Universal Preschool and Supply-Side Responses: Evidence from Vermont

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Abstract

The United States aims for providing universal access to high-quality pre-kindergarten (Pre-K) to promote holistic child development and long-run education and earning outcomes. However, limited funding has constrained the scope of state-level universal Pre-K (UPK) programs, and therefore little is known about providers' responses to UPK policies. This paper fills in the knowledge gap by examining the supply-side market impacts of Vermont's UPK program, which provides a uniform per-child subsidy for all 3- and 4-year-olds. I find heterogeneous responses to the policy. I then estimate a static demand and supply model, and use the model to simulate consequences of alternative policies. I find that the current part-time UPK successfully increased high-quality childcare supply across the state, encourages enrollment from middle-income and low-income families, but generates less quality upgrade incentives for providers in lower-income counties compared to higher-income counties. I also compare the current UPK policy with means-tested demand subsidies to an expanded pure UPK subsidy, and find that the pure UPK results in fewer childcare supply and fewer quality upgrades, especially among low-income counties, indicating that a combined UPK and demand subsidy for lower-income families is more cost-effective in generating high-quality enrollment and provider upgrade. These findings highlight the importance of subsidy design for aligning family access with policy goals of expanding high-quality early education and reducing inequality.

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1 Introduction

Research on early childhood education under age five has emphasized the importance of high-quality non-parental care in shaping children's short-run health and cognitive outcomes, long-run education attainment and employment success, and female labor force participation (Ludwig and Miller, 2007; Duncan and Sojourner, 2013; Gruber et al., 2023; Baker et al., 2005). Thus, childcare market in the US has long faced significant challenges, most notably financial constraint and limited availability of high-quality care.

Childcare in the US is notoriously expensive, despite childcare workers earn extremely low wages. Parents are highly price-sensitive because they are typically early in their careers and face financial constraints. As a result, even modest tuition increases can push families to quit jobs or switch to cheaper, lower-quality care, harming both children's development and labor market participation in the long run. Providers, in turn, cannot raise wages without passing costs onto families, perpetuating a cycle of low pay, limited supply, and potentially low-quality of care.

Policy makers have responded to the childcare crisis with increased federal- and state-level financial assistance, which increases affordable access to childcare. Programs such as Head-start, demand subsidies targeting low-income families, public schools, and special education programs help reduce childcare costs for disadvantaged families. In recent years, several states have introduced universal preschool (UPK) programs that are not means-tested, and many others are planning similar rollouts. However, because UPK is relatively new in the United States, with only six states implemented so far, research on its impact remains limited, particularly regarding how UPK affects the structure and dynamics of the childcare market.

This paper aims to provide evidence on how the voucher-like Vermont UPK policy affects the structure and dynamics of the local preschool market, with a focus on provider entry, exit, upgrades (in star ratings), and pricing of private preschools. Vermont has several unique features that make it a good case study for UPK policies. The state combines means-tested Child Care Financial Assistant Program (CCFAP) with the UPK policy in order to expand access of care to all families. The UPK policy is not completely universal, as it only subsidizes for part-time care in certain prequalified UPK providers. Despite the intention of the UPK policy - that is, to increase access to high-quality care for all children - its true effect remains unclear. In theory, the policy should shift demand outward because it reduces out-of-pocket cost of UPK-prequalified care, and therefore should stimulate quality upgrades on the supply side. Nevertheless, the policy can also trigger unexpected consequences due to its mixed delivery system of private and public provision, and the fixed subsidy across all families with top-up fees. The policy also has ambiguous impact on lower-income families due to a means-tested subsidy already in place.

Motivating evidence suggests that following the UPK implementation, the number of high-quality preschools have steadily increased, despite the overall declining market, demonstrating the policy's success in improving the market quality composition. However, middle-income counties have fewer available slot per child, suggesting a potential "doughnut-hole" effect of the existing means-tested subsidy (Humphries et al., 2024). Difference-in-difference analysis comparing counties with different income levels suggests increased aggregated childcare quality in middle-income counties compared to high-income counties, but overall smaller increase in the probability of program upgrades in low- and middle-income counties, indicating potentially limited supply-side response to the UPK policy incentives.

The reduced-form evidence indicates a positive impact of the UPK and a heterogeneous effect on program upgrades across different regions, which motivates me to build a structural demand and supply model of Vermont's preschool market. I first estimate a static model of competition using annual data on all licensed and registered Vermont childcare providers between 2017 and 2019, which reveals family choices and providers' costs of operating UPK, and allows me to compute variable profits of providers operating at different quality levels in different states. Then, I recover upper and lower bounds for fixed costs of entry and quality upgrades using observed provider actions. Providers make entry, upgrades and exit decisions by comparing the expected profits from an action to its corresponding costs.

The demand and supply model allows heterogeneous preferences for child care for families with different income. It incorporates both the UPK, which reduces prices for UPK-prequalified programs, and the Child Care Financial Assistance Program (CCFAP) that reduces prices for low-income families regardless of program quality. On the supply side, the model allows higher marginal costs for UPK programs, and nonlinear costs as enrollment approaches capacity to address potential capacity constraints. The model reveals significantly higher utility of families from UPK-prequalified programs, but lower utility for paying more out-of-pocket costs and travelling long distances from home to school. In particular, lower-income families are more price-sensitive. This helps explain an interesting observation from the motivating analysis, that is, there are more provider quality upgrades in high-income counties than low-income counties after policy implementation. Because the policy serves as a fixed-rate subsidy for full-time UPK enrollment, this drives down the out-of-pocket cost for UPK enrollment, shifts demand outward, and therefore providers have more incentive to pass through additional cost to consumers by raising price to less price-sensitive families, capture some of the subsidy's values. This implies providers serving higher-income families are more able to raise UPK price in response to the subsidy, and therefore more likely to upgrade to become UPK prequalified.

Policy implications. Using the estimated consumer preferences, marginal costs and fixed cost bounds, I construct meaningful counterfactuals to answer the research questions. The design of these counterfactuals is inspired by current policy schemes in other states, and discussions of rolling-out UPK policies for these states. Because the state space is extremely large, I follow Fan and Yang (2020) and apply a heuristic algorithm to iterate through every provider in the market and find a provider's best-response action given the states of its competitors nearby.

My first counterfactual is a market without the UPK policy. Comparing this alternative market structure to the current market structure demonstrates that the UPK policy successfully increases high-quality provider supply for all markets across Vermont, suggesting a universal program that subsidizes all families reduces the financial burden and increases demand for high-quality UPK across Vermont, therefore encouraging more providers to upgrade to become UPK-prequalified. The policy introduces more quality upgrades in higher-income counties, suggesting that a flat subsidy that allows top-up fees for attending full time does not help close the inequality gap across socioeconomic groups. Breaking down by family income, middle-income families (between 150% and 400% FPL) doubled enrollment in response to part-time UPK, low-income families (below 150% FPL) also increased demand, while high-income families have little response on the extensive margin of enrollment, suggesting that the UPK successfully attract demand from mid-to-low-income families, but affects high-income families' enrollment by shifting their choices from low-quality to high-quality care.

My second counterfactual doubles the UPK subsidy payment by removing the CCFAP income-based subsidy. The alternative policy results in fewer UPK providers in Vermont in total. It introduces slightly more UPK providers in higher-income counties, but fewer UPK providers in lower-income counties. It also reduces enrollment among low-income families, while slighly increases enrollment among mid-income and high-income families. This suggests that the UPK policy along is not as effective in promoting equity as a means-tested program. However, it is a useful intermediate design when a state with an established means-tested program wants to gradually roll out UPK. The results are crucial in resolving the current policy debates. With many states planning to roll out UPK policies, my research provides guidance on how they should implement the UPK policy if the states are not able to guarantee universal care for all eligible children.

Related Literature. This paper builds on a growing literature on the impact of Early Childhood Education programs in the US. A large body of evidence documents the high returns to investment in high-quality care, with short-run improvements in children's cognitive development and health outcomes, and long-run gains in educational attainment and labor market outcomes (Herbst, 2013, 2018a; Gathmann and Sass, 2018). Evaluation of universal preschool programs in Oklahoma, Georgia, and Boston similarly demonstrate the benefits of extending child care access (Cascio, 2017; Cascio and Schanzenbach, 2013; Gray-Lobe et al., 2021; Durkin et al., 2022).

The latest evidence on UPK policies is more nuanced, due to the variety of policy designs. Humphries et al. (2024) studies UPK program in New Haven that has a centralized assignment mechanism combined with random lottery, and find the UPK has limited effects on children's long-term academic achievement, with the exception of modest gains among middle-income families. However, the program significantly increased parental earnings, with effects persisting for six years. The largest earnings gains accrued to middle-income households, suggesting that universal preschool filled the "doughnut hole" in the existing policy landscape: middle-income families earn too much to qualify for subsidies, but too little to afford high-quality private care. Despite these benefits, the implementation of universal child care policies at scale also poses risks. Studies of Quebec's publicly-provided universal child care program in the late 1990s (Baker et al., 2005, 2015) show that the policy induced a large shift into formal care but also led to adverse outcomes. Children exposed to the program exhibited worse behavioral and emotional skills, which extend to worse health, lower life satisfaction, and higher crime rates in adolescence, as well as worse parental mental health and family relationship. The authors hypothesize that these negative effects arose from increased parental stress, and lowered childcare quality due to rapid expansion.

My research fills a key gap in the ECE literature by examining the impact of ECE programs supply side, and in particular, the impact of UPK program designs. Ignoring provider responses to government intervention risks misspecifying customer welfare impact. Recent work highlights that government interventions can have unintended effects on market structure. Hotz and Xiao (2011) show that more stringent quality regulation decreases ECE supply in disadvantaged neighborhoods. Brown (2018) studies NYC UPK and find that UPK policy expansion leads to private childcare center's revenue loss, resulting in lower average quality, reduced capacity or exit of existing programs. Bassok et al. (2014) applies synthetic controls to compare Oklahoma and Georgia to other US states and finds significant increase in public school provision in both states, but accompanied by crowd-out of private care in Georgia and insignificant decrease in private care in Oklahoma. My research provides the first evidence on the impact of a state-level UPK policy on the providers, and apply structural models to understand how the UPK policy affects consumer surplus through changes in equilibrium.

This paper also contributes to an emerging IO literature on the supply side of ECE. I apply a structural model, incorporating spatial demand estimation, and addressing the capacity constraint using nonlinear marginal costs. Many recent IO papers study the impact of public school provision or school vouchers on the provision of private schools. Neilson (2021) uses micro data from Chile to study the impact of school voucher on market competition and finds that the voucher leads to inequality in school quality, because of higher market power in poorer areas. Allende (2019) incorporates social interactions in demand estimation and concludes that schools have higher market power in high-SES markets because high-SES families value social interactions (peers) more compared to low-SES families, and are less sensitive to price. Singleton (2019) also studies funding mechanism, and argues that a flat charter school funding causes schools to favor lower-cost students. The paper that is most similar to my research is Bodere (2023), which investigates a tiered reimbursement system in Pennsylvania using aggregate data at the centers' level, and find that a targeted demand subsidy with financial incentive for low-income children encourages providers to invest in quality. My paper studies a different universal PreK policy in a different state. Vermont's UPK policy allows me to directly measure the impact of a demand subsidy that encourages quality upgrade, and compare the cost-effectiveness of means-tested subsidies vs. UPK subsidies. My data also include family daycare homes in addition to child care centers, so that I can better monitor provider dynamics in the market. By shedding light on how a part-time UPK affects provider dynamics in a competitive market, I provide important policy insights for governments seeking to expand access with established child care subsidies.

2 Institutional Context

2.1 Early Childhood Education (ECE) in the US

Demand for non-parental childcare grows following an increase in female labor force participation in the last century. In particular, call for high-quality care surges, as people realize the long-term benefits of ECE. In this paper, I study the preschool market, which is the market of formal care for children of three or four years old. Despite the importance of access to affordable high-quality care, the federal government historically spent little on preschool-aged children: in 2019, the US spent about \$2,800 per child for 3-4-year-olds, compare to \$12,800, more than 4 times the mount for childrens aged 5-18 (Davis and Sojourner, 2021). This implies childcare in the US is largely private provision, which causes severe market failure.

Childcare in the US is extremely expensive, inaccessible for many families in need, and often of low quality. The median annual price for center-based preschool care is \$13k in a large county in 2024, which consumes 10% of married families' median income, or 35% of median income for a single parent with child (Poyatzis and Livingston, 2024). This far exceeds the federal benchmark of 7% for affordable childcare, and roughly 60% of U.S. families cannot afford formal care. At the same time, providers operate on thin margins and can only afford to pay very low wages, creating a chronic shortage of supply, especially since they must maintain a strict children-to-teacher ratio. This is because ECE is the single education system that depends largely on family payments as the main source of revenue, which is different from other education (e.g. elementary, high school and college all have additional federal support). As a result, families bear the high cost of childcare, while providers struggle to live with the wages. In addition, given that families are price-sensitive because childcare consumes a significant percentage of their income, it is hard for providers to pass some of the cost burdens to consumers through raising price, as this may lead to parents switching to cheaper, low-quality care, or quit jobs. These decisions were make without fully taking into account the positive social externalities of high-quality ECE.

Governments can relieve the problem through interventions that improve affordability, accessibility, and quality of ECE. In recent years, there has been increasing federal and state efforts on improving ECE landscape. Two major federal funding for child care are the Child Care Development Fund (CCDF) and Temporary Assistance to Needy Families (TANF) program, both aims to provide financial assistance to low-income families with children. States also contribute through mandatory matching funds to CCDF and additional state funds.

Most states have thus implemented means-tested programs that target low-income families, who are more likely to face financial constraints, and therefore less likely to afford high-quality professional childcare. Very few states have implemented non-means-tested universal preschool (UPK) program (Oklahoma, Florida, Georgia, Iowa, Vermont, and DC), arguing that UPK is more effective at reaching disadvantaged children by avoiding complicated application and recertification process. Furthermore, UPK programs address the "doughnut hole" problem, where strict income caps of means-tested programs exclude mid-income families who also struggle with high costs.

2.2 ECE in Vermont, and Universal Preschool

Vermont is one of the six states that implemented a universal preschool (UPK) in the United States. Vermont established its Universal Prekindergarten (UPK) program under Act 166 in 2014. The act was fully implemented in the 2016–2017 school year, and mandates that all public school districts provide access to publicly funded preschool education for every 3-4-year-old child, regardless of family income or child's abilities. The program was designed to promote equitable access to high-quality early education. It helps families pay for part-time preschool with a minimum of 10 hours per week for 35 weeks annually, which allows families to choose from a range of prequalified providers, including public school programs, Head Start, and private early education centers. The program pays the prequalified providers directly at a flat rate, which was $\$3,092$ per child in 2016/2017 school year, adjusted each year based on the New England Economic Project cumulative price index, and does not allow providers to charge families any out-of-pocket charge for enrolling in part-time UPK.

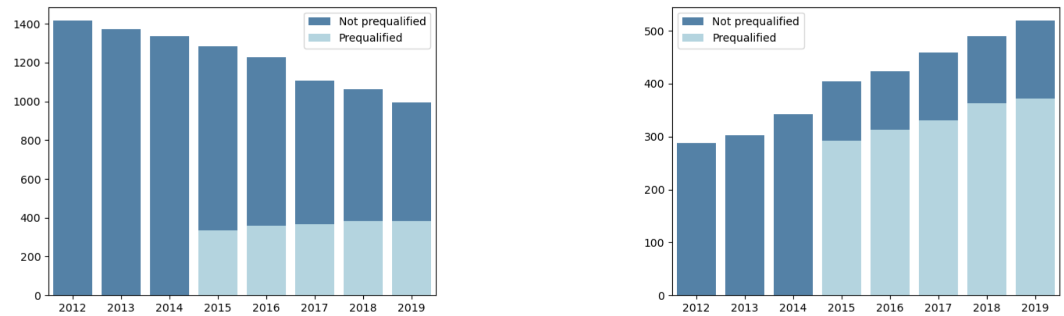
To become prequalified for UPK, providers must meet specific criteria, such as employing licensed educators and aligning curricula with the Vermont Early Learning Standards. Additionally, all UPK programs are required to participate in the state's quality rating system, the Step Ahead

Recognition System (STARS), achieving at least four out of five stars, or be a 3-star program with detailed plans of progressing into 4+ star in the next 2 years. This criteria further encourages providers to upgrade quality of care. On the other hand, it could push up the price of high-quality care, as providers need additional efforts to meet more stringent requirements to qualify for UPK. Some providers thus consider the UPK program as a provider-side subsidy that offsets the increased cost needed for operating UPK programs.

The original goal of the policy is to allow more children to enroll in affordable high-quality preschool, as the policy reduces out-of-pocket cost for high-quality care. It creates more demand for part-time UPK, because part-time UPK is completely free for all families. It also potentially create more demand for full-time high-quality care from families who originally face financial constraint to afford these cares on their own. Whereas for high-income families who are likely to have already enrolled in high-quality preschool, the policy acts as a pure transfer but does not necessarily induce more demand on the extensive margin. In theory, the increase in demand not only encourages providers to become UPK prequalified, but also allows providers to have more power to raise full-time tuition rates, as the subsidy covers partially the cost of families.

Ever since its implementation, the number of privately operated UPK programs in Vermont has steadily increased, despite the market decline, suggesting that the policy is successful in driving providers to offer high-quality UPK-prequalified preschool care (Figure 1). The policy also encourages new entrants to become UPK prequalified. As shown in Figure 2, new private-market entrants after UPK implementation in 2016-2017 (panel (a)) are more likely to become high-rating (4-5 star) in 2 years, compared to new entrants before UPK implementation in 2013-2014 (panel (b)). Nevertheless, the Vermont UPK policy faces significant challenges, primarily due to its funding structure. The most prominent issue is the mismatch between the subsidy rate and the market rate. UPK subsidy is often lower than the average market rate for part-time care (Figure 3): in 2019, for example, the average part-time annual tuition was \$5,106, while the UPK payment was only \$3,356. Since prequalified UPK providers are prohibited from charging additional fees for the 10 hours of part-time UPK, this creates a disincentive for providers to offer part-time UPK, as the revenue is lower than what they could earn from a non-UPK program of similar quality.

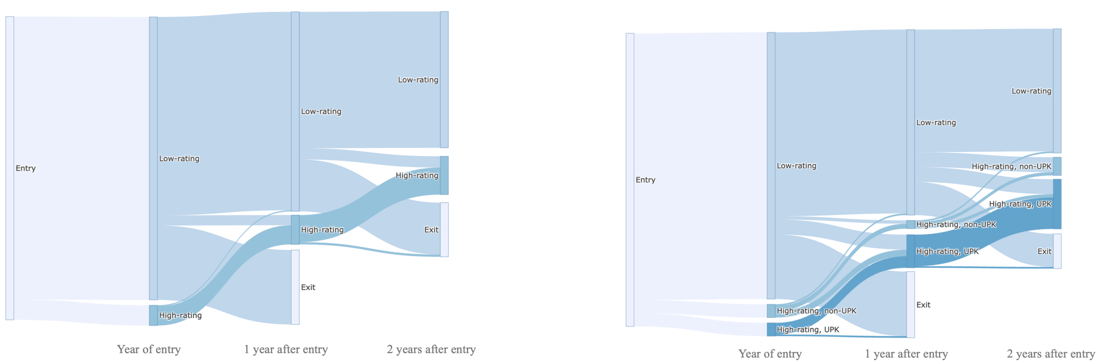
To make up for this loss, providers may charge higher rates for full-time UPK services. However, this strategy is only viable if the demand for full-time care is price-inelastic. If parents are highly



(a) # Programs

(b) # 4-5 Star Programs

Figure 1



(a) New Entrants in 2013-2014

(b) New Entrants in 2016-2017

Figure 2: Dynamics of New Entrants

sensitive to price changes, this could lead to a decrease in enrollment in full-time programs, undermining the provider's ability to cover costs and potentially pushing them toward a lower-quality service model to remain profitable.

Furthermore, as is the case with most other states that provide "universal" preK, access to affordable high-quality care remains limited for many three- and four-year-old children in Vermont. This is because either it is costly for states to guarantee truly "universal" preschool, or supply is complicated with a mixed delivery system of public and private programs. As of May 2019, 50% of private UPK programs had reached capacity and could not accept more children, while 39% of public UPK programs had reached capacity. In particular, high-poverty regions faced even tighter constraints, with 60% of UPK programs at full capacity, compared to an average of 43% statewide (Waterman Irwin and Gallo, 2021). These statistics suggest that supply constraints disproportionately bind in economically disadvantaged areas, where demand for subsidized care

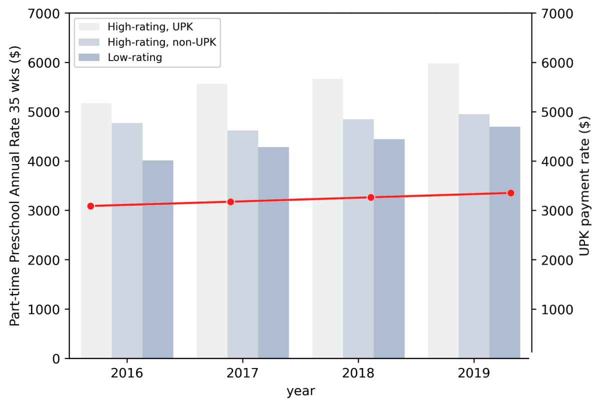


Figure 3: Part-time PreK Annual Rate vs. UPK Fund Rate

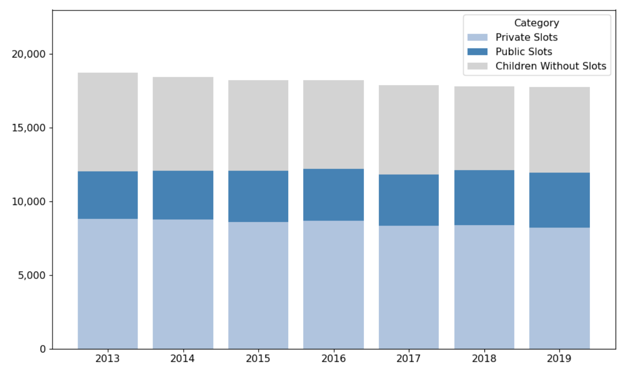
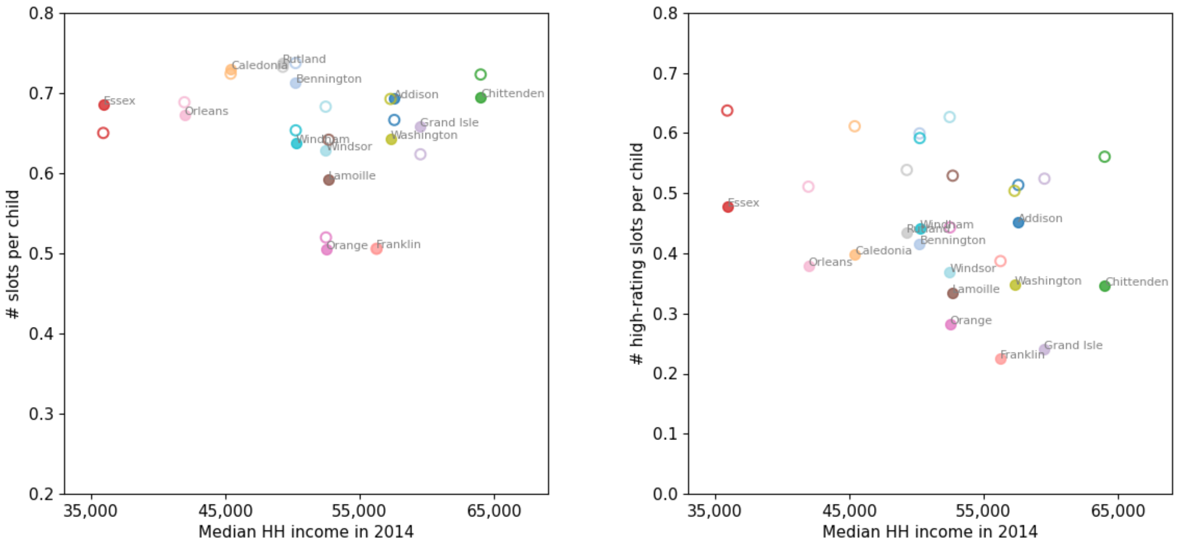


Figure 4: Number of Vermont 3-4-year-old and Available Preschool Slots

is likely highest. As a result, children in high-poverty neighborhoods face reduced availability of UPK programs. Moreover, since parents in these regions may be less able to afford high-quality private alternatives or commuting costs, the effective price of access to high-quality care is higher for low-income households. Overall, this implies that in practice, Vermont's UPK is not completely "universal", as it does not guarantee equal access to UPK care for all children.

Our data indicates that the aggregate supply of preschool slots in Vermont remains insufficient to accommodate full-time enrollment for all eligible children. As illustrated in Figure 5 panel (a), the total statewide capacity for preschool slots consistently falls short of the total population of 3-to-4-year-old children. Moreover, disaggregation of childcare availability by county reveals a significant disparity: both the highest- and lowest-income counties demonstrate comparatively high availability (approximately 0.7 slots per child in 2014), while several middle-income counties face lower availability (ranging from 0.5 to 0.6 slots per child in 2014). This finding is consistent with



(a) All Preschool

(b) High-Rating Preschool

Figure 5: Preschool Availability by County, 2014 vs. 2019

Note: the figure displays the average number of preschool slots per child in each county for 2014 (before UPK implementation) and 2019 (after UPK implementation). Each unique color consistently represents the same county across both years. The data for each point is plotted against that county's Median Household Income (in 2014). Filled dots show the average slot availability in 2014, while empty dots show the corresponding availability in 2019.

Humphries et al. (2024), which finds a ”doughnut hole” in high-quality pre-k access. Moreover, the ”doughnut hole” in accessibility persists post-UPK implementation: middle-income counties continue to suffer the most pronounced dscarcity in childcare slots. A similar distribution is for high-rating slots availability in panel (b): middle-income counties maintain the lowest availability of high-quality slots per child, ane the pattern remained years after UPK implemented (2019).

The underlying reason for the persistence of scarcity of slots after UPK implementation, in particular in mid-to-low-income areas, likely stems from the program's funding structure. Vermont provides a fixed per-child subsidy to all UPK providers, which is far from covering the full cost of operating a UPK part-time program. National Institute for Early Education Research (NIEER) estimates the cost of providing high-quality UPK for 6 hours/day and 180 days/year is \$13,626 per student, and that the cost varies based on program settings. This implies an average cost over \$4,400 per student for required part-time care, which is higher than the paid subsidy rate of \$3,982. This limited funding potentially weakens incentives for existing providers to upgrade their quality, and deters potential entrants from supplying UPK.

Overall, the Vermont UPK system acts like a state-subsidized high-quality child care system. While it does not guarantee universal access to high-quality care, Vermont's UPK policy serves as a compelling case study for examining the effects of a nondiscriminative subsidized ECE programs on provider responses, including market entry, exit, and quality of care. The flat rate subsidy naturally creates a variation in treatment intensity: $\$3,092$ covers a higher proportion of child-care expenses for lower-income counties with lower tuition rates. This implies that families in lower-income counties have more incentive to respond to the program by enrolling in a preschool, potentially increasing demand for high-quality care and encouraging more providers to become UPK-prequalified.

However, the capped payment for part-time UPK makes it less profitable for providers to upgrade quality solely to qualify for UPK, since they must meet higher standards but receive limited reimbursement. To offset these costs, UPK providers often raise full-time tuition rates, effectively passing some compliance costs to families. Given that childcare demand is highly price sensitive, this creates a tension: only providers serving less price-sensitive, higher-income families may find upgrading to UPK financially viable. As a result, while the policy can improve overall market quality, its benefits may be concentrated in higher-income areas.

3 Data

The main data is provided by Vermont Department for Children and Families, and covers all licensed and registered childcare providers serving child under 5yo in Vermont. The data is collected every December between 2010 and 2019 (I cut off at 2019 to prevent disruption of Covid), and contains detailed information on provider characteristics such as capacity and enrollment (2017-2019 available) breakdown by age group (infant, toddler, preschool), star rating (not-rated, 1-5 star), program type (center/home), physical addresses, whether the program is prequalified for UPK, and whether it is a public program. In addition, the data reports providers' weekly rate for all programs that participate in Child Care Financial Assistance Program (CCFAP), which covers partially the family's cost of care based on family income. The majority of childcare providers in Vermont participate in CCFAP, so only 30% of providers have missing market rates, which I impute using *MissingForest*. All programs report full-time and part-time provider rates for infant,

Table 1: Summary Statistics of Provider Data

	2012		2019	
	mean	sd	mean	sd
Panel A: Program Characteristics				
5 Star	0.11	0.31	0.24	0.43
Star Accredited	0.41	0.49	0.99	0.11
UPK Prequalified			0.38	0.49
Publicly Provided	0.11	0.32	0.16	0.37
Panel B: Capacity and Enrollment				
Preschool Capacity	8.29	11.66	12.01	14.13
Preschool Enrollment			12.44	15.16
Toddler	2.77	4.04	3.19	4.81
Infant	2.57	4.11	3.30	5.69
Panel C: Market Dynamics				
# New Entrants	132		63	
# Exits	187		118	
# Upgrades	192		200	
Panel D: Provider Rates (Listed Price)				
Full-time Weekly Preschool	151.12	43.78	203.33	68.18
Part-time Weekly Preschool	104.06	41.00	145.45	56.22
Full-time Weekly Toddler	154.52	45.46	207.84	69.56
Full-time Weekly Infant	161.42	47.38	212.23	65.91
Observations	1,416		995	

toddler, preschool separately. Table 1 shows summary statistics for year 2012 and 2019. It is worth noting that the average enrollment is higher than the average capacity. This is because the enrollment data reports the pure headcount of enrollment in a program at the time of inspection, which does not distinguish between full-time and part-time children. Thus, if a program operates full-time but have children enrolled part-time, then the enrollment can exceed the capacity. Despite this data limitation, in the static model, I assume all enrollments are full-time as a proxy of the actual full-time equivalent enrollment.

The second set of data is ACS 5-year estimates. This data allows me to construct demographic characteristics of different census block groups, including population, number of children under age 5, income, poverty rate, female education level, and percentage of children under federal poverty line. Since I do not have family-level enrollment data, in my spatial demand model, I use the ACS demographics data to simulate families residing in different geographic locations.

Finally, I use National Survey of Early Care and Education (NSECE) 2019 data to construct additional micro moments in my static model. This survey contains detailed information on households' choices of childcare arrangements, in terms of distance and pricing, given household income.

4 Motivating Evidence

Recall the design of Vermont's UPK policy may have heterogeneous effects on providers in different regions, and we are concerned that the policy may have unintended effects on equity. While the direct price effect is stronger in lower-income counties, providers serving less price-sensitive, higher-income families may find upgrading to be more attractive, as they can charge higher price and earn more profits. Thus, we want to know whether the UPK narrows or widens the gap of high-quality care provision between low- and high-income counties. In addition, we observe a "doughnut-hole" in childcare availability among middle-income counties, and we are concerned whether the UPK policy can fill in the "doughnut-hole" and improve the accessibility of care for middle-income families.

To highlight the heterogeneous responses to the UPK policy, I divide Vermont into three groups of counties based on their median household income terciles: high-income, mid-income, and low-income counties. I use the high-income counties as the control group, and compare with low- and middle-income counties the likelihood of provider entry, exit, and upgrade, and providers' market rates. To account for differential pretrends between the two types of counties, I employ DiD with Inverse Probability Weighting (IPW) (Abadie 2005; Callaway & Sant'Anna 2020). This allows the parallel trends assumption to hold conditional on covariates:

$$E[Y_t(0) - Y_{t-1}(0)|X, T = 1] = E[Y_t(0) - Y_{t-1}(0)|X, T = 0], \tag{1}$$

where $Y_{i,t}(0)$ is potential outcome at time t if unit i remain untreated, that is, if unit i is in high-income counties, and $Y_{i,t}(1)$ is potential outcome at time t if unit i becomes treated in 2015 (that is, unit i is in low- or middle-income counties). Control variables include local demographics, such as average HH income, % of women with high-school degree, and % of HHs under federal poverty line. In addition, I focus on private programs, and control for total # of public programs and public slots, since public programs have lots of dnamics that are independent of market dynamics. I also construct an aggregated data at town-year level to create a balanced panel. The outcome variables of interest is the total # of slots per 1,000 children in town.

I choose a binary treatment variable instead of a continuous measure of treatment intensity because family responses to the subsidy are likely nonlinear in household income, and assuming

Table 2: Heterogeneous Treatment Effects

	Average Star Rating	Any Upgrade	Exit High-rating	# High-quality Slots per 1,000 Children
	(1)	(2)	(3)	(4)
Low-income (T) vs high-income (C)	0.2317	-0.1251**	-0.0113	13.5559
	(0.1465)	(0.0526)	(0.0745)	(76.4573)
p-value for pretrend test	0.3492	0.4814	0.2443	0.8571
N	7,498	7,498	1,330	1,570
Mid-income (T) vs high-income (C)	0.6375***	-0.1633***	-0.1125*	39.7533
	(0.2646)	(0.0452)	(0.0616)	(69.6139)
p-value for pretrend test	0.6208	0.1529	0.5279	0.9247
N	7,989	7,989	1,714	1,540

Note: Treatment effects of treatment indicator estimated using Callaway-Sant'Anna Difference-in-difference. Top panel compares low-income (treatment) to high-income (control) counties. Bottom panel compares middle-income (treatment) to high-income (control) counties. Unit of observation for columns (1)-(3) is provider-year, whereas unit of observation for column (4) is town-year. Columns (1) and (2) uses the full sample. Outcome variable in column (1) is star rating of provider, and outcome variable in column (2) is a dummy variable indicating whether the provider upgraded on star rating since last year. Column (3) uses only high-rating programs, and outcome variable is a dummy variable indicating whether the provider exits the market the following year. Column (4) aggregates the provider-level data to town-level, and the outcome variable represents the number of 4-5 star slots per 1,000 children in town. Specifications control for demographics such as county population, number of 3-4-year-old children, percentage of women with high-school diploma, percentage of families under federal poverty line, and percentage of children under 5 years old living in poverty.

a linear relationship between family income and family responses can generate messy outcomes. While the program was designed to broaden access among disadvantaged children, the very lowest-income families may be less responsive to UPK because they already receive full or nearly full tuition support through the Child Care Financial Assistance Program (CCFAP). For these families, the marginal value of the UPK subsidy is small. On the other hand, high-income families may have already purchased high-quality care since they are more capable of affording expensive preschool care themselves. Thus, UPK operates largely as an transfer that reduces their out-of-pocket costs but generates little additional demand. It follows that UPK policy is most likely to have an impact on the extensive margin among mid-income families who do not benefit from means-tested financial assistance programs, and who face financial constraints. For these families, UPK policy may encourages higher enrollment in prequalified programs.

Tables 2 and 3 present difference-in-difference outcomes comparing high-income counties to low-income and mid-income counties. As shown in Table 2, compare to high-income counties, low-income counties have no statistically significant difference in the average change in childcare quality following the UPK implementation. However, low-income counties experience a smaller increase in the probability of program upgrading, indicating potentially limited response to the UPK policy incentives. Providers in middle-income counties also show a smaller increase in upgrade probability

Table 3: Heterogeneous Treatment Effects: Provider Weekly Rates

	Full-time PreK	FT PreK Ever-UPK	FT PreK Never-UPK	Part-time PreK
	(1)	(2)	(3)	(4)
Low-income (T) vs high-income (C)	-94.6734	47.0537	-96.1293	-58.9678
	(126.4093)	(54.6345)	(118.4459)	(83.4049)
p-value for pretrend test	0.1782	0.8334	0.1580	0.1993
N	3,299	817	3,319	4,584
Mid-income (T) vs high-income (C)	41.4341	54.5098	24.3805	29.1748
	(40.9820)	(52.6543)	(22.2717)	(25.0482)
p-value for pretrend test	0.8262	0.5135	0.8643	0.8529
N	4,882	1,070	3,299	4,854

Note: Treatment effects of treatment indicator estimated using Callaway-Sant'Anna Difference-in-difference. Top panel compares low-income (treatment) to high-income (control) counties. Bottom panel compares middle-income (treatment) to high-income (control) counties. Unit of observation for all columns is provider-year. Each column only includes non-missing market rates. Specifications control for demographics such as county population, number of 3-4-year-old children, percentage of women with high-school diploma, percentage of families under federal poverty line, and percentage of children under 5 years old living in poverty.

compared to those in high-income areas. In contrast, average star rating in middle-income counties rises more than in high-income counties after the introduction of UPK, which is largely driven by a greater reduction in the exit probability of high-rated providers. This suggests that the policy increases competitive pressure, potentially crowding out lower-quality providers. Overall, neither low- nor middle-income counties have a significantly different change in the number of high-quality childcare slots per 1,000 children. These findings suggest that the UPK policy may not have effectively addressed the "doughnut-hole" gap in childcare accessibility for middle-income regions. Table 3 presents the treatment effects on selected provider rates. Overall, low-income counties and mid-income counties do not have insignificantly different growth rate any provider rates.

The fact that programs in more intensely treated lower-and-middle-income counties are less likely to upgrade to a higher star rating. raises concerns on the aggregate quality of the provider market after the policy implementation. Indeed, 80% of all new entrants during year 2017-2019 entered as low-quality programs with star rating less than 2 star. Taken together, these findings imply that while UPK stimulated entry, the majority of entrants did not meet the standards required to become prequalified UPK providers. As a result, the policy may have expanded the number of providers without meaningfully increasing the supply of high-quality care, thereby undermining its stated goal of improving access to high-quality early education.

4.1 Discussion

On the demand side, the UPK policy should, in principle, alter parental enrollment decisions by reducing the out-of-pocket cost of formal preschool care. The lowest-income families are already exposed to means-tested CCFAP subsidies, and therefore we expect little response from low-income families to UPK. Middle-income families, who might otherwise rely on informal arrangements or parental care, face stronger incentives to enroll in preschool once the policy lifts their financial constraints. For higher-income families, who are more likely to already purchase high-quality care, the UPK policy primarily acts as a subsidy that reduces expenditures on care they would have demanded even in the absence of the policy. Thus, we would expect demand responses to be stronger in middle-income counties relative to high-income counties, and in equilibrium, we expect increase in high-quality preschool slots in the middle-income disadvantaged areas.

Our empirical evidence suggests that the average preschool quality in middle-income counties have improved at a faster speed, compared to high-income counties. However, the improvement is likely due to decreased likelihood of exits, instead of program upgrades, with is contrary to our assumed mechanism. Overall, we find that providers in lower-income counties have smaller response in quality upgrades, compared to higher-income counties, which exacerbates our concern of increased inequality to high-quality childcare access after UPK. One possible explanation is that UPK is less profitable in mid-to-low-income counties, because lower-income families are less willing to pay a higher out-of-pocket price for attending full-time UPK. Since the flat per-child subsidy is lower than the average market rate for part-time preschool, this weakens the incentive for providers to upgrade, as upgrading to UPK-prequalified levels entails fixed and recurring costs that the flat subsidy does not cover. As a result, providers are willing to upgrade to UPK only if they can raise the full-time UPK price such that the expected revenue, minus the additional cost of operation, exceed the expected revenue of operating as a non-UPK program. This reduces demand for UPK from lower-income families, as they are more price-sensitive than higher-income families. Thus, providers may find the demand for high-quality, high-price UPK to be stronger in higher-income regions. However, it is hard to verify the story using reduced-form methods, because we do not observe families' choices of preschool. The empirical results can only serve as a suggestive evidence, as the relatively small sample size prevents us from further dividing the sample to examine more heterogeneous responses. Therefore, in the following section, I develop a structural model, where I use provider-level aggregate data to reveal families' preferences for preschool and providers' operation costs. The model allows me to assess whether the UPK subsidy effectively promotes the expansion of high-quality care as intended.

5 Modeling the Preschool Market

The motivating evidence suggests that the UPK policy has heterogeneous effects in different regions. In particular, the heteronegeity can be characterized by different family incomes. This motivates a structural model that incorporates heterogeneous preferences for different family income. I specify an empirical model of families' choice in preschool (demand), and school entry, exit, upgrade and pricing (supply). I explicitly model the UPK subsidy and the CCFAP tiered-reimbursement to examine how demand and supply respond to child care policies. While UPK is a subsidy on the demand side, it creates heterogeneity in consumer prices across markets, and therefore could generate distortions in equilibrium through interacting with market power on the supply side.

I define a market $m \times t$, where m is defined to minimize cross-border school choices. I define a total of 4 markets in Vermont, based on a proposed consolidated school district to reduce administrative cost. I assume parents residing in market m can send the child to any preschool program in the region. Because families can choose schools in a neighboring market, I create a 5km buffer surrounding each market following Allende (2019) paper when account for family child care choices. This means that for each market, the set of schools will be the ones within the market boundary, but I assume demand can come from all families within the market plus the buffer zone. See Figure 6 for illustration of a market and its buffer zone. Geographically, I divide each market m into multiple regions l (e.g. defined by census block group) that is characterized by the number of 3-5 age children N_{lmt}, HH income distribution F^y_{lmt}, family education collected from ACS 5-year estimates, and assume characteristics of each family with a 3-5 yo child is randomly drawn from the distribution of region l's distribution.

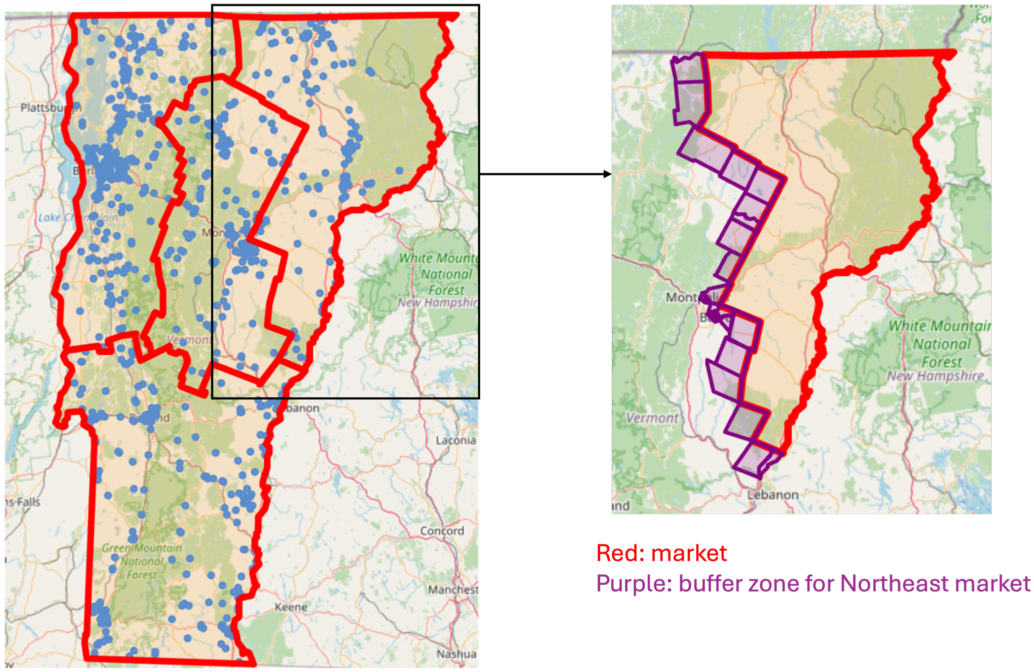


Figure 6: Defined Market and Buffer Zone

Note: Plot on the left shows the four markets defined in Vermont in red. Blue dots represent all preschool providers ever existed between 2017-2019. Plot on the right illustrates how the buffer zone (in purple) is defined for a specific market.

5.1 Static Model

The market rate that each provider receives for each enrolled child is p_{jt}, and parents sending their child to a pre-qualified UPK program pays $p'_{ijt} = p_{jt} - UPK_{jt} - CCFAP_{it}$. UPK_{jt} equals the subsidy rate if the provider is UPK-prequalified, and $CCFAP_{it}$ equals the means-tested subsidy rate the family qualifies for.

Each provider j offering child care for 3-5 yo child (pre-qualified for UPK or not) belongs to $\mathcal{J}_{mt}$ preschools in a market mt. Preschool-fixed characteristics ξ_j, time-fixed demand shock ξ_t, and transitory demand shock $\Delta\xi_{jt}$ are unobserved but known to parents. To simplify providers' actions in the counterfactuals, I define three levels of provider quality: ≤ 3 star, 4-5 star non-UPK, and 4-5 star UPK. I use r_{jt} to denote the quality level of provider j, and simplify quality rating to three levels of quality: low-rating (not rated or 1-3 star), high-rating non-UPK (4-5 star non-UPK), and high-rating UPK (4-5 star UPK). Thus, family i derives utility from choosing preschool j:

$$u_{iljt} = \underbrace{\beta^r \mathbb{1}\{r_{jt} = r\} + X_{jt}\beta' + \xi_t + \xi_j + \Delta\xi_{jt}}_{\delta_{jt}} + \underbrace{(\alpha_1 + \frac{\alpha_2}{y_{it}})p'_{ijt} + \lambda_d d_{lj}}_{\mu_{iljt}} + \epsilon_{ijt}. \tag{2}$$

I model consumer preferences on multiple observed provider characteristics, including provider age, whether it is a new entrant, and whether it is a center (vs. home). I allow price tradeoffs to depend on family income. p'_{ijt} takes into account UPK subsidy for pre-qualified programs. I assume all children enrolled in an UPK program receives UPK subsidy, since the transparency of this UPK program is relatively high. d_{lj} measures the distance between the centroid of region l and program j, so that utility takes into account distance from school. I assume all shocks are Extreme Value Type I distributed. The outside option is not attending licensed/registered child care (parental care, relatives care, non-professional care).

Then, the share of households in area l choosing program j is:

$$s_{ljt} = \int_0^\infty \frac{exp(\delta_{jt} + \mu_{lj}(y_{it}))}{1 + \sum_{k \in \mathcal{J}_{mt}} exp(\delta_{kt} + \mu_{lk}(y_{it}))}, \tag{3}$$

and the market share of program j is then computed by summing s_{ljt} over all regions l, and income n drawn from distribution F^y_{lmt}:

$$s_{jt} = \sum_{l \in \mathcal{L}_m} \sum_{n \in y(.)} w_{lnt} s_{lnjt}. \tag{4}$$

One caveat of this analysis is I do not take into account program wait lists, because I don't have the precise data on which provider have reached its capacity. Instead, I follow the literature's common practice to add an increasing term in the marginal cost, such that marginal cost increases as a provider reaches its capacity (Fowlie et al., 2012; Ryan, 2012). Based on 2017-2019 data, only 30% percentage of programs have enrollment $\geq$ capacity, suggesting capacity is not often a restricting factor of family choices, so my specification should not significantly affect the demand estimation. In addition, because the enrollment is pure headcount of enrolled children instead of full-time equivalent enrollment, this can bias our results if the part-time/full-time enrollment differs across provider types.

Another limitation of the analysis is that the data do not distinguish between full-time and part-time enrollments. If UPK programs tend to attract a higher share of part-time children than non-UPK programs, because the subsidy covers part-time UPK care, then the enrollment variable may overstate the full-time equivalent enrollment for UPK programs relative to non-UPK programs, potentially introducing bias. However, this concern is likely limited. Because the UPK subsidy reimburses providers at a lower rate for part-time enrollment, UPK providers face weak financial incentives to admit additional part-time children. Moreover, given the absence of admission mandates requiring programs to enroll all applicants, providers may prioritize admitting full-time children.

To assess this empirically, I conduct a simple data exercise using reported capacity and enrollment. Assuming that high-quality providers operate near full capacity, and given that the capacity constraint is strictly enforced, observing reported enrollment exceeds stated capacity is then evidence of part-time enrollment. For example, if a provider has a capacity of 100 but reports 120 enrolled children, this would imply that approximately 40 of the children are part-time. Applying this approach, I find that 4–5 star non-UPK programs have an average enrollment-to-capacity ratio of 1.25, while comparable UPK programs have a similar ratio of 1.20. This suggests that UPK programs do not systematically enroll a higher proportion of part-time children than similar non-UPK programs.

Marginal Cost: Preschool program chooses market rate p_{jt} to maximize profits in Bertrand competition. Although there are programs that are not for-profit (e.g. public programs), the majority of preschools in my data are for-profit. We thus have the usual setting of supply side, with variable profit:

$$\pi(p_{jt}, s_{jt}, sr_{jt}) = N_{mt} s_{jt}(p_{jt} - mc_{jt}), \tag{5}$$

The first order condition is:

$$s_{jt} + \frac{\delta s_{jt}}{\delta p_{jt}}(p_{jt} - mc_{jt}) = 0. \tag{6}$$

We can rewrite marginal cost as:

$$mc_{jt} = p_{jt} - \underbrace{[\Delta_t(p_{jt})^{-1} s_{jt}]}_{\eta_{jt}}, \tag{7}$$

where $\Delta_t(p_{jt})$ is the matrix of $\frac{\delta s_{jt}}{\delta p_{jt}}$. η_{jt} is the markup.

5.2 Supply

I model the supply side using a two-stage static game. The goal is to obtain an estimate for fixed costs associated with different actions, such that I can conclude whether the current UPK subsidy covers the cost of operating at a high quality level, and how an alternative policy can incentivize more high-quality child care provision. I assume different fixed costs for operating at different quality levels $\{\leq Star3, Star4-5\ non-UPK, Star4-5\ UPK\}$, and impose a common entry cost for all potential entrants because over 70% of all new entrants in years 2017-2019 entered as low-rating, therefore is reasonble to assume that entries as low quality have similar fixed cost.

The two-stage game is as follows:

1. Providers observe realizations of shocks to fixed costs of quality F_j. The shocks are unobserved to economists. They then simultaneously choose the quality of care or exit to maximize expected profits, and incur fixed costs.

$$\max_{quality} \{\{\mathbb{E}_{(\xi_t,\eta_t)}\pi_{jt}(quality, \Theta_t, \xi_t, \eta_t) - F_t^{quality}\}_{quality\in\{star1,\ldots,star5-UPK\}}, 0\} \tag{8}$$

   Potential entrants at each location l also decide whether to enter the market. I allow free entry at all locations in the market, and the number of potential entrants at each location depends on total observed previous number of entrants and scarcity of childcare in that location. Each location l has at least one potential entrant every year. The potential entrant's decision is:

$$\mathbb{E}_{(\xi_t,\eta_t)}\pi_{jt}(\Theta_t, \xi_t, \eta_t) - F_{jt}^{enter} \geq 0 \tag{9}$$

2. Providers observe realizations of demand and MC shocks unobserved to economists. They then simultaneously set prices.

At stage 1, providers know the distribution of shocks to demand and MC, but observe their realizations only at stage 2. In equilibrium, $F_t^{quality}$ solves eqn (8) for each provider j. F_t^{enter} solves eqn (9) for each potential entrant j. The idea is that deviation (entry, exit, upgrade) of one provider from equilibrium should not lead to higher expected profit for that provider, with the expectation taken over demand and MC shocks. If a provider upgrades to a new quality level, this implies an upper bound for the fixed cost of operating at the new quality level the provider upgrade to. If provider choose to exit the market from a quality level, this imposes a lower bound on the FC of operating at the quality level. For new entrants, I obtain an upper bound of the fixed cost of entry. From potential new entrants that do not enter the market, I obtain a lower bound of the FC of entry.

5.3 Estimation

I use 2017-2019 data to estimate the static model. This allows me to use the enrollment data (only available after 2017) instead of capacity data to calculate the market share, and excludes effects of the pandemic. The static parameters to be estimated in the demand model are:

- mean utility parameter: β^r,β^{UPK}, β'
- family type specific parameters (nonlinear): α_1, α_2, λ_d
- fixed unobservables ξ_t, ξ_j, $\Delta\xi_{jt}$

For the supply model, I assume marginal cost depends linearly on observed preschool characteristics X_{jt} (star rating, demographics), unobserved cost shocks (w_t, w_j, Δw_{jt}), and increasing as enrollment approaches the capacity:

$$\begin{aligned} mc_{jt} = X_{jt}\eta' + \gamma_c center_j(Enrollment - \theta_{jt})\mathbb{1}[(Enrollment - \theta_{jt}) > 0] \\ + \gamma_h(1 - center_j)(Enrollment - \theta_{jt})\mathbb{1}[(Enrollment - \theta_{jt}) > 0] + \omega_t + \omega_j + \Delta\omega_{jt}, \end{aligned} \tag{10}$$

where θ_{jt} is the threshold at which the MC binds, assuming programs have to increase marginal cost beyond the threshold.

The parameters in the static model will be estimated jointly using generalized method of moments (GMM) following the standard approach (Berry et al., 1995; Conlon and Gortmaker, 2020). To address the endogeneity of prices and market shares, I use two sets of instruments: cost-shifters using public school teachers' wages, and demand-shifters measuring local competition (Gandhi and Houde, 2019). I use the average public school teachers' wages in each school district as the cost-shifter to address endogeneity of prices, because public school wages affect providers' pricing

Table 4: Demand Estimates

Coefficients	Parameters	Estimates	Std.Errors
	Linear Demand Estimates		
Star 4 & 5, non-UPK	$\beta^{star4\&5,non-UPK}$	0.272	(0.082)
Star 4 & 5, UPK	$\beta^{star4\&5,UPK}$	0.408	(0.179)
Age		-0.050	(0.010)
Adjusted price	α_1	0.299	(0.077)
Adjusted Price / log income	α_2	-3.362	(0.847)
Distance	λ_d	-0.608	(0.089)

Estimates of the demand side coefficients include year and preschool fixed effects. Prices are in dollars per week, adjusted for CCFAP subsidies, and distance in km.

decisions through the supply side, but adjust less frequently to demand shocks, and are unlikely correlated to unobserved product characteristics such as implied program quality, therefore providing valid exclusion restrictions. In addition, I use differentiation instruments following Gandhi and Houde (2019). The differentiation instruments are constructed using competitors characteristics such as star rating and capacity (x_{jt}), and measures the degree of differentiation of each product in a market:

$$z_{jt}^{(x)} = \sum \frac{(x_{jt} - x_{kt})^2}{d_{jk}}$$

In addition to the IV moments, I use NSECE (2019) survey data to construct additional micro moments that identify families' heterogeneous preferences for prices and distances. The NSECE surveys parents of yound children, and records family characteristics such as income level, and childcare choices, including out-of-pocket prices and distances to providers. This survey allows me to compute the expectation of out-of-pocket price and distance, conditional on family income level and on using preschool.

To compute the fixed costs, I first obtain the expected variable profit by drawing $n = 30$ demand and MC shocks from the estimated distributions and recompute the equilibrium. Then, the average variable profits obtained from the simulation will allow me to estimate the fixed cost bounds that supports the observed provider deviation.

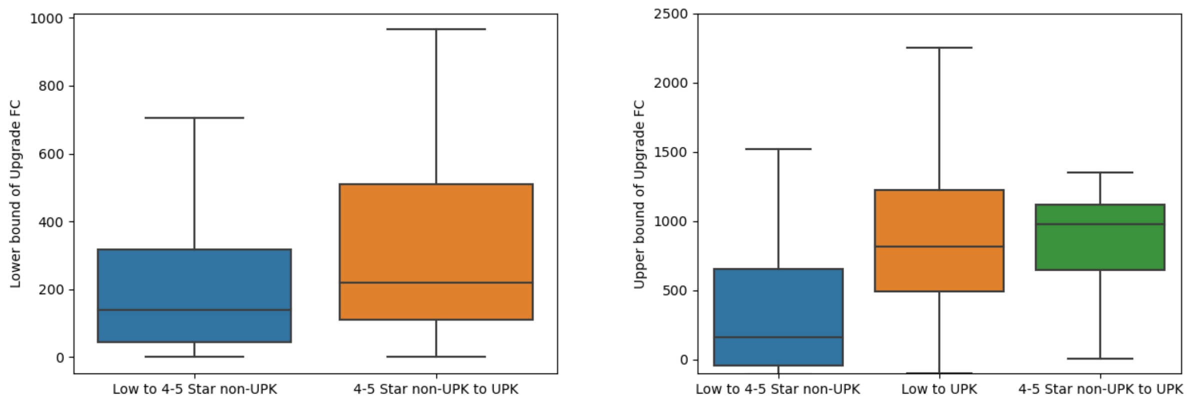
5.4 Results

Demand and marginal cost estimates are in Table 6 and Table 7. On the demand side, families significantly value star 4-5 UPK programs, suggesting that the UPK prequalification is a strong

Table 5: Marginal Cost Estimates

Star 4 & 5, non-UPK	14.434	(3.281)
Star 4 & 5, UPK	42.618	(3.329)
Center	40.540	(4.278)
Fraction PreK among All Capacity	-24.358	(6.832)
Age	-0.830	(0.175)
% over threshold (Home)	-0.468	(0.675)
% over threshold (Center)	11.230	(2.802)

Estimates of coefficients of programs' marginal costs include program and year fixed effects.



(a) Lower-bound

(b) Upper-bound

Figure 7: Upgrading Fixed Cost Distribution

signal for high-quality preschool care. Families do not significantly value star3-5 star non-UPK programs higher than low-rating (star 1-2) programs, which may be due to our data limitation that prevents us from accurately capturing the true market share of all programs. Families also have significantly lower utility for programs with long distance and higher prices. In terms of preference heterogeneity, families with lower income have a taste for less costly programs. On the supply side, I find considerable variation in marginal cost for different qualities of care, with star 4-5 UPK programs costing $40.5 more per child than low-rating programs.

Fixed cost estimation suggests that on average, the upper bound for fixed cost for operating at 4-5 Star UPK is $1,138 higher per week than operating as a 4-5 Star non-UPK. This implies extremely high cost of maintaining UPK prequalification. Figure 7 represents the fixed cost of upgrading from a lower quality to a higher quality. The median value of the fixed cost distributions suggests that while upgrading from low-rating to high-rating non-UPK incurs a fixed cost of less than \$200 per week, the fixed cost of further upgrading from high-rating non-UPK to UPK is much higher, ranging from \$226 (lower-bound) to \$1,083 per week. Note that the median upper-bound for upgrading from low-quality to UPK is lower than upgrading from non-UPK to UPK. This is likely due to imprecise estimates, because the data only has 73 observations that upgraded from low-rating to UPK, and 28 observations that upgraded from 4-5 star non-UPK to UPK. But overall, the estimated fixed costs of upgrading suggests that upgrading to UPK is more costly than upgrading to non-UPK. Given the higher fixed cost of maintaining UPK status and the capped tuition received from part-time UPK subsidy, it seems reasonable that current UPK providers increase full-time prices to become more profitable.

6 Counterfactuals

With the demand and supply model, I run several counterfactuals to understand the true impact of UPK policy, and how alternative policies may shape the market of supply.

The first counterfactual would be completely without the UPK policy, but with the CCFAP tiered-reimbursement subsidy. This allows me to compare the aggregate market quality change due to the UPK policy. The second counterfactual is a UPK policy that doubles the current UPK payment and removes the CCFAP subsidy for low-income families. In this counterfactual, we want to compare the current CCFAP + UPK policy to a roughly budget-neutral UPK policy that doubles the current UPK payment using the CCFAP funding. The goal is to understand whether a pure universal subsidy for targeted programs improves the market compared to a part-time UPK on top of a targeted subsidy. This counterfactual is particularly relevant for many states that currently have a targeted program for lower-income families in place, and plan to roll-out UPK step-by-step.

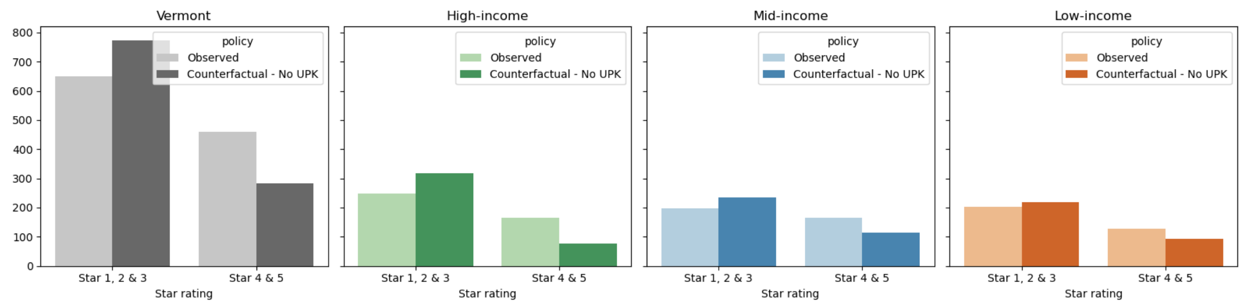
Running counterfactual is computationally expensive. Every provider has 3 possible quality levels: low-rating, high-rating non-UPK, and high-rating UPK. If I extensively search the space for counterfactuals, then I need to compute variable profits for over 3^{300} states in each market. Therefore, following Fan and Yang (2020), I use a simplified iteration process to find counterfactuals. For each counterfactual, I follow the steps below to collect a set of potential equilibrium:

1. Simulate a counterfactual $\mathcal{A}$ where programs remain the same state as in data $\rightarrow$ variable profits may change due to different policy

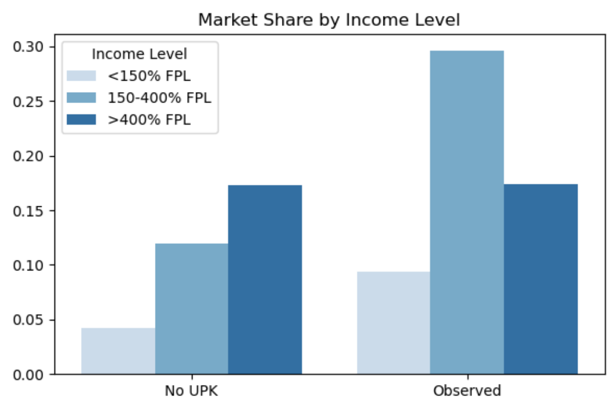
2. Loop through every incumbent and potential entrant, update the provider's status if a provider has a profitable deviation. Repeat the process until no profitable deviation can be made by a unilateral provider

This iteration process allows me to find an equilibrium such that no provider has the incentive to unilaterally deviate from the equilibrium. In my analysis, I always arrive at an equilibrium.

6.1 No UPK Policy



(a) Market Structure by County Income Level



(b) Enrollment by Family Income Group

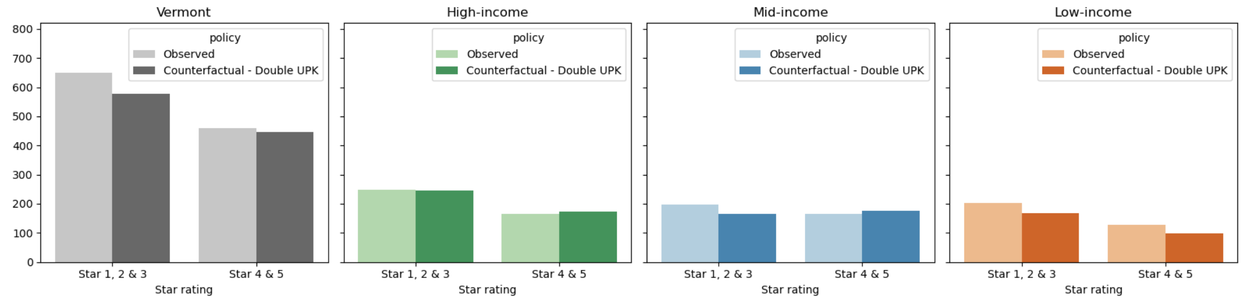
Figure 8: Counterfactual 1: without UPK

Figure 8 Panel (a) presents the simulated market in the absence of the UPK policy, with three additional plots that illustrate the market structure evolvements across high-income, middle-income, and low-income counties separately. Comparing the observed (baseline) market with the counterfactual suggests that UPK policy encourages more aggregate supply of 4-5 star providers, consistent with the policy's objective of expanding the supply high-quality child care. The subplots further indicate that prior to UPK, mid- and low-income counties have higher average childcare quality relative to high-income counties. This pattern likely reflects the design of the CCFAP subsidy, which provides larger payments to higher-rated providers serving lower-income families, thereby incentivizing quality upgrades in these areas. Nonetheless, the increase in the number of high-quality providers following UPK is substantially smaller in mid- and low-income counties compared to high-income ones. A plausible mechanism is that providersin high-income areas earn higher variable profits due to lower price sensitivity among families, allowing them to charge higher prices to account for additional UPK compliance costs. This raises the concern that the UPK may disproportionally encourage providers' quality improvements in high-income areas, potentially exacerbating inequity in access to high-quality childcare.

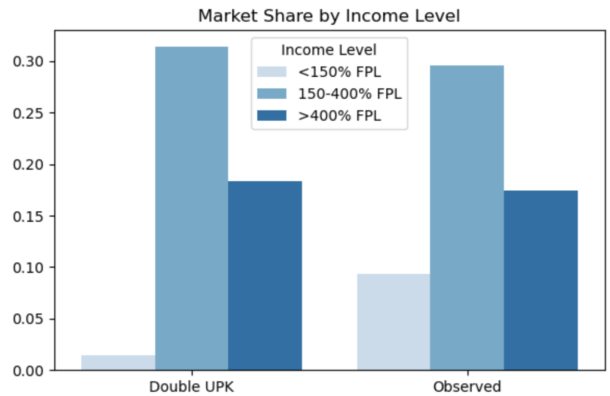
Panel (b) displays the simulated enrollment by three family income groups: low-income earning less than 150% FPL (who receive full childcare subsidy from CCFAP to cover preschool), middle-income earning between 150% and 400% FPL (who receive some CCFAP subsidies on a sliding scale), and high-income earning above 400% FPL (who are ineligible for any CCFAP subsidy). The low-income and middle-income families observe increases in enrollment after UPK, with the middle-income families seeing the most drastic increase. This suggests that the UPK reduces these families' financial burden for attending high-quality preschool, therefore increasing demand on the extensive margin. In contrast, enrollment among high-income families remains relatively stable, implying that the UPK subsidy primarily shifts their participation from non-UPK to UPK programs rather than increasing total enrollment.

6.2 Expand UPK subsidy

Figure 9 Panel (a) shows the simulated market that doubles the UPK subsidy while eliminating CCFAP payments for low-income families. This counterfactual reallocates CCFAP funding to expand the UPK subsidy. The idea is to simulate a counterfactual policy that increases the UPK subsidy using CCFAP funding. Comparing the observed data with the pure UPK subsidy, the pure UPK subsidy reduces the overall childcare supply, and reduces quality upgrade to 4-5 star. Breaking down, we see this drop in quality upgrade mainly comes from low-income counties. The reason is we redistribute the subsidy targeting low-income families to all families, therefore increasing the out-of-pocket cost for low-income families to attend any childcare, thus reducing their demand. Part of the funding is instead redistributed to higher-income families through increased UPK payment,



(a) Market Structure by County Income Level



(b) Enrollment by Family Income Group

Figure 9: Counterfactual 2: Expand UPK, Eliminate CCFAP

thus encouraging slightly more quality upgrades in higher-income counties.

In Panel (b), I break down simulated enrollment by three family income groups. Under the expanded UPK program, low-income families significantly decreased enrollment in any childcare program. Middle-income families and high-income families slightly increase total enrollment, because the expanded UPK further reduces their out-of-pocket cost for attending UPK programs. The counterfactual is directly relevant to many states that are planning to gradually roll out UPK over years, underscoring the importance maintaining support for low-income families through means-tested demand subsidies.

7 Conclusion

This paper contributes to the current policy debate on extending UPK policy to all states. Using a static demand and supply model, I show that the Vermont UPK policy successfully improves the aggregate provider quality for both high-income and low-income counties, encouraging providers to upgrade to become UPK-prequalified. The impact is heterogeneous across counties, with higher-income counties observing slightly more improvement, likely because higher-income families are more willing to attend full-time UPK programs by paying a higher out-of-pocket cost. In particular, the policy increases enrollment of professional care on the extensive margin among low-income and middle-income families, while it mainly affect high-income families through a substitution effect that shifts high-income families from other types of preschools to UPK programs. In addition, I find that a roughly budget-neutral policy that doubles the UPK subsidy for full-time care by eliminating the means-tested CCFAP lead to fewer providers and reduced quality upgrade investments in low-income counties, leading to widened inequality gaps in accessibility to high-quality care. Together, my counterfactuals suggest that policymakers who want to implement a similar voucher-based UPK policy need to closely examine its potential impact on different population to ensure that the policy does not disproportionally redistribute subsidy to high-income families from low-income families.

My research faces two primary limitations that future research may seek to address. First, the enrollment data distinguish between full-time and part-time participation, instead reporting total headcounts of enrolled children. Therefore, my model assumes that all enrollments are full-time, which likely yields conservative estimates of the UPK program's impact. Since part-time UPK is fully subsidized, it is reasonable to expect a relatively larger increase in part-time participation that is not captured under this assumption. This data limitation is not unique to Vermont's childcare market. Childcare programs differ in their operating schedules: some exclusively offer full-time or part-time care, while others provide a mix of both, and there is no universal definition of part-time care (that is, not all programs define it as 10 hours per week). As a result, many states report enrollment data that are, at best, an approximation of the full-time equivalent enrollment, while other states, like Vermont, account enrollment using headcount. Improving data collection by recording the number of hours of care and tracking program operation schedules would allow researchers to more accurately distinguish between programs that offer different types of care (part-time vs. full-time), and correctly account for their enrollment respectively.

In addition, my counterfactual analysis ignores providers' capacity decisions, assuming all families can enroll in their first choice. In reality, providers set a capacity due to a strict cap on student:teacher ratio, and put additional children on a wait list to ensure they are operating at maximum profit, so many families do not enroll in their first choice child care, and the observed enrollment may underestimate families' utilities for higher-quality care. Future research can consider collecting administrative data on full-time equivalent enrollment and provider waitlist, or conduct individual surveys that reveal families' first and second choices. Overall, studying U.S. childcare policy is challenging due to fragmented markets and inconsistent state-level data. My paper takes an initial step in quantifying how a partial UPK affects the market structure. As more states move toward full UPK from a means-tested subsidy, these findings can guide policymakers on how to implement step-by-step reform—using part-time UPK as a stepping stone to expand access while maintaining quality.

The annual cost across all of Vermont's preschool-age children for high-quality ECE is estimated to total about \$645 million in 2022 dollars. If Vermont plans to implement a full-time UPK where the state subsidizes all high-quality preschool care, this could imply an additional tax burden on Vermont families. RAND report suggests that to fill an annual \$194 million gap, Vermont will need to introduce a new 0.9 percent payroll tax, a 2.0% increase in the sales tax, a new limited services tax of 9.9 percent, or a new expanded services tax of 7.1 percent. While the direct effect of these taxes on family well-being is small, it is unclear weather the tax scheme will affect migration across states, another direction that future researchers can study.

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