An Up-to-Date Joint Labor Supply and Child Care Choice Model

Thor O. Thoresen and Trine E. Vattø

Statistisk sentralbyrå
Statistics Norway

An Up-to-Date Joint Labor Supply and Child Care Choice Model*

Thor O. Thoresen† and Trine E. Vattø‡

Abstract

Norwegian parents of preschool children base their care choices on a completely different choice set from their predecessor. Now there is essentially only one type of nonparental care – center-based care – and on the parental side fathers take a more pivotal role in early childhood care. In the present paper we develop and estimate a joint labor supply and child care choice model that takes account of these new characteristics, on the assumption that this model points to current and future modeling directions for several other economies too. Estimations suggest that the average wage elasticity for mothers is 0.25–0.30.

Keywords: family policy, child care, structural labor supply model
JEL codes: J13, J22, C25

*Financial support from the Ministry of Education and Research is gratefully acknowledged. We thank John Dagsvik, Zhiyang Jia, Egbert Jongen, Ray Rees, and participants of the workshop on Family Economics and Fiscal Policy (Oslo, April, 2017), Skatteforum 2017 (Gran, June, 2017) and seminar at CPB (The Hague, June, 2018) for comments on an earlier draft of this paper. We are also indebted to two anonymous reviewers for their comments and suggestions.

†Research Department, Statistics Norway, and Oslo Fiscal Studies (Department of Economics, University of Oslo), e-mail address: thor.olav.thoresen@ssb.no

‡Research Department, Statistics Norway. E-mail address: trine.vatto@ssb.no

1 Introduction

Norwegian family policy has gone through major changes in the last couple of decades, which implies that the conditions under which families with preschool children make their choices have been substantially altered. Most importantly, we have witnessed a massive expansion in the coverage rate of center-based care, in combination with considerable reductions in parental fees. Norwegian policy-makers formalized this through the so-called "child care compromise" (approved by parliament in spring 2003), which was a plan for eliminating queues at child care centers in combination with a maximum monthly parental fee. By 2009, the policy initiative had resulted in a market for center-based care through which the government could guarantee all families of children older than 1 year access to a slot at a center. Further, the maximum payment for 2017 is set at NOK 2,730 ($330 and €290)[1] per month, which means that less than 25 percent of the costs are paid by the parents. As expected, this combination has effectively terminated other nonparental care alternatives, such as care by paid childminders.

At the same time, and perhaps not entirely unrelated to the policy changes,[2] parents' preferences appear to have shifted towards a more gender-equal division of parental care. There are various indications of this. Firstly, the gap between mothers' and fathers' working hours has been clearly reduced over the last few decades (Statistics Norway, 2018). Secondly, evidence presented in Kitterød and Rønsen (2013) suggests that Norwegian fathers are playing a greater part in the physical and emotional care of their children than before. For example, fathers with small children spent much more time on household work in 2010 than in 2000. This happens in a society in which, according to Hook and Wolfe (2012), the involvement of fathers already (around the turn of the century) was substantially higher than in Britain, Germany and the U.S. Thus, we assert that neglecting fathers as alternatives to nonparental care when modeling parents' decisions can no longer be justified.

These characteristics form the background for the development of a new joint labor supply and child care choice model[3] that we believe represents a modeling option for several other economies too. In the new model, the involvement of fathers in care is taken into account by letting the choice of nonparental child care be affected by the working time of both mothers and fathers. This means that we leave the standard approach of treating only mothers' care as the alternative to paid care.[4]

[1] Average exchange rates for 2017.

[2] See Ellingsæter (2003) on the existence and implications of family policy feedback effects.

[3] See recent reviews of joint labor supply and child care choice literature in Blau and Currie (2006), Kalb (2009), Del Boca (2015), and Morrissey (2017).

[4] Blundell et al. (2000), Doiron and Kalb (2005) and Mumford et al. (2018) are other studies

When both parents' working hours are endogenously determined, and when there is flexibility in terms of work schedules, parents' working hours may not overlap, and there is no longer necessarily a fixed link between working time and the child's time in care outside the home.[5] The so-called "fixed link assumption" between working hours and hours in nonparental care (Ilmakunnas, 1993), which is often applied in the joint labor supply and child care choice literature, can then be abandoned. Along this line, ultimately, parents may choose to work shifts that enable them to handle two (full-time) jobs in combination with little or no nonparental care.[6] We assert that a realistic decision model should allow for the possibility that parents reduce the children's time in nonparental care by choosing jobs with non-overlapping working hours.

Time inputs as a determinant of care quality is a common approach in the literature on structural joint labor supply and child care choice;[7] see for example Blau and Robins (1988), Michalopoulos et al. (1992), Ribar (1995), Wrohlich (2011), Apps et al. (2016), and Gong and Breunig (2017).[8] Given that the present institutional setting only involves one type of nonparental care, it follows that a mix of parental time and time in center-based care is a key factor of care quality. These inputs are imperfect substitutes, and we believe that perceived relationships between care options and outcomes, such as cognitive and non-cognitive skills,[9] are important for parents' perception of preferred care combinations.

Like Lokshin (2004), Kornstad and Thoresen (2007), Tekin (2007), Apps et al. (2016), and Gong and Breunig (2017), we employ a discrete choice framework in the estimation of the model. We exploit Norwegian micro data from a survey of families' child care preferences and work choices, obtained from the Child Care Survey 2010 (Wilhelmsen and Löfgren, 2011; Moafi and Bjørkli, 2011). The survey includes detailed information on family composition, parents' main activity and labor market status, socioeconomic background, and mode and intensity of child care. Information on income (wages, transfers, etc.) and taxation are obtained from

that include male labor supply in the decision-making process.

[5]Non-overlapping working hours might explain the finding that reported hours in nonparental care are often fewer than the time each parent spends at work (Blix and Gulbrandsen, 1993).

[6]Implications of nonstandard work for care choices are discussed by Kimmel and Powell (2006) and Connelly and Kimmel (2007).

[7]Another line of research accounts for child care by including the fee enter in the budget constraint of a standard labor supply model; see Blundell et al. (2000) and Doiron and Kalb (2005).

[8]Several studies, such as Blau and Robins (1988) and Powell (2002), seek to account for the existence of a unpaid nonparental care alternative, such as care by grandparents. As we explain later, we argue that this care option can be discounted in the present context. See also Blau and Hagy (1998) on choices between specific modes of child care.

[9]As discussed by Todd and Wolpin (2003), Bernal (2008), Cunha et al. (2010), Bernal and Keane (2011), Del Boca et al. (2014), Black et al. (2014), and Havnes and Mogstad (2015).

the Income and Wealth Statistics for Households (Statistics Norway, 2017), and linked to the survey by using unique personal identification numbers. The estimated model is in turn applied to simulate responses to policy changes on labor supply and demand for nonparental care. Effects of several policy changes are discussed, such as an increase in the parental fee and the abolishment of the home care allowance (cash-for-care) schedule.

We shall argue that our model represents a more realistic depiction of choices of parents of preschool children in the Norwegian context by, to some extent, contrasting it to estimation results and performance of a conventional model, i.e., a model where fathers' labor supply is exogenous. A detailed exposition of the specification and estimation results of the alternative model can be found in Thoresen and Vattø (2018). The specification of the conventional model is kept as close as possible to our suggested up-to-date model, except for the endogenous labor supply of the fathers and the possibility for parents to choose non-overlapping working hours.

Even though the Nordic countries seem to take the lead with respect to equal parenting and support for center-based care (Datta Gupta et al., 2008), we believe that our modeling framework is relevant for other economies too, and increasingly in the years to come. For example, in Germany (since 2013) every family has a legal claim to a slot in a publicly subsidized child care institution, and the parental leave scheme includes a "daddy quota" (Geyer et al., 2015; Müller and Wrohlich, 2016), which we believe signals ambitions with respect to gender equality. We also note that subsidies to child care centers recently have been increased in several other countries, as in Canada (Quebec) (Baker et al., 2008), France (Givord and Marbot, 2015), the Netherlands (Bettendorf et al., 2015), and Spain (Nollenberger and Rodríguez-Planas, 2015). In the US, even though child care subsidy programs are very different from typical European programs, and public provision of center-based care is the exception rather than the rule (Blau and Tekin, 2007), one sees signs of a more active policy. When the Child Care and Development Block Grant was reauthorized in 2014 (for the first time since 1996), the goals of the program was adjusted, asserting that a main ambition is to strengthen the focus on the quality of care, which implies more center-based care (Krafft et al., 2017).

The paper proceeds in the following way. In Section 2 we refer to empirical evidence to substantiate our two main assertions behind our modeling framework: the increased coverage of center-based care and fathers taking a more pivotal role in the parental caregiving. Section 3 presents a discrete choice model that builds on the new choice set of Norwegian parents. In Section 4 we present the data and the estimation results, whereas the results of an out-of-sample model validation are

presented in Section 5. In Section 6 we discuss the model properties further by using the model in various policy simulations, including providing elasticity estimates. Section 7 concludes.

2 Changes in choice sets and preferences

Norwegian family policy has been an arena of substantial political controversy for the last couple of decades. In particular, the cash-for-care reform, which was introduced in 1998, generated a heated debate on the rationalization and directions of family policies. The reform introduced monetary compensation for *not* using subsidized care at child care centers, for parents of children aged 1 or 2. The three main aims of the reform were that parents should be provided with more time to care for their own children, to give families freedom of choice of care provider, and to equalize public support to families, independently of care option (Ellingsæter, 2003). The support equalization argument was strengthened by the fact that access to care in centers at that time (late nineties) was severely limited.

However, since then, there has been a massive expansion in the child care center participation rate in Norway, particularly for children under 3 years of age; see Figure 1. Policy-makers formalized their efforts to increase the supply of center-based care through the so-called "child care compromise", approved by parliament in spring 2003. The agreement included a plan for eliminating queues for care at child care centers, and introduced a substantial reduction in child care fees, regulated by a maximum monthly parental pay. For 2017, the maximum monthly fee is set at NOK 2,730 ($330, €290), which implies that the parental fee covers approximately 14 percent of the costs for children under 3 and approximately 25 percent for children aged 3–5 (Lunder, 2015).[10] It follows that gross child care fees, measured as a percentage of the average wage, are very low in Norway compared to most other countries (OECD, 2014).

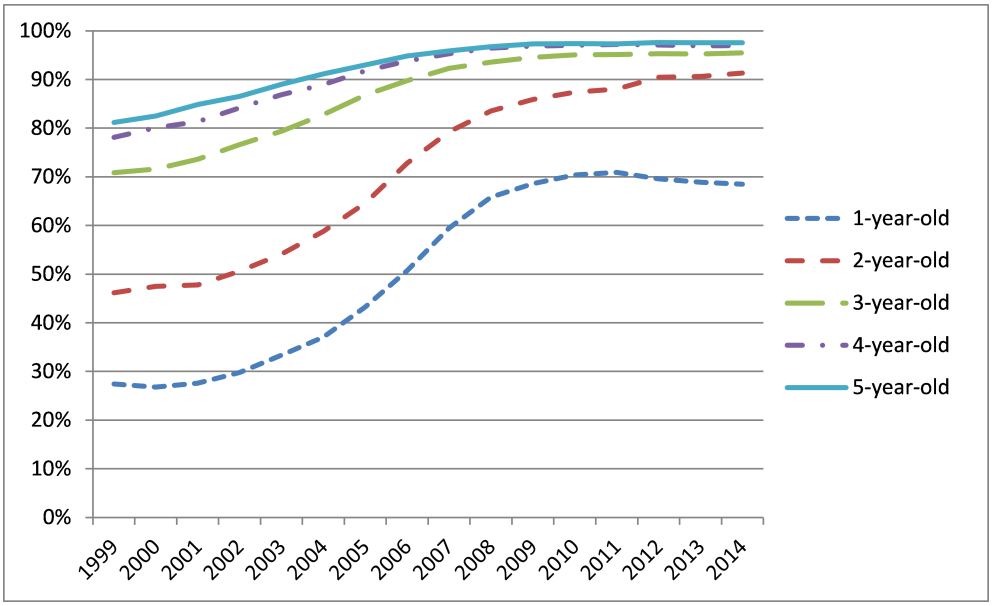
Figure 1 shows that participation in center-based care is close to 100 percent for children aged 3–5, and the majority of the youngest children (1- and 2-year-old) also attend child care centers.[11] These developments have implications for the design of modeling tools to guide the policy-making in this field.[12] Unpaid care alternatives

[10]The cost difference reflects the fact that care for small children involves a higher staff-to-child ratio.

[11]Parents are usually on paid parental leave until the child is 1 year. Note also that the home care allowance is still in place, but only for parents of children that are 1 year. At the time of the introduction of this scheme (in 1998), the plan was to let the support be equal to the child care subsidies, but that is currently not the case. In 2017, parents who do not use center-based care receive NOK 7,500 ($910, €800) per month for the 1-year-old child.

[12]For example, the model presented in Kornstad and Thoresen (2007), with two types of

Figure 1. Share of children (1–5) in center-based care, 1999–2014



Notes. The data source is Kindergarten Statistics Statistics Norway (2016), which is based on "Annual reports for kindergartens as of 15 December". All approved child care centers under the Day Care Institutions Act that receive subsidies are in the sample.

(for working parents), typically care by grandparents or other relatives, are not important in the Norwegian setting; this is also reflected in the data utilized in the present study (from 2010).[13]

With respect to the parental part of the care, we instead suggest that the choice set should be expanded, now letting care by fathers be an alternative. We argue that a model without any time input from fathers is misleading in the present Norwegian context. Firstly, the working pattern of Norwegian mothers is moving closer to the labor output of their male counterparts (Statistics Norway, 2018). This has, according to Miranda (2011), contributed to less difference in unpaid work across genders. Secondly, Hook and Wolfe (2012) find that around the turn of the century, Norwegian males took a greater role in the physical and emotional care of their children, and had more egalitarian relationships with their partners than fathers in other countries. They can therefore be described as examples of "new fathers", to use the terminology of Hook and Wolfe.[14] Moreover, according to Kitterød and

nonparental care and a focus on choice set restrictions (because of queues in the market for center-based care), obviously does not provide a good description of the decision-making of Norwegian families any longer.

[13]Only 0.4 percent of children aged 1–5 are cared for by relatives (Moafi and Bjørkli, 2011).

[14]The central role of Norwegian fathers in caregiving is also reflected by the so-called "daddy quota" of the parental leave scheme. The parental leave scheme is gender neutral, in the sense that the schedule allots the minimum weeks to each parent: for 2017, it says that out of 49 weeks (full coverage), each parent's share is at least 10 weeks; otherwise families lose the weeks. It is this

Rønsen (2013) this process is continuing: Norwegian fathers are more involved in child care in 2010 than in 2000.[15] This is also supported by the evidence reported in Miranda (2011), showing that the gap in hours of unpaid work between males and females has been reduced in the period from 1998 to 2009.

We interpret the pattern seen in Figure 2 and in Table 1 as corroborative evidence of the importance of Norwegian fathers as caregivers. First, Figure 2 shows that there is rather strong dependency between mothers' employment and the use of nonparental care, but most importantly, given the present context, we also see a relationship between fathers' working hours and the use of center-based care. Although there are relatively few males in the nonparticipation and part-time alternatives, the figure signifies, for example, an increase in the use of nonparental care (more full-time care) by the family when fathers move from part-time to full-time work. Further, in Figure 2 (panels to the right) we show how shift work is related to the use of center-based care for mothers and fathers, respectively.[16] As expected, we see that parents with nonstandard work are less inclined to have their children in full-time care, and again we observe a correlation between care choices and the work choices of fathers, although this not as clear as for mothers.

Next, in Table 1 we further explore how fathers' working hours relate to non-parental care options when conditioned on their partners' working hours. In families where mothers work (part-time, full-time or overtime) despite the fact that the family makes no use or less than full-time use of center-based care, we see that fathers work less and have more jobs with nonstandard working hours, compared to the case when the children are in full-time center-based care.[17] We read this as indications of several fathers being actively involved in caregiving by parents. As we soon will return to, in Section 3, we allow for parents reducing children's time outside home by choosing non-overlapping working hours – a line of reasoning which is reinforced by assigning a role to the (intentionally) caregiving father. Alternatively, one may see the pattern as revealed by Table 1 if fathers unintentionally are involved in care because, for example, they face constraints in the labor market. In this case, given an expectation that access to employment is a particular challenge for the low educated, one would expect to see less education and lower wages among the fathers

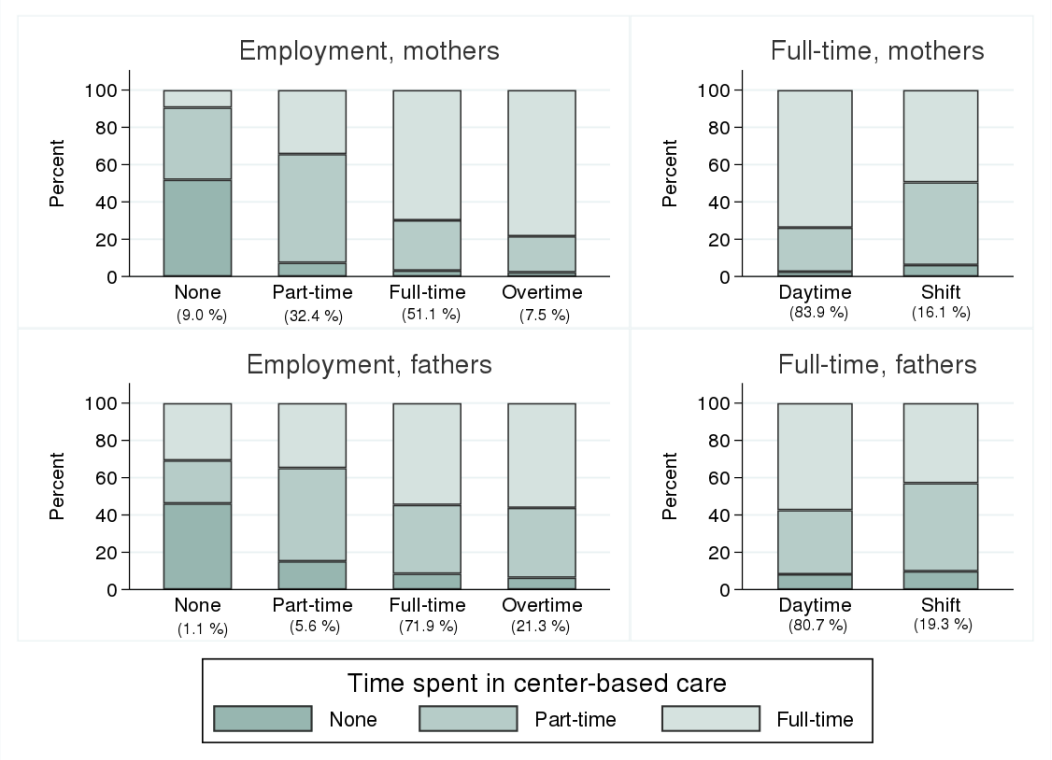
minimum share that is often referred to as the "daddy quota".

[15] Also, one may expect that policy changes themselves have contributed to this – for example, that the introduction of the father's quota in the parental leave scheme could have influenced attitudes. However, according to Cools et al. (2015) no such traces can be found in data.

[16] Note that shift work is defined as work outside weekday hours between 6am to 6pm.

[17] The figures give support to paternal reduction in working hours when there is no use of center-based care, whereas part-time care seems to go together with more shift work.

Figure 2. Observed relationships between employment of mothers and fathers and the use of center-based care



Notes. Own calculations based on a sample (further described in Section 4) of households participating in the Child Care Survey 2010 (Wilhelmsen and Löfgren, 2011; Moafi and Bjørkli, 2011). The allocation to different employment categories is based on working hours 0 ("None"), 1–34 ("Part-time"), 35–41 ("Full-time"), and 41+ ("Overtime"). The distinction between daytime work and shift work is based on the latter category including respondents with work outside the standard weekday hours between 6am to 6pm. Hours in the different care categories are 0 ("None"), 11–35 ("Part-time"), and 36+ ("Full-time").

involved in the child care. However, we see no signs of such patterns in the data.[18]

We accordingly suggest that an up-to-date joint labor supply and child care choice model for the decision-making of Norwegian couples should let both parents' working hours be endogenously determined, jointly with care choice. As both parents contribute to the parental care, we loosen the relationship between the children's time in child care and parents' working hours, the so-called fixed link assumption (Ilmakunnas, 1993). In the next section we probe deeper into the specification of the model.

[18]For example, when allowing different combinations of care choice and fathers working hours to be explained by wage and education in regressions.

Table 1. Labor market choices of fathers for different labor market choices of their partners and family care choices

		Center-based care		
Employment, mothers	Employment, fathers	None	Part-time	Full-time
None	Avg. working hours	38.7	39.4	38.0
	Share of shift work	0.27	0.37	0.20
	Observations	55	41	10
Part-time	Avg. working hours	33.4	39.1	39.1
	Share of shift work	0.18	0.27	0.21
	Observations	28	222	131
Full-time	Avg. working hours	33.8	39.5	39.8
	Share of shift work	0.32	0.31	0.19
	Observations	19	162	420
Overtime	Avg. working hours	20.0	42.4	42.9
	Share of shift work	0.50	0.29	0.14
	Observations	2	17	69
Daytime	Avg. working hours	35.6	39.1	40.3
	Share of shift work	0.29	0.24	0.18
	Observations	80	305	531
Shift	Avg. working hours	37.6	40.1	38.5
	Share of shift work	0.17	0.40	0.26
	Observations	24	137	99

Notes. Own calculations based on sample (described in Section 4) of households participating in the Child Care Survey 2010 (Wilhelmsen and Löfgren, 2011; Moafi and Bjørkli, 2011). The allocation into different employment categories is based on working hours 0 ("None"), 1–34 ("Part-time"), 35–41 ("Full-time"), and above 41+ ("Overtime"). The distinction between daytime work and shift work is based on the latter category including respondents with work outside the standard weekday hours between 6am to 6pm. Hours in the different care categories are 0 ("None"), 11–35 ("Part-time"), and 36+ ("Full-time").

3 A decision model for families with preschoolers

3.1 Discrete choice framework

In the following we provide further details of our two-parent model of joint labor supply and child care choice. The model is a unitary household model[19] based on a discrete choice framework, influenced by several studies using the discrete choice formulation both in analysis of standard labor supply (Dagsvik, 1994; Aaberge et al., 1995; van Soest, 1995; Dagsvik and Strøm, 2006; Dagsvik et al., 2014; Dagsvik and Jia, 2016) and in joint labor supply and child care choice setting (Kornstad and Thoresen, 2007; Apps et al., 2016; Gong and Breunig, 2017).

We depart from a modeling approach that shares similarities with Kornstad and Thoresen (2007), where parents choose among job and child care alternatives. Each job opportunity is characterized by a whole range of latent non-pecuniary attributes, reflecting factors related to job satisfaction, in addition to observed variables, such as wages and working hours. Similarly, the opportunities in the market for center-based child care are characterized by fees and opening hours and attributes associated with quality of care. However, several attributes of both jobs and care alternatives are unobserved by the researcher.[20]

We argue that parents' choice of labor supply and child care realistically can be viewed as a discrete choice problem, where the choice is made from a set of combinations of jobs in the labor market and slots in child care centers. Let $z\,(z = 1, 2, ..)$ index the (triple) combinations of child care alternative and job pairs (for mother and father). Each combination has a set of observable characteristics given by (h_m, h_f, s_m, s_f, q), where h_m and h_f denote hours of work for mother and father, respectively, and q the hours spent in nonparental child care. Furthermore, let s_m and s_f be dummy variables which indicate whether the jobs are shift jobs or ordinary day time jobs; i.e., $s_k, k = m, f$ is equal to 1 if the job considered is a shift job, and zero otherwise. It is assumed that each family has preferences for both observed and unobserved characteristics of the jobs and child care centers, in addition to consumption. The household makes choices conditioned on a number of observable and unobservable restrictions. Before considering how this framework accounts for unobservable constraints, let us first define the economic budget constraint. Consumption for a given job and child care combination is defined by disposable income, $C = f(w_m h_m, w_f h_f, p, I)$, where $f(.)$ is a function which transforms income

[19] An alternative, accentuated by considering the behavior of both parents, would be to adopt a collective model approach, as seen in Apps and Rees (1988).

[20] In fact, the extent to which the agents themselves have good perceptions of care quality may be unclear.

from work, $w_k h_k \, (k = m, f)$, costs of child care, p, and nonlabor income, I, into disposable income, given that w_m and w_f are the offered wage rates for the mother and father, respectively.

p is the fee for a child care slot which we do not allow to vary according to hours of care, q. Although the definition of part-time care in Figure 2 and in Table 1 includes care in the interval 11–35 hours, the mass center is at the high end of the interval, where we find families paying the full-time fee for a less than full-time service. As we allow the families to face three discrete hours of care alternatives, $q = [0, 30, 40]$, the price is the same for 30 and 40 hours of care. Note that (as seen in Section 1) the fee is low, the maximum payment for 2017 is 2,730 Norwegian kroner ($330 and €290). In addition, child care expenses are deductible, which means (in the year 2017) that the government pays 25 percent of the costs, limited by an upper expenditure threshold.

Furthermore, choices are restricted by mother's and father's time constraints. We cannot distinguish between parents' "real leisure" time and the time they spend with their children – recall that we only observe working hours and hours in nonparental care. However, we assume that the preference for leisure is highly influenced by the preference for spending time with children. Given that both parents are considered to be taking care of the child, there is not necessarily a fixed link (Ilmakunnas, 1993) between the parents' working hours and the child's time in nonparental care. Parents can (at least to some extent) reduce children's time outside the home by exploiting working hour flexibility and working non-overlapping hours. The time restriction is further loosened by allowing for parents choosing jobs with nonstandard working hours (shift work). Ultimately, then, parents may be able to handle two (full-time) jobs in combination with little or no nonparental care.

It follows from this that hours of parental care and hours in center-based care are viewed as key determinants of overall care quality. Using time inputs as determinants of care quality is a common approach in the structural joint labor supply and child care choice literature (Blau and Robins, 1988; Michalopoulos et al., 1992; Ribar, 1995; Wrohlich, 2011; Apps et al., 2016; Gong and Breunig, 2017). Since we argue that there is only one type of nonparental care, an essential part of the choice problem of the parents involves finding the preferred mix between own care and center-based care.

Next, we take into account that parents face a number of restrictions on their choice among the triples of jobs and child care center slots. These restrictions may vary across households. Let $B(h_m, h_f, s_m, s_f, q)$ be the set of triples, z, with working hours, job type (shift work or not) and care hours equal to (h_m, h_f, s_m, s_f, q) that are

available to the household, and let $b(h_m, h_f, s_m, s_f, q)$ be the number of triples in the choice set $B(h_m, h_f, s_m, s_f, q)$. These are not observable, but we follow Dagsvik et al. (2014) and Dagsvik and Jia (2016), who discuss how the probability of an observed combination of hours of work can be specified in the absence of detailed information about the latent non-pecuniary aspects of the alternatives in $B(h_m, h_f, s_m, s_f, q)$.

The utility function is assumed to have the following structure

$$U(C, h_m, h_f, s_m, s_f, q, z) = v(C, h_m, h_f, s_m, s_f, q) + \varepsilon(z), \tag{1}$$

where $v(.)$ is the deterministic part, whereas $\varepsilon(z)$, $z = 1, 2, ...$, are iid random terms with c.d.f. $\exp(-\exp(-x))$. When the economic budget restriction, is taken into account, the utility function can be expressed as

$$\begin{aligned} &\tilde{U}(f(h_m, h_f, s_m, s_f, q, I), h_m, h_f, s_m, s_f, q, z) \\ &= \tilde{v}(f(h_m, h_f, s_m, s_f, q, I), h_m, h_f, s_m, s_f, q) + \varepsilon(z). \end{aligned} \tag{2}$$

It then follows that the probability of the household shall choosing jobs and non-parental care alternatives with corresponding characteristics equal to (h_m, h_f, s_m, s_f, q) is given by

$$P(h_m, h_f, s_m, s_f, q) = \frac{\exp(v(f(.), h_m, h_f, s_m, s_f, q) + \log b(h_m, h_f, s_m, s_f, q))}{\sum_d \sum_j \sum_u \sum_x \sum_y \exp(v(f(.), d, j, u, x, y) + \log b(d, j, u, x, y))}. \tag{3}$$

Note that the choice probability in Equation 3 differs from the standard multinomial logit formulation, for example as in the labor supply model of van Soest (1995), in that the systematic part of the utility function is modified by the term $b(h_m, h_f, s_m, s_f, q)$. As already seen, the term $b(h_m, h_f, s_m, s_f, q)$ accounts for a key feature of the choice problem, namely that the household faces latent choice restrictions and that there are more alternatives with specific observable attributes. For example, in the labor market, there are more jobs characterized by full-time working hours. The specification of b is further explained in the next subsection.

3.2 Econometric specification

In this section we further specify the functional form of preferences, $v(C, h_m, h_f, s_m, s_f, q)$, and opportunities, $b(h_m, h_f, s_m, s_f, q)$. We assume that the systematic part of the utility function, $v(C, h_m, h_f, s_m, s_f, q)$, we assume that it can be separated into four different parts:

$$v(C, h_m, h_f, s_m, s_f, q) = v_1(C) + v_2(h_m, h_f, s_m, s_f) \\ +v_3(q) + v_4(h_m, h_f, s_m, s_f, q). \tag{4}$$

Thus, in addition to consumption, v_1, and leisure (non-work), v_2, we let the "quality of care part" be represented by two components: care in centers, v_3, and an interaction term, v_4, that captures the relationship between center-based care and work (or leisure). The components will be further explained in the following.

When C_0 is a (fixed) subsistence level of consumption, $v_1(C)$, is further specified as

$$v_1(C) = \alpha_0(f(w_m h_m, w_f h_f, p, I) - C_0) + \alpha_1(f(w_m h_m, w_f h_f, p, I) - C_0)^2, \tag{5}$$

where $f(.) = w_m h_m + w_f h_f + I - p - T(w_m h_m, w_f h_f, p, I)$, where T denotes taxation. As already discussed, we do not let fees, p, vary with hours of care (q). Moreover, to simplify, we measure p only for the youngest child. However, child care expenses for older children are taken into account in the budget constraint, under the assumption that the children are in full-time center-based care.[21] The price structure reflects discounts for siblings too. The subsistence level of disposable income, C_0, is entered into the specification of consumption, given by a fixed amount (NOK $60,000\sqrt{2}$), and then normalized by dividing by $10,000\sqrt{2}$.[22]

The empirical literatue on discrete choice of labor supply, see references in Section 3.1, differs with respect to assumptions about wage heterogeneity. For example, Aaberge et al. (1995) let wage rates vary across jobs, but assume that there is no unobserved variation across individuals. In contrast, Dagsvik and Strøm (2006) and Dagsvik et al. (2014) assume that wage variation is due solely to person-specific characteristics. Here, we follow the latter approach, also because the evidence presented in Dagsvik and Jia (2016) provides support for this alternative. Thus, it is assumed that the offered wage rates, w_m and w_f, do not vary across jobs (including between shift and daytime jobs), but only across individuals.

Further, we operationalize the preferences for leisure (or non-market time), $v_2(h_m, h_f, s_m, s_f)$, as

$$v_2(h_m, h_f, s_m, s_f) = \beta_1 \log l_m + \beta_2 \log l_f + \beta_3 \log l_f \log l_m \\ +\beta_4(1 - s_f)(1 - s_m) \log l_f \log l_m, \tag{6}$$

[21] Figure 1 provides support for older children predominantly spending their time in center-based care.

[22] This normalization does not affect results, but helps to achieve convergence in the estimation of the model.

where l_m and l_f are specified by $l_k = \frac{\bar{l}-h_k}{\bar{l}}$, $k = m, f$, given that $\bar{l}$ is the maximum number of hours available, set as 80 hours. In practice, we let the choice set of working hours for both parents consist of four alternatives, $h_k = [0, 20, 37.5, 45]$, $k = m, f$. It follows from Equation 6 that β_1 and β_2 reflect the mother's and father's preference for leisure. Taste modifying characteristics in the specification of preference for leisure are included, for mothers and fathers, such that $\beta_1 = \beta_{10} + \mathbf{X}_{mr}\beta_{1r}$ and $\beta_2 = \beta_{20} + \mathbf{X}_{fr}\beta_{2r}$, where β_{10} and β_{20} are constants and β_{1j} and β_{2j} are vectors of parameters. r denotes the taste modifiers, which include age, immigrant status, an indicator variable of low/high education, and the number of preschool children in the household. β_3 and β_4 measure interactions between the spouses' preferences for leisure, i.e., that there may be additional utility from leisure when the spouse or partner also enjoys a substantial amount of leisure. Note also that we allow for differences in interaction of leisure between spouses, dependent on one of the spouses working shifts (β_3) and both holding jobs with a standard work schedule ($\beta_3 + \beta_4$). Thus, we allow for a possible joint utility of "not working" for the spouses. One reason may simply be that the spouses want to spend time together when taking care of children. This raises the question of whether parents' leisure consumption is a substitute or a complement in the family's demand for care quality, as discussed by Hallberg and Klevmarken (2003), Connelly and Kimmel (2009), and Bloemen and Stancanelli (2014). Both Hallberg and Klevmarken (2003) and Connelly and Kimmel (2009) find evidence of complementarity in parental time use.[23] We return to this issue in Section 6, when we discuss cross-wage elasticity estimates.

The specification of preferences for nonparental care, $v_3(q)$, is based on time spent in center-based care, given by a quadratic function,

$$v_3(q) = (\gamma_{00} + \gamma_{01}age)q + (\gamma_{10} + \gamma_{11}age)q^2, \tag{7}$$

where the choice alternatives in center-based care are given by $q = [0, 30, 40]$, normalized to $[0, 0.75, 1]$. These discretizations are influenced by the observed distributions; see Figure A.1 in the Appendix. We let preferences vary with the age of the child (age), by defining two parameters, $\gamma_0 = \gamma_{00}+\gamma_{01}age$ and $\gamma_1 = \gamma_{10}+\gamma_{11}age$, where γ_{00} and γ_{10} are constants. As most parents prefer a combination of parental and nonparental care, we expect that there are positive and decreasing returns on time spent in centers.

As already discussed, we expect that there is a relationship between parents'

[23]This also relates to the question of bargaining within the household more fundamentally, as discussed by Chiappori (1992), Apps and Rees (1997) and Browning and Gørtz (2012). Here, such complications are ignored.

choice of leisure and their preferences for care quality. To incorporate this element in the modeling framework, an interaction term between preference for leisure and preference for care in centers is specified, given by $v_4(h_m, h_f, s_m, s_f, q)$:

$$\begin{aligned} v_4(h_m, h_f, s_m, s_f, q) = (\delta_{11}\log l_m + \delta_{21}\log l_f + \delta_{31}s_m + \delta_{41}s_f)q \\ +(\delta_{12}\log l_m + \delta_{22}\log l_f + \delta_{32}s_m + \delta_{42}s_f)q^2. \end{aligned} \tag{8}$$

After rearranging and defining $\delta_i = \delta_{i1} + \delta_{i2}q,\ i = \{1, 2, 3, 4\}$, we get

$$v_4(h_m, h_f, s_m, s_f, q) = \delta_1 q\log l_m + \delta_2 q\log l_f + \delta_3 q s_m + \delta_4 q s_f. \tag{9}$$

The present framework thus relates to several studies highlighting the effects of parents' time use in child development. Both Todd and Wolpin (2003) and Bernal (2008) let mothers' time input influence child outcomes. More importantly, given the "gender equal society" point of departure, both mothers and fathers are taken into account in Equation 8. Also in the care production process of Del Boca et al. (2014) *both* parents contribute to the outcome.

Recall that an idiosyncrasy of the present approach is that we also specify and estimate the number of triples in the choice set, $b(h_m, h_f, s_m, s_f, q)$. As $b(.)$ is not observed, it is estimated simultaneously with the systematic part of the utility function. We assume that the choice set is made up of three components:

$$\log\ b(h_m, h_f, s_m, s_f, q) = b_1(h_m, h_f) + b_2(s_m, s_f) + b_3(h_m, h_f, s_m, s_f, q). \tag{10}$$

b_1 accounts for characteristics of the standard job market, b_2 characterizes shift work opportunities, whereas the last term, b_3, is intended to capture restrictions on particular combinations of work and care.

First, we let the number of jobs with full-time working hours ($full$), and the number of options in nonparticipation (no) differ as follows:[24]

$$b_1(h_m, h_f) = \begin{cases} g_{no,k} & if\ h_k = 0,\ k = m, f \\ g_{full,k} & if\ h_k = 37.5,\ k = m, f \\ 0 & else \end{cases} \tag{11}$$

Thus, we open up for differences in the number of possibilities in nonparticipation and in full-time, represented by the latent variables $g_{no,k}$ and $g_{full,k}$, respectively.

[24]Note that it is not perfectly clear what the number of options in the nonparticipation/home care alternative in reality represents. One can not rule out the possibility that the g's may pick up factors which in reality belong to preferences.

Further, we allow the available number of "shift jobs", relative to the number of regular daytime jobs to vary with the individuals' field of education ($edufield$), seen as

$$b_2(s_m, s_f) = \varsigma_1(s_m \times edufield_m) + \varsigma_2(s_f \times edufield_f). \tag{12}$$

There are expected to be relatively more shift work opportunities for some types of educational background. For example, it is well-known that there are more part-time jobs in the health sector than in other areas, which is assumed to be accounted for by the type of education.

Finally, we expect that there are not so many job/care combinations that allow parents to combine two full-time jobs with less than full-time center-based care. The last term of Equation 10, $b_3(h_m, h_f, s_m, s_f, q)$, accounts for this possibility by defining a latent variable, κ, as

$$b_3(h_m, h_f, s_m, s_f, q) = \begin{cases} \kappa & if\ q < \min(h_m, h_f)\ \wedge\ \min(s_m, s_f) = 0 \\ & or\ if\ q = 0\ \wedge\ \frac{h_m + h_f}{2} \geq 30\ \wedge\ \min(s_m, s_f) = 1 \\ 0 & otherwise \end{cases} \tag{13}$$

Thus, κ reflects that there might be limitations with respect to combinations that involve fewer hours in center-based care than parents' working hours (upper line of Equation 13). Further, if at least one parent does shift work, we expect that there are fewer options which allow for full-time work by both parents (or close to full-time: ≥ 30 on average) in combination with no nonparental care (second line of Equation 13).

The separation of effects into preferences and opportunities is based on assumptions and functional form, and we can therefore not rule out the possibility that the opportunity parameters partly reflect (systematic) differences in preferences across choices. Similarly, estimates of preferences may also capture "opportunity patterns" in the economy. However, as long as preferences and opportunities are not affected by the policy changes we study, the simulation results are not likely to be affected by these ambiguities.

4 Estimation results

4.1 Description of data

In the estimation of the model we use data from the Child Care Survey 2010, which maps child care preferences for about 3,000 households (Wilhelmsen and Löfgren, 2011; Moafi and Bjørkli, 2011). The survey includes detailed information on family composition, main activity/labor market status of parents, socioeconomic background, and mode/intensity of child care. Information on reported income (wages, transfers, etc.) and tax payments is obtained from Income and Wealth Statistics for Households (Statistics Norway, 2017), and linked to the Child Care Survey by using personal identification numbers.

We limit the dataset to couples with at least one child in the age group 1–5 years.[25] After excluding couples in which one parent is either a student, unemployed, self-employed, or the recipient of parental leave payments, we are left with 1,176 households. Low income families and immigrants are oversampled, but this is not critical with respect to the estimation of the model. However, when results are used in simulations of policy changes, representativity is achieved by the use of weights. Table 2 provides summary statistics of the main variables used in the model estimation.

Recall that we assume that child care prices do not vary with respect to use; see Section 3. Table 2 shows that most parents pay for a full-time center-based care service, as the average contractual hours in care is approximately 42 hours, but on average use it fewer hours, approximately 33 hours. This has previously been found by Blix and Gulbrandsen (1993). We take this as corroborative evidence of parents having strong preferences for spending leisure time with their children, although the price for nonparental center-based care is 0 at the margin. Some parents reduce their working hours to spend more together with the child(ren), but a main assumption of the present analysis is that it is possible to exploit the flexibility of the labor market to reduce hours in nonparental care, and instead increase the parental care time.

Individual wages, reported in Table 2, are obtained from OLS wage regressions, for mothers and fathers; see estimation results in Table A.1 in the Appendix.

As described in Section 3, we assume that families choose among four working hour alternatives and two work time schedules (daytime or shift), for both the mother and the father. Furthermore, they choose among three nonparental care alternatives: no participation, part-time and full-time.[26] Figure 3 describes how

[25] Recall that parents normally are on parental leave in the first year after birth, and children are therefore usually older than 1 year when entering into center-based care.

[26] In total we end up with 147 combinations in the choice set. Each parent has 7 work alternatives:

Table 2. Descriptive statistics for the sample used in the estimation of the model

	Mother		Father	
	Mean	Std. Dev.	Mean	Std. Dev.
Age	34.1	4.80	36.8	5.50
Years of education	13.3	2.70	13.4	2.55
Immigrant dummy	0.25	0.43	0.22	0.42
Working hours per week	31.1	12.5	39.4	7.44
Wage rate (per hour)	211.1	48.3	289.5	53.7
Shift dummy	0.22	0.42	0.23	0.42

	Youngest child (1–5 years)			
	Mean	Std. Dev.	Min.	Max.
Age	2.54	1.29	1	5
Hours in center-based care	32.6	12.2	0	50
Contractual hours in center-based care	41.9	14.8	0	62.5

	Household			
	Mean	Std. Dev.	Min.	Max.
Number of children 1–5 years	1.40	0.54	1	3
Non-labor income	67,493	137,920	-147,250	2,926,443

Number of household observations	1,176

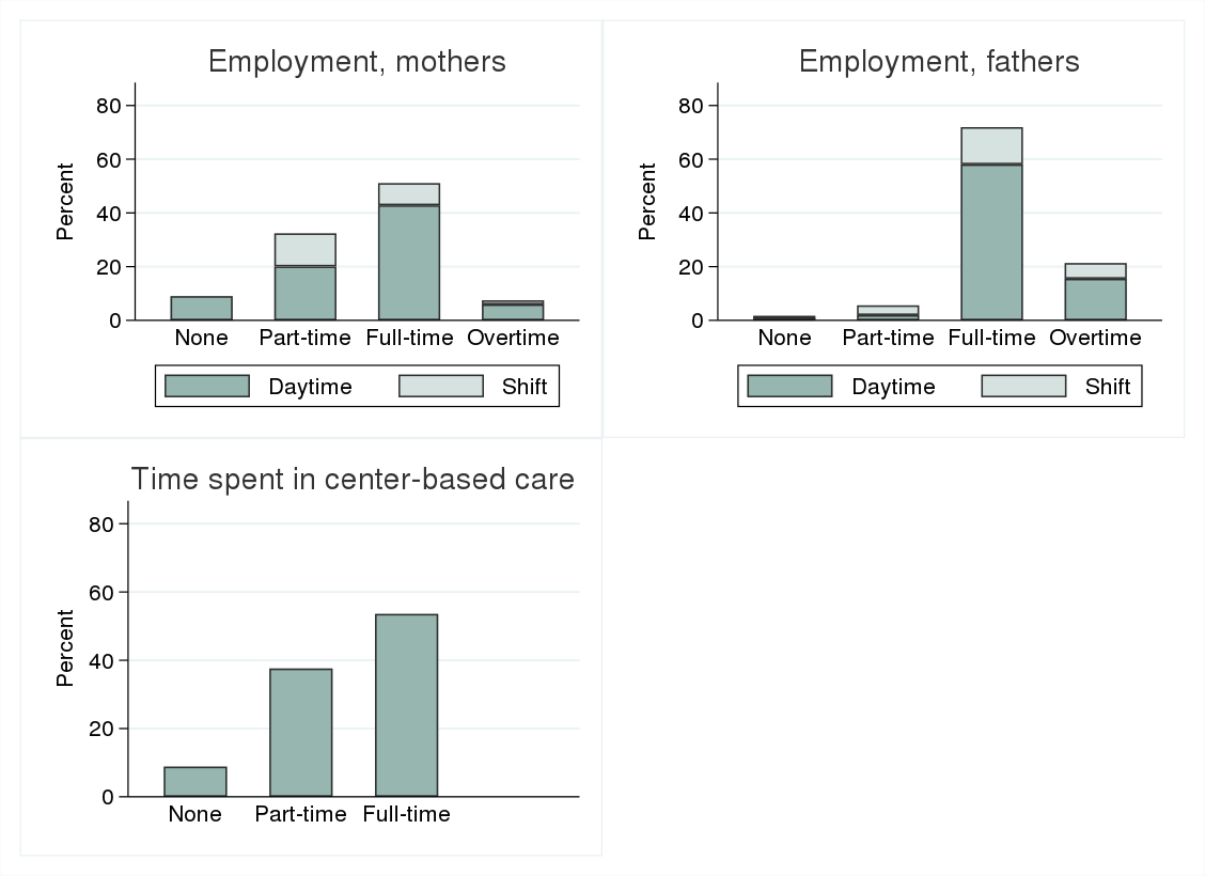
Notes. Data retrieved from the Child Care Survey 2010 (Wilhelmsen and Löfgren, 2011; Moafi and Bjørkli, 2011). Average exchange rates for 2010 were used to convert income and wage measures to euros and US dollars: 1€=NOK 8.01, and 1$=NOK 6.05.

mothers and fathers in our sample are distributed by categories of working time, working time arrangements and use of center-based care (for the youngest child). Figure A.1 in the Appendix provides further details on how these discretizations relate to the observed choices. A tax-benefit model is utilized to derive after-tax income for each alternative state.[27]

3 categories of working hours in standard work and shift work, respectively, plus the "no work" alternative. The 49 work combinations of the couple are combined with three nonparental care options.

[27]The calculation takes into account that child care expenses are deductible up to a threshold in the income tax return.

Figure 3. Observed labor market and child care choices



Notes. The allocation into different employment categories is based on working hours 0 ("None"), 1–34 ("Part-time"), 35–41 ("Full-time"), and 41+ ("Overtime"). The distinction between daytime work and shift work is based on the latter category including respondents with work outside the standard weekday hours of between 6am and 6pm. Hours in the different care categories are 0 ("None"), 11–35 ("Part-time"), and 36+ ("Full-time").

4.2 Parameter estimates and model fit

Parameters of the utility function, given by Equations 5, 6, 7, and 9, and the opportunity measure, given by Equations 11, 12, and 13, are estimated simultaneously by maximum likelihood. Table 3 reports estimates of the main parameters of the model, whereas Table A.2 in the Appendix shows estimates for the full set of parameters. First, we note that not all parameters are statistically significant. However, when the model is employed to simulate effects of alternative policies, we use the parameter point estimates, although not all of them are strictly significant (in a statistical sense).

The utility function behaves well, as preferences for both consumption and leisure are positive, and the estimate of α_1 suggests decreasing returns with respect to consumption (although not statistically significant). Given that leisure to a large extent is spent on giving care to children, it is worth noting that the valuation of leisure is higher for mothers than for fathers, and only statistically significant for mothers.

Recall that the modeling framework opens up for the couple having preferences for joint parental care, represented by an interaction term in leisure, see Equation 6. The estimation results show that the common interaction term is clearly insignificant (β_3), but that there is positive valuation from both parents having standard working time schedules (β_4). Further, with respect to the preferences for child care, estimates of γ_0 and γ_1 imply that parents attain positive utility of having their children in nonparental care, but at a decreasing rate. This is expected, since we observe that parents tend to underutilize nonparental care, i.e., using it less than the opening hours. With respect to the interaction of preferences for nonparental care and leisure, the estimation results suggest a negative relationship, which fits with a scenario where parents use their leisure time caring for their kids (however, note that only the negative interaction for mothers' leisure, δ_1, is significant). Thus, even though the Norwegian males are found taking an important role in the upbringing of children, the estimated parameters of preferences suggest that there are still gender differences between Norwegian parents. We will return to this issue soon, when discussing how preferences for nonparental care vary with respect to the parents' labor market choices.

Estimates of the opportunity parameters are interpreted against the excluded alternatives. It then follows that the estimates of job opportunities for standard working hours, $\exp(g_{no,k=m,f})$ and $\exp(g_{full,k=m,f})$, are measured against the excluded alternatives, part-time and overtime work, both set to $\exp(0) = 1$. The estimates reported in Table 3 then signify that there are more jobs with full-time

work schedules, as expected. In contrast, the estimates of opportunities for nonparticipation alternatives are negative, which implies that there are fewer nonparticipation alternatives than the left out alternatives.[28] Similarly, the estimates for shift work, ς_0 and ς_1, seem to suggest that there are less job options within this job category.

The last component of the choice set specification is a latent variable, κ, representing limitations in the possibilities for combining full-time work and less than full-time care; see Equation 13. In Table 3 this is referred to as "decoupling". We see that the estimate of $\exp(\kappa) = 0.85$ is close to 1 and statistically insignificant. Thus, the anticipation that the agents face fewer combination when parents want to combine less nonparental care and full-time (or close to full-time) work, might not be binding.

As explained in the Introduction, we have also estimated a version of our model in which we diverge from the key role of fathers as care providers and consequently let their labor supply enter the model exogenously, referred to as the conventional approach. We refer to Thoresen and Vattø (2018) for further details of the alternative model, together with estimation results. A likelihood ratio test has been conducted to assess to whether our preferred model outperforms the alternative nested model, with "standard fathers" – the test gives clear support for our augmented model.

Figure 4 displays the actual frequencies of the different combinations of working time and child care modes for mothers and fathers, respectively, and the corresponding probability distribution based on model simulations. The simulated probabilities are derived by calculating the average probability for each state based on the individual probabilities. We see fairly close correspondence between the actual distribution and the model predictions.[29]

To further highlight the novel role of fathers in the present model, Figure 5 shows how the model predicts fathers' labor supply choices, depending on the (predicted) choices for mothers' labor supply and nonparental care.[30] A model without assigning a role for fathers as caregivers would show no differences in care choices across fathers' labor supply choices, i.e., the bars, reflecting family care choices, would be identical for "None", "Part-time", "Full-time", and "Overtime" for each category of mothers' labor supply. The pattern displayed in Figure 5 then diverges considerably from the results of a restricted (or nested) model: the model results suggest substantial dependency between care choices and fathers' labor supply.

[28] For practical reasons, part-time and overtime work are the benchmark alternatives in the present specification, instead of the non-working alternative. This reflects a choice of normalization and does not influence results.

[29] A similar figure for the conventional model suggests weaker fit, see Thoresen and Vattø (2018).

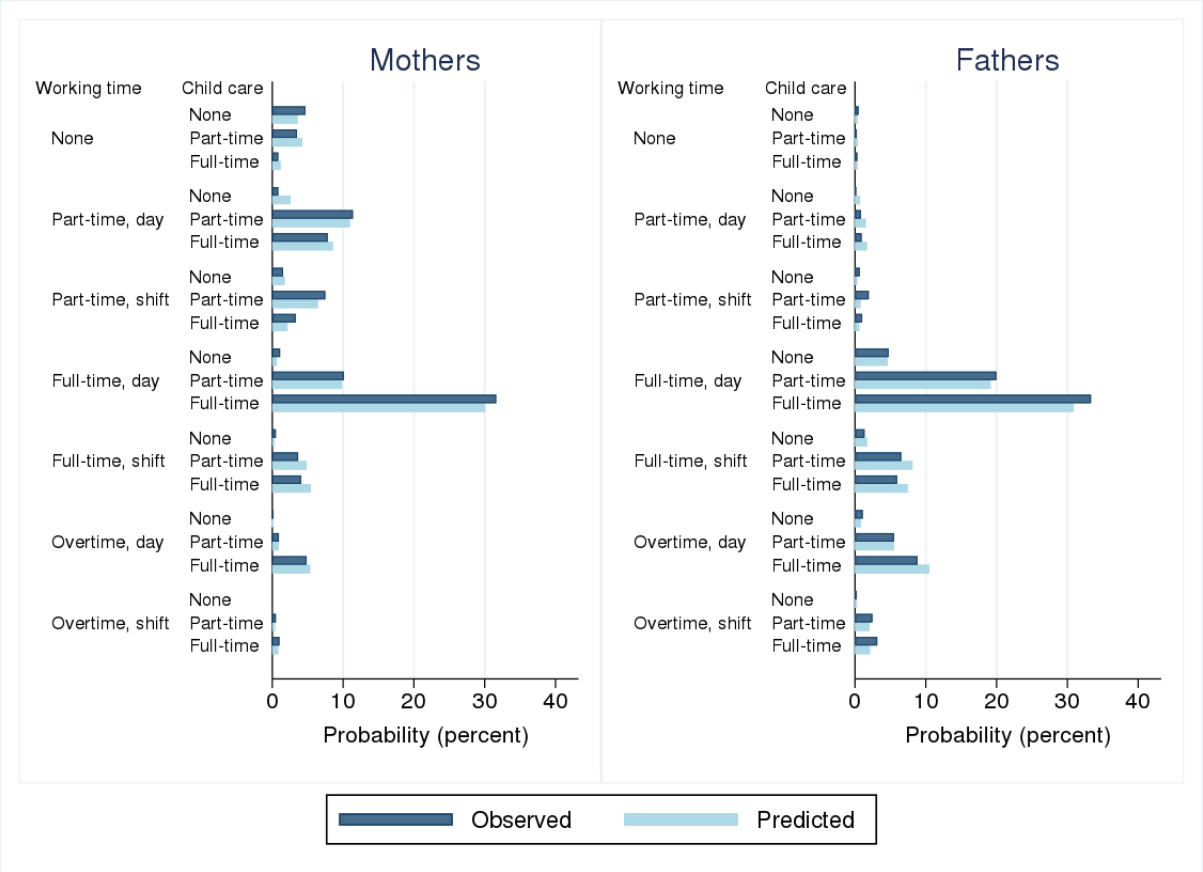
[30] Thus, close to a "prediction" counterpart to the description of actual choices in Table 1.

Table 3. Results of the estimation of the decision model

Variables	Parameter	Estimate	Std. error
Preference, $v(C, h_m, h_f, s_m, s_f, q)$			
Consumption, $v_1(C)$			
Intercept	α_0	0.1462***	(0.0319)
Squared term	α_1	-0.0002	(0.0001)
Leisure, $v_2(h_m, h_f, s_m, s_f)$			
Mother's leisure	β_1	11.9354***	(1.7752)
Father's leisure	β_2	3.4543	(1.8071)
Interaction	β_3	-0.2739	(1.0996)
Interaction, standard schedules	β_4	1.7512***	(0.3871)
Nonparental child care, $v_3(q)$			
Intercept	γ_0	4.1333	(2.1744)
Squared term	γ_1	-5.9967*	(2.0562)
Care int., $v_4(h_m, h_f, s_m, s_f, q)$			
Mother's leisure	δ_1	-5.8906*	(2.2930)
Father's leisure	δ_2	-2.5697	(3.1319)
Shift work, mother	δ_3	-0.2442	(1.1075)
Shift work, father	δ_4	0.2718	(1.0651)
Opportunity, $b(h_m, h_f, s_m, s_f, q)$			
Nonparticipation, mother	$g_{no,m}$	-1.6315***	(0.2127)
Nonparticipation, father	$g_{no,f}$	-0.1307	(0.3877)
Full-time, mother	$g_{full,m}$	1.4244***	(0.0883)
Full-time, father	$g_{full,f}$	1.5965***	(0.0794)
Shift work, mother (mean)	ς_1	-0.5247	(0.5438)
Shift work, father (mean)	ς_2	-0.9806*	(0.4221)
Decoupling work/care	κ	-0.1687	(0.1644)
Number of observations		1,176	

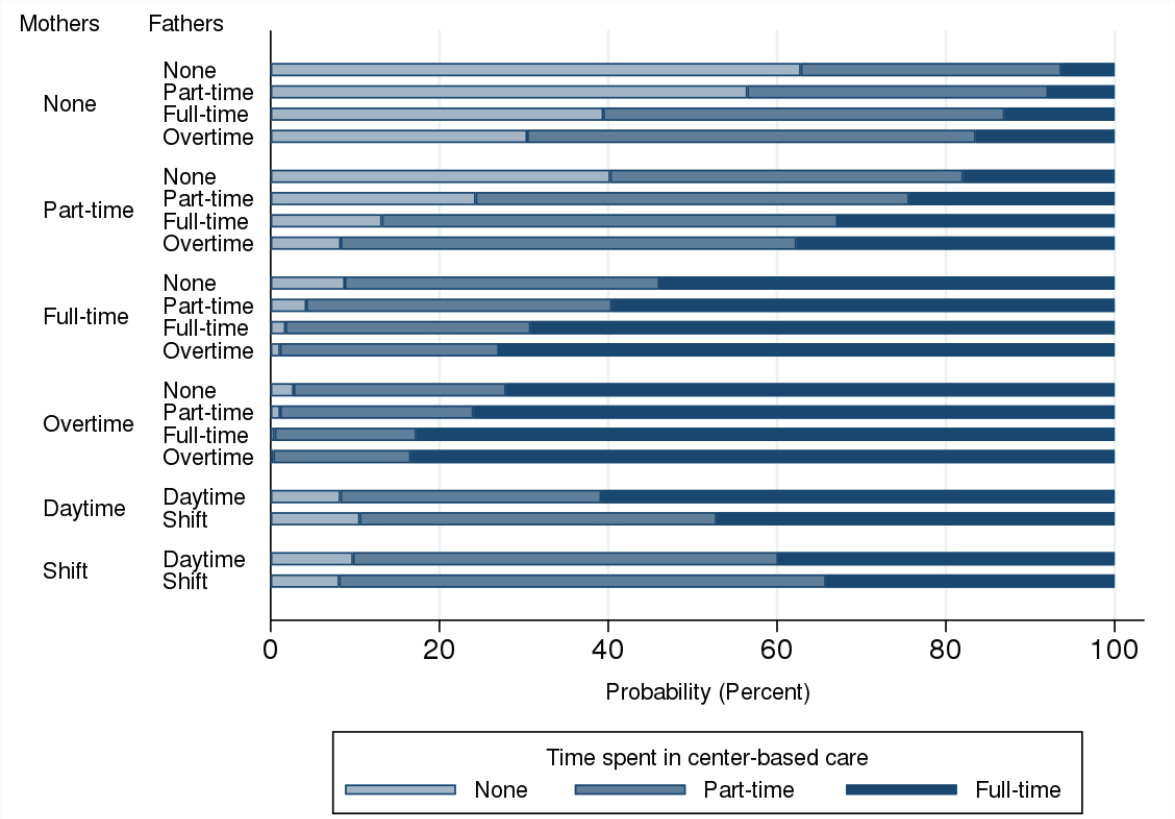
Notes. Standard errors are obtained by non-parametric bootstrap. The leisure of mothers and fathers is interacted with the individual's age, immigrant status, education and number of preschool children. Nonparental child care is interacted with the age of the child to capture the fact that (perceived) child care quality at home, compared to nonparental care, may depend on the age of the child. The shift work opportunity measure is interacted with field of education. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Figure 4. Model fit: distributions of predicted and observed choices



Notes. The allocation into different employment categories is based on working hours 0 ("None"), 1–34 ("Part-time"), 35–41 ("Full-time"), and 41+ ("Overtime"). The distinction between daytime work and shift work is based on the latter category including respondents with work outside the standard weekday hours between 6am to 6pm. Hours in the different care categories are 0 ("None), 11–35 ("Part-time"), and 36+ ("Full-time").

Figure 5. Predicted family care choices for different predicted choices of hours of work for mothers and fathers



Notes. The allocation into different employment categories is based on working hours 0 ("None"), 1–34 ("Part-time"), 35–41 ("Full-time"), and 41+ ("Overtime"). The distinction between daytime work and shift work is based on the latter category including respondents with work outside the standard weekday hours of between 6am and 6pm. Hours in the different care categories are 0 ("None"), 11–35 ("Part-time"), and 36+ ("Full-time").

Table 4. Estimated (deterministic) preferences for nonparental child care, dependent on labor market choices and age of youngest child

	Preference for center-based care				
	None	Part-time		Full-time	
Average	0.00	2.91	(0.24)	3.14	(0.24)
Mother and father choose full daytime work	0.00	3.46	(0.31)	4.49	(0.34)
Mother chooses shift work	0.00	2.90	(0.25)	2.48	(0.27)
Father chooses shift work	0.00	3.13	(0.35)	3.13	(0.35)
Mother chooses not to work	0.00	1.04	(0.16)	-0.40	(0.17)
Mother chooses part-time work	0.00	2.18	(0.18)	1.75	(0.17)
Father chooses part-time work	0.00	2.22	(0.26)	2.22	(0.36)
Age of youngest child					
1 year	0.00	1.74	(0.22)	1.87	(0.25)
5 years	0.00	4.80	(0.39)	5.15	(0.33)
Number of observations	1,176				

Notes. Standard errors (in parentheses) are obtained by non-parametric bootstrap. In cases where results are reported for choices of one of the spouses, average values for the other spouse is used.

Next, we discuss the performance of the model by describing valuations of nonparental care for different labor market choices and with respect to the age of the youngest child, see Table 4. We do this by using Equation 7 and Equation 8 and the accompanying parameter estimates. Table 4 shows that parents on average value full-time nonparental care higher than part-time care. Thus, the parents are still on the increasing part of the concave (nonparental) care function. Further, with respect to the age of the child, Table 4 shows that the valuation of center-based care increases with age, as expected.

However, the main information derived from Table 4 comes from looking at how these valuations are altered by different choices by fathers and mothers, interpreted as preference differences between mothers and fathers. Although, in the motivation for the present work, we have stated that Norwegian males are well on the way to a gender-equal position, the results in Table 4 indicate that there are still some differences. Mothers' and fathers' valuation of care for the shift work and part-time work alternatives signify the differences between genders. Whereas for mothers, full-time center-based care is valued below part-time care for other choices than full-time work, valuations of part-time and full-time center-based care are identical when fathers' choices deviate from standard full-time work. Given that we let nonparental care quality perceptions vary according to the leisure of fathers and mothers, see Equation 8, we interpret these results as being generated by higher valuations of mothers' care than fathers' care. This does not mean that fathers are unaffected, as implied by a conventional model (as the one discussed in Thoresen and Vattø, 2018):[31] for example, we see that the value of the full-time care option when fathers work part-time is lower than the average figure (upper line of Table 4). Yet, these results suggest that the preferences for nonparental care are still more connected to mothers' than fathers' working time decisions. Thus, Norwegian fathers may still have a way to go before they are involved in caretaking at the same level as their female counterparts.

4.3 Robustness checks - accounting for unobserved heterogeneity in preferences for nonparental care

So far, individuals with identical observed characteristics are assumed to have the same preferences for child care, leisure and consumption. It is generally acknowledged that it is challenging to account for unobserved heterogeneity in discrete choice

[31] When obtaining results similar to those reported in Figure 4 by the conventional model, these preferences are independent of fathers' working time and independent of shift work, for both mothers and fathers.

Table 5. Estimated preferences for nonparental child care when allowing for two latent family types

Two unobserved		Preferences for center-based care				
types of families	Probability	None	Part-time		Full-time	
Type 1	0.946	0	2.83	(0.53)	3.10	(0.13)
Type 2	0.054	0	23.15	(0.91)	22.60	(0.92)
Number of observations			1,176			

Note. Standard errors (in parentheses) are obtained by non-parametric bootstrap.

models; see for example Haan (2006) and Train (2009). Since preference for child care is especially important in our model set-up, we have, in a robustness check, assessed to what extent results are sensitive to an alternative specification in which unobserved heterogeneity in preferences for formal child care is allowed for. This is done by letting the parameters γ_{00} and γ_{10}, see equation 7, differ according to two latent types of families. The model parameters for each group and the probability of belonging to each type are obtained simultaneously.

Two types of families are identified, see Table 5: a majority, with a share of 95 %, and a minority, which consists of only 5 % of the families. Parents in the smallest group have positive preferences for nonparental care, but negative preferences for longer hours in child care, whereas the estimates based on the majority of families are in line with the estimated parameters in the benchmark model. Most importantly, when using this alternative specification in simulations of alternative policies, which we will return to in Section 6 for the benchmark model, we find that results are not sensitive to this alternative specification. We take this as corroborative evidence for the model performing well without introducing unobserved heterogeneity in child care preferences.

5 Validation of model against quasi-experimental evidence

In this section we discuss the extent to which the predictions given by the model are supported by results from other information sources. Results from quasi-experimental analyses are often used to validate structural models (Blundell, 2012), see for example Todd and Wolpin (2006), Hansen and Liu (2015), and Thoresen and Vattø (2015). Here, we validate the performance of the model by using a reform in the schedule for the home care allowance (cash-for-care) in 2012. Responses are measured in terms of changes in income and in the use of center-based care.

The reform is presented in Table 6. Recall that the home care allowance (cash-

Table 6. Cash-for-care schedule, pre- and post-reform

Monthly cash-for-care rates (nominal NOK)			
	Age 13–18 months	Age 19–23 months	Age 24–35 months
Pre-reform	3,303	3,303	3,303
Post-reform	5,000	3,303	0

Note. To convert to euros and US dollars, divide by 6.05 and 8.01, respectively (2010).

for-care) schedule is a monetary compensation for *not* using subsidized care at child care centers, for parents of children aged 1 or 2. Here, we use a reform of the schedule in 2012 in the model validation. Before 2012, families received approximately NOK 3,300 ($550, €410)[32] per child per month, whereas the 2012-change implied that children aged 13–18 months and 19–23 months received NOK 5,000 ($830, €620) and NOK 3,300 ($550, €410), respectively; thus eliminating this type of support for the oldest age group (2-year-old).[33]

The model simulation results of this change are presented in Table 7, where we decompose results into effects on families with 1- and 2-year-old children. The table shows that the qualitative results are as expected – fathers and mothers of the youngest children reduce their labor supply and the use of center-based care, whereas opposite effects are seen for parents of the 2-year-old children. As we validate the model results against responses in labor income, we recalculate the labor supply effects into corresponding effects on earnings. This is simply done by using the individual-specific wage rates, derived from the wage equation estimations.[34]

A major challenge in validity tests is to obtain clear and reliable results from the empirical studies that are used in the model validation.[35] Even though families may respond along several margins to a change in the budget constraint, as argued by Feldstein (1995), we assert that in the short run, responses in labor earnings primarily pick up adjustments in working hours. We have access to income information for the whole population, derived from administrative registers (Statistics Norway, 2017), which facilitates detailed studies of income developments for the relatively small group of couples with children aged 1 and 2. We use similar figures on income developments for parents with 4-year-old children to portray the counterfactual

[32]As all simulations are carried out in relation to a 2010-benchmark, conversions to euros and U.S. dollars are based on exchange rates for 2010.

[33]After this change the schedule has been adjusted again, such that (from 2017 onwards) there is only one rate, NOK 7,500 ($910 and €800, for 2017 exchange rates) per month per child, for 1-year-old children.

[34]Remember that it follows from the modeling approach that individual wage rates are kept fixed in the simulations.

[35]We largely replicate an approach described in Weierud (2015).

Table 7. Model simulations: effects of the 2012-changes in the cash-for-care schedule on working hours, earnings and use of center-based care

	Employment		Child care,
	Mothers	Fathers	participation
YOUNGEST CHILD 1-YEAR-OLD ($N = 288$)			
Baseline, working hours/use of care	27.08	37.46	0.806
	(0.35)	(0.19)	(0.014)
Effect of reform, working hours/use of care	-0.26	-0.04	-0.016
	(0.05)	(0.01)	(0.003)
Effect of reform, earnings (NOK)	-1,175	-253	
	(221)	(67)	
YOUNGEST CHILD 2-YEAR-OLD ($N = 313$)			
Baseline working hours/use of care	28.68	37.78	0.894
	(0.25)	(0.17)	(0.008)
Effect of reform, working hours/use of care	0.49	0.08	0.030
	(0.07)	(0.02)	(0.004)
Effect of reform, earnings (NOK)	2,219	471	
	(326)	(107)	

Note. Standard errors (in parentheses) are obtained by non-parametric bootstrap.

Table 8. Effects on labor earnings of change in the cash-for-care scheme in 2012. Results of difference-in-differences regressions, based on income data for 2011 and 2012

	Estimate	95 % confidence interval	Observations
Mothers, 1-year-olds	677.8	[-1,475 – 2,830]	175,639
Mothers, 2-year-olds	3,143.8**	[1,022 – 5,266]	178,457
Fathers, 1-year-olds	-204.0	[-5, 847 – 5,439]	101,159
Fathers, 2-year-olds	108.7	[-5,491 – 5,709]	106,248

Notes. Figures for families of 4-year-old children used as benchmark. Individual control variables included are: age of parents, age of parents squared, education level, immigrant-background, labor income three years prior to the reform, and a dummy variable for siblings.* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

common trend. With respect to the use of center-based care, we do not have individual information that can be used in the present context. We therefore validate against measures of aggregate coverage rates over the time period, derived from the yearly reports of child care institutions (Statistics Norway, 2016). Since average rates are used directly, we cannot compute confidence intervals for these measures.

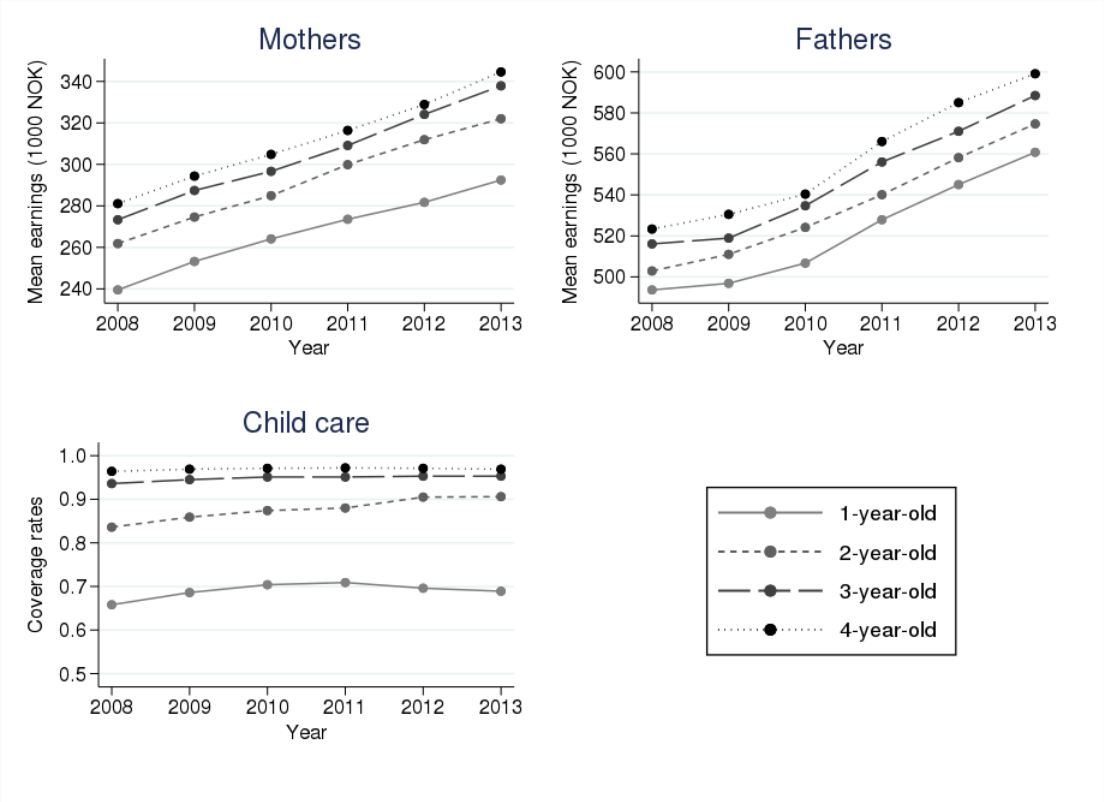
Figure 6 presents mean earnings for the time period 2008–2013, comparing developments for parents of 1-year-old and 2-year-old children with developments for parents of older children (aged 3 and 4). We see no clear indications of behavioral responses by visual inspection of the graphs, but when we turn to the results of difference-in-differences regressions,[36] from the same data material, we find that the income of parents of the 2-year-old children increases, see Table 8.

The observed effects are close to the results of the model simulations presented in Table 7. Table 8 shows that no significant effects are obtained for the mothers of the 1-year-old children. However, the standard errors are large, and we note that the 95 percent confidence interval includes the effect predicted by the model simulation. The table also confirms that fathers do not respond to the change in the cash-for-care schedule, as was also predicted by the model simulations. Thus, we find it reassuring that the predictions of the labor supply model are not far from the results of the quasi-experimental data analysis. Of course, this only implies that the model has not been rejected in the validation exercise – it does not mean that the model has been approved.

The simulated effects on the use of child care centers after the reform are also

[36]Regressions are based on standard difference-in-differences technology, with the parents of the 4-year-old children representing the common trend.

Figure 6. Observed earnings (NOK 1,000) and coverage rates in center-based care by age of children



Notes. Child care information derived from Kindergarten Statistics, for example see Statistics Norway (2016), based on "Annual reports for kindergartens as of 15 December". Information on earnings is obtained from Income and Wealth Statistics for Households.

close to what we see in the data. Figure 6 shows an increase in the child care coverage rate for 2-year-olds and a decrease for 1-year-olds in 2012, as is also shown by the average figures (from the same data source), reported in Table 9.[37] The participation rate of the youngest children goes down by 1.2 percentage points, whereas it increases by 2.6 percentage points for children aged 2. As these figures are close to the model predictions, see Table 7, this evidence also provides support for the performance of the model.[38]

[37]Thus, this implies that the validation benchmark is established not by using difference-in-differences micro data techniques in this case, but by aggregate information.

[38]Simulation results obtained by the restricted model (without endogenous labor supply of fathers) show a better fit to the quasi-experimental evidence for the mothers of 2-year-old children, and a worse fit for the mothers of 1-year-olds and the use of child care centers; see results in appendix in Thoresen and Vattø (2018). With respect to the use of center-based care, simulation by the alternative model predicts that participation in child care centers for 2-year-olds is 0.037, which exceeds the results reported in Table 9 (0.026).

Table 9. Effects on the use of center-based care from change in the cash-for-care scheme in 2012. Care coverage rates derived from aggregate data

	Change, participation center-based care
1-year-olds	-0.012
2-year-olds	0.026

Notes. Results are obtained by simple difference-in-differences calculations using aggregate coverage rates in December 2011 and December 2012, letting the change in coverage rates for 4-year-olds represent the "common trend".

6 Further explorations of model properties

6.1 Simulated elasticities

In this section we shall further examine the performance of the model. First we present simulated labor supply and child care demand elasticities, and next, model properties are discussed by showing the results of various simulations. Estimates of labor supply elasticities and child care demand elasticities are obtained from simulations, in which the wage rate and the child care fees are increased by 10 percent from the baseline.

The elasticity estimates are reported in Table 10, where the labor supply response is divided into a participation elasticity (extensive margin) and an elasticity conditional on participation (intensive margin); the overall (Marshallian) wage elasticity is obtained by adding the two estimates. Importantly, and as discussed in detail in Section 3, given that the model holds no fixed link between working hours and hours in care, price changes and wage changes have nonidentical effects on parents' behavior. As we have developed a model for couples, we also provide cross-wage elasticity estimates.

Note that as the price for nonparental care is not related to hours of use, the price is essentially zero at the margin.[39] This means that at the intensive margin, an increase in the child care fee can be seen as a pure income effect. Thus, in this perspective, the finding that the intensive margin price elasticity is essentially zero is not so unexpected. We also note that the extensive margin demand elasticity with respect to the fee is small. The previous literature on the price responsiveness of child care demand does not give clear guidance; for example, the review in Chaplin et al. (2000) shows estimates ranging from large positive values to large negative

[39]If the demand for nonparental care is larger than the opening hours of center-based care, parents may in reality choose other options of nonparental care in addition, which implies that there is a positive marginal price too.

Table 10. Simulated elasticities of labor supply and child care demand with respect to wage and child care fee

	Labor supply, mother		Labor supply, father		Demand for center-based care	
	Particip.	Hours	Particip.	Hours	Particip.	Hours
Wage of mother	**0.147**	**0.120**	-0.001	0.004	0.072	0.028
	(0.020)	**(0.018)**	(0.001)	(0.002)	(0.011)	(0.004)
Wage of father	-0.004	-0.002	**0.021**	**0.042**	0.011	0.001
	(0.004)	(0.004)	**(0.005)**	**(0.006)**	(0.003)	(0.001)
Price, child care	-0.001	0.004	-0.002	0.002	**-0.016**	**0.002**
	(0.005)	(0.004)	(0.001)	(0.002)	**(0.003)**	**(0.001)**

Notes. Standard errors (in parentheses) are obtained by non-parametric bootstrap. The effects on hours of work are calculated by conditioning on working (intensive margin).

values.

Similarly, we find that fees have a limited effect on the labor supply of both parents. Again, previous studies do not show consistent results, see surveys on maternal labor supply effects in Blau and Currie (2006), Kalb (2009), Del Boca (2015), Morrissey (2017), and Akgunduz and Plantenga (2018). Relatively limited female labor supply responses to fees are also found by Kornstad and Thoresen (2007), with Norwegian data from the late nineties, when there were queues for access to center-based care.[40] Another study that finds response estimates close to zero is Lundin et al. (2008), with data for Sweden. They argue that in countries with a well-developed and highly subsidized child care system, further reductions in the price of child care have limited effects on mothers' labor supply. Thus, this can explain the low response in the Norwegian case too.

Table 10 shows that the parents' labor supply is more responsive with respect to wages than to the price of care. However, there is a clear gender difference – mothers' labor supply is more sensitive to the wages than fathers' work. The overall wage elasticity for mothers is 0.27 ($0.147 + 0.120$), which is relatively close to what Kornstad and Thoresen (2007) found (0.35) when using Norwegian data from the 90s, and somewhat lower than reported by Thoresen and Vattø (2015) for all Norwegian females in couples (0.46). Compared to the results of studies of mothers of preschool children in other countries, the response is higher than, for example, one of the estimates seen in Ribar (1995) for the US (0.09), but considerably below what Powell

[40] As there is no rationing in the Norwegian market for child care anymore, one may expect to find higher price responsiveness in the present situation, not less responsiveness, as was found.

(2002) finds for Canada (0.85). It is worth noting that the increased labor supply following from increased wages of mothers, also results in a relatively large increase in the demand for center-based care, although smaller than the response in working hours. A key characteristic of our modeling approach is that increased parental labor supply does not necessarily result in nonparental care on the same scale – parents may exploit the flexibility in the labor market to let children be taken care of by the parents.

Given that there are few studies based on models of joint parental labor supply, the literature offers few estimates of the wage responsiveness of fathers of preschool children.[41] However, we note that the elasticities for males reported here are very close to the estimates presented in Thoresen and Vattø (2015) for all males (not restricted to fathers of preschool children). Note also that low responsiveness among fathers should not be interpreted as evidence of them playing an insignificant role in family care or the model performing equally well without endogenous male labor supply (as already discussed in Section 4). In fact, when neglecting the contribution of males (as implied by a conventional model), the wage responsiveness of females increases, to 0.178 and 0.144 for participation and hours, respectively; see more details in Thoresen and Vattø (2018).

As discussed in Section 3, our modeling approach facilitates the derivation of cross-wage elasticities, which are influenced by how mothers' and fathers' consumption of leisure interact. Recall that we find estimation results in accordance with parents having preferences for spending time together, as there are stronger preferences for leisure when the partner has more leisure; see the estimate of β_4 in Table 3. Such preferences limit the cross-wage responses, and correspondingly we see cross-wage elasticity estimates that are close to zero in Table 10.

6.2 Closing the gender wage gap

In Table 11 we elaborate further on model properties by discussing the extent to which the different labor market adjustment of men and women can be explained by differences in wages. More precisely, we use the model to simulate how mothers' and fathers' labor supply is affected when the gender gap in wages is closed. This can be done in two ways: either by increasing mothers' wages to the level of fathers', or by reducing fathers' wages down to the level of mothers'; see Table 11. Results are measured against a benchmark, denoted "Baseline, 2010".

Firstly, we note that if the mothers obtain "male wages", they increase their

[41] One exception is Mumford et al. (2018), who find similar wage elasticities for mothers and fathers.

Table 11. Labor supply effects when the gender wage gap is closed

	Labor supply, mother		Labor supply, father		Demand for center-based care	
	Particip.	Hours	Particip.	Hours	Particip.	Hours
Baseline, 2010	0.912	31.91	0.990	38.17	0.913	35.89
	(0.006)	(0.23)	(0.002)	(0.16)	(0.007)	(0.14)
Change from baseline						
Increase in wage of mother	0.039	1.27	-0.000	0.02	0.019	0.32
	(0.004)	(0.20)	(0.000)	(0.02)	(0.003)	(0.05)
Decrease in wage of father	0.002	0.08	-0.011	-0.46	-0.003	0.01
	(0.002)	(0.07)	(0.003)	(0.08)	(0.001)	(0.02)

Notes. Standard errors (in parentheses) are obtained by non-parametric bootstrap. The effects on hours of work are calculated by conditioning on working (intensive margin).

participation rate by 3.9 percentage points. As the difference between participation between mothers and fathers is approximately 7.8 percent (see the baseline simulation), this means that about half of the difference is explained by higher wages for males. The rest of the gap in the participation is then explained by other differences, such as different preferences and unequal opportunities in the labor market. If we instead decrease the fathers' wages, the reduction in the participation rate for fathers is only 1.1 percent, and the participation of mothers increases by only 0.2 percent. The asymmetry in results follows from higher elasticities among mothers than fathers, in addition to low cross-elasticities, as seen in Table 11. This imbalance is also found with respect to the results on the intensive margin. An increase in mothers' wages explains 1.25 hours $(1.27 - 0.02)$ of the difference in hours of work, whereas an decrease in fathers' wages leads to a smaller change, only 0.54 hours $(0.08 + 0.046)$.

6.3 More on the effects of parental fees

Recent family policy discussions in Norway have centered on whether to make child care services cheaper or to strengthen cash benefits schedules. Given this, and given that the elasticity estimates suggest that parents' labor supply is rather insensitive to child care fees, we take a closer look at the effects of larger changes in payments for center-based care. In Table 12 we report the simulated effects of alternative pricing schemes for nonparental care, both letting the price be doubled and making the service free. Moreover, in order to look further into the heterogeneity of responses,

simulation results for specific groups of households are presented – for families where both parents are immigrants and for families where mothers are low-educated or have low predicted wage rates.

The results of Table 12 signify that the relationship between the price of non-parental care and the labor supply of mothers follows a nonlinear pattern. Although Table 10 shows that labor supply is very insensitive to the price of care, close to zero, we see clearer effects when introducing larger changes, such as a doubling of the parental fee (from the level of 2010).[42] As expected, mothers decrease their labor supply. Correspondingly, they increase their labor supply when they are offered full-time center-based care free of charge. The labor supply of fathers is almost unaffected by these changes.

With respect to the selected subgroups, the most distinct deviation from the responses of the overall population is seen for the category of families with low paid mothers. For the simulation alternative where they experience a doubled price for nonparental care, the average reduction in hours of labor supply is 0.4 for mothers and 0.1 for fathers. This is not a large response, for example compared to what other studies find, but clearly higher than for the whole population. It should also be acknowledged that many of the confidence intervals are relatively wide.

6.4 Abolition of the cash-for-care scheme

In the validation of the model we used a change in the cash-for-care scheme in 2012. However, the removal of the program is an ever returning question in the Norwegian policy debate, having for instance been recently suggested by a governmentally appointed expert group (Ministry of Children and Equality, 2017). In Table 13 we report the simulated effects of abolishing the scheme altogether, i.e., eliminating the schedule reported as the pre-reform schedule in Table 6. Recall that support to eligible families is substantial, NOK 3,300 ($550, €410) per child per month. Despite this, the responses are again very small on average for all individuals. Effects are larger when restricted to the target population of the schedule, but even in that group the effects are fairly small: labor supply participation increases by 0.64 hours and participation in center-based care increases by 4.0 percentage points. Given that the model also involves responses on the standard versus shift work margin, Table 13 also reports the effects on the choice of shift work. However, although we see that families change to less shift work when the cash-for care schedule is eliminated, the effects are not significant.

[42] In 2010 the maximum price was NOK 2,330, or approx. $385 and €290.

Table 12. Simulated effects on hours of work and hours in care of alternative child care fee schemes. Effects on all households and population subgroups

	Labor supply mother		Labor supply, father		Demand, center-based care	
ALL HOUSEHOLDS ($N = 1,176$)						
Baseline (2010)	29.16	(0.25)	37.79	(0.16)	32.77	(0.28)
Change from baseline schedule						
2 x maximum price	-0.16	(0.08)	-0.03	(0.02)	-0.53	(0.09)
Free full-time care	0.14	(0.03)	0.02	(0.01)	0.35	(0.04)
MOTHERS WITH NON-NORWEGIAN BACKGROUND ($N = 297$)						
Baseline (2010)	27.67	(0.63)	37.41	(0.23)	32.24	(0.57)
Change from baseline						
2 x maximum price	-0.20	(0.07)	-0.05	(0.03)	-0.55	(0.73)
Free full-time care	0.15	(0.03)	0.02	(0.01)	0.35	(0.67)
MOTHERS WITH LOW EDUCATION ($N = 182$)						
Baseline (2010)	26.59	(0.80)	37.21	(0.23)	31.82	(0.41)
Change from baseline						
2 x maximum price	-0.21	(0.06)	-0.05	(0.02)	-0.57	(0.52)
Free full-time care	0.16	(0.02)	0.03	(0.01)	0.37	(0.50)
MOTHERS WITH LOW PREDICTED WAGE RATE ($N = 150$)						
Baseline (2010)	25.30	(0.55)	37.20	(0.24)	30.69	(0.59)
Change from baseline						
2 x maximum price	-0.38	(0.10)	-0.11	(0.04)	-0.88	(0.69)
Free full-time care	0.25	(0.04)	0.04	(0.01)	0.53	(0.54)

Notes. Standard errors (in parentheses) are obtained by non-parametric bootstrap. Effects on hours of work measure unconditional effects (both extensive and intensive margins).

Table 13. Simulated effects of abolishing the "cash-for-care" schedule

	Labor supply mother		Labor supply, father		Demand, center-based care	
	Hours	Shift share	Hours	Shift share	Particip.	Hours
All households ($N = 1,176$)						
Baseline (2010)	29.16	0.218	37.79	0.230	0.913	35.89
	(0.25)	(0.008)	(0.16)	(0.009)	(0.007)	(0.14)
Change from baseline						
No "cash-for-care"	0.33	$-9.5 \cdot 10^{-5}$	0.05	$-5.2 \cdot 10^{-4}$	0.021	0.00
	(0.05)	(0.001)	(0.01)	(0.001)	(0.003)	(0.00)
"Cash-for-care" eligible households ($N = 601$)						
Baseline (2010)	27.90	0.222	37.63	0.233	0.851	35.72
	(0.28)	(0.010)	(0.17)	(0.009)	(0.011)	(0.18)
Change from baseline						
No "cash-for-care"	0.64	$-1.9 \cdot 10^{-4}$	0.10	$-1.0 \cdot 10^{-3}$	0.040	0.00
	(0.09)	(0.001)	(0.02)	(0.001)	(0.005)	(0.00)

Notes. Standard errors (in parentheses) are obtained by non-parametric bootstrap. The effects on hours of work refer to the total effect (both intensive and extensive margin). The "shift share" is the share of individuals with work outside the standard weekday hours of between 6am and 6pm.

7 Concluding remarks

Developments in Norway and several other countries imply that there is reason to question the design of the typical structural model for joint labor supply and child care choice. In particular, we assert that the negligence of fathers as caregivers can no longer be justified with reference to the decision-making of Norwegian families. Even though Norway and other Nordic countries are regarded as taking the lead with respect to equal parenting and support for center-based care, we expect that the model presented here represents a relevant approach for other economies too.

Two new characteristics in particular are taken into account to in the design of the updated model. Firstly, the choice set of nonparental care has been simplified – in effect, parents now choose between own care and center-based care. Secondly, in contrast, the decision-making on the parental side has become more complicated. It is asserted that Norwegian couples are moveing towards more gender equality in family life, which implies that care by fathers should also be accounted for in the care choice set. As both parents are assumed to take part in the care, and parents' working hours may not overlap, a model is developed that accounts for the possibility that parents may exploit labor market flexibility to reduce time in nonparental care.

The simulation results suggest that parents' labor supply is rather insensitive to the price of child care. This finding is supported, or at least not rejected, by validations against other information sources. Model simulation results are relatively close to findings derived from quasi-experimental data analysis, using a reform in the cash-for-care scheme as an out-of-sample validation.

Further, even though simulation results suggest that parents are not responding to changes in the price of center-based care, they show more responsiveness with respect to changes in wages. The model predicts that mothers more than fathers increase their labor supply in response to an increase in their wages. The average wage elasticity for mothers is 0.27, whereas fathers are much less responsive: their wage elasticity is around 0.06. The cross-wage elasticity estimates are small. The labor supply effects generated by increased wages for mothers result in increased demand for center-based care, but not in the same range as given by the labor supply response. This reflects the key characteristic of our model: we allow parents exploit the flexibility in the labor market to spend more time with their children at home, and, in particular, we allow the fathers to contribute to the caregiving.

We find results that confirm that fathers are involved in care, although most likely not on the same scale as their partners. Our estimation results seem to suggest

that Norwegian fathers still have a way to go before they are involved in caretaking at the same level as their female counterparts. But we expect that fathers will continue on the path to a more equal position in family caregiving. Moreover, we hypothesize that the greater involvement of fathers is spreading to other economies too. In that respect we believe that our modeling approach will increase its applicability in the years to come.

References

Aaberge, R., J. K. Dagsvik, and S. Strøm (1995). Labor supply responses and welfare effects of tax reforms. *Scandinavian Journal of Economics 97*, 635–659.

Akgunduz, Y. E. and J. Plantenga (2018). Child care prices and maternal employment: A meta-analysis. *Journal of Economic Surveys 32*, 118–133.

Apps, P., J. Kabátek, R. Rees, and A. van Soest (2016). Labor supply heterogeneity and demand for child care of mothers with young children. *Empirical Economics 51*, 1641–1677.

Apps, P. F. and R. Rees (1988). Taxation and the household. *Journal of Public Economics 35*, 355–69.

Apps, P. F. and R. Rees (1997). Collective labour supply and household production. *Journal of Political Economy 105*, 178–190.

Baker, M., J. Gruber, and K. Milligan (2008). Universal child care, maternal labor supply, and family well-being. *Journal of Political Economy 116*, 709–745.

Bernal, R. (2008). The effect of maternal employment and child care on children's cognitive development. *International Economic Review 49*, 1173–1209.

Bernal, R. and M. P. Keane (2011). Child care choices and childrens cognitive achievement: The case of single mothers. *Journal of Labor Economics 29*, 459–512.

Bettendorf, L. H., E. L. W. Jongen, and P. Muller (2015). Childcare subsidies and labour supply - Evidence from a large Dutch reform. *Labour Economics 36*, 112–123.

Black, S. E., P. J. Devereux, K. V. Løken, and K. G. Salvanes (2014). Care or cash? The effect of child care subsidies on student performance. *Review of Economics and Statistics 96*, 824–837.

Blau, D. and J. Currie (2006). Pre-school, day care, and after-school care: Who's minding the kids. In E. Hanushek and F. Welch (Eds.), *Handbook of the Economics of Education*, Volume 2, pp. 1163–1278. Elsevier.

Blau, D. and E. Tekin (2007). The determinants and consequences of child care subsidies for single mothers in the USA. *Journal of Population Economics 20*, 719–741.

Blau, D. M. and A. P. Hagy (1998). The demand for quality in child care. *Journal of Political Economy 106*, 104–46.

Blau, D. M. and P. K. Robins (1988). Child-care costs and family labor supply. *Review of Economics and Statistics 70*, 374–381.

Blix, K. W. S. and L. Gulbrandsen (1993). Småbarnsfamilienes økonomi og bruk av barnetilsyn. Report 1993:2, INAS, Oslo, Norway (in Norwegian).

Bloemen, H. G. and E. G. F. Stancanelli (2014). Market hours, household work, child care, and wage rates of partners: An empirical analysis. *Review of Economics of the Household 12*, 51–81.

Blundell, R. (2012). Tax policy reform: The role of empirical evidence. *Journal of the European Economic Association 10*, 43–77.

Blundell, R., A. Duncan, J. McCrae, and C. Meghir (2000). The labour market impact of the working families' tax credit. *Fiscal Studies 21*, 75–104.

Browning, M. and M. Gørtz (2012). Spending time and money within the household. *Scandinavian Journal of Economics 114*, 681–704.

Chaplin, D. D., P. K. Robins, S. L. Hofferth, D. A. Wissoker, and P. Fronstin (2000). The price elasticity of child-care demand. Manuscript, The Urban Institute, Washington DC.

Chiappori, P.-A. (1992). Collective labor supply and welfare. *Journal of Political Economy 100*, 437–467.

Connelly, R. and J. Kimmel (2007). The role of nonstandard work hours in maternal caregiving for young children. IZA Discussion Paper No. 3093, Bonn, Germany.

Connelly, R. and J. Kimmel (2009). Spousal influences on parents' non-market time choices. *Review of Economics of the Household 7*, 361–394.

Cools, S., J. F. Fiva, and L. J. Kirkebøen (2015). Causal effects of paternity leave on children and parents. *Scandinavian Journal of Economics 117*, 801–828.

Cunha, F., J. J. Heckman, and S. M. Schennach (2010). Estimating the technology of cognitive and noncognitive skill formation. *Econometrica 78*, 883–931.

Dagsvik, J. K. (1994). Discrete and continuous choice, max-stable processes, and independence from irrelevant attributes. *Econometrica 62*, 1179–1205.

Dagsvik, J. K. and Z. Jia (2016). Labor supply as a choice among latent jobs: Unobserved heterogeneity and identification. *Journal of Applied Econometrics 31*, 487–506.

Dagsvik, J. K., Z. Jia, T. Kornstad, and T. O. Thoresen (2014). Theoretical and practical arguments for modeling labor supply as a choice among latent jobs. *Journal of Economic Surveys 28*, 134–151.

Dagsvik, J. K. and S. Strøm (2006). Sectoral labour supply, choice restrictions and functional form. *Journal of Applied Econometrics 21*, 803–826.

Datta Gupta, N., N. Smith, and M. Verner (2008). The impact of Nordic countries' family friendly policies on employment, wages, and children. *Review of Economics of the Household 6*, 65–89.

Del Boca, D. (2015). Child care arrangements and labor supply. IDB Working Paper Series No. 569, Inter-American Development Bank.

Del Boca, D., C. Flinn, and M. Wiswall (2014). Household choices and child development. *Review of Economic Studies 81*, 137–185.

Doiron, D. and G. Kalb (2005). Demands for childcare and household labour supply in Australia. *Economic Record 81*, 215–236.

Ellingsæter, A. L. (2003). The complexity of family policy reform. The case of Norway. *European Societies 4*, 419–443.

Feldstein, M. (1995). The effect of marginal tax rates on taxable income: A panel study of the 1986 Tax Reform Act. *Journal of Political Economy 103*, 551–572.

Geyer, J., P. Haan, and K. Wrohlich (2015). The effects of family policy on maternal labor supply: Combining evidence from a structural model and a quasi-experimental approach. *Labour Economics 36*, 84–98.

Givord, P. and C. Marbot (2015). Does the cost of child care affect female labor market participation? An evaluation of a French reform of childcare subsidies. *Labour Economics 36*, 99–111.

Gong, X. and R. Breunig (2017). Child care assistance: Are subsidies or tax credits better? *Fiscal Studies 38*, 7–48.

Haan, P. (2006). Much ado about nothing: Conditional logit vs. random coefficient models for estimating labour supply elasticities. *Applied Economics Letters 13*, 251–256.

Hallberg, D. and A. Klevmarken (2003). Time for children: A study of parent's time allocation. *Journal of Population Economics 16*, 205–226.

Hansen, J. and X. Liu (2015). Estimating labor supply responses and welfare participation: Using a natural experiment to validate a structural labor supply model. *Canadian Journal of Economics 48*, 831–854.

Havnes, T. and M. Mogstad (2015). Is universal child care leveling the playing field? *Journal of Public Economics 127*, 100–114.

Hook, J. L. and C. M. Wolfe (2012). New fathers? Residential fathers' time with children in four countries. *Journal of Family Issues 33*, 415–450.

Ilmakunnas, S. (1993). Female labour supply and work incentives. Labour Institute for Economic Research, Helsinki, Finland.

Kalb, G. (2009). Children, labour supply and child care: Challenges for empirical analysis. *Australian Economic Review 42*, 279–299.

Kimmel, J. and L. M. Powell (2006). Nonstandard work and child care choices of married mothers. *Eastern Economic Journal 32*, 397–419.

Kitterød, R. H. and M. Rønsen (2013). Does parenthood imply less specialization than before? Tales from the Norwegian Time Use Surveys 1980-2010. Discussion Papers No. 757, Statistics Norway.

Kornstad, T. and T. O. Thoresen (2007). A discrete choice model for labor supply and childcare. *Journal of Population Economics 20*, 781–803.

Krafft, C., E. E. Davis, and K. Tout (2017). Child care subsidies and the stability and quality of child care arrangements. *Early Childhood Research Quarterly 39*, 14–34.

Lokshin, M. (2004). Household childcare choices and women's work behavior in Russia. *Journal of Human Resources 39*, 1094–1115.

Lunder, T. E. (2015). Nasjonale satser til private barnehager. TF-notat nr 97/2015, Telemarksforsking, Bø i Telemark (in Norwegian).

Lundin, D., E. Mörk, and B. Öckert (2008). How far can reduced childcare prices push female labour supply? *Labour Economics 15*, 647–659.

Michalopoulos, C., P. K. Robins, and I. Garfinkel (1992). A structural model of labor supply and child care demand. *Journal of Human Resources 27*, 166–203.

Ministry of Children and Equality (2017). Overføringer til barnefamiliene. Norges offentlige utredninger (NOU) 2017: 6, Akademika (in Norwegian).

Miranda, V. (2011). Cooking, caring and volunteering: Unpaid work around the world. OECD Social, Employment and Migration Working Papers No. 116, Organisation for Economic Co-operation and Development, Paris.

Moafi, H. and E. Bjørkli (2011). *Barnefamiliers tilsynsordninger, høsten 2010*. Rapporter 2011/34, Statistics Norway (in Norwegian).

Morrissey, T. W. (2017). Child care and parent labor force participation: A review of the research literature. *Review of Economics of the Household 15*, 1–24.

Müller, K.-U. and K. Wrohlich (2016). Two steps forward – one step back? Evaluating contradicting child care policies in Germany. *CESifo Economic Studies 62*, 672–698.

Mumford, K., A. Parera-Nicolau, and Y. Pena-Boquete (2018). Labour supply and childcare for two-parent families: Allowing both parents to choose. Manuscript, University of York.

Nollenberger, N. and N. Rodríguez-Planas (2015). Full-time universal childcare in a context of low maternal employment: Quasi-experimental evidence from Spain. *Labour Economics 36*, 124–136.

OECD (2014). *Doing Better for Families*. OECD Publishing: Organisation for Economic Co-operation and Development, Paris.

Powell, L. M. (2002). Joint labor supply and child care choices of married mothers. *Journal of Human Resources 37*, 106–128.

Ribar, D. C. (1995). A structural model of child care and the labor supply of married women. *Journal of Labor Economics 13*, 558–597.

Statistics Norway (2016). *Kindergartens 2015*. https://www.ssb.no/en/utdanning/statistikker/barnehager/aar-endelige/2016-04-20.

Statistics Norway (2017). *Income and Wealth Statistics for Households*. https://www.ssb.no/en/inntekt-og-forbruk/statistikker/ifhus.

Statistics Norway (2018). *Labour Force Survey*. https://www.ssb.no/en/arbeid-og-lonn/statistikker/aku.

Tekin, E. (2007). Childcare subsidies, wages, and employment of single mothers. *Journal of Human Resources 42*, 453–487.

Thoresen, T. O. and T. E. Vattø (2015). Validation of the discrete choice labor supply model by methods of the New Tax Responsiveness literature. *Labour Economics 37*, 38–53.

Thoresen, T. O. and T. E. Vattø (2018). An Up-to-Date Joint Labor Supply and Child Care Choice Model. Discussion Papers No. 885, Statistics Norway.

Todd, P. E. and K. I. Wolpin (2003). On the specification and estimation of the production function for cognitive achievement. *Economic Journal 113*, F3–F33.

Todd, P. E. and K. I. Wolpin (2006). Assessing the impact of a school subsidy program in Mexico: Using a social experiment to validate a dynamic behavioral model of child schooling and fertility. *American Economic Review 96*, 1384–1417.

Train, K. E. (2009). *Discrete Choice Methods with Simulation* (Second ed.). Cambridge University Press.

van Soest, A. (1995). Structural models of family labor supply: A discrete choice approach. *Journal of Human Resources 30*, 63–88.

Weierud, M. (2015). Kontantstøttens samfunnsøkonomiske effekter. En empirisk analyse av avviklingen av kontantstøtten for toåringer i 2012. Master thesis, Department of Economics, University of Oslo (in Norwegian).

Wilhelmsen, M. and T. Löfgren (2011). Undersøkelsen om barnefamiliers tilsynsordninger 2010. dokumentasjonsrapport. Notater 13/2011, Statistics Norway (in Norwegian).

Wrohlich, K. (2011). Labor supply and child care choices in a rationed child care market. DIW Discussion Papers No. 1169, Deutsches Institut für Wirtschaftsforschung, Berlin.

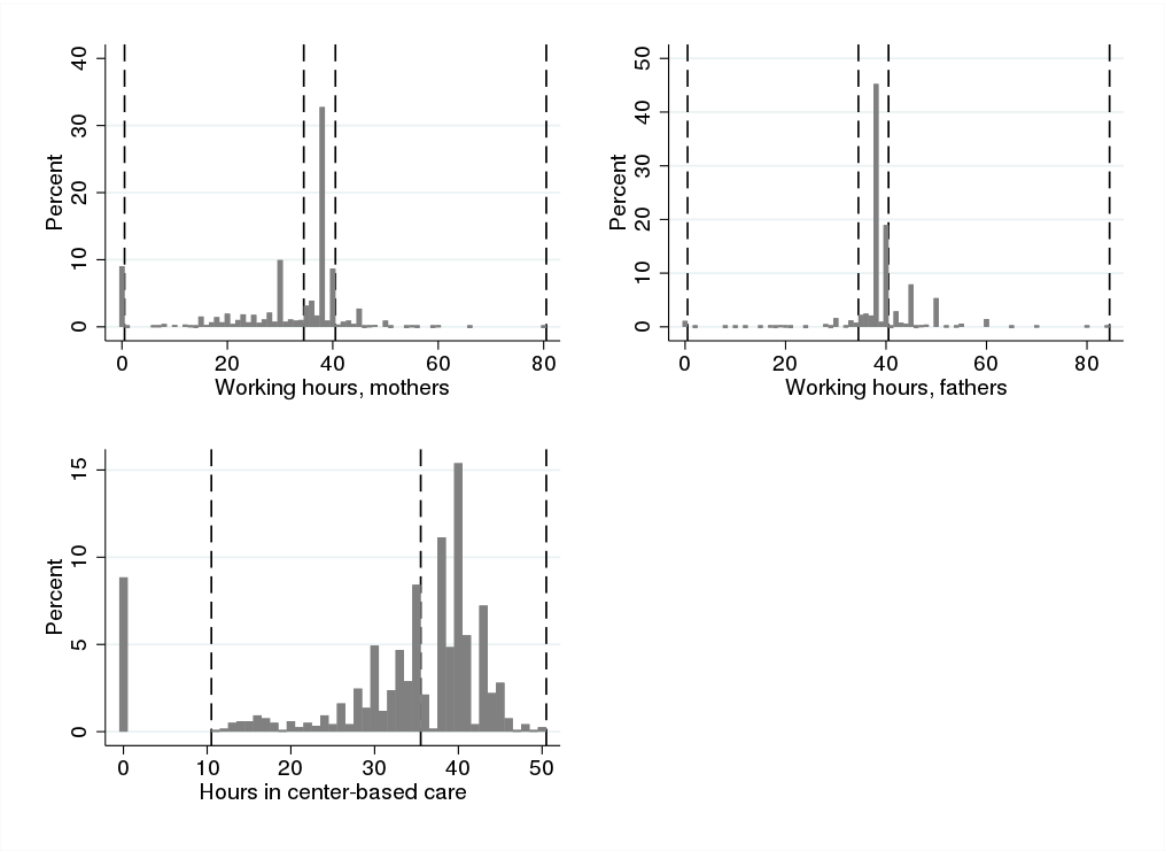
Appendix

Table A.1. OLS wage regressions

	Mothers		Fathers	
Experience	0.0688***	(0.0150)	0.0202	(0.0040)
Experience squared	-0.0017**	(0.0005)	-0.0005	(0.0001)
Low education	-0.3323***	(0.0781)	-0.2121*	(0.0921)
High education	0.2296***	(0.0486)	0.2672***	(0.0471)
Education category (base: "unknown")				
General	0.4833***	(0.0886)	0.2570**	(0.0969)
Human/art	0.3057**	(0.0999)	-0.0999	(0.1185)
Education	0.2943**	(0.0909)	0.0085	(0.1165)
Social/law	0.5078***	(0.1051)	0.0206	(0.1167)
Business	0.4942***	(0.0844)	0.3180**	(0.0892)
Technology	0.6091***	(0.0930)	0.2616**	(0.0691)
Health	0.4319***	(0.0782)	0.1475	(0.1011)
Primary	0.4504*	(0.2035)	-0.1384	(0.1368)
Service	0.4203**	(0.1622)	0.2780**	(0.1006)
Constant	4.1004***	(0.1274)	4.9824***	(0.1279)
Number of observations	1,144		1,176	

Notes. Standard errors are reported in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Figure A.1. Distribution of observed working hours and hours in center-based care



Notes. The dashed lines illustrate the chosen boundaries points when discretizing the observed choices into "None" (0), "Part-time" (1–34), "Full-time" (35–41), and "Overtime" (41+) for mothers' and fathers' working time, and "None" (0), "Part-time" (11–35), and "Full-time" (36+) for center-based care.

Table A.2. Complete list of estimated parameters

Variables	Parameter	Estimate	Std. error
Preference, $v(C, h_m, h_f, s_m, s_f, q)$			
Consumption, $v_1(C)$			
Intercept	α_0	0.1462***	(0.0319)
Squared term	α_1	-0.0002	(0.0001)
Leisure, $v_2(h_m, h_f, s_m, s_f)$			
Mother's leisure	β_{10}	8.6351***	(1.3601)
Age	β_{11}	0.0809**	(0.0301)
Immigrant status	β_{12}	-0.1396	(0.3118)
Low education	β_{13}	-0.0424	(0.4011)
High education	β_{14}	-0.4449	(0.3266)
Number of preschool children	β_{15}	0.5868*	(0.2385)
Father's leisure	β_{20}	0.4899	(1.8071)
Age	β_{21}	0.0618	(0.0381)
Immigrant status	β_{22}	0.6242	(0.4962)
Low education	β_{23}	1.2838*	(0.6179)
High education	β_{24}	-0.5299	(0.5173)
Number of preschool children	β_{25}	0.4491	(0.4004)
Interaction	β_3	-0.2739	(1.0996)
Interaction, standard schedules	β_4	1.7512***	(0.3871)
Nonparental child care, $v_3(q)$			
Intercept	γ_{00}	0.0143	(1.9183)
Age of the child	γ_{01}	1.6227***	(0.3680)
Squared term	γ_{10}	-3.9584*	(1.8893)
Age of the child	γ_{11}	-0.8030**	(0.2898)
Care int., $v_4(h_m, h_f, s_m, s_f, q)$			
Leisure of mother×care	δ_{11}	1.2855	(1.8223)
Leisure of father×care	δ_{21}	-2.6700	(2.4433)
Shift mother×care	δ_{31}	2.4286**	(0.8818)
Shift father×care	δ_{41}	1.5375	(0.8416)
Leisure of mother×care sq.	δ_{12}	-8.7768***	(1.7024)
Leisure of father×care sq.	δ_{22}	0.1227	(2.3964)
Shift mother×care sq.	δ_{32}	-3.2690***	(0.8195)
Shift father×care sq.	δ_{42}	-1.5480	(0.7985)

Note. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Variables	Parameter	Estimate	Std. error
Opportunity, $b(h_m, h_f, s_m, s_f, q)$			
Nonparticipation, mother	$g_{no,m}$	-1.6315***	(0.2127)
Nonparticipation, father	$g_{no,f}$	-0.1307	(0.3877)
Full-time, mother	$g_{full,m}$	1.4244***	(0.0883)
Full-time, father	$g_{full,f}$	1.5965***	(0.0794)
Shift work, mother, ς_1			
Intercept	ς_{10}	-0.8720	(0.3871)
Field of education			
General	ς_{11}	0.7372*	(0.3326)
Human/art	ς_{12}	0.2069*	(0.4451)
Education	ς_{13}	-0.8412	(0.4430)
Social/law	ς_{14}	-1.2357	(0.6623)
Business/administration	ς_{15}	-0.3261	(0.4048)
Natural sciences/technology	ς_{16}	-0.1625	(0.4508)
Health	ς_{17}	1.6334***	(0.3211)
Service	ς_{18}	0.4378	(0.7115)
Shift work, father, ς_2			
Intercept	ς_{20}	-0.3528	(0.3028)
Field of education			
General	ς_{21}	-0.1444	(0.2633)
Human/art	ς_{22}	-0.2837	(0.4027)
Education	ς_{23}	-1.7118**	(0.5647)
Social/law	ς_{24}	-1.0419*	(0.4622)
Business/administration	ς_{25}	-1.0552**	(0.3333)
Natural sciences/technology	ς_{26}	-0.9809***	(0.2463)
Health	ς_{27}	0.2648	(0.3196)
Primary industries	ς_{28}	-0.7173	(0.5438)
Service	ς_{29}	0.1434	(0.3275)
Decoupling work/care	κ	-0.1687	(0.1644)
Number of observations		1,176	

Note. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$