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Effects of Child Care Vouchers on Price, Quantity, and Provider Turnover in Private Care Markets

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W.E. UPJOHN INSTITUTE FOR EMPLOYMENT RESEARCH
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ABSTRACT

Harnessing changes in funding for a voucher program that subsidizes consumers' use of child care services at private providers, this study quantifies effects on local markets' service capacity and prices. We also estimate how increased funding effects provider entry rate, exit rate, and highly rated provider market share. The evidence shows that an additional $100 in private voucher funding per local young child would 1) raise the number of private-provider slots by 0.026 per local young child, 2) raise average prices by $0.56 per week, mainly driven by a price increase among incumbent providers, and 3) induce new provider entry to the market by 0.4 percentage points. The estimates imply a highly elastic supply elasticity of 10.7. Thus an increase in public funding and subsequent increase in demand is expected to result in expansion of available slots accompanied by a limited increase in price.

JEL Classification Codes: D24, H25, H42, J13, J22, J28

Key Words: child care, vouchers, prices, capacity, supply elasticity, entry rate, exit rate

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1 Introduction

Child care voucher programs aim to improve child care access and choice for low-income families, with the ultimate objectives of facilitating economic self-sufficiency for low-income families and harnessing the social benefits of high-quality early childhood settings. However, like any subsidy, child care assistance vouchers have potential unintended consequences (Adams and Rohacek, 2002; Bassok et al., 2014). To the extent that supply is limited, increased demand from subsidized consumers may increase market prices and crowd out unsubsidized consumers (Bassok et al., 2016). On the other hand, new providers would be expected to enter the market to meet demand from subsidized consumers, blunting price increases and expanding access overall. While economic theory suggests that increased funding for child care vouchers may lead to both capacity and price increases, theory provides little guidance to policymakers about the relative magnitude of these effects. Yet these relative magnitudes are of critical importance to policymakers, who must assess the benefits and costs of child care assistance programs. Existing studies of child care supply argue that the supply of child care is highly elastic (Blau, 2001). If supply is highly elastic, increased demand resulting from subsidies should be met primarily by increasing child care supply, and price effects should be minimal. However the research on price elasticity of child care is several decades old. Improved labor market opportunities for female workers and increasing regulation of child care providers may have altered the fundamental supply relationships governing the child care sector.

This paper uses longitudinal data on local child care markets and public child care funding in Minnesota to estimate the price and quantity effects of child care subsidy spending on the child care market. We use administrative data from Minnesota's child care assistance program to construct school district by year estimates of child care subsidy spending. We combine these spending estimates with data on child care prices and licensed capacity and use a panel regression model that controls for school district fixed effects and year fixed effects to estimate the relationship between subsidy spending and child care market outcomes. The estimated relationships include effects linking subsidies to average prices and total licensed capacity, a proxy for the overall quantity of child care services utilized in a district. These estimated price and quantity effects provide a means to calculate an estimate of supply elasticity for the child care market, a critical structural quantity that governs the relationship between funding and child care supply.

Though many policymakers support public investments in early childhood care and education (ECE), there remains debate and uncertainty about how increases in subsidies would affect crowd-out, prices, and other outcomes. Similar concerns about crowd-out and other unintended consequences arise around subsidized K-12, higher education, and health care, but much less is known about the ECE setting. A few recent studies examined the effects of governmental funding and provision on child care supply empirically (Bassok et al., 2014; Bassok et al., 2016; Brown, 2018). These studies focused on the effects on the private child care sector of new, publicly funded universal pre-kindergarten programs in several states and New York City. Generally they find expansion of ECE capacity occurred, with the size of increases in private versus public capacity varying because of differences in program design. Brown (2018) also finds a decrease in capacity for children under age two, however. These studies did not examine effects on prices or quality, key outcomes for understanding the costs and impacts of the early childhood interventions.

This study provides new empirical estimates of the elasticity of private ECE supply with respect to price using data from an entire state. The baseline estimates imply a supply elasticity of 11.6, which suggests that an increase in public funding and subsequent increase in demand in ECE will result in the expansion of available slots, while there is a limited increase in price. As a result, crowd-out effect due to the private voucher funding is expected to be small. The elasticity estimate is somewhat imprecise, and we assess robustness using a variety of alternative estimation methods, samples, and market definitions. Although the magnitudes of the elasticity estimates vary somewhat, the estimated effect on capacity is robustly larger than the estimated effect on price, suggesting elasticity well above 1.

2 Policy and Institutional Context

In the United States, early care and education (ECE) services are provided by a mix of private and public providers and funded through both parent fees and public funding streams. Separating ECE services into "child care" and "education" is not a useful distinction, as programs focusing on early education also provide care that frees up parent time for employment or other activities, and child care and educational development are inseparable for young children. Thus we use the terms "early care and education" and "child care" interchangeably.

In Minnesota as in the United States as a whole, the majority of ECE services are provided by private providers (National Survey of Early Care and Education Project Team, 2014), which include licensed home-based providers (also called licensed family child care) and licensed or certified child care centers. In addition, a substantial number of children are cared for by unlicensed providers, also called informal or family, friend, and neighbor care, some of which is unpaid. In Minnesota, an adult may care for the children from one unrelated family without obtaining a license.[1] Licensed home- and center-based providers are subject to regulations that set age-based limits on the number of children per staff member, group size, and qualifications of personnel. These regulations can affect the cost of providing ECE services and limit the ability of incumbent providers to expand capacity.

While families pay the majority of costs for ECE (BUILD Initiative, 2017), public funding is also an important revenue source for some ECE providers. Some of these funding streams are aimed at private ECE providers, while others support public ECE provision, as described below.

Child care vouchers. The main focus of this paper is on child care subsidies through the state-federal Child Care Development Fund (CCDF) partnership, which is a longstanding program that provides child care vouchers to low-income parents. Minnesota's CCDF program

[1]Licensing regulations are set at the state level, and states vary in the number of children or families that can be served without a license.

is called the Child Care Assistance Program (CCAP). Parents choose their ECE provider, but the only kind of ECE care services eligible for CCDF vouchers are private.[2] Parents must be in the labor force or in education or training programs, and meet other eligibility requirements.[3] The CCDF voucher program is the largest of these ECE funding streams in Minnesota and served the most young children over the sample period (Appendix Table A.1).

While the focus of this paper is on increased funding for CCDF vouchers, which are used to purchase ECE services at private providers, conceptually it is important to control for potentially confounding changes in spending via other ECE programs. The different funding streams—with different eligibility requirements, payment amounts, and type of providers allowed—are expected to have differential effects on private and public ECE providers.

Head Start and Early Head Start. Head Start and Early Head Start are federal-local partnerships designed to provide care, education, nutrition, and health services to children from low-income families. We treat these programs as direct public provision, given the strict quality standards and contracted services that are required.

Public school–based pre-kindergarten programs. School Readiness is a public school pre-kindergarten program offered to children under age 5 by all school districts in Minnesota. The purpose of the program is to prepare children to enter kindergarten with the skills and behaviors that are necessary to be successful in future learning. The Minnesota Voluntary Pre-Kindergarten (VPK) program, started in 2016, provides state funding for pre-K services for children age 3 and up in approved locations for the purpose of preparing children for success as they enter kindergarten. The funding allows public school districts, charter schools with recognized early learning programs, or a combination thereof, to incorporate a voluntary pre-K program into their E-12 system.

Minnesota Early Learning Scholarships. The state of Minnesota's Early Learning Scholarship (ELS) program provides scholarships to certain low-income families with children

[2] Public providers cannot use the funds for ECE care services, but can use them to add on wrap-around services.

[3] Our study does not attempt to identify demand, so work requirements do not factor directly into the analysis.

age 3 up to kindergarten entry.[4] ELS funding is divided between two "pathways." Pathway 1 scholarships are provided to the family as a voucher, which must be used at a highly rated provider.[5] Most of the Pathway 2 funding was provided directly to school districts and public ECE providers.

Much of the literature focuses on the impacts of ECE subsidies on families, yet the responses of the supply side of the private market to increases in different funding streams are important drivers of the impacts on ECE access and affordability for families.

3 Methods

Model: We begin with a simple economic model of the private child care market. The quantity of child care services that parents demand is negatively related to price, and providing subsidies to parents lowers the amount they must pay for ECE services. The key assumption is that increases in the funding of vouchers for ECE care from private providers shift out the local demand curve for private ECE services without changing the local supply curve.

This key idea is illustrated in Figure 1. An increase in voucher funding shifts the local demand curve outward ($D' \rightarrow D''$). We observe two equilibrium points (Q^*, P^*) and (Q^{**}, P^{**}) on the fixed supply curve (S) as increased private-voucher funding enables more families to afford care, increasing demand, and shifting up the market price $(P^* \rightarrow P^{**})$ and aggregate quantity $(Q^* \rightarrow Q^{**})$. The elasticity of supply with respect to price (ϵ) expresses, for each percent increase in price, by what percent does quantity change:

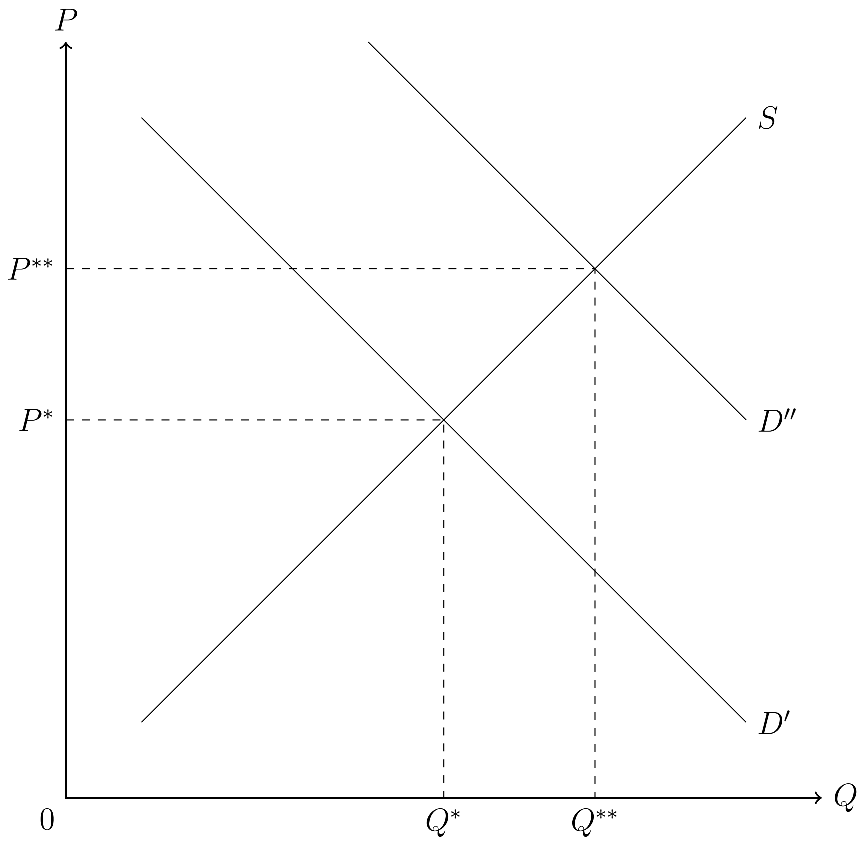
$$\epsilon = \frac{\%\Delta Q}{\%\Delta P} = \frac{(Q^{**} - Q^*)/\bar{Q}}{(P^{**} - P^*)/\bar{P}}. \quad (1)$$

Consider the two extreme cases. If supply is perfectly inelastic, the quantity of care supplied cannot change, and S would be a vertical line so that the outward demand shift will

[4] Children birth to 2 years old are eligible under certain conditions such as for having a 3–4-year-old sibling, a teen parent, being in foster care or child-protection services, or being homeless. The vast majority of ELS scholarships go to 3- and 4-year-olds.

[5] Minnesota's Quality Rating and Improvement System for ECE providers is voluntary. Providers who participate are given a rating from one to four stars.

Figure 1: When Demand Increases from D' to D"



be fully absorbed as a price increase. If supply is perfectly elastic, the quantity of care can increase freely without any change in price and S is a flat line. In this case the outward shift in demand from subsidies will be fully absorbed as an increase in quantities. The elasticity of supply is determined by the availability of inputs, such as facility space and qualified workers. If these inputs are comparatively scarce, then expanding quantity supplied will lead to increases in the price of inputs, which in turn will increase the price of care. Realistically, supply is likely somewhat elastic but the question is how much.

Thus, the elasticity of supply in the private child care market is a key parameter for understanding how expansions of public funding for child care vouchers will affect the supply and price of private child care services. These effects have important implications for families who do not receive subsidies and may face changes in availability and price as a result of policy changes, and for policymakers in knowing how much of expanded subsidies will go to changing children's care experiences and how much will go to providers via higher prices.

Empirical Approach: Our primary approach is to analyze changes in funding in local markets defined as school districts. We identify several sources of public ECE funding (detailed below). The primary focus is on vouchers that parents can use only at private child care providers. We control for other types of public funding, such as Head Start and school-based pre-K, as well as for scholarships that can be used at both public and private providers. More detail on these funding sources is provided in Section 4.1.

We assume a two-way fixed effects model with school district fixed effects and year fixed effects that explains district-year log total private ECE capacity per young child (as a proxy for quantity utilized) and log average price among licensed, private providers as a function of private-provider funding levels per young child in the district-year population (F_{dt}).

$$ln(Capacity/youngchild)_{dt} = \beta_1 F_{dt} + \alpha_1 X_{dt} + \gamma_{1d} + \tau_{1t} + \upsilon_{1dt} \tag{2}$$

$$ln(AveragePrice)_{dt} = \beta_2 F_{dt} + \alpha_2 X_{dt} + \gamma_{2d} + \tau_{2t} + \upsilon_{2dt}. \tag{3}$$

The Data section below provides details about measurement.

The main policy variable of interest is public spending on ECE vouchers that can be used only at private providers, which varies by district-year (F_{dt}). Funding is expressed as thousands of dollars per young child in the district boundary's population. This stream of funding is through a particular program, the CCAP, which is Minnesota's version of the CCDF state-federal partnership. The coefficients on F, $\beta_.$, are constant, imposing the constant-treatment-effects assumption. If this assumption is violated, estimates could be biased or inconsistent (Goodman-Bacon, 2021; Callaway et al., 2021).

X_{dt} represents observed covariates at the school district-year level. These observed variables could influence outcomes, and changes in these variables are potentially correlated with changes in the primary policy variable of interest (F). X includes two other forms of ECE subsidy funding at the locale-year level that would otherwise be confounded with changes in funding for ECE services at private providers only (F). First is ECE funding that can be used at both private and public providers, referred to as flexible funding. Second is public-only ECE funding that consumers can use only at public providers such as Head Start or school-based pre-K. As local funding levels via these sources change, they could influence local demand for private providers' ECE services. Funding for public ECE services would not influence private providers' supply but would affect demand by financing a close substitute for private providers' services. Further, X includes characteristics of parents in each district, which can change over time and affect the local ECE services market. We estimate models both with and without X.

$\gamma_{\cdot d}$ are sets of district indicators that remove the influence of stable unobservable, additive differences between school districts on each outcome. $\tau_{\cdot t}$ are sets of year dummies that remove the influence of average year-to-year differences shared across all Minnesota school districts. $\upsilon_{\cdot dt}$ measure district-year specific unobservable influences.

The ratio of the coefficients on the funding variable expresses the elasticity of private ECE supply ($\epsilon = \beta_1/\beta_2$). The change in capacity and prices are driven by the same policy changes and thus provide information about the implied elasticity of supply.

If changes in funding levels, F_{dt}, were truly random, we would be able to interpret the estimates of β as the causal effect of increases in vouchers on the outcomes. However, changes in F_{dt} derive from appropriated funding levels for the CCAP program, changes in the maximum reimbursement rates, and from families' and providers' take-up of vouchers. In our model, an identifying condition is that changes in districts' unobservable determinants of outcomes ($\upsilon_{\cdot dt}$) are mean independent of changes in their funding level F_{dt} conditional on (X, γ, τ) . Letting Δ represent first-differences in a variable within district, the assumption is: $E[\Delta\upsilon_{\cdot dt}|\Delta F_{dt}, X, \gamma, \tau] = E[\Delta\upsilon_{\cdot dt}|X, \gamma, \tau]$. We estimate both equations simultaneously using seemingly unrelated regressions (SUR) to allow for correlation between υ_{1dt} and υ_{2dt}.

The variation in CCAP policy comes from a combination of sources, and endogeneity is a concern. The CCAP program has annual budgets fixed by the legislature, supplementing a federal block grant with state funds. New funds went to both expanding the number of children served and the quality of care participating children received. In 2014, the state adopted a differential payment for CCAP providers rated as high quality under a quality measurement system, so that they were paid up to 20% more per child served than other providers, as a way of incentivizing provision of higher-quality care through providers' internal improvement and through entry and preventing exit of higher-quality providers. The biggest systematic change was an increase in CCAP provider payments per participating child in 2014, following a 2013 state legislative change, aimed at making provider participation in the CCAP more attractive and sustainable and, thereby, at improving the quality of care and broadening access to care. There were smaller changes to payment rates in other years, with similar intent. At other times, the legislature added new funds with the explicit intention of serving more children ("shortening waiting lists"). The allocation of funds to local communities resulted from a process of state administrative policy setting (e.g., choosing eligibility criteria and maximum payment rates), county administrative processes (e.g., taking applications and determining eligibility), and family and provider participation decisions. We endeavored to accurately measure program funds spent in each local area-year as well as confounding program spending but, in the end, rely on the mean independence assumption rather than more-credible research design features.

The approach assumes that vouchers for ECE services at private providers only affect private-provider demand, not supply. It assumes that alternative ECE funding, which could go to public providers only (e.g., pre-K and Head Start), or flexible funding that can be used at either private or public providers (e.g., Minnesota's Early Learning Scholarship program), can affect private-provider demand.[6]

[6] If public-provider ECE services substitute for private-provider ECE services, increased funding for public-provider services could reduce demand for private-provider services. On the other hand, if free care at later ages makes parents less likely to withdraw from the labor force to provide care themselves, it could increase demand for private-provider services at younger child ages.

4 Data

We compile a unique data set of ECE market outcomes and relevant policy variables measuring ECE funding in each market-year. We use the boundaries of 317 Minnesota school districts to define markets.[7] The unit of observation is the district indexed by $d = 1, 2...D$ and the state fiscal year starting in July of $t = 2012, 2013...2018$. We focus on school district boundaries because they are the smallest available geographic unit that is large enough to contain local child care markets. An ideal unit of analysis will be large enough that few consumers cross into other units to access child care, but not so large that relevant local variation in funding and child care access is erased. School districts, by construction, group populations for an area defined by transportation of children to a central location for a daily activity. Minnesota school districts are typically centered around a local population center and have a median area of 183 square miles, which is comfortably larger than available estimates of the locally relevant area for child care choice. The National Survey of Early Care and Education suggests that most households use child care within five miles of the home (National Survey of Early Care and Education Project Team, 2016). Borowsky (2020), analyzing data from Minnesota's CCAP program, argues that in urban areas the locally relevant radius for child care choice is between three and five miles, whereas in rural areas the locally relevant area is the catchment areas of the nearest city or town.

From Census data, we estimate the number of children aged 0–5 in each district-year. We start with detailed 2010 decennial Census information on the spatial distribution and incomes of families with children aged 0–5 and update it with more current information from the 2011–2015 American Community Survey on population counts, which are only available at a coarser level of geography. The number of young children (aged 0–4) in each Census block group matches the ACS counts but the distribution of children across block groups within tract matches the 2010 distribution, assuming each of the 6 aged 0–5 birth cohorts is

[7] There were 332 SDs in Minnesota in 2014. We keep the balanced sample, the 317 SDs that have observed outcomes and predictors in all years.

equal in size. In order to reflect district young child population changes over time, we use county-level population projection data from the Census and distribute child counts down to the block-group level using the data estimated based on 2010 Census and ACS data.[8]

Outcome Variables: We measure the total amount of private ECE service capacity in each district-year as the total infant, toddler, and preschooler capacity at private, licensed centers and licensed home-based providers located in the district. We sum the provider-level capacity data in each year to the school district level. The child care provider data come from NACCRAware, through agreement with the Minnesota Department of Human Services, and was previously described in Davis et al. (2018).[9] Across school districts and years, total private child care capacity per young child (aged 0–4) averages 0.6 with a standard deviation of 0.18.

The average price of private ECE care in each district-year is the weighted average weekly full-time care price across providers. For each provider, we average across age-group prices according to the share of months that a child would spend in each age group. Within school district-year, we average across providers weighting by providers' total capacity. To harmonize prices reported in different time units (hourly, daily, and weekly), we convert to weekly prices using the observed within-provider ratios of daily and weekly or hourly and weekly prices, as described in Davis et al. (2018).[10] Across district-years, the weekly price averages \$187 with a standard deviation of \$56.

The average child care price at the district level can change either because currently operating providers change their prices or because of changes in the composition of providers (with different prices) from entry and exit. As some incumbent providers exit and new

[8]The county-level population projection data from Census is available at https://www.census.gov/data/tables/time-series/demo/popest/2010s-counties-detail.html

[9]Each provider has a total licensed capacity, as well as age-group specific capacities. Age groups of interest are infants, toddlers, and preschoolers. Some providers also are licensed to serve school-aged children. The sum of the age-specific capacities exceed the total capacities because the age-specific capacities are independent constraints. We interpret the age-specific capacities as shares of total capacity. If the provider serves school-aged children, we scale down their total capacity to focus only on infants through preschoolers.

[10]Prices were imputed for approximately one quarter of private providers missing price data. Details available in Davis et al. (2018).

providers enter, if the two groups have different average prices, this will shift the overall average price even if no incumbents change their prices.

In addition to analyzing the effect on average price, we use chain-weighted price indexes to develop evidence on the extent to which price changes are due to changes within providers versus changes in the composition of providers. We use a simple linear decomposition approach for defining "within-provider" versus "composition effect" price changes using a chain-weighted index. For any district d at each time t, the set of providers that are active is S_{dt}. Each active provider j has a quantity (capacity) q_{jt} and a price p_{jt}. We wish to analyze changes in the quantity-weighted average price,

$$P_{dt} = \frac{\sum_{j \in S_{dt}} q_{jt} p_{jt}}{\sum_{j \in S_{dt}} q_{jt}}.$$

In order to measure within-provider price changes, we define a chain-weighted price index based on price changes in the providers that carry over between each pair of consecutive periods. Let $I_{d,t+1} = S_{dt} \cap S_{d,t+1}$. Then we define P^w using the difference equation:

$$P^w_{d,t+1} - P^w_{d,t} = \sum_{j \in I_{d,t+1}} \frac{q_{jt}(p_{j,t+1} - p_{jt})}{\sum_{j \in I_{dt}} q_{jt}}.$$

This definition uses the quantities from the earlier year as weights for the within-provider price differences. The definition of P^w is closed by fixing a reference year, e.g., $P^w_{d,0} = P_{d,0}$.

Having defined an index that measures within-provider changes, we can define composition changes as the portion of average price movements that is not explained by within-provider changes. Thus,

$$P^b_{d,t+1} - P^b_{d,t} = [P_{d,t+1} - P_{d,t}] - [P^w_{d,t+1} - P^w_{d,t}].$$

This definition is closed in the same way by setting, e.g., $P^b_{d,0} = P_{d,0}$. The indexes take positive and negative values. The within-provider index averages 4.61 with a standard deviation of 7.04 and the between-provider index averages 1.66 with a standard deviation of 4.01.

This analysis decomposes the change in a district's average price from one year to the next into the within-provider change and the between-provider change. However, note that the object being decomposed here—the change in a district's average price—is slightly different than the object analyzed when using average price as an outcome. Here the outcome is the price change, rather than the price level. So, we first present the effect of policy change on average price *change*, which differs slightly from the effect on price levels, and then decompose the price change effect into price change among incumbents and price change from entry and exit, omitting the base year, 2012.

We also measure provider entry and exit rates each district-year. Theory suggests that introducing or increasing subsidies would reduce exit rates and increase entry rates. The entry rate is the share of all providers that are newly licensed (i.e., not licensed in the previous year). The entry rate averages 8.0% with a standard deviation of 6.1%. The exit rate is the share of all providers not operating in the following year. It averages 11.5% with a standard deviation of 6.4%.

Finally, we partition all providers into two nonoverlapping groups by whether they were ever highly rated in the state's Quality Rating and Information System (QRIS). Minnesota's QRIS system, ParentAware, is voluntary for providers and it rates participating providers from 1 to 4 stars. We define highly rated as those who have 3- or 4-stars. We focus on whether or not each provider's highest rating was ever at least 3 stars and classify each provider in a time-invariant way. This approach focuses on how changing payments affects provider entry, size change, and exit among distinct populations of providers and ignores change in ratings within provider. We measure highly rated providers' market share as the percent of district-year capacity that is in ever highly rated providers, which averages 31%.

4.1 Policy Variables: Measures of Public ECE Spending

Our primary interest in this paper focuses on the impact of the ECE funding for families using private providers through CCDF vouchers. However, changes in this funding occurred in the context of changes in other ECE programs, so we compile data on those changes as well. In order to estimate the effect of funding changes on the local market, we need measures of where the funding was spent. However, there is no unified data system that describes the geographic distribution of funding from different programs. From public- and restricted-use sources, we combine the best-available data on each ECE funding program with the aim of measuring how many dollars flowed into each district each year through each program. The available level of geographic detail varies by program.

Leveraging Census data on child populations, locations, and incomes, we build a harmonized measure of funding across programs by district and by year using two techniques: one when funding is reported at a specific location and the other when it is reported by zone or area. Reporting zones sometimes differ from school district and from each other. The zone at which the funding data for any program are available is dictated by administrative procedures. We can choose our geographic unit of analysis, but it has to be the same across all programs and outcomes. When funding is reported at a location, either a family residence or provider location, it is easy to construct school district totals. We simply sum funding amounts across locations within each district. When funding is reported by zone, we transform this into a measure by district using Census data on where low-income children tend to live within each zone combined with an assumption that funds were distributed equally across such children.[11] First, we allocate dollars down to the Census block group within zone, then aggregate up to the district. We assign the zone's dollars each year ($\$Policy_{gzt}$) to Census blocks in proportion to their share of the zone's low-income children. Program funding amount in block group b in zone z in year t is calculated as: $\$Policy_{bt} = \$Policy_{zt} \times \frac{\#EligibleKids_b}{\#EligibleKids_z}$. Next, we sum up across blocks within each district d and divide through by the total number of children in the district, yielding our measure of program funding per child by district-year: $\$Policy_{dt} = \#AllKids_d^{-1} \times \sum_{b \in d} \$Policy_{bt}$.

We divide the three ECE funding programs in Minnesota by whether the funds can be spent at private ECE providers or are for public programs like Head Start. A third type of

[11]While funding is actually received by some children and not by others, for our purposes, the amount of funding at the district level is relevant rather than the individual locations.

funding is flexible and can be used by families at either public or private ECE providers. We next describe the details of how we measure these funding streams in Minnesota.

Private-provider-only ECE funding: Minnesota's CCAP provides vouchers to eligible parents who choose a private child care provider. Through an agreement with DHS, we accessed de-identified data on each child each year whose care was subsidized by a CCDF voucher, including information on residential location and dollars of subsidy used. From this micro-data, we aggregate across all children to directly measure how many dollars flowed into each district-year through CCDF.

The same dollar amount change in funding level will provide a smaller shock to the local ECE market in a district with a larger population of young children than in a district with a smaller population. Thus, we divide funding levels by the total number of young children in the population of that district in that year. We refer to this measure as private-provider-only funding per population child. In our models, we weight each district by its average number of young children across years. Using these weights, the average private-only funding per population child is $474 with a standard deviation of $392 (Table 1). For context, only about 3% of young children in Minnesota participate in the voucher program. Thus, even large funding changes per participating child are still quite small changes per population child.

Table 1 also reports the population-child weighted statistics for capacity per young child, price, entry rate, exit rate, and highly rate percent of capacity that correspond to those used in the analysis.[12]

Public-provider-only ECE funding: Three major programs fund ECE services for young children in public settings in Minnesota over this period: Head Start, School Readiness (Plus), and Voluntary Pre-Kindergarten. Working with published and restricted data from the Minnesota Department of Education, we construct district-year measures of spending through each program and sum them to measure total public-only ECE funding by district-year.

Thirty-two nonprofit, tribal government, or school district grantees provide Head Start

[12]Because prices are higher in districts with more population, this weighted average price is higher than the average reported earlier based on equal weighting of district-years.

Table 1: Summary statistics across district-years

	Mean	SD	Min	Max	N
Private-only \$100/yng child	4.74	3.92	0.00	17.49	2,219
Public-only \$100/yng child	3.22	4.31	0.00	87.11	2,219
Flexible \$100/yng child	0.58	0.66	0.00	16.34	2,219
Total Capacity / yng child	0.60	0.18	0.04	2.08	2,219
Average Price	186.53	55.64	74.50	341.09	2,219
Δ_{t-2012} avg price	6.27	7.85	-88.41	91.26	1,902
Within-provider price index	4.61	7.04	-92.60	91.92	1,902
Between-provider price index	1.66	4.01	-84.03	91.26	1,902
Provider entry rate (%)	8.01	6.07	0.00	100.00	2,219
Provider exit rate (%)	11.49	6.44	0.00	100.00	2,219
Highly rated capacity / yng child	0.18	0.10	0.00	1.13	2,219
Highly rated price	222.83	67.52	66.67	379.31	1,461
Not highly rated capacity / yng child	0.42	0.19	0.03	2.08	2,219
Not highly rated price	168.68	45.14	74.50	313.42	2,219
Highly rated provider % of capacity	31.05	17.25	0.00	90.67	2,219
% Parents BA+	42.74	14.18	0.00	86.30	2,219
FTFY Father Earnings, \$1000s	65.26	15.90	0.00	188.06	2,219
% Parents Married	75.36	8.27	0.00	100.00	2,219

Note: Funding variables are in hundreds of \$ per population young child. All variables are weighted by the number of young (aged 0–5 years) children in each school district's boundary's population across years, as in the analysis. % Parents BA+ is percent of parents of children up through age 17 in the district-year who have at least a bachelor's degree. FTFY Father Earnings is median annual earnings of such fathers who work full time and full year (FTFY). The parent demographic variables are missing in 9 (0.02% of) observations. Missing values are replaced with 0 and indicators for missing values included in models with controls.
Sources: NACCRRAware provider data; administrative data on CCAP, HS, VPK, and ELS programs; block and block-group child population data from 2010 Census and 2011-2015 ACS; MSDC; Parent demographic data from ACS-ED. Source detail in Table A.8.

and Early Head start programs at 522 locations. The annual provider-level enrollment data and agency-level grant amount data from the Minnesota Department of Education (MDE) is used for the analysis. We convert provider enrollment into district funding using agency-level average funding per child served and provider locations. Along with data on enrollment by Early Head Start and Head Start, this yields an estimate of total Head Start/Early Head Start funding flowing into each district-year.

The main public school pre-kindergarten programs in Minnesota funded with state and local dollars include the School Readiness Programs and Voluntary Pre-Kindergarten (VPK).

Approximately $50 million was spent on the Schoool Readiness program in FY2016, where 52% of the funding comes from the state and rest was funded by local tuition/fees and local tax dollars. The school district-year level funding data is publicly available from MDE, but only includes the state aid. In recent years, the state created a School Readiness Plus program, which is also included in this category. We have data from MDE on the funding for these services in each district-year. MDE also provided data at the school-year level on the number of children served in the VPK program. Dividing total appropriations by the number of children and allocating that to each school's district gives a VPK funding level measure for each year.

For each district-year, public-provider-only funding is the sum of HS/EHS, School Readiness, and VPK funding. We normalize this total by the number of young children in the population. The average level is $322 with a $431 standard deviation (Table 1).

Flexible funding: Minnesota's Early Learning Scholarship (ELS) program provides scholarships to certain low-income families with children age 3 up to kindergarten entry. ELS funding went to both private- and public-providers, so we refer to this funding stream as flexible. We use data from MDE that give the amount of each ELS recipient's scholarship used by zip code, aggregate up to the district-year level, and normalize by young children in the population. For zip codes split across district boundaries, we split the funds according to population weights using Census block centroids. Flexible spending averages $58 per young population child across district-years.

There are moderate positive correlations between the funding variables. Private-only funding per young child has a 0.12 correlation with public-only funding per young child and 0.22 correlation with flexible funding per child.

Parent characteristics: We use data from a new data series, the American Community Survey–Education Tabulation reports, for each school district for the five-year period centered on each study year, including the characteristics of parents of children up through age 17 who live in the district boundaries. We control for the share who are married, the share with at least a bachelor's degree, and the median earnings of fathers who work full time and full year (FTFY), a measure of family budgets that is more exogenous to the ECE service market than family income, mothers' earnings, or parents' earnings.

5 Results

We first present estimates of the effects of additional private voucher funding on local, private ECE provider capacity and price along with the elasticity of private ECE supply with respect to price that is implied by those estimates. Increasing public funding for private-provider-only ECE services by $100 per young child in the population increased licensed, privately provided ECE capacity per local young child by 4% or 0.024(=0.6*0.040) slots per local young child in a model with only school district fixed effects and year fixed effects and raised the average price of weekly, full-time ECE care by an estimated 0.3% or $0.56(=186.5*0.003) (Table 2: Columns 1 & 2). For the capacity outcome, both the outcome and policy variable are expressed per local young child. So these estimates imply that a new slot is created by about a $4,167(=100/0.024) increase in funding, a plausible estimate given that the annual price of private ECE slots averages about $10,000. This suggests that public funding may attract, rather than crowd out, private revenue. The implied elasticity estimate, the ratio of the private-only coefficients, is 11.6 and has a p-value of 0.051.[13]

The result remains similar after accounting for coincident changes in other ECE funding streams and parent characteristics, which could theoretically be important confounders. Adding controls for ECE funding per young child in each locale-year via public-provider-only

[13]The measurement process doubtlessly leads to measurement error in key policy variable of interest (F), which can bias regression estimates. In a simple regression, it's well known that if noise (ν) is classical, meaning independent of the true variable (F^*), then the coefficient bias is towards zero with $plim\hat{\beta}. = \beta.\frac{\sigma^2_{F^*}}{\sigma^2_{F^*}+\sigma^2_\nu}$. However, note that for the elasticity ($\frac{\beta_1}{\beta_2}$), the noisy policy variable (F) is the same in estimating both β_1 and β_2, so $\frac{\sigma^2_{F^*}}{\sigma^2_{F^*}+\sigma^2_\nu}$ is also the same in the numerator and denominator of the elasticity estimate and cancels out in the ratio. Beyond classical white-noise error, we conducted simulations to assess the impact of measurement error when ν is correlated with F^*. When we estimated simple SUR models with policy variables that had correlated measurement error, we observed that the coefficients for funding in both the capacity and price models exhibited the same degree of attenuation bias. This yielded a consistent measure of elasticity even in the presence of nonclassical measurement error. There are likely conditions under which this wouldn't hold, but in the simple simulation it did. It suggests measurement error is less of an issue with the elasticity than with the coefficients in the capacity or price models.

Table 2: Effects of private-provider-only spending per young child in the local population on log district total capacity per local young child and log district average price with estimate of implied elasticity of private supply

Model:	Baseline		Added Controls	
Outcome:	Ln(Capacity/child)	Ln(Price)	Ln(Capacity/child)	Ln(Price)
Private-only $100/yng child	0.040 ***	0.003 *	0.036 ***	0.003
	(0.007)	(0.002)	(0.009)	(0.002)
Public-only $100/yng child			0.001	0.001
			(0.027)	(0.006)
Flexible $100/yng child			0.019	-0.003
			(0.069)	(0.017)
% Parents BA+			0.001	0.000
			(0.005)	(0.001)
FTFY Father Earnings, $1000s			0.007 *	0.001
			(0.003)	(0.001)
% Parents Married			0.002	0.000
			(0.005)	(0.001)
Elasticity estimate, p-value	11.6, 0.051		10.7, 0.174	
District-years	2,219		2,219	

Note: Balanced panel of 317 districts in fiscal years ending 2012 to 2018 has 2,219 district-year observations. Each two-equation model estimated with seemingly unrelated regression. Indicators for the 0.02% of observations missing parent demographic are included but not displayed; no such coefficient is significant at 10%. Each equation includes district fixed effects and year fixed effects and allows clustering of errors within district. Significance: * 10%, ** 5%, *** 1%. Sources: NACCRRAware provider data; administrative data on CCAP, HS, VPK, and ELS programs; block and block-group child population data from 2010 Census and 2011-2015 ACS; MSDC; Parent demographic data from ACS-ED. Source detail in Table A.8.

funding and flexible funding and parent characteristics barely changes the estimates, implying our preferred estimate of supply elasticity at 10.7 (Table 2: Columns 3 & 4).

As noted earlier, the market-level changes in capacity and prices may be due to changes in prices at existing providers as well as due to changes in the composition of providers through entry of new providers or exit of incumbent providers. Table 3 provides some evidence on mechanisms by which the increase in capacity and prices occurred. The increased private-only funding led incumbent providers to raise their prices. There is also some evidence that the funding increase attracted new entrants with slightly lower prices than incumbents. The new funding strongly increases entry, lifting the provider entry rate by 0.4 percentage points from an average rate of 8%. The relationship with exit rate is weaker but appears negative (e.g, fewer exits when funding increases), which is consistent with funding supporting higher quantities. Effects on the composition of provider quality appear small. Increased voucher funding of $100 per population child is estimated to expand highly-rated providers' market share by a slight 0.5 percentage points.[14]

[14] This result is somewhat fragile. Analyzing effects on Ln(highly-rated capacity/young child) and on Ln(not-highly-rated capacity/young child) separately yields estimated effects that are slightly larger on the latter, so results are sensitive to functional form.

Table 3: Effects of private-only funding per young child in local population on within-provider and between-provider price indexes, provider entry and exit rates, and percent of capacity in highly-rated providers

	Δ_{t-2012} price	Price-Within	Price-Btwn	Entry Rate	Exit Rate	% High-Rated
Private-only $100/yng child	0.39	0.56 ***	-0.17	0.38 ***	-0.20	0.49 ***
	(0.30)	(0.20)	(0.21)	(0.10)	(0.23)	(0.17)
Public-only $100/yng child	-0.15	-0.10	-0.05	-0.08	0.16	0.26
	(0.20)	(0.16)	(0.13)	(0.10)	(0.12)	(0.19)
Flexible $100/yng child	-0.69	-0.59	-0.10	0.10	0.16	1.71 ***
	(0.69)	(0.54)	(0.40)	(0.33)	(0.44)	(0.64)
% Parents BA+	0.12	-0.06	0.18 **	-0.00	0.00	-0.09
	(0.12)	(0.09)	(0.08)	(0.06)	(0.08)	(0.09)
FTFY Father Earnings, $1000s	0.17	0.12	0.05	-0.02	-0.01	-0.01
	(0.12)	(0.10)	(0.05)	(0.06)	(0.05)	(0.07)
% Parents Married	-0.06	-0.03	-0.03	-0.03	-0.06	0.08
	(0.11)	(0.11)	(0.05)	(0.05)	(0.06)	(0.08)
Adj. R^2	0.204	0.178	0.014	0.290	0.264	0.939
District-years	1,902	1,902	1,902	2,219	2,219	2,219

Note: Each model includes district fixed effects and year fixed effects. Outcome variables are defined in the Data section. Fiscal years ending 2013 to 2018 for price change analysis with 2012 as base year omitted. Fiscal years ending 2012 to 2018 for entry and exit rates. Indicators for the 0.02% of observations missing parent demographic are included but not displayed; no such coefficient is significant at 10%. Each equation allows clustering of errors within district. Significance: * 10%, ** 5%, *** 1%.
Sources: NACCRRAware provider data; administrative data on CCAP, HS, VPK, and ELS programs; block and block-group child population data from 2010 Census and 2011-2015 ACS; MSDC; Parent demographic data from ACS-ED. Source detail in Table A.8.

6 Robustness

6.1 Spatial spillovers?

The main analysis assumes that there is no interaction or spillover between district markets. However, there is likely spillover between some districts. If funding in Minneapolis goes up but stays flat in St. Paul, the Minneapolis funding might cause a rise in demand, capacity, and prices in St. Paul as well as in Minneapolis because some newly funded Minneapolis families may purchase ECE services in St. Paul. This kind of spillover will tend to cause attenuation bias, where estimates are closer to zero than reality. Contrasts between neighboring districts' outcomes will be smaller due to spillover of funding effects. We study the effects of spatial spillovers with two additional analyses.

First we replicate the analysis of effects on capacity and price in a subsample of 65 school districts that are "isolated" ECE service markets. Our definition of isolated markets is strict and aims to capture locations where parents are most likely to shop within the area and not likely to look outside of that market for ECE care services. We start with Census-defined places with a population of 500 or more and that are at least seven miles apart from each other. Using Census shapefiles, we create 3.5-mile buffers around each Census place. We discard Census places that intersect with at least one other Census place that has a population of at least 500 according to 2010 Decennial Census. We also drop Census places that do not have a licensed child care provider during the covered period. There are 111 Census places that satisfy these criteria. Our sample for this analysis is thus limited to the 65 school districts that are contained in isolated markets.

The isolated markets subsample is interesting for two reasons. First, focusing on isolated markets attempts to avoid the attenuation bias described above. Second, isolated markets are, by definition, not in large, urban areas. The effects of increased voucher funding might differ in smaller, less urban areas, given different consumers, density, returns to scale, and input (labor, real estate) markets. For instance, if the distance between their home and their provider is an important barrier to consumers, then large child care centers will be less viable in communities with less population density.

Repeating the analysis of Table 2 with the isolated market subsample yields similar estimated effects on capacity and price and, consequently, similar estimated elasticities (Table 4). Dropping most of the sample leads to estimates that are less precise. Controlling for the potential confounders of other ECE funding streams and parental demographics makes little difference to the results. The fact that estimated effects and elasticities are similar suggests that neither heterogeneous elasticities nor attenuation bias from spillovers in the full sample appear to be a major concern.

Table 4: Effects of private-provider-only spending per young child in the local population on log district total capacity and log district average price with estimate of implied elasticity of private supply in the isolated market subsample

Model:	Baseline		Added Controls	
Outcomes:	Ln(Capacity/child)	Ln(Price)	Ln(Capacity/child)	Ln(Price)
Private-only $100/yng child	0.030	0.004	0.034	0.002
	(0.037)	(0.006)	(0.023)	(0.006)
Public-only $100/yng child			0.005	-0.002
			(0.009)	(0.002)
Flexible $100/yng child			0.064	-0.001
			(0.035)	(0.008)
% Parents BA+			0.003	0.001
			(0.004)	(0.001)
FTFY Father Earnings, $1000s			0.000	0.002
			(0.004)	(0.001)
% Parents Married			-0.004	-0.001
			(0.003)	(0.001)
Elasticity estimate, p-value	8.5, 0.684		13.9, 0.689	
District-years	455		455	

Note: Balanced panel of 65 isolated-market districts in fiscal years ending 2012 to 2018 has 455 district-year observations. Each two-equation model estimated with seemingly unrelated regression. Each equation includes indicators for the 0.02% of observations missing parent demographic are included but not displayed; no such coefficient is significant at 10%. Each equation includes district fixed effects and year fixed effects and allows clustering of errors within district. Significance: * 10%, ** 5%, *** 1%.
Sources: NACCRRAware provider data; administrative data on CCAP, HS, VPK, and ELS programs; block and block-group child population data from 2010 Census and 2011-2015 ACS; MSDC; Parent demographic data from ACS-ED. Source detail in Table A.8.

Second, analysis from a spatial Durbin model that allows spatial spillovers yields quantitatively similar results. The estimated effect of own funding on Ln(Capacity/young child) in Appendix Table A.2 is similar to that in Table 2 though the effect on Ln(Price) shifts from from 0.003 to -0.001. Though the signs differ, the estimates are close quantitatively and each is within the other's 95% confidence interval. We interpret these estimates as evidence consistent with small nonnegative (from theory) price effects. The spatial model also estimates the effect of spending in nearby districts. Here, the nearby funding has a larger estimated coefficient on capacity (0.046) than own funding does (0.030), which is surprising and doesn't make a lot of sense theoretically. However, again the quantitative difference is small and the estimates are not significantly different, even at 10%.

6.2 Additional specifications

We consider three additional specifications. First, we estimate the model and supply elasticity (with and without controls) with markets and variables defined at the county level, rather than the school district level, as a strategy to address concerns about possible spillover effects. The findings demonstrate similarities between the county- and district-level results (Appendix Tables A.3 to A.6). In models with controls, an increase of $100 in funding per young child for private-provider-only services resulted in a 3.6% increase in capacity per local young child at the district level and a 3.8% increase at the county level. The funding led to an estimated 0.3% increase in the average price of care at the district level and a 1% increase at the county level. This larger price effect implies a smaller elasticity estimate (4.0). Supply may be less responsive at this higher level of geographic aggregation because it is more difficult for child care labor to adjust at the county rather than school district level. Even still, these small estimated price changes highlight supply's relative elasticity, providing evidence that capacity expands significantly in response to changes in demand. However, our preferred market definition remains the school districts, as evidence suggests that the child care market tends to be relatively localized, with parents typically seeking care close to their homes or workplaces.[15]

Second, we instrument for price using the policy variable. The instrumental variables (IV) estimation method yields similar results. The F-stat is 14.5, above the old rule of thumb of 10 but much lower than the high levels advocated in more recent work. IV focuses on the relationship between how changes in Ln(Prices) affect Ln(Capacity/young child). The first estimation stage focuses on variation in prices driven by changes in the policy variables through demand. Each additional $100 in private-only funding per population child lifted prices by 0.003 log points or 0.3% (Table A.7). The second stage focuses on how that policy-induced price changes affected capacity. The 10.7 estimated coefficient on Ln(Avg Price) expresses the estimated elasticity directly and matches the estimate from the Added Controls models of Table 2.

Third, we estimate a long first-differences model, which yields similar results. Long difference estimators, by dropping data from the transition period, provide useful information about the importance of dynamic variation in treatment effects. With the same basic specification as the model reported in Table 2 with controls added, using only one observation for each district that is the difference between each district's last year value and its first year value (2018 value - 2012 value = change over 6 years) for outcomes and all predictors yields a coefficient for change in Ln(Capacity/young child) on change in private-only funding per child of 0.041 (p <0.001), a coefficient for change in Ln(Price) of 0.003 (p=0.104), and the implied elasticity estimate is 13.7 (p=0.107). This elasticity estimate is similar to the main estimate that uses all 7 years of data in levels. We would expect the long term elasticity to be more elastic than short term. However, the small difference suggests that dynamic variation in treatment effects may be small in this setting.

[15] As an example, the National Survey of Early Care and Education Project Team (2016) found that the driving distance between child care facilities and homes is generally less than five miles.

7 Conclusion

Despite evidence of substantial benefits to child human capital development from high-quality early care and education experiences (Cunha and Heckman, 2007; Council of Economic Advisers, 2016b), particularly for low-income children (Duncan and Sojourner, 2013; Elango et al., 2015), public investment in ECE is low in the United States relative to public spending at later ages (Council of Economic Advisers, 2016a; Davis and Sojourner, 2021) and compared to other nations Council of Economic Advisers (2016b). Much of the funding is through voucher programs that are used by parents at private providers. Thus, the responses of private providers in terms of capacity, price, and quality are important for policymakers to understand. Yet there is limited research on key parameters such as the supply elasticity and only a few studies of crowding out effects of public preschool funding.

This paper generates new, quantitative evidence on how funding for ECE services delivered through vouchers used at private providers affects ECE service markets. Consistent with theory, increased consumer subsidies expands the quantity of ECE care supplied by subsidy-eligible providers and their average price charged to private-pay customers. In the model with controls for ECE funding via other types of programs, parent characteristics, school district fixed effects, and year fixed effects, an additional \$100 in private voucher funding per young child in the district population would raise the number of private-provider slots by 0.026 per young child or 4% and raise average prices by \$0.56 per week (0.3%).[16] These estimates imply an elasticity of private-provider supply of 10.7. There is little evidence of heterogeneity in the effects and the elasticity of supply, in that the isolated markets analysis finds similar quantity and price effects.

The additional funding appears to accelerate entry of new providers who have similar or slightly lower price levels than incumbents. Incumbents raise their prices, perhaps reflecting a need to pay higher input prices (e.g., higher wages or rent) to expand scale. These market

[16] Adding \$100 per young child in the local population would represent an increase of about a fifth relative to the status quo.

responses to funding increases are reassuring given recent concerns about child care shortages and the “broken” child care market. Proponents of public supply sometimes argue that there is a shortage of privately provided care and that market failures prevent privately provided care from expanding to meet social needs. Our results provide evidence that privately supplied care expands to meet the demand induced by child care vouchers, and suggest that the supply is quite elastic. Furthermore, we find that higher voucher funding is associated with a slightly greater proportion of highly rated care. Whether public provision enables better quality assurance than vouchers is a pressing research question. However, extrapolation of these results to predict the effects of very large increases in funding is highly uncertain. A large expansion of public funding could lead to bottlenecks in the expansion of supply (for example, due to the time needed to train teachers and build and license facilities).

The most significant inputs in the production of child care are facility costs and labor costs (which include wages for both teaching and support staff, as well as hiring costs, training, and benefits). Some other important inputs are materials (e.g., books, licensed curriculum materials, toys, and furniture), food and supplies, and technology. Child care centers are often located in commercial spaces such as main street storefronts or suburban strip malls. Since child care businesses are only a small portion of the relevant market for commercial real estate, the supply of child care facilities is likely to be highly elastic, at least in the long term. In some older and denser urban areas, there may be fewer commercial properties that are suitable for child care businesses, and the supply of child care facilities may be less elastic.

It is more difficult to speculate on the extent to which the child care labor supply can adjust to accommodate changes in quantity. Many people are capable of becoming ECE teachers, and many find working with children desirable and rewarding. However ECE work can also be physically and emotionally demanding and does not currently attract high compensation. It is not clear how much wages would need to rise in order to attract more people to ECE work.

While exploration of the mechanisms of expansion are beyond the scope of this paper, we note that the measure of private provider quantity that we use, licensed capacity, is not a perfect measure of quantity. Many ECE providers operate with a small gap between licensed capacity and enrollment. If that is the case, quantity used (i.e., enrollment) may be able to respond more quickly and more than licensed capacity. As a result, using licensed capacity as a proxy for quantity will lead to a conservative estimate of the supply elasticity, estimating supply as less elastic than it actually is.

We acknowledge that our estimates have methodological limitations. First, these estimates are based on a two-way fixed effects model, which is not robust to heterogeneity in effects across units (Goodman-Bacon, 2021). Second, it uses a continuous treatment variable. This area of econometrics is evolving rapidly (Callaway et al., 2021), and rather than presenting results that would depend on researcher choices about which the literature does not yet provide definitive guidance, we prefer to present the results from traditional two-way fixed effects estimation which applies the stronger conditional parallel trends assumption symmetrically to all observations. In light of the new difference-in-differences literature and the absence of consensus best-practices for continuous policy variables, caution is warranted in interpreting any two-way fixed effects results.

While this study provides important new insights into the role of public funding in child care markets, the results are based on one state, and state-specific regulations and local labor market and child care market conditions could result in different supply responses in different locations. Minnesota tends to have relatively strict child care regulations, and supply responses may be even more responsive in states with fewer restrictions. Minnesota also has median income higher than the average state, and more college educated workers. These factors may influence the demand for child care. An important focus of future research will be to explore how supply responses differ in different states, and how these differences are related to regulatory and labor market conditions.

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A Appendix

A.1 Children served

Table A.1: Number of Minnesota children aged 0–5 years served, by program

Program	Number served	Fiscal Year
Child Care Assistance Program	25,900	2016
Early Head Start	2,878	2017
Head Start	11,886	2017
Minnesota Early Learning Scholarship	11,250	2016
School-Readiness Pre-Kindergarten	21,000	2016
Voluntary Pre-Kindergarten	4,300	2016

These data come from the State of Minnesota Office of the Legislative Auditor's "Early Childhood Programs 2018 Evaluation Report."[17]

A.2 Spatial model

Child care market may extend beyond the limits of school districts, with market participants freely crossing boundaries when making choices about where to establish or seek their services. One way to deal with potential spillover between markets is to model spatial interactions across school districts. We estimate a spatial panel-data model that allows each district's outcomes to be affected not just by policy changes within its borders but also policy changes and outcome changes in nearby districts, with nearby districts' influence assumed to be a declining function of distance. The spatial Durbin model uses the 317×317 spatial weighting matrix (W) that expresses the spatial weight between all district pairs' centroids. Abusing notation slightly to now let F capture the vector of treatment and control variables, the model becomes

$$Y_{lt} = \rho W Y_{lt} + \beta F_{lt} + \lambda W F_{lt} + \gamma_l + \tau_t + \epsilon_{lt}, \tag{A.1}$$

where ρ captures the direct spatial effect, indicating how the outcome is influenced by nearby

[17] https://www.auditor.leg.state.mn.us/ped/pedrep/earlychildhood.pdf

districts' outcome. β is the vector of coefficients for funding and other time-varying control variables within own districts, and λ represents the influence of funding and control variables of neighboring districts on capacity and price of district l.

Table A.2: Effects of private-only funding per young child in population on private log total capacity per young child and log average price allowing for spatial correlation

	Ln(Capacity/yng child)	Ln(Avg. Price)
Own		
Private-only \$100/yng child	0.030***	-0.001
	(0.010)	(0.002)
Public-only \$100/yng child	-0.000	0.001
	(0.003)	(0.001)
Flexible \$100/yng child	0.024**	-0.001
	(0.012)	(0.004)
% Parents BA+	0.000	0.001
	(0.002)	(0.001)
FTFY Father Earnings, \$1000s	0.005***	0.001
	(0.001)	(0.000)
% Parents Married	0.002	-0.000
	(0.002)	(0.000)
Nearby districts'		
Private-only \$100/yng child	0.046*	0.004
	(0.027)	(0.013)
Public-only \$100/yng child	0.006	-0.012**
	(0.016)	(0.006)
Flexible \$100/yng child	0.026	0.017
	(0.036)	(0.014)
% Parents BA+	-0.012	0.007*
	(0.009)	(0.004)
FTFY Father Earnings, \$1000s	0.027***	-0.002
	(0.008)	(0.002)
% Parents Married	0.016	-0.003
	(0.011)	(0.004)
Spatial		
ρ	0.183***	-0.041
	(0.049)	(0.117)
Variance		
σ_e^2	66.053***	8.250***
	(7.062)	(0.861)
Observations	2219	2219
R^2	0.025	0.405

Note: Fiscal years ending 2012 to 2018 estimated by spatial regression with both year and district fixed effects. Standard errors allow for spatial correlation and clustering within district. Indicators for the 0.02% of observations missing parent demographic are included but not displayed. Some are significant. Significance: * 10%, ** 5%, *** 1%.
Sources: NACCRRAware provider data; administrative data on CCAP, HS, VPK, and ELS programs; block and block-group child population data from 2010 Census and 2011-2015 ACS; MSDC; Parent demographic data from ACS-ED. Source detail in Table A.8.

Table A.3: Summary statistics across county-years

	Mean	SD	Min	Max
Private-only \$100/yng child	4.73	2.65	0.01	9.28
Public-only \$100/yng child	3.26	2.95	0.01	25.77
Flexible \$100/yng child	0.59	0.56	0.00	5.90
Capacity / yng child	0.60	0.12	0.16	1.13
Price	187.22	54.11	87.59	281.17
$\Delta\_t - 2012$ avg price	6.48	5.53	-24.96	39.54
Within-provider price index	4.70	4.89	-32.09	42.16
Between-provider price index	1.78	2.39	-26.46	28.79
Provider entry rate (%)	7.91	4.16	0.00	42.86
Provider exit rate (%)	11.46	4.40	0.00	45.45
Highly rated capacity / yng child	0.18	0.07	0.01	0.35
Highly rated price	220.99	65.90	69.90	313.44
Not highly rated capacity / yng child	0.42	0.15	0.12	0.99
Not highly rated price	168.78	42.96	86.53	250.07
Highly rated provider % of capacity	31.18	14.30	0.00	69.88
% Parents BA+	42.03	12.63	0.00	62.50
Family income with children , \$1000s	85.68	18.21	35.00	136.86
% Parents Married	77.88	4.35	0.00	97.85

Note: Funding variables are in hundreds of \$ per population young child. All variables are weighted by the number of young (aged 0–5 years) children in each county boundary's population across years, as in the analysis. % Parents BA+ is percent of parents of children up through age 17 in the county-year who have at least a bachelor's degree. Family income with children is the median family income with children under 18 years. The parent demographic variables are missing in 1 (0.16% of) observation. Values are replaced with 0 and indicators for missing values included in models with controls.
Sources: NACCRRAware provider data; administrative data on CCAP, HS, VPK, and ELS programs; block and block-group child population data from 2010 Census and 2011-2015 ACS; MSDC; Parent demographic data from ACS-ED. Source detail in Table A.8.

Table A.4: Effects of private-provider-only spending per young child in the local population on log total capacity and log average price with estimate of implied elasticity of private supply using counties

Model:	Baseline		Added Controls	
Outcome:	Ln(Capacity/child)	Ln(Price)	Ln(Capacity/child)	Ln(Price)
Private-only $100/yng child	0.068 ***	0.010	0.038 **	0.010
	(0.014)	(0.006)	(0.013)	(0.007)
Public-only $100/yng child			0.005	0.000
			(0.024)	(0.009)
Flexible $100/yng child			0.065	-0.005
			(0.055)	(0.021)
% Parents BA+			-0.001	0.002
			(0.009)	(0.004)
Family income with children, $1000s			0.009 **	-0.000
			(0.003)	(0.001)
% Parents Married			-0.001	-0.001
			(0.008)	(0.003)
Elasticity estimate, *p*-value	7.1, 0.213		4, 0.158	
County-years	609		609	

Note: Balanced panel of 87 counties in fiscal years ending 2012 to 2018 has 609 county-year observations. Each two-equation model estimated with seemingly unrelated regression. Indicators for the 0.16% of observations missing parent demographic are included but not displayed; no such coefficient is significant at 10%. Each equation includes district fixed effects and year fixed effects and allows clustering of errors within county. Significance: * 10%, ** 5%, *** 1%.

Sources: NACCRRAware provider data; administrative data on CCAP, HS, VPK, and ELS programs; block and block-group child population data from 2010 Census and 2011-2015 ACS; MSDC; Parent demographic data from ACS-ED. Source detail in Table A.8.

Table A.5: Effects of private-only funding per young child in population on within-provider and between-provider price indexes and provider entry and exit rates using counties

	Δ_{t-2012} price	Price-Within	Price-Btwn	Entry Rate	Exit Rate	% High-Rated
Private-only $100/yng child	0.53	1.24 ***	-0.70 **	0.28	-1.05 **	0.043
	(0.39)	(0.33)	(0.29)	(0.33)	(0.41)	(0.642)
Public-only $100/yng child	-0.08	0.18	-0.26	-0.17	0.12	0.252
	(0.22)	(0.19)	(0.18)	(0.19)	(0.21)	(0.244)
Flexible $100/yng child	0.07	1.15	-1.07 **	0.22	1.27 *	0.178 **
	(0.92)	(0.94)	(0.43)	(0.50)	(0.71)	(0.866)
% Parents BA+	0.10	-0.09	0.19	-0.06	-0.27 *	0.264
	(0.14)	(0.11)	(0.12)	(0.11)	(0.14)	(0.206)
Family income with children, $1000s	0.27 ***	0.19 **	0.08 *	0.01	0.12	0.176
	(0.09)	(0.09)	(0.04)	(0.05)	(0.09)	(0.124)
% Parents Married	0.07	0.19	-0.12	0.13	0.16	0.056
	(0.17)	(0.16)	(0.13)	(0.09)	(0.14)	(0.120)
Adj. R^2	0.606	0.580	0.167	0.566	0.506	0.966
County-years	522	522	522	609	609	609

Note: each model includes county fixed effects and year fixed effects. Fiscal years ending 2013 to 2018 for price change analysis with 2012 as base year omitted. Fiscal years ending 2012 to 2018 for entry and exit rates. Indicators for the 0.16% of observations missing parent demographic are included but not displayed; coefficients are not significant at 10%. Each equation allows clustering of errors within county. Significance: * 10%, ** 5%, *** 1%. Source: NACCRRAware ECE Provider data 2012-2018, Minnesota administrative data on programs CCAP, HS, VPK, ELS. Block and Block-group child population data from 2010 Census and 2011-2015 ACS; MSDC; Parent demographic data Parent ACS (see Table A.8 for detail).

Table A.6: Effects of private-only funding per young child in population on private log total capacity per young child and log average price allowing for spatial correlation using counties

	Ln(Capacity/yng child)	Ln(Avg. Price)
Own		
Private-only $100/yng child	0.050***	-0.002
	(0.010)	(0.003)
Public-only $100/yng child	0.003	0.000
	(0.005)	(0.001)
Flexible $100/yng child	0.071***	0.001
	(0.015)	(0.005)
% Parents BA+	-0.003	0.003***
	(0.002)	(0.001)
Family income with children, $1000s	0.007***	-0.000
	(0.002)	(0.000)
% Parents Married	-0.001	-0.001
Nearby counties		
Private-only $100/yng child	-0.016	-0.052
	(0.245)	(0.062)
Public-only $100/yng child	-0.269***	-0.074***
	(0.074)	(0.024)
Flexible $100/yng child	0.091	0.110
	(0.226)	(0.081)
% Parents BA+	-0.109*	0.048**
	(0.057)	(0.020)
Family income with children, $1000s	0.023	0.021***
	(0.028)	(0.007)
% Parents Married	-0.150**	-0.033*
	(0.059)	(0.018)
Spatial		
rho	0.113	-3.108***
	(0.386)	(0.680)
Variance		
sigma2_e	64.514***	8.375***
	(7.078)	(0.983)
Observations	609	609
R^2	0.030	0.777

Note: Fiscal years ending 2012 to 2018 estimated by spatial regression with both year and county fixed effects. Standard errors allow for spatial correlation and clustering within county. Indicators for the 0.16% of observations missing parent demographic are included but not displayed. Some are significant. Significance: * 10%, ** 5%, *** 1%.

Sources: NACCRRAware provider data; administrative data on CCAP, HS, VPK, and ELS programs; block and block-group child population data from 2010 Census and 2011-2015 ACS; MSDC; Parent demographic data from ACS-ED. Source detail in Table A.8.

Table A.7: Estimated elasticity of private supply from IV regression of log total capacity per young child on log average price instrumenting with private-only, flexible, and public-only spending per young population child

	First Stage		Second Stage
	Ln(Price)		Ln(Capacity/yng child)
Private-only $100/yng child	0.003	*	
	(0.002)		
Public-only $100/yng child	0.001		-0.008
	(0.001)		(0.014)
Flexible $100/yng child	-0.003		0.057
	(0.004)		(0.058)
% Parents BA+	0.000		-0.004
	(0.001)		(0.008)
FTFY Father Earnings, $1000s	0.001		-0.001
	(0.000)		(0.007)
% Parents Married	0.000		0.002
	(0.001)		(0.006)
ln(Avg Price)			10.740
			(7.400)
Weak instrument F-stat			14.5
Adj. R^2			-9.583
District-years	2,219		2,219

Note: Fiscal years ending 2012 to 2018 estimated by two-stage least squares with district fixed effects and year fixed effects. Indicators for observations missing parent demographic are included but not displayed; no such coefficient is significant at 10%. Allows clustering of errors within district. Significance: * 10%, ** 5%, *** 1%.
Sources: NACCRRAware provider data; administrative data on CCAP, HS, VPK, and ELS programs; block and block-group child population data from 2010 Census and 2011-2015 ACS; MSDC; Parent demographic data from ACS-ED. Source detail in Table A.8.

Table A.8: Data Sources

	Abbr.	Years	Data observed	Source
Program Data				
D1: Early Learning Scholarship	ELS	2013–2018	Zipcode	Minn. Department of Education
D2: Voluntary Pre-Kindergarten	VPK	2016–2018	Zipcode	Minn. Department of Education
D3: Head Start	HS	2012-2018	Provider Location	Minn. Department of Education
D4: Child Care Development Fund	CCAP	2012–2018	Residential Location	Minn. Department of Education
Provider Data				
D5: Capacity and Price	NACCRRAware	2012–2018	Provider location	NACCRRAware ECE Provider data
Policy population Weight & Outcome Denominator				
D6: Population Count, Block	2010 Census	2010	Census Block	NHGIS 2010 Decennial Census
D7: Population Count, Block Group	2011–2015 ACS	2011–2015	Census Block Group	NHGIS American Community Survey 5-year estimates
D8: Time-varying Population Count, County	MSDC	2012–2018	County	Minnesota State Demographic Center
Additional Controls				
D9: Parent characteristics, District	Parent ACS-ED	2012–2018	School District	NCES American Community Survey-Education Tabulation
D10: Parent characteristics, County	Parent ACS	2012–2018	County	NHGIS American Community Survey 5-year estimates

D1:https://education.mn.gov/MDE/index.htm
D2:https://education.mn.gov/MDE/index.htm
D3:https://education.mn.gov/MDE/index.htm
D4:https://education.mn.gov/MDE/index.htm
D5:https://mn.gov/dhs/
D6:https://www.nhgis.org/
D7:https://www.nhgis.org/
D8:https://mn.gov/admin/demography/data-by-topic/population-data/our-estimates
D9:https://nces.ed.gov/programs/edge/Demographic/ACS
D10:https://www.nhgis.org/