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Child Care Markets, Parental Labor Supply, and Child Development

Samuel Berlinski
Maria Marta Ferreyra
Luca Flabbi
Juan David Martin

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Abstract

This paper develops and estimates a model of supply and demand for child care. On the demand side, one- and two-parent households make consumption, labor supply, and childcare decisions. On the supply side, non-parental care providers include child care centers, paid caregivers who operate at the child's home, and unpaid, informal care-givers. Centers make entry, price, and quality decisions under monopolistic competition. Child development is a function of the time spent with each parent and non-parental care providers; these inputs vary in impact. The model's structural parameters are estimated using the 2003 Early Childhood Longitudinal Study, which contains information on parental employment and wages, child care choices, child development, and center quality. The model features locations that differ in size and median family income. Parameter estimates are used to evaluate multiple policies including vouchers, cash transfers, and public provision. Vouchers that can only be used in high-quality centers or that require mothers to work are particularly effective, as they deliver child development gains while increasing mothers' labor supply, thereby limiting policies' fiscal cost.

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Samuel Berlinski
Inter-American Development Bank
and IZA

Maria Marta Ferreyra
The World Bank

Luca Flabbi
University of North Carolina at Chapel Hill
and IZA

Juan David Martin
Banco de la Republica Colombia

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1 Introduction

Parental inputs play a critical role in child development.[1] At a child's young age, parental time is particularly important and presents parents with crucial trade-offs as they allocate their time between the labor market, child care, and leisure. By supplying labor in the market, parents receive income and support consumption but lower their time available for child care. A specific institution is at the center of these trade-offs in the child's early years: the child care market. Parental demand in this market is met by a variety of providers, including dedicated centers outside the home as well as caregivers who operate inside the child's home. The role of these providers, which not only relax parental time constraints but also contribute to child development, is key to the policy debate, particularly when discussing family-friendly policies.[2] The objectives of policy advocates are not always the same. The traditional argument is that increasing access to child care services would raise female labor force participation, thereby increasing national output as well as women's human capital and self-sufficiency. More recent arguments have focused on child care impacts on children, as high-quality child care for disadvantaged children has been shown to improve children's skills and well-being, with positive long-term effects.[3]

In countries with well-developed child care markets, child care use is a market equilibrium outcome. In these markets, providers choose their service quality and price while parents choose the quantity and quality of child care services to purchase. Therefore, a sound evaluation of proposals to expand child care access must investigate their impact on child care demand and supply while accounting for effects on child development and parental labor market outcomes.

This paper develops and estimates a model of supply and demand for child care. On the demand side, parents who face a set of wage offers and child care options decide on consumption, labor supply, and child care. Child development–which we measure by a cognitive score–is a function of time spent with parents and with non-parental providers. We allow for two-parent and one-parent households, recognizing that childcare needs are particularly pressing for the latter. On the supply side, child care providers include dedicated centers outside the home, paid providers at the child's home (such as nannies and babysitters), and informal, unpaid providers outside the child's home (such as grandparents and other relatives). We model the market for center-based care as one of monopolistic competition with vertical and horizontal differentiation, and endogenize center entry through a two-stage game. In the first stage, potential entrants decide on entry and quality; in the second stage, actual entrants choose prices.[4] Households are heterogeneous in marital status, parental wage offers

[1] The relationship between parental inputs and child development has been heavily studied; see reviews in Heckman et al. (2005), Björklund and Salvanes (2011), and Currie and Almond (2011).

[2] For a general policy review, see Chzhen et al. (2019). For policies specific to young children, see UNICEF (2017) and Grimshaw and Rubery (2015).

[3] Notable examples of high-quality child care programs in the US are the Perry Preschool Project and the Abecedarian Program. They are described and evaluated in, among others, Heckman et al. (2010b,a); Conti et al. (2016); Campbell et al. (2014a). For a recent review on early childhood programs and their impacts, see Currie (2001) and Berlinski and Vera-Hernández (2019).

[4] Similar two-step games are implemented in Mazzeo (2002), Dranove et al. (2003), and Seim (2006). For an example of monopolistic competition among schools, see Urquiola and Verhoogen (2009).

and education, initial child development, preferences, availability of informal care, and location. Child care providers are heterogeneous in their marginal costs–capturing, for instance, heterogeneous managerial ability.

To see the relevance of the equilibrium mechanisms in our model, consider a policy that provides child care vouchers to all households. Such policy would raise the demand and use of child care and, if the supply of child care centers did not change, it would raise prices by a given amount. Our model, however, allows incumbents to alter their supply and also allows for the entry of new providers, leading to a lower price increase (or even a decrease) and a greater expansion of child care use than if supply did not change. These equilibrium effects are crucial when evaluating the large-scale policies often proposed to increase access to center-based care.

We estimate the model's structural parameters by Simulated Method of Moments (SMM) using data from the Early Childhood Longitudinal Study (ECLS). We focus on the ECLS birth cohort (ECLS-B), which is a nationally representative sample of children born in 2001 and followed from birth through kindergarten. We use the second wave, conducted between January 2003 and December 2003, when the children were two years old. The data are well suited for our study because they contain information parental labor supply, child development, child care modes, and providers' quality. We focus on households with two-year-old children because the child care market for this age features mostly private providers and has a large expansion potential.[5]

The estimated model fits the data well. It replicates the patterns of child care quality and price across households of different parental income, education, labor supply, and marital status. It also replicates the variation of child care markets across locations, which we define based on size (children population) and income (median family income). The point estimates show that parents value child development and mothers' time inputs are very effective in producing child development. A novel result for children of this age is the high substitutability between time with parents and time with other care providers. Location-specific parameters imply that parental wage offers and cost of care rise with location size and income, albeit not at the same rate. As a result, high-quality child care centers are less costly relative to wages in large, high-income locations than in others.

We use the estimated model to simulate two types of policies: subsidy-based policies (vouchers and cash transfers) and public provision (e.g., public control of supply). We consider universal vouchers as well as vouchers provided only to individuals that satisfy income or work requirements, or that can only be used to attend high-quality centers. The simulations, which take into account child care market equilibrium effects, deliver large effects for universal, employment-based, and quality-based vouchers, and small effects for cash transfers, income-targeted vouchers, and public provision. All policies raise average child development relative to the baseline but the increase is small and mostly driven by children who switch from low- to high-quality centers. The impact on mothers' labor supply is more substantial, and highest among mothers with less than a college degree. Comparing vouchers with and without work requirements shows that if access to center-based care were subsidized, many

[5] Enrollment rates in center-based care at ages 3 to 5 are relatively high in developed countries (Laughlin (2013) and Chzhen et al. (2019)), and provision is frequently public. The US has seen a stable increase in public preschool programs targeting children ages three and four but not two.

women would choose to work even in the absence of work requirements. Interestingly, most policies lead to a decline in the average price of center-based care although they expand its demand because of equilibrium effects on the supply side. Indeed, the policies lead the most efficient incumbents to expand and offer high-quality services while encouraging the entry of additional providers. Accounting for equilibrium effects also illustrates that some voucher policies could "pay for themselves" by increasing mothers' labor supply and aggregate household income, thereby lowering the implicit tax rate needed to finance the policies. Location characteristics affect some policy implications. For example, vouchers-based policies expand the use of child care centers in all locations but to a greater extent in large, high-income locations due to two equilibrium channels. On the demand side, higher-income locations have a higher share of college-educated households, in which mothers have greater incentives to join the workforce and hire center-based care. On the supply side, larger locations have a larger customer base, favoring the entry of more centers in the market.

Which policy is preferable depends on the policy maker's objective. If the goal is maximizing aggregate household income through increases in female labor supply, then vouchers with work requirements are the best choice according to our simulations. If the goal is maximizing child development gains, then vouchers to attend high-quality centers are the best choice. Further, the preferable policy varies across locations. For example, quality-based vouchers are the best option to maximize child development gains in large locations but universal vouchers are best for small locations. In a large location, limiting vouchers to high-quality centers does not impose a substantial constraint because the large size encourages entry by high-quality providers under *any* voucher program. In contrast, a small location may not support many high-quality providers, which hinders the usefulness of quality-based vouchers. Regardless of specific features and locations, what makes vouchers effective is that, by harnessing the power of the market, they trigger a supply expansion and deliver widespread gains, whereas attempts to publicly control supply shrink the market and only benefit those initially using center-based provision.

Although no other study models both supply and demand of child care, numerous contributions have focused on a single side of the market. On the demand side, a large literature looks at parental labor supply, child care use, and child development. The first strand of this literature starts with the early contributions based on static labor supply models with unitary households that make employment and child care decisions.[6] These papers use various US datasets and estimate reduced form and structural models to identify the effect of child care costs on female labor supply and child care demand. They find that, consistent with the neoclassical model, maternal employment and use of formal child care are sensitive to child care costs. Child care subsidies, particularly for the poor, can substantially increase labor force participation and child care use. Our modeling of parents' labor supply is similar to that of these first-generation papers.

The second strand of the demand-side literature conducts impact evaluation of child care subsidy policies to estimate their effect on maternal employment and child development outcomes.[7] For example, Baker et al. (2008) analyze the introduction of the $5-dollar-a-day

[6]See, for example, Heckman (1974b), Blau and Robins (1988), Ribar (1992), Kimmel and Connelly (2007).

[7]There is a growing literature on child development impacts of parental leave policies (e.g., Dustmann and Schonberg (2012) and Carneiro et al. (2015)).

child care policy in Quebec, Canada. They find an increase in child care use and maternal employment yet negative effects on child outcomes. Havnes and Mogstad (2011b) find that universal child care in Norway crowds out informal care modes but does not increase maternal employment. The impact on long-run children's outcomes is heterogeneous, with positive effects at the bottom of the income distribution and negative at the top. Our model captures such effects by introducing rich heterogeneity in demand and supply while allowing some structural parameters to vary with mothers' education.

The third strand of the demand-side literature studies the effect of maternal time as an input for child development. The earlier papers estimate hybrid equations, where parameters embody both technological properties of the production function and the effect of mediating variables. For example, Ruhm (2004) uses data on the children of individuals from the National Longitudinal Survey of Youth (NLSY), and finds that maternal employment during the first three years of life is negatively associated with children outcomes at ages three to five. Bernal and Keane (2011) evaluate the effect of child care versus maternal time using single mothers from the NLSY79. Exploiting exogenous variation in welfare policy rules, they find a negative effect of child care relative to maternal care on child development. Attanasio et al. (2020) estimate dynamic factor models of child cognitive and socio-emotional skills as a function of endogenous material and time investments, and find that time inputs are an important determinant of child outcomes.[8] Our model includes both mother's and father's time as inputs in child development production as well as time with non-parental providers, whose impact varies across providers.

The fourth strand of the demand-side literature employs a fully structural approach. Bernal (2008) estimates a dynamic model of employment, child care use, and production of child cognitive ability, which allows her to handle endogeneity in maternal employment and perform counterfactuals. She estimates the model on a sample of single mothers from the NLSY79, and finds that a child care subsidy would increase overall parental utility yet at the expense of child development. Also in the context of dynamic structural model of skill formation, Del Boca et al. (2014) use the Child Development Supplements of the Panel Study of Income Dynamics and exploit detailed data on parental time use with children rather than the usual, coarse measure of maternal employment. Consistent with the rest of the literature, they find that parental time inputs are relatively more important than material resources for children's cognitive development.[9] Our paper also seeks to recover the structural parameters underpinning parents' decision. In addition, it models the supply side of the market. To handle the inherent complexity of endogenizing both demand and supply, it uses a static rather than a dynamic framework.

The supply-side literature is much more limited in number of papers and scope. Blau and Mocan (2002) estimate the relationship between cost and child care quality with data from a US sample of child care centers. Using a center quality measure similar to ours, they show that the supply of quality is moderately elastic with respect to prices and child

[8]Cunha et al. (2010) and Agostinelli and Wiswall (2016) also estimate dynamic models but do not separate returns to material and time investments.

[9]Within this structural approach, Liu et al. (2010) is a rare contribution estimating a dynamic model which includes a location decision affected by K-12 school quality, in addition to labor supply and child quality production. This paper does not include maternal time as an input in child development.

care worker wages. Based on US longitudinal data, Hotz and Xiao (2011) find that more stringent regulations on establishment inputs increase quality (particularly in high-income locations) but reduce child care provision (particularly in low-income locations). Bastos and Cristia (2012) develop a model of monopolistic competition to explain the behavior of child care providers in a large Brazilian city. Consistent with their model, they find a positive empirical association between household income and child care quality. We also model the supply side as one with monopolistic competition. We build on the two-stage model of Mazzeo (2002), whose study is known in the industrial organization literature as one of the first to estimate an entry model with endogenous product characteristics (Reiss and Wolak (2007)). This framework has been extended and adapted to study competition among health maintenance organizations (Dranove et al. (2003)), and in the the video retail (Seim (2006)) and airline industries (Ciliberto and Tamer (2009)).

The remainder of the paper is organized as follows. Section 2 describes the model, and Section 3 presents the data. Section 4 discusses econometric issues, including identification and estimation procedure. Section 5 presents the estimation results, and Section 6 reports the policy simulations. Section 7 concludes, and Appendices A–F contain additional materials.

2 Model

The economy includes two sets of agents: households and child care providers. Households consist of one or two parents and one child. Parents are the decision makers, as they choose their own labor supply and the child's care. They can care for the child fully by themselves, in which case they cannot both work full time. They can also use non-parental child care providers, in which case they have three options. The first is child care centers, operated by private firms. Potential center-based providers decide whether to enter the market or not, and choose quality and price. Their supply is endogenous; in equilibrium, it depends on parental demand. The second option is paid caregivers, such as nannies and baby-sitters (henceforth, non-relatives), that provide a homogeneous quality service at the child's home, at an equilibrium-determined price. The third option is unpaid caregivers, such as grandparents or other relatives (henceforth relatives), who provide the services in their own homes. Their services are of homogeneous quality and free, yet are only available to some households (e.g., those that have grandparents living nearby). In equilibrium, no household wishes to alter its decisions on labor supply or child care, and actual providers make non-negative profits and do not wish to alter their price or quality.

2.1 Environment

2.1.1 Households

Each household includes either one or two parents and operates under a unitary model, where parents maximize total household utility. Two-parent households include a mother (denoted by subscript m), a father (denoted by subscript f), and a child. One-parent households include a mother and one child. Since one-parent households are a straightforward specialization of two-parent households, we focus here on two-parent households and discuss one-parent households in Appendix A.1.

The economy is populated by a continuum of households of mass M. There are J household types, each with measure M_j. Household types vary in labor market opportunities (wage offers), preferences, initial level of child development, and availability of relative care. To facilitate exposition, we define the environment conditioning on a given type j and suppress the dependence on j. There are $(S+3)$ possible child care options: S center-based child care providers, non-relative care (provided at home), relative care (if available), and exclusive parental care (at home). Without loss of generality, we sort the alternatives so that $s = 1, ..., S$ denotes a child care center, $s = S+1$ denotes non-relative care, $s = S+2$ denotes relative care, and $s = S+3$ denotes exclusive parental care.

Household utility function is given by:

$$U_s = c^{\alpha_c} q^{\alpha_q} l_f^{\alpha_f} l_m^{\alpha_m} \exp(\varepsilon) \tag{1}$$

where c is total household consumption, q is child development, l_f and l_m denote father's and mother's leisure, respectively, and ε represents the household's idiosyncratic preferences for the chosen child care mode. Each household has a $(S+3) \times 1$ vector of idiosyncratic preferences, $\boldsymbol{\varepsilon}$, with one element per child care option. These vectors are independently distributed among households, and vary within and between household types. We follow Del Boca et al. (2014) and others by imposing homogeneity of degree one in the utility function: $\alpha_c + \alpha_q + \alpha_f + \alpha_m = 1$.

The household faces a budget constraint:

$$c = h_f w_f + h_m w_m - t_d p(s) + I, \tag{2}$$

where $\{w_f, w_m\}$ are parents' hourly wages, $\{h_f, h_m\}$ are parents' daily hours of labor supply, I is non-labor income, and t_d is the daily hours spent by the child in non-parental care (center, relative, or non-relative) at the hourly price of $p(s)$. Prices can vary across child care centers; non-relatives, in contrast, all charge the same price, and relatives are free. When the child only receives parental care, $t_d p(s) = 0$. Since the model is static, all income is spent either in consumption or child care services.

The household also faces a set of time constraints:

$$\text{Father} : \quad h_f + t_f + l_f = 16 \tag{3}$$

$$\text{Mother} : \quad h_m + t_m + l_m + \xi \mathbb{I}_{\{s \in S \cup (S+2)\}} = 16 \tag{4}$$

$$\text{Child} : \quad t_f + t_m + t_d = 16 \tag{5}$$

where $\{t_f, t_m\}$ are daily hours of care provided by the parents, $\mathbb{I}$ is the indicator function, and ξ is the homogeneous time cost associated with using one of the S centers or relative care (option $S+2$). We introduce this time cost to differentiate between forms of care outside the home, which require parent's time to drop-off and pick-up the child, and forms of care provided at home, which do not require it. For simplicity we assign the time cost to mothers but father's time allocation choices are also affected by the time cost through the common child time constraint (5). The interpretation of time constraints is as follows. Each household member sleeps for eight hours and is therefore endowed with 16 hours a day. Parent x can devote her time to working h_x hours, caring for the child for t_x hours, or enjoying l_x hours of leisure. Child spends t_f and t_m hours a day with father and mother, respectively, and t_d hours a day in non-parental child care.

Child development is produced according to a Constant Elasticity of Substitution (CES) production function. Inputs are parents' time $\{t_f, t_m\}$ and time spent with non-parental care providers, t_d.[10] In a value-added sense, these are added to the *ex ante* child development, q_0, and produce (current) child development as follows:[11]

$$q - q_0 = \gamma_0 + \left\{\gamma_f t_f^r + \gamma_m t_m^r + \gamma(s) t_d^r\right\}^{\frac{1}{r}} \tag{6}$$

where parameter r governs the substitution elasticity (equal to $1/(1-r)$) between time inputs. This functional form allows for substitutability or complementarity among inputs; it nests common functional forms such as linear ($r = 1$) and Cobb-Douglas ($r = 0$). The specification also allows mother's productivity to differ from father's as $\{\gamma_f, \gamma_m\}$ govern the returns to the time spent with the father and mother, respectively. The coefficient on time spent with non-parental care provider s is $\gamma(s)$. *Ex ante* child development, q_0, captures the contribution of all past inputs to child development, in the spirit of the child development process modeled by Cunha et al. (2010). Finally, γ_0 is a constant.

Household types reflect the *ex ante* heterogeneity of households, prior to their decisions on labor supply and child care. Each type j is characterized by a vector of preference parameters over consumption, child development, and leisure, $\boldsymbol{\alpha}(j) \equiv \{\alpha_c(j), \alpha_q(j), \alpha_f(j), \alpha_m(j)\}$; a vector of wage offers for the two parents, $\boldsymbol{w}(j) \equiv \{w_f(j), w_m(j)\}$; an initial child development value, $q_0(j)$; and whether relative care is available, $d^R(j)$, where $d^R(j)$ is equal to 1 if household type j has this form of care available, and 0 otherwise. While household types reflect non-idiosyncratic heterogeneity, households *within a type* may have different idiosyncratic preferences for a given child care option as captured by ε_s in equation (1). For example, two same-type households may have different preferences over unobserved attributes of child care centers (e.g., proximity to home or languages spoken at the center) and, as a result, choose different centers. These preferences are common in random utility models such as ours. By creating a taste for variety on the part of households, they create horizontal differentiation in the child care market.[12] In addition, our model features vertical (quality) differentiation as parents value child care quality but differ in their ability to pay for it.

[10]Lack of data prevent us from adding goods as an input in child development. This restriction is of little consequence because of our focus on two-year-old children. According to the American Academy of Pediatrics (Shonkoff et al., 2012), and as shown by the home-visiting literature (Grantham-McGregor et al. (1991) and Zhou et al. (2022)), at age two the most essential factor is "a nurturing, protective network of relationships with adults" as opposed to factors more closely related to monetary investments. We argue that such relationships can be well captured by time spent with the child and its impact on child development.

[11]This functional form is common in the literature even when the inputs considered are different from ours and do not include child care providers. The seminal example is Cunha et al. (2010).

[12]See, for example, the seminal Berry et al. (1995). In the education context, see Bayer et al. (2007), Ferreyra (2007), Ferreyra (2009), Fu (2014), Bordon and Fu (2015), and Ferreyra and Kosenok (2018).

2.1.2 Child care centers

The economy includes $\bar{S}$ *potential* center-based child care providers. Setting up a center requires a fixed cost, F. Potential providers are profit-maximizers; they may choose to enter the market or not. Centers can differ in quality $\gamma(s)$ and price $p(s)$.

For computational reasons we assume only two center qualities, high and low, so that $\gamma(s) \in \{\gamma^L, \gamma^H\}$ for any $s \in \bar{S}$, with $\gamma^L < \gamma^H$. Potential entrants are heterogeneous in their variable costs of providing high- and low-quality care. Variable costs for s are:

$$\boldsymbol{c}(s) = \begin{cases} c_s^L, & \text{if } \gamma(s) = \gamma^L \\ c_s^H, & \text{if } \gamma(s) = \gamma^H \end{cases} \tag{7}$$

where $\{c_s^L, c_s^H\}$ are drawn from a joint distribution with $E\big[c_s^L\big] \leq E\big[c_s^H\big]$. The moments of the distribution and the s-specific draws are common knowledge.

2.1.3 Non-relative and relative care

There is a perfectly elastic supply of non-relative caregivers who supply services of homogeneous quality γ^{NR} at the child's home. They are profit-maximizers with zero fixed costs and an opportunity cost equal to the local minimum wage. These cost assumptions reflect the fact that their actual market is quite flexible and does not entail large fixed costs, mandatory certifications, or formal skill requirements. Meanwhile, relative caregivers provide services of homogeneous quality γ^R at no monetary cost outside the child's home. While inexpensive, this form of care may not be available to all households. Both γ^{NR} and γ^R are observed to all market participants.

2.2 Equilibrium

2.2.1 Household decision problem

In each household, parents make labor supply and child care choices. They allocate their time between work, child care, and leisure. We discretize the choice set of working hours, h_f and h_m, and time spent with child care providers, t_d as follows:

$$h_f \in \{8\} \tag{8}$$
$$h_m \in \{0, 4, 8\} \tag{9}$$
$$t_d \in \{0, 8\} \tag{10}$$

In other words, father always works full time whereas mother can work full- or part-time (for eight or four hours a day, respectively) or not work. Although this discretization reduces parents' choice set, it reflects actual choices observed in the data and is computationally tractable. In addition, it creates some cross-constraints. For example, a household where both parents work eight hours per day *must* use non-parental care to satisfy the child's time constraints (5) and enjoy some leisure. These constraints, combined with the available child care options, give rise to a set of discrete alternatives for the household. Given that fathers work full time, we denote each alternative, ω, as a combination of mother's work time and child care option, $\omega \equiv \{h_m, s\} \in \Omega$ with $\dim\{\Omega\} = \{0,4\} \times \{S+3\} \cup \{8\} \times \{S+2\}$. In other words, when mother does not work or works part time, she can either care herself for the child or use non-parental care, but must use the latter when she works full time. When the household uses non-parental care, it can only use one option and must use it for eight hours a day, regardless of whether mother works and for how many hours. Although we discretize parents' work time options, we allow for continuous options when allocating non-work time between leisure and time with the child.

The overall optimization problem consists of maximizing the household utility in (1) with respect to $\{c, q, l_f, l_m, s\}$ under the constraints (2)–(6), the choice set restrictions (8)–(10) and given the $S+2$ non-parental care options. We can describe the household utility maximization as a two-step decision. In the first step, parents choose mother's optimal time with the child, $t_m \in (0, 16]$, for each possible alternative $\omega \in \Omega$. Conditional on an alternative, mother's optimal time is $t^*_m(\omega)$ and yields utility equal to $U(t^*_m(\omega))$. In the second step, parents choose the ω alternative that maximizes $U(t^*_m(\omega))$, denoted by ω^*. This is the global solution to the household optimization problem; it specifies the mother's work time, child care mode, and non-work time with the child, $\{\omega^*, t^*_m(\omega^*)\}$, such that:

$$U(t^*_m(\omega^*)) \geq U(t'_m(\omega')) \tag{11}$$

for any $t'_m(\omega') \in (0, 16]$ and $\omega' \in \Omega$.

Recall that, for each child care mode s, a household has idiosyncratic preference ε_s (equation (1)). We assume ε_s follow a type I extreme value distribution with scale parameter $\mu_\varepsilon > 0$, and is independently and identically distributed across the $(S+3)$ child care options for a given household and across households. In order to define market demand for child care, it is useful to focus on the (log) non-idiosyncratic component of utility for type-j households from choosing $\omega = \{h_m, s\}$:

$$\tilde{u}_{js}(p(s), \gamma(s); \omega) \equiv \alpha_c \ln c(p(s)) + \alpha_q \ln q(\gamma(s)) + \alpha_f \ln l_f + \alpha_m \ln l_m \tag{12}$$

Hence, the share of type-j households that make this choice is equal to:

$$P_{js}(\mathbf{p}, \boldsymbol{\gamma} \mid \omega) = \frac{\exp(\tilde{u}_{js}(p(s), \gamma(s); \omega)/\mu_\varepsilon)}{\sum_{\omega' \in \Omega} \exp(\tilde{u}_{js'}(p(s'), \gamma(s'); \omega'))/\mu_\varepsilon)} \tag{13}$$

The resulting market demand for child care provider s is thus equal to:

$$N_s(\mathbf{p}, \boldsymbol{\gamma}) = \sum_{j=1}^{J} \left[\sum_{\{\omega \in \Omega : s \in \omega\}} P_{js}(\mathbf{p}, \boldsymbol{\gamma} \mid \omega) \right] M_j. \tag{14}$$

2.2.2 Center-based providers

We follow Mazzeo (2002) by assuming that potential entrants engage in a two-stage game. The first (*entry*) stage is a Stackelberg game in which providers choose among the following options: enter the market offering low quality, γ^L; enter offering high quality, γ^H; and not enter at all. As a result, the first stage determines the market configuration $\Im$, which is the set of $S \subset \bar{S}$ providers active in the market as well as their qualities. In the second (*competition*) stage, active providers engage in a Bertrand game of simultaneous competition by choosing prices, $p(s)$, conditional on $\Im$ and households' demand for child care services.

Entry stage is a Stackelberg, sequential sub-game. Potential entrants make their decisions sequentially, in an order given by their expected profitability or efficiency. Intuitively, the most efficient firm decides on entry and quality knowing that subsequent entrants will take its decision into account; the second most efficient firm makes its decisions given the first entrant's choices and knowing that subsequent entrants will take into account the first and second entrants' choices, and so forth. By establishing which firms enter the market and their qualities, the first stage determines the equilibrium market configuration, $\Im^*$.

Competition stage is a Bertrand game in which center-based providers simultaneously choose prices in order to maximize expected profits given $\Im^*$. Since players have complete information about all potential entrants, each provider knows the cost vector (c_s^L, c_s^H) for every firm in the market. However, providers do not know the idiosyncratic preferences $\boldsymbol{\varepsilon}$ of a given household; they only know their distribution. The problem of firm $s \in \Im^*$ is thus:

$$\max_{p(s)} \quad E(\pi(s)|\Im^*) = [p(s) - c(s)]N\left[(p(s), \mathbf{p}(-s), \Im^*\right] - F \tag{15}$$

where $p(s)$ and and $\mathbf{p}(-s)$ are the prices charged by s and its competitors, respectively.

In the entry stage, the sub-game perfect Nash equilibrium is obtained by backward induction as in a standard Stackelberg game, such that only centers with expected positive profits operate in the market. In the competition stage, the Nash equilibrium consists of a vector of prices $\mathbf{p}^*$ that satisfies the first-order condition of profit maximization for every $s \in \Im^*$:

$$p^*(s) = c(s) - N\left[(p(s), \mathbf{p}(-s), \Im^*\right]\left[\frac{\partial}{\partial p(s)}N\left[(p(s), \mathbf{p}(-s), \Im^*\right]\right]^{-1} \tag{16}$$

Mazzeo (2002) demonstrates that this two-stage game has a unique equilibrium for a given number of firms.

2.2.3 Non-relative caregivers

Their optimization problem is similar to that of centers but with zero fixed costs. They engage in Bertrand price competition with each other and with center-based providers. Furthermore, since each household has a single idiosyncratic preference value (i.e., same value of ε_{S+1}) for all non-relative caregivers (though this value generally differs among households), and non-relatives offer homogeneous services, in equililibrium they set a common price, p^{NR}.

2.2.4 Equilibrium definition

Bringing together demand and supply for child care defines the market equilibrium. Households choose labor supply, leisure, child care mode, child development, and consumption by solving the utility maximization problem defined in Section 2.2.1. The solution leads to the demands defined by equation (14). Center-based providers choose whether to enter the market and with what quality; conditional on entering, they choose price.

Definition 1 ***Equilibrium Definition.***
An equilibrium in this model specifies the set of child care providers available to households as well as their prices and qualities, and the decisions made by households with respect to work and child care, such that: (1) the child care providers in parental choice sets are indeed available in the market; (2) every child care provider in the market makes non-negative profits, and (3) neither parents nor child care providers wish to alter their decisions.

Due to the discreteness of household and firm choices, as well as the finite number of household types and potential firms, the equilibrium does not have a closed-form solution and must be solved numerically for a given set of parameter values. Appendix B.1 describes the quantitative version of our model, and Appendix B.2 describes the equilibrium computation.

3 Data

3.1 Sources

We estimate the model with data from the US Early Childhood Longitudinal Study birth cohort (ECLS-B), which follows individuals from birth through kindergarten for a nationally representative sample of children born in 2001 and includes several waves to capture children's development as they grow. We use the second wave, collected between January and December 2003, when the children are two years old. In this wave the ECLS-B uses instruments to assess child development in the physical, cognitive, and socio-emotional domains. We focus on the cognitive domain, assessed with the Bayley-Short Form instrument (Research Edition-Mental), which contains measures of general cognitive ability such as problem solving and language acquisition.

The ECLS-B also collects household demographic data (household members; parents' education, age, and marital status; living arrangements) and parental labor market information (labor force participation, hours of work, and hourly wages). It contains detailed information on child care modes (parental care, relative care, non-relative care, center-based care), hours of use for each one, and hourly child care expenses. Further, it provides an assessment of the quality of center-based care using an instrument designed by developmental psychologists, the ITERS (Infant/Toddler Environment Rating Scale).[13] Scores range from 1 to 7 (inadequate and excellent quality, respectively). ITERS scores are only available for the centers that agreed to be observed (45 percent of centers, enrolling about half of the children.)

Starting from the second wave's full dataset, we arrive at our estimation sample by imposing three main restrictions: we focus on two-parent and one-parent households with only one child, who is two years old; we restrict one-parent household to cases where the parent is the mother; and we focus on households in which the father, if present, works full time. The first restriction greatly reduces the problem's dimensionality as child care is chosen for only one child. It also avoids modeling fertility or scale economies in child care. The second restriction reflects that virtually all one-parent households in our sample are led by women. The

[13] The ITERS scale contains 39 items in seven sub-scales: space and furnishings, personal care routines, listening and talking, activities, interaction, program structure, and parents and staff. We focus on the overall score (mean over the seven sub-scales.)

third restriction eliminates the need to model fathers' labor supply, further reducing dimensionality with limited loss of empirical generality because most fathers with small children work full-time. Our estimation sample includes households in which, on average, parents are more educated than in the full dataset and earn higher wages. Appendix C provides further comparison between our estimation sample and the full dataset.

3.2 Descriptive Statistics

Our estimation sample consists of 600 two-parent households and 150 single-mother households that meet the criteria described above (sample sizes are rounded to the nearest 50 to comply with ECLS-B confidentiality rules.) In Table 1 we define the main variables used in estimation and report descriptive statistics. About 27 percent of two-parent households and 41 percent of single-mother households use a child care center as the main form of care and pay on average \$4.50 and \$3.88 per hour of full-time care, respectively (all monetary values are expressed in dollars of 2003). The average quality of child care centers, as measured by the ITERS score, is on average satisfactory, as values of 4 and 5 denote satisfactory and good quality, respectively. This average is in line with previous work for the US population (e.g., Blau and Mocan (2002)) and is the same as the mean value of ITERs for two-year olds in the full ECLS sample. About 5 percent of households pay non-relatives for home-based care and 20 percent use relatives as the main form of care. Single mothers rely more on relative care than two-parent households. The average child cognitive score is approximately equal to 129 and 124 in two-parent and single-mother households, respectively.

We observe the usual gender differentials in parental labor market outcomes, as women participate substantially less than men (only 50 percent of them work) and earn lower wages on average. The average gender wage gap in two-parent households is 15 percent, smaller than in the full dataset, and the correlation between father's and mother's wage is 0.54. In about half of two-parent households both parents have completed college, whereas only 12 percent of single mothers have completed it. In both cases, however, parents have higher educational attainment than in the full dataset.

4 Econometric Issues

4.1 Empirical Specification

4.1.1 Household Heterogeneity

Recall that household types vary in wage offers $\boldsymbol{w}(j)$, preferences $\boldsymbol{\alpha}(j)$, initial child development $q_0(j)$, and availability of relative care $d^R(j)$. When computing the equilibrium for estimation or counterfactuals, we treat each household in the sample as a different type, in which q_0 is measured as the child's cognitive score at age one and serves as the initial condition in the value-added specification of child development production in equation (6).

As mentioned in Section 2, in addition to two-parent households we model one-parent households (henceforth, single-mother households or single mothers). We treat them as a special case of two-parent households (see Appendix A.1) and allow some structural parameters to be different for them (see Section 4.1.2 below).

For a better data fit and richer policy analysis, we introduce an additional source of *ex ante* household heterogeneity–parental educational attainment–with three possibilities: complete college (or more), complete high school (including some college), and incomplete high school. Fathers' and mothers' education in two-parent households are e_f and e_m respectively; single mothers' education is e_o; and subscripts 1 (lowest), 2, and 3 (highest) denote attainment. For instance, $e_m = e_{m3}$ is for married mothers with complete college.

The model described in Section 2 assumes that all households and providers participate in the same labor and child care market. This is a common assumption in labor market models estimated on representative samples of the US economy,[14] but is less common in empirical industrial organization models for specific goods or services, often estimated for specific locations.[15] Labor market models use large datasets and yield parameter estimates applicable to a large population, whereas industrial organization models provide a more granular study of local markets. While our data and objective are closer to those of labor market models, child care markets exhibit substantial variation at the local level. Therefore, we introduce household *location* as an additional source of *ex ante* household heterogeneity. Each location constitutes its own child care and labor market, generating a segmented structure where agents in different locations are faced with different wage offers and a different supply of child care services. In the theoretical model, each agent behaves in its location exactly as in the model described in Section 2. In the empirical application, location heterogeneity is represented by four "locations" that are assumed to be exogenous to the household and are fully observed by us.[16] Section 4.1.2 provides further details on locations.

To summarize, in our empirical specification *ex-ante* household heterogeneity encompasses seven dimensions in total: parental education, marital status, preferences, wage offers, initial child development, relative care availability, and location.

4.1.2 Functional Forms and Empirical Definitions

We address six issues. First is heterogeneity in household preferences. Among-two parent households, recall that household type j has the preference parameter vector $\boldsymbol{\alpha}(j) \equiv \{\alpha_c(j), \alpha_q(j), \alpha_f(j), \alpha_m(j)\}$, where $\alpha_c(j) + \alpha_q(j) + \alpha_f(j) + \alpha_m(j) = 1$. As in Del Boca et al. (2014), for our empirical specification we assume these parameters are i.i.d. draws from a distribution constructed as follows. We define the 3×1 normally distributed random variable

[14] This is the case in seminal labor supply papers (Heckman, 1974a; MaCurdy, 1981) and also in recent contributions on labor supply and child investments. For a review on empirical labor supply models, see Keane (2011); for recent contributions on labor supply and child investments, see Attanasio et al. (2020); Del Boca et al. (2014).

[15] For example, Mazzeo (2002) focuses on motel locations along interstate highways. For a review of these issues in empirical industrial organization, see Einav and Levin (2010).

[16] In other words, we do not model locational choice. For an interesting example of locational choice within a model of labor supply and child development, see Liu et al. (2010).

$\boldsymbol{v} \sim N(\boldsymbol{\mu}_v, \boldsymbol{\Sigma}_v)$, where:

$$\boldsymbol{\mu}_v = \begin{bmatrix} \mu_{vc} \\ \mu_{vq} \\ \mu_{vf} \end{bmatrix} \quad \text{and} \quad \boldsymbol{\Sigma}_v = \begin{bmatrix} \sigma^2_{vc} & 0 & 0 \\ 0 & \sigma^2_{vq} & 0 \\ 0 & 0 & \sigma^2_{vf} \end{bmatrix} \tag{17}$$

For household type j, we draw a $\boldsymbol{v} = [\, v_c, v_q, v_f]$ vector and generate j's utility parameters:

$$\alpha_c(j) = \frac{\exp(v_c)}{1 + \sum_{y \in \{c,q,f\}} \exp(v_y)} \tag{18}$$

$$\alpha_q(j) = \frac{\exp(v_q)}{1 + \sum_{y \in \{c,q,f\}} \exp(v_y)} \tag{19}$$

$$\alpha_f(j) = \frac{\exp(v_f)}{1 + \sum_{y \in \{c,q,f\}} \exp(v_y)} \tag{20}$$

$$\alpha_m(j) = \frac{1}{1 + \sum_{y \in \{c,q,f\}} \exp(v_y)} \tag{21}$$

This procedure is flexible, uses a convenient distribution, and makes the sum of the four scalars be equal to one. Since fathers are not present in single-mother households, the utility function for these includes only three preference parameters, which are allowed to differ from those of two-parent households. This leads to $\boldsymbol{v}^o \sim N(\boldsymbol{\mu}^o_v, \boldsymbol{\Sigma}^o_v)$ where ^{o} denotes the parameters associated to single mother households, $\boldsymbol{\mu}^o_v$ is a 2×1 vector, and $\boldsymbol{\Sigma}^o_v$ a 2×2 matrix. Vector $\boldsymbol{v}^o$ maps into the three-dimensional vector $\boldsymbol{\alpha}^o(j)$ in an analogous way as that defined by equations (18)–(21) for two-parent households.

Second, we address heterogeneity in household labor market opportunities. Among two-parent households, recall that household type j faces wage offers $\boldsymbol{w}(j) \equiv \{w_f(j), w_m(j)\}$. We assume these are drawn from a joint lognormal distribution, frequently used in the literature for its good fit. We allow the distribution to depend on parental education and to capture possible assortative (on education) mating between parents. Log-wage offers follow a normal distribution with mean

$$\boldsymbol{\mu}_w(\boldsymbol{e}) = \begin{bmatrix} \mu_{w_f}(e_f) \\ \mu_{w_m}(e_m) \end{bmatrix} \tag{22}$$

and variance-covariance matrix:

$$\boldsymbol{\Sigma}_w(\boldsymbol{e}) = \begin{bmatrix} \sigma^2_{w_f}(e_f) & (\rho_0 \mathbb{I}_{\{e_f = e_m\}} + \rho_1 \mathbb{I}_{\{e_f \neq e_m\}})\sigma_{w_f}(e_f)\sigma_{w_m}(e_m) \\ (\rho_0 \mathbb{I}_{\{e_f = e_m\}} + \rho_1 \mathbb{I}_{\{e_f \neq e_m\}})\sigma_{w_f}(e_f)\sigma_{w_m}(e_m) & \sigma^2_{w_m}(e_m) \end{bmatrix} \tag{23}$$

where $\boldsymbol{e} \equiv \{e_f, e_m\}$ is parental educational attainment and $\{\rho_0, \rho_1\}$ captures assortative mating in wage offers for parents with the same or different educational attainments, respectively. For single mothers, wage offers follow the same distribution as for mothers in two-parent household but without correlation with father's wage offers. They obey a lognormal distribution with parameters $\{\mu_{w_f}(e_o), \sigma_{w_f}(e_o)\}$ where e_o is the single mother's educational attainment.

Third, we allow mother's education to affect child development production. Recall that mother's productivity in child development is γ_m. For two-parent households we assume:

$$(q - q_0) = \gamma_0 + \left\{\gamma_f t^r_f + \gamma_m(e_m) t^r_m + \gamma(s) t^r_d\right\}^{\frac{1}{r}} \tag{24}$$

We focus on the effect of mother's education and ignore the effect of father's given previous findings on the asymmetric roles of mothers and fathers in child-rearing and limitations of our estimation sample.[17] In single-mother households, we allow mother's productivity in child development production to depend on her education differently from two-parent households, leading to:

$$(q - q_0) = (\gamma_0 + \gamma_0^o) + \{(\gamma_m(e_o) + \gamma_m^o)t_m^r + \gamma(s)t_d^r\}^{\frac{1}{r}} \tag{25}$$

where $\{\gamma_0^o, \gamma_m^o\}$ are the single-mother shifters.

Fourth, we assume a parametric distribution for center-based variable costs. Recall from (7) that potential child care provider s has variable costs c_s^L and c_s^H to provide low- and high-quality care, respectively. We assume c_s^L and c_s^H are drawn from lognormal distributions with parameters $\{\mu_c^L, \sigma_c^L\}$ and $\{\mu_c^H, \sigma_c^H\}$, respectively. For computational reasons we assume that c_s^L and c_s^H are positively correlated for a given entrant but are independent across entrants (see Appendix B.1 for further details.) As a result, potential entrants that are more efficient in the provision of high-quality care are also more efficient in the provision of low-quality care–for instance, because greater managerial ability leads to greater efficiency regardless of service quality. Finally, we assume that fixed costs depend on quality, leading to $\{F^L, F^H\}$ for low- and high-quality provision respectively, but are homogeneous across firms.

In addition, we assume that center-based providers face a capacity constraint or maximum allowable enrollment, $\bar{N}$. To enroll additional children, they can increase capacity by paying the (quasi) fixed cost as many times as needed:

$$F_s^k(N_s) = F^k \lceil N_s/\bar{N} \rceil,$$

where $\lceil \cdot \rceil$ is the ceiling operator. We set $\bar{N} = 40$. For instance, in order to serve 45 children, a firm must incur the fixed cost twice; for 92 children, three times, and so forth. The firm can therefore run multiple centers, each with a 40-children maximum capacity.[18]

Fifth, we set values for non-labor income I (see equation (2)). We focus on income from transfers since income from assets is mostly negligible. Households in the data report whether they receive a transfer but not the amount. Given this limitation and the complexity of actual transfer rules,[19] we assume that two-parent households receive no transfers while single mothers receive a positive, homogeneous transfer amount, calibrated to match the 2003 poverty line.[20] We also assume that non-college single mothers receive a 35% discount at child care centers, since in the sample they pay about 65% percent of center-reported prices.

[17] Correlation studies indicate that "the productivity of women in home production appears to increase as their education increases" (Schultz (1993), p 53) while fathers' education seems substantially less important. Admittedly, the conclusion is more nuanced among the several studies that use arguably exogenous variation on maternal education to look at its effect on children in the short and long run (for a survey, see Black and Devereux (2010)). An example is Carneiro et al. (2013)'s finding that maternal education has a positive effect on children when they are 7 to 8 years old but a negative one when they are younger than 24 months old. In addition, the reduced form relationship between mother's education and children outcomes estimated by these studies involves a variety of mechanisms such as labor market participation and assortative mating in the marriage market. At least the second one is clearly not independent of father's education.

[18] In our sample, this is the maximum observed enrollment.

[19] For a survey on children-related transfers, see Fang and Keane (2004); for one focused on single-mother households, see Hoynes and Schanzenbach (2018).

[20] See Appendix C.2.3 for additional details. Transfers are scaled by location.

Sixth, we define four composite locations (henceforth, locations) based on population and income. Population (number of children below age 5) captures potential market size for child care services while (median family) income captures the ability to pay for them. We assign households to locations based on their observed place of residence and 2000 census county data on population and family income (see Appendix C.2.2 for further details). Locations 1 through 4 are defined as follows: low population ("small"), low income; low population, high income; high population ("large"), low income; and high population, high income, respectively. While admittedly coarse, these locations clearly vary in *ex ante* household characteristics. For instance, low-income locations have a higher share of single-mother households and a lower share of college-educated parents than high-income locations (Table C.2.) Marital status does not vary much by location size conditional on location income yet parental education rises substantially with location size. In our empirical implementation, locations differ not only as described but also in location-specific parameters such as parental wage offer distributions and center costs, as explained below.

This setting gives rise to four heterogeneous, distinct child care markets. For example, the large, high-income location includes a large amount and share of college-educated parents and supports greater quality and variety in center-based care than other locations. What this setting does not feature, however, is heterogeneity *within* locations, such as differences among a city's high- and low-income neighborhoods. Since our dataset is representative of the US population, it does not allow us to characterize child care markets at the neighborhood level. Nonetheless, we argue that neighborhood-level differences are less important in child care markets than in K-12 school markets, where catchment areas impose a strong geographic dimension to the choice set. Child care services for 2-year-olds are less subject to such constraints, as parents use child care providers located not only in their neighborhood but also close to their workplace or even at relatives' homes. As a result, the relevant child care choices are geographically located in the same broad area where parents supply labor. Heterogeneity across such broad areas is what our setting is best equipped to capture.

4.2 Identification

The model includes four sets of parameters, related to household utility and constraints, child development production, parental wage offers, and child care providers. Given the model's nature, there is no direct mapping between empirical features and model parameters. However, some empirical features play a greater role than others to identify specific parameters. Our discussion below follows this intuition and focuses on aggregate-level parameters, common to all locations. Appendix D.1 discusses identification of location-specific parameters.

4.2.1 Household utility and constraints

These parameters fall into three groups. The main one includes parameters for heterogeneous preferences over consumption, leisure, and child development: $\{\mu_{vc}, \mu_{vq}, \mu_{vf}\}$ and $\{\sigma_{vc}, \sigma_{vq}, \sigma_{vf}\}$ (equation (17)). These preferences affect trade-offs among leisure, consumption, and child development. We observe wages, labor supply, and child care choices for each household in the sample. Choices made by the "average" household identify "average" preferences and hence $\{\mu_{vc}, \mu_{vq}, \mu_{vf}\}$, whereas the choice variation across household types with similar observed heterogeneity (education, marital status, and initial child development) identifies variance in preferences and hence $\{\sigma_{vc}, \sigma_{vq}, \sigma_{vf}\}$.

The second group are parameters for idiosyncratic preferences on child care options. Given our type I extreme value distributional assumption (section 2.2.1), we only need to identify scale parameter μ_ε. If all households of a given type had the same idiosyncratic preferences, they would all choose the same child care mode. The greater the heterogeneity in idiosyncratic preferences, the greater the horizontal differentiation in the child care market. Thus, the dispersion of households' observed child care choices on use, price, and quality conditional on observed household heterogeneity is the main source of identification for μ_ε.

As for household time constraints, the time cost ξ incurred when using center-based or relative care (equation (4)) is also identified by child care choices over price, quality, and type of mode conditional on observed household heterogeneity. It can be separately identified because ξ is a cost entering the time constraint rather than the budget constraint, affecting the choice combinations differently than monetary costs. Without ξ, the model would systematically over predict center-based and relative care use.

4.2.2 Child development production function

These twelve parameters are present in equations (24) and (25) and include the constant γ_0; father's productivity γ_f; the three mother's education-specific productivities $\gamma_m(e_m)$; productivity parameters for the non-parental forms of care $\gamma^L, \gamma^H, \gamma^{NR}, \gamma^R$; single-mother productivity shifters γ_0^o, γ_m^o; and r, which governs the substitution elasticity . Given our model, the observed data identify these parameters as follows. We observe time inputs from non-parental care providers (t_d) and assume that parents use them for eight hours a day. We do not directly observe parents' time inputs (t_f, t_m) but observe their extensive and intensive labor supply margins. Parental time inputs are directly related to labor supply through time constraints (equations (3)–(5)) and assumed optimal behavior (equation (11)). As a result, given a set of parameters and assuming the model's equilibrium, there is a one-to-one mapping between parental labor supply and time inputs. We observe child development since we assume that the Bailey indicator measures it without error, and observe parental education levels under the aggregation defined in Section 4.1.2. We observe child care mode used by parents but must assume an empirical definition of high- and low-quality child care centers.[21] For the ITERS score, values of 4 and 5 mean 'satisfactory' and 'good' quality, respectively. We classify centers with ITERS > 4 as high-quality and all others are low-quality.[22] Since we observe q, q_0, and all child care choices and can recover equilibrium time inputs, we identify productivity parameters (the γ's) and the elasticity of substitution

[21] Recall we assume only two qualities, high (H) and low (L), so that $\gamma^L < \gamma^H$.

[22] We have performed robustness checks on the threshold of 4. Differences in estimates are negligible when using a threshold of 5 but grow with thresholds of 6 or higher because the proportion of high quality center decreases substantially. Further, we observe ITERS only for about half of the centers. Since households in those centers do not appear systematically different in the variables of interest than other households, we assume that the observations with reported ITERS values are representative for the corresponding cells used to compute SMM moments.

between time inputs by exploiting the variation in parental time inputs and child care choices conditional on educational attainment and marital status.

4.2.3 Parental wage offers

Parameters in equations (22) and (23) include the gender- and education-specific parameters of the lognormal wage offers distributions, $\{\mu_{w_f}(e_f), \sigma_{w_f}(e_f)\}$ for fathers and $\{\mu_{m_f}(e_f), \sigma_{m_f}(e_f)\}$ for mothers, and the $\{\rho_0, \rho_1\}$ parameters of assortative mating in married parents' wage offers. Since fathers always work in the model, their wage offer distribution is equal to the observed (accepted) wage offer distribution, allowing us to directly estimate the former from the empirical wage distribution. Mothers, instead, decide on labor supply, thereby making the observed distribution of accepted wages a truncation of the unobserved distribution of wage offers. Since the lognormal distribution is recoverable and we characterize mother's optimal labor supply decision, we can identify wage offer parameters from observed hourly wages. We identify gender- and education-specific parameters from the observed wage distribution conditional on these observables and identify the assortative mating parameters from correlations in spousal wages conditional on education.

4.2.4 Child care providers

The identification of their productivity for child development is discussed in Section 4.2.2; here we focus on the remaining parameters. For child care centers, these are the fixed costs $\{F^L, F^H\}$ and the lognormal distributional parameters for heterogeneous variable costs, $\{\mu_c^L, \sigma_c^L\}$ and $\{\mu_c^H, \sigma_c^H\}$. Since our data do not allow us to identify fixed costs, we calibrate them using industry cost reports. Using data from the Generic Cost Model for child care centers provided in Mitchell and Stoney (2012), we obtain fixed cost values of \$128.90 and \$322.25 a day for low-quality and high quality centers, respectively.[23] Regarding variable costs, we face the usual selection problem in that we do not observe all potential entrants but only those that do enter, and not even for these do we observe variable costs. Identification is therefore based on observed price and quality. We observe prices as reported by centers and observe quality in the high/low quality aggregate fashion described above. Given fixed costs, the observed market shares for high- and low-quality and the price distribution by quality identify variable cost parameters because active firms make non-negative profits and the lognormal distribution is recoverable.

For non-relative caregivers, no additional parameters are left to be identified. For relative care, we have one remaining parameter: the proportion of households with available relative care. We observe some households using relative care (which therefore have it available, or

[23] The Generic Cost Model for child care centers provided in Mitchell and Stoney (2012) is compiled by the *Alliance for Early Childhood Finance* to model "budgets for a proposed center and to understand the costs of operating a better quality center". In the fixed cost calculation we include non-personnel costs for the building (rent/lease, insurance, utilities, maintenance/repair/cleaning) and setup costs (audits, fees and permits, telephone, and Internet). We compute all costs at 2003 prices and assume that the typical center size is two and five classrooms for low- and high-quality centers, respectively, reflecting differences in spaces for play, music, and other enrichment activities. These values are comparable with the \$200 a day fixed cost from occupancy and overhead reported in previous studies such as Helburn and Howes (1996).

$d^R(j) = 1$) but do not know *all* households that have it available. In principle, we could estimate the proportion of such households from the data because we model the choice of non-relative care and observe the households using it. Since the proportion is poorly identified in the data, we calibrate it. Compton and Pollak (2015) use data from the second wave of the National Survey of Families and Households (NSFH) to estimate distances from the husband's mother and the wife's mother conditional on their education. Using their estimates and our sample data on household parental education, we arrive at 40% of households having relative care available.[24] Parents in the two low-income locations, in turn, are more likely to have relative care available than others (Table D.2).

4.3 Estimation Method

We estimate the model by Simulated Method of Moments. This is particularly well-suited for our model, which lacks a closed-form solution. Let $\boldsymbol{\theta}$ be a column vector of dimension P, equal to the number of parameters to be estimated. Our estimator, $\hat{\boldsymbol{\theta}}_{\text{SMM}}$, is such that:

$$\hat{\boldsymbol{\theta}}_{\text{SMM}} = \arg_{\boldsymbol{\theta}} \min \, [\mathbf{s}(\boldsymbol{\theta}) - \mathbf{z}]' \, \mathbf{W}^{-1} [\mathbf{s}(\boldsymbol{\theta}) - \mathbf{z}] \tag{26}$$

where $\mathbf{z}$ is the column vector of $B > P$ sample moments to match, and $\mathbf{s}(\boldsymbol{\theta})$ is the column vector of the corresponding moments evaluated at $\boldsymbol{\theta}$. Weighting matrix $\mathbf{W}$ is diagonal; weights are the bootstrapped standard deviations of the sample moments.[25] We perform full-solution estimation, which requires equilibrium computation for every value of $\boldsymbol{\theta}$.

We estimate the model in two steps. In the first step, we match 77 moments aggregated over the four locations and recover the structural parameters common to all of them. In the second step, we match 24 moments for each location to estimate location-specific parameters. Besides being computationally convenient, this approach helps us overcome small sample issues generated by our modest sample size. By aggregating moments over locations, we can condition on a rich set of household-specific observables while having an acceptable number of observations per moment. This criteria, together with our identification strategy (Sections 4.2 and D.1) guides the selection of moments for estimation, which include moments on child care markets, child development, and parental labor market outcomes. Mothers are the unit of observation for most moments.[26] While ideally we would condition on mother's marital status, educational attainment, work status, and location for every moment and location, this is not always possible because some cells contain very few observations, leading us to only use moments with at least 50 observations.

The second column of Table E.1, *Sample*, shows aggregate moments; the third, fifth, seventh, and ninth columns of Table E.2 show location-specific moments. The first column

[24] We use the aggregate proportions conditional on parental education provided in Table V of Compton and Pollak (2015), and assume that only grandmothers living within 30 miles are available for child care. Conditioning on education is important. For example, when both spouses have a college degree, the proportion of married couples living more than 30 miles *away* from both grandmothers is 49.4%; when neither spouses has a college degree, it falls to 18.9%.

[25] The weighting matrix is useful to give all moments a similar scale and to reduce the estimation's sensitivity to imprecise sample moments.

[26] In our sample we only have one child per mother. Fathers' labor market moments are the only ones using fathers as the unit of observation, and we match them exactly (Section 4.2.3.)

of Table E.1 presents moment definitions and conditioning observables. For example, the first row reports child care center use among married, college-educated, full-time working mothers. Moments on child care choice (Panel a) include proportions of households using the different care modes by mother's characteristics and labor market choices. Moments on child development (Panel b) include mean Bailey score conditional by mother's characteristics, labor market choices, and child care choices. Moments on mother's labor market (Panel c) include proportions by labor market status, mean and standard deviation of accepted wages, and correlations with husband's wage. Moments on center-based supply (Panel d) include the mean and standard deviation of center-based prices and the proportion of parents using high-quality centers. Table E.2 presents similar information by location.

5 Estimation Results

5.1 Estimates

5.1.1 Preference parameter estimates

Table 2 reports parameter point estimates using aggregate moments. Panel a reports household utility function and time constraint parameters. The first ten are for preferences over consumption, leisure, and child development and the eleventh is for idiosyncratic preferences for child care options, while the twelfth is the time cost from using a child care center or relative. Given the parameterization in Section 4.1.2, it is convenient to discuss preference heterogeneity based on the top panel of Table 3, which reports the mean and standard deviations of utility weights $\boldsymbol{\alpha}(j)$ and shows that households place, on average, a lower weight on consumption than on child development, and an even lower weight on parents' leisure. Further, average value of mother's leisure is about twice as high as father's. Our estimates broadly agree with others in the literature yet with important differences. Using the same preference specification as ours, Del Boca et al. (2014) obtain similar estimates of average utility weights on consumption but substantially lower estimates of average utility weights on child development.[27] In addition, they estimate that father's and mother's leisure time have similar utility weights yet mother's is higher than father's for us. Our finding reflects, at least partly, our sample's greater gap between father's and mother's labor supply.

The estimated dispersion in idiosyncratic preferences (μ_ε) suggests these have a smaller role than non-idiosyncratic utility components.[28] Vertical differentiation is thus more prevalent than horizontal differentiation, and households sort among high- and low-quality providers based mostly on willingness and ability to pay. The estimated time cost to use center-based or relative care (ξ) is about an hour per day–a non-negligible cost that discourages their use.

[27] We compare our estimates with their estimates for the one-child case, reported in their Table 5, column 1. Their estimated average weights on consumption and child development are equal to 0.257 and 0.353 respectively, whereas ours are 0.268 and 0.697.

[28] As equation (13) shows, the size of μ_ε relative to that of the utility function parameters determines the relative role of the idiosyncratic preferences. By construction, utility function coefficients add up to 1. Since the estimate for μ_ε is equal to $0.012 < 1$, idiosyncratic preferences play a relative small role relative to non-idiosyncratic preferences (see equation 13.)

5.1.2 Child development parameter estimates

Table 2's panel b shows estimates for the child development production functions (equations (6) and (A.5) for two-parent and single-mother households, respectively. Parameters γ_f through γ_R are related to input returns, and r is related to the substitution elasticity. Estimates show a strong positive impact of mother's time, increasing in mother's education: college mothers in two-parent households have the highest parameter among all inputs. It is about 25% higher than father's time parameter and 60% higher than the high-quality center parameter. Single mothers' time also has a strong positive impact but slightly lower than married mothers'.[29] Non-parental caregivers are less productive than parents, although they have a substantial positive impact. Relatives are most effective and non-relatives are least effective, with child care centers somewhere in the middle. Center quality matters: the parameter for low-quality centers is about 20% lower than for high-quality centers.

Our ranking of mother's and father's productivity in child development is broadly consistent with previous literature.[30] However, the comparison between parents' time and time spent in other forms of care is less common and has interesting implications. Since the point estimate of r is quite close to one, inputs are highly substitutable.[31] Still, we replicate the well-established fact that on average, at young ages, development is highest when the child is cared for full-time by mother, whether single or married.[32] To illustrate this point, we consider a typical scenario for married households, in which the child spends four hours each with father and mother, and the remaining eight hours with one of five possible options: high-quality center, low-quality center, non-relative care, relative care, and mother's care. The typical scenario for single mothers is similar, except that mother spends at least eight hours with the child since there is no father. For every option we calculate the child's cognitive score. Exclusive parental care, which maximizes time with mother, always generates the highest value. The difference relative to the second-best option (relative care) is smallest for single mothers with incomplete high school and highest for married college mothers (6% and 21% higher, respectively). Further, center quality is relevant: choosing a high-quality rather than a low-quality center increases the child score by about 10% regardless of parental education and marital status.

[29]Recall from equation 25 that γ_m^o denotes the productivity difference between married and single mothers. Negative 0.020 implies that the γ_m coefficients are about 5% lower for single than married mothers, although the difference is not statistically significant.

[30]As Del Boca et al. (2014), we find that mother's time is more productive than father's yet by a larger amount than implied by their estimates, perhaps because Del Boca et al. (2014) distinguish between active and passive time with the child while we model total time with the child.

[31]Previous studies have found various degrees of complementarity and substitutability depending on inputs and functional forms. Cunha et al. (2010), Agostinelli and Wiswall (2016), Attanasio et al. (2020), and Attanasio et al. (2015) find complementarities in production between time and monetary inputs but they do not estimate complementarities among various time inputs. Del Boca et al. (2014) is the closest to us in terms of inputs and directly assumes complementarities by positing a Cobb-Douglas production function.

[32]See for example, Bernal (2008); Bernal and Keane (2011, 2010).

5.1.3 Wage offer parameter estimates

Table 2's panel c shows aggregate wage offer parameters. To obtain location-specific structural parameters, we combine aggregate point estimates with the estimated location multipliers (Table 4) as indicated in equations (D.1) and (D.2). Wage offer estimates are easier to interpret by looking at their implied mean and standard deviations (Tables 3 and 5). Starting with aggregate estimates, we find the expected ranking: higher wage offers for college graduates than others, and higher for men than women regardless of education. Wage offers are particularly low for non-college mothers, who are over represented among single mothers. For two-parent households, estimates for ρ_0 and ρ_1 indicate substantial assortative mating in wage offers particularly for same-education parents, leading to a low gender wage gap when both parents are college graduates. Results by location show dramatic differences in wage offers across labor markets, particularly for college-educated parents. For example, the average wage offer to college mothers in the small, low-income location is 45% lower than to college mothers in the large, high-income location.

5.1.4 Cost parameter estimates

Table 2's panel d shows aggregate center variable cost estimates. As with wages, aggregate estimates combined with the location multiplier estimates from Table 4 based on equations (D.3) and (D.4) yield location-specific cost parameters. To facilitate interpretation, Tables 3 and 5 report the implied mean and standard deviation of variable costs. Starting with aggregate estimates, variable costs are on average 21.8% higher for high- than low-quality centers. Dispersion in variable costs reflects substantive provider heterogeneity. Center variable costs are increasing in location income and population (Table 5). Moreover, variable cost differential between high- and low-quality centers varies across locations–from 21% in the large, high-income location down to 11% in the small, low-income location.

If the implications of the location-specific wage and cost parameters are fairly intuitive, the equilibrium outcomes (shown in the "Baseline" column of Tables F.1 through F.4) are less obvious. The predicted market share of high-quality centers rises with location income *only* in large locations (going from 11% in the large, low-income location to 17% in the large, high-income location). This is because both wages and center prices rise with location income yet at different rates depending on location size: wages rise faster than center prices in large locations, and more slowly in small ones. The substitution between relative and non-relative care is, instead, unambiguously related to income: as location income increases, parents substitute more free relative care for paid non-relative care.

5.2 Model fit

The model fits the data reasonably well. We start by discussing the fit of aggregate moments, show in Table E.1. Predicted ("Simulated") values are usually within 10-15% of observed ones ("Sample"). Child development moments are very well matched; prediction errors are smaller than 1%. We fully reproduce child development patterns by mother's work status and education (Panel b). Child care choices are well fitted (Panel a). We fit well the large proportion of working mothers using center-based care (for full-time working mothers, observed and predicted proportion equal 65 and 62%, respectively, for college mothers, and 61 and 62% respectively for single mothers). We fit well proportions of parents using relative care but are less successful at fitting non-relative care use, perhaps because lack of data on non-relative care quality leads us to assume homogeneous quality.

Labor market moments are well fitted (Panel c).[33] Exceptions are the proportion of single mothers working full-time (substantially lower in the model than the sample) and spousal wage correlated for non-college educated mothers working part time (substantially higher). The first mismatch may relate to our assumption of a common wage offer distribution for all women, single and married, which is consistent with a standard labor market model. The second mismatch is likely due to small sample sizes, as we can only capture assortative mating conditional on wife's education rather than both husband's and wife's.

We replicate patterns of child care center prices although with some quantitative mismatch (Panel d). We correctly predict higher average prices for high- than low-quality centers but over predict price differentials and under predict price variance. Nonetheless, we correctly rank average prices by mother's characteristics. We predict well the proportion of parents choosing high-quality centers when mother is college-educated but under predict it otherwise.

Table E.2 reports the fit of location-specific moments. We focus on moments that are significantly different between at least two locations. In the data, married mothers are more likely to work–especially part-time–in low-income locations than others. Mother wages are increasing in location size and income, and are highest in large, high-income locations. Working married mothers are more likely to use relative care in large, low-income locations than in others, perhaps because of their greater availability of relatives (Compton and Pollak, 2015). They are also more likely to use non-relative care in large, high-income locations than in others, perhaps because of higher parental education (and income) and lower availability of relative care. Similar to wages, center prices are increasing in location size and income and are highest in large, high-income locations, where average prices more than double those in small, low-income locations. Average child development score is increasing in location income and is highest in large, high-income locations.

The *ex-ante* heterogeneity in our locations as well as the flexibility afforded by the location-specific parameters allows us to capture these patterns. We replicate the variation across locations in child care modes and price, and in mother wages. For instance, the predicted proportion of married working mothers using center care is within 10% of observed values for all locations. We correctly predict that center prices rise with location and income and predict averages well by location. Further, we correctly predict that center affordability (relative to mother's wages) rises with income in large locations but falls in small ones. We also match the variation in married mothers' full-time employment but less so in their part-time employment, perhaps because we do not model local labor market demand. Despite these shortcomings, overall our model seems to accommodate local markets well and is therefore useful to explore counterfactuals' variation across locations.

[33]Recall that we match exactly father's labor market moments given our model and sample selection.

6 Policy Simulations

In this section we focus on interventions relevant to the debate on center-based care access (e.g., Chzhen et al. (2019)). The main policies are demand subsidies and public provision. In addition, recent evidence on the potentially harmful effects of low-quality care has led policymakers to focus on center quality.[34] Below we describe our simulations' setup, present aggregate results, and study them in local markets.

6.1 Setup

We simulate subsidy-based policies (including vouchers and cash transfers) and public provision. Vouchers and cash transfers are similar in that they give parents a cash subsidy but differ in that vouchers can only be used to purchase center-based care whereas cash transfers can be used to purchase *any* good or service, including child care. In public provision, the public sector controls center-based supply in the specific way described below. While subsidy-based policies directly affect the demand side of the market, public provision directly affects the supply side. The discussion below focuses on effects on center use, child development, mothers' labor market, center supply, and fiscal costs.

Given our equilibrium model, we estimate *equilibrium effects*. Consider, for instance, a policy providing child care vouchers to all households. It would raise center use and, if center supply did not change, it would raise prices by a given amount. In our model, however, the supply adjusts not only through prices but also through entry. As a result, the amount and composition of providers changes because new entrants are potentially different from incumbents and these may expand or change supply, leading to a greater expansion in child care use and a lower price increase than in a fixed supply model. These equilibrium effects are particularly relevant for the policies under consideration, which have been implemented or proposed for a large share of households,[35] and are more likely to trigger equilibrium effects than policies concerned with small changes.

We implement the policy simulations as follows. The *voucher* gives parents $40 a day ($5 per hour of service) that may only be used to purchase center-based care. This amount is roughly equal to household baseline daily expenditures at high-quality centers. If center price is up to $5, the household does not make additional payments and the voucher's unused portion returns to the policymaker; otherwise the family supplements the voucher. We simulate *universal vouchers* (all households and centers are eligible) and conditional vouchers (only some households or centers are eligible). Among conditional vouchers, we simulate *employment-based vouchers* (only available if mother works), *income-targeted vouchers* (only available for households at the bottom quartile of the baseline household income distribution, or $92 a day), and *quality-based vouchers* (available to all households but only to attend high-quality centers.)

[34]This has led, for instance, to establishing quality standards. On center quality effects and policy responses, see Baker et al. (2008) and Berlinski and Schady (2015). For a rare study on minimum quality standards, see Xiao (2010).

[35]For example, the expansions of center-based care studied by Baker et al. (2008) and Havnes and Mogstad (2011a) apply to all children in the relevant age range of Quebec and Norway respectively.

We set the *cash transfer* to the same amount as the voucher ($40 a day.) The transfer is universal, without requirements. Households can use it to purchase child care services–either from centers or from non-relative providers–but also to consume more. This experiment mimics actual cash transfer programs to households with newborn and young children and provides a useful comparison to vouchers.[36]

Our *public provision* simulation mimics a public entity that chooses the lowest-cost firms to operate and caps prices at cost in order to raise affordability. Since we do not model a government, we simulate a benevolent policymaker that controls center-based supply. It observes marginal costs for all potential providers and considers every possible market configuration, choosing that which maximizes social surplus (total household welfare minus center-based costs) subject to zero profits per provider. We assume that households–not the government–pay for the service because even in countries with widespread public provision (e.g., Denmark, Germany, and Sweden) most households still pay. Thus, the "public" aspect in this counterfactual refers to the policy maker's control of supply, not free provision. Formally, let $Z = \{(c_1^L, c_1^H), \ldots, (c_S^L, c_S^H)\} \times \{0, \gamma^L, \gamma^H\}$ be the set of all possible market configurations and $W(z, \mathbf{p})$ the social surplus for configuration $z \in Z$ and prices $\mathbf{p}$. The optimal market configuration maximizes social surplus:

$$\max_z \; W(z, \mathbf{p}) \quad \text{s.t.} \quad p_s = c_s + \frac{F}{N_s(\mathbf{p})}, \; \forall s = 1, \ldots, S, \tag{27}$$

where $N_s(\mathbf{p})$ denotes provider k's total enrollment given prices $\mathbf{p}$.

To provide intuition for public provision, consider two thought experiments. In the first, households do not have a taste for variety, which leads to only the most efficient provider operating in the market–with minimum costs yet minimum variety. In the second, households have a taste for variety and firms have zero fixed costs, which leads to potentially one firm per household–with maximum variety yet not minimum costs. By maximizing social surplus subject to zero profits, public provision strikes a balance between costs and variety and is reminiscent of the social optimum in monopolistic competition (Dixit and Stiglitz, 1977). In general, then, public provision yields fewer providers and lower prices than the baseline.

6.2 Results

Table F.1 shows detailed simulation results for all policies. The magnitude of policy impacts varies across policies partly reflecting their eligibility and take-up rates (top panel of Table 6). All households are eligible for the cash transfer, universal voucher, quality-based voucher, and public provision, but only 46 and 25 percent of households are eligible for the employment-based and income-targeted vouchers, respectively. Moreover, not all eligible households use a policy. Only 55 percent of households take up the universal voucher, with even lower take-up rates for conditional vouchers: 48, 42, and 8 percent respectively for quality-based, employment-based, and income-targeted vouchers. Take-up rates are also low for public provision, as only 27 percent of households use child care centers.

[36]Universal child benefits, frequently in the form of cash transfers, are common in numerous European countries and Canada. See for example, OECD (2011), González (2013), and Schirle (2015).

6.2.1 Child care center use

In the baseline, 48 percent of children receive exclusive parental care; 29 percent attend childcare centers (almost equally split between low- and high-quality centers); and 20 and 3 percent receive relative and non-relative care, respectively (Table F.1 panel a). Exclusive parental care is most common among less-educated married mothers; relative care among married mothers with incomplete high school as well as single mothers; and non-relative care among college mothers. High-quality centers are most common among college-educated married mothers while single mothers, and low-quality centers among single mothers.

Subsidy- and non-subsidy-based policies have markedly different impacts on center-based care. We begin with subsidy-based policies, which have two effects. On the extensive margin, they expand use by attracting children previously cared for by their parents, relatives, or non-relatives (Table 7). On the intensive margin, they encourage the substitution of low- for high-quality centers. All subsidy-based policies expand center-based care (Figure 1a) yet to varying degrees depending on which margin prevails. Universal, quality-based, and employment-based vouchers deliver the largest increase (expanding center care use to 55, 48 and 46 percent of all households respectively) because the extensive margin effect dominates. Cash transfers barely raise center-based use because the intensive margin prevails but, more importantly, because they are mostly used to raise consumption. Income-targeted vouchers deliver a negligible effect for a different reason: low eligibility and take-up rates.

In addition to raising overall center use, subsidy-based policies raise access to high-quality centers (Figure 1b). Not only do the policies expand access to existing high-quality centers; they also create the customer base necessary for *new* centers to offer high-quality care profitably. Three policies–universal, quality-based, and employment-based vouchers-raise the fraction of children in high-quality centers by about 30 percentage points (pp), with the largest gains accruing to non-college married mothers and single mothers (see Figure F.1 using universal vouchers as an example.)

In the policy debate on center quality, minimum-quality regulations are often proposed to ensure that only high-quality centers operate in the market (Blau and Currie (2006), Hotz and Xiao (2011), and Xiao (2010)), leading to the concern that many households might be priced out of high-quality markets and deprived of childcare services altogether. Although not simulating such supply-side regulations, our counterfactuals nonetheless speak to these issues. We find that quality-based vouchers raise the share of children in high-quality centers to the greatest extent (up to 48 percent, slightly above universal vouchers), thereby dispelling the notion that many children would be priced out of high-quality markets. At the same time, we find that quality-based vouchers are less successful than universal vouchers at expanding overall center use because they are not useful to families that would use an unrestricted, universal voucher to attend low-quality centers. These families, however, are only "deprived" of center-based care relative to universal vouchers, not the baseline. Relative to the baseline, quality-based vouchers expand overall and high-quality center use, leading us to conclude that demand subsidies for high-quality centers can mitigate the unintended effects of quality-based policies–with equilibrium supply channels playing a critical role, as discussed below.

Unlike subsidy-based policies, public provision leads to a decline in overall and high-quality center use. While this seems counter intuitive given the 25% average price decline, supply and demand factors explain it. On the supply side, firms have less incentives to enter or operate high quality centers because they can no longer charge a mark-up. On the demand side, the price decline does not suffice to expand center use, particularly given the lower variety and quality. In an attempt to make center-based care more affordable, public provision lowers overall supply and merely favors baseline center users with a price decline.

An important feature of our model is non-center based childcare options. Since subsidy-based policies make center-based care more affordable, the use of other options falls. Effects are different under public provision, which, by reducing center supply, leaves about two percent of households in need of a non-center based option–the favored one being non-relatives. Since these compete a-la-Bertrand with child care centers (priced at cost in this policy), their price falls relative to the baseline, further promoting their use. Indeed, non-relatives are used the most under public provision, particularly by college-educated mothers.

Going forward, these policy effects anticipate two themes. First is the large effects of universal, employment-based, and quality-based vouchers, and the small effects of cash transfers, income-targeted vouchers, and public provision. Second is the distributional implications, as the most disadvantaged mothers experience the largest effects.

6.2.2 Child development

All policies raise average child development relative to the baseline (Figure 2a), but the increase is quite small–between 0.02 and 0.13 standard deviations (s.d.) of the baseline child development distribution. This is because few households (30 percent at most) experience child development gains (Figure 2b), mostly by switching from low- to high-quality centers. By maximizing the fraction of children in high-quality centers, the quality-based voucher delivers the greatest average gain. And, by minimizing this fraction, the income-targeted voucher and public provision deliver the lowest one.

Average child development gains vary across mother types, with non-college educated married mothers and single mothers obtaining the highest gains. The largest average gains accrue to the children of single mothers under quality-based vouchers (about 0.16 s.d.). These children, in fact, obtain average quality gains larger than 0.08 s.d. from all policies except income-targeted vouchers and public provision.

6.2.3 Mother labor market outcomes

In the baseline (Figure 3a), 46 percent of mothers work–mostly full-time–and college mothers participate the most (54 percent). Mother labor force participation rises the most (by about 8 pp) under employment-based vouchers, followed by universal and quality-based vouchers (Figure 3b). In contrast, it falls under the other policies.

In the policy debate, employment-based vouchers are often proposed to encourage mothers' work. We find that employment-based vouchers are indeed more successful than universal vouchers on this score yet only slightly. This indicates that, if access to center based care were subsidized, many women would choose to work even in the absence of work requirement.

Effects on labor force participation vary across mothers. They are small for married college mothers yet large for non-college married mothers, who work more both a full- and part-time basis. For example, employment-based vouchers raise the labor force participation for married mothers with incomplete high school by 25 pp (Figure 3c), making them the group that participates the most (64 percent). They also raise participation for single mothers from 45 to 50 percent, mostly through part-time employment. This is a remarkable success, given that most policies studied here lead single mothers to participate *less* rather than more. Overall, voucher effects on participation indicate that access to center-based care may not be a current impediment to college mothers' employment but may be an obstacle to others.

It is interesting to explore why cash transfers, income-targeted vouchers, and public provision have such little effect on employment. With cash transfers, households consume more rather than purchasing child care services so that mother can work. With income-targeted vouchers, mothers on the margin are discouraged from working because household incomes must be kept low in order to qualify for the voucher. Single mothers, for example, become 4 pp less likely to participate in the labor force. With public provision, center-based access remains virtually stagnant and employment impacts are therefore negligible.

Not only does mother labor force participation change; wages change as well. Average mother wages fall under policies expanding participation (Figure F.2a) due to a composition effect, as new working mothers are less educated, on average, than baseline working mothers. Importantly, changes in mother labor market outcomes lead to changes in the economy's aggregate household income (Figure F.2b). Employment-based vouchers, for example, raise mothers' employment but lower average wages. Since the first effect prevails, aggregate income rises–and similarly for universal and quality-based vouchers. In contrast, aggregate income falls under the other policies. Child care policies, therefore, have a well-defined potential to affect the economy's aggregate income, lending credence to traditional arguments in favor of child care policies (see Section 1, first paragraph.)

6.2.4 Center-based care supply

In our simulations, policies affect the number, quality, and size of firms in the market. Number of firms in the market (proxied by the share of potential entrants that effectively enter) *falls* under most policies, yet the average firm captures a *higher* market share than in the baseline (Figure 4a). The causes and consequences of this market concentration differ between subsidy-based policies and public provision.

Subsidy-based policies stimulate the entry and expansion of the most efficient firms. They make it more profitable to offer high-quality care and encourage the most efficient firms to enter as high-quality providers. As a result, some firms that would offer low-quality care in the baseline choose high-quality in the counterfactuals, driving down the number and share of low-quality centers (Figure 4b). Fewer firms remain, but they are more efficient, on average, and operate more centers. Effects are largest under universal, employment-based, and quality-based vouchers. While public provision also stimulates the entry of the most efficient firms, fewer enter and operate fewer centers. This is because public provision is akin to a regulated market with capped prices, where preventing firms from charging a markup reduces their incentive to enter or offer high-quality care.

Most policies lead to an average price decline (Figure 4c). Under public provision, this happens by design because the policy eliminates markups. Under subsidy-based policies, it is the net result of two opposing forces. First is the higher demand for center-based care, which alone would raise prices. Second is the greater supply, which alone would lower prices. Overall, the supply increase dominates yet the picture is quite nuanced because of firms' endogenous entry and quality decisions. While the average firm in the high-quality segment is now more efficient, the opposite is true in the low-quality segment, leading to a price decline in high-quality centers but an increase in low-quality ones. In the end, the change in supply composition in favor of high-quality centers operated by the most efficient firms lowers overall average prices. This result illustrates the usefulness of an equilibrium model and its endogenous supply channels.

The equilibrium model also illuminates the supply-side effects of restricting vouchers to high-quality centers. The fraction of children in high-quality centers rises slightly more under quality-based than universal vouchers–as discussed above–but, perhaps surprisingly, average center price *falls more* as well. This is because no entrant chooses to offer low-quality services under quality-based vouchers; instead, only the most efficient firms enter–as high-quality providers–and push prices down. Thus, in equilibrium this voucher eliminates the low-quality segment from the market without imposing supply-side controls such as minimum quality requirements. By reshaping supply and expanding access to high-quality care, the policy also dispels concerns that households might be priced out of it.

6.2.5 Fiscal cost

We measure a policy's fiscal cost in two ways. The first is per-child average daily cost, calculated as daily cost ($40) times take-up rate (Figure 5a). The second is the implicit tax rate for the households, answering the following question: if the policy were financed through a proportional income tax on all households, what would be the tax rate? We calculate it as total policy cost (=per-child average daily cost times number of children who take up the policy) divided by aggregate household income (Figure 5b). Public provision is the only zero-fiscal cost policy because households pay on their own for center-based care.

Among subsidy-based policies, per-child average daily cost is directly related to take-up rates and is thus highest for cash transfers. The implicit tax rate follows the same pattern but with nuances due to aggregate household income effects. For example, universal voucher's per-child average daily cost is about half of the cash transfer's but the implicit tax rate is less than a third of the cash transfer's. This is because the voucher expands mothers' labor force participation and aggregate household income whereas the cash transfer shrinks them. In other words, to some extent voucher policies "pay for themselves" by expanding economic activity, further illustrating the usefulness of an equilibrium model.

Comparing policies based on fiscal costs alone could be misleading. Income-targeted vouchers, for example, have very low fiscal costs but also small effects because of low eligibility and take-up rates. Based on the full range of policy effects as well as fiscal costs, two well-defined sets of policies emerge. In the first are policies with similarly large effects on center use and labor-force participation and similar fiscal costs (universal, employment-based, and quality-based vouchers). In the second are policies with similarly small effects (cash transfer, income-targeted voucher, and public provision) yet very dissimilar costs. For a policymaker aiming to maximize effects on center use, child development, and labor force participation, the optimal choice will be among policies in the first set.

6.2.6 Welfare analysis

Building on this intuition, we now analyze policies' welfare implications. Our welfare gain metric is the *compensating variation*, equal to the consumption change needed by a household in the baseline to reach the same utility as under the policy. It is expressed in dollars per day; when positive, it indicates welfare gains. As with policy effects, when comparing welfare across policies it is important to recall that policy eligibility and take-up rates lead to large differences in the total amount of resources received by households (panel d of Table 8). For example, cash transfers give $40 a day to every household whereas income-targeted vouchers give the same amount to a small fraction of households, leading to strikingly different economy-wide totals ($36,000 and $2,000 a day, respectively) and implicit tax rates (18.4% and 0.09%, respectively).

As expected, the percent of winning households from a policy is close to its take-up rate. About half of households experience welfare gains from universal, employment-based, and quality-based vouchers yet only 25-30 percent benefits from income-targeted vouchers or public provision (panel a of Table 8.) All households benefit from cash transfers since these are universal and unconditional. Importantly, the most disadvantaged households (two-parent households in which mother has incomplete high school, and single mothers) are most likely to benefit from the policies.

Because the policies induce price, quality, and variety changes in the childcare market, many households are affected even if not eligible for the policies. This raises the question of what drives welfare gains among the winning households. As Table 8 panel b shows, these experience gains in consumption, child development, parental leisure, and idiosyncratic match with the childcare option. Consumption gains are most common, followed by gains in the idiosyncratic match and child development.

Average welfare gain is highest under cash transfers (and close to the transfer's $40 value) and smallest (about $1) under public provision and income-targeted vouchers (Table 8 panel c). It is about $11-$16 for universal, employment-based, and quality-based vouchers. When measured relative to baseline household income, average welfare gain is small for public provision and income-targeted vouchers but quite large (between 5 and 20 percent) for the other policies. The distributional effects from welfare gains are even larger, as gains from all programs are higher for single than married mothers and, among the latter, for the least educated. In other words, the sources and distribution of welfare gains are consistent with the program effects we have described so far.

While useful, this welfare analysis is limited. First, we expect our static framework to underestimate welfare gains. For instance, current gains in child development are likely to persist into the future as shown by the literature on early childhood interventions (see, for example, Gertler et al. (2014), Campbell et al. (2014b) and Heckman et al. (2010c)). Similarly, as mothers work additional hours in the current period, they accumulate experience that provides higher future wages. By not capturing future gains, our estimated welfare gains are downward biased. Second, even from a purely static perspective, the fact that some households enjoy much higher gains than others suggests that policy targeting and financing can substantially affect welfare gains. Given these caveats, our welfare analysis provides a suggestive comparison rather than a definitive judgment of policies' relative merits.

6.2.7 Choosing among child care policies

Ultimately, which policy is best depends on the policymakers' goal. If the goal is maximizing aggregate household income, then the employment-based voucher is best because it maximizes mothers' labor force participation at a relatively low fiscal cost while delivering a reasonable child development gain. If, in contrast, the goal is maximizing average child development gain, then the quality-based voucher is best. Although the universal voucher would perform well at both goals, fiscal costs would be higher by subsidizing households that, in the baseline, already use centers or include working mothers.

Single mothers are often the focus of policy debates. The good news is that, per our welfare analysis, they benefit from most programs at a higher rate than other households and obtain larger relative welfare gains. At the same time, which program is best for them depends on the policymaker's goal. To maximize their welfare using vouchers, the best program is universal vouchers, which make 60 percent of them better off (Table 8 panel a) and deliver average welfare gains of about 24 percent of baseline income (Table 8 panel c). To maximize their children's development, the best policy is quality-based vouchers, which maximize the percent of those children in high quality centers (raising it from 18% to 54%) and their child development gains (at 0.16 s.d., the highest gain across all mothers and policies). But, to maximize their labor force participation, the best policy is employment-based vouchers, which raises their participation rate by 5 pp.

An overarching lesson emerges: if the policymaker's goals are those mentioned here, then the best policies are subsidy-based (or demand-side) policies. The effort to control supply via public provision shrinks the market and favors the relatively affluent households already using center-based care in the baseline. In contrast, the subsidy from demand-side policies expands supply and benefits a broader group of households. By harnessing the market's power, demand-side policies are hence the more effective option.

6.3 Location-specific counterfactual effects

In principle, it is conceivable that some policies would be more effective in some locations than others. To explore this issue, we simulate the same six policies in our four locations. For comparability, we set the voucher or cash transfer to the same nominal amount ($5 per hour) across locations, which is above the average baseline price in small, low-income locations but is roughly similar to it in others. As the bottom panel of Table 6 shows, eligibility and take-up rates for the various policies are fairly similar across locations except for income-targeted vouchers, whose eligibility peaks at 46-47 percent in the small, low-income location but falls to about 10 percent in the large, high-income location.

Appendix Tables F.2–F.5 present detailed policy effects by location. Qualitatively, they echo results from the previous section and are similar across locations. At the same time, *ex ante* location differences render some policies more effective in some locations than others, as described below.

6.3.1 Child care center use and child development

Three policies raise center use in all locations–universal vouchers, employment vouchers, and quality-based vouchers–while the others change it little across the board (Figure 6). Those three policies, in addition, raise the fraction of children in high-quality centers in all locations.

Beyond these qualitative similarities, policy effects are quantitatively different across locations. Center use rises the least in the small, low-income location, where mothers face the lowest wage offers. Even though the voucher fully covers the baseline price in this location, center use expands the least because mothers' wage offers are not high enough to induce additional work. Center use expands more in high- than low-income locations, and in large than small ones. Holding location size constant, high-income locations have more educated households, whose higher wage offers create greater incentives to join the workforce and hire center-based care. Holding location income constant, large locations have a greater number of college-educated households and a larger customer base, giving firms more room for entry. Although firms face higher costs in large than small locations, on balance they offer greater capacity and variety at relatively low prices.

Location size affects not only firm quantity but also quality, as large locations make it more profitable to offer high-quality center-based care. Therefore, policies are most successful at raising high-quality center use in the large, high-income location. The exception is quality-based vouchers, whose greatest impact is in the large, *low-income* location, where relative care is quite plentiful and only quality-based vouchers can induce many mothers to work and hire center-based care. With the exception of public provision, new centers usually provide high-quality care except in the small, low-income location (Figure F.3), where a small and relatively poor customer base only supports the opening of low-quality centers. In this location, too, center number changes the least in response to policy.

Average child development gains are positive but low in all locations, and are lowest for cash transfers and public provision (Figure F.4). Universal vouchers, employment-based vouchers, and quality-based vouchers deliver the largest average gains. Income-targeted vouchers deliver comparable gains only in the small, low-income location, where eligibility is highest. Whereas the largest gains come from universal vouchers in small locations, they come from quality-based vouchers in large ones. This is because limiting vouchers to high-quality centers is of little consequence in large locations, as these encourage entry by high-quality providers under *any* policy. In small locations, where the limitation leaves households with fewer voucher-eligible choices, universal vouchers are therefore more effective.

6.3.2 Mothers' labor force participation

Mothers' labor force participation declines in all locations under three policies–cash transfers, income-targeted vouchers, and public provision–yet rises with the others (Figure 7). Employment-based vouchers expand it the most (between 4 and 8 pp) in all locations except for large, low-income location, where they second quality-based vouchers. The greatest effects from employment-based vouchers accrue to non-college educated married mothers (participation increases between between 6 and 18 pp) and single mothers, who work less on a full-time basis but more on a part-time one (Figure 8). Mothers respond the most to employment-based vouchers in the large, high-income location, where wage offers are highest.

To summarize, policy effects are qualitatively similar across locations, and largest for universal, employment-based, and quality-based vouchers. Which of these three policies is best depends not only on the policy maker's goal–as is the case for the aggregate economy–but also on the specific location. If the goal is maximizing mothers' labor force participation, then employment-based vouchers are the best policy for all locations except the large, low-income location. If the goal, instead, is maximizing average child development gains, then universal vouchers are the best option for small locations whereas quality-based vouchers are the best option for large ones.

6.4 Comparison with Previous Literature

Three features characterize our environment and policy simulations: (1) they illustrate large-scale policies, (2) center-based provision is private and quality endogenous, and (3) children are two years old. These features reflect margins for meaningful expansion in the US and represent the status quo for center-based care supply. However, they complicate the comparison with previous literature particularly for the US, where no reform includes all three features. Hence, the literature cited here for the US mostly focuses on the 3 to 5 age group.[37] Only contributions on a few case studies include interventions in our age group.[38] Case studies are difficult to compare with our setting for three main reasons. First, they have a very narrow scope, focusing on specific socioeconomic groups and small numbers of children, and are unlikely to trigger equilibrium effects. Second, the child care centers studied are usually purpose-built and provide a level of quality much higher than even our sample's highest quality centers. Third, they typically do not monitor mothers' labor supply decisions and outcomes. Still, by looking at a wider range of countries and focusing on some aspects of previous studies and interventions, we can establish some meaningful comparisons.

Universal voucher simulated effects can be compared with those in Baker et al. (2008), who study the impact of a major child care subsidy in the Canadian province of Quebec.[39] As in our simulations, they find an increase in child care use and female labor supply. Contrary to our simulations, they find no effect on children's cognitive outcomes, presumably because the subsidy was used by children from relatively affluent households who would otherwise have stayed home with their mothers. These children are likely to have highly educated mothers who could have provided child care of a quality equal or superior to the one provided by the centers. A similar result is implied by Fort et al. (2019), who study a program leading to a preschool enrollment increase for 2 year-old children in Bologna, Italy. Our theoretical model contains all the channels that could have generated results similar to those in Baker et al. (2008) and Fort et al. (2019). However, our simulation results are different likely because we allow for an endogenous adjustment of supply in response to the policy, thereby increasing

[37] Examples include the large literature on the expansion of public preschool provision (Cascio (2021), Cascio (2009), Fitzpatrick (2010) and Fitzpatrick (2012)) or contributions on case studies such as *Head Start* (Currie and Thomas (1995) and Garces et al. (2002)) and the *Perry School* (Heckman et al. (2010c)).

[38] See for example Love et al. (2005) evaluating *Early Head Start* and Campbell et al. (2002) Campbell and Ramey (1994) studying *Abecedarian.*

[39] All parents of children aged 0 to 4 were offered subsidized non-home based care $5 per day. Center-based care supply was expanded, as in our experiments.

quantity and quality of center-based care, and we simulated a broader set of households using vouchers, some of which benefit from high-quality centers in terms of child development.

We can compare the effects of our targeted voucher simulations with those of several actual programs. For example, Bettendorf et al. (2015) study a child care policy in the Netherlands, in which the subsidy amount is decreasing in family income and covers between 25 and 95 percent of child care costs. They find only modest increases in maternal employment rate, a result consistent with the relatively small decline in mothers' participation rates implied by our income-targeted voucher simulations.

Some tax credit policies are similar to our income-based and work-requirement vouchers. Credit fungibility is different, since tax credits can be used to buy any goods and services, but conditionality is the same. For instance, the Earned Income Tax Credit (EITC) requires that at least one household member work, and the benefit amount decreases after an income threshold. There is evidence that EITC raises labor market participation for single mothers but lowers it for secondary earners (Eissa and Hoynes (2006) and Hotz (2003)). Dahl and Lochner (2012), Dahl and Lochner (2017) and Lundstrom (2017) find that EITC expansions improve children's math and reading achievement. However, Heckman and Mosso (2014) caution against taking these results as evidence that cash transfers substantially improves children's outcomes because they ignore equilibrium effects on female labor supply. Agostinelli and Sorrenti (2018) improve on this margin by controlling for the endogeneity of family income and maternal labor supply to study the EITC and its impact on single mothers who work. They find that a subsidy of $1,000 a year increases average child development by about 0.044 s.d–an impact bigger than ours.[40]

Since our sample children are very young, our cash transfer simulation is comparable to cash transfers for households with newborn or very young children, common in numerous European countries and Canada (OECD, 2011). González (2013) considers the effect of a large and unanticipated lump-sum universal child cash transfer to mothers with newborn babies. She finds the policy led to a substantially lower use of formal day care services and a temporary reduction in mother's labor supply, with an increase in maternal care time. Schirle (2015) studies the Canadian Universal Child Care Benefit, which distributes a monthly amount ($100 in 2012) per child under six years of age. She finds substantial reductions in labor supply for mothers with high and low education levels, with stronger impacts for the latter. Milligan and Stabile (2009) studies a transfer expansion to households with children ages zero to five in the Canadian state of Manitoba. They find large differences in labor supply responses by mother's education and estimate a negative impact only for households with low education levels. In our cash transfer simulation, we also find different effects on labor force participation and child development by mother's education, with larger effects for college mothers. Since education is correlated with income, these heterogenous effects by mother's education are consistent with the heterogenous effects by income estimated in the literature (see Løken et al. (2012) using Norwegian data.)

[40]In our simulations, the subsidy and voucher are $40 per day, generating a subsidy of $10,000 a year if the subsidy is used five days a week for about 11 months a year. As shown in Table F.1, the effect of the most effective interventions for married mothers is at most 0.13 s.d. The highest effect is for single mothers under quality-based vouchers (0.16 s.d.). A caveat worth noting is that income enters child development in our model and policy simulations through the choice of child-care mode, unlike in the reduced form literature where income can also affect the use of other goods and services which may directly affect child development.

Our quality vouchers connect with an established literature on quality regulation that has identified key trade-offs (for a survey, see Blau and Currie (2006)). Blau (2003) and Hotz and Xiao (2011) articulate the most important one: while quality regulations improve quality, they frequently lower use because higher quality is more expensive. The negative impact of lower use is compounded by the selection of the children priced out of the market–children who come from disadvantaged households and who would benefit the most from high-quality child care. Hotz and Xiao (2011) find that, in the US, state-level regulations on supply and quality of child care services has led to fewer centers but higher quality for the remaining ones. Consistent with the trade-off described, the reduction in number of centers is concentrated in low-income areas while quality increase is concentrated in high-income areas.

Our quality-based voucher simulation endogenously eliminates low quality centers from the market while reducing average prices for high-quality centers from $5.28 an hour in the baseline to $4.08 an hour, which is just a few cents higher than average baseline prices for low-quality centers. The reason for the relatively low price of high-quality centers in the counterfactuals is that, due to the quality requirement of the voucher, new high-quality providers enter the location and push prices downward. This is an additional example of how our counterfactuals, which incorporate supply-side equilibrium responses (driven by the subsidy-induced demand expansion) lead to different conclusions than those omitting them.

A final word of caution is in order about comparing our results with previous literature. Our model is static and estimates policy impacts that ignore important life cycle effects on child development and mothers' human capital accumulation in the labor market. It also ignores potential impacts on fertility and marriage decisions. It is not clear whether these shortcomings lead to over or under estimating our policies' impact. All these policies deliver child development gains. If intertemporal complementarities are present (Cunha et al., 2010), our results do not account for the positive impact of these gains on future levels of child development. Most of our policies increase mothers' labor supply. Our static analysis misses the life-cycle impact of such increase on mothers' human capital accumulation. Exactly the opposite, i.e. the depreciation of human capital, is what we miss in policies that decrease labor supply. Therefore, our results provide a lower bound of benefits when the policy increases labor supply and an upper bound when it lowers it. The impact on marriage decisions is ambiguous. Consider policies that deliver child development gains and increase mothers' labor supply. They lower child care costs, leading mothers to participate more in the labor market and become more financially independent, thereby raising their marriage reservation value. Everything else equal, this lowers women's marriage probability. At the same time, as women raise their labor market value they receive more marriage offers, potentially raising their marriage probability (Chiappori et al., 2018; Flabbi et al., 2021). The impact on fertility decisions is also ambiguous because our policies generate an ambiguous impact on the costs of having a child. Subsidies to childcare reduce a crucial direct cost of having children, but the ensuing accumulation of human capital through greater labor market participation increases the opportunity cost of children. The potential for quantity/quality trade-offs in the number of desired children (Becker and Lewis, 1973; Becker and Tomes, 1976) and the impacts on marriage decisions only magnify the ambiguity of our policies' impact on fertility.

7 Conclusions

Child care markets are at the center of the trade-off facing parents as they allocate time between the labor market, child care, and leisure. By supplying labor in the market, parents receive income yet lose a portion of the time they would otherwise devote to caring for children. Therefore, access to high-quality child care options, which can effectively substitute for parents' time, is crucial to family-friendly policies, child development, and labor supply. Any policy seeking to expand child care access should recognize that center-based quality and price are market equilibrium outcomes, which will adjust in response to policies.

We model the child care market and estimate its structural parameters, endogenizing both demand and supply to evaluate policies in an equilibrium context. We model parental choices on labor supply, child care, and time allocation and providers' decisions on entry, quality, and price. We model two- and single-parent households. In addition to exclusive parental care, we allow parents to choose between care provided outside the home by center-based providers or relatives (e.g., grandparents), and home-based care provided by non-relatives (e.g., nannies). In equilibrium, the market features multiple levels of quality as well as horizontal differentiation and price variation within and across qualities.

We estimate the model by Simulated Method of Moments on a sample of two-year old children from the 2003 Early Childhood Longitudinal Study (ECLS-B). We obtain precise point estimates that provide a good fit of the data and are comparable with previous literature. Parameter estimates imply that households value consumption less than child development and show that mother's time has a strong positive impact (increasing in education) on child development. They also show a high degree of substitutability among time with various care providers. We allow multiple parameters to vary by household location, finding that both wage offers and costs of care are increasing in the location's size (children's population) and (average) income yet not at the same rate.

We simulate policies inspired by the current debate on increasing access to center-based care. We simulate subsidy-based policies (vouchers and cash transfers) and public provision. We implement both universal vouchers and vouchers with income, work, or center quality requirements. The simulations, which account for equilibrium effects in the child care market, deliver relatively large effects for universal, employment-based, and quality-based vouchers, and small effects for cash transfers, income-targeted vouchers, and public provision. All policies raise average child development relative to the baseline yet the increase is small and mostly driven by children who switch from low- to high-quality centers. The impact on mothers' labor force participation is more substantial, and highest among those with less than a college degree. If access to center based care were subsidized, many women would choose to work even when not required to access the subsidy. Overall, effects are largest for non-college educated married mothers and single mothers.

Equilibrium effects are particularly relevant for prices. All policies, with the exception of cash transfers, lead to an average price decline in child care centers despite increasing their demand. The decline occurs because supply effects dominate: policies lead to a larger and higher-quality supply because they induce more efficient firms to supply high-quality services and expand. The results inform policymakers concerned that, while quality regulations and policy interventions could indeed raise child care quality, they might raise prices and deprive the neediest children of the service. Taking into account equilibrium effects also illustrate how some policies could "pay for themselves." Voucher policies increase mothers' labor force participation and aggregate household income, expanding economic activity and lowering the implicit tax rates necessary to finance the policies. Finally, equilibrium effects also contribute to different policy impacts by location. As a result of voucher-based policies, center use rises the most in large, high-income locations. This result is generated by two equilibrium channels. First, higher-income locations have more educated households, creating greater incentives for mothers to join the workforce and hire center-based care. Second, larger locations have a larger customer base, giving more room for center entry into the market.

In the end, which policy is preferable depends on the policymaker's objective–whether to maximize child care use, child development, or female labor force participation–as well as fiscal resources. If the goal is maximizing aggregate household income, then employment-based vouchers are the best choice according to our simulations. If the goal is maximizing average child development gain, then quality-based vouchers are the best choice. If the goal is maximizing welfare improvements for vulnerable households such as single mothers, then the best policy might be a voucher program combining elements from universal, quality-based, and employment-based programs. All these policies have something in common–they harness the power of the market and trigger a supply expansion, something that public control of supply cannot accomplish. The range of our simulation results illustrates the tension between different policy objectives and quantitatively shows that endogenous adjustments in the child care market can magnify or dampen policies' adverse effects. They also illustrate that an equilibrium analysis, such as the one in this paper, is indispensable to identify unintended effects and design sound policy.

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Table 1: Descriptive Statistics: Main Variables

Household Type:	Two-Parent		Single	
Variables	Mean	Std. Dev.	Mean	Std. Dev.
Child Care Choices:				
Child Care Center Providers				
Use: =1 if main form of care is a day care center	0.27		0.41	
Units: 0–1				
Price: Hourly fee for a 2 year old attending full-time	4.54	1.74	3.88	2.41
Units: 2003 US dollars per hour				
Quality: Average overall ITERS score	4.26	0.94	4.35	1.16
Units: ITERS scale 1–7				
Non-relative Caregivers				
Use: =1 if main form of care is non-relative to the child	0.06		0.04	
Units: 0–1				
Relative Caregivers				
Use: =1 if main form of care is a relative other than a parent	0.18		0.23	
Units: 0–1				
Child's Cognitive Score:				
Bailey Short Form Mental Ability Score	128.9	11.52	123.8	9.97
Units: Original Score Unit				
Parents' Characteristics:				
Mothers				
Labor Supply				
=1 if working full-time for pay	0.32		0.42	
=1 if working part-time for pay	0.16		0.13	
=1 if not working for pay	0.52		0.45	
Units: 0–1				
Wage: Gross hourly wage	20.14	13.99	10.13	4.90
Units: 2003 US dollars per hour				
Education				
=1 if college completed or more	0.49		0.12	
=1 if high school completed or some college	0.45		0.58	
=1 if incomplete high school	0.06		0.30	
Units: 0–1				
Fathers				
Labor Supply				
=1 if working full-time for pay	1.00			
Units: 0–1				
Wage: Gross hourly wage	23.22	16.41		
Units: 2003 US dollars per hour				
Education				
=1 if college completed or more	0.51			
=1 if high school completed or some college	0.41			
=1 if incomplete high school	0.08			
Units: 0–1				
Both				
Correlation between parents wages	0.54			
Units: 2003 US dollars per hour				
Sample Size				
Number of Households	600		150	

NOTE: Table reports definitions and descriptive statistics of the estimation sample's main variables. Sample extracted from the second wave of ECLS-B for children born in 2001. Sample size is rounded to the nearest 50 to comply with ECLS-B confidentiality rules.

Table 2: SMM Parameter Estimates

	Estimate	S.E.
Panel a. Household Utility and Constraints:		
μ_{vc}	1.881	0.250
μ_{vq}	3.572	0.081
μ_{vf}	-1.041	0.075
σ_{vc}	2.251	0.895
σ_{vq}	0.925	0.688
σ_{vf}	0.793	0.261
μ^o_{vc}	0.526	0.072
μ^o_{vq}	3.600	0.079
σ^o_{vc}	1.822	0.725
σ^o_{vq}	2.891	1.338
μ_ε	0.012	0.003
ξ	1.090	0.017
Panel b. Child Development Production Function:		
γ_0	-0.644	0.095
γ^o_0	-0.046	0.012
γ_f	0.375	0.033
$\gamma_m(e_{m1})$	0.397	0.071
$\gamma_m(e_{m2})$	0.412	0.048
$\gamma_m(e_{m3})$	0.468	0.018
γ^o_m	-0.020	0.024
γ^L	0.242	0.049
γ^H	0.291	0.017
γ^{NR}	0.231	0.155
γ^R	0.306	0.104
r	0.921	0.210
Panel c. Parental Wage Offers:		
$\mu_{w_f}(e_{f1})$	2.348	0.337
$\sigma_{w_f}(e_{f1})$	0.395	0.013
$\mu_{w_f}(e_{f2})$	2.666	0.829
$\sigma_{w_f}(e_{f2})$	0.522	0.066
$\mu_{w_f}(e_{f3})$	3.282	1.941
$\sigma_{w_f}(e_{f3})$	0.540	0.101
$\mu_{w_m}(e_{m1})$	1.848	0.874
$\sigma_{w_m}(e_{m1})$	0.308	0.024
$\mu_{w_m}(e_{m2})$	1.959	0.750
$\sigma_{w_m}(e_{m2})$	0.499	0.023
$\mu_{w_m}(e_{m3})$	3.045	0.091
$\sigma_{w_m}(e_{m3})$	0.517	0.020
ρ_0	0.670	0.276
ρ_1	0.543	0.122
Panel d. Center Variable Costs:		
μ^L_c	1.351	0.022
σ^L_c	0.386	0.138
μ^H_c	1.586	0.019
σ^H_c	0.271	0.118

NOTE: See Sections 2 and 4.1 for parameter definitions. S.E. denotes bootstrapped standard errors.

Table 3: Implied Distributions

	Expected Value	Standard Deviation
Household Utility Parameters:		
α_c	0.268	0.293
α_q	0.697	0.286
α_f	0.012	0.019
α_m	0.023	0.023
α_c^o	0.163	0.255
α_q^o	0.750	0.331
α_m^o	0.087	0.171
Parental Wage Offers:		
$w_f \mid e_{f1}$	11.32	4.66
$w_f \mid e_{f2}$	16.48	9.23
$w_f \mid e_{f3}$	30.80	17.91
$w_m \mid e_{m1}$	6.65	2.10
$w_m \mid e_{m2}$	8.03	4.27
$w_m \mid e_{m3}$	24.02	13.29
Center Variable Costs:		
c^L	4.157	1.665
c^H	5.066	1.401

NOTE: Implied values obtained using point estimates reported in Table 2. See Sections Sections 2 and 4.1 for symbol definitions.

Table 4: SMM Location-Specific Parameter Estimates

	Estimates	S.E.
Location 1: Low Population – Low Income		
Parental Wage Offers:		
$\chi_{0_f}(l)$	0.908	0.009
$\chi_{1_f}(l)$	0.998	0.012
$\chi_{0_m}(l)$	0.770	0.027
$\chi_{1_m}(l)$	0.832	0.043
Center Variable Costs:		
$\psi_0(l)$	0.715	0.145
$\psi_1(l)$	1.232	0.123
Location 2: Low Population – High Income		
Parental Wage Offers:		
$\chi_{0_f}(l)$	0.952	0.015
$\chi_{1_f}(l)$	1.027	0.017
$\chi_{0_m}(l)$	1.030	0.051
$\chi_{1_m}(l)$	0.783	0.057
Center Variable Costs:		
$\psi_0(l)$	0.986	0.139
$\psi_1(l)$	1.552	0.118
Location 3: High Population – Low Income		
Parental Wage Offers:		
$\chi_{0_f}(l)$	1.025	0.008
$\chi_{1_f}(l)$	0.942	0.016
$\chi_{0_m}(l)$	1.027	0.028
$\chi_{1_m}(l)$	0.749	0.038
Center Variable Costs:		
$\psi_0(l)$	1.089	0.098
$\psi_1(l)$	1.088	0.105
Location 4: High Population – High Income		
Parental Wage Offers:		
$\chi_{0_f}(l)$	1.055	0.010
$\chi_{1_f}(l)$	0.775	0.053
$\chi_{0_m}(l)$	1.363	0.013
$\chi_{1_m}(l)$	0.997	0.091
Center Variable Costs:		
$\psi_0(l)$	1.150	0.109
$\psi_1(l)$	1.449	0.082

NOTE: See Appendix D.1 for parameter definitions. S.E. denotes bootstrapped standard errors.

Table 5: Location-Specific Implied Distributions

	Expected Value	Standard Deviation
Location 1: Low Population – Low Income		
Parental Wage Offers:		
$w_f \mid e_{f1}$	9.70	4.20
$w_f \mid e_{f2}$	13.49	7.39
$w_f \mid e_{f3}$	19.78	11.24
$w_m \mid e_{m1}$	6.30	3.94
$w_m \mid e_{m2}$	7.56	7.81
$w_m \mid e_{m3}$	18.64	10.14
Center Variable Costs:		
c^L	2.940	1.480
c^H	3.286	1.128
Location 2: Low Population – High Income		
Parental Wage Offers:		
$w_f \mid e_{f1}$	7.46	2.57
$w_f \mid e_{f2}$	17.25	11.42
$w_f \mid e_{f3}$	34.14	21.76
$w_m \mid e_{m1}$	6.22	1.19
$w_m \mid e_{m2}$	8.61	6.33
$w_m \mid e_{m3}$	24.03	10.06
Center Variable Costs:		
c^L	4.530	2.974
c^H	5.219	2.296
Location 3: High Population – Low Income		
Parental Wage Offers:		
$w_f \mid e_{f1}$	13.57	6.12
$w_f \mid e_{f2}$	17.61	10.08
$w_f \mid e_{f3}$	26.41	9.96
$w_m \mid e_{m1}$	8.05	6.47
$w_m \mid e_{m2}$	9.13	7.44
$w_m \mid e_{m3}$	23.61	9.15
Center Variable Costs:		
c^L	4.811	2.111
c^H	5.959	1.796
Location 4: High Population – High Income		
Parental Wage Offers:		
$w_f \mid e_{f1}$	12.22	3.04
$w_f \mid e_{f2}$	18.66	7.98
$w_f \mid e_{f3}$	34.96	21.00
$w_m \mid e_{m1}$	8.99	2.51
$w_m \mid e_{m2}$	9.37	4.57
$w_m \mid e_{m3}$	28.91	10.37
Center Variable Costs:		
c^L	5.525	3.345
c^H	6.693	2.733

NOTE: Implied values obtained using point estimates reported in Table 4. See Sections Sections 2 and 4.1 for symbol definitions.

Table 6: Counterfactuals: Eligibility and Take-up

Policy:	Cash transfers	Universal voucher	Employment-based voucher	Income-targeted voucher	Quality-based voucher	Public provision
Acronym:	CT	UV	EV	IV	QV	PP
			Aggregate			
Eligibility (baseline)	100.00	100.00	45.85	25.00	100.00	100.00
Eligibility (equilibrium)	100.00	100.00	54.26	26.93	100.00	100.00
Take-up rate	100.00	54.90	41.83	7.54	47.87	26.84
			Locations:			
			Location 1: Low Population – Low Income			
Eligibility (baseline)	100.00	100.00	48.77	46.21	100.00	100.00
Eligibility (equilibrium)	100.00	100.00	53.44	46.93	100.00	100.00
Take-up rate	100.00	46.24	39.44	14.16	41.60	25.41
			Location 2: Low Population – High Income			
Eligibility (baseline)	100.00	100.00	44.24	21.01	100.00	100.00
Eligibility (equilibrium)	100.00	100.00	52.44	21.33	100.00	100.00
Take-up rate	100.00	46.29	40.42	7.58	50.75	27.87
			Location 3: High Population – Low Income			
Eligibility (baseline)	100.00	100.00	44.46	26.76	100.00	100.00
Eligibility (equilibrium)	100.00	100.00	52.97	28.81	100.00	100.00
Take-up rate	100.00	36.94	36.19	9.20	54.47	19.45
			Location 4: High Population – High Income			
Eligibility (baseline)	100.00	100.00	47.64	10.43	100.00	100.00
Eligibility (equilibrium)	100.00	100.00	56.63	10.65	100.00	100.00
Take-up rate	100.00	51.03	41.01	4.11	51.03	16.82

NOTE: *Eligibility (baseline)* and *Eligibility (equilibrium)* denote the percent of households who fulfill the policy eligibility requirements at the baseline and at the policy equilibrium, respectively. *Take-up rate* is the percent of households who use the policy. Both eligibility and take up rates are relative to all households in the economy.

Table 7: Counterfactuals: Childcare Mode Choices

		Change with respect to Baseline					
Policy:	Baseline	Cash transfers	Universal voucher voucher	Employment-based voucher	Income-targeted voucher	Quality-based	Public provision
Acronym:		CT	UV	EV	IV	QV	PP
HQ Center	13.85	16.48	33.25	26.71	1.01	34.02	-0.99
LQ Center	15.03	-10.10	-7.24	-9.45	2.46	-15.03	-1.05
Non-relative	3.02	-0.16	-1.63	-0.84	-0.33	-0.69	2.08
Relative	19.84	-3.02	-11.27	-7.73	-1.81	-8.50	-0.01
Home	51.74	-3.21	-13.11	-8.69	-1.34	-9.81	-0.03

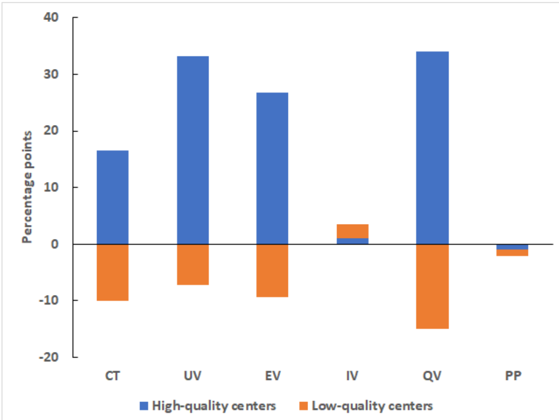
NOTE: The Baseline column shows the percent of households using each childcare mode in the baseline. The remaining columns show the difference, relative to the baseline, in the percent of households using a given childcare mode, expressed in pp. *HQ* and *LQ* denote high-quality and low-quality childcare centers, respectively. *Home* indicates that the child receives exclusive parental care.

Table 8: Counterfactuals: Welfare Implications

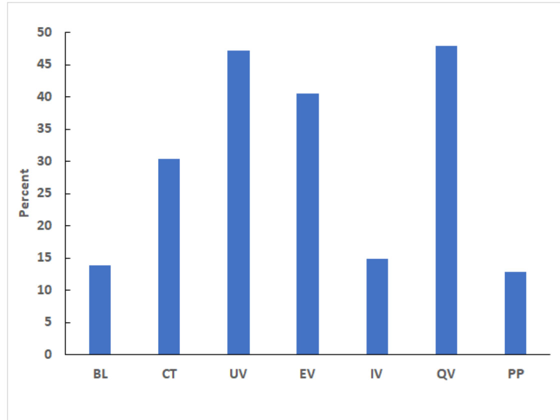
Policy:	Cash transfers	Universal voucher	Employment-based voucher	Income-targeted voucher	Quality-based voucher	Public provision
Acronym:	CT	UV	EV	IV	QV	PP
Panel a. Percent of households that gain or lose						
Percent of households that gain						
All households	100.00	56.17	47.77	29.60	49.69	27.31
Married mothers, college	100.00	54.85	48.55	29.74	48.67	30.34
Married mothers, high school	99.99	54.64	45.84	23.01	48.13	21.09
Married mothers, incomplete high school	100.00	63.03	53.95	16.35	55.49	16.43
Single mothers	100.00	60.25	48.25	46.18	53.43	36.21
Percent of households that lose	0.00	1.18	2.14	4.64	2.17	4.56
Percent of households with no welfare change	0.00	42.65	50.09	65.76	48.14	68.13
Panel b. Percent of winning households with an increase in:						
Consumption	95.93	65.87	74.60	82.97	68.93	92.37
Idiosyncratic preferences for child care provider	12.61	60.52	48.49	21.72	49.27	9.01
Child development	13.05	50.03	42.99	16.84	44.73	12.54
Mother's leisure	15.64	35.61	31.42	13.12	39.31	9.09
Father's leisure	5.74	37.28	32.32	9.38	33.69	7.60
Panel c. Avg. welfare change						
Avg. dollars/day	44.24	16.15	10.72	1.55	11.80	0.43
Avg. dollars/day as a % of baseline household income						
All households	19.39	7.08	4.70	0.68	5.17	0.19
Married mothers, college	12.67	5.22	3.64	-0.02	3.74	0.06
Married mothers, high school	22.01	7.54	5.16	0.55	5.74	0.37
Married mothers, incomplete high school	28.82	9.60	7.25	0.83	7.65	0.44
Single mothers	73.56	23.59	12.30	9.12	16.36	0.45
Panel d. Fiscal Costs						
Total fiscal costs (dollars per day)	36,000	16,857	12,204	2,376	14,013	0.00
Fiscal cost per child ($/day)	40.00	18.73	13.56	2.64	15.57	0.00
Implicit Tax Rate (%)	18.40	4.62	2.55	0.09	3.37	0.00

NOTE: For a given policy, welfare changes are computed as compensating variation relative to the baseline. *Winning households* are those that experience a positive welfare change (i.e., a welfare gain). *Total fiscal costs* is the sum of cash transfers or vouchers taken up by households. *Implicit Tax Rate* is equal to (total fiscal cost / total household income)*100 in the policy equilibrium.

Figure 1: Counterfactuals: Center-based care



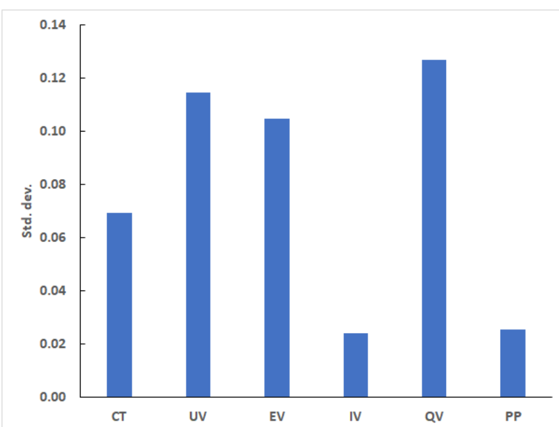
(a) Change relative to the baseline



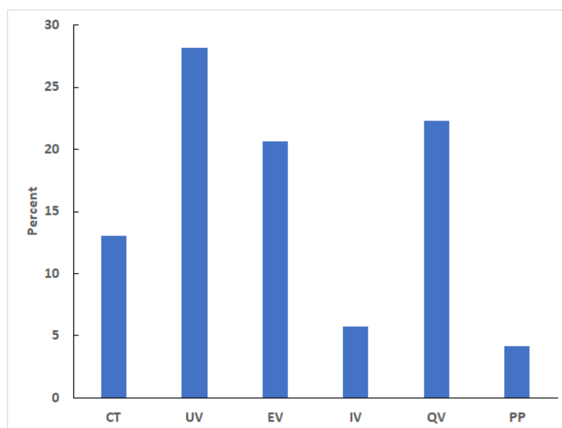
(b) Children in high-quality centers

NOTE: For each policy, panel a shows the difference, relative to the baseline, in the percent of households that use high- or low-quality centers (expressed in pp). Panel b shows the percent of households that use high-quality centers in each scenario. CT=cash transfers; UV=universal vouchers; EV=employment-based vouchers; IV=income-targeted vouchers; QV=quality-based vouchers; PP=public provision.

Figure 2: Counterfactuals: Child development gains



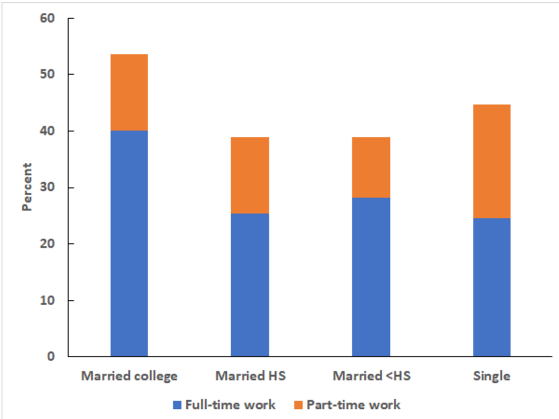
(a) Average child development gain



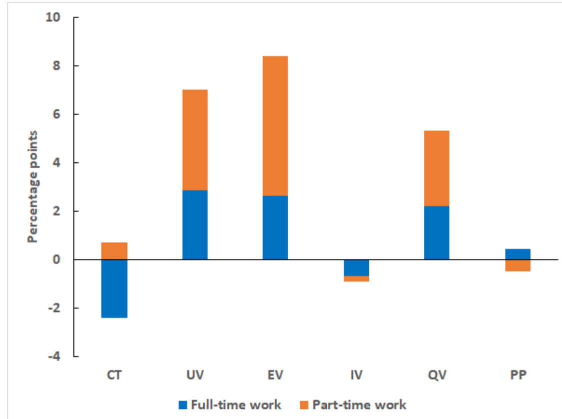
(b) Percent of households with child development gains

NOTE: For each policy, panel a shows the average child development gain, equal to the average difference in child development between the policy and the baseline, expressed in terms of standard deviations of baseline child development (see Section 6.2.2). Panel b shows the percent of households in each policy that experience child development gains. For the definition of policy acronyms, see Figure 1.

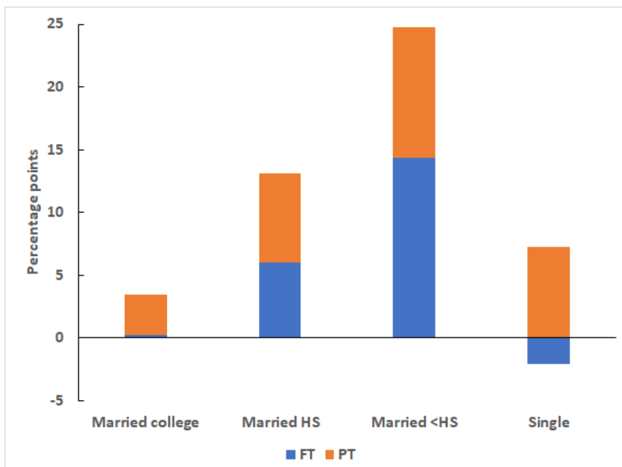
Figure 3: Counterfactuals: Mother's labor force participation



(a) Baseline, by mother characteristics



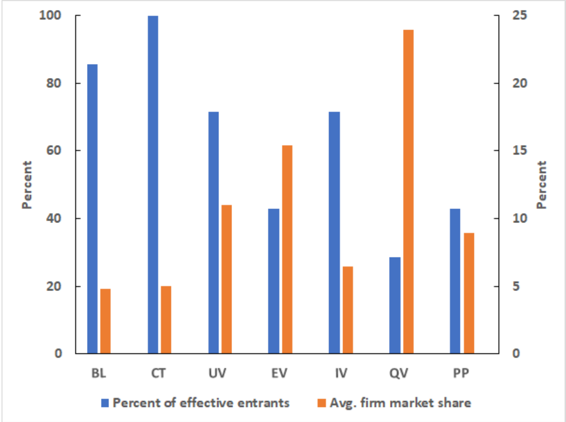
(b) Change: All scenarios, all mothers



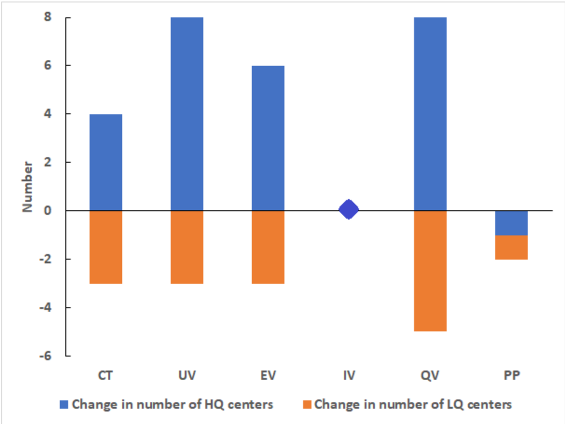
(c) Change: Employment-based voucher, by mother characteristics

NOTE: Panel a shows the baseline labor force participation (full- or part-time) by mother characteristics. For a given policy, panel b shows the labor force participation difference relative to the baseline; change is expressed in pp. Panel c shows the difference in labor force participation by mother characteristics between the employment-based voucher and the baseline; change is expressed in pp. *Married college, Married HS, Married* $<$ *HS*, and *Single* refers to the following mothers: married, with college; married, with complete high school; married, with incomplete high school; and single mothers, respectively. For the definition of policy acronyms, see Figure 1.

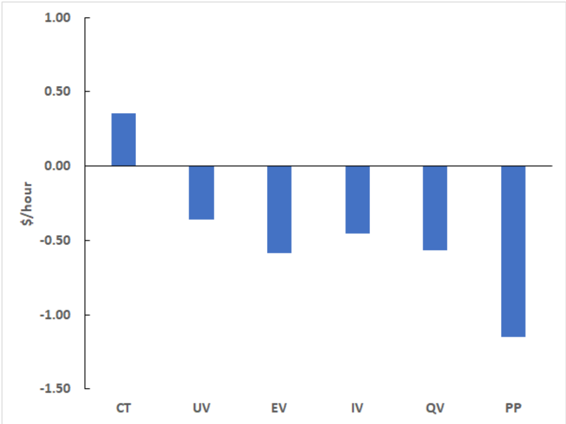
Figure 4: Counterfactuals: Firms, centers, and prices



(a) Number of firms and average firm market share



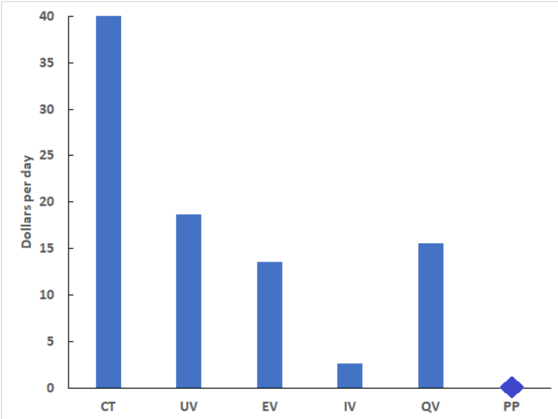
(b) Change in number of centers



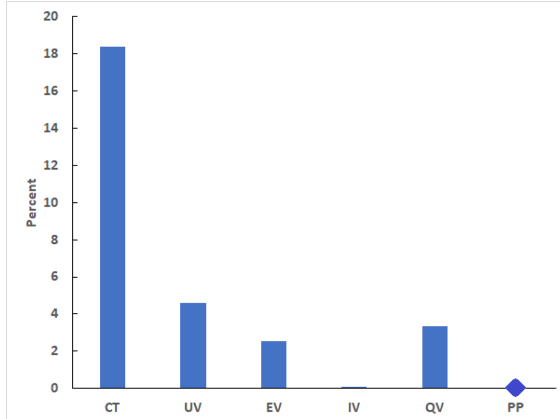
(c) Change in average price

NOTE: On the left axis (in blue), panel a shows the percent of effective entrants (= number of firms that enter the market / number of all potential firms in the market); on the right axis (in orange), it shows the average market share per firm in the market. Panel b shows the change in the number of centers; a blue diamond indicates zero change. Panel c shows the change in average center price (average is weighted by center's market share). HQ and LQ denote high- and low-quality centers, respectively. For the definition of policy acronyms, see Figure 1.

Figure 5: Counterfactuals: Fiscal cost



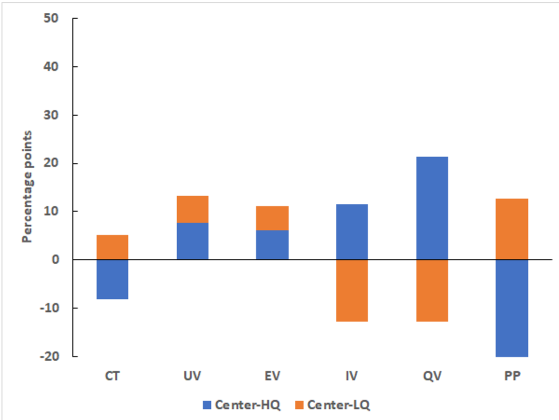
(a) Fiscal cost per child



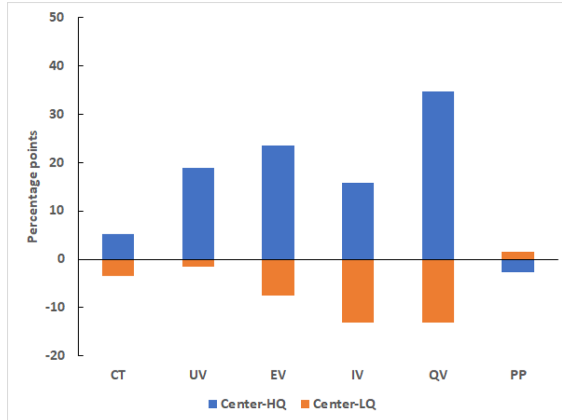
(b) Implicit tax rate

NOTE: For each policy, panel a shows the average fiscal cost per child in the economy. Panel b shows the implicit tax rate paid by families, equal to total fiscal cost * 100 / total household income in the policy equilibrium (see Section 6.2.5). For the definition of policy acronyms, see Figure 1.

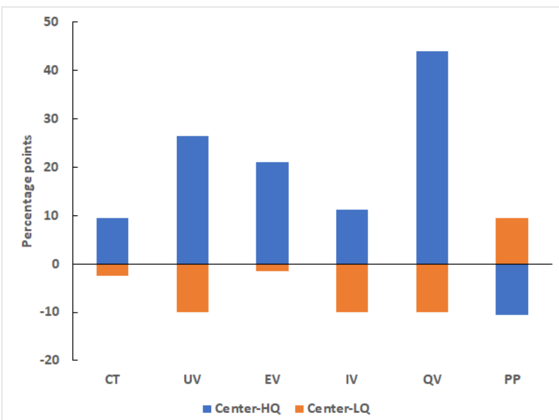
Figure 6: Counterfactuals by location: Change in percent of children in child care centers



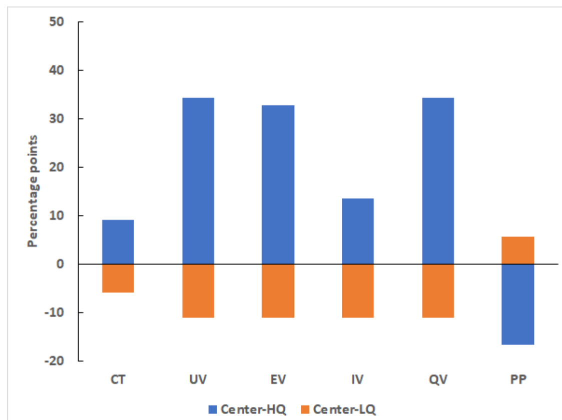
(a) L 1: Low Population – Low Income



(b) L 2: Low Population – High Income



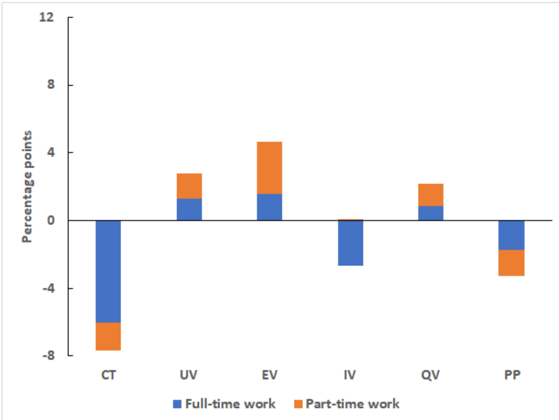
(c) L 3: High Population – Low Income



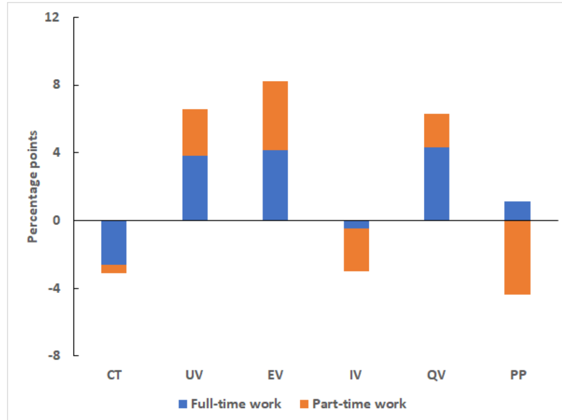
(d) L 4: High Population – High Income

NOTE: For each location (Locations 1 through 4, or L1 through L4), the figure shows the change, relative to the baseline, in the percent of children in child care centers (change expressed in pp). HQ and LQ denote high- and low-quality, respectively. For the definition of policy acronyms, see Figure 1.

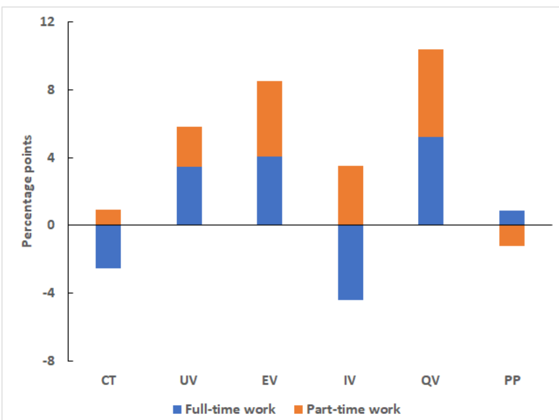
Figure 7: Counterfactuals by location: Change in mothers' labor force participation



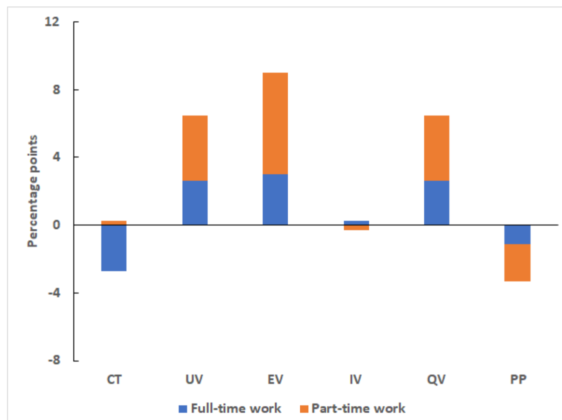
(a) L 1: Low Population – Low Income



(b) L 2: Low Population – High Income



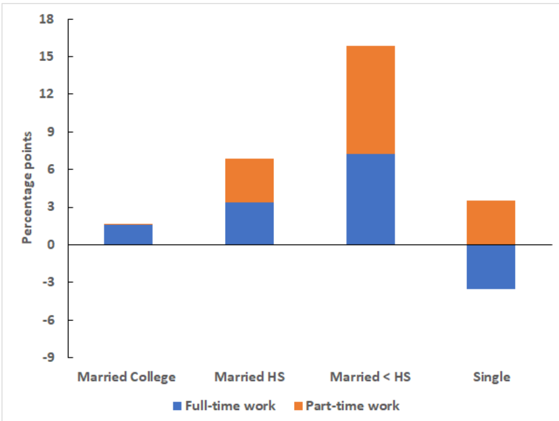
(c) L 3: High Population – Low Income



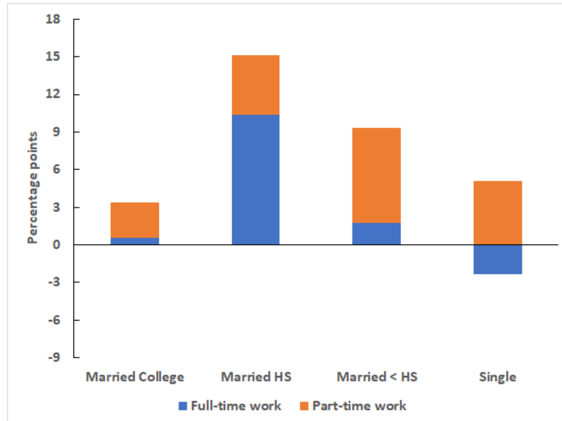
(d) L 4: High Population – High Income

NOTE: For each location (Locations 1 through 4, or L1 through L4), the figure shows the change, relative to the baseline, in mother's labor force participation (change expressed in pp). For the definition of policy acronyms, see Figure 1.

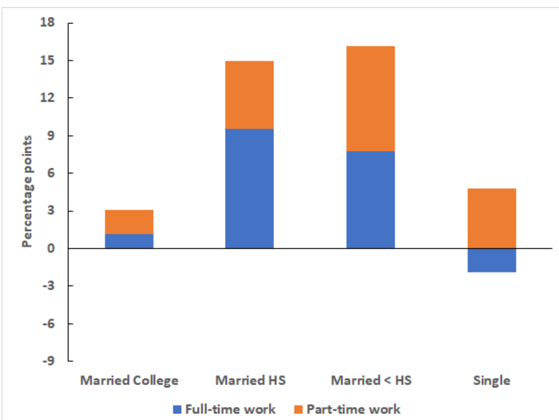
Figure 8: Counterfactuals by location: Change in mothers' labor force participation under the employment-based voucher



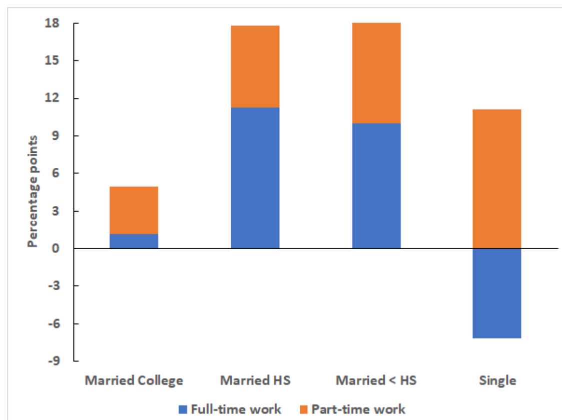
(a) L 1: Low Population – Low Income



(b) L 2: Low Population – High Income



(c) L 3: High Population – Low Income



(d) L 4: High Population – High Income

NOTE: For each location (Locations 1 through 4, or L1 through L4), the figure shows the change, relative to the baseline, in mother's labor force participation by mother characteristics under the employment-based voucher (change expressed in pp). HQ and LQ denote high- and low-quality centers, respectively. Mother characteristics are defined as in Figure 3.

Appendices

A Model

A.1 Single Mother Households

Single mother households include one mother and one child and their behavior is a straightforward specialization of the one described in Section 2.1.1 for two-parent households. Just as those, single mother household types vary in labor market opportunities (wage offers), preferences, initial level of child development, and relative care availability. They can also choose one of the $(S+3)$ possible child care modes. A household's utility function is given by:

$$U = c^{\alpha_c} q^{\alpha_q} l_m^{\alpha_m} \exp(\varepsilon) \tag{A.1}$$

where c is total household consumption, q is child development, l_m is mother's leisure and ε represents the household's idiosyncratic preferences for the chosen child care mode. We impose homogeneity of degree one in our Cobb-Douglas formulation of the utility function: $\alpha_c + \alpha_q + \alpha_m = 1$.

The household faces a budget constraint:

$$c = h_m w_m - t_d p(s) + I, \tag{A.2}$$

and time constraints:

$$\text{Mother} : \quad h_m + t_m + l_m + \xi \mathbb{I}_{\{s \in S \cup (S+2)\}} = 16 + \tau, \tau > 0 \tag{A.3}$$

$$\text{Child} : \quad t_m + t_d = 16 \tag{A.4}$$

where w_m is mother's hourly wage and h_m her labor supply measured in hours per day; I is non-labor income and t_m are mother's daily hours of care; t_d is the daily hours spent by the child in non-parental care at an hourly price of $p(s)$; and ξ is the time cost of using center-based or relative care. We assume single mothers have a larger time endowment than married mothers: $(16+\tau)$ instead of 16, which allows more flexibility in their choices.[41]

As in two-parent households, child development is produced according to a CES production function, in which the current inputs are mother's time, t_m, and time spent with non-parental care providers, t_d:

$$q - q_0 = \gamma_0 + \{\gamma_m t_m^r + \gamma(s) t_d^r\}^{\frac{1}{r}} \tag{A.5}$$

Mothers make labor supply and child care choices. They allocate their time between work, child care, and leisure. If they choose to use child care providers, they decide which one

[41] Without τ, we fall into corner solutions. For example, a single mother who does not use child care providers can neither work nor have leisure time. We can interpret our assumption as single mothers having to sleep less (8-τ hours a day) than married ones (who are endowed with 16 hours a day because they are assumed to sleep 8) because they do not have a husband to share in child care duties. In the empirical specification, we assume $\tau = 2$.

taking into account price and quality. As in Section 2.2.1, we restrict the choice sets of working hours and time with child care providers to be discrete:

$$h_f \in \{0, 4, 8\} \tag{A.6}$$

$$t_d \in \{0, 8\} \tag{A.7}$$

The discretization over working hours reflects actual choices observed in the data and simplifies the computational problem but creates cross-constraints that are more severe than in two-parent households. Specifically, when single mothers work–either part- or full-time– they *must* use non-maternal child care providers. As with two-parent households, we do not discretize the non-work time allocation between leisure and at-home child care.

Single mother's overall optimization problem consists of maximizing the household utility in (A.1) with respect to $\{c, q, l_m, s\}$ subject to the constraints (A.2)–(A.5), choice set restrictions, and equilibrium set of child care providers. Their optimal choices generate demand for child care services, which is added to the one coming from two-parent households in order to obtain the market demand defined in equation (14).

B Computational Aspects

In this appendix we describe our model's quantitative version and equilibrium computation. For simplicity, the description below focuses on two-parent households but all features are analogous for single-mother households.

B.1 Quantitative Model

We present the quantitative version of the aggregate model and discuss, as needed, modifications for the location-specific model.

Our sample includes 750 households. We assume each one represents a household type, thereby yielding $J = 750$ types. In our empirical application for the aggregate model, a household type is a combination of parental wage offers, preferences, initial child development, relative care availability, and parental education. We construct types as follows. First, for each type (household in the sample) we take from the data the initial child development, father's education, and mother's education. Second, for each type and a given parameter vector, we generate parental wage offers and preference parameters. We draw the vector (v_c, v_q, v_f) from a joint normal distribution to create the vector of preference parameters, $(\alpha_c, \alpha_q, \alpha_f, \alpha_m)$, as defined in equations (18)-(21). Similarly, we draw a pair of wage offers, (w_f, w_m) from a joint lognormal distribution with the mean vector and variance-covariance matrix defined in (22) and (23), respectively. We set the non-labor income as follows: $I_j = 0$ if j is a two-parent household and $I_j = 41$ if j is a single-mother household (see Section C.2.3). For location-specific models, we use the location-specific wage offer distributions and scale the non-labor income transfer using the "Wage" factors from Table D.1. Given the calibrated proportions of households with available relative care by location (Table D.2), in each location we randomly assign relative care to the proportion of households indicated in this table.

On the child care supply side, an important issue is the number of potential entrants, $\bar{S}$, as it relates to the total measure of households in the economy, $\sum_{j=1}^{J} M_j$. A higher $\bar{S}$ gives more heterogeneity among potential entrants yet also raises the computational cost of solving the two-stage supply side game. In the aggregate model, we strike a balance by setting $\bar{S} = 7$ and $M_j = M = 1.3$ for all $j = 1, ..., J$. In the location-specific model, we set M to the following values in locations 1 through 4: 2.93, 3.24, 3.98 and 3.17, respectively, to reflect the fact that locations differ in size.

Since potential entrant $\bar{s}$ is defined by the pair $(c_{\bar{s}}^L, c_{\bar{s}}^H)$, we draw $\epsilon_{\bar{s}}$ from a standard normal distribution and define the marginal costs for providing low and high quality as $c_{\bar{s}}^L = \exp(\mu_c^L + \sigma_c^L \epsilon_{\bar{s}})$ and $c_{\bar{s}}^H = \exp(\mu_c^H + \sigma_c^H \epsilon_{\bar{s}})$, respectively. As a result of this procedure, the ordering of potential entrants based on marginal costs is the same for low- and high-quality provision. In other words, potential entrants who are more efficient in the provision of high-quality services are also more efficient for low-quality services, a feature that simplifies the equilibrium computation below.

In the aggregate model, we set the common pair of daily fixed costs for low- and high-quality provision to $F^L = 128.90$ and $F^H = 322.25$, respectively, based on industry cost reports (see Mitchell and Stoney (2012) and footnote 23 for more details). In the location-specific model, we scale these costs by location as described in Appendix D. The opportunity cost of non-relative care providers is set to the US federal minimum wage in 2003 (equal to \$5.15 per hour) for the aggregate sample and is similarly scaled by location.

Recall that a market configuration, $\Im$, is the set of firms operating in the market as well as their qualities. With $\bar{S}$ potential entrants, each facing three choices (not entering, entering with high quality, and entering with low quality), there are $3^{\bar{S}}$ configurations of available providers and child care qualities. In some of them only a subset of potential entrants might actually enter, $S \subseteq \bar{S}$. Further, two configurations might have the same number of actual entrants yet differ in the entrants' identity or their chosen qualities.

For a given parameter point, we prepare for the computation of the equilibrium by finding the *profit function*, $\pi(\mathbf{p}; \Im)$. For each possible market configuration $\Im$, this function returns firms' maximum profits. To compute the function, for every possible market configuration we find the equilibrium of the Bertrand sub-game of price competition among the corresponding firms. We compute the vector of optimal prices $\mathbf{p}(\Im)$ using a fixed-point algorithm on the first-order conditions defined in equation (16). Thus, the profit function gives the equilibrium of each possible subgame of the second stage of the supply-side model–not the model equilibrium but rather the subgame equilibrium for a given market configuration.

B.2 Computation of the Equilibrium

Here we describe the equilibrium computation for a given parameter point. We perform separate computations for the aggregate model and each location.

We proceed as follows:

1. For each of the J household types, we draw a pair of wage offers (w_a, w_b) from a bivariate lognormal distribution with parameters μ_{w_a}, μ_{w_b}, σ_{w_a}, σ_{w_b} and ρ.

2. We generate $\bar{S}$ random draws of $(c^L_{\bar{s}}, c^H_{\bar{s}})$ from a bivariate lognormal distribution with mean vector $\boldsymbol{\mu}_c$ and variance matrix $\boldsymbol{\Sigma}_c$. Each draw represents a potential entrant.

3. We establish the entry order of the $\bar{S}$ potential entrants based on their marginal costs and hence efficiency. We do it by sorting entrants such that the first entrant has the lowest marginal cost and the last one has the highest. While this step establishes the order of entry, it does not specify which firms enter or which quality they offer.[42]

4. Given the order of entry from step 3 and the profit function $\pi(\mathbf{p}; \Im)$, we solve the first (entry) stage of the supply side model by backward induction, as each firm decides on entry and quality. The first-stage solution yields the market configuration of the subgame-perfect Nash equilibrium, $\Im^*$.

Since the equilibrium of the entry stage is found by backward induction, in principle the profit function should be computed for all $3^{\bar{S}}$ possible market configurations. To lessen the computational burden, we apply a refinement to limit the number of market configurations.

[42]In Stackelberg games, players move sequentially. In our Stackelberg entry game we define the entry sequence based on marginal costs, which reflect firm efficiency.

In this refinement, a potential entrant with order of entry $\bar{s}$ does not consider entering if potential entrant with order of entry $\bar{s} - 1$ decides not to enter. This is because the order of entry reflects firm efficiency. As a result, if a more efficient firm decides not to enter, the less efficient firm should not enter either. We can then eliminate all configurations in which potential entrant $\bar{s}$ enters the market while the $l < \bar{s}$ previous providers do not.

C Data

The data used in estimation were extracted from the US Early Childhood Longitudinal Study birth cohort (ECLS-B). This study follows from birth through kindergarten a nationally representative sample of children born in 2001. The data were collected over several waves to capture child development. We focus on the second wave, collected between January and December 2003, when the children were two years old.

C.1 Estimation Sample

As mentioned in Section 3, we arrive at our estimation sample by imposing three main restrictions: we focus on two-parent and one-parent households with only one child, who is two years old; we restrict one-parent household to cases where the parent is the mother; we focus on households in which the father, if present, works full time. In addition, we impose other restrictions that are less costly in terms of observations lost. We drop households where parents' main jobs include shift work; we eliminate households using non-relative or relative caregivers that take care of multiple children at the same time; we drop two-parent households where both parents work full-time but do not use outside child care; we drop single-mother households where the mother works full- or part-time but does not use outside child care; and we trim the top and bottom 0.5 percent of hourly earnings conditional on gender and education.

In Table C.1 we report how the main restrictions affect our estimation sample as they are progressively applied to two-parent and single-mother households, respectively. Per the first restriction (fourth and fifth columns), we keep households with three or two members– mother, father (if married), and a two-year old child. We do not drop households that go on to have more children after our sample period but drop households in which the two-year old child already has other siblings (biologically or through adoption) during our sample period, or that include additional adults.

Per the second restriction (sixth and seventh columns), from the previous set we select the households where the father works full-time. Full-time is defined as working for pay for no less than 40 hours a week. We eliminate all households where at least one parent does shift work, since shift workers have distinct child care needs. We eliminate a few (eight) observations for which child care use seems measured with error, as both parents work full time (not from home) yet do not use outside child care.

Per the third restriction (fourth column), from the previous set we focus on parents that use either exclusive parental care or a combination of parental care and either relative care, paid non-relative care, or paid center-based care. Note that all parents in the data provide at least some parental care.

The estimation sample is composed of households that are, on average, more educated than those in the full dataset. Among married couples, wages are somewhat higher for mothers in the estimation sample than the full dataset while their participation rates and father's wages look fairly similar. For single mothers, participation rates are higher in our sample but wages are about the same. Child's cognitive score is also higher in the married-household sample than the full dataset but is practically the same for single-mother households.

Table C.1: Estimation Sample Comparison

Sample:	Raw Data		HH with One Child		Estimation Sample	
Household Type:	Two-Parent	Single	Two-Parent	Single	Two-Parent	Single
	Married	Single	Married	Single	Married	Single
Child's Cognitive Score:						
Mean	126.74	124.02	127.82	124.86	128.90	123.81
Std. Dev.	11.00	10.32	11.50	10.14	11.52	9.97
Proportion Missing	0.09	0.10	0.10	0.13	0.09	0.11
Parents' Characteristics:						
Mothers						
Labor Supply						
working full-time	0.32	0.33	0.37	0.42	0.32	0.42
working part-time	0.19	0.20	0.22	0.20	0.16	0.13
not working	0.50	0.46	0.42	0.38	0.53	0.45
Wage: Gross hourly wage						
Mean	18.70	10.46	18.00	11.19	20.14	10.13
Std. Dev.	40.29	9.62	17.18	11.58	13.99	4.90
Education						
college completed or more	0.32	0.06	0.41	0.10	0.49	0.12
high school completed or some college	0.53	0.67	0.50	0.66	0.45	0.58
incomplete high school	0.15	0.27	0.09	0.23	0.06	0.30
Fathers						
Labor Supply						
working full-time	0.81		0.83		1.00	
working part-time	0.08		0.08		0.00	
not working	0.10		0.09		0.00	
Wage: Gross hourly wage						
Mean	23.32		22.21		23.22	
Std. Dev.	93.68		28.99		16.41	
Education						
college completed or more	0.32		0.38		0.50	
high school completed or some college	0.52		0.50		0.41	
incomplete high school	0.16		0.38		0.08	
Sample Size						
Number of Households	5150	1800	1700	300	600	150

Note: Samples extracted from the second wave of ECLS-B for children born in 2001. Moving left to right, we progressively add the restrictions leading to the estimation sample. Sample sizes are rounded to the nearest 50 in order to comply with ECLS-B confidentiality rules.

C.2 Definitions of Specific Variables

C.2.1 Child Care Modes

As described in Section 2, we assume that parents can choose one of three child care modes in addition to exclusive parental care: child care centers, non-relative care, and relative care. ECLS-B defines these three modes of care in the following way. They assign to *child care providers* children whose parents report that the main form of care on a regular basis is "child care centers" [..] "Such centers include early learning centers, nursery schools, and preschools." They assign to *non-relative care* children whose parents report that the main form of care on a regular basis is "someone not related to" the child. [..] "This includes home child care providers, regular sitters." They assign to *relative care* children whose parents parents report that the main form of care on a regular basis is "a relative other than a parent [..], for example, grandparents". In addition to the main form of care used on a regular basis, ECLS-B also collects form of care used on an irregular basis, for example a sitter for the night. We ignore non-parental form of care used on an irregular basis.

C.2.2 Locations

We assign every household to one of four locations. We define locations using 2000 Census county data on population and income. Given our focus on child care markets, we consider as the relevant population the *number of children younger than 5* in the county. Given our focus on household decisions, we consider as relevant income the *median family income*. We build the assignment as follows. Given each household's county of residence, we sort households by county population and calculate their median county population (36,150 children). Households below the median are assigned to Locations 1 and 2 (small locations) and those above are assigned to Locations 3 and 4 (large locations). We then sort households in Locations 1 and 2 by county median family income, the median of which is ($47,150), and assign them to Location 1 or 2 if they are below or above $47,150, respectively. For households in Locations 3 and 4, the corresponding threshold is $53,950; we assign them to Location 3 or 4 if they are below or above the median, respectively. As a result, locations 1 through 4 are defined as low population, low income; low population, high income; high population, low income; and high population, high income. By construction, locations have roughly the same number of households. In equilibrium computation, however, a household represents a different number of simulated households depending on its location so that the number of simulated households does indeed vary across locations (see further details in Appendix B).

Table C.2 presents descriptive statistics by location and, for comparison, for the aggregate. Households in high-income locations have lower rates of single motherhood and higher parental education. Consistent with more educated parents, these locations exhibit higher parental wages and child cognitive development. In all locations, home-based care is the most common choice and non-relative care is the least common. The second most-common choice is center-based care (for about 30 percent of children) except in the high-population, low-income location where center-based and relative care are used in similar proportions. Prices for center-based care are higher in high- than low-income locations. Finally, households in low-population locations use less non-relative care than others.

Table C.2: Descriptive Statistics by Locations: Main Variables

	Aggregate	Location 1	Location 2	Location 3	Location 4
Child Care Choices:					
Use: =1 if main form of care is a day care center	0.30	0.34	0.30	0.24	0.31
Price: Hourly fee for a 2 year old attending full-time	4.38	2.82	4.32	4.53	5.80
Quality: Average overall ITERS score	4.29	4.33	4.13	4.08	4.54
Use: =1 if main form of care is non-relative care	0.06	0.03	0.05	0.06	0.08
Use: =1 if main form of care is relative care	0.19	0.23	0.16	0.25	0.12
Child's Cognitive Score:					
Bailey Short Form Mental Ability Score	127.94	126.94	128.29	126.42	129.87
Parents' Labor Market:					
Mothers					
=1 if working full-time for pay	0.28	0.29	0.31	0.25	0.28
=1 if working part-time for pay	0.21	0.27	0.14	0.22	0.18
=1 if not working for pay	0.52	0.44	0.54	0.53	0.54
Wage: Gross hourly wage	17.97	13.03	18.49	16.87	24.40
Education					
=1 if college completed or more	0.42	0.27	0.47	0.31	0.62
=1 if high school completed or more but no college	0.47	0.56	0.47	0.55	0.32
=1 if not completed high school	0.11	0.17	0.06	0.14	0.05
Fathers					
=1 if working full-time for pay	1.00	1.00	1.00	1.00	1.00
=1 if working part-time for pay	0.00	0.00	0.00	0.00	0.00
=1 if not working for pay	0.00	0.00	0.00	0.00	0.00
Wage: Gross hourly wage	23.24	14.78	26.25	20.75	29.46
Education					
=1 if college completed or more	0.51	0.32	0.55	0.40	0.69
=1 if high school completed or more but no college	0.42	0.52	0.42	0.51	0.25
=1 if not completed high school	0.09	0.17	0.03	0.09	0.05
Proportion Single Mothers					
=1 if single-mother household	0.19	0.25	0.14	0.25	0.12

NOTE: Table reports definitions and descriptive statistics of the estimation sample's main variables. Sample extracted from the second wave of ECLS-B for children born in 2001.

C.2.3 Transfers

As described in Section 4.1.2, we assign non-labor income equal to zero to two-parent households and equal to $41 a day to single mothers. This amount is calibrated to match the poverty line in 2003; the transfer is sufficient to allow single mothers to consume and purchase center-based care.[43] Of course, in reality two-parent households might also receive transfers, and transfers might not be homogeneous among households. We have chosen this simplified transfer rule because transfer amounts are not reported in our data, and the simplification reduces household-level heterogeneity thereby lowering computational burdens.

[43]We have tried alternative transfer amounts, including values extracted from the literature (Fang and Keane, 2004; Hoynes and Schanzenbach, 2018), values proportional to the minimum wage, and values proportional to the poverty line. Calibrating the transfer to the 2003 poverty line provides the best fit.

D Econometrics Issues

D.1 Location-Specific Parameters: Definition and Identification

We define location-specific parameters by striking a compromise between the location-specific features we wish to capture and our data availability. In particular, we wish to avoid using moments calculated from data cells containing with too few observations (such as single-mothers that work part-time in Location 4, a cell that only contains two observations.) Therefore, we aggregate some moments and use the aggregates to estimate fewer but crucial location-specific parameters. We also scale some calibrated parameters to take into account cost and wage differences between locations.

First, with respect to heterogeneity in household labor market opportunities, we allow for gender-specific location effects in wage offers. We restrict these effects to be the same across parental educational attainments. This allows us to average out wages over education levels by location and gender and use the corresponding differences to identify the parameters of interest. Formally, we modify equations (22) and (23) to allow for:

$$\boldsymbol{\mu}_w(\boldsymbol{e}, l) = \boldsymbol{\chi}_0(l) \odot \boldsymbol{\mu}_w(\boldsymbol{e}) \tag{D.1}$$

$$\boldsymbol{\sigma}_w(\boldsymbol{e}, l) = \boldsymbol{\chi}_1(l) \odot \boldsymbol{\sigma}_w(\boldsymbol{e}) \tag{D.2}$$

where $\boldsymbol{\chi}_0(l)' \equiv [\chi_{0_f}(l), \chi_{0_m}(l)]$ and $\boldsymbol{\chi}_1(l)' \equiv [\chi_{1_f}(l), \chi_{1_m}(l)]$ are the scale effect vectors in location l for fathers and mothers, and $\odot$ denotes element-by-element multiplication.

Second, we allow fixed costs and variable costs of center-based care to vary by location. Similar to wages, we allow location effects to impact cost distribution parameters but restrict the effects to be the same across qualities. By aggregating cost-related moments over household types and center qualities we identify and estimate these location effects. For variable costs, we modify the parameters of the corresponding lognormal distributions to allow for:

$$\boldsymbol{\mu}_c(l) = \psi_0(l)\boldsymbol{\mu}_c \tag{D.3}$$

$$\boldsymbol{\sigma}_c(l) = \psi_1(l)\boldsymbol{\sigma}_c \tag{D.4}$$

where $\psi_0(l), \psi_1(l)$ are the scale effects in variable costs in location l.

As for fixed costs, in the aggregate model they are calibrated outside the estimation procedure using industry cost reports (see footnote 23). We scale these calibrated values by location to take into account possible cost differences among locations. We use the *Census Data for Residential Rents in 2000*, which reports residential median gross rent at the county level. This is a price measure with national coverage, suitable granularity, and related to a critical fixed cost item for center-based providers, namely rent. We assign counties to our four locations based on population and income as described in Section C.2.2. We then take the mean of the county median rents for each location. The ratios between these means and the aggregate mean are the scaling factors reported in the "Rent" column of Table D.1 and are the ones use to scale fixed costs $\{F^L, F^H\}$.

Third, we scale the single-mother transfer to account for cost-of-living differences across locations. We build the scaling factor with the same procedure used for the fixed costs

Table D.1: Scaling Factors used on Calibrated Parameters

Location	Scaling based on:	
	Rent	Wage
1: Low Population – Low Income	0.688	0.906
2: Low Population – High Income	0.995	1.004
3: High Population – Low Income	1.021	1.030
4: High Population – High Income	1.297	1.059

NOTE: Scaling factors computed using the 2000 Census, country-level data.

Table D.2: Proportion of Households with Available Relative Child Care.

Location	Proportion
1: Low Population – Low Income	0.431
2: Low Population – High Income	0.391
3: High Population – Low Income	0.420
4: High Population – High Income	0.368

NOTE: Values calibrated using proximity to grandparents by parents' education levels estimated by Compton and Pollak (2015).

but using average wages instead of rents. They generate the scaling factors reported in the "Wage" column of Table D.1.

Fourth, we scale the the opportunity cost of non-relative care providers–set equal to the federal minimum wage of $5.15 an hour–so that it varies across locations. We use the same scaling factors as for transfers.

Finally, we allow the availability of relative care to vary across locations. As mentioned in Section 4.2.4, we use parental characteristics in our sample as well as estimates from Compton and Pollak (2015) to calibrate the aggregate sample's proportion of households that have relative care available in close proximity. Those estimate show that not only parental education but also population density and labor market opportunities are related to this proximity. We therefore combine Compton and Pollak (2015)'s estimates with the distribution of parental education by location to obtain location-specific availability, as reported in Table D.2.

E Model Fit

Tables E.1 and E.2 report the sample and simulated moments used in estimation, as described in Section 4.3. Aggregate moments are in Table E.1 and location-specific moments in Table E.2.

Table E.1: Model Fit: Sample and Simulated Moments

Moments	Sample	Simulated
Panel (a): Child Care Choices		
Percent using Child Care Centers		
Married mothers, college, working full time	65.22	62.20
Married mothers, college, working part time	43.48	42.80
Married mothers, college, not working	6.87	8.03
Married mothers, less than college, working full time	44.00	51.29
Married mothers, less than college, working part time	25.53	27.40
Married mothers, less than college, not working	6.52	5.15
Single mothers, working full time	61.02	62.39
Single mothers, not working	15.87	19.29
Percent using Non-relative Care		
Married mothers, college, working full time	11.30	7.27
Married mothers, college, working part-time	26.09	4.25
Married mothers, college, not working	2.29	0.72
Married mothers, less than college	2.61	2.08
Single mothers	4.29	3.40
Percent using Relative Care		
Married mothers, college, working	21.12	28.74
Married mothers, college, not working	2.29	3.85
Married mothers, less than college, working	53.28	41.30
Married mothers, less than college, not working	3.26	7.31
Single mothers, working	33.77	33.67
Single mothers, not working	9.52	16.16
Panel (b): Child's Cognitive Score		
Average Score		
Married and single mothers, college	13.10	13.17
Married and single mothers, high school	12.53	12.58
Married and single mothers, incomplete high school	12.13	12.15
All mothers, working	12.92	12.79
All mothers, not working	12.68	12.64
Married mothers, college	13.20	13.17
Married mothers, less than college	12.60	12.61
Married mothers, not working	12.77	12.73
Married mothers, high school, not working	12.59	12.58
Single mothers	12.38	12.35
Single mothers, not working	12.21	12.30
Single mothers, high school, not working	12.16	12.25
Average Score by care choice		
All mothers, choosing High-quality centers	13.25	13.27
All mothers, choosing Low-quality centers	12.84	12.62
All mothers, choosing Non-relative care	12.69	12.71
All mothers, choosing Relative care	12.54	12.69

Moments	Sample	Simulated
Panel (c): Mothers' labor market		
Labor Supply Choices (%)		
Married mothers, college, working full time	39.25	40.00
Married mothers, college, working part time	15.70	13.61
Married mothers, college, not working	45.05	46.39
Married mothers, less than college, working full time	24.51	25.77
Married mothers, less than college, working part time	15.36	13.17
Married mothers, less than college, not working	60.13	61.06
Single mothers, working full time	42.14	24.59
Single mothers, not working	45.00	55.30
Wage (gross $/hour)		
Average		
All mothers, college, working	25.09	28.26
All mothers, high school, working	11.96	11.59
All mothers, incomplete high school, working	7.65	7.43
Married mothers, less than college, working	12.69	11.81
Married mothers, high school, working	13.17	11.59
Single mothers, working	10.13	9.33
Single mothers, high school, working	9.52	9.09
Standard Deviation		
All mothers, college, working	14.77	13.36
All mothers, high school, working	7.23	8.53
All mothers, incomplete high school, working	3.18	3.92
Married mothers, less than college, working	7.96	8.93
Married mothers, high school, working	8.10	8.53
Single mothers, working	4.90	5.66
Single mothers, high school, working	4.16	4.80
Father-Mother wage correlation (0-100)		
Married mothers, college, working full time	40.23	38.16
Married mothers, college, working part time	57.03	52.58
Married mothers, less than college, working full time	64.57	68.49
Married mothers, less than college, working part time	29.43	72.28

Moments	Sample	Simulated
Panel (d): Child care center supply		
Price ($/hour)		
Average		
All centers, married mothers, college	4.85	4.79
All centers, married mothers, less than college	3.80	4.51
All centers, single mothers	3.88	4.47
High-quality centers	4.78	5.28
Low-quality centers	4.17	4.04
Standard Deviation		
All centers, married mothers, college	1.82	1.01
All centers, married mothers, less than college	1.27	0.99
All centers, single mothers	2.41	1.12
High-quality centers	2.40	0.95
Low-quality centers	1.47	0.73
Percent choosing High quality among those using Centers		
Married mothers, college	48.15	51.55
Married mothers, college, working	48.08	50.96
Married mothers, less than college	60.87	41.07
Married mothers, less than college, working	57.89	38.92
Single mothers	60.71	49.15
Single mothers, working	62.50	45.15

NOTE: *Sample* refers to moments computed from the estimation sample described in Table 1. *Simulated* refers to moments computed from the simulated sample. The sample is simulated at the model's equilibrium corresponding to the parameter estimates reported in Table 2. Cognitive scores are divided by 10. All price and wage variables are in 2003 dollars per hour.

Table E.2: Model Fit: Location-Specific Sample and Simulated Moments

		Location 1		Location 2		Location 3		Location 4	
	Outcome	Sample	Simulated	Sample	Simulated	Sample	Simulated	Sample	Simulated
Panel (a): Child Care Choices									
Percentage:									
Married mothers, working	Relative	35.00	33.81	31.80	29.45	51.50	46.55	23.00	31.69
Married mothers, working	Non-relative	3.90	2.59	9.10	4.91	10.60	8.26	18.90	7.42
Married mothers, working	Center	51.90	53.42	57.60	53.49	34.80	33.28	52.70	51.97
Married mothers, not working	Relative	3.30	7.33	1.10	5.69	4.20	4.19	3.30	2.05
Married mothers, not working	Non-relative	3.30	0.47	2.20	0.69	2.80	0.67	2.20	0.83
Married mothers, not working	Center	5.00	4.79	7.70	5.65	4.20	4.28	8.70	7.26
Single mothers	Relative	28.90	21.74	28.00	17.62	19.10	31.48	13.00	32.46
Single mothers	Non-relative	2.20	0.42	8.00	1.07	4.30	2.52	4.30	8.59
Single mothers	Center	40.00	46.28	36.00	46.82	38.30	30.61	52.20	26.34
Panel (b): Child's Cognitive Score									
Non-parental care	Mean	12.70	12.63	12.93	12.85	12.74	12.73	13.10	13.09
Exclusive parental care	Mean	12.68	12.70	12.73	12.79	12.52	12.70	12.87	12.92
Panel (c): Mothers' labor market									
Labor Supply Choices (%)									
Married mothers	FT	34.30	35.06	31.20	28.79	31.20	31.10	30.70	33.34
Married mothers	PT	21.90	13.94	10.80	14.14	16.70	13.10	13.90	12.93
Married mothers	No Work	43.80	51.00	58.00	57.07	52.20	55.81	55.40	53.73
Single mothers	FT	44.40	21.80	36.00	20.09	40.40	24.97	47.80	29.22
Single mothers	PT	11.10	26.27	32.00	32.39	6.40	20.28	8.70	28.25
Single mothers	No Work	44.40	51.93	32.00	47.52	53.20	54.75	43.40	42.52
Wage (gross $/hour)									
All mothers, working	Mean	13.03	12.75	18.49	18.63	16.87	17.15	24.40	23.38
All mothers, working	SD	12.08	11.51	11.95	12.31	12.03	11.79	14.44	13.32
Married mothers, working	Mean	14.62	14.97	20.31	20.26	18.96	19.65	26.65	24.98
Married mothers, working	SD	13.38	12.41	12.63	12.55	12.74	12.20	14.46	13.42
Married mothers, working	Corr	48.80	57.55	65.80	61.05	64.60	64.18	30.70	55.88
Panel (d): Child care center supply									
Price ($/hour)									
All centers	Mean	2.82	2.87	4.32	4.25	4.53	4.95	5.80	5.45
All centers	SD	0.72	0.61	1.17	1.06	2.47	0.80	1.84	1.15

NOTE: *Sample* refers to moments computed from the estimation samples described in Table C.2. *Simulated* refers to moments computed from the simulated sample. The sample is simulated at the model's equilibrium corresponding to the parameter estimates reported in Table 2 and 4. Cognitive scores are divided by 10. All price and wage variables are in 2003 dollars per hour. "SD" denotes standard deviation and "Corr" denotes correlation with husband's wage scaled 0–100. FT=full-time; PT=part-time. Location 1: Low Population – Low Income; Location 2: Low Population – High Income; Location 3: High Population – Low Income; Location 4: High Population – High Income.

F Policy Simulations

F.1 Tables

Table F.1: Policy Simulations

	Baseline	Cash Transfer	Universal Voucher	Employment-Based Voucher	Income-Targeted Voucher	Quality-Based Voucher	Public Provision
Panel (a): Child care mode							
Percent using non-relative care							
All mothers	3.02	2.86	1.39	2.17	2.69	2.33	5.10
Married mothers, college	3.82	3.01	2.21	3.28	3.95	3.73	6.33
Married mothers, high school	2.20	1.78	1.17	1.67	2.19	1.99	3.43
Married mothers, incomplete high school	1.20	1.12	0.63	0.93	1.11	1.03	2.37
Single mothers	3.40	5.17	0.23	1.11	1.35	0.32	6.51
Percent using relative care							
All mothers	19.84	16.82	8.57	12.11	18.03	11.34	19.83
Married mothers, college	17.19	14.40	7.49	10.07	17.40	10.15	17.25
Married mothers, high school	19.78	17.86	8.67	11.79	18.92	11.33	19.94
Married mothers, incomplete high school	26.17	21.78	10.04	14.01	25.17	13.69	26.38
Single mothers	23.99	18.66	10.30	16.69	15.65	13.33	23.43
Percent using HQ centers							
All mothers	13.85	30.33	47.11	40.56	14.86	47.87	12.86
Married mothers, college	17.75	33.12	44.45	39.97	14.67	46.01	16.51
Married mothers, high school	8.70	23.12	46.15	38.42	10.49	45.71	8.63
Married mothers, incomplete high school	4.57	18.91	53.64	46.62	7.55	54.32	5.70
Single mothers	18.27	41.85	53.01	44.47	26.08	54.51	15.35
Percent using LQ centers							
All mothers	15.03	4.94	7.79	5.58	17.50	0.00	13.98
Married mothers, college	16.68	6.17	8.40	6.09	19.09	0.00	14.51
Married mothers, high school	12.14	3.98	6.96	5.13	14.58	0.00	12.39
Married mothers, incomplete high school	9.07	3.68	8.09	6.23	12.19	0.00	12.26
Single mothers	18.90	4.51	8.05	5.23	21.35	0.00	16.50
Panel (b): Child development gains							
Average child development gains							
All mothers	n.a.	0.07	0.11	0.10	0.02	0.13	0.03
Married mothers, college	n.a.	0.05	0.11	0.09	0.02	0.12	0.03
Married mothers, high school	n.a.	0.07	0.13	0.12	0.02	0.13	0.02
Married mothers, incomplete high school	n.a.	0.08	0.09	0.08	0.04	0.03	0.01
Single mothers	n.a.	0.09	0.11	0.11	0.02	0.16	0.03
Panel (c): Mothers' labor market							
Percent of mothers working							
All mothers	45.85	44.15	52.86	54.26	44.94	51.18	45.77
Married mothers, college	53.61	51.87	56.92	57.09	52.78	55.78	53.07
Married mothers, high school	38.93	37.93	50.58	52.08	38.99	48.65	39.99
Married mothers, incomplete high school	38.98	40.07	62.91	63.77	41.65	60.95	43.41
Single mothers	44.70	40.92	45.77	49.83	40.71	43.56	42.13
Average wage ($/hour)							
All mothers	18.04	18.13	17.21	17.09	18.00	17.32	17.95
Married mothers, college	28.57	28.79	28.00	27.88	28.65	28.11	28.55
Married mothers, high school	12.38	12.47	10.93	10.77	12.34	11.09	12.16
Married mothers, incomplete high school	7.66	7.50	6.81	6.83	7.50	6.85	7.37
Single mothers	9.33	9.19	9.18	9.08	9.04	9.20	9.39
Aggregate household income ($/day)	197,770	195,610	200,370	200,493	196,811	199,261	197,377
Panel (d): Child care center supply							
Percent of effective entrants	85.71	100.00	71.43	42.86	71.43	28.57	42.86
Average firm market share	4.81	5.04	10.98	15.38	6.47	23.94	8.95
Number of centers							
All centers	9.00	10.00	14.00	12.00	9.00	12.00	7.00
HQ centers	4.00	8.00	12.00	10.00	4.00	12.00	3.00
LQ centers	5.00	2.00	2.00	2.00	5.00	0.00	4.00
Average price ($/hour)							
All centers	4.64	4.99	4.27	4.05	4.18	4.07	3.49
HQ centers	5.28	5.09	4.18	4.05	4.46	4.07	4.05
LQ centers	4.04	4.36	4.84	4.06	3.95	n.a.	2.97
Panel (e): Eligibility and Fiscal cost							
Eligibility (%)	n.a	100.00	100.00	10.00	26.93	100.00	100.00
Take-up rate (%)	n.a	100.00	54.90	41.83	7.54	47.87	26.84
Fiscal cost per child ($/day)	n.a	40.00	18.73	13.56	2.64	15.57	0.00
Implicit Tax Rate (%)	n.a	18.40	4.62	2.55	0.09	3.37	0.00

Table F.2: Policy Simulations Location 1: Low Population – Low Income

	Baseline	Cash Transfer	Universal Voucher	Employment-Based Voucher	Income-Targeted Voucher	Quality-Based Voucher	Public Provision
Panel (a): Child care mode							
Percent using non-relative care							
All mothers	1.24	1.93	0.92	0.94	1.96	1.64	1.92
Married mothers, college	2.29	2.22	1.52	1.53	3.78	2.76	3.56
Married mothers, high school	1.34	1.43	1.08	1.08	2.19	2.03	1.45
Married mothers, incomplete high school	0.09	0.21	0.04	0.05	0.14	0.05	0.20
Single mothers	0.42	3.08	0.33	0.41	0.39	0.39	1.65
Percent using relative care							
All mothers	20.66	18.93	13.63	14.51	19.62	16.00	21.88
Married mothers, college	14.67	14.13	9.86	9.89	15.94	11.71	16.12
Married mothers, high school	21.42	19.68	14.36	15.33	21.27	16.78	22.26
Married mothers, incomplete high school	31.30	27.20	19.58	20.29	30.44	22.54	31.55
Single mothers	21.74	19.63	14.15	15.81	16.79	16.76	23.68
Percent using HQ centers							
All mothers	20.32	12.17	28.03	26.47	31.79	41.60	0.00
Married mothers, college	22.01	11.47	23.51	22.69	23.23	34.03	0.00
Married mothers, high school	14.98	6.97	26.19	24.30	27.43	40.17	0.00
Married mothers, incomplete high school	13.65	7.03	33.91	31.42	27.87	48.43	0.00
Single mothers	29.86	23.39	33.65	32.18	49.18	49.28	0.00
Percent using LQ centers							
All mothers	12.67	17.94	18.20	17.60	0.00	0.00	25.41
Married mothers, college	7.32	13.82	15.39	15.14	0.00	0.00	21.92
Married mothers, high school	14.30	20.11	19.12	18.63	0.00	0.00	26.29
Married mothers, incomplete high school	9.87	14.48	19.29	18.62	0.00	0.00	17.85
Single mothers	16.42	19.77	19.16	18.05	0.00	0.00	30.22
Panel (b): Child development gains							
Average child development gains							
All mothers	n.a.	0.02	0.11	0.10	0.09	0.05	0.02
Married mothers, college	n.a.	0.04	0.11	0.10	0.06	0.00	0.01
Married mothers, high school	n.a.	0.01	0.14	0.12	0.10	0.01	0.03
Married mothers, incomplete high school	n.a.	0.03	0.25	0.22	0.12	0.11	0.00
Single mothers	n.a.	0.03	0.02	0.01	0.12	0.10	0.00
Panel (c): Mothers' labor market							
Percent of mothers working							
All mothers	48.77	41.10	51.58	53.44	46.17	50.93	45.51
Married mothers, college	50.33	45.10	51.80	52.02	48.91	51.20	47.62
Married mothers, high school	47.88	42.21	53.39	54.77	45.66	52.67	46.61
Married mothers, incomplete high school	50.45	41.10	63.21	66.31	47.71	62.18	47.15
Single mothers	48.07	35.15	44.19	48.09	43.68	43.75	40.96
Average wage ($/hour)							
All mothers	12.75	13.63	12.37	12.13	13.05	12.41	13.08
Married mothers, college	23.54	24.23	23.25	23.21	23.73	23.32	23.93
Married mothers, high school	10.79	11.35	10.21	10.08	11.03	10.24	10.91
Married mothers, incomplete high school	9.00	9.87	8.17	8.01	9.24	8.22	9.30
Single mothers	5.85	5.88	5.84	5.81	5.83	5.84	5.86
Aggregate household income ($/day)	74,840	72,523	75,409	75,659	73,928	75,090	73,830
Panel (d): Child care center supply							
Percent of effective entrants	60.00	80.00	80.00	80.00	20.00	20.00	60.00
Average firm market share	11.00	7.53	11.56	11.02	31.79	41.60	8.47
Number of centers							
All centers	5.00	5.00	7.00	7.00	5.00	6.00	5.00
HQ centers	3.00	2.00	4.00	4.00	5.00	6.00	0.00
LQ centers	2.00	3.00	3.00	3.00	0.00	0.00	5.00
Average price ($/hour)							
All centers	2.87	3.32	2.67	2.66	3.12	3.35	1.86
HQ centers	3.26	4.90	2.42	2.41	3.12	3.35	0.00
LQ centers	2.24	2.25	3.05	3.03	n.a.	n.a.	1.86
Panel e. Eligibility and Fiscal cost							
Eligibility (%)	n.a	100.00	100.00	53.44	46.93	100.00	100.00
Take-up rate (%)	n.a	100.00	46.24	39.44	14.16	41.60	25.41
Fiscal cost per child ($/day)	n.a	40.00	9.86	8.45	3.54	11.15	0.00
Implicit Tax Rate (%)	n.a	29.40	6.97	5.95	2.55	7.91	0.00

Table F.3: Policy Simulations Location 2: Low Population – High Income

	Baseline	Cash Transfer	Universal Voucher	Employment-Based Voucher	Income-Targeted Voucher	Quality-Based Voucher	Public Provision
Panel (a): Child care mode							
Percent using non-relative care							
All mothers	2.30	2.24	1.55	1.80	2.73	1.69	3.70
Married mothers, college	3.14	3.07	2.38	2.76	3.92	2.66	4.97
Married mothers, high school	1.95	1.84	1.18	1.38	2.32	1.27	3.12
Married mothers, incomplete high school	0.10	0.19	0.07	0.08	0.09	0.06	0.24
Single mothers	1.07	1.10	0.22	0.26	0.62	0.17	1.99
Percent using relative care							
All mothers	16.13	14.35	10.21	10.38	15.48	8.60	16.34
Married mothers, college	13.25	11.93	8.57	8.51	13.10	7.28	13.53
Married mothers, high school	16.75	14.86	10.81	11.00	15.98	8.84	16.86
Married mothers, incomplete high school	52.18	45.17	35.60	36.86	49.09	28.67	51.80
Single mothers	17.62	15.58	9.52	10.24	16.14	8.84	17.97
Percent using HQ centers							
All mothers	15.99	21.29	34.84	39.42	31.88	50.75	13.38
Married mothers, college	18.27	23.48	29.53	33.37	28.97	42.72	15.28
Married mothers, high school	10.60	14.75	36.19	42.49	29.19	55.76	9.00
Married mothers, incomplete high school	3.43	9.26	27.44	25.61	12.24	42.32	3.65
Single mothers	26.76	35.66	48.83	51.65	52.16	62.65	21.89
Percent using LQ centers							
All mothers	13.03	9.59	11.45	5.46	0.00	0.00	14.50
Married mothers, college	11.20	7.05	10.12	5.06	0.00	0.00	10.71
Married mothers, high school	13.27	10.69	13.49	5.91	0.00	0.00	17.01
Married mothers, incomplete high school	0.65	0.59	3.26	1.18	0.00	0.00	0.74
Single mothers	20.06	15.79	10.94	6.10	0.00	0.00	21.20
Panel (b): Child development gains							
Average child development gains							
All mothers	n.a.	0.02	0.10	0.06	0.02	0.07	0.02
Married mothers, college	n.a.	0.03	0.06	0.02	0.00	0.04	0.01
Married mothers, high school	n.a.	0.02	0.18	0.14	0.05	0.16	0.03
Married mothers, incomplete high school	n.a.	0.00	0.11	0.08	0.04	0.14	0.00
Single mothers	n.a.	0.00	0.02	0.05	0.02	0.06	0.00
Panel (c): Mothers' labor market							
Percent of mothers working							
All mothers	44.24	41.15	50.37	52.44	45.28	52.04	44.50
Married mothers, college	43.58	41.73	46.19	46.96	43.82	47.44	42.97
Married mothers, high school	42.46	39.41	55.13	57.60	45.59	57.38	44.60
Married mothers, incomplete high school	38.69	32.62	43.57	48.05	39.21	45.75	38.47
Single mothers	52.48	45.83	50.59	55.21	49.95	51.78	50.02
Average wage ($/hour)							
All mothers	18.63	19.11	17.37	17.03	18.32	17.18	18.37
Married mothers, college	28.37	28.54	27.83	27.63	28.28	27.66	28.37
Married mothers, high school	12.04	12.34	10.64	10.51	11.58	10.46	11.67
Married mothers, incomplete high school	6.76	6.78	6.69	6.60	6.75	6.65	6.78
Single mothers	10.25	10.61	10.38	10.11	10.37	10.38	10.35
Aggregate household income ($/day)	141,922	140,249	143,702	144,171	141,498	144,279	141,775
Panel (d): Child care center supply							
Percent of effective entrants	80.00	80.00	80.00	60.00	40.00	60.00	40.00
Average firm market share	7.26	7.72	11.57	14.96	15.94	16.92	13.94
Number of centers							
All centers	6.00	6.00	8.00	7.00	5.00	9.00	5.00
HQ centers	3.00	4.00	6.00	6.00	5.00	9.00	2.00
LQ centers	3.00	2.00	2.00	1.00	0.00	0.00	3.00
Average price ($/hour)							
All centers	4.25	4.62	4.22	3.73	3.84	4.00	2.96
HQ centers	4.89	5.27	4.37	3.67	3.84	4.00	3.77
LQ centers	3.47	3.17	3.76	4.20	n.a.	n.a.	2.21
Panel (e): Eligibility and Fiscal cost							
Eligibility (%)	n.a	100.00	100.00	52.44	21.33	100.00	100.00
Take-up rate (%)	n.a	100.00	46.29	40.42	7.58	50.75	27.87
Fiscal cost per child ($/day)	n.a	40.00	14.48	12.08	2.35	16.26	0.00
Implicit Tax Rate (%)	n.a	16.83	5.94	4.94	0.98	6.65	0.00

Table F.4: Policy Simulations Location 3: High Population – Low Income

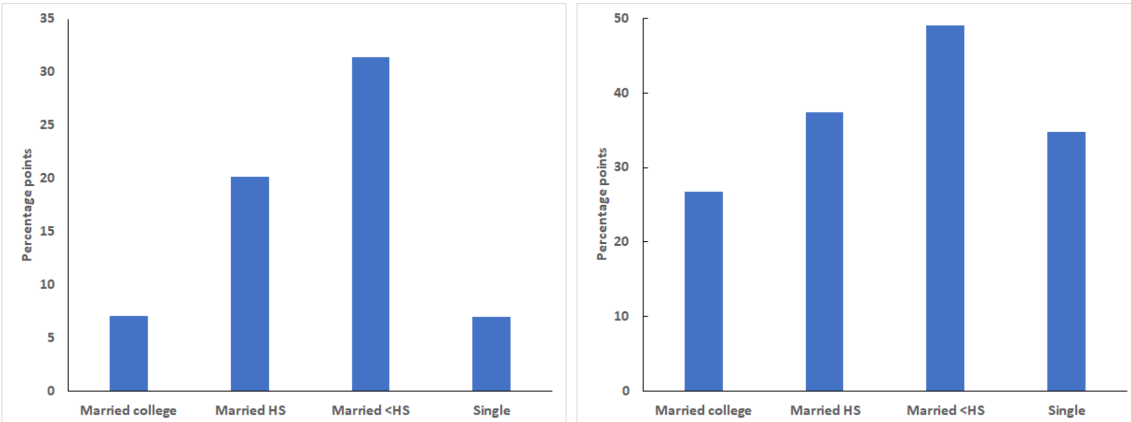
	Baseline	Cash Transfer	Universal Voucher	Employment-Based Voucher	Income-Targeted Voucher	Quality-Based Voucher	Public Provision
Panel (a): Child care mode							
Percent using non-relative care							
All mothers	3.64	2.99	1.75	1.43	4.00	0.97	4.00
Married mothers, college	5.72	3.62	2.91	2.35	6.58	1.57	6.17
Married mothers, high school	3.13	2.13	2.02	1.56	3.61	1.13	3.05
Married mothers, incomplete high school	1.62	1.09	0.20	0.15	1.62	0.09	2.08
Single mothers	2.52	4.05	0.37	0.48	2.21	0.21	3.42
Percent using relative care							
All mothers	25.09	22.01	19.62	17.23	23.59	11.25	25.26
Married mothers, college	19.81	17.25	15.71	13.49	20.07	9.33	19.88
Married mothers, high school	22.78	21.17	18.55	14.22	22.75	10.03	22.58
Married mothers, incomplete high school	38.98	37.53	31.42	24.69	38.97	16.50	38.72
Single mothers	31.48	25.15	23.03	24.44	25.33	14.12	32.46
Percent using HQ centers							
All mothers	10.56	19.99	36.94	31.51	21.74	54.47	0.00
Married mothers, college	12.65	20.67	29.89	26.61	18.15	43.02	0.00
Married mothers, high school	5.92	13.28	37.84	33.46	14.23	58.22	0.00
Married mothers, incomplete high school	5.56	11.89	34.56	33.60	13.37	57.83	0.00
Single mothers	16.54	31.54	44.20	33.62	39.48	60.99	0.00
Percent using LQ centers							
All mothers	9.97	7.48	0.00	8.42	0.00	0.00	19.45
Married mothers, college	7.03	4.64	0.00	6.29	0.00	0.00	17.65
Married mothers, high school	10.47	7.95	0.00	10.19	0.00	0.00	19.64
Married mothers, incomplete high school	3.51	2.43	0.00	6.98	0.00	0.00	10.21
Single mothers	14.07	11.22	0.00	8.45	0.00	0.00	23.39
Panel (b): Child development gains							
Average child development gains							
All mothers	n.a.	0.01	0.03	0.08	0.04	0.11	0.01
Married mothers, college	n.a.	0.01	0.04	0.03	0.02	0.06	0.01
Married mothers, high school	n.a.	0.00	0.15	0.13	0.05	0.19	0.01
Married mothers, incomplete high school	n.a.	0.02	0.14	0.12	0.06	0.20	0.00
Single mothers	n.a.	0.04	0.05	0.02	0.02	0.00	0.01
Panel (c): Mothers' labor market							
Percent of mothers working							
All mothers	44.46	42.83	50.28	52.97	43.59	54.88	44.11
Married mothers, college	45.77	44.23	47.65	48.85	45.63	50.65	44.90
Married mothers, high school	43.10	41.03	54.24	58.08	41.34	59.86	45.05
Married mothers, incomplete high school	43.72	42.57	55.89	59.90	43.22	60.37	44.97
Single mothers	45.25	44.10	45.86	48.14	44.84	50.71	41.55
Average wage ($/hour)							
All mothers	17.15	17.28	16.02	15.66	17.30	15.50	17.09
Married mothers, college	28.16	28.47	27.91	27.70	28.16	27.60	28.27
Married mothers, high school	13.82	14.00	12.25	11.89	14.13	11.70	13.50
Married mothers, incomplete high school	14.05	14.26	12.15	11.70	14.15	11.65	13.81
Single mothers	9.98	9.82	9.88	9.85	9.87	9.68	10.08
Aggregate household income ($/day)	136,979	135,549	138,903	139,807	135,837	140,861	136,882
Panel (d): Child care center supply							
Percent of effective entrants	40.00	100.00	20.00	40.00	20.00	60.00	60.00
Average firm market share	10.26	5.50	36.94	19.97	21.74	18.16	6.48
Number of centers							
All centers	4.00	7.00	7.00	8.00	5.00	11.00	5.00
HQ centers	2.00	5.00	7.00	6.00	5.00	11.00	0.00
LQ centers	2.00	2.00	0.00	2.00	0.00	0.00	5.00
Average price ($/day)							
All centers	4.95	6.05	5.65	4.40	5.50	4.66	3.54
HQ centers	5.72	6.78	5.65	4.48	5.50	4.66	n.a.
LQ centers	4.13	4.08	0.00	4.11	n.a.	n.a.	3.54
Panel (e): Eligibility and Fiscal cost							
Eligibility (%)	n.a	100.00	100.00	52.97	28.81	100.00	100.00
Take-up rate (%)	n.a	100.00	36.94	36.19	9.20	54.47	19.45
Fiscal cost per child ($/day)	n.a	40.00	14.78	12.72	3.68	19.82	0.00
Implicit Tax Rate (%)	n.a	21.72	7.83	6.70	1.99	10.36	0.00

Table F.5: Policy Simulations Location 4: High Population – High Income

	Baseline	Cash Transfer	Universal Voucher	Employment-Based Voucher	Income-Targeted Voucher	Quality-Based Voucher	Public Provision
Panel (a): Child care mode							
Percent using non-relative care							
All mothers	4.45	3.33	1.85	1.91	4.36	1.85	9.57
Married mothers, college	4.69	4.32	2.55	2.61	4.64	2.55	11.17
Married mothers, high school	2.34	2.23	1.20	1.24	2.24	1.20	5.20
Married mothers, incomplete high school	0.26	0.35	0.02	0.04	0.16	0.02	1.02
Single mothers	8.59	1.43	0.16	0.25	8.37	0.16	12.79
Percent using relative care							
All mothers	17.80	16.37	9.00	9.21	17.17	9.00	19.01
Married mothers, college	16.88	15.49	8.77	8.87	16.92	8.77	18.27
Married mothers, high school	13.60	12.75	7.02	7.37	13.57	7.02	14.11
Married mothers, incomplete high school	11.89	9.72	7.90	8.86	11.73	7.90	12.00
Single mothers	32.46	29.67	14.59	14.91	27.15	14.59	34.52
Percent using HQ centers							
All mothers	16.60	25.81	51.03	49.43	30.09	51.03	0.00
Married mothers, college	18.02	25.58	46.08	45.15	29.68	46.08	0.00
Married mothers, high school	13.32	24.38	58.52	55.57	29.95	58.52	0.00
Married mothers, incomplete high school	7.11	18.34	59.66	52.33	23.52	59.66	0.00
Single mothers	18.51	31.33	57.34	56.42	33.51	57.34	0.00
Percent using LQ centers							
All mothers	11.15	5.31	0.00	0.00	0.00	0.00	16.82
Married mothers, college	11.23	4.93	0.00	0.00	0.00	0.00	16.72
Married mothers, high school	13.20	5.48	0.00	0.00	0.00	0.00	20.00
Married mothers, incomplete high school	2.37	1.29	0.00	0.00	0.00	0.00	4.84
Single mothers	7.83	7.47	0.00	0.00	0.00	0.00	12.48
Panel b. Child development gains							
Average child development gains							
All mothers	n.a.	0.03	0.06	0.05	0.01	0.06	0.01
Married mothers, college	n.a.	0.04	0.03	0.02	0.01	0.03	0.01
Married mothers, high school	n.a.	0.02	0.17	0.15	0.01	0.17	0.01
Married mothers, incomplete high school	n.a.	0.06	0.17	0.12	0.02	0.17	0.02
Single mothers	n.a.	0.03	0.04	0.04	0.02	0.04	0.02
Panel (c): Mothers' labor market							
Percent of mothers working							
All mothers	47.64	45.15	54.12	56.63	47.58	54.12	44.32
Married mothers, college	49.03	47.11	52.89	53.96	49.49	52.89	46.03
Married mothers, high school	42.54	41.57	58.00	60.32	44.41	58.00	40.29
Married mothers, incomplete high school	15.83	15.24	40.09	57.43	19.52	40.09	11.79
Single mothers	57.48	48.63	54.08	61.42	50.06	54.08	50.44
Average wage ($/hour)							
All mothers	23.38	23.64	22.22	21.83	23.41	22.22	23.44
Married mothers, college	30.92	31.01	30.46	30.35	30.79	30.46	30.94
Married mothers, high school	10.15	10.13	9.61	9.57	10.14	9.61	9.99
Married mothers, incomplete high school	7.50	7.48	6.69	7.06	7.62	6.69	7.25
Single mothers	14.14	14.87	14.40	13.95	14.53	14.40	14.15
Aggregate household income ($/day)	174,381	172,042	176,960	177,873	174,378	176,960	171,690
Panel (d): Child care center supply							
Percent of effective entrants	80.00	80.00	60.00	60.00	40.00	60.00	20.00
Average firm market share	6.94	7.78	17.01	16.48	15.04	17.01	16.82
Number of centers							
All centers	6.00	6.00	8.00	8.00	5.00	8.00	3.00
HQ centers	3.00	5.00	8.00	8.00	5.00	8.00	0.00
LQ centers	3.00	1.00	0.00	0.00	0.00	0.00	3.00
Average price ($/day)							
All centers	5.45	5.48	5.01	5.03	4.83	5.01	2.81
HQ centers	6.16	5.69	5.01	5.03	4.83	5.01	n.a.
LQ centers	4.39	4.42	n.a.	n.a.	n.a.	n.a.	2.81
Panel (e): Eligibility and Fiscal cost							
Eligibility (%)	n.a	100.00	100.00	56.63	10.65	100.00	100.00
Take-up rate (%)	n.a	100.00	51.03	44.50	4.11	51.03	16.82
Fiscal cost per child ($/day)	n.a	40.00	19.30	16.88	1.57	19.30	0.00
Implicit Tax Rate (%)	n.a	13.95	6.54	5.69	0.54	6.54	0.00

F.2 Figures

Figure F.1: Universal voucher effects on center use by mother characteristics

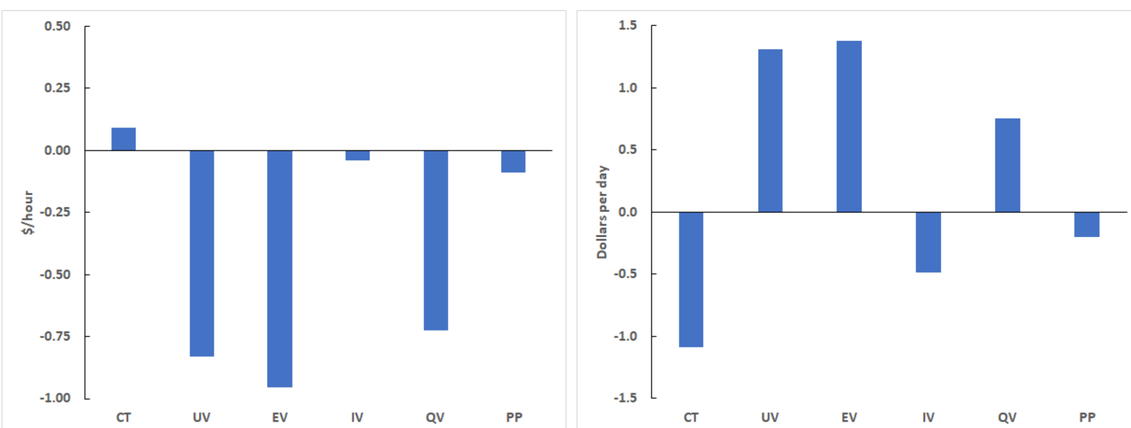


(a) Change in percent of children in child care centers

(b) Change in percent of children in high-quality centers

Note: Panel a (b) shows the difference in the percent of households whose children attend child-care centers (high-quality child-care centers) between the universal voucher and the baseline, by mother characteristics. Change is expressed in pp. Mother characteristics are defined as in Figure 3.

Figure F.2: Counterfactuals: Change in mother's wage and aggregate household income

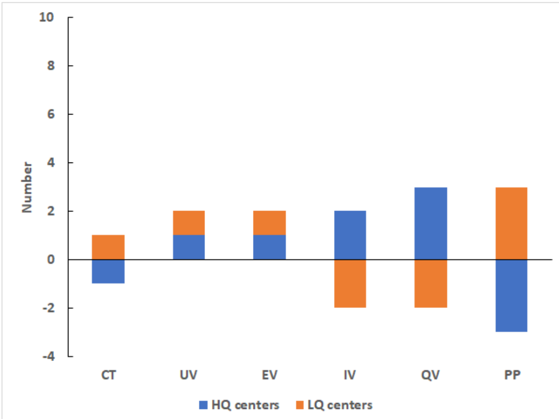


(a) Change in mothers' average wages

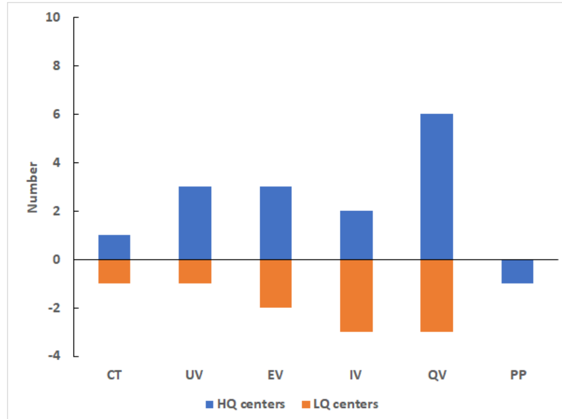
(b) Change in aggregate household income

Note: For a given policy, panel a shows the difference in mothers' average wages between the policy and the baseline. Panel b shows the differences in aggregate (or total) household income in the economy between the policy and the baseline. For the definition of policy acronyms, see Figure 1.

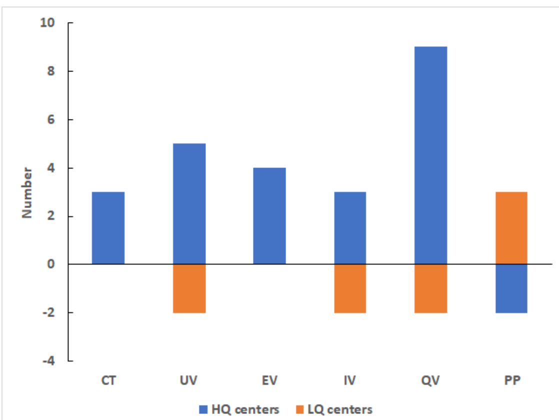
Figure F.3: Counterfactuals by location: Change in number of centers



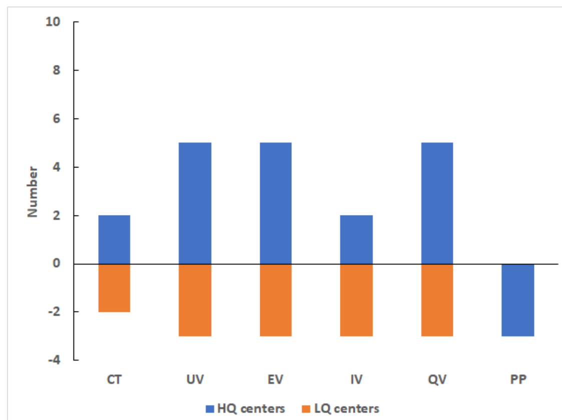
(a) L 1: Low Population – Low Income



(b) L 2: Low Population – High Income



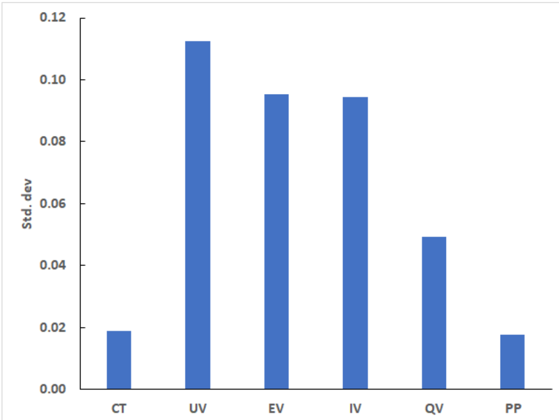
(c) L 3: High Population – Low Income



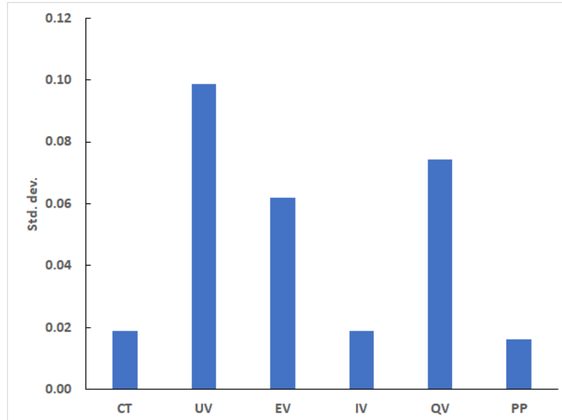
(d) L 4: High Population – High Income

NOTE: This figure shows, for every location (L1 through L4), the change in the number of centers under each policy relative to the baseline. HQ and LQ denote high- and low-quality centers, respectively. For the definition of policy acronyms, see Figure 1.

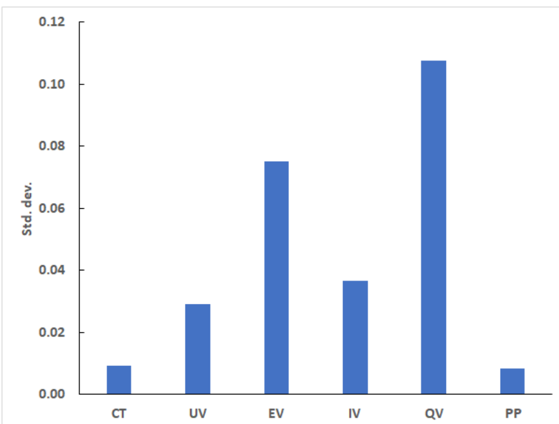
Figure F.4: Counterfactuals by location: Average child development gain



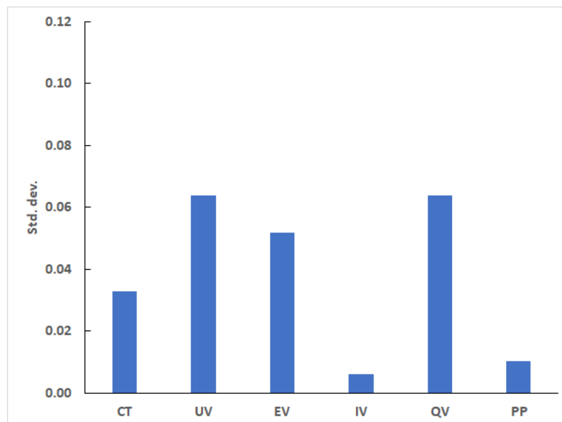
(a) L 1: Low Population – Low Income



(b) L 2: Low Population – High Income



(c) L 3: High Population – Low Income



(d) L 4: High Population – High Income

NOTE: This figure shows, for every location (Locations 1 through 4, or L1 through L4), the average child development gain under each policy relative to the baseline (gains are reported in baseline child development standard deviations). For the definition of policy acronyms, see Figure 1.