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## Daycare Matching with Siblings: Social Implementation and Welfare Evaluation<sup>1</sup>

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### Abstract

In centralized assignment problems, agents may have preferences over joint rather than individual assignments, such as couples in residency matching or siblings in school choice and daycare. Standard preference estimation methods typically ignore such complementarities. This paper develops an empirical framework that explicitly incorporates them. Using data from daycare assignment in a municipality in Japan, we estimate a model in which families incur both additional commuting distance and a fixed non-distance disutility when siblings are assigned to different facilities. We find that split assignment generates a large disutility, equivalent to more than twice the average commuting distance. We then simulate counterfactual assignment policies that vary the strength of sibling priority and evaluate welfare. The sibling priority reform that we designed and that was implemented in 2024 increases welfare by 6.4% while reducing inequality in assignment rates across sibling groups; models that ignore sibling complementarities substantially understate these gains. At the same time, we uncover a clear efficiency-equity tradeoff, whereby along the frontier, welfare gain equivalent to 100 meters of commuting distance is associated with an increase in inequality of about 1.7 percentage points, and the welfare-maximizing policy entails substantially higher inequality through the displacement of households without siblings.

Keywords: market design, demand complementarities, structural estimation  
JEL classification: D47, I21, D12

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# 1 Introduction

In centralized assignment mechanisms, some agents value being assigned to the same facility as a specific counterpart, such as couples in residency matches or siblings in school choice and daycare. In school choice, families with multiple children face substantial logistical costs when children are assigned to different schools, making joint assignment a first-order concern and motivating sibling priority in many mechanisms. At the same time, such preferential treatment raises equity concerns for families with only one child. In the United Kingdom, for example, the national school admissions watchdog expressed concerns in 2013 that granting top priority to siblings could disadvantage first-born children.<sup>1</sup> This illustrates a broader pattern in which assignment mechanisms that prioritize joint assignments, such as sibling priority, must balance the efficiency gains from accommodating such preferences against the resulting equity concerns.

To understand this efficiency–equity tradeoff, an empirical framework is needed that explicitly accounts for demand complementarities across siblings assignments. However, existing methods for preference estimation in school choice do not allow for such complementarities. Instead, they estimate individual students preferences over individual schools. We propose an estimation method that accommodates sibling complementarities and apply it to the Japanese daycare context. Sibling priority is also a salient issue in this setting, where daycare assignment is centralized and operates in a manner similar to school choice. For example, a comment submitted to a municipality states, "My children attend different facilities, and pick up and drop off is far more difficult than expected. Each facility has different supplies and communication methods."<sup>2</sup> Our estimation framework allows us to quantify these burdens.

In our model, parents with multiple children have preferences over tuples of assignments. They receive the sum of individual utility from individual assignments but also incur disutility from split assignment, modeled as a fixed penalty term and additional commuting distance arising from the trip-chain. We follow Fack et al. (2019) and convert the stability property of the observed match into a discrete choice problem, but here sibling preferences are taken into account by adopting the extended stability notion of Sun, Yamada, et al. (2024), which allows for preferences over sibling assignments.

We use data from Koriyama City in Fukushima Prefecture, located in northeastern mainland Japan. Unlike many other municipalities, Koriyama had virtually no sibling priority in daycare admissions prior to 2024. Many parents strongly preferred joint non-

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<sup>1</sup>See reporting by *The Independent* (2013): [<https://www.independent.co.uk/news/education/education-news/schools-urged-to-scrap-unfair-admissions-rule-for-siblings-8973650.html>] (<https://www.independent.co.uk/news/education/education-news/schools-urged-to-scrap-unfair-admissions-rule-for-siblings-8973650.html>).

<sup>2</sup>See Kawasaki City (2023), municipal briefing materials on daycare admission rules and sibling related priority adjustments (author’s translation). Available at [https://www.city.kawasaki.jp/450/cmsfiles/contents/0000154/154865/04shiryoushou3\\_20230906.pdf](https://www.city.kawasaki.jp/450/cmsfiles/contents/0000154/154865/04shiryoushou3_20230906.pdf).

assignment to split assignment, resulting in systematically lower assignment rates for parents with siblings. Japanese daycare assignment relies on a single index priority score, and the policy question facing the municipality was how much weight to assign to sibling applicants, as excessive weight could give rise to the equity concerns discussed above. The municipality’s stated objective was to reduce disparities in assignment outcomes between parents with siblings and those without. To this end, Koriyama implemented a priority reform that introduced sibling priority, with the point value calibrated by us through simulations to achieve this policy goal.

We use the municipality’s post-reform application data to estimate applicant preferences. In addition to the expected findings that applicants dislike longer commuting distances and that parents with higher opportunity costs of parental home care, such as full time working mothers, derive higher utility from daycare services, we find substantial disutility associated with split assignment. Beyond the additional commuting distance it entails, split assignment generates a non-distance disutility equivalent to an increase in daily commuting cost of 4.8 kilometers, more than twice the average commuting distance in the sample. This additional cost likely reflects reduced family coordination, differences in daily schedules, and uncoordinated communication across facilities. Because traditional models ignore this large disutility, they underestimate distance disutility and mean daycare utility. In particular, such models treat sibling applicants who prefer joint assignment or joint non-assignment at more distant daycares over split assignment at closer daycares as if they simply have weaker distance sensitivity or lower mean daycare utility.

We simulate counterfactual assignments under alternative weights on sibling priority and evaluate welfare using the estimated preferences. We find a substantial tradeoff between efficiency and equity, where equity is measured as the standard deviation of assignment rates across sibling-status groups. Along the efficiency–equity frontier, increasing mean welfare by 100 meters requires an increase in inequality of about 1.66 percentage points. The observed policy reform substantially improved welfare for households with multiple children, while households without siblings experienced little change, resulting in an overall welfare gain of 6.4% alongside a reduction in assignment-rate inequality of about 1.26 percentage points. Because households with siblings contribute more to aggregate welfare, the welfare-maximizing policy places substantially greater weight on sibling priority, but at the cost of markedly higher inequality through the displacement of households without siblings. A model that ignores sibling complementarities fails to capture the avoided disutility from split assignment and therefore understates the reform’s benefits.

## 2 Related Literature

This paper contributes to the literature on preference estimation in centralized matching models with non transferable utility. Existing work primarily estimates individual student preferences over schools, including Agarwal and Somaini (2018), Calsamiglia and Güell (2018), and Fack et al. (2019), as well as related work for daycare markets such as Kuno (2023). Our approach is closest to Fack et al. (2019), who exploit the stability property of the matching outcome and translate it into a discrete choice framework. To the best of our knowledge, no existing paper estimates student or household preferences while explicitly accounting for sibling complementarities. We propose an estimation method that incorporates such complementarities by combining ideas from demand estimation for bundle goods, as in Gentzkow (2007), with school choice style matching mechanisms.

This paper relates to the literature on matching with siblings and couples. Early work by Roth (1984) shows that stable matchings may fail to exist when couples have joint preferences, and Ronn (1990) shows that verifying existence is computationally hard. Despite these theoretical difficulties, Roth and Peranson (1999) document that stable outcomes frequently arise in practice. Building on this motivation, Klaus and Klijn (2005) establish existence under weakly responsive preferences, and Kojima et al. (2013) and Ashlagi et al. (2014) establish existence results for large markets. In school choice settings, Dur et al. (2022) study mechanisms that accommodate family considerations, and Correa et al. (2019) document the large scale implementation of a nationwide school assignment system in Chile that favors joint sibling assignment. Focusing on Japanese daycare markets, Sun, Yamada, et al. (2024) propose a notion of stability with sibling complementarities and show how to compute stable matchings, while Sun, Yokoyama, et al. (2025) establish that stable matchings exist with high probability in large markets under similar priority structures. Relying on the stability concept developed by Sun, Yamada, et al. (2024) and the existence justification provided by Sun, Yokoyama, et al. (2025), this paper estimates household preferences in centralized assignment systems with siblings.

Our paper also contributes to the literature on priority design in centralized assignment mechanisms. Theoretical work has largely treated priority as an exogenous input to the mechanism, with Çelebi and Flynn (2022) as an exception that studies the optimal coarsening of priority levels when applicant attributes are continuous. Which priority structure is preferable depends on the underlying distribution of applicant characteristics and is therefore inherently an empirical question, yet empirical evidence remains limited. Kessel and Olme (2018) provide one of the few empirical studies by simulating alternative priority structures, including proximity-based rules, lottery-based rules, and reserved seats, using estimated student preferences in Swedish primary school choice and examining their effects on student welfare and segregation. Our contribution is to evaluate the

welfare impact of an actual policy reform and to quantify the efficiency–equity tradeoff arising from priority design.

### 3 Institutional Background

In Japan, access to licensed daycare is allocated through a publicly administered assignment system. Children aged 0 to 5 from households that meet eligibility requirements apply through their municipal government. Municipalities assign children to facilities using a priority based mechanism that considers each child’s priority score and the household’s rank ordered list of preferred facilities, subject to capacity constraints. Fees at licensed daycare facilities are largely uniform across providers and are determined by household income rather than by individual facilities. Households may alternatively use unlicensed daycare providers, which are free to set prices and typically charge higher fees. For children aged 3 to 5, households may also choose kindergartens, which operate separately from licensed daycare and typically provide shorter daily hours, making them an imperfect substitute for full day care.<sup>3</sup>

Koriyama City, the focus of this paper, is a mid-sized regional hub city located in Fukushima Prefecture in northeastern Japan. As of 2020, the city has a population of approximately 328,000 residents,<sup>4</sup> and private automobiles are the dominant mode of transportation, accounting for 82.8% of commuting trips.<sup>5</sup> There are about 12,000 children aged 0 to 5,<sup>6</sup> of whom roughly 1,400 apply each year to the centralized licensed daycare allocation system.<sup>7</sup> As of 2025, the city has 90 licensed daycare centers, 31 nonlicensed daycare providers, and 32 kindergartens.<sup>8</sup>

In Koriyama City, households seeking daycare enrollment beginning in April, which marks the start of the Japanese fiscal and school year and therefore accounts for the majority of annual admissions, must submit applications in November of the preceding year. Before the application deadline, the municipality publishes information on coarse availability by age group for each licensed daycare facility. Applications are submitted at the household level, with each child listed and ranked separately within the same application. For each child, households report a rank order list of up to ten preferred facilities. Households applying for multiple children may also indicate that they wish

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<sup>3</sup>Licensed daycare includes traditional daycare centers (*hoikusho*), regulated under the Child Welfare Act, and integrated early childhood education and care centers (*kodomoen*), certified under the Act on Advancement of Comprehensive Service for Preschool Children. Both are publicly funded through the Child and Childcare Support System. In this paper, kindergartens (*yochien*) refers only to stand alone kindergartens operating under the School Education Act and does not include integrated *kodomoen*, which are part of the licensed daycare system.

<sup>4</sup>Koriyama City, Graph Koriyama Data Book 2025.

<sup>5</sup>Statistics Bureau of Japan, 2020 Population Census.

<sup>6</sup>Koriyama City, Graph Koriyama Data Book 2025.

<sup>7</sup>Calculated from the administrative application data described in Section 4.

<sup>8</sup>Calculated from the facility level data described in Section 4.

to accept placement only if all children can be assigned to the same facility, in which case they decline any allocation in which siblings are separated.<sup>9</sup> We refer to this as a household preference for *joint assignment*, as opposed to *split assignment*, and define *joint non-assignment* as the outcome in which none of the children are assigned when joint assignment is requested but infeasible. Applicants additionally provide information used to compute priority scores, including parental employment status and sibling related criteria. Appendix A.1 presents the full priority scoring formula after the priority reform. Details of the priority reform implemented from 2024 onward are discussed in Section 7.

## 4 Data

We use anonymized application data covering the years 2022 to 2025. For each application, we observe the parent ID, child ID, the total priority score and its components, including maternal employment status, paternal employment status, sibling status, and income status, the reported rank-ordered list, the preference for joint assignment when households apply for multiple children, the assigned daycare, and the household address. In addition, the data record each child’s current care status, such as parental care, enrollment in a nonlicensed daycare, kindergarten, or licensed daycare. We interpret this status as the child’s outside option, corresponding to the care arrangement that the child is assumed to use if the household ends up unassigned in the current application.

Table 1 presents summary statistics of applicant demographics. We classify applicants into three groups based on sibling status: *simultaneous* applicants, who apply for multiple children in the same year; *incumbent* applicants, who apply while another child is already enrolled in a licensed daycare and is scheduled to remain enrolled in the following academic year; and *no siblings* applicants, who apply for a single child and have no enrolled siblings. In 2025, 19.5% of applications are from simultaneous applicants and 14.5% from incumbent applicants, implying that sibling households represent a substantial fraction of the applicant pool.<sup>10</sup> While fathers’ employment status shows little variation, with over 90% employed full time, mothers’ employment status is more heterogeneous. In 2025, 77.8% of mothers are employed full time and 9.3% part time, with the remaining 13% either searching for a job or not in the labor force. Although a large majority of applicants are on parental leave, 99.4% of these applicants have mothers who are employed either full time or part time, based on 2025 data. Appendix A.2 reports the summary statistics for the licensed daycare facilities.

Table 2 reports summary statistics on application behavior by sibling status. Here, we

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<sup>9</sup>This preference reporting structure, consisting of child level rank order lists together with an indication of whether joint assignment is required, is similar to that used in the Chilean school choice system, as described in Correa et al. (2019).

<sup>10</sup>We drop families with more than two children, which account for less than 1% of the sample.

**Table 1:** Demographic Balance Across Years

Variable	2022	2023	2024	2025
Number of Applicants	1402	1442	1415	1422
Age 0	381	365	368	296
Age 1	550	581	559	609
Age 2	141	165	175	173
Age 3	231	235	217	259
Age 4	62	63	63	64
Age 5	37	33	33	21
Siblings				
Incumbent	0.163	0.163	0.168	0.148
Simultaneous	0.205	0.192	0.198	0.195
No Siblings	0.631	0.645	0.634	0.657
Mother Employment Status				
Full-Time	0.688	0.739	0.767	0.778
Part-Time	0.149	0.135	0.111	0.093
In Job Search	0.128	0.099	0.085	0.101
Not in Labor Force	0.035	0.028	0.037	0.029
Father Employment Status				
Full-Time	0.925	0.937	0.919	0.934
Part-Time	0.005	0.003	0.005	0.002
In Job Search	0.006	0.007	0.006	0.008
Not in Labor Force	0.064	0.053	0.069	0.056
Other				
Low SES	0.115	0.096	0.11	0.13
Single Mother	0.062	0.05	0.065	0.046
Parental Leave	0.437	0.436	0.499	0.481

Notes: Age rows and the number of applicants are counts. Other rows report shares (means of indicators). Low SES is defined as an indicator equal to one if the household is classified as low income, exempt from resident taxation, or receiving public assistance.

focus on application behavior in 2025 to illustrate baseline patterns. Among simultaneous sibling applicants, 73% indicate a preference for joint assignment, meaning that they prefer both children to remain unassigned unless they can be placed in the same daycare center. Turning to incumbent sibling applicants, 94.3% list the daycare currently attended by the incumbent child as their top choice, and 63.0% list only this daycare in their application. Taken together, these patterns provide clear evidence of a strong preference for joint assignment among applicants with siblings.

To assess whether aversion to additional commuting distance contributes to the dislike of split assignment, we focus on simultaneous applicants and examine the geographical dispersion of daycare centers listed in an applicant’s rank order list, separately by whether the household requires joint assignment. The key idea is that households who do not require joint assignment face the possibility that their children may be placed at different centers and therefore must consider the total commuting distance across potential split placements. In contrast, households who require joint assignment will either have all children assigned to the same center or none at all, and therefore do not face additional

**Table 2: Summary by Year and Sibling Status**

	2022			2023			2024			2025		
	no siblings	simultaneous	incumbent	no siblings	simultaneous	incumbent	no siblings	simultaneous	incumbent	no siblings	simultaneous	incumbent
Number of Applications	885	288	229	930	277	235	897	280	238	934	277	211
Age 0	233	49	99	219	51	95	215	51	102	180	49	67
Age 1	366	79	105	401	66	114	380	72	107	427	72	110
Age 2	86	44	11	100	51	14	102	52	21	107	48	18
Age 3	150	69	12	148	76	11	141	70	6	180	64	15
Age 4	35	25	2	40	23	-	36	25	2	32	31	1
Age 5	15	22	-	22	10	1	23	10	-	8	13	-
Score	397.04	396.35	444.92	417.43	416.63	450.38	446.01	606.77	585.30	448.45	612.48	599.32
Pref. Length	3.20	3.48	1.88	3.32	2.99	1.83	3.42	2.99	1.92	3.50	3.42	1.90
Pref. Joint Assignment	-	0.78	-	-	0.76	-	-	0.73	-	-	0.73	-
Assigned	0.68	0.45	0.82	0.77	0.69	0.91	0.71	0.69	0.86	0.71	0.77	0.86
Jointly Assigned	-	0.85	0.89	-	0.90	0.89	-	0.85	0.92	-	0.90	0.86
Assigned Rank	1.58	1.99	1.11	1.51	1.66	1.04	1.55	1.55	1.05	1.62	1.56	1.09

Notes: Age rows and the number of applications are counts. Other rows report shares (means of indicators). Pref. Joint Assignment is the share of simultaneous sibling households that request placement only if all children can be assigned to the same facility. Jointly Assigned is an indicator equal to one if all children in the household are assigned to the same facility, conditional on being assigned. Assigned Rank is the rank of the assigned facility in the reported rank order list, conditional on being assigned. Cells with no observations are shown as “-”.

commuting distance arising from split placements. If commuting burden is an important driver of split assignment aversion, we would expect households that do not require joint assignment to list centers that are geographically closer to one another than households that require joint assignment.

We measure the geographic proximity of daycare centers in an applicant’s rank order list using the mean pairwise Haversine distance (km) across all listed centers.<sup>11</sup> Figure 1 supports the prediction derived above. It plots the distribution of this proximity measure by sibling status and stated joint assignment preference, and shows that applicants who do not require joint assignment tend to apply to more geographically concentrated sets of daycare centers. Table 3 reports estimates from quantile regression models of the form  $Q_\tau(D | Joint) = \alpha_\tau + \beta_\tau Joint$ , for  $\tau \in \{0.25, 0.50, 0.75\}$ , where  $D$  denotes the proximity metric and  $Joint$  is an indicator for preferring joint assignment. The estimates indicate that, at the median, simultaneous applicants who prefer joint assignment list daycare centers that are approximately 0.198 km more geographically dispersed than those who do not, and this difference is statistically significant. Taken together, these results motivate modeling applicant choice as reflecting not only individual trips, but the overall trip-chain distance associated with potentially multiple daycare placements.

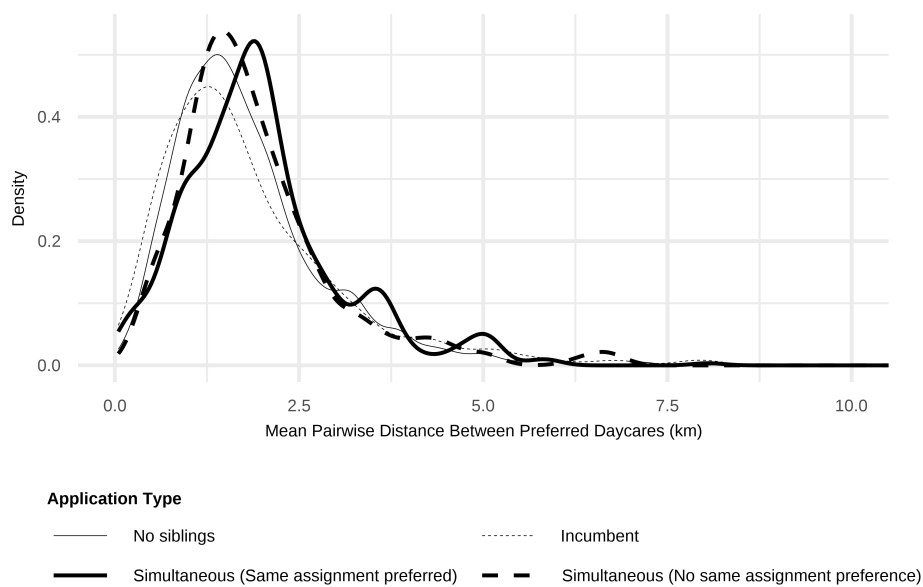
**Table 3:** Quantile Regression of Geographic Dispersion on Joint Assignment Preference

	$\tau = 0.25$	$\tau = 0.50$	$\tau = 0.75$
Joint	0.077 (0.088)	0.198*** (0.068)	0.180 (0.139)
Constant	1.232*** (0.064)	1.660*** (0.064)	2.255*** (0.115)
Observations	732		

Notes: The sample is restricted to simultaneous applicants. The dependent variable is the mean pairwise Haversine distance (km) among daycare centers listed in the applicants rank order list. The regressor *Joint* equals 1 if the applicant requires joint assignment and 0 otherwise. Each column reports a quantile regression at the indicated quantile. Bootstrap standard errors (1,000 replications) are reported in parentheses. Significance: \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

<sup>11</sup>The Haversine formula computes great circle distances between two points on the Earth’s surface using their latitude and longitude coordinates, accounting for the curvature of the Earth. Distances are calculated in kilometers based on facility geocodes.

**Figure 1:** Geographic Proximity of Daycare Choices by Sibling Status and Joint Assignment Preference



Notes: The figure plots kernel density estimates of the mean pairwise geographic distance between daycare centers listed in an applicant’s rank order list. The sample is restricted to applicants who list at least two daycare centers. All density curves are shown in black. Line type and line width jointly indicate the application type, distinguishing applicants with no siblings, incumbent applicants, and simultaneous sibling applicants with and without a preference for joint assignment. Mean pairwise distance is computed using Haversine distances between geocoded daycare locations. Lower values correspond to more geographically concentrated choice sets.

## 5 Empirical Model

Our empirical model of daycare choice extends standard school choice frameworks by allowing parents to value joint rather than individual assignments for their children. Following Gentzkow (2007), we model sibling complementarity in an additive manner relative to the sum of individual flow utilities. Family utility is specified as the sum of each child’s flow utility plus a penalty that captures the utility loss when siblings are assigned to different daycare centers.

### 5.1 Model Setup

We index children by  $c \in \mathcal{C}$ , families by  $f \in \mathcal{F}$ , and facilities by  $d \in \mathcal{D}$ . The set of facilities is partitioned as

$$\mathcal{D} = \mathcal{D}^I \cup \mathcal{D}^O \cup \mathcal{D}^K \cup \{0\},$$

where  $\mathcal{D}^I$  denotes licensed daycares,  $\mathcal{D}^O$  denotes nonlicensed daycares,  $\mathcal{D}^K$  denotes kindergartens, and  $d = 0$  represents parental care at home. Each child  $c$  belongs to a grade  $G(c) \in \mathcal{G} = \{0, 1, \dots, 5\}$ . Each daycare  $d$  has a capacity  $Q(d, g) \in \mathbb{N}_0$  for children in grade  $g$ . We only impose capacity constraints on licensed daycare centers and assume  $Q(d, g) = \infty$  for all  $d \in \mathcal{D} \setminus \mathcal{D}^I$ . Each child  $c$  has an exogenous priority score  $e_c \in \mathbb{N}$  and a current assignment (including parental care)  $\bar{D}(c) \in \mathcal{D}$ . Following the municipality’s practice of assigning siblings the priority score of the higher-scoring child, we assume  $e_c = e_f$  for all children  $c \in C(f)$ . The set of children belonging to family  $f$  is denoted by  $\bar{C}(f) \subset \mathcal{C}$ . Among them, the subset of children not currently enrolled in a licensed daycare is

$$C(f) = \{c \in \bar{C}(f) \mid \bar{D}(c) \in \mathcal{D} \setminus \mathcal{D}^I\}.$$

The set of families can be partitioned into three mutually exclusive groups,

$$\mathcal{F} = \mathcal{F}^{\text{no siblings}} \cup \mathcal{F}^{\text{simultaneous}} \cup \mathcal{F}^{\text{incumbent}}.$$

Here,

$$\mathcal{F}^{\text{no siblings}} = \{f \in \mathcal{F} \mid |C(f)| = 1\},$$

$$\mathcal{F}^{\text{simultaneous}} = \{f \in \mathcal{F} \mid |\bar{C}(f)| = 2, |C(f)| = 2\},$$

$$\mathcal{F}^{\text{incumbent}} = \{f \in \mathcal{F} \mid |\bar{C}(f)| = 2, |C(f)| = 1\}.$$

We parameterize the family’s preference as follows. For each child  $c \in \bar{C}(f)$  of family  $f$  with grade  $G(c) = g$ , the flow utility net of commuting cost from attending daycare  $d \in \mathcal{D}$  is given by

$$u_{c,d} = \bar{\alpha}_g + \alpha_d + Z'_f \beta,$$

where  $\bar{\alpha}_g$  is an age fixed effect, and  $\alpha_d$  is a facility fixed effect (to reduce the number of parameters, we assume  $\alpha_d = \alpha_{d'}$  whenever  $d, d' \in \mathcal{D}^K$  or  $d, d' \in \mathcal{D}^O$ ).  $Z_f$  is a vector of observable covariates, including indicators for the mother working full time, working part time, the family being low SES, the mother being single, and either parent being on parental leave.<sup>12</sup> We normalize  $u_{c,0} = 0$ , so utilities are measured relative to parental care. The term  $Z_f'\beta$  thus shifts the flow utility from nonparental daycare across the observed family groups defined by  $Z_f$ .

Given each child's flow utility, a family  $f$  has preferences over joint assignments for its children in  $(\mathcal{D} \cup \{0\})^{|\bar{C}(f)|}$ . For  $f \in \mathcal{F}^{no\ siblings}$ , the family's utility from assignment  $d$  equals the child's flow utility net of commuting cost plus an unobservable taste shock,

$$u_{f,d} = u_{c,d} - \kappa d_{f,d} + \epsilon_{f,d}.$$

Here  $d_{f,d}$  denotes the Haversine distance in kilometers from family  $f$ 's residence to daycare  $d$ . Parental care involves no commuting, so  $d_{f,0} = 0$ . We assume that  $\epsilon_{f,d}$  follows an independent and identically distributed Type I Extreme Value distribution with unit variance.

For  $f \in \mathcal{F}^{simultaneous} \cup \mathcal{F}^{incumbent}$ , the utility of family  $f$  when child  $c$  is assigned to daycare  $d$  and child  $c'$  is assigned to daycare  $d'$  is

$$u_{f,(d,d')} = u_{c,d} + u_{c',d'} - \kappa d_{f,d,d'} - \bar{\Gamma}_f \mathbb{I}\{d \neq d'\} + \epsilon_{f,(d,d')}.$$

The third term represents the trip-chain distance from family  $f$ 's residence to the two daycare centers  $d$  and  $d'$ ,

$$d_{f,d,d'} = \min\{d_{f,d} + d_{d,d'}, d_{f,d'} + d_{d',d}\},$$

where  $d_{d,d'}$  denotes the Haversine distance in kilometers between daycare centers  $d$  and  $d'$ . For given  $f$  and  $d$ , this distance is minimized when  $d' = d$ , that is, when both children attend the same daycare and no additional commuting is required. The fourth term captures the loss of sibling complementarity beyond commuting distance when children are assigned to different daycare centers. We parameterize this term as

$$\bar{\Gamma}_f = \gamma_0 + Z_f'\gamma.$$

This term should be interpreted as a non-distance fixed cost of split assignment that is invariant across daycare pairs. In the Japanese context, parents are typically expected to prepare for a range of daycare related activities, such as events, festivals, and the

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<sup>12</sup>Low SES is defined as an indicator equal to one if the household is classified as low income, exempt from resident taxation, or receiving public assistance.

submission of daily diaries. These requirements often differ across facilities in timing and format, generating a substantial coordination burden when siblings attend different daycare centers. The last term again is an independent and identically distributed Type I Extreme Value distribution with unit variance.

In general, the utility of family  $f \in \mathcal{F}$  from being assigned to daycare tuple  $\delta \in (\mathcal{D} \cup \{0\})^{|\bar{C}(f)|}$  can be expressed as:

$$u_{f,\delta} = V_{f,\delta} + \epsilon_{f,\delta} = U_{f,\delta} - \Gamma_{f,\delta} - d_{f,\delta} + \epsilon_{f,\delta} \quad (1)$$

where

$$U_{f,\delta} = \sum_{c \in \bar{C}(f)} u_{c,\delta(c)}, \quad \Gamma_{f,\delta} = \mathbb{I}\{\delta \notin \Delta_k(\mathcal{D})\} \bar{\Gamma}_f,$$

$\delta(c)$  denotes the daycare assigned to child  $c$  under the daycare tuple  $\delta$ , and  $\Delta_k(\mathcal{D}) \subset \mathcal{D}^k$  is the diagonal set defined by  $\Delta_k(\mathcal{D}) = \{(d, d, \dots, d) \in \mathcal{D}^k : d \in \mathcal{D}\}$ .

## 5.2 Mechanism and Stability

Initially, for each daycare  $d$  and grade  $g$ , there is a number of vacant seats  $Q(d, g)$ , determined up to subsequent fluctuations. Prior to the application deadline, the municipality publicly announces information on expected availability.<sup>13</sup> Given this information, each family  $f$  submits a rank ordered list of length  $K_c$  for each child  $c \in C(f)$ , denoted by  $L_c = (l_c^1, \dots, l_c^k, \dots, l_c^{K_c})$ , where  $l_c^k \in \mathcal{D}$  represents the daycare ranked  $k$  in the child's ROL. Additionally, families specify whether they prefer joint assignment or not, that is, whether they prefer all their children to remain unassigned rather than be assigned to different daycare facilities. We capture this preference with a binary variable  $Joint_f \in \{0, 1\}$ , where  $Joint_f = 1$  indicates that the family prefers all children to remain unassigned rather than be separated.

Given each family's rank order lists  $\{L_c\}_{c \in C(f)}$ , joint assignment preference  $Joint_f$  for  $f \in \mathcal{F}^{simultaneous}$ , and priority score  $e_f$ , a matching determines each child's assignment. We denote this as a mapping

$$\mu : \left( \{L_c\}_{c \in C(f)}, Joint_f, e_f \right)_{f=1}^F \longrightarrow (\mathcal{D} \cup \{0\})^{|\mathcal{C}|}.$$

The matching  $\mu$  determines a cutoff score for each daycare  $d$  and grade  $g$ , defined as

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<sup>13</sup>The municipality does not disclose the exact number of vacant seats. Instead, it reports a coarse availability indicator based on expected intake. Actual vacancies may change due to turnover and internal transfers between grades and facilities.

follows:

$$P_{d,g}(\mu) = \begin{cases} \min\{e_c \mid \mu(c) = d, G(c) = g\} & \text{if } |\mu^{-1}(d, G(c))| = Q(d, G(c)) \\ 0 & \text{if } |\mu^{-1}(d, G(c))| < Q(d, G(c)) \end{cases}$$

The market employs the algorithm proposed in Sun, Yamada, et al. (2024), which finds a stable matching based on the reported preferences. Stability is defined as in Sun, Yamada, et al. (2024). In our setting, this definition can be stated as follows. Consider a preference profile  $(\succ_f)_{f \in \mathcal{F}}$ , where each family  $f$  has strict preferences over tuples of daycare assignments in  $(\mathcal{D} \cup \{0\})^{|\overline{C}(f)|}$ . Stability with respect to the preference profile  $(\succ_f)_{f \in \mathcal{F}}$  is defined below.

**Definition 1** (Stability). Given a preference profile  $(\succ_f)_{f \in \mathcal{F}}$ , a feasible matching  $\mu$  is **stable** if and only if it admits no blocking coalitions. A family  $f$  with children  $C(f)$  and a tuple of daycare centers  $\delta \in \mathcal{D}^{|\overline{C}(f)|}$  forms a **blocking coalition** if and only if (i)  $\delta \succ_f \mu(f)$ , and (ii)  $e_c \geq P_{\delta(c), G(c)}(\mu)$  for all children  $c \in C(f)$ .

The algorithm uses constraint programming to compute a matching that is stable with respect to reported preferences. Because the mechanism restricts each applicant's message space to individual rank order lists and an indicator for joint assignment preference, the algorithm must impose an auxiliary ordering over daycare tuples when the ordering is not fully determined by reported preferences. Details on how this ordering is constructed is available upon request. A matching that is stable with respect to reported preferences need not exist in general. Nevertheless, for all instances encountered in our empirical application, the algorithm successfully finds a matching that is stable with respect to reported preferences.

We assume that the observed matching is stable with respect to parents' true preferences, as represented by the cardinal utility  $u_{f,\delta}$ . In general, a stable matching with respect to true preferences need not exist for an arbitrary preference profile. In estimation, we therefore restrict attention to preference profiles that can be rationalized by some stable matching and identify the preference parameters that maximize the likelihood within this class. Moreover, Sun, Yokoyama, et al. (2025) show that when daycare facilities have similar priorities over children, the probability that a stable matching exists approaches one as market size grows. In our setting, priorities are uniform across daycare facilities and the market size exceeds one thousand, so the existence of a stable matching is likely.

### 5.3 Likelihood Function

Let  $\Delta_f(e_f, \mu) \subseteq \mathcal{D}^{|\overline{C}(f)|}$  denote the collection of tuples  $\delta$  of daycares such that  $\forall c \in C(f)$ ,  $e_c \geq P_{\delta(c), G(c)}(\mu)$ . Then an implication of a feasible, stable matching  $\mu$  is that family  $f$

chooses the tuple that maximizes her utility, among her set  $\Delta_f(e_f, \mu)$ :

$$\mu(f) = \arg \max_{\delta \in \Delta_f(e_f, \mu)} u_{f, \delta}$$

This allows us to reformulate the problem as a discrete choice problem with personalized choice sets, just like as Fack et al. (2019).

Let  $\tilde{Z}_f$  denote the vector of observed covariates for family  $f$ , including  $Z_f$  and the ages  $G(c)$  for all  $c \in \bar{C}(f)$ . Let  $\theta$  collect the parameters governing the distribution of applicant preferences, including  $\{\bar{\alpha}_g\}_{g \in \mathcal{G}}$ ,  $\{\alpha_d\}_{d \in \mathcal{D}}$ ,  $\beta$ ,  $\gamma_0$ ,  $\gamma$ , and  $\kappa$ . Given that the taste shocks  $\epsilon_f$  are independently and identically distributed Type I Extreme Value, the probability that family  $f$  is matched to the tuple of daycare centers  $\delta = \mu(f)$ , where  $\mu(f) \in \mathcal{D}^{|\bar{C}(f)|}$ , is

$$\begin{aligned} \mathbb{P}(\delta = \mu(f) \mid \tilde{Z}_f, e_f, \Delta_f(e_f, \mu); \theta) &= \mathbb{P}\left(\delta = \arg \max_{\delta' \in \Delta_f(e_f, \mu)} u_{f, \delta'} \mid \tilde{Z}_f, e_f, \Delta_f(e_f, \mu); \theta\right) \\ &= \frac{\exp(V_{f, \mu(f)})}{\sum_{\delta' \in \Delta_f(e_f, \mu)} \exp(V_{f, \delta'})} \end{aligned}$$

The second equality relies on the following assumptions: (i)  $e_f \perp\!\!\!\perp \epsilon_f$ ; and (ii)  $\Delta_f(e_f, \mu) \perp\!\!\!\perp \epsilon_f$ . Assumption (i) is plausible because the priority score  $e_f$  is exogenously determined by observable characteristics such as parental employment status. Assumption (ii) requires that family  $f$ 's personalized choice set be exogenously given; this is also likely to hold because the priority score  $e_f$  is not daycare specific (see Fack et al. (2019)).

Our likelihood function is

$$L(\theta \mid \{\tilde{Z}_f, e_f, \Delta_f(e_f, \mu)\}_{f \in \mathcal{F}}) = \prod_{f \in \mathcal{F}} \prod_{\delta \in \mathcal{D}^{|\bar{C}(f)|}} \mathbb{P}(\delta = \mu(f) \mid \tilde{Z}_f, e_f, \Delta_f(e_f, \mu); \theta)^{\mathbb{1}\{\delta = \mu(f)\}}.$$

Substituting the choice probabilities yields

$$L(\theta \mid \{\tilde{Z}_f, e_f, \Delta_f(e_f, \mu)\}_{f \in \mathcal{F}}) = \prod_{f \in \mathcal{F}} \frac{\exp(V_{f, \mu(f)})}{\sum_{\delta' \in \Delta_f(e_f, \mu)} \exp(V_{f, \delta'})}.$$

Taking logs, the log likelihood function is

$$\ln L(\theta \mid \{\tilde{Z}_f, e_f, \Delta_f(e_f, \mu)\}_{f \in \mathcal{F}}) = \sum_{f \in \mathcal{F}} V_{f, \mu(f)} - \sum_{f \in \mathcal{F}} \ln \left( \sum_{\delta' \in \Delta_f(e_f, \mu)} \exp(V_{f, \delta'}) \right).$$

We estimate the model parameters  $\theta$  by maximum likelihood.

## 6 Results

Table 4 reports the estimation results. Due to space constraints, the estimates of daycare fixed effects,  $\{\alpha_d\}_{d \in \mathcal{D}}$ , are omitted (they are reported in Appendix A.3). Column 1 presents the estimates from the model that incorporates demand complementarities, as described in the previous section. Column 2 reports, for comparison, the estimates from a conventional model that ignores such complementarities. In the latter specification, each child is treated as applying individually, that is, as if belonging to separate households. Numbers in parentheses report standard errors.

We first note that the estimated coefficient on commuting distance,  $\kappa$ , is positive and highly statistically significant, with a magnitude of 0.72 standard deviations of the unobserved taste shock. Since distance enters utility with a negative sign, this estimate implies that households strongly prefer daycare centers located closer to home, consistent with intuitive expectations.

Next, the estimates of the parameters  $\beta$ , which govern the average utility of childcare services, can be interpreted as reflecting the opportunity cost of home based childcare across household types. Relative to households in which the mother is not employed, households with a full time working mother exhibit the highest utility from childcare services (1.21), followed by those with a part time working mother (0.96), with both effects statistically significant. The coefficient for households on parental leave is negative (-1.12) and statistically significant, reflecting that employment is maintained during the leave period even when childcare is provided at home. Finally, the coefficient for single mother households is positive (1.42) and statistically significant, consistent with the fact that these households rely solely on maternal employment and therefore face particularly high opportunity costs when formal childcare is unavailable.

Turning to the complementarity parameters  $\gamma$ , the estimated constant term is large and positive, at 3.485, and is statistically significant. Normalizing this estimate by the distance coefficient  $\kappa$  allows the magnitude of sibling separation to be expressed in distance equivalents, corresponding to an additional daily commuting distance of approximately 4.8 kilometers. In our sample, the average commuting distance is 2.26 kilometers, implying that the non-distance penalty from split assignment is about 2.12 times the mean commuting distance. This indicates that assigning siblings to different daycare centers generates a utility loss substantially larger than a typical commute, over and above any direct increase in travel distance itself<sup>14</sup>.

Comparing these results with the conventional model in Column 2 reveals several

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<sup>14</sup>One might argue that  $\gamma$  captures a nonlinear effect of commuting cost. We estimate an alternative specification including a quadratic term in commuting distance. Although the constant term is somewhat smaller (2.352), it remains large, and the other parameter estimates are broadly similar. We therefore retain the linear specification for commuting disutility, as it facilitates the conversion of utility into distance-equivalent units, following standard practice in the literature.

key differences. The conventional model estimates a smaller disutility from commuting distance (0.67), because households with siblings may choose more distant daycare centers to avoid split assignments when only one child can be admitted nearby. At the child level, this behavior leads to longer observed commuting distances, which the conventional model, by ignoring complementarities, interprets as weaker distance disutility. In addition, the estimated average utility of childcare services is lower for most household types in the conventional model, reflecting that households with siblings often prefer joint non-assignment to split assignment. When complementarities are ignored, such behavior makes childcare services appear less attractive overall.

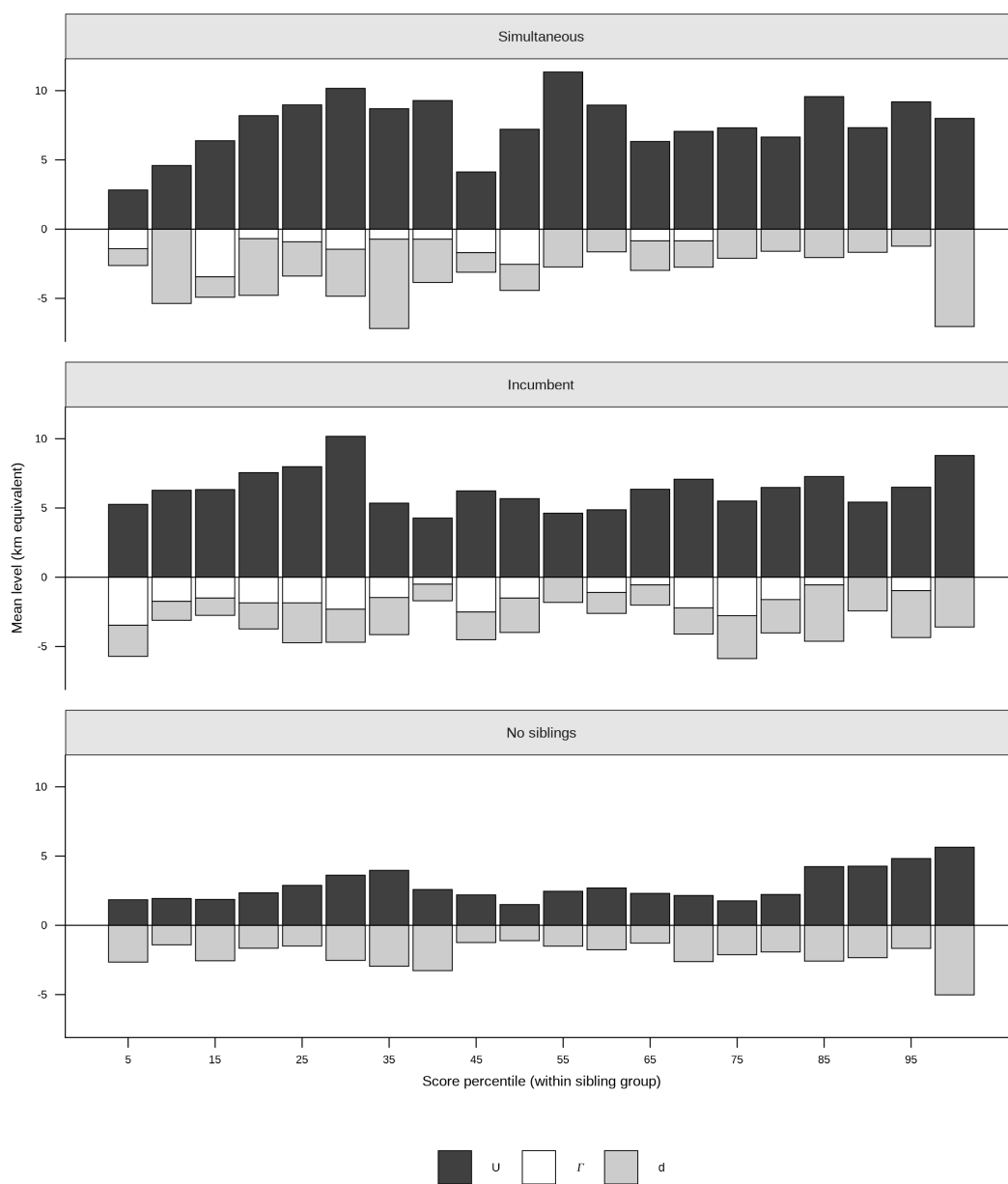
To understand how each component of utility contributes to realized overall utility, we decompose the mean realized utility of applicants in 2025. Using the decomposition in equation (1),  $V_{f,\delta} = U_{f,\delta} - \Gamma_{f,\delta} - d_{f,\delta}$ , Figure 2 reports, for bins defined by score percentiles within each siblings group, the contributions of the three components to mean utility, allowing for both positive and negative contributions. Utility is expressed in distance units by dividing all values by the distance disutility estimate  $\kappa$ , and all numbers are based on the full model. The figure shows that commuting cost has a large magnitude and plays a substantial role in shaping daycare preferences. The disutility from split assignment appears smaller in comparison, but this reflects a selection effect: the sample consists only of applicants who opted out of joint assignment, so the observed magnitude is attenuated by revealed preference. We further quantify the role of sibling complementarities in Appendix A.4, which shows that for jointly assigned simultaneous-sibling households, reallocating one child to their top choice typically yields only small gains in direct utility that are more than offset by the fixed disutility of split assignment.

Lastly, there are intrinsic differences in childcare utility across sibling groups even at the child level. For each household, we compute the maximal attainable household utility by optimizing over all feasible assignments and express it in per-child terms. Average utility is highest for simultaneous applicants (4.36), followed by incumbents (3.41) and no-sibling applicants (3.37). These differences reflect both variation in flow utility and in the cost structure. In particular, sibling households are less likely to be on parental leave, which increases flow utility given its negative coefficient, and commuting distance is determined at the household level, implying scale economies when expressed per child for multi-child households. As a result, prioritizing households with siblings can generate efficiency gains.

**Table 4:** Estimated Coefficients (estimate with standard error in parentheses)

Parameter	Full Model	Individual Model
<b>Age Fixed Effects (<math>\bar{\alpha}_g</math>)</b>		
Age 0	0.000 (-)	0.000 (-)
Age 1	-2.886 (0.431)	-2.194 (0.242)
Age 2	0.085 (0.571)	-0.803 (0.270)
Age 3	-1.096 (0.543)	-1.251 (0.279)
Age 4	-1.367 (0.628)	-1.290 (0.351)
Age 5	0.564 (1.034)	-0.474 (0.451)
<b>Flow Utility Covariates (<math>\beta</math>)</b>		
Mother Full-Time	1.218 (0.296)	0.478 (0.290)
Mother Part-Time	0.957 (0.405)	0.254 (0.411)
Low SES	-0.261 (0.303)	-0.681 (0.297)
Single Mother	1.422 (0.691)	1.773 (0.699)
Parental Leave	-1.195 (0.251)	-1.581 (0.224)
<b>Same-Daycare Fixed Cost (<math>\gamma</math>)</b>		
Baseline	3.485 (0.573)	0.000 (-)
×Mother Full-Time	0.192 (0.636)	0.000 (-)
×Mother Part-Time	1.127 (0.960)	0.000 (-)
×Low SES	2.029 (1.085)	0.000 (-)
×Single Mother	6.753 (47.848)	0.000 (-)
×Parental Leave	0.315 (0.397)	0.000 (-)
Distance penalty ( $\kappa$ )	0.7230 (0.0209)	0.6736 (0.0189)
Log-Likelihood	-3305.5	-4094.7

Notes: Standard errors in parentheses. Column 1 reports estimates from the model with demand complementarities. Column 2 reports estimates from a conventional model without complementarities, treating each child as applying individually. Due to space constraints, daycare fixed effects  $\{\alpha_d\}_{d \in \mathcal{D}}$  are omitted.



**Figure 2:** Welfare decomposition by score percentile

*Notes:* The figure decomposes mean realized household welfare in 2025, evaluated at the observed assignment, by score percentile within each sibling group. The horizontal axis shows score percentiles defined within each sibling group. For each percentile bin, bars decompose mean household welfare according to equation (1),  $V_{f,\delta} = U_{f,\delta} - \Gamma_{f,\delta} - d_{f,\delta}$ , into utility from the assigned daycare ( $U$ ), the fixed disutility from non joint assignment ( $\Gamma$ ), and commuting distance cost ( $d$ ). Utility enters positively, while  $\Gamma$  and  $d$  enter as negative components. All components are expressed in kilometer equivalent units by scaling utilities by the distance disutility parameter  $\kappa$ , and all values are computed from the full model.

## 7 Policy Evaluation

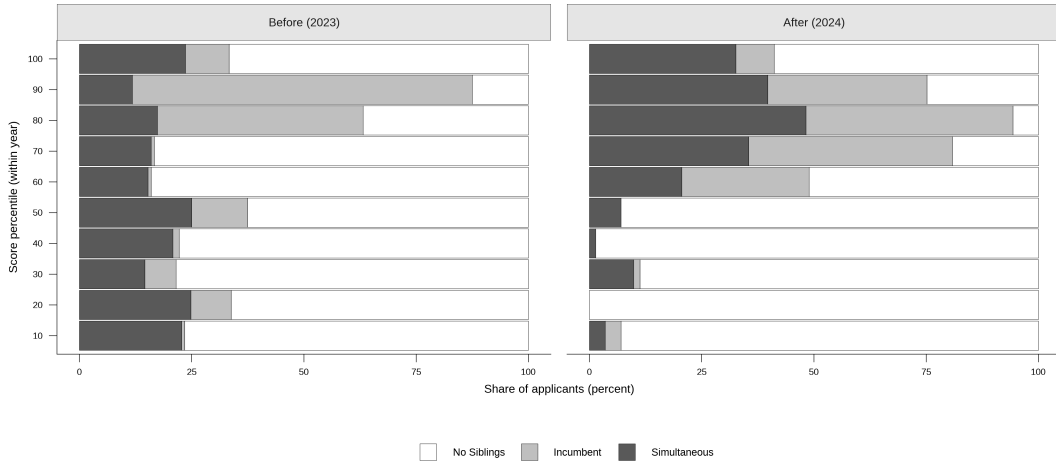
### 7.1 The 2024 Siblings Priority Reform

As shown in Section 4, applicants with siblings place a strong preference on joint assignment of their children. Because the municipality did not prioritize simultaneous applicants, this preference mechanically translated into lower assignment rates among simultaneous applicants. In 2022, the assignment rate was 45% for simultaneous applicants compared with 68% for no siblings applicants, while in 2023 the corresponding rates were 69% and 77%, respectively (see Table 2). To illustrate this mechanism, consider two applicants with the same child age and the same priority score who apply to the same daycare center. One applicant applies for a single child, while the other applies simultaneously for an additional child of a different age and prefers joint assignment. The latter applicant must satisfy the cutoff score not only for the first child but also for the sibling in a different age cohort, whereas the former faces no such additional requirement. As a result, even when priority scores are identical for each child, applicants with siblings face a systematically lower probability of assignment.

The municipality of Koriyama recognized this issue and implemented a priority reform in 2024 that explicitly prioritizes applicants with siblings. The objective of the reform was to equalize assignment rates across groups defined by sibling status. To achieve this goal, the new point scheme was calibrated using simulations based on application data from 2022 and 2023, with the aim of identifying the minimum additional points required for both simultaneous applicants and incumbent sibling applicants to attain comparable assignment outcomes. The final point scheme also incorporated several minor adjustments, which are documented in Appendix A.1. It suffices to note that the resulting point additions were largely uniform: simultaneous applicants received an additional 200 points if at least two siblings were of the same age and 160 points if all siblings were of different ages, while incumbent sibling applicants received 160 additional points. For details on the simulation design and the practical implementation of the reform, see Moriwaki et al. (2025).

Figure 3 shows how the composition of applicants varies across unconditional priority score percentiles before and after the 2024 reform. Before the reform, applicants are relatively mixed across sibling categories throughout the score distribution. After the reform, incumbent and simultaneous applicants account for a larger share of higher priority percentiles, while no siblings applicants are increasingly concentrated in lower percentiles. This pattern already highlights a distributional implication of the targeted priority expansion, whereby gains for sibling applicants are accompanied by relative displacement of no siblings applicants in the priority ranking.

**Figure 3:** Composition of sibling status across priority score percentiles before and after the 2024 reform



Notes: The figure reports, for each year, the composition of applicants by sibling status within unconditional priority score percentile bins. Percentile bins are constructed within year using 10 quantile bins of the priority score distribution, so each bin contains approximately 10% of applicants. For each bin, the stacked bar shows the share of applicants who are in each sibling status group. The left panel corresponds to the pre-reform year (2023) and the right panel corresponds to the post-reform year (2024).

## 7.2 Welfare Evaluation and Optimal Priority

To study the efficiency–equity tradeoff implied by sibling priority, and to evaluate the welfare and distributional consequences of the reform, we conduct a counterfactual welfare analysis using the estimated demand model. We vary the priority points granted to simultaneous applicants (*simultaneous priority*) and to incumbent applicants (*incumbent priority*) independently on a grid from 0 to 400 in increments of 5. Each policy scenario can therefore be represented as a coordinate pair  $(x, y)$ , where  $x$  denotes the level of simultaneous priority and  $y$  denotes the level of incumbent priority. The pre-reform policy (*Before*) corresponds to  $(0, 25)$ , while the post-reform policy (*After*) corresponds to  $(160, 160)$ .<sup>15</sup>

Using the 2025 application data, we simulate the assignment outcome under each policy scenario and evaluate welfare.<sup>16</sup> For each household  $f$ , welfare is measured by evaluating the deterministic component of utility  $V_{f,\delta}$  associated with the assignment  $\delta$  generated under the counterfactual policy. We then aggregate these values across households and compute mean welfare. In the counterfactual analysis, we hold submitted preferences fixed and vary only the priority structure. Because the assignment mechanism is not guaranteed to be strategy-proof, parental application behavior may itself respond

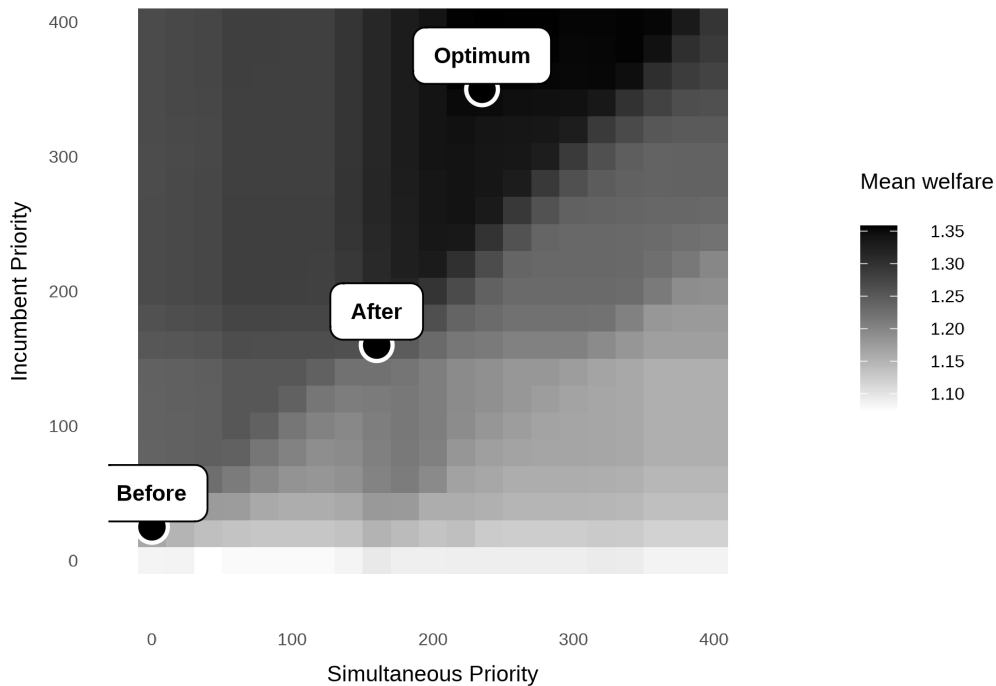
<sup>15</sup>As stated earlier, the actual reform granted simultaneous applicants 160 points if the siblings were of different ages and 200 points if at least two siblings were of the same age (twins). We ignore the latter case because it occurs in only a small number of observations in our sample.

<sup>16</sup>We focus on the 2025 data because, prior to this year, the municipality relied on a proprietary commercial algorithm provided by a third party, whose assignment outcomes cannot be replicated exactly.

to the presence or absence of sibling priority. A fully rigorous analysis would therefore require recomputing reported preferences under the equilibrium that would arise under each policy regime. We do not pursue this extension here and leave it for future research.

Figure 4 shows how mean welfare varies with simultaneous priority (horizontal axis) and incumbent priority (vertical axis). In general, welfare increases as priority for both groups rises. The actual reform increased mean welfare from 1.16 under the pre-reform policy to 1.23, corresponding to an increase of 6.4% relative to the pre-reform level. However, higher welfare could have been achieved by granting even larger priority to both groups. In the simulated policy grid, the welfare-maximizing policy occurs at  $(x, y) = (235, 350)$  and yields mean welfare of 1.36, which is 17.4% higher than the pre-reform level. These patterns are consistent with the earlier finding that households with siblings intrinsically derive higher utility from daycare, so prioritizing them in the assignment process tends to increase overall social welfare.

**Figure 4:** Mean welfare across the sibling-priority policy grid



Notes: The heatmap reports overall mean welfare across the policy grid defined by the  $(x, y)$  parameters, where  $x$  denotes simultaneous priority and  $y$  denotes incumbent priority. Darker colors correspond to higher welfare. The marker labeled “Optimum” indicates the welfare-maximizing policy point, while “Before” corresponds to  $(x = 0, y = 25)$  and “After” corresponds to  $(x = 160, y = 160)$ . The background heatmap is computed on a coarse grid with bin width 20 by averaging welfare within bins of the  $(x, y)$  space.

Increasing overall welfare comes at the cost of increasing inequality in assignment outcomes. Figure 5 plots each simulated policy scenario, with mean welfare on the horizontal axis and between-group inequality in assignment rates on the vertical axis.

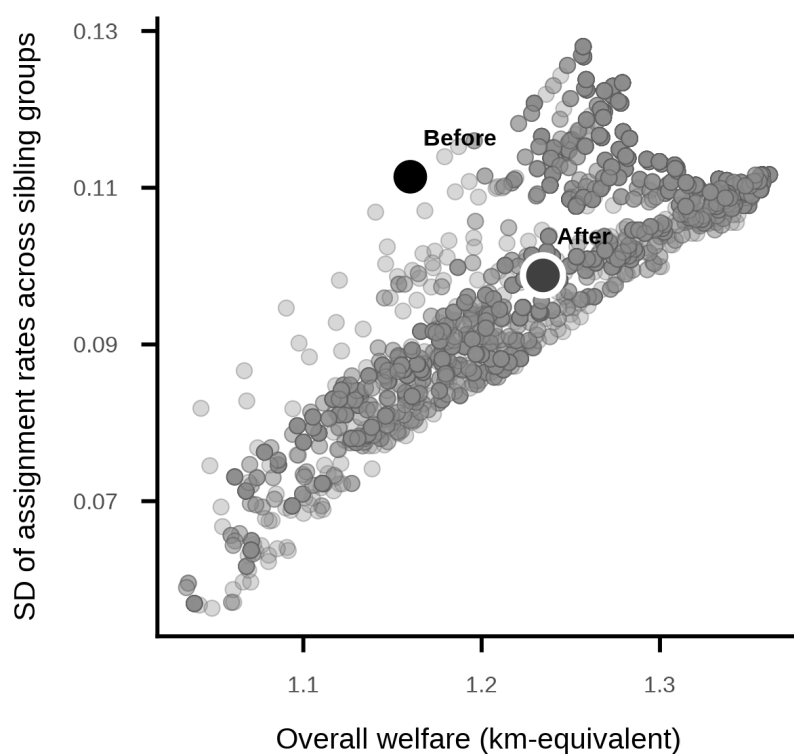
Inequality is measured as the standard deviation of assignment rates across the three sibling-status groups: no siblings, incumbent siblings, and simultaneous siblings. The points are clearly upward sloping, indicating a tradeoff between efficiency and equity. To characterize the slope of the frontier, we estimate a quantile regression at the 1% conditional quantile of inequality on welfare, which approximates the lower envelope of the policy cloud. The estimated slope is 0.166, implying that a 100-meter increase in welfare corresponds to an increase of about 1.7 percentage points in the standard deviation of assignment rates across sibling groups.

Relative to the pre-reform policy, the actual reform increased mean welfare while also reducing between-group inequality in assignment rates, from 0.111 before the reform to 0.0988 after the reform. Under the pre-reform policy, assignment rates were 72.1% for no siblings applicants, 93.1% for incumbent siblings, and 67.6% for simultaneous siblings. Under the post-reform policy, the corresponding assignment rates are 70.6%, 92.2%, and 78.5%, respectively. The decline in inequality is driven mainly by the sharp improvement for simultaneous siblings, whose assignment rate rises by 10.9 percentage points, while the rates for no siblings and incumbent siblings fall only modestly, by 1.5 and 0.9 percentage points. The post-reform policy lies close to the efficiency–equity frontier, although it is not fully optimal: alternative policy combinations could achieve slightly higher welfare with lower inequality. In contrast, the welfare-maximizing policy yields inequality of 0.112, essentially the same as under the pre-reform policy, because the gains for sibling applicants are accompanied by a further decline in the assignment rate of no siblings applicants. Under that policy, assignment rates are 68.6% for no siblings applicants, 96.0% for incumbent siblings, and 82.8% for simultaneous siblings, so the dispersion widens as both sibling groups pull further away from the no-siblings group.

To assess the importance of complementarities for the welfare evaluation, Table 5 reports a welfare decomposition of the policy reform. The upper panel presents results from the full model with sibling complementarities, while the lower panel reports results from an individual model without complementarities. Each row corresponds to a sibling group. The table reports mean welfare and the change  $\Delta V$ , measured in kilometer-equivalent units, with the column  $n$  reporting the number of applicants in each group. Welfare changes are further decomposed into changes in direct utility from daycare ( $\Delta U$ ), split-assignment disutility ( $\Delta \Gamma$ ), and commuting distance ( $\Delta d$ ).

In the full model, the estimated gains are driven primarily by improvements for simultaneous applicants, who experience a large increase of 0.565 km (22.9%), reflecting both higher daycare service value and a substantial reduction in split-assignment disutility, partly offset by longer commuting distances. Incumbent applicants also benefit, with a gain of 0.085 km (3.2%), mainly due to reduced split-assignment disutility despite some decline in daycare utility. By contrast, no-siblings applicants appear to experience a slight welfare gain of 0.005 km (less than 1%), but this is driven by a reduction in assignment

**Figure 5:** Welfare–inequality frontier across policy scenarios



Notes: Each point corresponds to a simulated policy scenario defined by  $(x, y)$ , where  $x$  denotes the level of simultaneous sibling priority and  $y$  denotes the level of incumbent sibling priority. The horizontal axis reports mean household welfare under the full model, measured in kilometer-equivalent commuting distance. The vertical axis reports between-group inequality in assignment rates, measured as the standard deviation of assignment rates across the three sibling-status groups (no siblings, incumbent siblings, and simultaneous siblings). The black marker indicates the baseline policy ( $x = 0, y = 25$ ) and the dark gray marker indicates the actual policy ( $x = 160, y = 160$ ).

rates that shifts some households into parental care, eliminating commuting costs. This may seem at odds with revealed preference, but note that these comparisons are based on mean utilities and ignore heterogeneous preference shocks. When complementarities are ignored, the overall welfare gain falls to 0.030 km per applicant, or 4.0% relative to baseline. The individual model captures improvements in daycare utility but fails to account for the welfare gains from avoiding split assignments, thereby understating the overall welfare effects of the reform.

**Table 5:** Welfare effects by sibling group

Sibling group	$n$	Before	After	$\Delta V$	$\Delta U$	$\Delta \Gamma$	$\Delta d$
<b>Full model (with complementarities)</b>							
All Applicants	1273	1.160	1.234	0.074	0.019	-0.044	-0.012
Incumbent	211	2.632	2.716	0.085	-0.059	-0.145	0.001
No Siblings	934	0.649	0.654	0.005	-0.049	0.000	-0.054
Simultaneous	128	2.463	3.028	0.565	0.643	-0.196	0.274
<b>Individual model (no complementarities)</b>							
All Applicants	1273	0.743	0.773	0.030	0.018	0.000	-0.012
Incumbent	211	2.883	2.823	-0.059	-0.058	0.000	0.001
No Siblings	934	0.052	0.063	0.010	-0.043	0.000	-0.054
Simultaneous	128	2.259	2.574	0.315	0.588	0.000	0.274

Notes: Before and After correspond to the simulated baseline ( $x = 0, y = 25$ ) and post-reform ( $x = 160, y = 160$ ) policy scenarios, respectively. All entries except  $n$  are group means in km-equivalent units.  $\Delta V = V^{\text{After}} - V^{\text{Before}}$ , and  $\Delta U$ ,  $\Delta \Gamma$ , and  $\Delta d$  are defined analogously.

## 8 Conclusion

In this paper, we propose a method to estimate family preferences with complementarity for joint assignment of siblings, which has been ignored in existing preference estimation methods in school choice. A family incurs additional commuting burden and a fixed cost from split assignment. We translate an extended notion of stability by Sun, Yamada, et al. (2024) into a discrete choice problem, following an approach similar to Fack et al. (2019).

We apply our estimation method to the Japanese daycare market, focusing on a municipality in which we assisted in designing a priority reform. We find that applicants face a severe non-distance disutility from split assignment. We analyze a partial equilibrium counterfactual in which the priority reform is not implemented and find that the overall welfare gain from the reform mainly arises from avoided disutility due to split assignment. We further show that a conventional model that ignores this complementarity substantially underestimates the welfare gain and can even lead to different qualitative

implications.

Our approach is applicable beyond the Japanese daycare context. Existing school choice mechanisms often grant sibling priority, justified by logistical burdens and family considerations, while also raising concerns about equity and diversity. Applying our method allows researchers to quantify the welfare and distributional impacts of such priorities or their absence. This enables a more systematic and evidence based approach to priority design, which has often been determined through political processes rather than empirical analysis and has largely been treated as given in the market design literature.

Our paper has several limitations. First, our counterfactual simulation does not re-compute reported preferences and is therefore partial equilibrium in nature. Because the mechanism used by the municipality is not guaranteed to be strategy-proof, applicants may strategically adjust their reports in response to changes in the priority system. Second, we do not identify a globally optimal priority structure and instead focus on a two-dimensional sibling-priority design motivated by the relevant policy discussion. Exploring optimal priority design more generally is challenging due to the high-dimensional nature of the problem and remains an important direction for future research.

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# A Appendix

## A.1 Full Priority Tables

As of April 1, 2026, admission priority is determined by a point system that aggregates scores from three components: guardian employment and related conditions (Table 6), household characteristics of the child (Table 7), and the child’s current childcare arrangement (Table 8). Values and conditions reported with an arrow ( $\rightarrow$ ) indicate changes induced by the sibling priority reform, with the left value corresponding to the pre-reform rule and the right value to the post-reform rule. In addition to these three components, the municipality applies several supplementary adjustments, including bonuses or penalties related to parental occupation in childcare or education, withdrawal and reapplication within the same allocation year, score harmonization across siblings applying simultaneously, and other exceptional circumstances. These additional factors are governed by municipal administrative rules. All information reflects the official criteria in effect as of April 1, 2026. For the authoritative and legally binding definition of the priority rules, see the relevant municipal ordinance and administrative guidelines.

**Table 6:** Employment Status and Related Conditions of Guardians

Category	Description	Father	Mother
Employment	140 hours or more per month	200	200
	110 to less than 140 hours per month	180	180
	90 to less than 110 hours per month	160	160
	80 to less than 90 hours per month	140	140
	65 to less than 80 hours per month	120	120
	52 to less than 65 hours per month	100	100
	Job seeking	50	50
Pregnancy or childbirth	Pregnancy or childbirth	—	210
Illness	Hospitalization or equivalent home care requiring bed rest	260	260
	Weekly outpatient care requiring constant rest	210	210
	Weekly outpatient care requiring limited rest	140	140
Disability	Severe physical or mental disability	260	260
	Moderate physical or mental disability	210	210
	Mild physical or mental disability	140	140
Caregiving	Full time care for a cohabiting family member	195	195
	Partial care or daily life support for a cohabiting family member	155	155
	Other caregiving or accompaniment	115	115
Absence	Divorce, death, separation, missing status, or unmarried status	230	230
Other	Single parent household with limited employment	170	170
	Sudden household shock within two months	250	250
	Sudden household shock within four months	240	240
	Sudden household shock within six months	210	210
	Enrollment in vocational training or school	200	200
	Natural disasters or fires	300	300

Note: If multiple conditions apply to a guardian, the score corresponding to the primary condition is used.

**Table 7:** Household Characteristics of the Child

Description	Score
Children reaching age three by March 31 of the following year and applying to eligible childcare facilities including siblings applying at the same time	250
Re-admission of children (and their siblings applying concurrently) who previously withdrew due to childbirth, childcare leave, or other unavoidable reasons	200
Households receiving public assistance or exempt from municipal resident tax with expected economic self sufficiency	10
Households with a total municipal income-based tax levy of less than 48,600 yen	5
Sibling related conditions	
Siblings applying at the same time and of the same age	0 → 200
Siblings applying at the same time and of different ages	0 → 160
Siblings currently enrolled in childcare	25 → 160
Eligibility for childcare due to illness, disability, caregiving, nursing, and cases where one or both parents are absent (Limited to single-child households).	0 → 160
For households with three or more children under 18 → For households with multiple children under 18 (Per child for the second and each subsequent child)	10
Siblings cared for at home or enrolled in kindergarten	-30
Cases where a relative who was providing care for the applicant child becomes unable to continue due to illness, disability, caregiving, or other unavoidable reasons	30
Guardians working as childcare workers, nurses, etc., at facilities within Koriyama City	150 → 170

Note: If a cohabiting grandparent under age 65 is seeking employment, the score for the parent with the lower employment rating will be set at 50 points. The final row reflects a rule change implemented in 2025.

**Table 8:** Current Childcare Arrangement of the Child

Description	Score
Cared for by a parent on childcare leave	30
Receiving care at a childcare facility	10
Cared for by a family member living separately outside the city	8
Cared for by a parent at their workplace (working while accompanied by the child)	5
Cared for by a family member living separately within the city	2
Cared for by a cohabiting family member	1

## A.2 Summary Statistics for Daycare Facilities

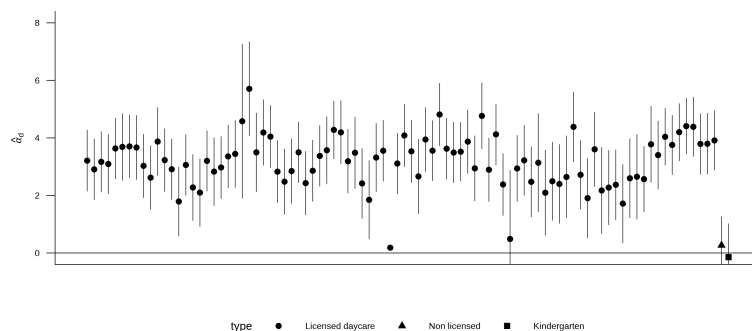
Table 9 reports summary statistics for licensed daycare centers in the municipality. Total vacant seats consistently exceed the number of applicants reported in Table 1. In addition to licensed daycare centers, the municipality has 32 kindergartens and 31 nonlicensed daycare facilities as of 2025.

**Table 9:** Daycare Characteristics by Year

Variable	2022	2023	2024	2025
Number of Daycares	86	89	89	90
Facility Type				
Licensed Daycare Center	59	59	59	60
Small-Scale Daycare	18	19	19	19
Certified Child Center	7	8	8	8
Employer-Based Daycare	2	3	3	3
Operator Type				
For-Profit	27	27	27	27
Public	25	25	25	25
Other	13	14	14	15
Social Welfare Corp.	13	13	13	13
School Corp.	8	10	10	10
Vacant Seats (Mean)				
Age 0	7.2	6.95	6.48	6.14
Age 1	6.39	5.7	5.33	5.32
Age 2	3	3.36	2.85	3.5
Age 3	4.66	4.58	4.27	4.39
Age 4	5.77	3.1	2.61	2.96
Age 5	4.23	4.6	2.22	2.67
Total Vacant Seats	1874	1756	1417	1518
Cutoff (Mean)				
Age 0	393.2	363.6	391.37	408.23
Age 1	394	399.27	463.5	445.76
Age 2	342.57	442.54	580.97	470.97
Age 3	445.06	515.9	611.43	591.72
Age 4	303	407	605	423.67
Age 5	430	516.43	659.71	488
Share of Positive Cutoffs	0.182	0.507	0.545	0.527

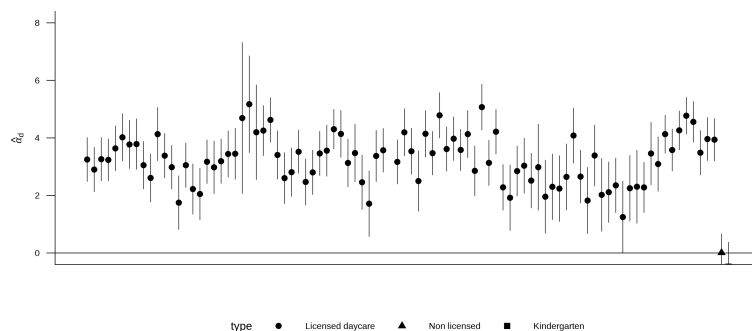
Notes: The table summarizes characteristics of licensed daycare facilities by year. Facility type and operator type rows report counts of distinct facilities. Vacant seats and cutoff rows report age specific means across facilities within each year. Mean cutoffs are computed conditional on the cutoff being positive. Share of Positive Cutoffs is the fraction of facility age categories for which admission is constrained by a binding cutoff.

### A.3 Estimates of Facility Fixed Effects



**Figure 6:** Facility fixed effects: full model

*Notes:* The figure plots estimated facility fixed effects  $\hat{\alpha}_d$  from the full model with demand complementarities. Points correspond to point estimates, and vertical bars indicate 95% confidence intervals. Confidence intervals are omitted for facilities with extremely imprecise estimates, defined as having standard errors above a pre specified threshold. Licensed daycare facilities are shown individually, while nonlicensed daycare and kindergarten are each represented by a single fixed effect.

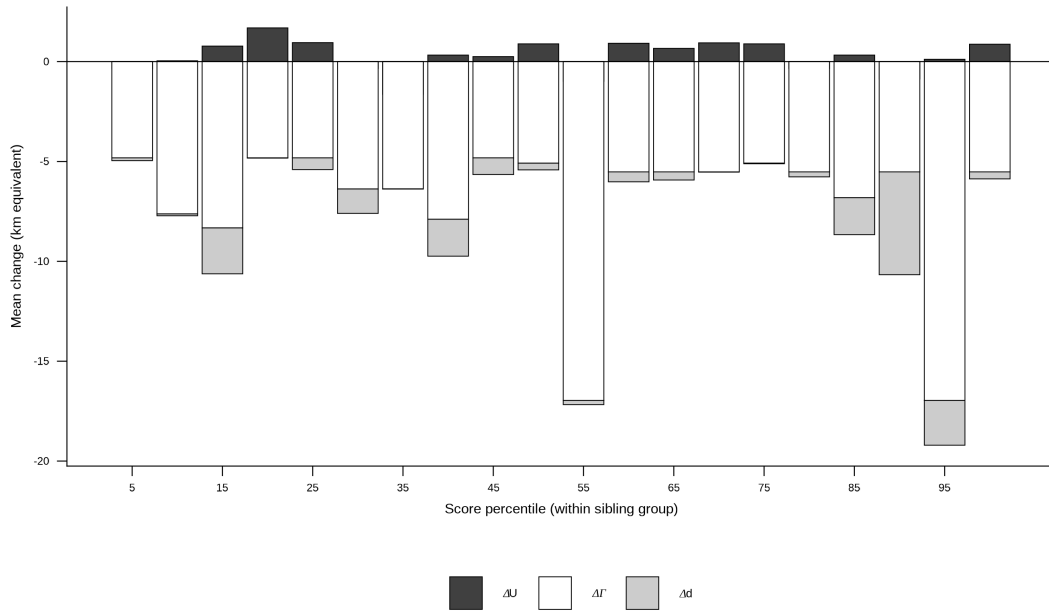


**Figure 7:** Facility fixed effects: individual model

*Notes:* The figure plots estimated facility fixed effects  $\hat{\alpha}_d$  from the individual choice model without demand complementarities. Points correspond to point estimates, and vertical bars indicate 95% confidence intervals. Confidence intervals are omitted for facilities with extremely imprecise estimates, defined as having standard errors above a pre specified threshold. Licensed daycare facilities are shown individually, while nonlicensed daycare and kindergarten are each represented by a single fixed effect.

## A.4 Quantifying Disutility from Split Assignment

Figure 8 constructs a counterfactual for simultaneous sibling households that are jointly assigned in the baseline but receive at least one assignment at rank two or worse. In this counterfactual, one child is hypothetically reassigned to their top choice while holding the other child’s baseline assignment fixed. The figure plots the resulting changes in each utility component ( $\Delta U$ ,  $\Delta \Gamma$ ,  $\Delta d$ ) by score percentile within the sibling group. In a standard model without sibling complementarity, such a reallocation would generally increase utility. Instead, the figure shows that this is rarely the case in the data: the gain in utility from moving one child to their top choice is small relative to the loss associated with breaking joint assignment, and this loss is driven primarily by the fixed disutility of split assignment rather than by changes in commuting distance.



**Figure 8:** Counterfactual welfare decomposition from reallocating one child to top choice

*Notes:* The figure reports average changes in household welfare components under a counterfactual in which, for simultaneous sibling applicants who (i) prefer joint assignment, (ii) are jointly assigned in the baseline, and (iii) have at least one child assigned to a rank of two or worse, the *other* child is reassigned to their first choice daycare, holding the baseline assignment of the worse ranked child fixed. Welfare is evaluated using the estimated model. Bars decompose the change in welfare into utility from daycare assignment ( $\Delta U$ ), the same daycare fixed cost ( $\Delta \Gamma$ ), and commuting distance cost ( $\Delta d$ ). Utility changes are shown above zero, while cost components enter negatively. The horizontal axis shows applicant score percentiles, and all components are expressed in kilometer equivalent units.

## A.5 Heterogeneous Welfare Impacts of the Policy Reform

**Table 10:** Heterogeneous Welfare Effects by Sibling Status and Score Quartile (Full Model)

Quartile	Score percentile			Welfare		
	Before	After	Difference (pp)	Before	After	Difference
<i>No Siblings</i>						
Q1	12.9	10.8	-2.1	0.194	0.199	0.004
Q2	44.4	38.3	-6.1	0.600	0.554	-0.046
Q3	60.1	52.8	-7.3	0.513	0.494	-0.018
Q4	82.3	82.3	0.0	1.480	1.467	-0.013
<i>Simultaneous</i>						
Q1	11.5	42.4	30.9	0.992	1.707	0.715
Q2	48.7	73.2	24.5	2.813	3.376	0.563
Q3	62.3	82.7	20.5	4.682	5.506	0.825
Q4	89.8	94.7	4.9	5.403	5.469	0.065
<i>Incumbent</i>						
Q1	42.7	61.6	19.0	1.112	2.793	1.681
Q2	79.9	77.0	-2.9	2.907	2.027	-0.880
Q3	83.4	80.8	-2.6	3.469	2.894	-0.575
Q4	81.4	88.2	6.8	2.612	2.980	0.368

Notes: Rows are defined by score quartiles constructed within sibling status using the observed score. Score pct. (Before) is computed from simulated score using the overall distribution of simulated scores among households with finite counterfactual welfare. Score pct. (After) is computed from observed score using the overall distribution of observed scores among households with finite baseline welfare. After evaluates welfare at the observed (new regime) assignment and Before evaluates welfare at the simulated (old regime) assignment. Differences are After minus Before. All welfare values are in km equivalent units.