Child-care quality and fee structure: Effects on labor supply and leisure composition*

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Abstract

This paper studies the effects of public child-care subsidies on parental time allocation. We develop a model where parents are allowed to utilize subsidized care during both working and leisure hours. The model distinguishes between subsidies to child-care quality and to fees. Three types of fees are considered: flat, based on time spent in care, and based on parental income. We show that parental time allocation depends on whether quality or fees are subsidized, and also that fee subsidies have different effects depending on the fee structure. We further show that even if a subsidy increases the use of public care, the effect on labor supply may be unclear due to the possibility of using child care also when not working.

Keywords: Public child care; Child-care quality; Child-care fees; Time allocation; Labor supply

JEL classification: H42; J13; J22

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1 Introduction

Universal access to high-quality child care has become a policy objective in many European countries, since it facilitates mothers' increasing labor market activity and also promotes children's development.[1] Child-care subsidies are therefore regarded to be an important welfare-enhancing policy tool.

Previous research has shown that women's labor-market decisions are sensitive to what is subsidized, fees or quality. A large number of studies supports the idea that lower fees increase the demand for paid child care, implying that subsidizing fees may be successful in encouraging labor supply.[2] Less successful has child-care quality subsidies shown to be. However, the few studies made on the link between time allocation and child-care quality describe the situations in the U.S. and the U.K., which both are countries with differentiated child-care markets where parents face a menu of fee-quality alternatives.[3]

In many European countries the child-care market works differently. In contrast to the Anglo-American countries, these markets are characterized by universal and heavy subsidies that allow for politically determined parental fees and quality requirements.[4] An important implication of such policies is that parents do not face a variety of quality and fees. The only parental choices are therefore about time use: How many hours should be allocated to market work and how many hours should the child spend in non-parental care?

In this paper, we theoretically analyze the effects of child-care subsidies on parental time allocation in a European context. Two types of subsidies are considered, targeted either to improve quality or to reduce fees. Subsidized child care is often available and utilized also when not working. The model we develop does therefore allow the parent to utilize subsidized child care also during leisure hours, a feature that distinguishes our model from previous contributions where child-care utilization is associated with market work only.[5] We find that the non-correspondence

[1]See OECD (2001) for a cross-country comparison of early childhood education and care.

[2]See e.g. Blau (2000) and citations therein, Gustafsson and Stafford (2001), Del Boca (2002), Duncan et al. (2001) and Doiron and Kalb (2002).

[3]See Hagy (1998) and Blau and Hagy (1998) for U.S. evidence and Duncan et al. (2001) for U.K. evidence.

[4]Of course, all aspects of European child-care quality are not necessarily politically determined or costly, for example different confessional directions or teaching methods.

[5]See e.g. Gustafsson and Stafford (2001), Bergstrom and Blomquist (1995), and Lundholm and Ohlsson (1998).

between market work and child-care utilization is an important extension, since policies that increase child-care utilization not necessarily increase labor supply.

The Nordic countries stand out among the OECD countries as having close to universal child-care access for preschool children. In these countries, subsidized child care has mainly been used to promote labor market activity among mothers with young children. After the parental leave period, children are guaranteed a place in subsidized care to make it possible for the parents to return to work; see Kamerman (2000, 2003). Less than 20 percent of the child-care costs are covered by parental fees that generally are time or income based up to a ceiling. A considerable decrease of the ceiling was recently made in Sweden (2003) and Norway (2004), making many families pay the same, quite low, flat fee irrespective of utilized hours. So far, the effects of the fee reforms have not been researched, but anecdotal evidence suggests that parents have increased their use of public child care during leisure hours as a consequence of the zero marginal fees. This type of occurrence points to the importance of the design of child-care fees, an issue which has not yet been discussed in the child-care literature. Since much of the research has focused on competitive child-care markets, the fees assumed are by necessity cost based (and therefore time based). In this paper we recognize the fact that heavily subsidized child care enables fees to be based on other factors than time spent in child care. We explicitly study the effects of different fee structures. This is an important extension of the literature since many European countries do not use pure time-based fees, but rather mixes of time-based, income-based and flat fees, where time-based fees dominate.

The model developed in this paper assumes there are no supply-side constraints on subsidized child-care. Our results do therefore have implications especially for the Nordic countries, where provision is close to universal. Some insights may, however, be gained also about time allocation of mothers in continental Europe. In these countries the primary focus of child care has been on education. From the age of 3, children in Italy, France and Belgium have the legal right to attend publicly funded preschools that are free of charge, irrespective of the parents' labor market status. In Portugal and the Netherlands, this right is for children aged 4-6; see OECD (2001) and Kamerman (2000). The preschool day does not cover the standard workday. Shortage of both out-of-school provision and provision for younger children has therefore made it difficult to combine motherhood with market work.[6] The female labor supply aspect of child care is, however, getting increased attention. For instance, in France and in Belgium there are supplementary services available before and after school at an income-based fee. In France, there is also a priority to achieve full preschool coverage of the two-year-old children. Hence, the provision of subsidized child care in continental Europe is expanding, thus weakening the provision constraint faced by mothers to preschool children.

Section 2 presents our model of parental time allocation, where the parent obtains utility from consumption, two types of leisure (with and without child), and the child's well-being, which is affected by time and quality in public and parental care. Section 3 analyzes how subsidies of child-care quality and fees affect the parent's time allocation. We show that subsidies used for improving child-care quality have similar effects on parental time use as subsidies used for decreasing time-based fees. With a dominating substitution effect the time spent in child care increases in the subsidy. Since our model allows the parent to use child care also during leisure hours, the effect on labor supply is, however, unclear. We further show that if fees are income based, the result is different; with a dominating substitution effect, a decreased fee increases labor supply, but not necessarily the time spent in child care. Finally, Section 4 concludes the paper.

2 The model

We consider a one-parent time allocation model with one child.[7] The parent has preferences over private consumption, c, leisure without child, l, leisure spent together with the child, l_b, and the child's well-being, b. Preferences are represented by the utility function

$$W = U(c,\ l,\ l_b) + V(b), \tag{1}$$

where U and V are increasing and strictly concave. We assume that consumption

[6] Del Boca (2002) discusses the gravity of this problem in Italy, where mothers experience scarce access to child care services that cover a full workday in combination with a labor market that offer few part-time employment opportunities.

[7] This does not necessarily imply a one-parent household. If two parents, the other parent is assumed to make his labor supply decision independently of the caretaking parent. If this other parent is the father it is also likely that his labor supply is relatively constant, since empirical evidence suggests that male labor supply is fairly inelastic.

and both types of leisure are normal goods. To assure leisure normality, we make the sufficient assumption that $U_{ll_b} = 0$. Consumption and leisure are further assumed to be weak complements, such that the cross-derivatives U_{cl} and U_{cl_b} are non-negative.

Parental time can be allocated between market work, h, and two types of leisure,

$$h + l + l_b = 1, \tag{2}$$

where total time is normalized to unity. We assume that the parent at least spends some time together with the child ($l_b > 0$).[8] Public child care with exogenous and uniform quality is utilized whenever the parent is not together with the child, that is during $1 - l_b$. The term public child care is used throughout the paper, where public means that child care is publicly subsidized, but not necessarily publicly provided. Subsidized uniform care is thus the only form of child care available. To make the results clear we rule out the possibility of informal care.

The household's private consumption is constrained by post-tax labor income, hw, where w the post-tax wage rate,[9] m is non-labor income, and φ the fee paid if child care is utilized.

$$c = hw + m - \varphi \tag{3}$$

In contrast to private child care, where fees are cost based, fees in subsidized public care can be designed in several ways. In our model we distinguish between three different fee structures: time-based, income-based, and flat (constant) fees. Fees that are time based are similar to fees in private child care. A constant fee β is charged for every time unit the child spends in child care. In public care the size of β is determined by the size of the subsidy.

$$\varphi^{\beta} = \beta\,(h + l)\,,\ \varphi_h^{\beta} = \varphi_l^{\beta} = \beta, \tag{4}$$

where φ^{β} is the total fee charged and where subscripts denote partial derivatives. For a time-based fee, the marginal fee of an extra hour of child care is the same

[8] This is a reasonable assumption, which allows us to disregard corner solutions with low practical relevance.

[9] In contrast to e.g. Bergstrom and Blomquist (1995) and Lundholm and Ohlsson (1998) we do not explicitly model the tax system as financing the public sector, including child care. Thus, the tax system is only implicitly assumed.

irrespective of the parent's time use.

An income-based fee, on the other hand, is not neutral regarding the parent's time use. Since the fee is based on the parent's earned income, the only time use affecting the fee is market work.

$$\varphi^{\alpha} = \alpha w h,\ \varphi^{\alpha}_{h} = \alpha w,\ \varphi^{\alpha}_{l} = 0, \tag{5}$$

where α is the share of labor income charged for child-care utilization. There are two main differences from a time-based fee. First, there is no marginal fee of an extra hour of child-free leisure, since such a time use does not affect the parent's income. Second, the marginal fee of an extra hour of market work increases in the wage rate. This makes an income-based fee a tool for redistribution in a way that is not possible with time-based fees.

We also consider a flat fee, where a fixed amount is charged for everybody utilizing public child care, irrespective of the extent. Depending on the amount, the marginal fee of starting to utilize public care could be considerable. However, when already paying the fee, the marginal fee of an extra hour is zero irrespective of the parent's time use.

Henceforth, we abstain from the superscripts and simply denote fees φ.

The child's well-being is a concave function of the time in and quality, q of public child care.[10]

$$b = b\left(h + l, q\right) \tag{6}$$

Due to the time constraint, each additional hour spent in public child care implies one hour less of parental care. This implies that the net effect on b of an extra hour in daycare may be either positive or negative, depending on the sign of $b_{(h+l)}$. If positive, then the child would be better off with an extra hour in child care. If negative, the child would instead benefit from an extra hour in parental care. It is plausible that the sign of $b_{(h+l)}$ varies in quality and time spent in public child care. The idea that $b_{(h+l)} > 0$ up to a certain time in child care, but then declines and turns negative is consistent with the way in which child-care policy is designed in many European countries. Some hours of public child care often are guaranteed,

[10]Duncan et al. (2001) model the child's well-being in a similar manner.

irrespective of the parents' labor market status.[11] [12]

We make the assumption that the cross-derivative $b_{(h+l)q} > 0$, implying that improved quality increases the child's marginal benefit of public care.

Inserting the constraints (2), (3) and (6) into the utility function (1) yields the following optimization problem:

$$\max_{l,\ h} W\left(c,\ l,\ l_b,\ b\right) \quad \text{s.t.} \quad h \geq 0,\ l \geq 0 \text{ and } h + l < 1. \tag{7}$$

where $W\left(c,\ l,\ l_b,\ b\right) = U\left[hw + m - \varphi,\ l,\ 1 - h - l\right] + V\left[b\left(h + l, q\right)\right]$. The first-order conditions can be written as

$$\begin{aligned} h: \qquad & U_c\left(w - \varphi_h\right) - U_{l_b} + V_b b_{(h+l)} \leq 0, & (8)\\ & h \geq 0,\ \ \frac{\partial W}{\partial h} h = 0. & \\ l: \qquad & U_l - U_c \varphi_l - U_{l_b} + V_b b_{(h+l)} \leq 0, & (9)\\ & l \geq 0,\ \ \frac{\partial W}{\partial l} l = 0. & \end{aligned}$$

where the subscripts denote partial derivatives.

The optimal levels of h, l and l_b are jointly determined by Conditions (8) and (9). Condition (8) describes the choice between work and leisure together with the child, while the choice between leisure with and without the child is shown by Condition (9). The child-care fee structure affects the parent's incentives by making market work and child-free leisure more or less costly compared to leisure together with the child. Contrary to the marginal child care fees the other policy variable – public

[11] In Sweden, for instance, also children whose parents are unemployed or on parental leave are eligible for public child care three hours per day. In France, Belgium and Italy preschool activities are provided for children aged 3-6 for free some hours of the day, but if parents want their children to have longer hours they are charged an income-based fee.

[12] Aside from quality and time spent in child care, the age of the child may affect the sign of $b_{(h+l)}$. Infants are by most European policy makers considered to be best cared for by the parents, implying that $b_{(h+l)} < 0$ for this age group; see e.g. Kamerman (2003). For toddlers child-care policies are more diverse. The public care provided for children aged 1-3 is throughout Europe mainly targeted to children with employed mothers and charged with fees. This indicates that toddler care is provided mainly to facilitate mothers' market work and not because of children's needs for this type of care. For children aged 3-6, there seems to be a consensus among policy makers that children benefit from some time in public preschool.

child-care quality – enters only implicitly by its impact on $b_{(h+l)}$. For a given quality the child's well-being is maximized when $b_{(h+l)} = 0$. However, the child's well-being is only one aspect to consider when parental time allocation is determined. For instance, we see in Condition (8) that a high marginal utility of consumption could lead parents to work more than what would be optimal only concerning the child's well-being, i.e. $b_{(h+l)} < 0$ in optimum. This is consistent with the idea that child care is not primarily used for the child's sake, but also to facilitate market work of parents.

3 Effects of child-care subsidies

We assume that a subsidy can be used to improve child-care quality. For instance, quality is generally improved by increasing the cost of staff, either by increasing the staff-to-child ratio or by employing better trained teachers. Quality can also be improved by reducing group sizes, which involves increased costs both for staff and premises. Hence, by covering the care provider's costs, subsidies can be used to especially improve child-care quality. An alternative use of subsidies is to decrease fees.

We start our analysis by examining a stay-at-home parent's decision to enter the labor market. We define Δ as Condition (8) holding with strict inequality.

$$\Delta = U_c (w - \varphi_h) - U_{l_b} + V_b b_{(h+l)} < 0 \tag{10}$$

The more negative the value of Δ, the weaker are the incentives to enter the labor market rather than staying at home with the child.

Proposition 1. *Suppose $l_b = 1$. Then a subsidy increases the incentives to enter the labor market.*

Proof.

$$\frac{\partial \Delta}{\partial q} = V_b b_{(h+l)q} + V_{bb} b_q b_{(h+l)} > 0 \text{ since } b_q = 0 \text{ when } l_b = 1 \tag{11}$$

$$\frac{\partial \Delta}{\partial \alpha} = -U_c w - \left[U_{cc} w^2 (1-\alpha) - U_{cl_b}\right] h < 0 \text{ since } h = 0 \tag{12}$$

$$\frac{\partial \Delta}{\partial \beta} = -U_c - \left[U_{cc} (w - \beta)(h+l) - U_{cl_b}\right](h+l) < 0 \text{ since } h + l = 0 \tag{13}$$

By assumption, a subsidy can be used to improve quality or to reduce fees. It follows that Δ increases in a subsidy. □

If the parent does not utilize public child care, but spends all her time together with the child, a subsidy is associated with increased marginal utility of market work, while the marginal utility of time together with the child is unaffected. Improved quality increases the child's marginal well-being of public child care, while decreased fees decrease the parental cost of it. A subsidy thus increases the incentives to enter the labor market irrespective of whether quality is improved or fees are decreased. It should be noted that this is true also if fees are flat. When not utilizing public child care there is a substitution effect associated also with a flat fee. If a high fee deters the parent from entering the labor market, reducing that fee decreases the deterrence.

In the following, where the parent utilizes public child care, the effects of subsidizing a flat fee are different from the other subsidies, in the sense that there are no substitution effects associated with changes in the flat fee. Therefore, we study this fee in a separate section.

3.1 Quality, and time- and income-based fees

It is not unusual that non-working parents actually send their children to child care. If the non-working parent already uses public care during leisure hours ($l > 0$, $l_b < 1$), then the incentive to enter the labor market is not as easily affected by improved child-care quality as if $l = 0$.

Proposition 2. *Suppose $h = 0$ and $l > 0$. Then a decreased income-based fee increases the incentives to enter the labor market. A decreased time-based fee or a quality improvement may either increase or decrease the incentives to enter the labor market.*

Proof. See Appendix A.

From (12) it is clear that only labor income affects the income-based fee and that l is then free of charge. Thus the incentive effect is the same as in Proposition 1. For the two other two types of subsidies the use of child care during leisure hours affects the incentives to enter the labor market. There are now two effects on the parent's choice between market work and leisure together with the child. On the one hand, there is a substitution effect, making time in child care and thereby market work more attractive. On the other hand, when a time-based fee is reduced there is an income effect working in the opposite direction since also the fee paid for the existing l is reduced, which is clear from (13). The income effect thus increases the incentives to spend more time on leisure activities – both alone and together with the child. We can therefore conclude that l will increase if β is reduced, but the incentives to enter the labor market are strengthened only if the substitution effect dominates the income effect.

The result for improved quality is similar. According to the substitution effect the incentive to enter the labor market becomes stronger, since q increases the child's marginal well-being of public child care more than of parental care ($b_{(h+l)q} > 0$). On the other hand, if public care is better for the child than parental care ($b_{(h+l)} > 0$), then there is an effect working in the opposite direction to the substitution effect. The total effect on Δ (Equation (10)) is then undetermined. The reason is that the parent's leisure composition choice depends on the child's marginal well-being of public child care. As implied by Condition (9), if the child benefits more from public than from parental care, then more l is chosen. If q is increased, child care does not have to be used for the purpose of increasing the child's well-being to the same extent; the child's well-being can remain the same (or even increase) also with fewer hours in public care. We call this a capitalization effect, since the parent can capitalize the utilized time in child care. When public care is already used, this effect implies that q has a negative impact on the marginal utility of market work. The capitalization effect works in the opposite direction if $b_{(h+l)} < 0$. If the child benefits more from parental care than from public child care, the parent limits the time in public care to keep up the child's well-being. As q increases, the parent is less constrained by the child, who can spend more time in child care without becoming worse off. The two effects on the parent's choice between h and l_b then moves in the same direction and $\frac{\partial \Delta}{\partial q} > 0$ if $b_{(h+l)} < 0$.

Public child care is often thought to be utilized during working hours only. Much of the literature on child-care utilization and labor supply assume that there is a one-to-one relation between the two.[13] (In our case that implies, $h > 0$ and $l = 0$) We next turn to this case, where a working parent chooses to have all leisure together

[13] See e.g. Gustafsson and Stafford (2001).

with the child.

Proposition 3. *Suppose $h > 0$ and $l = 0$. Then (i) $\frac{\partial h}{\partial q} > 0$ if the substitution effect dominates the capitalization effect, (ii) $\frac{\partial h}{\partial \alpha} < 0$ and $\frac{\partial h}{\partial \beta} < 0$ if the substitution effect dominates the income effect.*

Proof. See Appendix A.

The result in Proposition 3 is the working-parent analogue to the non-working parent in Proposition 1. The effect of a fee subsidy on labor supply is straightforward, since it decreases the costs associated with market work.

The effect of improved quality follows the same mechanisms. If the child's marginal well-being of parental care is greater than of public child care, then improved quality results in increased labor supply. When $b_{(h+l)} > 0$ the result is unclear, due to the counteracting substitution and capitalization effects previously discussed. On the one hand, increasing the relative quality difference between public and parental care tends to increase public child care utilization. On the other hand, as quality is improved the time in public care can be reduced without negatively affecting the child's well-being. This makes the parent prone to increase leisure together with the child instead. The relative strength of these effects determine whether labor supply increases or decreases as child care quality is improved.

In many countries public child care is available irrespective of the parent's working hours, and may therefore be utilized also during leisure hours. We next turn to this situation, where the time allocation effects of a subsidy become more complex. If there is no one-to-one correspondence between labor supply and time in daycare (i.e. if both $h > 0$ and $l > 0$), the labor supply choice cannot be made in isolation from the leisure composition choice. The following two propositions show that a subsidy may affect the parent's response in different ways depending on what is subsidized.

Proposition 4. *Suppose $h > 0$ and $l > 0$. If the substitution effect is dominating, then (i) $\frac{\partial h}{\partial q} > 0$ and $\frac{\partial h}{\partial \beta} < 0$ if $U_{cl} \geq U_{cl_b}$, (ii) $\frac{\partial l_b}{\partial q} < 0$ and $\frac{\partial l_b}{\partial \beta} > 0$, (iii) $\frac{\partial l}{\partial q} > 0$ and $\frac{\partial l}{\partial \beta} < 0$.*

Proof. See Appendix A.

Subsidizing a time-based fee decreases the marginal child-care cost of child-free leisure. l will therefore unambiguously increase, and if the substitution effect dominates the income effect, it will be at the expense of l_b, which will decrease. The substitution effect on labor supply can be divided into two separate components. The decreased marginal cost of child care stimulates an increase in h, but the labor supply choice does also depend on the usefulness of additional consumption. Since the leisure composition is changed, the relative complementarity between consumption and the two types of leisure matters. If l_b is the stronger complement to c, then the substitution effect on h is undetermined.[14] The effects of a quality subsidy are qualitatively the same as of subsidizing a time-based fee, since both decrease the cost of child care.

Both the above mentioned subsidies are neutral about the parent's time use when the child is in child care. In contrast, an income-based fee discriminates between the parent's time uses while the child is in public care. Hence, subsidizing an income-based fee has other effects on the parent's time allocation.

Proposition 5. *Suppose $h > 0$ and $l > 0$. If the substitution effect dominates the income effect, then (i) $\frac{\partial h}{\partial \alpha} < 0$, (ii) $\frac{\partial l_b}{\partial \alpha} > 0$ if $U_{cl_b} \leq U_{cl}$, (iii) $\frac{\partial l}{\partial \alpha} > 0$ if $U_{cl_b} \geq U_{cl}$.*

Proof. See Appendix A.

Subsidizing an income-based fee is equivalent to reducing a proportional income tax, since it decreases the cost associated with market work by decreasing the fee during working hours. But since the marginal fee of child-free leisure is zero, the subsidy does not affect the cost of l. If the substitution effect dominates the income effect h therefore unambiguously increases when α is reduced. To free the time needed to increase labor supply, leisure time has to be decreased, either by decreasing l or l_b or both. Since the marginal cost of both leisure types are zero, the parent will decrease the leisure type that is the weakest complement to consumption. If l and l_b are equally good complements, i.e. if $U_{cl} = U_{cl_b}$ then both are decreased.

[14] While there are some studies made on how much time parents spend with their children (see Hallberg and Klevmarken (2003) for Swedish evidence), there is very little research done on what parents and children actually do when they are together. The impact of additional consumption on the marginal utility of the time spent together with the child in relation to leisure alone is not evident. The utility of spending time together with the child is maybe not very sensitive to additional consumption, since the value of this time use primarily comes from the company of the child. On the other hand, when alone, the marginal utility of consumption is likely to be higher since consumption enables more expensive leisure activities. This reasoning would imply that $U_{cl} \geq U_{cl_b}$.

3.2 Flat fee

In this section we examine the effects of a flat fee, i.e. a constant fee charged for everybody who utilizes public child care, irrespective of the time use. The marginal fee of en extra hour is therefore zero for a parent whose child is already enrolled in public child care. Hence, then there is only an income effect associated with the flat fee. This type of fee has recently been introduced in two of the Nordic countries, Sweden and Norway, and very little research has been done to analyze the effects of such a fee.[15]

Proposition 6. *For a parent utilizing public child care, changes in a flat fee, k, have the following effects: (i) If $h > 0$, then $\frac{\partial h}{\partial k} > 0$ and $\frac{\partial l_b}{\partial k} < 0$. (ii) If $h = 0$, then the incentives to enter the labor market increase in k, and $\frac{\partial l_b}{\partial k} < 0$ iff $U_{cl_b} > U_{cl}$.*

Proof. See Appendix A.

For parents utilizing public child care there is no substitution effect, but only an income effect associated with changes in the flat fee. Hence, if the flat fee is reduced the parent wants to have more leisure. For a working parent labor supply will unambiguously decrease as well as total time in child care.

The mechanisms are the same for the non-working parent. A reduced flat fee decreases the incentives to enter the labor market due to the income effect. A reduced fee increases consumption, thereby altering her marginal utility of leisure. Leisure composition will therefore change if $U_{cl} \neq U_{cl_b}$. The leisure type that is the stronger complement to consumption will increase at the expense of the other leisure type.

4 Concluding remarks

In this paper we have analyzed parental time-allocation effects of child-care subsidies. Subsidies are used for either increasing child-care quality or decreasing fees. We consider flat, time- and income-based fees. In our model there are two types of child care, publicly subsidized child care and parental care. This can be seen as a limitation of our model since we disregard informal child-care alternatives as well as

[15]Before the Swedish reform was implemented, Flood and Wahlberg (1999) simulated the expected effects of a flat fee on labor supply and household income.

child care bought in the market. However, for countries where the parental choice of child-care quality is limited (which is more likely if child care is heavily subsidized and fees politically determined) our paper provides some new insights about parental time allocation and demand for subsidized child care. Indeed, for countries where the share of subsidized child care is low (as in the U.S.), our model does not properly describe the parental child-care choice. In such countries child care quality cannot be regarded as supply-side determined and exogenous, but rather as the market outcome of consumer choices.

We show that if child care is utilized during working hours only and if the substitution effects dominate, then the qualitative effects of a subsidy are the same irrespective of whether quality or fees are subsidized: Labor supply, and thereby child-care utilization, increases. If child care is utilized also during leisure hours, then different subsidies have different qualitative impact. The reason is that income-based fees do not impose a parental cost on child-free leisure, which the other fees do. Fee subsidies do therefore give different results depending on the fee structure. Labor supply increases if fees are income based, but if quality or time-based fees are subsidized we can only tell that child-care utilization increases. This increase can be due to either increased labor supply or increased child-free leisure or both.

In Sweden there was a big child-care reform in 2003. It meant that the maximum parental fee was so low, so that most parents actually face a flat child-care fee. A few years earlier it was legislated that also children whose parents are unemployed or on parental leave are eligible for public child care. In terms of this paper, this has created many people in the $h = 0$, $l > 0$ solution. There has also been a debate about whether people "over utilize" pubic child care, in the sense that they do not only work, but also have child free leisure to a too large extent when the marginal cost of an extra hour is zero. One year after the fee reform, in January 2004, the flat fee was increased with roughly 10 percent. According to our model this would encourage market work and discourage child-free leisure among working parents. The same holds true for a parent who, for instance, is on parental leave with a younger child while an older child is sent to public child care. If the parent already pays the maximum fee when on parental leave, her incentives to return to the labor market sooner will be strengthened by the higher fee. For future research it is a given task to analyze whether this has become the case or not.

Appendix A: Proofs

Proof of Proposition 2. We make use of the equations (11) to (13) for the case where $h = 0$ and $l > 0$:

$$\begin{aligned}
\frac{\partial \Delta}{\partial q} &= V_b b_{(h+l)q} + V_{bb} b_q b_{(h+l)} > 0 \text{ if } b_{(h+l)} < 0, \\
\frac{\partial \Delta}{\partial \alpha} &= -U_c w < 0 \text{ since } h = 0, \\
\frac{\partial \Delta}{\partial \beta} &= -U_c - \left[U_{cc} \left(w - \beta \right) l - U_{cl_b} \right] l.
\end{aligned}$$

Hence, a decreased income-based fee unambiguously increases the incentives to enter the labor market, whereas the effects of increased quality and of a decreased time-based fee are unclear without any further assumptions. □

Proof of Proposition 3. By differentiating the first order condition (8), which holds with equality when $l = 0$ and $h > 0$, and setting $\frac{\partial l}{\partial q} = 0$ (to remain in the specific solution) we derive

$$\left. \frac{\partial h}{\partial q} \right|_{l=0} = \frac{V_b b_{(h+l)q} + V_{bb} b_q b_{(h+l)}}{-U_{cc} \left(w - \varphi_h \right)^2 + 2U_{cl_b} \left(w - \varphi_h \right) - U_{l_b l_b} - V_b b_{(h+l)(h+l)} - V_{bb} b_{(h+l)}^2}, \quad (14)$$

where the denominator is positive. The first term of the numerator represents the substitution effect and the second term the capitalization effect. If the substitution effect dominates the capitalization effect then $\frac{\partial h}{\partial q} > 0$.

By differentiating the first order condition (8), which holds with equality when $l = 0$ and $h > 0$, and setting $\frac{\partial l}{\partial \beta} = 0$ if fees are time based (to remain in the specific solution), and $\frac{\partial l}{\partial \alpha} = 0$ if fees are income based we derive

$$\left. \frac{\partial h}{\partial \beta} \right|_{l=0} = \frac{-U_c - U_{cc} \left(w - \beta \right) h + U_{cl_b} h}{-U_{cc} \left(w - \beta \right)^2 + 2U_{cl_b} \left(w - \beta \right) - U_{l_b l_b} - V_b b_{(h+l)(h+l)} - V_{bb} b_{(h+l)}^2}, \quad (15)$$

$$\left. \frac{\partial h}{\partial \alpha} \right|_{l=0} = \frac{-U_c - U_{cc} w^2 \left(1 - \alpha \right) h + U_{cl_b} w h}{-U_{cc} w^2 \left(1 - \alpha \right)^2 + 2U_{cl_b} w \left(1 - \alpha \right) - U_{l_b l_b} - V_b b_{(h+l)(h+l)} - V_{bb} b_{(h+l)}^2}, \quad (16)$$

where the denominators are positive. In (15)$-U_{cc}(w-\beta)h+U_{cl_b}h$ is the positive income effect part of the numerator, whereas $-U_c$ is the substitution effect. It follows that $\frac{\partial h}{\partial \beta}<0$ if the substitution effects dominates the income effect. For the income-based fee in (16) the term $-U_{cc}w^2(1-\alpha)h+U_{cl_b}wh>0$ is the income effect part of the numerator, and $-U_c<0$ is the substitution effect part of the numerator. It follows that $\frac{\partial h}{\partial \alpha}<0$ if the substitution effects dominates the income effect. □

Proof of Proposition 4. By total differentiating the first order conditions (8) and (9), we obtain the system in Appendix B. Using Cramer's rule gives us the expressions for $\frac{\partial h}{\partial \gamma}$ and $\frac{\partial l}{\partial \gamma}$, where γ differs depending on the fee structure. $\frac{\partial l_b}{\partial \gamma}$ is residually determined since $h+l+l_b=1$.

$$\frac{\partial h}{\partial \gamma}=\varphi_\gamma\frac{\partial h}{\partial m}+\frac{U_c}{|A|}\left(\varphi_{h\gamma}a_{22}-\varphi_{l\gamma}a_{12}\right), \tag{17}$$
$$\frac{\partial l}{\partial \gamma}=\varphi_\gamma\frac{\partial l}{\partial m}+\frac{U_c}{|A|}\left(\varphi_{l\gamma}a_{11}-\varphi_{h\gamma}a_{21}\right), \tag{18}$$
$$\frac{\partial l_b}{\partial \gamma}=\varphi_\gamma\frac{\partial l_b}{\partial m}+\frac{U_c}{|A|}\left[\varphi_{h\gamma}\left(a_{22}-a_{21}\right)+\varphi_{l\gamma}\left(a_{11}-a_{12}\right)\right], \tag{19}$$

where $|A|>0$ is the system determinant presented in Appendix B and $a_{11}-a_{22}$ refers to terms in the matrix in Appendix B. Equations (17)-(19) are explicitly divided into an income effect and a substitution effect. The terms $\frac{\partial h}{\partial m}<0$, $\frac{\partial l}{\partial m}>0$ and $\frac{\partial l_b}{\partial m}>0$ are the pure income effects presented in Appendix C. The second terms are the substitution effects. In order to prove Proposition 4 it is sufficient to sign the substitution effects, since the income effects are unambiguously signed.

For a time-based fee $\gamma=\beta$, where $\varphi_\beta=h+l$, $\varphi_{h\beta}=\varphi_{l\beta}=1$. The following expressions for the substitution effects (with superscript s) are obtained:

$$\frac{\partial h^s}{\partial \beta}=\frac{U_c}{|A|}\left[U_{cc}w\beta-\left(U_{cl}-U_{cl_b}\right)w-U_{cl}\beta+U_{ll}\right], \tag{20}$$
$$\frac{\partial l^s}{\partial \beta}=\frac{U_c}{|A|}\left[U_{cc}(w-\beta)w-U_{cl_b}w-U_{cl}(w-\beta)\right]>0, \tag{21}$$
$$\frac{\partial l_b^s}{\partial \beta}=\frac{U_c}{|A|}\left[-U_{cc}w^2+2U_{cl}w-U_{ll}\right]>0. \tag{22}$$

A sufficient condition for Equation (20) to be negative is that $U_{cl}\geq U_{cl_b}$. It follows that $\frac{\partial h}{\partial \beta}<0$ if $U_{cl}\geq U_{cl_b}$. Both Equations (21) and (22) are unambiguously signed, (21) is negative and (22) is positive. Thus, $\frac{\partial l}{\partial \beta} < 0$ and $\frac{\partial l_b}{\partial \beta} > 0$ if the substitution effect dominates the income effect.

By total differentiating the first order conditions (8) and (9), we obtain the system in Appendix B. Using Cramer's rule gives for a quality improvement:

$$\frac{\partial h}{\partial q} = \frac{D}{|A|}\left[(w+\varphi_l-\varphi_h)(U_{cl}-U_{cl_b})+\varphi_l\left[U_{cl}-U_{cc}(w+\varphi_l-\varphi_h)\right]-U_{ll}\right], \quad (23)$$

$$\frac{\partial l}{\partial q} = \frac{D}{|A|}\left[(w+\varphi_l-\varphi_h)U_{cl_b}+(w-\varphi_h)\left[U_{cl}-U_{cc}(w+\varphi_l-\varphi_h)\right]\right]. \quad (24)$$

$\frac{\partial l_b}{\partial q}$ is residually determined since $h+l+l_b=1$. It follows that

$$\frac{\partial l_b}{\partial q} = \frac{D}{|A|}\left[(w+\varphi_l-\varphi_h)\left[U_{cc}(w+\varphi_l-\varphi_h)-2U_{cl}\right]+U_{ll}\right], \quad (25)$$

where $D = V_b b_{(h+l)q} + V_{bb} b_q b_{(h+l)} > 0$ if and only if the substitution effect part of D, $V_b b_{(h+l)q}$, dominates the capitalization effect part of D, $V_{bb} b_q b_{(h+l)}$. $|A| > 0$ is the system determinant presented in Appendix B. For $\frac{\partial h}{\partial q} > 0$ when the substitution effect dominates, we thus require the bracketed expression in (23) to be positive. A quick look gives at hand that a sufficient condition for this is that $U_{cl} \geq U_{cl_b}$. The bracketed expressions in Equations (24) and (25) are unambiguously signed; in (24) it is positive and in (25) negative. Thus, $\frac{\partial l}{\partial q} > 0$ and $\frac{\partial l_b}{\partial q} < 0$ when $D > 0$. □

Proof of Proposition 5. We use the parts of the expressions in Equations (17)-(19) that represent the substitution effects. For an income-based fee $\gamma = \alpha$; $\varphi_\alpha = wh$, $\varphi_{h\alpha} = w$, $\varphi_{l\alpha} = 0$. We obtain

$$\frac{\partial h^s}{\partial \alpha} = \frac{wU_c}{|A|}\left[V_{bb}b^2_{(h+l)} + V_b b_{(h+l)(h+l)} + U_{l_b l_b} + U_{ll}\right] < 0, \quad (26)$$

$$\frac{\partial l^s}{\partial \alpha} = \frac{-wU_c}{|A|}\left[(U_{cl_b}-U_{cl})w(1-\alpha) + U_{l_b l_b} + V_{bb}b^2_{(h+l)} + V_b b_{(h+l)(h+l)}\right], \quad (27)$$

$$\frac{\partial l^s_b}{\partial \alpha} = \frac{wU_c}{|A|}\left[(U_{cl}-U_{cl_b})w(1-\alpha) - U_{ll}\right]. \quad (28)$$

Equation (26) is unambiguously negative. It follows that $\frac{\partial h}{\partial \alpha} < 0$ if the substitution effect dominates the income effect. A sufficient condition for Equation (27) to be positive is that $U_{cl} \geq U_{cl_b}$. If this condition holds, $\frac{\partial l}{\partial \alpha} > 0$ if the substitution effect dominates the income effect. Similarly, Equation (28) is unambiguously positive if

$U_{cl} \leq U_{cl_b}$. Then $\frac{\partial l_b}{\partial \alpha} > 0$ if the substitution effect dominates the income effect. $\square$

Proof of Proposition 6. By differentiating (8) when $l = 0$ and $\varphi = k$, where k denotes a flat fee, we obtain

$$\left.\frac{\partial h}{\partial k}\right|_{l=0} = \frac{-U_{cc}w + U_{cl_b}}{-U_{cc}w^2 + 2U_{cl_b}w - U_{l_b l_b} - V_b b_{(h+l)(h+l)} - V_{bb} b^2_{(h+l)}} > 0. \tag{29}$$

Since $l = 0$ and $\frac{\partial h}{\partial k} > 0$ it follows that $\frac{\partial l_b}{\partial k} < 0$.

In the interior solution where both h and l are positive, we obtain

$$\frac{\partial h}{\partial k} = -\frac{\partial h}{\partial m} > 0 \text{ and } \frac{\partial l_b}{\partial k} = -\frac{\partial l}{\partial m} < 0, \tag{30}$$

where $\frac{\partial h}{\partial m} < 0$ and $\frac{\partial l_b}{\partial m} > 0$ are the pure income effects, which can be found in Equations (32) and (34) in Appendix C.

In the corner solution where $h = 0$ and $l > 0$, Δ in (10) is strictly negative. The more negative the value of Δ, the weaker are the incentives to enter the labor market. Differentiating (10) with respect to k yields

$$\frac{\partial \Delta}{\partial k} = -U_{cc}w + U_{cl_b} > 0. \tag{31}$$

Differentiating (9) when $\varphi = k$ yields

$$\left.\frac{\partial l}{\partial k}\right|_{h=0} = \frac{U_{cl} - U_{cl_b}}{U_{ll} + U_{l_b l_b} + V_b b_{(h+l)(h+l)} + V_{bb} b^2_{(h+l)}},$$

where the denominator is negative. Since $\frac{\partial h}{\partial k} = 0$ it follows that $\frac{\partial l_b}{\partial k} = -\frac{\partial l}{\partial k}$. Hence, if and only if $U_{cl_b} > U_{cl}$, then $\frac{\partial l_b}{\partial k} < 0$. $\square$

Appendix B: The equation system representing the interior solution

$$\begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} \begin{bmatrix} dh \\ dl \end{bmatrix} = \begin{bmatrix} b_{11} & b_{12} & b_{13} \\ b_{21} & b_{22} & b_{23} \end{bmatrix} \begin{bmatrix} dq \\ dm \\ d\gamma \end{bmatrix}$$

where $\gamma = \alpha$ if daycare fees are income based and $\gamma = \beta$ if daycare fees are time based.

$$a_{11} = U_{cc}\left(w - \varphi_h\right)^2 - 2U_{cl_b}\left(w - \varphi_h\right) + U_{l_b l_b} + V_{bb} b_{(h+l)}^2 + V_b b_{(h+l)(h+l)}$$

$$a_{12} = a_{21} = -U_{cc}\varphi_l\left(w - \varphi_h\right) - U_{cl_b}\left(w - \varphi_h - \varphi_l\right) + U_{l_b l_b} + U_{cl}\left(w - \varphi_h\right) + V_{bb} b_{(h+l)}^2 + V_b b_{(h+l)(h+l)}$$

$$a_{22} = U_{cc}\varphi_l^2 - 2U_{cl}\varphi_l + 2U_{cl_b}\varphi_l + U_{l_b l_b} + U_{ll} + V_{bb} b_{(h+l)}^2 + V_b b_{(h+l)(h+l)}$$

$$b_{11} = b_{21} = -V_b b_{(h+l)q} - V_{bb} b_{(h+l)} b_q$$

$$b_{12} = -U_{cc}\left(w - \varphi_h\right) + U_{cl_b}$$

$$b_{13} = -\varphi_\gamma\left(U_{cc}\left(w - \varphi_h\right) - U_{cl_b}\right) + U_c\varphi_{h\gamma} = \varphi_\gamma b_{12} + U_c\varphi_{h\gamma}$$

$$b_{22} = -U_{cl} + U_{cc}\varphi_l + U_{cl_b}$$

$$b_{23} = -\varphi_\gamma\left(U_{cl} - U_{cc}\varphi_l - U_{cl_b}\right) + U_c\varphi_{l\gamma} = \varphi_\gamma b_{22} + U_c\varphi_{l\gamma}$$

The system determinant of the left-hand side matrix is

$$
\begin{aligned}
|A| = &- \left[U_{cl}\left(w-\varphi_h\right) - U_{cl_b}\left(w-\varphi_h+\varphi_l\right)\right]^2 \\
&+ \left(U_{l_b l_b} + V_{bb} b^2_{(h+l)} + V_b b_{(h+l)(h+l)}\right)\left[U_{cc}\left(w-\varphi_h+\varphi_l\right)^2 - 2U_{cl}\left(w-\varphi_h+\varphi_l\right) + U_{ll}\right] \\
&+ U_{ll}\left(U_{cc} - 2U_{cl_b}\right)\left(w-\varphi_h\right)^2 > 0.
\end{aligned}
$$

The first bracketed term is negative, but that $|A| > 0$ becomes obvious if we rewrite the expression,

$$
\begin{aligned}
|A| = &\left[V_{bb} b^2_{(h+l)} + V_b b_{(h+l)(h+l)}\right]\left[U_{cc}\left(w-\varphi_h+\varphi_l\right)^2 - 2U_{cl}\left(w-\varphi_h+\varphi_l\right) + U_{ll}\right] \\
&+ 2U_{cl}U_{cl_b}\left(w-\varphi_h\right)\left(w-\varphi_h+\varphi_l\right) + U_{l_b l_b}\left(U_{ll} - 2U_{cl}\left(w-\varphi_h+\varphi_l\right)\right) - 2U_{ll}U_{cl_b}\left(w-\varphi_h\right)^2 \\
&+ \left(w-\varphi_h\right)^2\left(U_{cc}U_{ll} - U^2_{cl}\right) + \left(w-\varphi_h+\varphi_l\right)^2\left(U_{cc}U_{l_b l_b} - U^2_{cl_b}\right).
\end{aligned}
$$

The terms $\left(U_{cc}U_{ll} - U^2_{cl}\right)$ and $\left(U_{cc}U_{l_b l_b} - U^2_{cl_b}\right)$ are positive due to concavity.

Appendix C: Pure income effects

By total differentiating the first order conditions (8) and (9), we obtain the system in Appendix B. Using Cramer's rule gives us the expressions for the pure income effects $\frac{\partial h}{\partial m}$ and $\frac{\partial l}{\partial m}$:

$$\begin{aligned}\frac{\partial h}{\partial m} =& \frac{1}{|A|}\Big[-(w-\varphi_h+\varphi_l)\left(U_{cc}U_{l_bl_b}-U_{cl_b}^2+U_{cl}U_{cl_b}+U_{cc}B\right) \\ & -(w-\varphi_h)\left(U_{cc}U_{ll}-U_{cl}^2+U_{cl}U_{cl_b}\right)+U_{cl_b}U_{ll}+U_{cl}\left(U_{l_bl_b}+B\right)\Big]<0,\end{aligned} \tag{32}$$

$$\begin{aligned}\frac{\partial l}{\partial m} =& \frac{1}{|A|}\Big[(w-\varphi_h+\varphi_l)\left(U_{cc}U_{l_bl_b}-U_{cl_b}^2+U_{cc}B\right) \\ & +(w-\varphi_h)\,U_{cl}U_{cl_b}-U_{cl}\left(U_{l_bl_b}+B\right)\Big]>0,\end{aligned} \tag{33}$$

$$\begin{aligned}\frac{\partial l_b}{\partial m} =& -\frac{\partial h}{\partial m}-\frac{\partial l}{\partial m}= \\ =& \frac{1}{|A|}\Big[(w-\varphi_h)\left(U_{cc}U_{ll}-2U_{cl}^2\right)+(w-\varphi_h+\varphi_l)\,U_{cl}U_{cl_b}-U_{cl_b}U_{ll}\Big]>0,\end{aligned} \tag{34}$$

where $B=V_{bb}b_{(h+l)}^2+V_bb_{(h+l)(h+l)}<0$ and $|A|>0$ is the system determinant presented in Appendix B.

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