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Maternal employment: the impact of triple rationing in childcare

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Abstract This paper analyses how maternal labor supply relates to the availability of childcare services in Flanders, a region that has a fairly abundant service provision, but does not offer a service guarantee as in several Nordic countries. Variation in price/quantity bundles that stems from the interplay of three types of childcare services are used to identify mothers' labor supply responses. The estimates indicate that policy measures which increase the availability may exhibit large labor supply effects. Moreover, budgetary simulations suggest the expansion of subsidised care services to be beneficial to the exchequer.

Keywords Labor supply · Childcare · Microsimulation

JEL Classification C35 · H24 · J13 · J22 · D10

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1 Introduction

Childcare is a key factor in the employment decisions of parents, especially of mothers. The availability of different childcare options, their quality and their price are major determinants of the work-family balance of households with (young) children. Moreover, the market of childcare services is prone to information asymmetry because parents are only indirect consumers of the service (Mocan 2007). Consequently, in many countries quality standards have been imposed and non-profit institutions have established an important role in the provision of childcare services because of the trust they engender. Furthermore, governments have engaged in service provision themselves or distribute subsidies to fuel the supply of services, so as to foster labor supply.

In this paper we investigate the effect of alternative availability and price levels on employment decisions of mothers with young children in Belgium (Flanders region). As in many countries, the Belgian federal and regional governments have adopted a mixed strategy, setting quality standards and subsidizing childcare provision by non-profit institutions. With an enrolment rate in formal care of children younger than three of 48.4 % (2008), Belgium figures among the top nations in this respect in the OECD. Nevertheless, Belgian governments have not issued a service provision guarantee as some Scandinavian countries (e.g. Sweden and Denmark) have. Therefore, it should not be a surprise that the availability of childcare places remains an issue. There are indications that all three forms of non-parental childcare that we distinguish (i.e. informal care, non-subsidized and subsidized formal care) are perceived to be in short supply. In this contribution we wonder how changes in the balance between the three channels of provision would affect maternal labor supply and more specifically, if public engagement beyond the current above OECD-average, but below Scandinavian level would still foster labor supply.

The richness of our dataset, the Flemish Families and Care Survey, allows us to incorporate the quasi-market interplay between the three types, which is a novelty in the literature. The distinction between types allows for a robust identification of price and availability (supply) effects, since the price and supply of the types varies strongly between municipalities, while the service quality is relatively homogeneous, because public supervision extends to all types of (formal) childcare.

Our paper builds on a structural labor supply model as proposed by Van Soest (1995), using a discrete random utility maximization model. We extend the conventional discrete labour supply methodology by explicitly taking the interplay between informal, subsidized formal and non-subsidized formal care into account.

This paper contributes to the existing literature in several ways. First, we extend the framework suggested by Wrohlich (2011) explicitly taking into account that household may perceive supply restrictions in the market for childcare services (even if part of that market is open to free entry, for example). Second, we propose an alternative way of taking supply restrictions in the childcare market into account in the estimation of the labor supply model by distinguishing between two groups of households, i.e. the non-restricted and restricted. Households who face a low probability of finding suitable childcare face a restricted labor supply choice set.

Finally, our methodology can be used to analyse how labor supply is affected by different policy changes.

We start with a brief overview of related studies in the literature (Sect. 2). Section 3 discusses the childcare context in Flanders and explains in detail how the different offer probabilities for the three types of childcare are estimated by applying a partial observability model. Section 4 presents our methodological framework, and the data assumptions are explained in Sect. 5. Results are presented in Sect. 6. The final section concludes.

2 Literature review

There exists a large amount of literature describing the effect of children, more specifically the effect of childcare, on parental labor supply. Anderson and Levine (1999), Brewer and Paull (2004) and Kalb (2009) provide overviews of the existing studies related to childcare and labor supply. This latter study discusses in detail how the monetary cost, availability and quality of childcare affect parental labor supply decisions for different countries.

The literature about labor supply and childcare demand can be broadly classified into two categories depending on the assumptions made regarding parental demand for childcare. The first stream, known as the *Cost of Working Approach*, considers childcare only as a way to make time available for parents to engage in market work. As such, childcare only forms part of the costs of working and the demand for care is completely determined by the parental labour supply decision. The main advantage of this type of modeling is that it simplifies a more complicated model in the case where the main focus is not on modeling parental childcare demand but there is still a need to include it into the model. Hence, most studies in this stream of the literature focus only on the parental labour supply decision. Studies whose main purpose is to model both the childcare and labor supply decision mostly allow for other justifications for childcare demand, such as the quality of different types of care and educational and development opportunities for the children. In this second stream, known as the *Simultaneous approach,* households make their employment and childcare decisions simultaneously and studies investigate the link between both, rather than only focussing on the former. The work presented in this paper can be situated in the first stream of literature as our main purpose is to see how employment decisions are affected by characteristics of the childcare market and not how childcare choices are made.

The existing literature focuses mainly on three aspects of childcare: price, quality and availability. Basic economic intuition suggests the price of childcare to be one of the most important features of childcare in the parental labor supply decision. Hence, many studies have put emphasis on these monetary costs to explain labor market behaviour, such as the participation decision of mothers. These effects are most often presented as elasticities that report the change of labor supply and labor market participation which results from a change in childcare prices. Anderson and Levine (1999) and Kalb (2009) provide summary tables of estimated elasticities for different countries and subgroups. Their estimates vary across a wide range but

indicate that, on average, childcare prices affect labor supply negatively. For example, Blau and Robins (1988) find for the United States an elasticity of maternal employment relative to the price of childcare of −0.34;[1] Ribar (1995) reports an elasticity of −0.09 for married women in the United States; Wrohlich (2004) finds an elasticity of −0.21 for German mothers with full-time working husbands; Mahringer and Zulehner (2013) find an elasticity of −0.13 for Austria; and Hardoy and Schone (2013) find an elasticity of −0.25 for Norway. Gong et al. (2010) state that this variation partly reflects the fact that childcare and other welfare institutions vary across countries and that differences in methodology and data sources may also play an important role, making a direct comparison difficult.

In more recent literature, the focus has shifted from the monetary cost of childcare to its availability. This literature provides mixed evidence of the size and sign of the effect of these availability constraints on labor supply. For Germany, Kreyenfeld and Hank (2000) employ a multinomial logit model to estimate how the availability of public and informal day-care arrangements affect female labor-force participation. The authors find no significant effect of regional childcare provision on female labor-force participation. Wrohlich (2011), however, does find significant labor supply responses for German mothers of an increase in childcare availability. She models availability restrictions explicitly in the budget constraint, and assumes that rationing occurs only with respect to subsidized childcare. The author assumes that childcare can always be bought at some (potentially very high) price on the private market. Wrohlich (2011) shows that policy reforms in Germany targeted at an increase in childcare slots had larger effects on maternal labor supply than reductions of the monetary cost in childcare. For Italy, Del Boca (2002), Del Boca and Vuri (2007) and Brilli et al. (2013) find a positive impact of childcare availability on the likelihood of mothers working. These studies restrict the choice set of households according to a simulated probability of being rationed in the childcare sector. For Russia, Lokshin (2004) models rationing by restricting the choice set of parents who report to be rationed in the childcare market. Kornstad and Thoresen (2007) follow a similar method for Norway. Both studies find positive labor supply responses to increased availability of the childcare sector.

For Belgium in particular, there is hardly any literature about the effects of childcare on the labor supply decision of households. The only recent paper that estimates labor supply elasticities with respect to childcare costs is Van Klaveren and Ghysels (2012). The authors find, in contrast to many studies in the literature, positive labor supply elasticities with respect to childcare costs. However, it is hard to compare their work to the work presented above because the authors use a collective household model which treats childcare costs as a pure income effect, given the power balance (sharing rule) in the household. Rising costs reduce the non-labor income of the household and, hence, motivate parents to increase their working hours.

[1] See Herbst (2010) for a more recent study on labor supply effects on childcare costs for the US.

3 Three types of supply restrictions in the childcare sector

This section looks at the childcare sector in Flanders and analyzes the search process of households for childcare. It discusses how each type of childcare is confronted with its own type of supply restrictions and, consequently, households may feel restricted in their childcare choice. Furthermore it shows how household specific offer probabilities for childcare are estimated by applying a partial observability framework as suggested by Poirier (1980).

3.1 Childcare in Flanders: types, usage and costs of childcare

The childcare landscape in Flanders can be divided in two large categories: formal and informal care. Informal childcare is an important care channel. Mainly grandparents, but also other family members, neighbors or friends are possible providers of care.

Subsidized formal care, which receives cost-covering subsidies from the government body 'Child and Family', is mainly organised by social organisations. Non-subsidized care consists of a mixed population of non-profit and for-profit organisations, though no large corporations are active in childcare services in Flanders. In both types of formal childcare services, parents can apply for a tax deduction if they have their children cared for by an approved provider. Through this approval process Child and Family ensures that quality standards are imposed quite effectively and homogeneously, which allows us in the remainder of this contribution to focus on the quantities of supply only rather than on quantity/quality bundles.

Under the simplifying assumption of homogeneity, the search process of households for childcare is determined by the availability and the price of each childcare type. Grandparents hardly ever charge for their care, which makes their care by far the most cost-attractive for parents. Within the formal sector, however, prices vary considerably. Subsidized providers of formal childcare are obliged to apply a legally determined means-tested tariff structure (dependent on household income), while non-subsidizes providers are free to determine their prices. In the subsidized sector, the daily price in 2005 (2014) lies between a minimum price of 1.26 (1.56) Euro and a maximum of 22.40 (27.71) Euro, with an average cost of 13.5 Euro. The only information about the price setting in the non-subsidized sector comes from a 2009 report (Hedebouw and Peetermans 2009), which indicates that on average a non-subsidized childminder charged 17.16 Euro in 2009 and a non-

Table 1 Most frequently used type of childcare, 3 months–3 years, Flanders (%)

Type of care	2001	2009
Formal subsidized care	45.6	46.9
Formal non-subsidized care	17.8	23.9
Informal care (grandparents)	29.9	22.4

Source: Bettens et al. (2002) and Hedebouw and Peetermans (2009)

subsidized day nursery 21.16 Euro. Given the structure of the means-tested tariff , using childcare in the non-subsidized sector results in considerably higher monetary costs than in the subsidized sector for 90 % of the parents.

Table 1 looks at the evolution of the main childcare choices amongst user families in Flanders. The use of informal care as the primary care-taking channel decreased in favor of formal care and mainly the non-subsidized part of it (market care). This decrease of grandparental care in Flanders reflects a trend common to most European countries (Hank and Buber 2009; Aassve and Meroni 2012). Several explanations are given, such as more active ageing, through which grandparents are still working or do not have the time to take care of their grandchildren. This decrease notwithstanding, many parents state that grandparents are their preferred care providers (Ghysels and Debacker 2007)

3.2 Three types of supply restrictions

Despite the growing contribution of market services, complaints about a lack of childcare places still abound in public media. Parents are given the advice to start their search at least nine months before they want the service to initiate. Even so, research commissioned by Child and Family in 2007 indicated that 10% of the parents were not able to secure a suitable childcare place after a search period of 6 months (MAS 2007). The general perception of a lack of childcare services may especially deter non-employed mothers from entering the labor market, because their decision to become active in the labor market crucially depends on the perceived ability to secure a childcare service within the period of time an employer would be willing to wait for a job to start, typically a few weeks. Our analysis of the role of childcare services in the labor supply decision of mothers therefore studies how mothers perceive their likelihood of being able to secure a childcare service.

In this contribution we do not dwell on the market for childcare services in itself. It may well be that the market originating from the demand not fulfilled by informal and subsidized formal childcare, reaches equilibrium with the figures shown in Table 1. Yet it is likewise possible that there are important frictional imbalances because of the inflexible nature of demand (service provision for a prolonged period of typically 30 months between the end of maternity leave and the start of kindergarten) and the resulting discontinuous nature of supply. We leave a proper analysis of the childcare market for future research and rather focus here on the role of supply perceptions in labor market decisions. More specifically, we assume that parents separate their overall likelihood of an effective offer of a childcare service into three components, reflect on each of them taking into account specific supply determinants (to which we will return below) and decide whether they would be willing to accept an offer of the type considered. Regarding the latter decision, we assume cost optimization to be an important element: parents choose grandparental care if available, turn to subsidized care if needed and use non-subsidized care as the supplier of last resort, because it tends to be the most expensive offer. Yet, when estimating demand in the empirical analysis we will also include various taste shifters like the educational level of the parents, their family composition and their declared preference for the childcare type at hand.

Supply statistics underpin the signals of supply restrictions mentioned above (MAS 2007). Municipal supply statistics corresponding to our period of analysis (2005) show that the coverage rate (number of slots divided by the number of children in the age range of 3–30 months) averaged 24 % for subsidized care and 11% for non-subsidized childcare. For formal childcare overall, the 340 municipalities of Flanders had an average coverage rate of 34 % (interquartile range 27–40 %). While one small municipality boasted a coverage rate of over 100 %, it is more important to observe that the 95th percentile's coverage rate is only 54%. Confronted with municipal employment rates of mothers with young children of on average 70 %, there is little wonder that many parents perceive both the subsidized and the non-subsidized childcare sector to offer few options.[2] Therefore, we will assume that besides grandparental rationing, parents may also perceive formal childcare not to offer suitable childcare. The following section explains how we estimate a specific supply restriction probability for every household and every childcare type.

3.3 Estimating perceived supply restrictions: partial observability model

As will be discussed in the following section, our labor supply model incorporates the perception of restricted supply by estimating offer probabilities of childcare that parents experience. The model necessitates four household-specific offer probabilities of childcare: for childcare in general and for each type of care individually (informal, formal subsidized and non-subsidized). The general offer probability will be used to determine the set of labor market choices that are open to specific parents, while the offer probabilities of each type of care will be combined into a household-specific price of childcare.

To estimate these supply probabilities, we rely on a simultaneous estimate of demand and supply of childcare using the partial observability probit framework suggested by Poirier (1980) and adapted to a childcare setting by Viitanen and Chevalier (2003). We do not apply the modified framework suggested by Wrohlich (2008), because, unlike Germany, we see no large group of municipalities with full coverage, as already documented above. The historically high supply of childcare services in the eastern part of Germany allowed Wrohlich (2008) to restrict the estimation to demand for only part of her sample, but no such situation exists in Flanders. Neither do we rely on panel data, which might allow us to treat parents who had a slot in the year before to be non-rationed as in Haan and Wrohlich (2011).

Following Poirier (1980), we treat the observed use of a childcare service of household i, C_i, as the combined result of two unobserved, binary elements: having perceived to be offered a slot (effective supply S_i^*) and having decided to use the

[2] Note that the part-time nature of demand for childcare does not warrant a simple equation of the coverage rate with the employment rate of mothers. In effect, a full-time childcare slot may cover for more than one child. As a rule of thumb, the Flemish childcare authority 'Kind en Gezin' assumes in its planning exercises that a full-time slot can cover the demand of 1.2 children.

offer (effective demand D_i^*). With all variables in the following equation to take values $\{0, 1\}$, it is easily seen that use can only be observed when both supply and demand are secured (i.e. equal to 1).

$$C_i = S_i^* \cdot D_i^* \tag{1}$$

Poirier (1980) suggests modeling the realization of the two defining elements of observed use as separate equations in a bivariate probit model. We estimate this system of equations, but should stress that only the point estimates of the supply part will be used later on as these reflect the offer probabilities that are included in the labour supply model. The demand part of the estimates is a by-product that does not play part in the subsequent estimation of maternal labor supply.

To obtain identified estimates, Poirier (1980) proved—unsurprisingly—that exclusive instruments are needed in every equation separately (supply and demand). Detailed information on the actual estimates can be found in the "Appendix" and the online Appendix of this paper. This includes basic descriptives on all variables used. For the estimation of the overall use of childcare services (all types together), we identify demand through determinants of maternal market work (maternal health, father's labor market status, property status of the family dwelling, maternal mother's working status during the childhood of the mother and maternal task division preferences). Perceived supply is identified through various indicators of grandparental availability and the coverage rate of formal childcare services in the municipality of the household.

Regarding grandparental care, we identify supply through variables that have proven to determine grandparental childcare efforts in earlier research (Uhlenberg and Hammill 1998 and Hank and Buber 2009): the health of grandparents, their employment status and the distance between their home and the home of the children requiring care. Demand by the parents is identified through preference indicators in the dataset, which relate to the preferred type of childcare of the father (first preference is grandparental care or formal care, a similar indicator for the mother is not included to avoid multicollinearity with other characteristics of the mother).

Regarding subsidized care, we assume the likelihood of an effective offer to be identified by the municipal structure of childcare supply (coverage rate and proportion of subsidized provision). Furthermore, indicators of the search skills of the parents (educational level of the mother and poverty status) are included, as the latter proved to be linked to the rationing experienced (see MAS 2007). Also various elements that determine the preference rules of subsidised childcare institutions (family composition, family income) are taken into account. The latter allows us to reiterate that in our framework supply is to be understood as the offer as experienced (perceived) by the household. To the extent that household characteristics explain variation in the offer experienced by the household (because of search skills and/or preference rules), these characteristics are determinants of supply. We identify demand through the inclusion of preference indicators regarding formal childcare, and the likelihood of grandparental care as estimated in the grandparent

Table 2 Offer probabilities of three types of childcare and childcare in general

Type of care	Mean pred. prob.	p25	p75	% above .50
Informal care (p_i^{inf})	.50	.30	.72	50 %
Formal sub. care (p_i^{fs})	.86	.81	.99	90 %
Formal non-sub. care (p_i^{fns})	.63	.33	.95	64 %
Childcare in general (p_i^{tot})	.82	.73	.95	93 %

Source: Own calculations, FFCS (2005), N = 512

procedure, because we expect parents with a high likelihood of grandparental support to be less inclined to look for formal childcare.

Regarding non-subsidized care, we rely for identification of supply on the municipal structure of formal childcare. For demand, we incorporate preference indicators regarding formal childcare and include the previously estimated likelihoods of grandparental care and subsidized care. The latter reflects the cost hierarchy in the childcare search process, which explains why the most expensive type of care (non-subsidized care) is less likely to be demanded when either grandparental care or subsidized care are expected (i.e. have high estimated use probabilities).

Finally, since the predicted offer indicators are to be used in subsequent labor supply estimates, we do not incorporate the employment status of the mother in itself as a control variable. However, we do include the age and education level of the mother and incorporate furthermore the age of the youngest child and the number of children as common determinants of supply and demand. While not being exclusive instruments, they do influence the eventual use of childcare services.

Table 2 gives an overview of the estimated offer probabilities for informal care, formal subsidized and non-subsidized care and childcare in general.[3] Accordingly, parents perceive an average supply probability of 82 % with respect to childcare in general (total of any type of childcare service), while 7 % of the parents in our sample perceive supply to seriously restrict their ability to secure childcare services, i.e. have a predicted probability of a childcare offer (any type) of less than 50 %.[4] The variation in the predicted offer probabilities of the separate types of care, on the other hand, underpins the distinction we will make when calculating the expected monetary cost of childcare. Especially in the relatively smaller sectors of informal and non-subsidised childcare, a considerable proportion of parents is predicted to view the options as limited (respectively 50 and 46% have a predicted offer probability of less than 50 %). Also the interquartile range of the predicted probabilities is large (see Table 2). As will be discussed further in Sect. 4.2, we

[3] We use the Flemish Families and Care Survey (FFCS) data for these estimations. This dataset is described in detail in Sect. 5. It should be noted that, to obtain maximum reliability, estimation was done on the largest possible dataset (N = 870), representative of all types of households with small children in Flanders, thus including single parents households and households with an unemployed father. The table, however, reflects only the couple households of the target population of this paper.

[4] As a sensitivity analysis, we looked at the percentage of parents experiencing supply to be restricted, when taking other limits than 50 %. If we take 30 %, the percentage of parents living in such a situation drops to 2.5 %. This number raises to 4 % when taking 40 and 11 % when taking 60 and 19 % when taking 70 %.

expect the price of childcare to vary strongly between households, as a result of the high variation in offer probabilities for the three different sectors.

4 Methodological framework regarding labor supply

Up to the nineties, labor supply was modeled in a continuous way, see Hausman and Ruud (1986) and Arrufat and Zabalza (1986), where the household chooses from a continuous set of hours. However, an important drawback of this methodology is that individuals may choose their optimal point anywhere along the budget constraint (see e.g. Aaberge et al. (1999) for a discussion of this critique).

In order to overcome these problem, researchers have made use of a discrete random utility maximization model (RUM), initiated by Daniel MCFadden (1974). Van Soest (1995) can be seen as one of the first papers that applied this random utility framework to the estimation of labor supply. Our paper estimates such a discrete labor supply model for Flanders, with an explicit focus on childcare.

This section explains in detail which labor supply model is estimated, and how we extend the model suggested by Van Soest (1995) by taking childcare explicitly into account. We develop our approach only for couple households with a father engaged in full-time work. In other words, the choice variable of the household is the labor supply of the mother. Labor income of the father is assumed to be given.

4.1 General outline of the model

Van Soest (1995) assumes that each household is confronted with a limited amount of labor supply alternatives $j = \{0, 1, ..., J\}$. The utility of household i when supplying $j = \{0, 1, ..., J)$ hours of work per week is equal to:

$$V_{i,j} = U_i((T - h_{i,j}), C_{i,j}|X_i) + \epsilon_{i,j}, \tag{2}$$

in which T stands for the total available time per week, $h_{i,j}$ represents total labor supply of mother i at alternative j, X_i are household characteristics and $C_{i,j}$ stands for total disposable household income when the mother works j hours per week.

In line with Van Soest (1995), we assume that utility $V_{i,j}$ can be divided in two parts, namely a structural or deterministic component of utility which is assumed to be known to both researcher and household and a random part that is unknown to the researcher but assumed to be known to each household individually.[5]

As some households perceive availability restrictions in the childcare market and fear not to be able to find suitable childcare if needed and, hence, feel not to have the opportunity to accept market work, we extend the standard Van Soest (1995) model and assume that mothers who perceive strong care service restrictions, have a restricted labor supply choice set $j = \{0\}$ that includes only non-participation. In the estimation procedure, we attribute this restricted choice set to mothers who think their probability of being offered a childcare spot (of any type) is lower than 50 %.

[5] In contrast to Van Soest (1995), we have chosen not to include alternative specific constants as it is relatively hard to give a meaningful interpretation to these constants in terms of preferences.

We refer to this standard tipping point in probability analysis, but will also perform sensitivity analyses with less restrictive percentage bounds.

The parameters of the utility function U_i are estimated by maximum likelihood. The individual log likelihood contribution of households that face a restricted choice set equals zero.

4.2 Specification of the model

In line with Blundell and Macurdy (1999), we assume the following quadratic specification for the deterministic part of utility:

$$\begin{aligned} U_i((T-h_{i,j}),C_{i,j}|X_i) = {} & \beta_c\left[C_{i,j}\right] + \beta_{cc}\left[C_{i,j}\right]^2 \\ & + \beta_h(X_i)\left[T-h_{i,j}\right] + \beta_{hh}\left[T-h_{i,j}\right]^2 \\ & + \beta_{hc}\left[T-h_{i,j}\right]\cdot\left[C_{i,j}\right] \end{aligned} \tag{3}$$

where we allow for interaction effects between non-working time and income. We allow for heterogeneity in the estimated coefficient for non-working time $(T-h)$:

$$\beta_h(X_i) = \beta_{h,0} + \beta_h^{'} X_i^h \tag{4}$$

where X_i^h is a vector representing the observed heterogeneity that contains variables such as education and age of the mother, and number and age of children.[6]

The net disposable household income $C_{i,j}$ of household i when supplying j amount of hours can be formally written as:

$$C_{i,j} = t\left(h_{i,j}\cdot w_i, I_i\right) - \mathrm{E}\left[P_{i,j}\right], \tag{5}$$

where the function t denotes the tax-transfer system, w_i stands for the hourly gross wage, I_i represents all non-labor income and $E[P_{i,j}]$ equals the expected monetary childcare costs for household i when working j hours.

When mothers are considering labor supply, we assume they take into account two decision elements regarding childcare: the probability of finding a slot of any type, which determines the possibility to accept a job offer, and the price they are expected to pay for the service, which influences the net gain of a potential job offer. The former is included in our model in the restricted choice set of some households and the latter is reflected in the budget constraint of each household. The expected price of childcare of household i with the mother working j hours per week is the weighted average of the unit price of the three different types of childcare for j hours of care per week :

$$\mathrm{E}\left[P_{i,j}\right] = z_i^{inf}\cdot P_{i,j}^{inf} + z_i^{fs}\cdot P_{i,j}^{fs} + z_i^{fns}\cdot P_{i,j}^{fns}. \tag{6}$$

[6] In order to keep the extended labour supply model relatively simple, we have assumed that preferences only differ across individuals by observed heterogeneity. As such, we neglect household specific heterogeneity which is unobserved (Hansen and Liu 2011). We assume that all unobserved effects are captured by the stochastic term $\epsilon_{i,j}$ of total household utility. Haan (2006) showed that relatively simple models of this kind tend to perform well in labor force participation predictions, which is also illustrated by our case (see below).

The household-specific weights for the informal childcare market and the formal subsidized and formal non-subsidized childcare markets are represented respectively by z_i^{inf}, z_i^{fs} and z_i^{fns}. The household-specific price for the three different childcare types when working j hours is given by $P_{i,j}^{inf}$, $P_{i,j}^{fs}$ and $P_{i,j}^{fns}$. Given the zero price of grandparental care, the former equation reduces to:

$$\mathrm{E}\,[P_{i,j}] = z_i^{fs} \cdot P_{i,j}^{fs} + z_i^{fns} \cdot P_{i,j}^{fns}. \tag{7}$$

In this equation, weights depend on the perceived likelihood of an offer of a particular type of care relative to the other likelihoods, see Table 2. As explained in Sect. 3.2, we assume that parents choose informal care over formal childcare options, because the former is free and the latter is not, and to choose for subsidized formal childcare over non-subsidized childcare, because the former is generally cheaper than the latter. The household specific weights take this stepwise demand pattern into account, assuming that the probability of formal care is only counted to the extent that informal care is not expected to be available, $(1 - p_i^{inf})$. The probability of non-subsidized care is weighted to an even lesser degree because it is the option of last resort and depends on the probabilities of the two preceding options, $(1 - p_i^{inf})(1 - p_i^{fs})$. Therefore, the weights used in Eq. 6 are given by:[7]

$$z_i^{fs} = \frac{(1 - p_i^{inf}).p_i^{fs}}{[p_i^{fs} + (1 - p_i^{fs}).p_i^{fns}]} \tag{8}$$

$$z_i^{fns} = \frac{(1 - p_i^{inf}).(1 - p_i^{fs}).p_i^{fns}}{[p_i^{fs} + (1 - p_i^{fs}).p_i^{fns}]} \tag{9}$$

5 Data issues and intermediate estimates

Section 5.1 provides an overview of the data used in this study. Section 5.2 briefly shows which discrete labor supply points are available for each household. Finally, we discuss in detail how the budget constraints look and how they are affected by childcare costs.

5.1 Data

This paper uses data from the 2004–2005 Flemish Families and Care Survey (FFCS). It contains 1,300 households with a youngest child aged up to three years and includes relevant information such as childcare utilization, the cost of childcare, household income, working hours and household characteristics.[8]

[7] Note that Eqs. 8 and 9 contain a normalizing factor $(1 - p_i^{inf})$, which ensures that the sum of the weights for the formal care options to be $(1 - p_i^{inf})$ and hence to complement the weight of informal care which carries a zero price.

[8] For more information about the FFCS, see Debacker et al. (2006).

Due to the lack of a sufficient amount of single parent households (59 households in the sample), the model presented in this paper is estimated on a subsample of couples. Only couples in which both partners are available for the labor market are retained in our sample. Moreover, we only consider the labor supply decision of the mother and focus on couples in which the father works full-time (89 households are dropped). We try to keep the model relatively simple by focusing on this specific subgroup which represents the most common situation among families with young children. Hence, we can investigate the labor supply decisions of mothers separately.

Both partners need to be aged between 18 and 65 years old and not in education, (pre)retired, disabled or ill (24 households are dropped). Self-employed individuals (16 % of the total sample) are excluded from the sample for two reasons: no reliable information about hours worked is available for them, and the labor supply decisions of self-employed people are possibly very different from those of salaried workers. Furthermore, households with children already available for the labor market but still living with their parents are excluded from the sample (4 households are dropped). The reason for this is that it is possible that their labor supply decisions are different from households without working children, because it is not clear whether the former households see their labor supply decision as a collective or an individual process. We retain a dataset containing 512 households.[9] Descriptive statistics about this sub-sample can be found in Table 10 in the "Appendix".

5.2 Discrete labor supply points

The survey provides information on the number of weekly hours worked in the month before the interview was given. We assume that women face a choice set of four discrete points: not working (0 h), working part-time (20 h), 80 % work (32 h) and working full-time (40 h).[10]

As already discussed in Sect. 2, we use a cost of working approach, which considers childcare only as a way to make time available for mothers to engage in market work. The amount of childcare needed by parents is thus completely determined by the mother's labor supply (e.g. if the mother works full-time, full-time childcare is needed; if the mother is not working, no childcare is needed). Additionally, we make the assumption that it is not possible for parents to work and take care of their children at the same time and we assume that parents are unable to organize their working hours in a flexible way, in order to be able to maximize the amount of time they can take care of their children themselves.[11]

[9] 195 households are dropped for reasons of programming in EUROMOD. 112 households are dropped because they either report hours worked or reported income, but not both.

[10] Not working equals the interval [0,10] h/week, part-time is equal to [11,25] h/week, 4/5 to [26,35] h/week and full-time reflects the interval [35,50] h/week.

[11] The empirical data of the FFCS support this assumption. Only 6 % of the parents with a child younger than three actually stated to be able to do without childcare services because they were using flexible working hours to organize care by themselves (Ghysels and Debacker 2007: 57).

5.3 Budget constraints

In order to be able to estimate the model presented in Sect. 4, household disposable net income is required for each discrete point (see Eq. 5). We apply the tax benefit microsimulation model EUROMOD for the derivation of these budget constraints.[12] Gross earnings from employment are calculated by multiplying gross hourly wage by the respective working hour in each hours category. We hereby make the assumption that the hourly wage rate is independent of the amount of hours worked, which implies that gross earnings increase linearly with working time. Due to this assumption, hourly wages are obtained by dividing observed gross income by the actual observed number of hours worked. We estimated the gross hourly wages for individuals that are observed to be inactive, taking into account possible selection effects. Gross household income is equal to the sum of the labor earnings of all household members. The income tax and employees' social security contributions are deducted from gross income, and social transfers are added to obtain the net disposable household income. Social transfers include child benefits, education benefits for students and housing benefits. No social assistance benefits or unemployment benefits are granted to households. This assumption is of minor importance as we only look at households in which the male works full-time, so these families are not eligible for means-tested social assistance.

According to Eq. (5), expected monetary childcare costs are taken into account in the calculation of the budget constraints. Given the estimated probabilities of receiving an offer of childcare for the three sectors (see Table 2) and the stepwise search for care by parents, we derive the expected childcare cost for each household at each discrete labor supply point according to Eq. (6). The higher the probability of being offered a place in informal care, the lower the expected childcare cost. The lower the probability of an informal childcare place, the higher the expected childcare cost, as households must rely on more expensive childcare such as formal subsidized or non-subsidized care. Furthermore the unit cost level for subsidized childcare is calculated depending on the simulated household income because of its income-sensitivity. In contrast a fixed unit cost is assumed for non-subsidized care (17.84 Euro/day in 2005), since no further cost information is available for this type of care.

Table 3 presents the monetary cost of childcare for an average household in our sample for each of the three types of childcare. By assumption, the price households have to pay for informal care in each of the four discrete labor supply points is zero. If, on the other hand, this average household uses formal subsidized care it would pay 126 Euro/month when the mother is working 20 h per week. This amount increases to 295 Euro/month when working full-time. A similar household that uses formal non-subsidized childcare pays a considerably higher fee for each of the three strictly positive labor supply points.

Table 4 provides summary statistics of the weighting factors in the childcare cost Eq. (6). The weight for informal care, which is provided for free, is on average 50.41 %. The cost of formal subsizied care is, on average, for 45.90 % accounted for and the average weight of non-subsidized care equals 3.68 % We see, however, a large variation in these weights by looking at the minimum and maximum.

[12] More information about Euromod can be found at https://www.iser.essex.ac.uk/euromod.

Table 3 Illustration of average monetary cost of childcare (Euro/month)

Hours	Informal childcare	Formal sub. care	Formal non-sub. care
0	0	0	0
20	0	126	170
32	0	221	262
40	0	295	327

Source: Own calculations, FFCS (2005)

Consequently, the expected price of childcare varies strongly between different types of households. This is illustrated for the case of full-time work (40 h/week) in the bottom line of the table, with expected prices varying between 3 and 686 Euro per month.

Table 5 provides summary statistics of the budget constraints. Average household income if the mother is not participating in the labor market equals 2,579 Euro/month. Remember that we focus solely on households in which the father is working full-time. This income is included in the budget constraint and explains why net disposable income when working 0 hours is considerable. The more the mother works, the higher the average net disposable household income.

6 Labor supply estimation results

This section discusses the results from the labor supply estimation by looking at the parameter estimates of the quadratic utility specification, the fit of the model and by deriving labor supply elasticities. Section 6.2 looks at the effect of childcare costs on maternal labor supply in Flanders, and discusses how care supply restrictions affects maternal labor supply decisions.

6.1 Labor supply estimates

Table 6 presents the estimated parameters of the quadratic utility function in Eq. (3). Looking at the estimated coefficients for non-working time, we clearly see that there exists heterogeneity in preferences for leisure. The parameter for age of the mother has a significant negative value and the quadratic term is significantly positive. Older mothers appear to attribute less value to non-working time than younger ones. The taste for non-working time increases with the amount of children in different age intervals. However, we do not find a significant difference between the different age groups of children. The estimated coefficients with respect to schooling reveal that highly educated mothers have a lower preference for leisure. Consumption positively affects mother's utility and the quadratic term for consumption is negative, which is in line with theoretical predictions.[13] After the estimation of the

[13] Taste shifters in the preference for consumption were not significant and were therefore dropped from the estimation.

Table 4 Childcare cost weighting factor and resulting predicted childcare cost

	Mean	Std. dev	Min	Max
Informal z_i^{inf}	50.41	26.28	1.24	99.17
Formal sub z_i^{fs}	45.90	27.89	0.10	98.75
Formal non-sub z_i^{fns}	3.68	8.14	0.00	63.82
Predicted childcare cost per month (Euro for a 40 h week)	173.13	109.90	2.77	685.53

Source: Own calculations, FFCS (2005)

Table 5 Net disposable household income (Euro/month)

Hours	Mean	Std. dev	Min	Max
0	2,579	700	1,004	6,482
20	3,275	753	1,671	7,120
32	3,649	804	1,951	7,491
40	3,879	843	2,115	7,788

Source: Own calculations, FFCS (2005)

Table 6 Estimated parameters of quadratic utility function

	Coeff.	Std. error	95 % Conf. int.	
Consumption (β_c)	8.504**	3.120	2.389	14.618
Consumption sq. (β_{cc})	−0.621**	0.268	−1.150	−0.096
Non-work time ($\beta_f(X_i)$)				
Age	−0.027**	0.011	−0.049	−0.005
Age squared	0.0004**	0.0001	0.000	0.001
#Children 0–3	0.021**	0.009	0.003	0.039
#Children 4–6	0.033**	0.008	0.017	0.047
#Children 7–9	0.027**	0.0101	0.006	0.047
Higher education	−0.026**	0.001	−0.045	−0.007
Constant	0.595**	0.216	0.171	1.0718
Non-work time sq. (β_{ff}.)	−0.001	0.000	−0.002	0.000
Non-work time * Cons. (β_{fc})	−0.028*	0.019	−0.065	0.007

Source: Own calculations, FFCS (2005)

* Significant at 10 % level, ** significant at 5 % level

model, we find that the marginal utility with respect to consumption is positive for 98.4% of the estimation sample. Marginal utility with respect to leisure is positive in 95.7 % of all cases. As such, we conclude that the estimation results confirm the theoretical predictions.

A comparison of the actually observed and predicted frequencies of mothers in each discrete labor supply point shows that the estimated model fits the data very well, see Table 7.

Table 7 Observed and predicted labor supply densities

Hours	Observed density	Estimated density
0	19.36	18.50
20	20.70	19.93
32	26.56	27.76
40	34.38	33.80

Source: Own calculations, FFCS (2005)

An alternative way of interpreting the estimated coefficients is by looking at the size of labor supply responses with respect to changes in budgetary constraints. We calculate the elasticities with respect to increases in gross hourly wages and childcare prices.[14] The structural basis of a discrete labor supply model implies that there is no explicit labor supply function from where one can derive the wage elasticity. Therefore, numerical methods are used to analyse the sensitivity of labor supply with respect to wage changes. The individual's gross wage or childcare cost is increased by 10 %, keeping all the other characteristics constant. We simulate the new budget constraint of each household using EUROMOD, and the new expected labor supply can be calculated, given the estimated coefficients. The hours elasticity expresses the percentage change in total hours supplied with respect to a given percentage increase in gross hourly wage or childcare cost. The participation elasticity is defined as the percentage change in labor market participation after a given percentage change in gross wages or childcare cost.

We find a total hours elasticity for wages of 0.275 and a participation elasticity of 0.192. These results are in line with expectations and the literature, see, for example, Blundell and Macurdy (1999), Keane and Rogerson (2012) and Mahringer and Zulehner (2013). For Belgium more specifically, Bargain and Orsini (2006) estimates total hours elasticity in the range [0.16, 0.30] and participation elasticity between [0.10, 0.19]. They estimated a similar quadratic utility function on the Panel Survey of Belgian Households for 2001 on the whole subgroup of married women and not specifically on married women with preschool children and full-time working fathers.

The participation elasticity with respect to childcare costs is equal to −0.034 and total hours elasticity to −0.056. In line with the literature, these labor supply elasticities are negative and rather small. Increasing the cost of childcare by 10 % leads to a small decrease in labor force participation of 0.34 % for the subgroup of Flemish mothers. Flemish maternal labor supply appears to be rather insensitive to price changes. Van Klaveren and Ghysels (2012) draw the same conclusion for Flemish households.[15] Wrohlich (2011) asserts that policy reforms related to

[14] Only the gross hourly wage of the mother is raised with 10 %, the gross wage of the father remains constant. When changing the monetary cost of childcare, both the cost of formal subsidized and non-subsidized childcare is increased with 10 %.

[15] Note that it is obvious that a 10 % increase in gross hourly wages leads to higher labour supply responses than a 10 % decrease in childcare prices as the change in the budget constraint is considerably higher in the former counterfactual. For full-time working mothers, raising her gross wage with 10 % raises, on average, the monthly disposable household income with 123 Euro. Raising the cost of childcare with 10 % diminishes, on average, the monthly disposable household income with 18 Euro. If we would decrease childcare costs by the same amount as the increase in wages, similar labour supply effects would be observed as both effects have a similar effect on the budgetconstraint of households.

rationing in the childcare market are more effective than reforms that focus on the cost of care. Section 6.2 investigates if this statement also holds for Flanders.

6.2 Labor supply impact of alternative policy measures

The model can be used to analyse how policy proposals potentially affect Flemish maternal labor supply. We present the results of four different policy proposals by looking at the labor force participation rate and the percentage change in total hours, see Table 8.

The first two simulations are related to the calculation of the labor supply elasticities from Sect. 6.1. A 10% increase in gross hourly wages leads to an increase in the total amount of hours of labor supply of 2.75 %, and the labor force participation rate changes from 81.50 % up to 83.11 %. Increasing the monetary cost of childcare by 10 % only leads to a decrease of 0.56 % in labor supply and to a change of 0.34 % points in the labor force participation rate.

The third and fourth simulation are examples of two extreme reforms that are hardly implementable but are useful for gaining insight in potential labor supply responses. The policy debate on childcare reforms often boils down to the discussion whether to decrease the cost of care or to increase the availability and accessibility of childcare facilities. According to Table 8, providing free childcare, given the current availability constraints in childcare supply, would lead to an increase of 3.49 % in total hours of labor supply. The maternal labor force participation rate would increase with 1.74 % point from 81.50 up to 83.24 %.[16]

The fourth simulation assumes that there are no availability constraints (=unlimited supply) in the formal subsidized childcare sector and that the government makes sure this happens by expanding the subsidized sector. Consequently, it assumes that parents won't make use of formal non-subsidized care anymore, because subsidized care is cheaper for almost all households. Additionally, and most importantly, the elimination of supply restrictions makes that none of the households is constrained in the labor supply choice anymore. In the baseline situation, we assumed that some mothers do not have the option of working due to their perceived lack of suitable childcare. In this counter-factual simulation, these households can now choose their labor supply from the complete choice set. The total amount of hours of labor supply increases by 6.34 % and the labor force participation rate of Flemish mothers in our sub-sample increases to 87.29 %.[17]

[16] We assume that the supply of childcare is flexible enough to cover this limited increase in demand. However, we can not completely rule out that this reform also necessitates a slight increase in childcare capacity.

[17] As mentioned in chapter 3.4, we assume that parents experience labor inhibiting restrictions when they have a predicted probability of a childcare offer (any type) of less than 50 %. 7 % of the parents in our sample are in this situation. When taking another limit, e.g. 40 %, this amounts drops to 4%. Looking at the impact of our results when taking this new limit, we notice a predicted labor force participation of mothers in the baseline of 83.5 %. Consequently, moving away from the standard tipping point in probability analysis (50 %) comes at a cost of a loss in predictive efficacy, keeping in mind that the observed labor force participation is 80.6 % and the prediction at 50 % is 81.5 %. Therefore, we maintain the 50% threshold in the main analysis. Yet, a sensitivity analysis regarding the use of other thresholds can be found in the online Appendix.

Table 8 Simulation results

	LFP (%)	Change total hours (%)
Baseline	81.50	–
10 % higher gross wage	83.11	+2.75
10 % higher childcare costs	81.20	−0.56
Free childcare	83.24	+3.49
No supply restrictions in childcare (subsidized care)	87.29	+6.34

Source: Own Calculations, FFCS (2005)

As an alternative to the government led scenario to eliminate the perceived supply restrictions, one may also imagine that efforts to improve the matching in the market eliminate frictions to some extent and foster market equilibrium to be realized quicker. Ideally this may also lead to a similar outcome of no parents feeling restricted. If we simulate this extreme case, we assume that there are no availability constraints and all parents willing to buy care at the market price, feel they will be able to secure a suitable spot for their child in due time. Interestingly, this alternative scenario results in labor market outcomes that are virtually identical to simulation 4. It would give a labor force participation rate of 87.17 % and an increase of total hours worked of 6.23 %. For a policy maker, this alternative may be less appealing because it is hard to accomplish a completely frictionless market, but the alternative scenario illustrates that not all of the gap needs to be filled by subsidizing care.

Table 9 presents the governmental cost of implementing the two policy simulations. The provision of free childcare would cost the Flemish government 7.2 million Euro per month (in 2005 prices). It is important to keep in mind that the model is estimated on a sub-sample, i.e. married mothers in Flanders with a full-time working father and a youngest child under 3 years old. Only the budgetary effects of this subgroup is taken into account in Table 9. By far the biggest cost is the parental contribution, which is now assumed to be paid by the government. However, this simulation leads to additional employment which results in extra revenues for the government. Making childcare free leads to an increase in governmental revenue of 5.2 million per month. Taking these additional revenues into account, the compensatory effect for the government of this measure is 72.7 % of the initial budgetary cost. If, on the other hand, the government would provide enough suitable childcare, the compensatory effect is much larger and equals 474.8 %. Eliminating the excess demand for childcare leads to a governmental cost of 1.0 million Euro/month for subsidizing new childcare places.[18] Due to the large employment effects, the extra revenue equals 4.8 million Euro/month.

Note, however, that these results should be interpreted with caution. The model presented in this paper only considers labor supply effects and neglects, as common

[18] A full day of formal subsidized childcare costs the government 20.65 Euro per month (in 2005 prices). This amount is based on internal information of 'Kind en Gezin' and does for example not take into account the cost of new buildings. 1.0 million Euro/month might thus be an underestimation of the real governmental cost.

Table 9 Budgetary cost (Euro/month)

	Free childcare	No supply restrictions in childcare: subsidized care
Governmental cost:	7,225,157	1,007,571
Subsidizing extra places	502,770	1,007,571
Cost of childcare:	6,722,387	–
Governmental revenue:	5,254,374	4 783 641
Change in SSC employer	1,013,339	1,733,059
Change in SSC employee	544,499	1,002,054
Change in taxes	3,588,141	1,896,093
Change in benefits	108,395	152,435
Net governmental cost	1,970,783	−3,776,070
Compensatory effect	72.7 %	474.8 %
Cost per new FTE	2,766	−2 883

Source: Own calculations, FFCS (2005)

SSC Social Security Contributions

in this literature, labor demand and general equilibrium effects. We thus assume that additional labor supply of mothers translates to additional employment on the macro level (no unemployment, no substitution effects). Hence, the presented figures could be seen as an upper bound of the effects of the different policy proposals. Yet, the size of the compensatory effect suggests that even a very incomplete translation of labor supply into actual employment, would still engender positive effects to the exchequer.

7 Conclusion

In this paper we have estimated the impact of childcare provisions on employment decisions of mothers with young children in Flanders. Even though many parents state that grandparents are their preferred care providers, the care contribution of grandparents is decreasing in Flanders, in line with the trend in most European countries. Moreover, government subsidies have been unable to keep pace with rising maternal employment rates and hence the contribution of non-subsidized care services (market care) is on the rise. Not surprisingly, the unmet demand for the two traditional and cheaper forms of childcare services, coupled with market frictions that are typical in a sector with a very discontinuous product, lead to ongoing complaints of a lack of suitable childcare places. We assume the latter to be especially troublesome for mothers who are not yet participating in the labor market, because their participation decision depends crucially on their perceived ability to secure childcare within a few weeks, the period they can keep an employer waiting for them to start working. Consequently, our analyses focus on perceived probabilities of childcare offers.

We integrated the perception of the likelihood of childcare supply in our model in the form of a three-level hierarchy. By adopting the partial observability model of Poirier (1980), we estimate the perceived supply probabilities in all three childcare sectors and include these estimates in the budget constraint of each household. Subsequently, we estimate a discrete labor supply model of the Van Soest (1995) type, while allowing for heterogeneity in prices and distinguishing between households who do and who do not perceived supply restrictions.

The resulting labor supply elasticities have the expected sign: we find a small negative effect of childcare costs on both participation and hours-of-work decisions. This indicates that Flemish mothers with young children are sensitive to price changes of childcare, but not very much so in the given context with a large proportion paying an income-related fee or enjoying free care by the grandparents. Not surprisingly, the simulation of an extreme policy scenario (making childcare totally cost free) increases the labor force participation rate of our group of mothers with only 1.74 % points. Simulations regarding the availability of subsidized formal childcare show larger promise: when removing rationing in the subsidized formal childcare sector, the labor force participation rate would increase by 5.79 % points.

Both the price and supply effects are in line with previous findings for Germany and Italy, countries with a lower employment rate of mothers and less formal childcare use (below the Barcelona target of the EU) than is the case in Belgium (which surpassed the Barcelona target of childcare slots for 33% of children younger than three years by 2005). Our analyses suggest that even beyond the Barcelona target there remains scope for expansion. A guaranteed offer of a childcare service at a subsidized price is likely to motivate a substantial number of mothers who currently are not participating in the labor market to do so. Moreover, the factual imposition of a care service guarantee that we simulate, suggests a sizeable, positive budgetary effects for the government: the additional cost of increasing subsidized formal childcare is, in balance, likely to result in extra government revenue mainly in the form of additional social contribution and tax receipts, with the revenue largely exceeding the extra costs. Even if we want to stress that the outcomes of our simulations should be interpreted as indications rather than as exact predictions, our results suggest a potentially large benefit for the public budget.

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Appendix: Basic descriptives

See Table 10.

Table 10 Descriptive statistics sub-sample

	Couples	
	Mother	Father
Average working time/week (hours)	27.44	42.01
Average hourly gross wage	16.96	18.86
Participation (%)	80.66	100
Average age	33.25	36.78
University degree (%)	62.70	49.22
Presence of child 0–3 (%)	100	
Presence of child 4–6 (%)	37.70	
Presence of child 7–9 (%)	15.23	
Presence of child 10–12 (%)	9.18	
Presence of child 13–15 (%)	4.88	
Amount of observations	512	

Source: Own calculations, FFCS (2005)

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