MAFREPS) were separately geocoded and then merged based on their spatial location. Given the data availability described in subsection 4.1, the final universe of childcare providers includes all childcare providers that had a license to operate between 2012 and 2022. For them, if they were operating before 2012, I can also retrieve their data for previous years. [9]

Reference Centers. Treatment in this study is defined by offering NCPK slots. Because the strategy is to analyze what happens when a center joins the program, I identify centers that will be labeled as "reference centers". These are childcare providers that began offering NCPK between 2012 and 2018, as indicated in MAFREPS data. Each reference center has a reference year associated, which is the year in which they first started offering NCPK slots. Even though I have NCPK information for earlier years, I limit the definition of reference centers to those that opened after 2012. The reason for this decision is that I cannot fully observe the entire childcare market around them during the previous years.

Ring construction (treatment and control groups). After geocoding all childcare providers and identifying reference centers, I calculate the distance between each childcare provider and the closest reference center. After computing this distance, two groups are defined based on drawing two concentric circles or rings around reference centers. On the one hand, centers that are within half a mile of a reference center are part of the "treatment" group, or *Ring 1*. On the other hand, centers that are between 0.5 and 1 mile away from a reference center are part of the "control" group, or *Ring 2*.[10] Despite being arbitrary, the choice of the ring size in this study is comparable to the distances used in recent related

[8]The decision of using 5-year estimates at the block level is due to the existing trade-off between the geographic and time precision of the ACS estimates. I chose to prioritize variation at the geographic level.

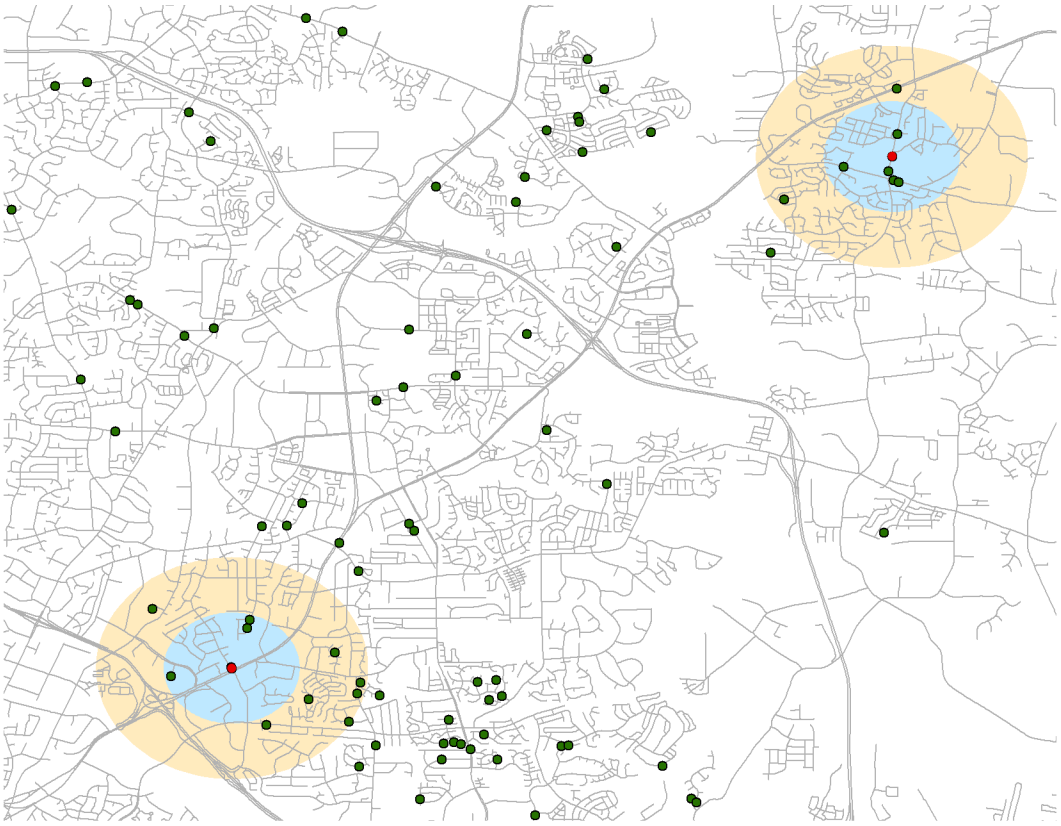
[9]There are some cases in which the same childcare provider might have changed their license ID number before 2012. If that is the case, then I cannot include their pre-2012 data.

[10]See Currie and Walker (2011) for an implementation of the ring design, and Brown (2018) for a discussion of the method.

studies showing that childcare decisions happen at a very local level (e.g., Brown (2018)). Additionally, increasing the ring size can increase the likelihood of having overlapping rings, adding bias to the analysis. With the results, I show several sensitivity tests to ensure that the reported findings are not driven by the arbitrary ring-size choice.

Example. Figure 1 shows an example of rings and group definition for one year. In this selected area, two centers began offering NCPK slots in 2016. Centers located in the blue area (within 0.5 miles) are considered treated, and centers in the yellow area (0.5-1 mile) are part of the control group. For all of them, 2016 will be their event zero, i.e., I will compare their outcomes before and after 2016. This approach is implemented for all NCPK centers that offered NCPK slots for the first time between 2012 and 2018 and their surrounding areas.

Figure 1: Example of centers that offered NCPK slots in 2016 for the first time, treatment and control group definition



Notes: This screenshot shows an area of North Carolina and all geocoded childcare providers (dots). In this area, in 2016, two centers started offering NCPK slots (red dots). Childcare providers that fall within the study sample for this year are those within 0.5 miles of the reference centers (in the blue area) and those between 0.5 and 1 mile (yellow area). The remaining childcare providers are not included in the 2016 reference year.

Sample overview. The main analytic sample is composed of 229 childcare centers that were within half a mile (treatment group) and 490 centers that were at a 0.5 to 1-mile distance of reference centers.[11] These facilities were either open when the reference center began offering NCPK (91%) or opened later (9%). After measuring the distance to the closest reference center, I apply the following sample restrictions. First, I remove providers that, during the years considered, were eventually in both treatment and control groups in different years (n=85). This allows for a "pure" treatment vs control comparison. Second, I removed providers who were treated more than once (n=27), avoiding the post-treatment period receiving more shocks.

An additional consideration is that I do not consider providers that have a license to operate as family childcare homes. Due to differences in the characteristics of the population served and licensing requirements (e.g., lower maximum capacity), they are likely less affected by NCPK. In any case, I include them as a robustness check.

Finally, due to the large impact of the COVID-19 pandemic on the childcare market (Zhang et al., 2023), I removed the years 2020-2022 from the analysis. While this decision gets rid of measurement error, it creates a sample imbalance, i.e., areas where NCPK opened later have fewer post-treatment years. I confirm the robustness of the results in the appendix.

5 Analytical Strategy

For this analysis, I exploited the moment when a center begins to offer NCPK slots (defined as "reference centers"). Then, I created two groups of childcare providers based on their distance to the closest reference center.[12] I implemented a dynamic Difference-in-Difference design, comparing the changes in enrollment in childcare providers that are located within half a mile of a reference center, before and after the corresponding reference center began offering NCPK slots, controlling for the changes in enrollment in childcare providers that are just half-a-mile further away from them. This was estimated with the following main two-way-fixed-effects (TWFE) specification:

$$Y_{pt} = \beta_0 + \beta_1 RingOne_{pt} + \beta_2 POST_{pt} + \beta_3 (POST * RingOne)_{pt} + \beta_4 Distance_p t + \theta_t + \gamma_{rc} + u_i \quad (1)$$

where Y_i is the outcome variable for provider p in event t, $RingOne_{pt}$ equals one if the provider is located in a first ring, $POST_{pt}$ equals one if the year is after the reference center

[11] A count of childcare providers in the treatment and control group by year is included in Appendix B1

[12] A similar approach is used by Currie and Walker (2011) to estimate the effects of traffic congestion on infant health and further discussed by Brown (2018).

started offering NCPK slots, $Distance_pt$ is the linear distance to the closest NCPK provider, and θ_t and γ_c are year and reference center fixed effects.

In addition, one could analyze it dynamically by decomposing the before and after periods in different year dummies interacted with the group assignment:

$$Y_{pt} = \beta_0 + \beta_1 RingOne_{pt} + \Sigma_{j=-7}^{j=2} \pi_j 1(\pi_{pt} = j) + \Sigma_{j=-7}^{j=2} \pi_j 1(\pi_{pt} = j) * RingOne_{pt} + \beta_4 Distance_p t + \theta_t + \gamma_{rc} + u_i \quad (2)$$

where $1(\pi_{pt} = j)$ are events relative to the year in which the reference center offered NCPK slots for the first time (year 0). The year before the switch is omitted, i.e., year -1.

A starting point and a fundamental assumption behind this analysis is that location plays a key role in childcare decisions. Following this, I conceptualize the proximity to an NCPK center as an intensity of treatment: the closer to an NCPK center a provider is, the more likely it is to be affected by the policy. For simplicity, by drawing rings, I am making the assumption that there is an actual geographic limit.

A simplified first analysis would be to define an area that is considered "close", and look at what happens to the enrollment numbers of childcare providers located in this area, in a given year. In other words, this would be only looking at one "treatment" group (or one ring) affected in one year, before and after the event. However, NCPK funding allocations may be associated with other policies or conditions of the community that can simultaneously affect the enrollment of children in other childcare facilities. To address this, I take advantage of the continuous expansion of the NCPK program. By comparing changes before and after NCPK openings that happened in different years, I can isolate the effect of the NCPK opening from other forces that could be operating in a specific year.

The described event study approach would possibly be enough to identify a causal effect of NCPK. However, the possibility of adding a second ring, or a control group, provides another layer of strength to the analysis. The assumption is that facilities that are just a bit further away from an NCPK center are similar to those that are in Ring 1, but they are not affected by the reference center's NCPK status. If we observed that the enrollment in Ring 2 facilities is flat, it would be more convincing that changes in enrollment in Ring 1 facilities are due to the policy.

It is worth noting that, in the real world, there is no real line to distinguish both groups. In section 6.3, I discuss the validity of this analytical decision further and test the results with different ring size definitions.

As highlighted by the new developments in the difference-in-difference literature, if treatment effects vary over time, the estimates derived from equation 2 could be biased (Goodman-Bacon, 2021), and the coefficient for a specific period might be contaminated by the effects

from other periods. Given that the treatment is staggered and absorbing (i.e., once a center is treated, it remains treated), this setting fits into the framework of Callaway and Sant'Anna (2021). An advantage of this study, however, is that the control group remains always untreated. As presented in section 6.3, the results are robust to these adjustments.

Finally, in the context of limited dependent variables, such as enrollment counts, nonlinear models could provide a better fit compared to linear models (Wooldridge, 2023). In Appendix A3, I report estimates based on Poisson regressions.

6 Main Results

6.1 First Stage: Changes in NCPK Centers *(Reference Centers)*

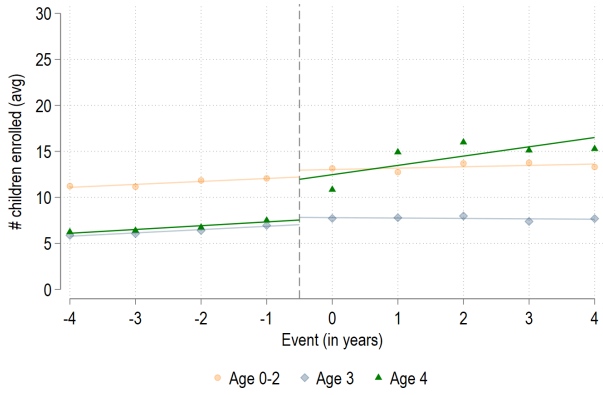
A total of 332 centers were identified as offering NCPK slots for the first time between 2012 and 2018, including private community-based centers (n=214) and classrooms in public school buildings (n=118). In the typical case, NCPK is offered in centers that are already offering childcare services: licensed childcare providers that meet the requirements can join the program and offer NCPK slots, for whom they receive funding from their NCPK contractor. In some other cases, although the goal of the program was not to create new centers, NCPK slots may be offered in new facilities.[13] Based on NCPK administrative data, when they first joined the program, NCPK centers enrolled an average of 14 NCPK-funded children.

To understand what the treatment means for the surrounding childcare providers, it is important to understand the changes in enrollment in NCPK centers. While there is no clean comparison group for reference centers, one could take advantage of the variation in the year that they joined the program and see if there is a change in trends before and after this event. As shown in Figure 2, and consistent with the conceptual framework (section 2), NCPK centers increased the enrollment of four-year-old children by about 10 children (Panel A) after joining the program. Moreover, there was a change in the age composition of the centers: they increased the share of four-year-old children from about 30% to over 40%, while decreasing the share of 0- to 3-year-olds. This suggests that NCPK centers were able to increase the available seats in their promises to some extent, but also changed the composition of the population served in order to receive more NCPK-eligible children.

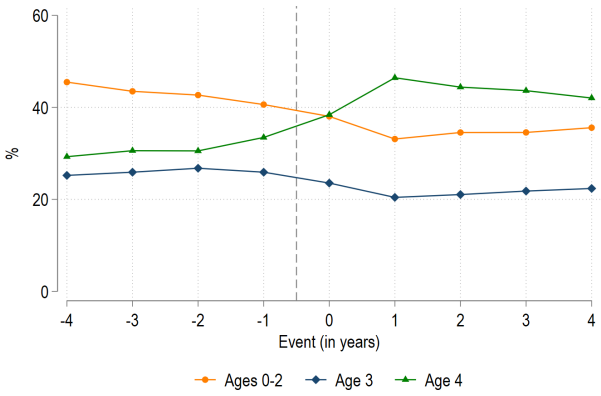
[13] As shown in Figure A2, the majority of private centers already existed when they joined the NCPK program (at event 0). Still, 15% of them were not operating in the previous year, and about 30% were not open four years before the event. This is different when NCPK slots are offered in public schools. While the schools are not new, the majority (76%) of public schools that joined NCPK did not have a childcare license before, suggesting that they did not have a preschool classroom. This distinction matters to understand whether the treatment shock is only an increase in subsidized childcare or a combination of an increase in subsidized childcare and an expansion in childcare supply.

Figure 2: Changes in Reference Centers

A. Number of children enrolled in all reference centers



B. Composition of children enrolled in centers if they were open before joining NCPK



Notes: Panel A shows raw changes in enrollment in reference centers before and after joining the NCPK program. Panel B shows changes in the share of each age among all the 0- to 4-year-old children served in the center.

6.2 Effects on surrounding facilities

In this section, I present the results derived from estimating the two-way fixed-effects specification in providers that were located in areas where NCPK slots were introduced. First, Table 1 presents the results from Equation 1. Overall, when centers began offering NCPK slots, surrounding childcare providers experienced an increase in the enrollment of 3 and 4-year-old children of 18% and 30%, respectively. On average, centers located within half a mile of a reference center enrolled almost two additional four-year-old children ($\beta = 1.727, p < 0.01$) and one additional three-year-old child ($\beta = 0.805, p < 0.10$), compared to childcare centers that were located further away, but still within a mile distance. Moreover, the share of four-year-olds among the enrolled children in these centers grew by about 5 percentage points ($p < 0.01$).

Table 1: Main effects of joining NCPK on nearby providers

	# Children enrolled			Facility characteristics (indicators)		
	Ages 0-2	Age 3	Age 4	Facility is open	Facility enrolls 0-3 kids	Prop. of 4yo among enrolled kids
Within 0.5 miles=1 × Post=1	0.805	0.805*	1.727***	0.035	-0.001	0.049***
	(0.529)	(0.438)	(0.620)	(0.024)	(0.030)	(0.013)
Post=1	-0.585**	-0.344	-0.567	-0.042**	-0.024	-0.013
	(0.250)	(0.212)	(0.349)	(0.016)	(0.017)	(0.010)
Within 0.5 miles=1	-1.656*	-0.357	-0.087	0.009	-0.022	0.036*
	(0.895)	(0.585)	(0.747)	(0.030)	(0.036)	(0.021)
Observations	6015	6015	6015	6015	6015	4830
Mean [post=0 & Ring1=0]	7.698	4.496	5.679	0.815	0.728	0.269

Standard errors in parentheses

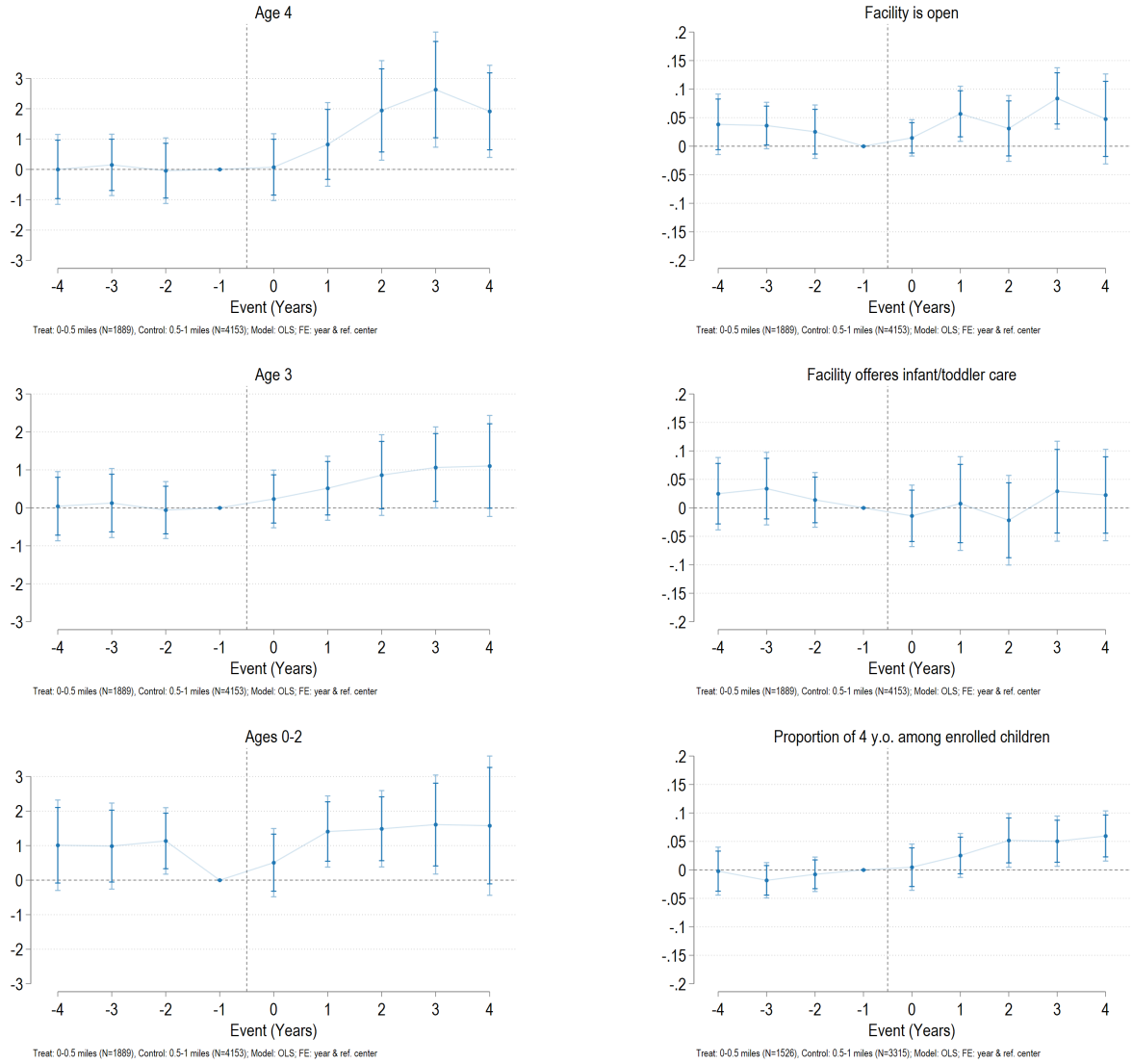
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: This table presents the results from estimating Equation 1. Standard errors are clustered at the county level. The coefficient of interest is derived from interacting an indicator for being in Ring 1 and an indicator for the post-treatment years, i.e., after the corresponding Reference Center began offering NCPK slots. To facilitate the interpretation of the results, the last row shows the mean of the outcome variable in the pre-treatment years among providers in the control group.

Next, in Figure 3, I present the figures derived from estimating the dynamic specification (Equation 2). The corresponding table is included in Appendix Table B2. The first thing to notice is that, in general, and except for age 0-2 enrollments, which have more noise, all the pre-treatment event coefficients are not significantly different from zero. In other words, the parallel trend assumption holds.

The graphs also show that the effects on age-3 and age-4 enrollments are not immediate, but grow slowly in the years after the event. This is not surprising. First, the process of data collection and registration described in section 4.1 requires at least one year to be confident that all childcare providers have received a monitoring visit and updated their information. For instance, for providers for whom event zero is 2015, the event zero enrollment data corresponds to the Statistical Report of September 2015. This report includes the enrollment information based on the last monitoring visit, which could have happened some months earlier, e.g., in the spring of the academic year 2014-2015. Still, the shock is defined by the NCPK center that began offering NCPK in September 2015. For this reason, event zero should be interpreted with caution and considered a lower bound. Secondly, even without measurement error, it is expected that some of the effects need some time to build up due to adjustment frictions in the childcare market.

Figure 3: Dynamic effects of offering NCPK slots on the enrollment in nearby providers



Notes: These figures are created by estimating Equation 2. The figures plot the coefficients of the interactions between each event (year) and "Ever Ring 1" (treatment group) indicator (Equation 2). The model also includes Reference Center and year fixed-effects, as well as non-interacted event (year) and "Ever Ring 1" indicators, and covariates. Standard errors are clustered at the county level.

6.3 Validation and Robustness Tests

One potential concern that arises given the two-way-fixed-effect setting with a staggered treatment is that there could be heterogeneity in the effects over time (de Chaisemartin and D'Haultfœuille, 2023; Roth et al., 2023). If this is true, the event coefficients might be

contaminated by the effects in other periods. The figures in Appendix A8 show that the results are, generally, heterogeneity-robust (Borusyak et al., 2023; Callaway and Sant'Anna, 2021; de Chaisemartin and D'Haultfœuille, 2023; Sun and Abraham, 2021).[14]

Another concern might be the use of linear models. Given that the main outcome variables are enrollment counts, which contain a large number of zeros (e.g., if the provider is closed in a given year or if they did not enroll any child of the specified age), estimating a Poisson regression might be more appropriate. Following Wooldridge (2023)'s recommendation to compare the results from linear regressions to the Poisson regression, I do not observe any difference in the estimates.

On the other hand, the results might be sensitive to some of the decisions made around model specification such as the use of covariates and the level of fixed effect, as well as sample restrictions. While some of them may decrease the effect sizes, the results presented in the previous section are not very sensitive to these changes (Appendix Figure A9).

Finally, the results could be sensitive to the ring size definition. I explore this by changing the ring size definition in two steps. First, I leave the treatment group fixed (at the baseline level, i.e., at a 0-0.5-mile distance) while changing the control group ring size (Appendix A10). The results remain robust when increasing the size of the control group area (Panel A). Second, I leave the control group size fixed while changing the treatment group size. As expected, the results are larger when the treatment group is defined within a shorter distance, and get closer to zero when the treatment area grows. This suggests that the effects are very local around the reference centers (within half a mile). In fact, measuring the effects in areas that are further away from the reference center can be interpreted as a placebo test.

7 Disentangling the results

As presented in section 6, the opening of NCPK centers led to an increase in the enrollment of 3- and 4-year-old children in providers that were located within 0.5 miles. In this section, I present some supplementary analysis to understand the mechanisms.

These results are consistent with the hypothesis that NCPK led to a reallocation of children to centers. Based on this hypothesis, when childcare centers join the NCPK program and face capacity constraints, they "replace" ineligible children (either because of their age

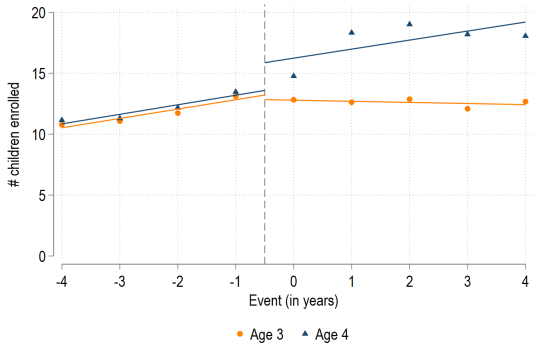
[14]For enrollments of 0- to 2-year-old children, the adjustments "cleaned" the noise in the pre-trends, and some of the adjusted regressions suggest small but significant positive effects on this outcome. The Age-3 results are quite robust for at least a few years after the event. The estimates start to fade out at the end of the period, when the panel becomes imbalanced due to the removal of post-COVID years. Finally, the age-4 results, while slightly smaller in size, remained positive.

or income) with eligible four-year-old children. Nearby childcare might be losing the enrollment of low-income four-year-olds that switch to reference centers, but this appears to be compensated by enrolling the children that the reference centers are not serving anymore.

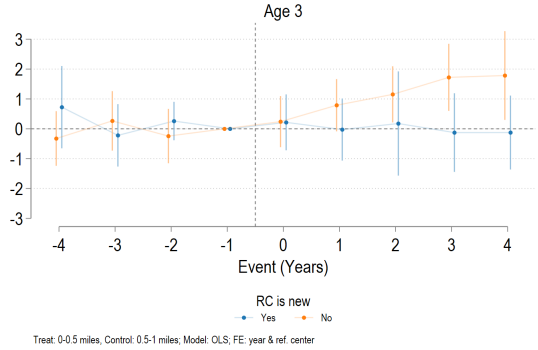
Supporting evidence for the reallocation of 3-year-old children comes from the finding that reference centers that already existed before joining the NCPK program decreased the number of slots they had allocated to three-year-olds (illustrated by the change in the enrollment trend, in Figure 4, Panel A). Moreover, the age-3 effect is driven by cases when the reference center was not new but existed before offering NCPK slots (Figure 4, Panel B).

Figure 4: Exploring mechanism behind age-3 results

Panel A. Changes in enrollment in Reference Centers that served three-year-old children



Panel B. Heterogeneity in age-3 effects by whether reference center is new



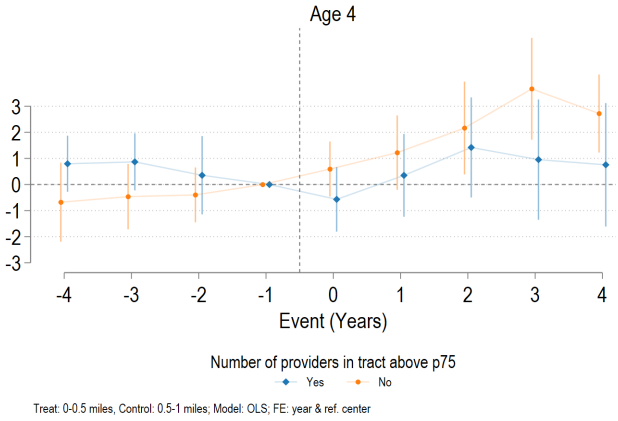
Notes: Similar to Figure 2, Panel A shows raw changes in enrollments in reference centers; however, in this figure, the sample is limited to centers that served at least one three-year-old children at event -1. Panel B plots the coefficients of the interaction between event and treatment group from Equation 2, estimated separately for providers that were near an NCPK provider that was already in place before joining the program and providers that were near an NCPK provider that did not have a childcare license before offering NCPK slots (i.e., as shown in Appendix Figure A2, this is mostly public schools).

The mechanism behind the Age-4 effect is harder to test because we do not observe the characteristics of children enrolled in reference centers before joining the program (other than their age). Put differently, it is not possible to investigate whether, besides adding four-year-old seats, reference centers are serving fewer ineligible children. However, site-level data shows that even in the first year of the program, most of the four-year-old children in NCPK classrooms are funded by NCPK (above 80%). This suggests the number of slots available for non-eligible children must be reduced (or not growing as much as it would in the counterfactual condition).

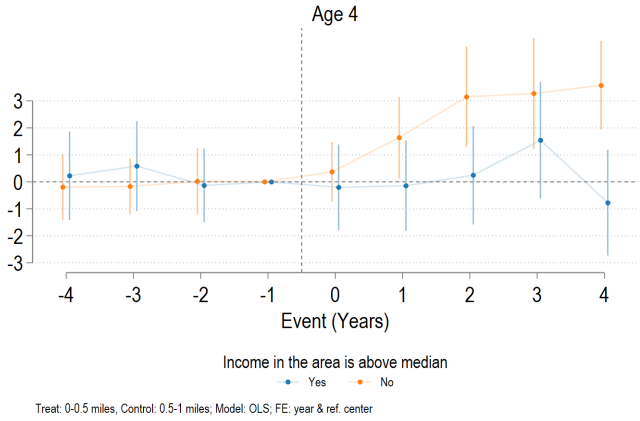
As described in section 2, age-4 effects should be larger when NCPK centers are enrolling children who would not have participated in any formal childcare arrangement. I explore this with two approaches. First, we would expect that, in the absence of NCPK, children would be less likely to be in a formal arrangement in areas that have fewer childcare facilities. We observe that in the surroundings of reference centers that have more childcare facilities (in the top 25th percentile), the age-4 effects are statistically null (Figure 5, Panel A). Second, families from low-income backgrounds are less likely to participate in center-based care (U.S. Department of Education, National Center for Education Statistics, 2021; U.S. Department of the Treasury, 2021). Hence, we would expect that in lower-income areas, NCPK centers would enroll more children who would not have been in a childcare setting in the absence of NCPK. We observe that the age-4 results are driven by areas with household income below the median (Figure 5, Panel B). This suggests that, in higher-income areas, NCPK is more likely to be substituting childcare from another provider, as opposed to home-based or informal arrangements, which are more prevalent in low-income families.

Figure 5: Heterogeneity in age-4 results by selected characteristics

Panel A. By number of CC providers in the area



Panel B. By household income in the area



8 Conclusion

With growing awareness of the potential benefits of early childhood education, most states have been increasing their investments in preschool programs for four-year-old children. While universal pre-k is gaining attention, most of the states currently implement a targeted program for children from low-income families, which is usually delivered through existing childcare providers (Friedman-Krauss et al., 2023). Given the overlap and combination of

different policies and funding streams directed to support the provision of childcare services (Duer and Jenkins, 2023) a natural question to analyze is how the childcare market responds to the addition of pre-k funded seats.

In this study, I found that offering subsidized NCPK slots for low-income families with children in North Carolina through existing public schools and private childcare centers led to an increase in access for the targeted age group. Each center that began offering NCPK slots between 2012 and 2018 served an average of 14 NCPK-eligible children. This led to an increase in the number of four-year-old children enrolled in centers that offered the program (by about 10 seats) and in those that did not but were within a 0.5-mile distance (by about 2 seats). This spillover can be explained by a market response to the high demand for the NCPK slots: to enroll more eligible children, ineligible children who would have attended those centers were crowded out to other nearby providers. To a lesser extent, three-year-old children were also reallocated to non-NCPK childcare centers (an average of 0.8 per NCPK center). Importantly, while increasing access to preschool, given the redistribution of children based on program eligibility, these results suggest that NCPK increased economic segregation across childcare centers. Future research may directly measure whether there was an increase in prices in nearby non-NCPK facilities, as well as the consequences of the increased segregation on child outcomes.

As previously mentioned, NCPK currently serves about 50% of the eligible 4-year-old population. What do these spillovers mean for future expansions of the NCPK program? NCPK centers seem to be operating at the limits of their capacity, meaning that, to increase program access, slots should be offered in more centers. Assuming that there is no treatment heterogeneity over time, a back-of-the-envelope calculation suggests that, for every 100 childcare centers that start offering the NCPK program, it will create 1200 new four-year-old seats in both NCPK and surrounding non-NCPK childcare providers. Additionally, about 80 three-year-old children are crowded out to non-NCPK providers.

A key takeaway for policymakers is the importance of considering the different responses that might be triggered by the design of the pre-k programs. In contrast to Brown's study of Universal Pre-K in New York (Brown, 2018), I do not find evidence of crowd-out from younger children in the context of a targeted program. The main explanation is that non-pre-k centers still have a large demand coming from pre-k ineligible children that they can serve. However, it leads to economic segregation through the reallocation of children to centers and the high concentration of eligible children in pre-k centers. A policy recommendation to mitigate this effect would be to cap the proportion of pre-k-funded slots that can be offered in a pre-k center. Because this will mechanically decrease the number of children that can be served, it must be accompanied by an expansion in the number of centers that offer the

program, e.g., by allowing licensed family childcare homes to offer pre-k slots (Harmeyer et al., 2023).

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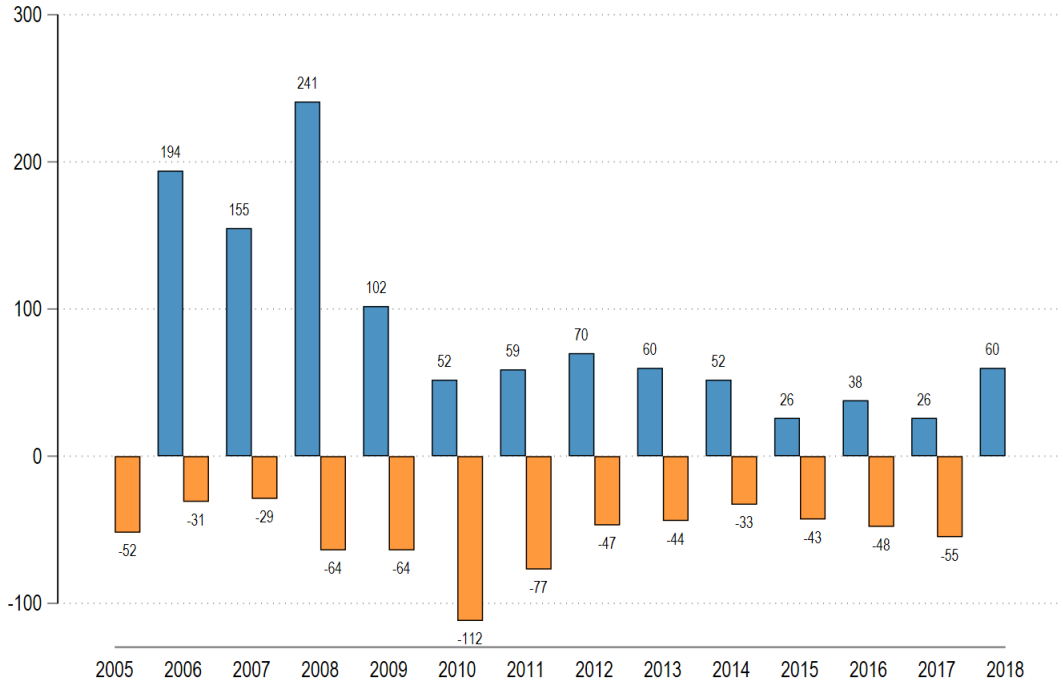
Appendix

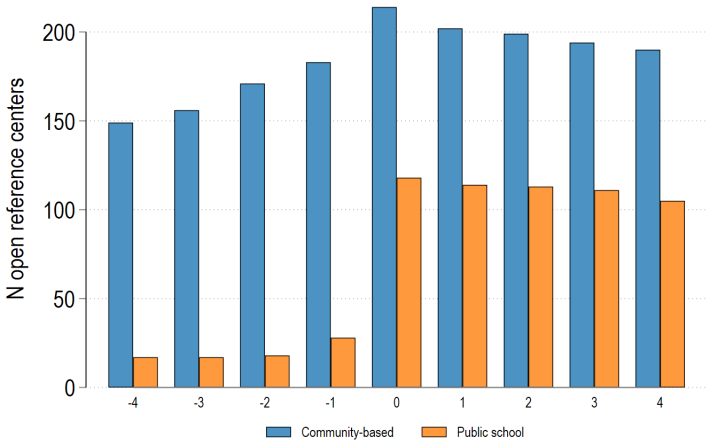
A. Additional Figures

Figure A1: Number of childcare centers joining and leaving the NCPK program, 2005-2018



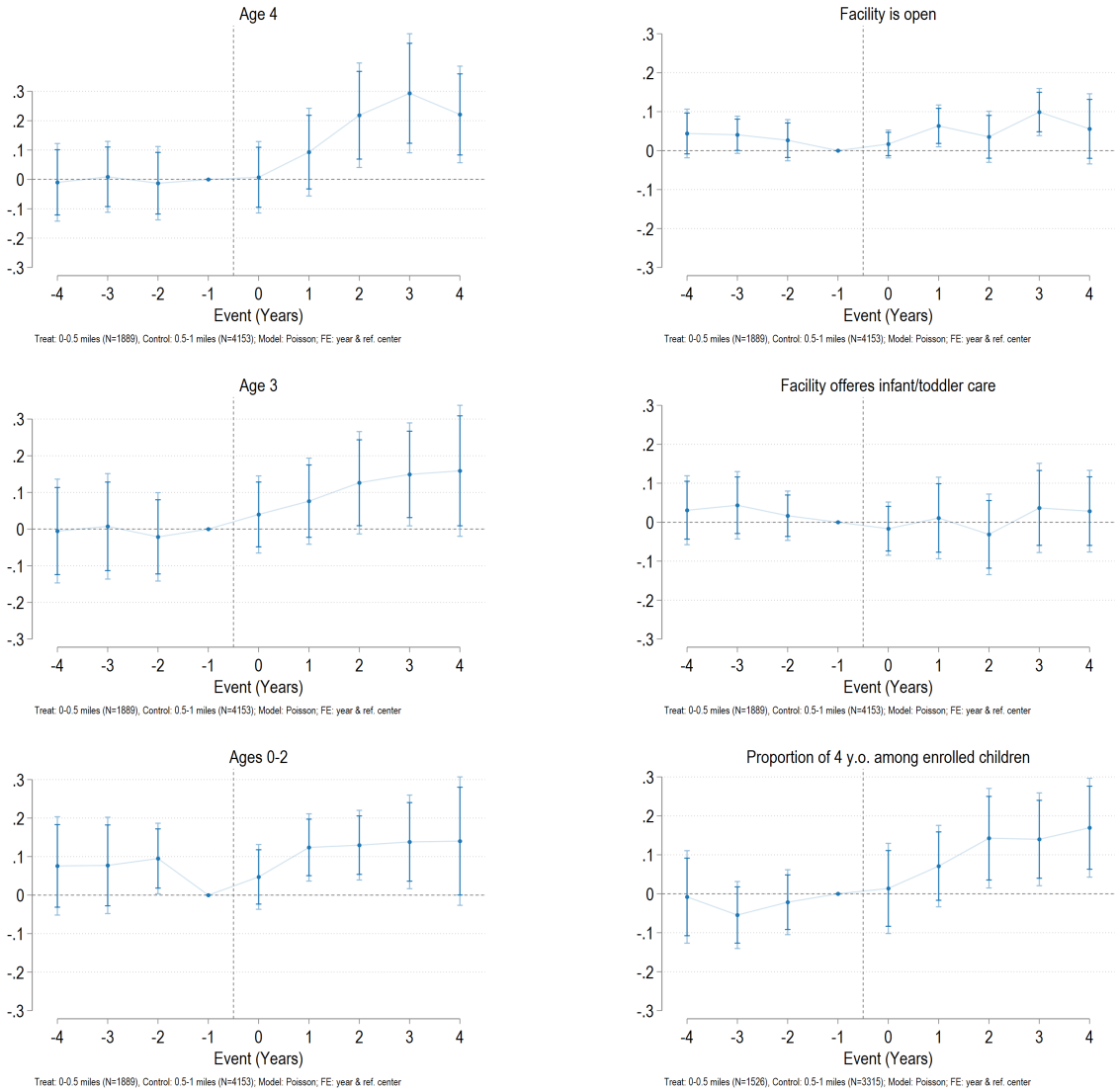
Notes: This figure plots the number of centers that joined (blue) and left (orange) the NCPK program by year. The program started in 2001 as a pilot program with 100 centers. However, I have access to the NCPK data starting in 2005. I cannot distinguish if a center joined the program in 2005 or earlier, therefore I omit 2005 for openings. Similarly, every center is "leaving" the dataset in 2018, then, I cannot identify closures in 2018. Given the accuracy of the data, I use the variation that comes from centers that joined the program between 2012 and 2018.

Figure A2: Number of reference centers opened by event



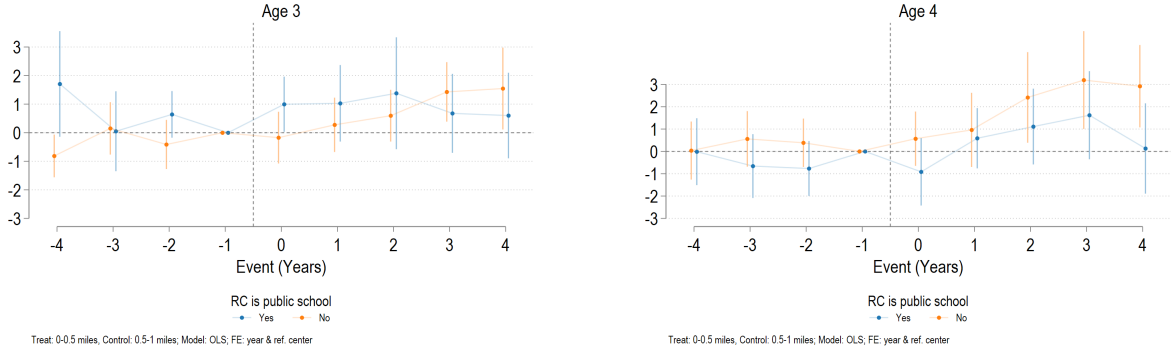
Notes: This figure illustrates the number of NCPK centers that are open by year, relative to the year when they joined the NCPK program (event 0). By construction, all are open at event 0. Hence, the graph shows for how long they had a childcare license before joining the NCPK program (negative events) and whether they stayed open after it (positive events).

Figure A3: Dynamic effects of offering NCPK slots on the enrollment in nearby providers, Poisson estimates



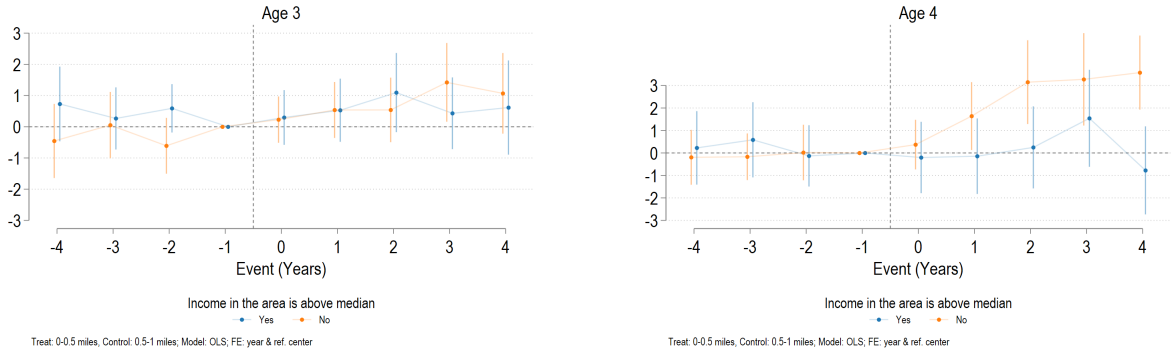
Notes: These figures are created by estimating Equation 2 with a Poisson regression (using STATA command *ppmlhdfe*). The figures plot the coefficients of the interactions between each event (year) and "Ever Ring 1" (treatment group) indicator (Equation 2). The model also includes Reference Center and year fixed-effects, as well as non-interacted event (year) and "Ever Ring 1" indicators, and covariates. Standard errors are clustered at the county level.

Figure A4: Dynamic effects of offering NCPK slots on the enrollment in nearby providers by NCPK type



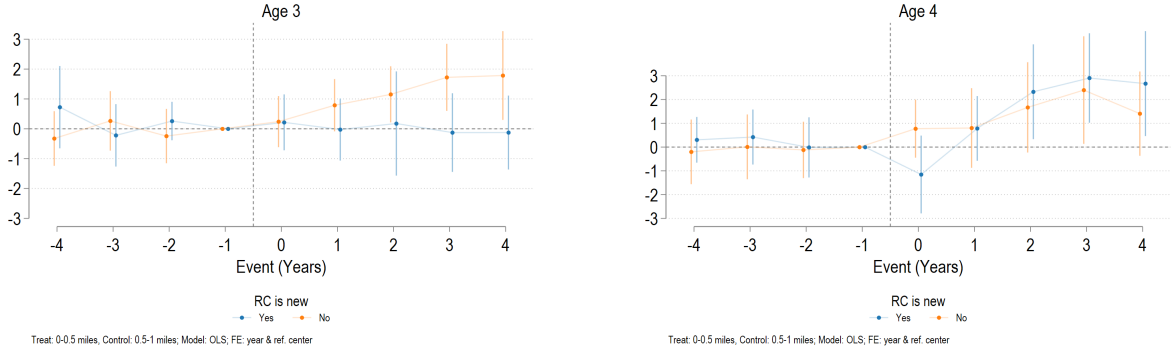
Notes: These figures are created by estimating Equation 2 separately for two subgroups. The figures plot the coefficients of the interactions between each event (year) and "Ever Ring 1" (treatment group) indicator. The model also includes Reference Center and year fixed-effects, as well as non-interacted event (year) and "Ever Ring 1" indicators, and covariates. Standard errors are clustered at the county level.

Figure A5: Dynamic effects of offering NCPK slots on the enrollment in nearby providers by income in the area



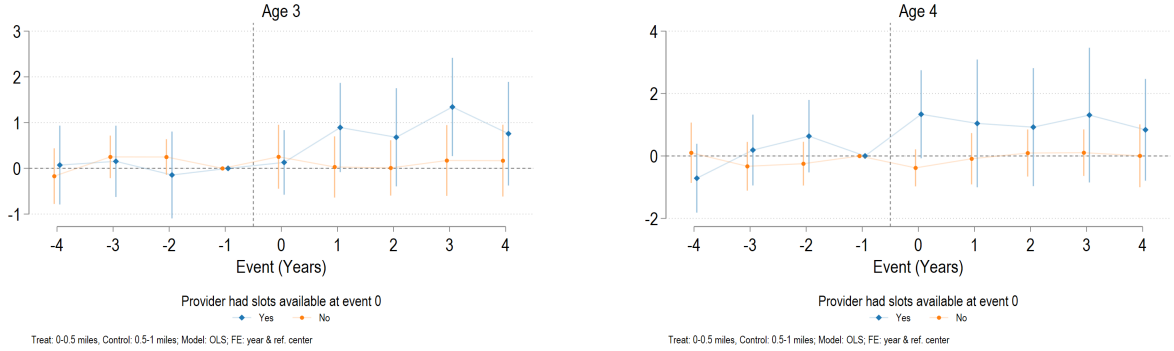
Notes: These figures are created by estimating Equation 2 separately for two subgroups. The figures plot the coefficients of the interactions between each event (year) and "Ever Ring 1" (treatment group) indicator. The model also includes reference center and year fixed-effects, as well as an "Ever Ring 1" indicator. Standard errors are clustered at the county level.

Figure A6: Dynamic effects of offering NCPK slots on the enrollment in nearby providers by whether RC is new



Notes: These figures are created by estimating Equation 2 separately for two subgroups. The figures plot the coefficients of the interactions between each event (year) and "Ever Ring 1" (treatment group) indicator. The model also includes reference center and year fixed-effects, as well as an "Ever Ring 1" indicator. Standard errors are clustered at the county level.

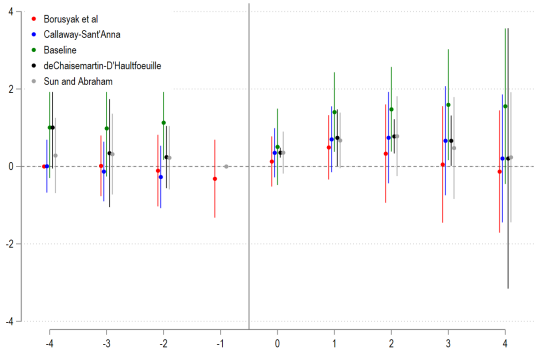
Figure A7: Dynamic effects of offering NCPK slots on the enrollment in nearby providers by whether provider had slots available at event 0



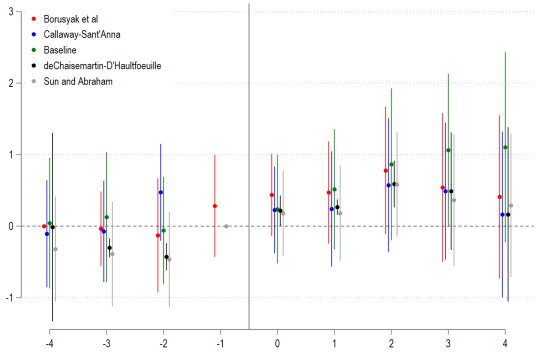
Notes: "Having slots available" is defined as having a difference between licensed capacity and actual enrollment of at least 5.

Figure A8: Heterogeneity-robust estimates

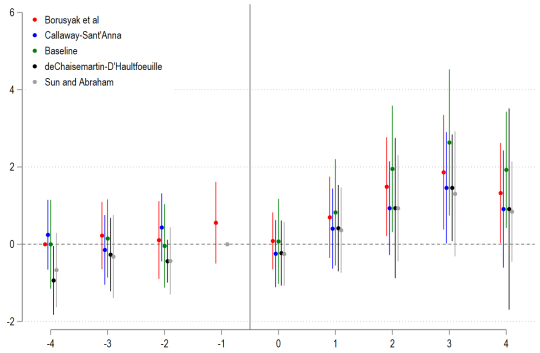
Ages 0-2



Age 3

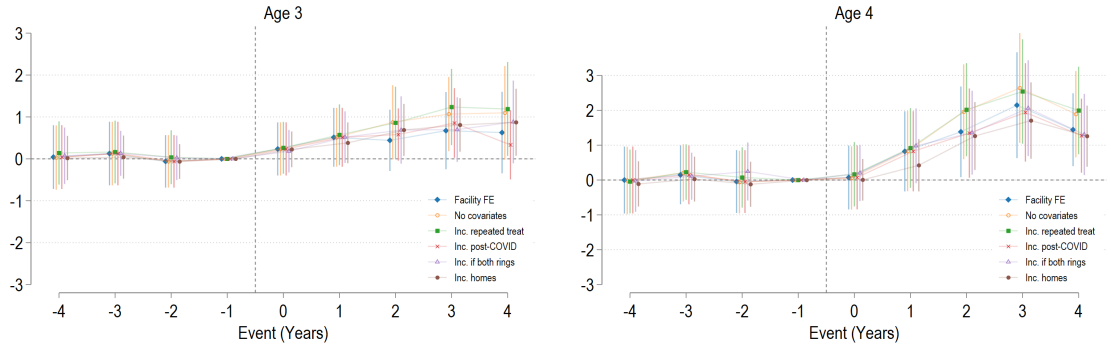


Age 4



Notes:

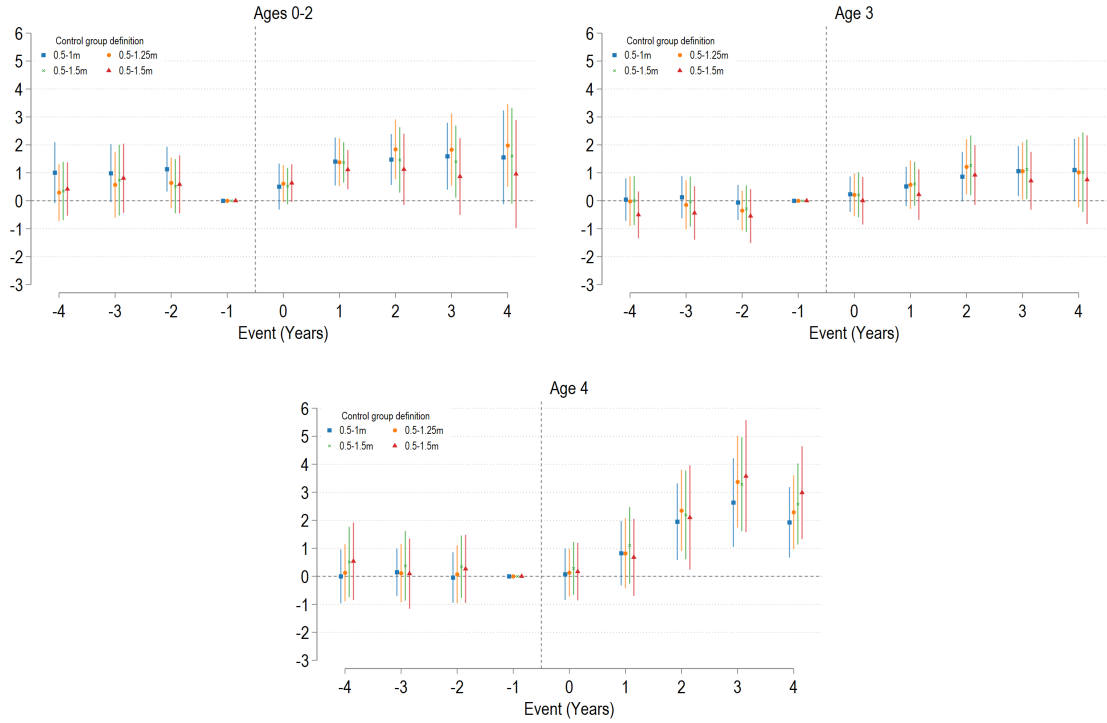
Figure A9: Robustness of the age-3 and age-4 enrollment results



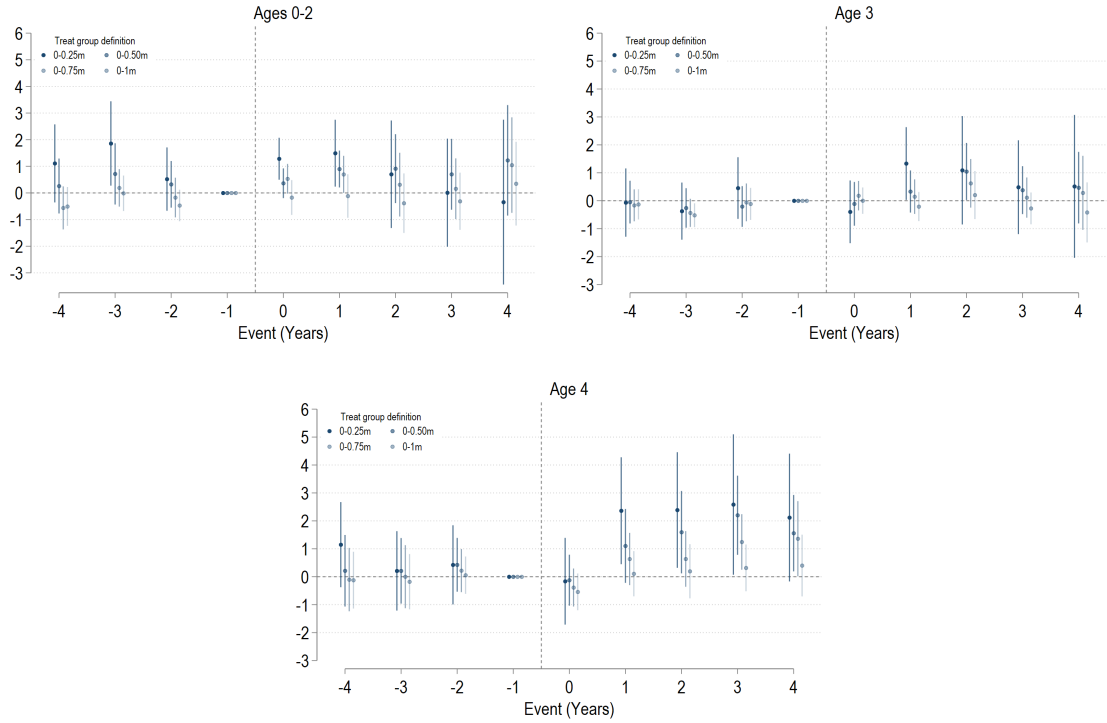
Notes: The figures plot the coefficients of the interactions between each event (year) and "Ever Ring 1" (treatment group) indicator (Equation 2). The model also includes Reference Center and year fixed-effects, as well as non-interacted event (year) and "Ever Ring 1" indicators, and covariates. Standard errors are clustered at the county level. Each line is derived from a different regression with the following variations: (1) using facility fixed effects instead of reference center fixed effects, (2) removing covariates, (3) including centers that were "treated" in more than one year, (4) including post-COVID years, (5) Including providers that were in both rings at different times, (6) Including family childcare homes.

Figure A10: Effects on enrollment when varying ring size

Panel A. Treatment group fixed at a 0 to half-a-mile distance, varying control group size



Panel B. Control group fixed at a 1 to 1.5-mile distance, varying treatment group size



Notes:

B. Additional Tables

Table B1: Treatment and control counts by reference year

	Before exclusions		After exclusions	
	Treatment	Control	Treatment	Control
	(1)	(2)	(3)	(4)
2012	76	134	55	134
2013	52	107	38	107
2014	60	108	45	108
2015	19	23	13	23
2016	32	43	24	43
2017	18	11	14	11
2018	46	64	40	64
All	303	490	229	490

Notes: Treatment is defined as being within 0.5 miles of a reference center, while control is defined as being between 0.5 and 1 mile away from a reference center.

Table B2: Dynamic effects of offering NCPK slots on the enrollment in nearby providers by age and the probability of being open

	# Children enrolled			Facility characteristics			
	Ages 0-2	Age 3	Age 4	Facility is open	Facility enrolls 0-3 kids	Prop. of 4yo among enrolled kids	A_prop4yo
Event -4=1 × treat=1	1.007	0.042	-0.001	0.726*	0.036	0.024	-0.002
	(0.654)	(0.456)	(0.576)	(0.394)	(0.027)	(0.032)	(0.021)
Event -3=1 × treat=1	0.984	0.126	0.149	0.305	0.034*	0.033	-0.018
	(0.623)	(0.455)	(0.506)	(0.337)	(0.020)	(0.032)	(0.016)
Event -2=1 × treat=1	1.132**	-0.060	-0.043	0.054	0.023	0.014	-0.008
	(0.481)	(0.375)	(0.541)	(0.301)	(0.023)	(0.024)	(0.015)
Reference year	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(.)	(.)	(.)	(.)	(.)	(.)	(.)
Event 0=1 × treat=1	0.507	0.236	0.074	0.452	0.015	-0.014	0.005
	(0.494)	(0.380)	(0.550)	(0.498)	(0.016)	(0.027)	(0.021)
Event 1=1 × treat=1	1.405***	0.515	0.825	0.817**	0.057**	0.008	0.025
	(0.514)	(0.421)	(0.690)	(0.381)	(0.024)	(0.041)	(0.019)
Event 2=1 × treat=1	1.477***	0.864	1.951**	1.263***	0.031	-0.022	0.052**
	(0.547)	(0.532)	(0.820)	(0.399)	(0.029)	(0.040)	(0.024)
Event 3=1 × treat=1	1.594**	1.063*	2.634***	1.793***	0.086***	0.029	0.051**
	(0.717)	(0.535)	(0.948)	(0.530)	(0.027)	(0.044)	(0.022)
Event 4=1 × treat=1	1.555	1.103	1.927**	0.810	0.047	0.022	0.060***
	(1.006)	(0.666)	(0.753)	(0.546)	(0.040)	(0.040)	(0.022)
treat	-0.801	-0.554	-0.920	-0.935	0.027	-0.020	0.027
	(2.115)	(0.969)	(1.204)	(0.659)	(0.064)	(0.075)	(0.039)
Observations	6033	6033	6033	6033	6033	6033	4830

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: This table presents the results from estimating Equation 2. The model also includes Reference Center and year fixed-effects, as well as a treatment indicator. Standard errors are clustered at the county level.

Table B3: Heterogeneous effects of joining NCPK on nearby providers

	Age 3				Age 4			
	Base	NCPK Type	Income	RC new	Base	NCPK Type	Income	RC new
Within 0.5m=1	-0.357	-0.113	0.331	0.005	-0.087	-0.161	0.527	0.584
	(0.585)	(0.792)	(0.705)	(0.803)	(0.747)	(1.005)	(1.142)	(1.055)
Post=1	-0.344	-0.467*	-0.529*	-0.481*	-0.567	-0.667	-1.289***	-0.346
	(0.212)	(0.246)	(0.299)	(0.255)	(0.349)	(0.478)	(0.461)	(0.493)
Within 0.5m=1 × Post=1	0.805*	1.123**	1.155**	1.330**	1.727***	1.909**	2.970***	1.462
	(0.438)	(0.500)	(0.554)	(0.526)	(0.620)	(0.903)	(0.845)	(0.891)
Within 0.5m=1 × RC is public school=1		-0.733				0.222		
		(1.204)				(1.620)		
Post=1 × RC is public school=1		0.314				0.275		
		(0.307)				(0.539)		
Within 0.5m=1 × Post=1 × RC is public school=1		-0.812				-0.510		
		(0.904)				(1.134)		
Within 0.5m=1 × High income area=1			-1.699				-1.594	
			(1.400)				(1.945)	
Post=1 × High income area=1			0.419				1.617***	
			(0.385)				(0.485)	
Within 0.5m=1 × Post=1 × High income area=1			-0.803				-2.810***	
			(0.648)				(0.894)	
Within 0.5m=1 × RC is new=1				-0.898				-1.759
				(1.216)				(1.828)
Post=1 × RC is new=1				0.346				-0.591
				(0.341)				(0.644)
Within 0.5m=1 × Post=1 × RC is new=1				-1.409				0.750
				(0.901)				(1.332)
Observations	6015	6015	6015	6015	6015	6015	6015	6015

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: