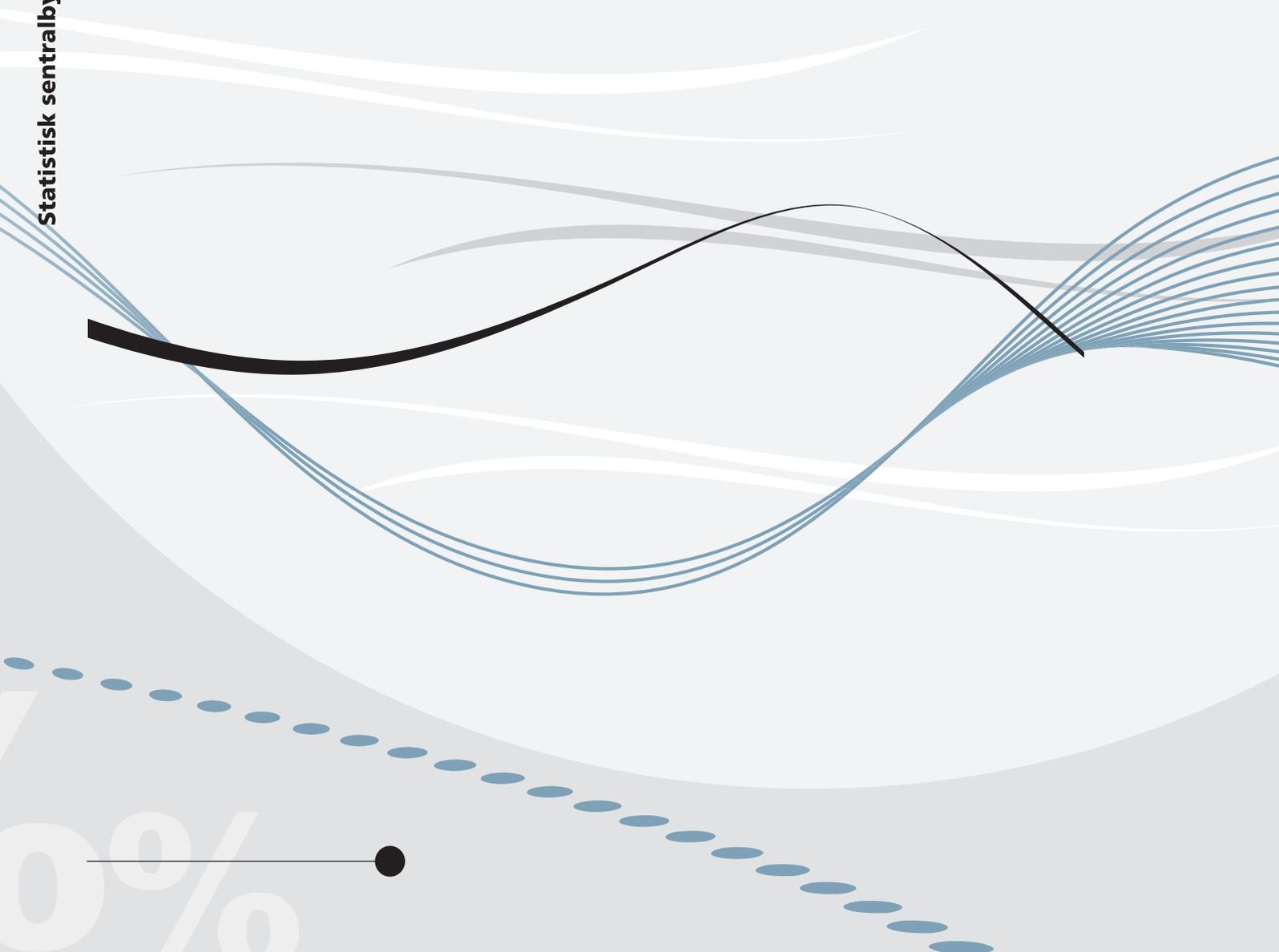


Nina Drange and Kjetil Telle

Universal child care and inequality of opportunity

Descriptive findings from Norway



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Abstract:

Encouraging effects from random assignments of intensive and high-quality early child care to disadvantaged children have spurred hopes that publicly funded universal child care can improve human development and social mobility. However, in a universal system advantaged parents can improve the relative performance of their own children if they are better at identifying and occupying the high-quality centers, relegating children from disadvantaged families to lower quality centers. To avoid such segregation, the universal child care system of Norway is based on strict regulations of structural quality, parental payment and generous public subsidies. Still, using administrative data covering every child in Oslo over the last decade, we document substantial segregation. The segregation results from parents of similar socioeconomic backgrounds applying to the same centers, and partly from private centers cream-skimming advantaged children. Though this can to some extent be explained by residential segregation, we show that reallocating children across centers only 500 meters from their homes would substantially reduce segregation.

Keywords: : universal child care, child development, segregation, immigrants

JEL classification: H31, J13

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Sammendrag

Ulikhet begynner tidlig. Allerede i en alder av tre år er språkutvikling av barn med høyt utdannede foreldre vesentlig bedre enn barn av lavt utdannede foreldre (Heckman og Mosso, 2014; Lareau, 2011; Kalil, 2014; Cunha et al., 2013; Schjølberg et al., 2008). Tidlig ulikhet kan vedvare eller forverre seg gjennom skoleløpet og senere i livet. Data fra PISA-undersøkelsen viser at sosioøkonomiske forskjeller i utdanning er av tilsvarende størrelse i den norske velferdsstaten som i USA, og slike forskjeller ser ut til å ha blitt større de siste tiårene (Kalil, 2014). Intensive intervensjoner i tidlig barndom har funnet gunstige effekter på både kognitive og ikke-kognitive ferdigheter, spesielt for barn fra vanskeligstilte familier (Heckman og Kautz, 2014; Almond og Currie, 2011; Hoynes og Schanzenbach, 2018). Dette har skapt håp om at en utvidelse av offentlig subsidiert universell barnehage av høy kvalitet kan forbedre mulighetene til barn fra slike familier og dermed øke sosial mobilitet.

Når generøse offentlige investeringer blir universelt tilgjengelige i stedet for målrettet mot vanskeligstilte grupper, vil alle foreldre ha insentiv til å endre atferd (Pop-Eleches og Urquiola, 2013; Böhlmark et al., 2016). De vil ha insentiver til å skaffe seg mer av den subsidierte barnehagen og å skaffe barnehage av høyere kvalitet. Dersom ressurssterke foreldre er mer villige og bedre i stand til å plassere sine barn i barnehager av høyere kvalitet sammenlignet med foreldre fra vanskeligstilte familier, er det ikke like klart at universell barnehage vil lykkes med å fremme sosial mobilitet (verken i muligheter eller i utfall). I tillegg kan barnehager tenkes å ha insentiver til å endre atferd. Hvis barnehager av høy kvalitet i større grad kan velge å ta inn barn fra ressurssterke familier, kan universell barnehage redusere sosial mobilitet. I Norge har myndighetene pålagt barnehagene strenge retningslinjer for strukturell kvalitet og fastsatt en lav foreldrebetaling for å sikre at systemet tilbyr barnehage av høy kvalitet til alle.

Vi benytter detaljerte administrative data som dekker alle barn i Oslo over flere år for å beskrive hvordan offentlig finansiert universell barnehage blir fordelt mellom barn med ulik bakgrunn. Vi fokuserer spesielt på segregering etter sosioøkonomisk bakgrunn, og særlig på barn fra innvandrerfamilier. Tidligere studier har dokumentert at barn fra vanskeligstilte familier i mindre grad benytter seg av barnehage (Drange og Havnes, 2018; Drange et al., 2016; Drange og Telle, 2015; Cornelissen et al., 2018), et resultat som vi reproducerer. Vi bidrar imidlertid til den eksisterende litteraturen ved å dokumentere sterk segregering etter sosioøkonomisk bakgrunn i barnehagene i Oslo, og vi viser at barn fra vanskeligstilte familier ser ut til å samles i barnehager som scorer svakere på indikatorer på strukturell kvalitet. Vi viser også at segregeringen hovedsakelig oppstår som følge av foreldrenes ønsker i søknadene.

Ved hjelp av data som nøyaktig plasserer barnehagene og barnas hjem geografisk, kan vi simulere alternative allokeringer av barna i Oslos barnehager. Vi viser at segregering av barn fra innvandrerfamilier kan bli vesentlig lavere ved å omfordele barn på tvers av barnehager som ligger i en omkrets på 500 meter fra barnas hjem. Denne alternative fordelingen reduserer andelen barn med innvandrerbakgrunn i de 10 prosent mest segregerte barnehagene fra den faktiske 68 prosent til 50 prosent. På samme måte faller andelen av barnehager uten barn med innvandrerbakgrunn fra 14 prosent til 2 prosent.

1 Introduction

Inequality begins early. Long before starting school, children from disadvantaged families face compromised environments and parenting that inadequately support learning and child exploration. For example, already at age three, language development of children of high-educated parents is substantially better than that of children of low-educated parents (Heckman and Mosso, 2014; Lareau, 2011; Kalil, 2014; Cunha et al., 2013; Schjølberg et al., 2008). Early inequality can persist or widen through school years and later life. Indeed, data from the PISA study show that socioeconomic inequalities in education are of similar magnitude in the generous welfare state of Norway as in the USA, and socioeconomic inequalities in education seem to have risen over the last decades (Kalil, 2014).

A main goal of public investments in child care is to provide children from various family backgrounds with equal opportunities. In addition to being considered fair, in the multi-period childhood model of Heckman and Mosso (2014), early investment in children with low initial (genetic) endowments can also be economically efficient. In line with the predictions of such models, intensive early-childhood interventions have shown beneficial effects on both cognitive and non-cognitive skills, particularly for children from disadvantaged backgrounds (Heckman and Kautz, 2014; Almond and Currie, 2011; Hoynes and Schanzenbach, 2018). This has spurred hope that publicly subsidized universal expansions of high-quality child care can improve opportunities of children from disadvantaged families and thereby raise social mobility.

However, when generous public investments are targeted exclusively at disadvantaged children, take-up will be high, and the non-eligible advantaged children will not benefit. In contrast to this, universal public investments may also benefit children from advantaged families. If advantaged parents to a greater extent than disadvantaged parents are able to exploit such public investments, universal access to high-quality child care could potentially amplify inequalities in outcomes.

When generous public investments become universally available — rather than targeted at disadvantaged groups —, parents of both advantaged and disadvantaged children will have incentives to change behavior (Pop-Eleches and Urquiola, 2013; Böhlmark et al., 2016).¹ They will have incen-

¹Böhlmark et al. (2016) provide a short review of research on parents' choice of school for their children, and conclude that more choice tends to increase segregation. See e.g. MacLeod and Urquiola (2013) for a review of the literature on how choice and competition affect school productivity. We are not aware of previous studies on how

tives both to obtain more of the subsidized child care and to obtain child care of higher quality. If advantaged parents are more willing and able than disadvantaged parents to occupy more and higher quality child care for their children, universal child care might not succeed in promoting social mobility (neither in opportunities nor in outcomes). In addition, child care centers and teachers could also have incentives to change behavior. If high quality centers prefer children from advantaged families, universal child care may reduce social mobility. To ensure that the system provides child care of high and uniform quality to everyone, Norwegian policymakers have undertaken efforts in the form of generous and standardized public subsidies, strict regulations of structural quality and a low parental co-payment set by the national government.

We use detailed administrative data covering every child in Oslo over the last decade to describe how publicly funded universal child care is distributed across advantaged and disadvantaged children. We focus specifically on segregation by socioeconomic background, and in particular on immigrant ancestry.² Previous studies have documented that disadvantaged children are less likely to enroll in formal child care (Drange and Havnes, 2018; Drange et al., 2016; Drange and Telle, 2015; Cornelissen et al., 2018), a result that we reproduce. Using detailed administrative register data covering every child in Oslo over the last decade, we add to the current literature by documenting strong segregation by socioeconomic background in child care centers, and, concerning, that disadvantaged children cluster in centers that seem to score weaker on indicators of center quality.³ Indeed, we can contribute with quantitative results on the

parents choose child care, but there is a large literature on how students and parents choose school (see e.g. recent review by Giustinelli and Manski, 2018).

²A high share of children with an immigrant background will presumably affect the language environment in the center, and may lead to a weaker language development among children with a low proficiency in the language spoken by the majority. To our knowledge, few studies have investigated how children with an immigrant background may influence the language environment in the child care center. However, there is a more mature literature on immigrant peers in the classroom. Jensen and Rasmussen (2011) find for Denmark that both native and immigrant children perform poorer if the share of immigrants in the classroom is high, although estimates are more pronounced for native children. Ohinata and van Ours (2013) and Geay et al. (2013) find no effects of native children from the share of immigrant peers in the classroom in the Netherlands and England. These latter studies do not consider outcomes among children with an immigrant background.

³Center quality is, like school quality, inherently hard to measure (Ladd and Loeb, 2013). For school there is ample evidence of advantaged students choosing and attending — at least what they believe to be — better schools. For example, for high-school students, Pop-Eleches and Urquiola (2013) show that better students select into schools of higher quality, where quality is measured as the peers' test scores. Black (1999) and Hastings and Weinstein (2008) similarly find that parents opt for (what they believe to

reason for the segregation, and we show that it stems largely from similar segregation in parental choices in the application.

With data on exact geographic location of centers and children’s homes, we can simulate alternative allocations across child care centers. We show that segregation of children from immigrant families could decline substantially by reallocating children across centers situated no more than 500 meters from the children’s homes. This alternative allocation reduces the share of children with immigrant background in the 10 percent most segregated child care centers from the actual 68 percent to 50 percent. Similarly, the share of centers with no children with immigrant background drops from 14 percent to 2 percent. The simulation illustrates that it would be possible to reduce segregation substantially by relatively modest changes in the assignment rules.

2 Theoretical Considerations

In several recent studies by James Heckman and colleagues, the model of human capital formation and social mobility by Gary Becker and Nigel Tomes (Becker and Tomes, 1979, 1986) has been extended (Heckman and Mosso, 2014). In a multi-period childhood model Heckman and Mosso (2014) show that early investment in children with low initial (genetic) endowments can be economically efficient, as well as fair. Even in the absence of inequality aversion, it can be socially beneficial to undertake compensating behavior through early investments in children’s human capital (i.e. allocate higher early investments to children of low initial endowments than to children of high initial endowments). In the model, early investments improve children’s later skills, which again raises the productivity of later period investments.⁴ For compensating behaviors to be optimal, it is sufficient that initial endowments and investments are substitutes.

All else equal, public investments in child care for disadvantaged children will enhance their development and reduce inequality. For several reasons, effects on inequality of public investments in *universal* child care is less clear, as it would depend on interactions between public and private investments across advantaged and disadvantaged children. For example, advantaged parents may be more able than disadvantaged parents to in-

be) better schools. These studies find that access to schools of perceived higher quality improves the students’ results, though typically only modestly.

⁴But later in childhood it is efficient to invest more in higher-skill students than in lower-skill students, as the payoff of investment in the last childhood period is always higher for the high than the low skill child.

crease the productivity of public investments (e.g. as private and public investments are complements), or public investments may crowd out private investments more among disadvantaged families.⁵ If we assume no crowding out, and that private and public investments are substitutes, then public investments increase the overall investment in both advantaged and disadvantaged children to the same extent, but — given the standard assumption of skill formation being concave in investments — the improvement in outcomes would be higher for the disadvantaged children since their initial level of private investment is lower. If we assume, however, that advantaged parents are better at transforming public investments into skill formation (e.g. if private and public investments are complements for advantaged children), universal provision of public child care, though possibly equally increasing the investment in both advantaged and disadvantaged children, could improve outcomes more for advantaged than disadvantaged children, i.e. having a dis-equalizing effect.

Publicly funded universal child care may not improve the equality of opportunity if it also changes the behavior of parents or child care institutions (Pop-Eleches and Urquiola, 2013; Böhlmark et al., 2016). When parents optimize the quality of care received by their children, publicly funded child care give parents incentives to occupy both more child care and child care of higher quality. If advantaged parents are willing⁶ to or more able than disadvantaged parents to occupy more and better child care for their children, universal child care can increase inequality (both in opportunities and outcomes). First, such selection might cause advantaged children to attend centers of higher quality as measured by statically child-unrelated indicators like current staff quality and physical environments. Second, it could lead to clustering of advantaged children in certain centers, with associated beneficial peer effects.⁷

⁵Kalil (2014) argue that advantaged parents both invest more and are more able to use the investments to improve the development of their children than disadvantaged parents. When it comes to crowding out, results appear less clear. For example, Gelber and Isen (2013) find evidence of crowding *in* of parental investments for children in Head Start, while Pop-Eleches and Urquiola (2013) find some evidence of more crowding out of parental investments for high-school students of lower skills than their high-skill peers (when getting access to a higher quality school).

⁶Parents may in fact prefer socioeconomic diversity among the children in the center they send their child, but over time segregation could still emerge in the presence of segregation dynamics with tipping (Schelling, 1969; Card et al., 2008).

⁷While associations between a child’s own family background and its future outcomes is well studied, it is not similarly clear how the characteristics of a child’s peers’ can and will affect its future outcomes. However, a growing body of research using randomized and natural experiments to address the endogeneity of peer group formation, tends to find support for peer effects, although estimates vary depending on the outcome and age

Child care centers and teachers could also have incentives to change behavior as a universal child care system expands. They might have incentives to do so in order to reduce costs or secure the quality of current children’s peers.⁸ Centers can maximize child quality through recruiting children of more resourceful parents, for example by targeting information and promotion campaigns to selected neighborhoods or parents, or by undertaking a more accommodating attitude toward such parents (Bauhoff, 2012). They might also offer amenities particularly appreciated by resourceful parents (Aizer et al., 2005), like geographic location (e.g. in advantaged neighborhoods), spending much time with the children outdoors, providing particularly healthy food or emphasizing reading and learning activities. Moreover, if allowed, centers may perform supply-side selection by manipulating which children are granted an offer among those who applies. Overall, centers establishing a reputation of high-quality, may over time attract an increasing share of children from advantaged families, further improving quality (see e.g. MacLeod and Urquiola, 2015).

Teachers or other staff may also prefer advantaged children.⁹ Thus, not only will advantaged parents aim to enroll their children in centers with better teachers (and centers will try to attract both better teachers and more advantaged children), the better teachers will also select into centers with more advantaged children. Over time, such selection dynamics could

of the children studied (Neidell and Waldfogel, 2010; Chetty et al., 2011).

⁸In health economics such supply-side selection has been studied theoretically for a long time (Breyer et al., 2011; Gaynor and Town, 2011), and there are also some empirical contributions. Bauhoff (2012) study supply-side selection of health insurance plans. The market for such plans in Germany is tightly regulated (to avoid such risk-selection), but he still finds that plans respond more favorably to applicants that appear lower-cost (compared with higher-costs) on observable characteristics. Duggan (2000) analyzes effects of a reform that increased the funding of low-income (i.e. under-insured) patients to see if responses were different across private for-profit, private not-for-profit and government-owned hospitals. He found that the increased funding spurred private hospitals to treat more low-income patients, but he found no improvement in health for these patients. The lack of benefits for the indigent is related to the ownership structure of the hospitals, in particular to the windfall of the public hospitals being “bailed out” by the local governments and thus not improving the quality of the treatment. Aizer et al. (2005) use the same reform as Duggan (2000), and find that it resulted in desegregation of poor publicly insured mothers from separate, often public, hospitals. The moving of affected mothers suggest that their choice were, before the reform, constrained and that the reform improved their welfare. Duggan (2002) looked at the same reform as Duggan (2000) and found that not-for-profit hospitals in areas with many for-profit hospitals responded more (than not-for-profit hospitals in areas with few for-profit hospitals), which indicates more scope to risk-select if in an area with many public centers (and few private), compared with areas with only private centers.

⁹In high school, Pop-Eleches and Urquiola (2013) find that better students are matched with better teachers, and they argue that this is a dynamic result of teachers’ preferences.

materialize with the most advantaged children occupying the highest quality centers, leaving the children from disadvantaged families in low-quality child care. We will then be in a situation where most public funding is allocated to the most resourceful children, which is the opposite of the intended compensating behavior of expanding child care, even if this was not intended by policy makers. This can deteriorate the relative opportunities of disadvantaged children, with associated expansions in inequality of outcomes.

3 Institutional Background

3.1 Child Care Expansion in Norway

Child care in Norway is now practically universal. In 2009 a policy introduced the legal right to a publicly funded and certified child care slot if the child was born prior to September the previous year.¹⁰ Child care institutions (both public and private) are strictly regulated, with provisions on staff qualifications, number of children per adult and per teacher, size of play area, and to some extent educational content. Institutions should be run by an educated child care teacher responsible for management and educational content. The child care teacher education is a three year college degree, including supervised practice in a child care center. National child care regulations specify that there should be at least one educated child care teacher per 10 children aged below three, and one per 18 children aged 3-5. In addition, municipal regulations specify that there should be one adult per three children below three, and one adult per six children above three. There are no educational requirements for the additional staff.

In Oslo, about 60 percent of child care institutions are public, while the remaining are privately operated. Private centers can be both for-profit and not-for-profit. Both types of institutions require municipal approval and supervision to be entitled to federal subsidies that cover around 80 percent of costs.¹¹ The very generous subsidies implies that it is not worthwhile for wealthy parents to try to set up alternative private child care arrangements of higher quality, since the quality of the publicly subsidized centers is already very high and since violations of the maximum co-payment, including pecuniary or in-kind side-payments and donations, would disqualify

¹⁰Children born September 1st and onward are not guaranteed a slot before the coming autumn, but the vast majority will enroll during their second year.

¹¹Parental co-payment is capped since 2003 at around 2400 NOK (approximately 400 US\$) per month.

the center from the very generous public subsidies. As a result of an expansion of child care slots and a lower maximum price, the share of children enrolled in centers rose sharply over the last decade. This was particularly true for the youngest children. In 2011 more than 90 percent of children aged 1-5 attended child care, and more than 98 percent of the children starting school in Norway had attended a child care center.¹²

3.2 Child Care Supply in Oslo

During the years our data covers (2005-2013), the main allocation of child care slots in Oslo took place in a centralized application round in March to May. Parents could rank up to seven child care centers in their city district when applying, and their ranking could be a mix of private and municipal institutions. With minor exceptions, private institutions had full discretion over their admissions based on applicant lists sent from the city administration, while municipal centers used an assignment lottery to offer slots prior to 2008, and birth date in subsequent years.

In reality there was no opening for advantaged parents to set up private alternatives of superior quality outside of the publicly funded and certified system. Indeed, when operating within the system (which everyone did because it was economically very attractive), providers were impeded from using parental payments to segregate children or to improve quality. However, strict quality regulations (of which parents were aware) prohibited providers from supplying low-quality care. Since access to child care within the system became a legal right in 2009, private alternatives of low-quality outside the system are hardly worthwhile any more (over-subscription to care within the system was extensive until a few years ago, but to a lesser extent for the later cohorts in our sample).

Setting up of private care (within the system) was regulated, so that providers would generally not be allowed to set up a child care center in areas with sufficient institutions already (and they might lose the permission if they did not follow the quality regulations). Given that municipal centers randomly assigned children (within centers that parents had applied for), there were limited possibilities for this type of centers to cream skim. Moreover, national wage regulations (and the quality regulations) made it virtually impossible to save by hiring low-cost/low-quality staff. The fixed income (limited parental co-payment and fixed public subsidy) made it very hard to use higher wages to attract better teachers. Moreover, centers received a certain extra subsidy when enrolling children with

¹²See <http://www.ssb.no/befolkning/nokkeltall/likestilling>

an immigrant background to secure that these children were allocated some teacher resources in order to develop proficiency in the majority language. This should facilitate similar quality across care institutions.

3.3 Child Care Quality

Though public regulations secured a minimum quality standard for all child care centers in Norway, there were several ways in which centers could differ in aspects of quality. One such aspect was teacher competency. While the expansion of available child care slots from 2003 and onward was extensive, the education of teachers did not keep a similar pace. Thus, there was a shortage of competent teachers, and some centers failed to recruit a sufficient amount of educated staff. To be allowed to run a center without sufficient staff with required education, the center had to apply for an exemption from the municipality. These exemptions were often granted, as the municipality wanted to secure a sufficient number of child care slots. Another way in which the center could increase quality and attract children from advantaged backgrounds was to promote amenities like geographic location, staff competency, or emphasis on learning activities. It was also to a limited extent possible to reduce the costs of the center through various kinds of voluntary parental participation, like being in the board, cutting lawns, shuffling snow, supporting employees at day trips, etc. This is unlikely to enable for-profit centers to extract a higher profit, but it could secure a better offer for children enrolled, and subsequently attract children from more advantaged families. Moreover, the private centers could influence the composition of enrolled children. One obvious way to exert such influence would be to set up the center in a geographical area with resourceful parents, since the catchment areas of centers was largely defined by geographical vicinity. But it could also be done by navigating the admission system to attract or/and admit less demanding children. One could, for example, attract applications from presumably tranquil children by allocating resources to characteristics assumed to be appreciated more by such parents (books, safety, out-door activities, etc.). Since private centers have some - though limited - discretion with respect to whom among the applicants to admit, there is also some room for cream skimming among the applicants.

4 Data and Methods

As noted in the introduction, we want to document descriptively how universal child care can be allocated across advantaged and disadvantaged children, and specifically how it may affect socioeconomic segregation in early childhood. In particular, we try to explore whether the segregation correlates with indicators of center quality, and explore how parental choices in applications and residential segregation can explain the segregation. To shed light on these questions we use the following detailed administrative data covering every child in Oslo over the last decade.

4.1 Data Sources, Variables and Indicators of Segregation

We have access to data from the Municipality of Oslo containing records with information on applications for and enrollments in virtually all child care institutions in Oslo for the years 2005–2013, including both public and private child care institutions. Applications, enrollment and offers are recorded with date of receipt, date of first attendance and date the offer was made, respectively. Since the dataset includes the unique official personal identifier of every child, we can link with the population register of Statistics Norway to identify the child’s parents. Linking with other registries, we obtain information about the child (birth year and month, sex, country of birth, geographic location of residency, etc.) and the parents (birth year and month, sex, country of birth, geographic location of residency, identifier of every child, marital status and identity of the spouse, education, earnings, income, drawing disability pensions, receiving (means tested) social assistance, etc.). Thus, data allow us to identify the immigration status of every resident, and we use this to define *children from immigrant families* (*children with immigrant background* is sometimes used synonymously) as children i) who immigrated to Norway, ii) whose mother *and* father immigrated to Norway or iii) whose four grandparents were born outside Norway.

Furthermore, we have access to Oslo municipality’s database on test scores at school entry for every child in Oslo. This provides information about scores on performance tests in Norwegian language, conducted in April of first grade. The tests are designed nationally, and are intended to help identify under-performing children, enabling schools to allocate resources to these children. The language test maps the ability to write letters, recognize written letters, identify spoken letters, combine sounds, write words, read words and read simple sentences.

As indicator of segregation we focus on the children’s immigrant background, but also include the following measures: father is a high-school drop out, a parent receives disability pension or social assistance, mother is not working and parents are not married. To measure the extent of segregation, we will mainly rely on plots of the full distributions or of values from lower/upper deciles for the child care centers. In addition, we will provide common indexes of segregation (Massey and Denton, 1988). To capture (un)evenness we report the Gini coefficient (G) and the dissimilarity index (D), both taking value 1 under full segregation and 0 when the proportion in each child care center is the same as the proportion in the overall population. The value of D represents the share of the group that would need to change center to make the group similarly represented in all centers.

To capture *exposure*, i.e the degree of potential interaction between group members, we report the isolation index (S) and a measure of over-exposure (R). The isolation index (S) is defined as the likelihood that a disadvantaged child has another disadvantaged child in its own center. Similarly, R captures own-group exposure for all children, but averaged over both groups, and normalized by the segregation that would have occurred under random assignment of children to centers (following Böhlmark et al. 2016, appendix 2; see also Aslund and Nordstrom Skans 2009). The interpretation is that the risk of a child sharing center with another child from its own group is R times what it would have been had the children been randomly assigned to centers. While R is one if there is no segregation relative to random assignment, it can both be below one (e.g. if policies are enforced to reduce segregation) and above one (if people self-select by similar characteristics), S is zero if there is no isolation and one under full isolation (i.e. just like D and G).

It is inherently hard to capture child care quality (see e.g. Ladd and Loeb (2013) for a discussion on measures of school quality). In principle we would like to capture the center’s ability – including possible peer effects - to improve the development of the child. Indeed, since the needs of children differ with individual characteristics and development stage, what constitutes high quality for one child may not be beneficial for all. In the school literature, characteristics of the peers are a common quality indicator (Chetty et al., 2011). We will also briefly present some data on the number of adults per child and characteristics of the staff, as well as test scores in primary school for the children from the center, though the latter may obviously be endogenous (especially since we do not have ability

indicators before entry to child care). Clearly, neither of these measures capture quality in a comprehensive and satisfactory way, and our empirical investigations will focus mainly on describing segregation.

4.2 Sample Definitions

We have arranged the data into five analytic samples. The *first analytic sample* uses information at the child level. Here, we are interested in the characteristics of the children who do and do not attend child care before school-starting age. We identify children who could have been attending child care (using complete and dated records of all residents in Oslo) and children who did attend. To know whether children attended before school start, we can only use children born before 2008 (since they start school in August 2013, which is the last calendar year we can observe child care attendance in our data). Thus, we use birth cohorts 2004-2007 and capture attendance over the calendar years 2004-2013. This dataset includes 27 544 children.

In the *second analytic sample*, we use information at the child care center level. In this dataset we include all children attending a child care center in Oslo as of January 1st 2011. This implies that we include children born 2005-2010. By linking on information of the children in the center at January 1st 2011, we can describe the characteristics of their families using data (like family income) from 2010. We will use this dataset to study differences across the centers with respect to characteristics of the children *attending* the center. To focus on child care centers, i.e. excluding family run day care of more varying quality, as well as ensuring results being more robust to outliers, we have excluded child care institutions with less than 10 children. This dataset includes 653 child care centers.

The *third analytic sample* is a subset of the *second analytic sample*, i.e. the subset of centers that we are able to uniquely identify in employer-employee databases maintained by Statistics Norway. In addition to allowing us to collect individual information on the employees of each center, these databases also include exact geographic location of each center. Since we know the exact geographic residential location of all the children's homes (from the population registry), we can calculate the distance from everyone's home to the child care centers. The dataset includes 440 child care centers, but we manually uniquely identified the geographic location of 79 more centers, leaving us with a sample of 519 centers for the analysis of distance to the centers in Section 6.2.

In the *fourth analytic sample* which is also at the center level, we iden-

tify the children who *applied* for a child care slot in a particular center. The sample includes first time applications submitted for the birth cohorts 2004-2007 over the calendar years 2004-2013, and a family's first priority center.¹³ We will use this dataset to study differences across the centers with respect to characteristics of the children *applying for* the center. Again, we exclude centers with less than 10 applying children. This dataset includes 529 centers.

The *fifth analytic sample* is at the child level. This dataset is used to explore if the children *attending* a child care center differ systematically from the children who *applied* (first priority) to the center. To do so we need to identify children who attended the center of first priority in their application. We start with the first application (available 2004-2013) of all children born 2004-2007, which comprises 34 723 children. Then we identify the center that this child attended at January 1st in the calendar year after the calendar year of application (or the next calendar year), which is available for the subset of 28 706 children. We can then compare the center that the child applied for with the center that the child ended up attending, given that the child did in fact start in a center in Oslo.

5 Empirical Findings

5.1 Utilization and Segregation

5.1.1 Utilization of Child Care by Socioeconomic Background

Using the *first analytic sample*, i.e. all children in birth cohorts 2004-2007, who resided in Oslo at the entry of the calendar year they turned 6 (i.e. January of the calendar year in which they start school in August), we see from Figure 1 that about 95 percent had attended child care (in Oslo) before school start. The average participation rate hides the fact that attendance rates rose considerably in this period, it was 87 percent for the 2004 cohort, 91 percent for the 2005 cohort and 95 percent for the 2006 cohort. From the figure we observe that children from disadvantaged backgrounds unsurprisingly have somewhat lower attendance rates, as measured along a number of dimensions. The attendance rates are particularly low for children from immigrant families (about 90 percent) and children of a disabled parent (about 86 percent).

¹³Due to a restrictive storage policy in the municipality, data on children born in January and February 2004 were deleted from the application data base before we got access to it. We are therefore not able to include these children in our sample.

In Figure 2 we show the number of years a child has been enrolled in child care (in Oslo) before school start. On average, a child is enrolled close to four years. Again, we see that children from more disadvantaged backgrounds tend to spend less time in child care than their more advantaged peers. In particular, children with immigrant background spend about a year less in child care before school start than the average child. It appears, both here and in subsequent results, that marital status of the parents is not correlated with socio-economic disadvantage. In Norway cohabitation is very common, and most children are born by cohabiting parents.

Given these socioeconomic differences in child care attendance, we would also expect a positive correlation between child care attendance and later school performance. We confirm this in Figure 3, where we see that among children with more child care experience, a lower share scored concerningly low on a language test in first grade. We would not only expect socioeconomic differences between observable categories (e.g. between children from immigrant families and other children), but also within such categories. For example, among children from immigrant families, we would expect the most advantaged to attend child care more and earlier than the disadvantaged. In Table 1 we have regressed test scores on the number of years in child care before school for each indicated socioeconomic category separately. The general picture confirms our expectation: Within each category, those who attended child care longer are less likely to score concerningly low on the test. Though the latter result could also reflect a causal effect of attending child care, there are clearly important selection processes determining child care attendance.

5.1.2 Segregation by Socioeconomic Background

Using the *second analytic sample* (i.e. all children enrolled in publicly subsidized child care in Oslo in 2011), we see from Figure 4 that there are a few very large centers with more than 100 children, and many smaller. In the following plots and analyses, we have only included centers with at least 10 children.

In Figure 5 we see that children from immigrant families clearly are unevenly distributed across centers. In about 15 percent of the centers, there are no children from immigrant families, while in the 10 percent centers with the highest share of children from immigrant families, about 80 percent have such background.

In Figure 6 we show the rate of the mean of the given variable for the top and bottom decile of centers. For a number of measures, it is evident that

disadvantaged and advantaged children are clustered in different centers. Starting with children of immigrant ancestry, findings from Figure 5 are confirmed. Proceeding to the share of children with mothers not working, we see that in the highest decile of child care centers almost 60 percent of children are from families where the mother does not work. In the lowest decile, the corresponding figure is less than 10 percent. We see a similar segregation across all background characteristics, and note that while none of the children come from families on welfare in the lowest decile, almost 30 percent have this background in the highest decile of child care centers.

These clear patterns of segregation are also evident from the segregation indexes presented in Table 2. As we will return to below, quite some of the segregation across centers in Oslo can be attributed to residential segregation, but from the lower panel of Table 2 we observe that substantial segregation remains when we calculate the indexes within the city districts (at the time the 15 districts of Oslo are identical to the catchment areas of the centers).

In Figure 7 we see that the test scores of the children in first grade differ remarkably for children across centers. Note that this might not only reflect selection into centers, but could also reflect the centers' ability to enhance child development.

Does this segregation suggest that advantaged children occupy the centers of higher quality? As already noted, it is hard to measure the quality of educational institutions (Ladd and Loeb, 2013), so we will look at several rough indicators of center quality (using the *third analytic sample*). Drange and Ronning (2017) rely on random assignment of children across centers, and find that the share of male employees in the centers is the best variable to capture latent center quality. In addition we also include the number of college educated adults per child, the share of the employees that are non-immigrants, and the score of the children on test scores in first grade. In Table 3 we present the correlations between these rough quality indicators and the indicators of family background applied above, and results are largely as expected. For example, children from immigrant families tend to be in centers with fewer male adults, fewer college educated adults per child, more immigrant employees and in centers where the children score weaker on tests scores in first grade. Similar associations are present for the other indicators of disadvantage. Though not conclusive, these findings are consistent with the conjecture that children from advantaged families are not only clustering in the same centers, but that they are clustering in centers of superior quality, relegating children from disadvantaged families

to the remaining child care centers.

5.1.3 Segregation by Center Ownership

We keep in mind from Section 3 that we are interested in whether the small differences in rules that regulate enrollment in private vs. municipal child care centers might be associated with the background of the children who actually enroll. Some previous studies indicate increased segregation when parents/students can choose private schools or private schools can cream skim students (Card et al., 2008; Hsieh and Urquiola, 2006; Böhlmark et al., 2016). To look closer at segregation by center ownership we study the children enrolled in child care in Oslo in 2011 (still the *second analytic sample*), and explore if there are socioeconomic differences across private and municipal centers. From Figure 8 we observe that there tend to be a significantly higher share of advantaged children in private compared to municipal centers. For example, the share of children with immigrant background is 13 percent in private centers and 31 percent in municipal centers. We note from Table 4 that the share of children from municipal centers who score concerningly low on tests in first grade is significantly higher than the share of children from private centers. Household income of families enrolled in municipal child care centers is considerably lower than in private centers, and, on average, fathers have about 1.6 years less schooling.

5.2 Parental Application Behavior

We have seen that there is considerable segregation in child care centers in Oslo, and, at least for certain background characteristics such as immigrant status, segregation is also present within city districts and across private and municipal centers. We proceed by looking at parents' application behavior as a possible explanation for this segregation. Using the *fourth analytic sample* (i.e. all children applying for the first time to publicly subsidized child care in Oslo over 2004-2013), we see from Figure 9 that there are excessive differences in characteristics of children across applications to child care centers. Note that only centers with at least 10 applying children are included. Applications of children from immigrant families are unevenly distributed across centers. For the lowest decile (measured as the share of children with immigrant background) of the centers, there are about 1 percent of children from immigrant families applying, while in the 10 percent centers with the highest share of children from immigrant

families applying, 86 percent have such background. It seems clear that parents with and without immigrant background apply for different child care centers. This is also the case for other socioeconomic characteristics (see Figure 9) and confirmed using the segregation indexes (see Table 5). Overall, these patterns correspond to what we found in Figure 6 and Table 2, and implies that the socioeconomic segregation of enrolled children, can largely be explained by parental application behavior.¹⁴ Not fully, however, as we observe that the segregation indexes generally suggest more limited segregation in applications than in enrollment.

In Figure 10 we see how parental background is associated with applications for municipal vs private child care centers. For example, it is clear that families with an immigrant background have a higher likelihood of applying for a municipal child care center than a private one. This may be explained by information asymmetries, preferences for this type of center, or it might reflect that parents prefer a nearby center, and that centers close to these families to a larger extent are run by the municipality.

5.3 Do Private Centers Skim the Cream?

Are there indications that private child care centers enroll a higher share of advantaged children than those who apply? To explore this, we use our *fifth analytic sample* to check whether the children who *attend* private centers differ systematically from the children who *applied* to private centers, and similarly for municipal centers. We keep in mind from Section 4.2 that we consider the families' first ranked center in this analysis. Figure 11 displays the share of children with the given background characteristic who applied and attended private vs. municipal centers, and the Figure suggests some cream skimming. For example, we see that while 34 percent of the children applying to municipal centers had an immigrant background, an even higher share of children who ended up attending a municipal center had such background (37 percent). For private centers, however, the share of children with an immigrant background applying was 16 percent, while the rate attending was 14 percent. Thus, municipal centers enroll 3 percentage points *more* children with immigrant background than those applying, while private centers enroll 2 percentage points *fewer* children with immigrant background than those who applied. This is in line with a hypothesis that private centers enroll disproportionately fewer children with an immigrant background than the mean of their application pool, and indicates

¹⁴As above, substantial segregation remains when we calculate the indexes within city districts; see lower panel of Table 5.

that private child care centers contribute to the segregation in child care. We note, however, that the contribution to the overall observed segregation that may stem from private centers' cream skimming, seems limited compared with the contribution from parental application behavior.

6 Simulations

One reason to subsidize child care is to improve the language skills of children from immigrant families. Improving skills in the language spoken by the majority, requires that this is in fact the language spoken by the adults and the children in the child care center. Excessive segregation, however, will result in child care centers where few or none of the children speak the language spoken by the majority. This may lead to weaker language development among children with a low proficiency in the language spoken by the majority. If some centers almost exclusively enroll children with immigrant background, and others enroll few or no children with immigrant background, policies to reduce segregation may be called for.

Segregation would also evolve with random allocation of children across centers, in which case policies to reduce segregation should be possible without raising costs in the form of e.g. increased travel distances. If so, uncontroversial policies to reduce segregation stemming from randomization should be available. But segregation may also be a result of residential segregation and associated travel distances from home to centers, or parental choices based on e.g. matches between the child's needs and characteristics of the center, in which case policies to reduce segregation can be controversial. In such cases, policymakers should weigh the possible costs of restricting parental choices and the possible costs of segregation.

In this section we undertake simulations to compare actual enrollment in child care centers with random enrollment and with the enrollment that minimizes segregation given that travel distance from home to the center should not exceed 500 meters. The simulations yield hypothetical outcomes that are only feasible if not counteracted by e.g. parental behavior. However, since child care in Norway is generously subsidized, heavily regulated and of high quality, there exists no alternative in the fully private market. In fact, except for postponing entry by a few months and applying for transfer to another center (Drange and Havnes, 2018), opting out of the system would not really be an attractive option in the long run. The outcome of the simulated policies may thus be a reasonable estimate of what could be achieved by changes in the assignment rules in this context.

6.1 Randomly Allocating Children to Centers

As we have already discussed, a certain amount of segregation of children based on background characteristics should be expected given the actual residential segregation across any city, including Oslo. Since children primarily will be assigned a child care slot in the city district where they live, residential segregation will carry over to segregation in child care centers. To look closer into how much of the observed segregation in child care centers that may and may not be explained by residential segregation, we have simulated two sets of random draws (obeying the actual number of children in each center) displayed in Figure 12 (based on the *second analytic sample*). In one set we randomly assign children to centers across the entire city independent on their city district of residence (black area). As expected from well-known socioeconomic residential segregation in most bigger Western cities, we see that this generates much smaller segregation by immigrant background in the child care centers than the actual differences (light gray dots, cf. Figure 5). In another set of random draws, we assign children randomly to a child care center within the child’s city district of residence (dark gray area). As expected, this generates more segregation than in the case with random draw to any child care center in Oslo, but it is still considerably lower than the segregation we actually observe (light gray dots).

6.2 Minimizing Center Segregation within Neighborhoods

To further explore the role of residential segregation in explaining the clustering by immigrant background in child care centers, we calculate the shortest distance (beeline) in meters between the family home and the child care center that the child actually attended (in the *third analytic sample*). For the actual allocation of children, the mean and median distance is 1338 and 595 meters. First, we study how segregation by immigrant background changes if we let two children switch child care center if such a switch reduces (weakly) the travel distance of both of them.¹⁵ From the dark gray dots in Figure 13 we see that pairwise reallocating children to reduce the travel distance from home to the center for both of them, do reduce the segregation of children with immigrant background in the centers somewhat.

¹⁵We did this simulation by randomly sorting all the children, and change the child care center of the two first children if the travel distance declined (weakly) for both of them, change the child care center for the two next children if travel distance declined (weakly) for both of them, and so on for all pairs of children in the dataset. We repeated this procedure 5,000 times, and though more such swaps exist, the results tended to change little after about thousand loops.

This suggest that allocating children to their nearest child care center, like is common for schools in Oslo, could reduce segregation.

Second, from the black dots in the same figure, we see that segregation by immigrant background is reduced further if we reallocate children to minimize segregation by immigrant background *given* that the travel distance from the home of each child to the child care center cannot exceed 500 meters or increase. Doing so results in an allocation where the share of children with immigrant background in the 10 percent most segregated child care centers declines from the actual 68 percent (light gray dots) to 50 percent (black dots). Interestingly, the rate of children with immigrant background drops from above 90 to below 60 percent in the five most segregated centers. Similarly, the share of centers with no children from immigrant families drops from 14 percent (light gray dots) to 2 percent (black dots). This drop in segregation is also evident from the segregation indexes presented in Table 6. The simulation illustrates that it would be possible to reduce segregation by immigrant background in child care centers substantially by making relatively modest changes in the assignment rules. Whether possible assimilation gains from such a change in assignment rules are sufficient to justify the accompanying restrictions to parents' choice of center, is ultimately a question of political preferences.

7 Conclusion

We have studied the allocation of publicly funded child care in a country with a very extensive provision of universal child care, and with a subsidy system that is designed to provide uniform and high quality child care for all children. In Oslo, public child care slots are assigned among applicants in a lottery (Drange and Havnes, 2018), strict regulations of structural quality applies to all centers and the maximum co-payment of parents is decided by the national government. This should presumably limit advantaged parents ability to use for example networks or side-payments to disproportionately occupy care of higher quality. Still, we describe excessive segregation of children by socioeconomic background across centers. The segregation is mainly driven by advantaged parents applying to the same centers, presumably contributing to these centers becoming of higher quality. We find some signs that private centers take advantage of their discretion with respect to which children to admit by enrolling disproportionately more advantaged children than those who applied. Largely, however, the socioeconomic clustering in the child care centers stems from application behavior and socioeconomic residential segregation. However, we show that the segregation by immigrant background can be reduced substantially by

reallocating children across centers only 500 meters from the family homes.

Expanding child care to new groups involves behavioral responses that can impede disadvantaged children's access to child care and the quality of the child care available to them. Our empirical results suggest that advantaged parents may be better at navigating the system and thereby take better advantage of the public funding to enhance the opportunities of their children. Thus, the need for publicly funded compensatory measures to secure the opportunities of children from disadvantaged backgrounds is very unlikely to be eliminated by a universal child care system of high quality. A main take-away from our study is that the need for well-targeted and publicly funded compensatory measures to disadvantaged children is not automatically eliminated by a universal system — not even when the universal system is heavily regulated, generously subsidized and generally of high quality. Policymakers can take this into account, for example, by attributing disproportionately higher subsidies to children from lower socioeconomic backgrounds. This can and is done in different ways, for example by restricting intensive early-childhood interventions to children from disadvantaged backgrounds or by adjusting public funding to child care centers to compensate for children's disadvantaged socioeconomic backgrounds.

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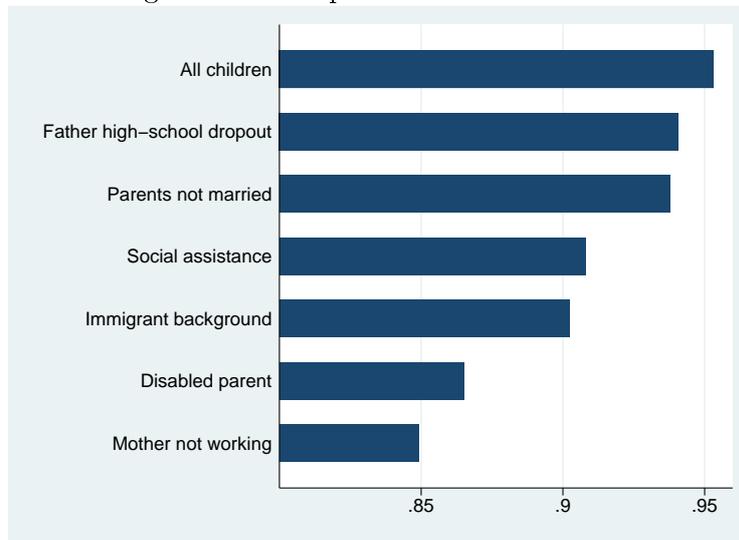
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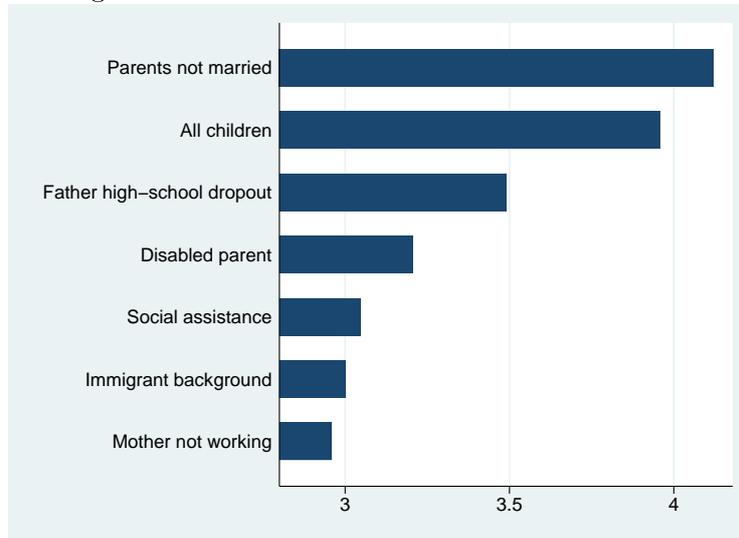
Tables and Figures

Figure 1: Participation Rates of Children



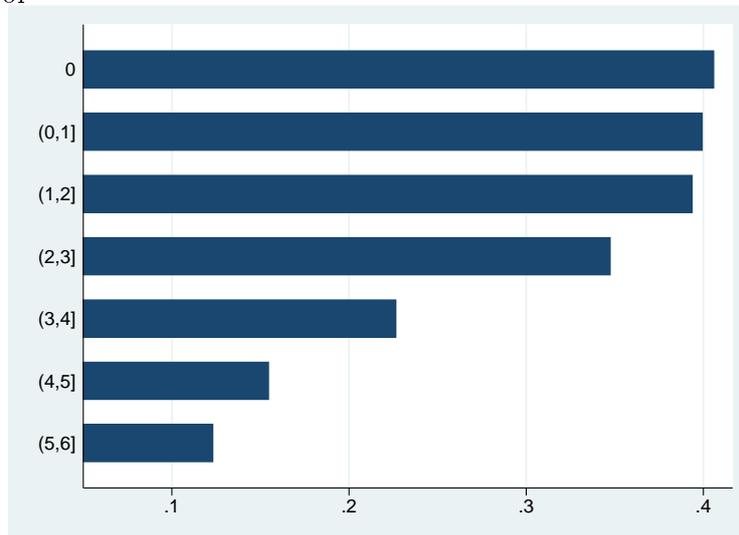
Fraction of children in cohorts 2004-2007 living in Oslo at the beginning of the calendar year they start school (in August), who had been to child care in Oslo before school start. Participation rates within given groups.

Figure 2: Years in Child Care before School Start



Years in child care before school start for children in cohorts 2004-2007 living in Oslo at the beginning of the calendar year they start school (in August), including only children who had been to child care before school start. Time within given groups.

Figure 3: Years in Child Care and Concerningly Low Score in Norwegian in School



Fraction of children in cohorts 2004-2007 living in Oslo at the beginning of the calendar year they start school (in August), who score concerningly low on a test in Norwegian in first grade. Fractions given by number of years in child care in Oslo before school start.

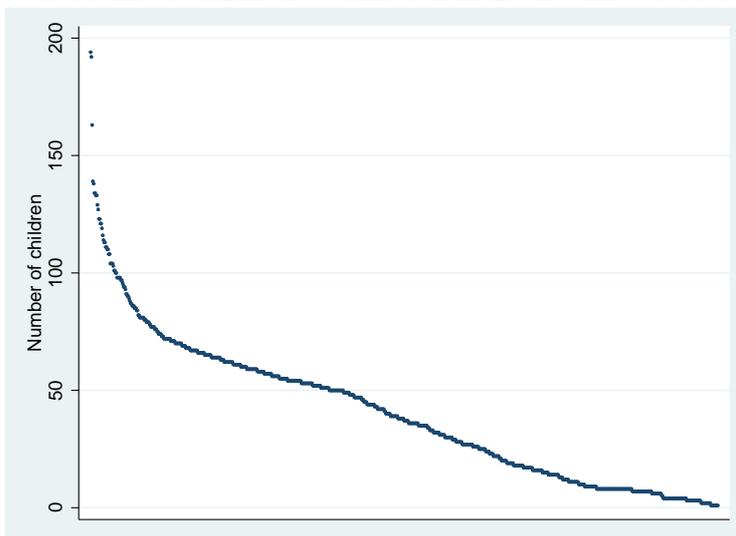
Table 1: Concerningly Low Score in Norwegian in School

	Coefficient	(St.Err.)	N
All children ^a	-0.07**	(0.002)	22 911
Immigrant background	-0.04**	(0.004)	7 570
Mother not working	-0.05**	(0.005)	4 778
Parents not married	-0.06**	(0.004)	7 368
Father high-school dropout	-0.06**	(0.004)	5 763
Social assistance	-0.05**	(0.007)	2 227
Disabled parent	-0.07**	(0.015)	462

Regression results for the association between years in child care and the likelihood of obtaining a concerningly low test score in Norwegian in first grade. Each line represents the results from a separate (linear) regression (no controls unless otherwise noted). Sample of children in cohorts 2004-2007 who lived in Oslo at the beginning of the calendar year they turned 6. * and ** indicate significance at the 5 and 1 percent level (two-sided t-test).

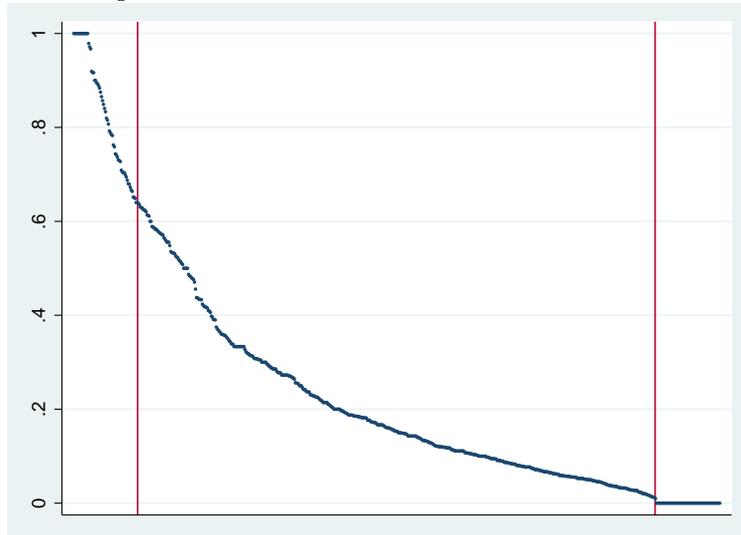
^aInstead of running separate regressions within each socioeconomic category, in this regression we have included the socioeconomic categories as control variables (without interactions).

Figure 4: Number of Enrolled Children in Each Child Care Center



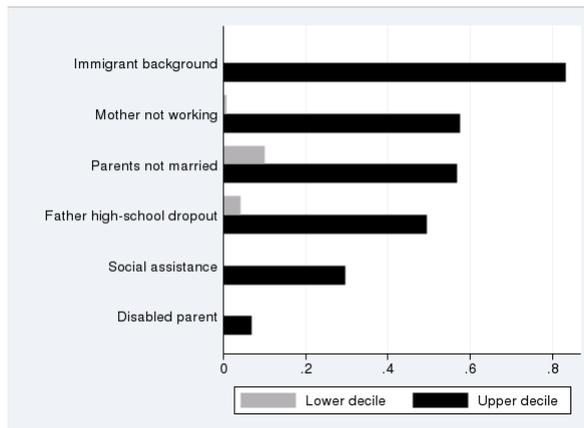
Each point represents one child care center, and the 805 centers are ordered by their number of enrolled children in 2011.

Figure 5: Distribution of Child Care Centers by Enrolled Children with Immigrant Background



Each point represents one child care center, and the 653 centers are ordered by the share of children with immigrant background that are enrolled. Centers with less than 10 children excluded.

Figure 6: Family Background Inequality for Enrolled Children Across Child Care Centers



Share of children with a certain background in the lower and upper decile (of that certain characteristic) of child care centers (in 2011).

Table 2: Segregation Indexes for Enrolled Children in Child Care Centers

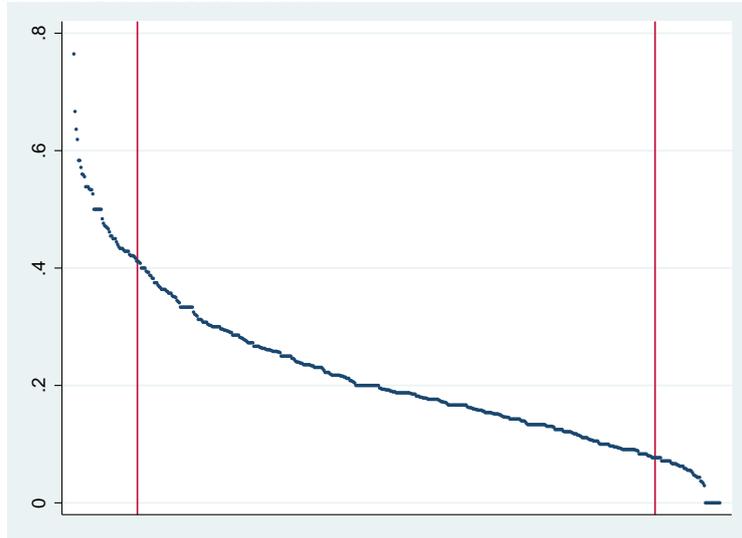
Disadvantaged Group	D-index	Gini-index	S-index	R-index
Immigrant background	0.51	0.67	0.48	1.17
Mother not working	0.36	0.50	0.30	1.05
Parents not married	0.21	0.30	0.38	1.04
Father high-school dropout	0.29	0.40	0.28	1.04
Social assistance	0.47	0.63	0.17	1.01
Disabled parent	0.59	0.72	0.04	1.00

Segregation Within City Districts

Disadvantaged Group	D-index	Gini-index	S-index	R-index
Immigrant background	0.38	0.50	0.37	1.18
Mother not working	0.20	0.25	0.21	1.04
Parents not married	0.12	0.17	0.36	1.04
Father high-school dropout	0.18	0.23	0.24	1.03
Social assistance	0.30	0.37	0.10	1.01
Disabled parent	0.19	0.25	0.01	1.00

The four segregation indexes; see Section 4.1 for details. Lower panel is the average of the index calculated within each of the 15 city districts of Oslo.

Figure 7: Fraction of Children in Child Care Center with Concerningly Low Score on Test in First Grade



Each point represents one child care center, and the 611 centers are ordered by their fraction of children (in 2011) with a concerning low test score in Norwegian in first grade (in 2010, 2011 or 2012). Centers with less than 10 children excluded.

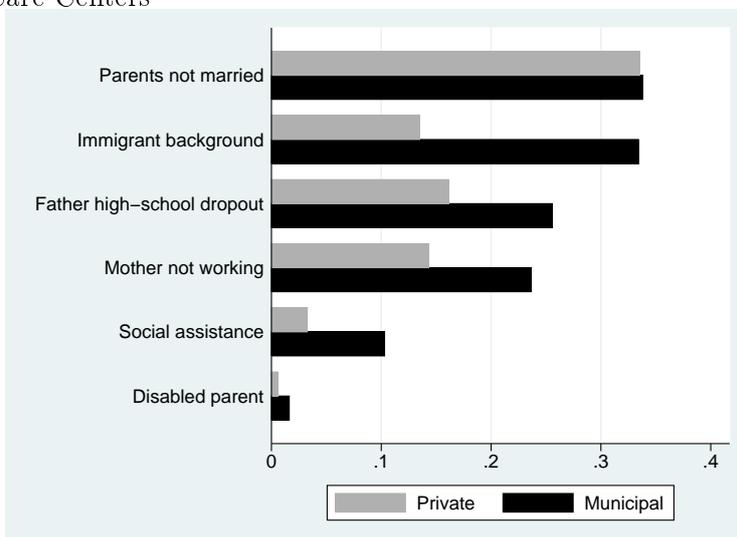
Table 3: Correlation Between Rough Indicators of Center Quality and Family Background

Indicator of center quality:	Share of male employees	College educated employees per child	Share of non-immigrant employees	Share with non-concerning score in first grade ^a
Indicator of family background:				
Immigrant background	-0.26*	-0.23*	-0.29*	-0.55*
Mother not working	-0.13*	-0.11*	-0.27*	-0.54*
Parents not married	0.19*	0.17*	0.04	0.17*
Father high-school dropout	-0.19*	-0.17*	-0.26*	-0.47*
Social assistance	-0.08	-0.08	-0.28*	-0.42*
Disabled parent	-0.12*	-0.01	-0.09	-0.21*

Bivariate correlations (Pearson) across child care centers in the *third analytic sample*. * indicates significance at the 5 percent level.

^aShare of children in the center without concerning low score in Norwegian in first grade, based on the 611 centers in the *second analytic sample* for which we had observations on children's test scores in first grade.

Figure 8: Family Background Differences Across Private and Municipal Child Care Centers



Share of children with a certain family background enrolled in municipal vs private child care centers.

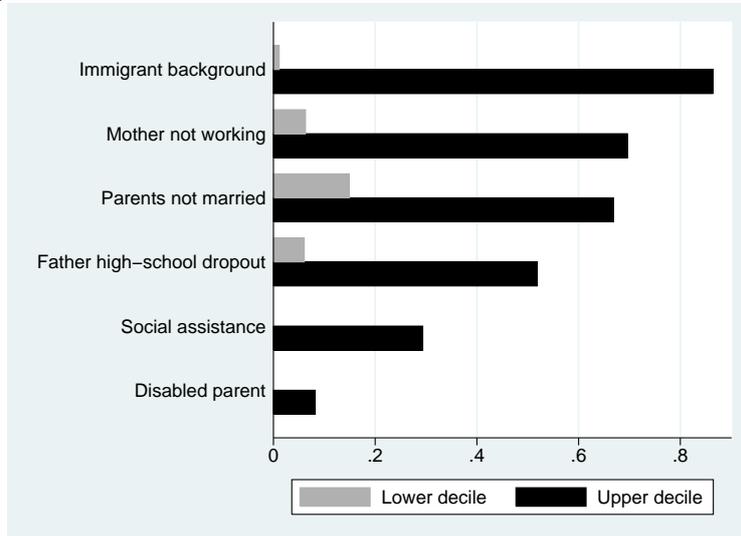
Table 4: Differences Across Private and Municipal Child Care Centers

	Mean		Difference
	Municipal	Private	
Family income	921 087	1 231 602	-310 515**
Boy	.52	.50	.02*
Concerningly low score			
Norwegian	.25	.18	.07**
Maths	.14	.09	.05**
Number of children	57	40	17**
Immigrant background	.33	.14	.20**
Fathers' yrs of educ	12.7	14.3	-1.6**

Number of centers 366 287

For 2011. Difference over centers (centers are unit of analysis). * and ** indicate significance at the 5 and 1 percent level (two-sided t-test).

Figure 9: Family Background Differences Across Applicants to Child Care Centers



Share of children with a certain family background applying for a slot, lowest vs highest decile.

Table 5: Segregation Indexes for Applicants to Child Care Centers

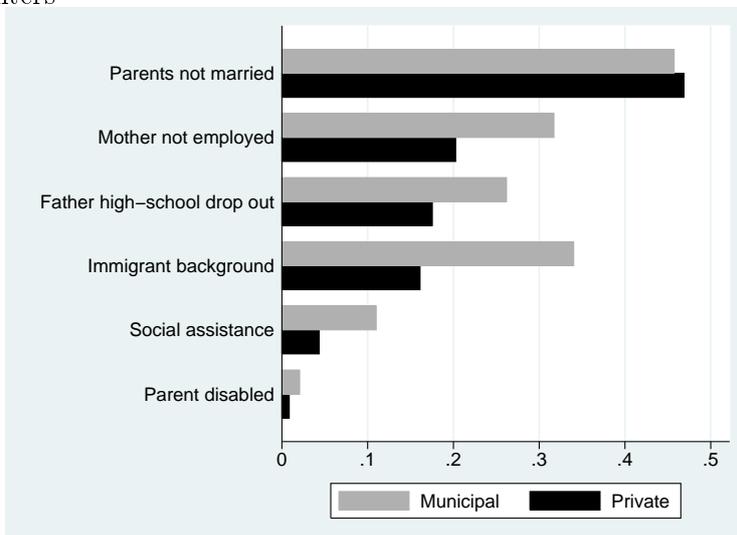
Disadvantaged Group	D-index	Gini-index	S-index	R-index
Immigrant background	0.51	0.66	0.51	1.21
Mother not working	0.32	0.44	0.37	1.08
Parents not married	0.22	0.30	0.50	1.06
Father high-school dropout	0.26	0.36	0.30	1.04
Social assistance	0.41	0.56	0.17	1.02
Disabled parent	0.45	0.60	0.04	1.00

Segregation within city districts

Disadvantaged Group	D-index	Gini-index	S-index	R-index
Immigrant background	0.38	0.59	0.40	1.22
Mother not working	0.20	0.25	0.30	1.08
Parents not married	0.16	0.21	0.48	1.06
Father high-school dropout	0.20	0.26	0.27	1.03
Social assistance	0.25	0.32	0.11	1.02
Disabled parent	0.21	0.26	0.02	1.00

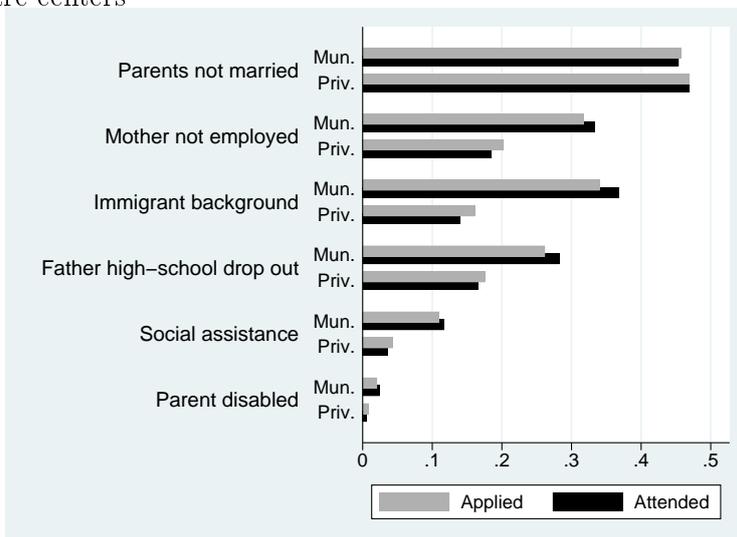
The four segregation indexes; see Section 4.1 for details. Lower panel is the average of the index calculated within each of the 15 city districts of Oslo.

Figure 10: Share of children who applied for a slot in public vs private child care centers



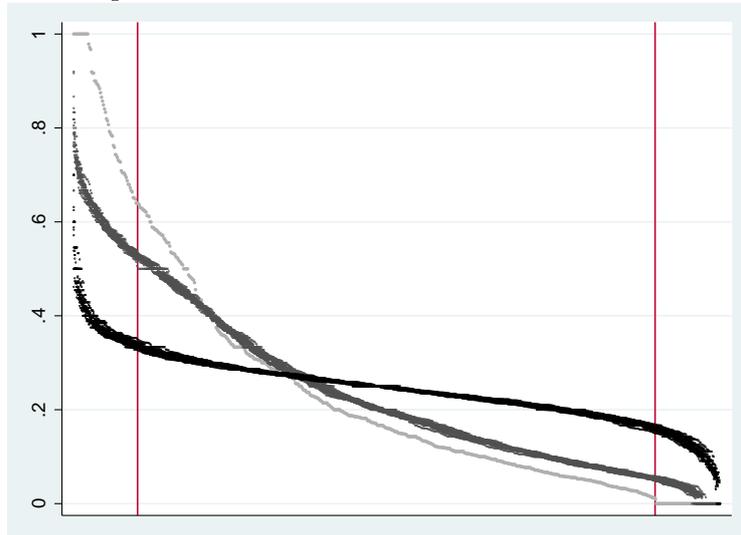
Share of children with a certain family background applying for a slot in municipal vs private child care centers.

Figure 11: Share of children who applied for and attended public vs private child care centers



Share of children with a certain family background applying for/attending a municipal vs private child care center (fourth analytic sample).

Figure 12: Simulation of a random draw: Enrollment of children with an immigrant background



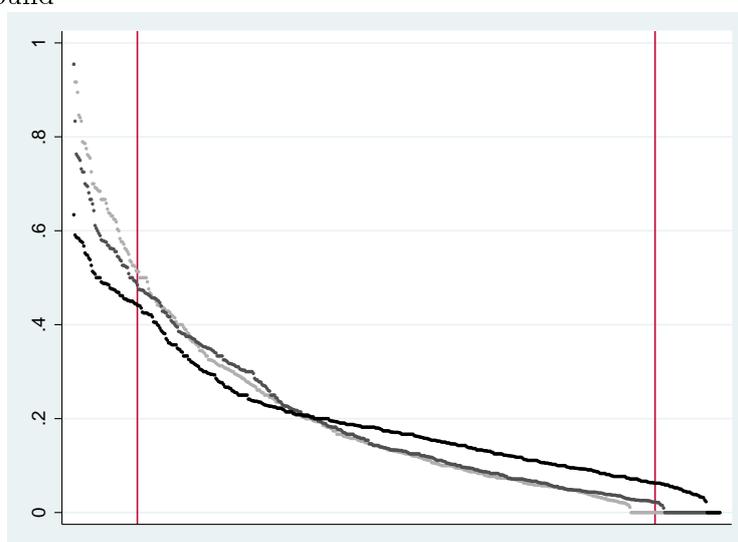
Light gray dots is observed differences in share of children from immigrant families across centers (as given in Figure 5); dark grey area displays the same differences resulting from us randomly assigning the children to centers within the child's city district of residence; whereas the black area displays the same differences resulting from us randomly assigning the children to any center in Oslo.

Table 6: Drop in Segregation Indexes in Simulation

	D-index	Gini-index	S-index	R-index
Actual Center	0.47	0.63	0.39	1.11
Simulated Center	0.32	0.44	0.29	1.04

The four segregation indexes on immigrant background; see Section 4.1 for details. The simulation (based on the *third analytic sample*) let children switch centers to minimize segregation (on immigrant background), but children are only allowed to switch center (starting with their actual center) if travel distance from home to center declines or becomes no more than 500 meters for any of them.

Figure 13: Simulation of a reassignment of children: Impacts of minimizing travel distance from home to center and share of children with an immigrant background



Light gray dots is observed differences in share of children from immigrant families across centers (i.e. *third analytic sample* which is a subset of centers in Figure 5); dark grey dots display the same difference resulting from simulation where pairs of children switch center if doing so reduces the travel distance from home for each of them; whereas the black dots display the same differences resulting from simulation where pairs of children switch center if doing so reduces the difference between the share of children with immigrant background in the two centers *given* that the distance from home to the center declines or becomes no more than 500 meter for either of them.

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