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**WORKING PAPERS**

# Childcare, maternal employment and residential location

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# **Childcare, maternal employment and residential location<sup>1</sup>**

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## **Abstract**

The economic literature provides mixed evidence of the relationship between local childcare provision and maternal employment. We document this question further by focusing on the role of the provision of childcare services close to the family's residential location. We use a simultaneous equations approach to estimate the employment and childcare decisions of mothers of children aged 0-3, conditional on their residential location. Our estimates are based on a rich data set, which matches household and individual level micro-data for Luxembourg in conjunction with municipality level data (provision of childcare services and other local amenities) and travel time distances for the year 2011. In line with the evidence provided by the recent literature, we find that, in a context where the female employment rate and the availability of childcare have increased over the last years, policies that make childcare services more widely accessible have no effect on maternal employment.

*Keywords:* childcare; labour supply; residential location; simultaneous equations model

*JEL classification codes:* J13 ;J22 ;J18

# 1 Introduction

The aim of this paper is to contribute to the literature on childcare policies, focusing on one factor that has been largely ignored in previous research: the proximity of childcare services to a family's residential location.

Over the last decades, the provision of affordable and high quality childcare services has become a great political concern in most OECD countries. Most countries have chosen to intervene in the market for childcare, to help parents to balance work and family life, reduce gender inequalities and improve outcomes amongst children. Most of these interventions have been made in order to reduce childcare costs. But in a context where childcare is (strongly) subsidized and where there are waiting lists, policies that aim at reducing childcare costs may not be efficient in encouraging the use of childcare services and promoting female employment. In such a context, the spatial access to available childcare services may be a major determinant. Indeed, living close to available childcare services is likely a key determinant of childcare attendance. For reasons of convenience, it is plausible that parents prefer that their children are taken care of close to their home (or their workplace in case the parents work). When slots are available but at a distance that the parents judge too great, these slots will not be used even if they are available.

Additionally, in case of waiting lists, it is likely that parents are better informed about the available slots when they live close to childcare services. The idea is that access to such information is likely to be greater when the childcare services are located close to family's home. Lastly, living close to childcare services may increase families' trust in these services. Potential users may consider such childcare services as providing quality childcare, and be more prone to apply for a place for their children.

Providing convincing evidence of the role of the proximity to childcare services is challenging for at least two reasons. First, referring to a Tiebout model, parents who have strong preferences for work and therefore for non parental childcare may have chosen to live close to childcare services.<sup>1</sup> Second there is a problem of reverse causality since childcare services are likely to be provided in areas where the demand is high (where families with young children live).<sup>2</sup>

Yet few authors pay attention to the selection issue deriving from the residential location decisions in their analysis of the relationship between local availability of childcare and maternal employment. One reason for such a lack of attention may be that, as argued by Compton and Pollak (2014), the

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<sup>1</sup>The location choices could also be driven by preferences in terms of composition of the local population. Some families prefer to live close to their peers in terms of income, level of education or ethnicity.

<sup>2</sup>For-profit childcare providers positively react to favourable demand conditions such as a high employment rate, a high prevalence of families with young children, childcare subsidies, no barriers to entry in the market (Herbst and Barnow, 2008)

endogeneity issue raised by residential location *is viewed by economists as less serious* than that raised by labour supply and childcare choices. In labour economics, the location is generally assumed to be exogenous. Another reason may be that, in reality, residential mobility is low. In particular, Rhode and Strumpf (2003) show that preferences for neighbours (in terms of socio-economic composition) and employment prevail over Tiebout motives, defined as preferences for local public goods. But this finding is based on the restrictive assumption that migration is costless. With a more general approach, that account for migration costs, Bayer and McMillan (2010) allow benefit from local amenities to enter into mobility choices.

An additional argument in favour of the existence of a link between local availability of childcare and location decisions is that residential mobility tends to be highly concentrated into the young-adult stage of life. Young couples anticipate the birth of their first child when deciding to become homeowners for the first time (Mulder and Wagner, 2001), and thus, when choosing their residential location. It is likely that young couples pay attention to the provision of services related to children (such as childcare services or preschool) in their residential choices.<sup>3</sup>

In this paper, we document further the role of childcare policies on female employment, focusing on the availability of childcare services close to a family's home. Previous studies have in common that they use a local provision rate (number of slots divided by the number of children in a given area) to define the availability of childcare services, which raises two limitations. First, the authors assume that all families living in the same area face the same availability of childcare services. Yet due to existing priority rules/eligibility rules for allocating available slots in case of rationing, some families can be expected to have a higher probability of getting a slot than other families do, even though all these families live in the same area. In other words, even in the same area, the availability of childcare services may differ from one family to another.

Second, like other spatial measures, the local provision rate raises the issue of the modifiable area unit problem (MAUP). The MAUP issue arises here from aggregating available slots into spatial units (locality, town, county, region), with geographical boundaries which do not relate in any meaningful sense to the actual childcare provision. In some cases, the local unit might be too small to reflect the slots available for families, while in other cases, it might be too large. For instance, if the local unit is the town of residence, the true provision of childcare services may be underestimated for families living close to the borders of the unit because these families may use childcare services from neighbouring localities. The true provision of childcare services may also be underestimated for parents who work

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<sup>3</sup>Previous studies have shown that parents consider the school supply when deciding where to live (Barrow, 2002, Epple and Romano, 2003, Bayer et al., 2007).

outside their localities of residence and who may have access to childcare services provided by other localities. Conversely, in cases where the local unit is the region of residence, it may be too large to mirror the childcare opportunities available for families: the provision rate may be overestimated in that case.

In this paper, we attempt to overcome these two limitations: on the one hand, we will explicitly account for priority rules in the definition of the local availability of childcare services; on the other hand, we will account not only for the slots provided in the locality of the residence, but also for those provided in neighbouring localities, putting less weight on the more distant slots. We use a simultaneous equations approach to estimate the employment and childcare use probabilities and a selection equation, to control for the fact that mothers who are employed and use childcare services have chosen to live close to available childcare services. Our estimates are based on a rich data set which matches household and individual level data from the Luxemburgish household survey in conjunction with municipality level data and travel time distances.

We find that living close to available childcare services has no effect on maternal employment. This finding is in line with recent literature showing that in a context where the female employment rate and the availability of childcare have increased, promoting access to childcare services has little effect on maternal employment decisions.

This paper relies on different strands of the literature. It contributes to the literature on childcare policies by taking into account the spatial access to childcare services, which has been largely ignored so far. A second contribution is to focus on early childcare (for children from 0 to 3 years old). While the effect of the provision of childcare services has been largely documented for children over 3 years old, it is not the case for younger children (Brilli et al., 2016). Yet providing access to childcare for children from 0 to 3 years old is of great political concern. First, it may help women to return to work more quickly after giving birth and it may thus avoid more or less lengthy career breaks (as it has been shown that it is more and more difficult to re-enter the labour market when the time out of the labour market increases). Second, as early interventions are assumed to have higher rates of return than later ones (Heckman and Masterov, 2007), it would be more efficient to promote access to quality childcare for children before they enter school. Finally, this paper is also related to the literature on housing and childbearing decisions (Öst, 2012) and on residential location choices of young couples (Løken et al., 2013) as it provides evidence of the link between childcare policies (through the provision of local childcare services) and the residential location choices of young adults.

The rest of this paper proceeds as follows. Section 2 briefly reviews the related literature. Section 3 explains the institutional background in Luxembourg. Section 4 presents a simple theoretical model,

that represents the framework for the empirical analysis. Section 5 explains the empirical strategy. Section 6 describes the data and gives descriptive statistics. The empirical results are presented and discussed in section 7. Section 8 concludes.

## 2 Literature on the local availability of childcare services and mothers' labour supply

Previous research has led to a detailed theoretical and empirical framework for analyzing the relationship between childcare and mothers' labour supply. The theoretical framework has been built on the domestic production model (Becker, 1965, Gronau, 1977) and on work on the "quality" of the child (Becker and Lewis, 1973). In this model, the mother is assumed to get satisfaction from consumption, leisure and also from the "quality" of her child. The labour supply of the partner is generally assumed to be exogenous.

Childcare is introduced as an intermediate good which is an input of the domestic production function of child quality. It can be produced in the household through the mother's leisure time and/or purchased in the market. The mother is supposed to have the choice between working and using non maternal childcare or not working and taking care of the child herself. The alternatives to maternal care are formal care (childcare centres or child minders) and informal care (care provided by relatives such as grand-parents or neighbours). In this framework, mothers labour supply and childcare choices are assumed to be interdependent. While the provision of childcare services may help women to quickly return to work after giving birth, it reduces the opportunity cost of having a child.<sup>4</sup> The provision of childcare services is thus expected to have a positive effect on mothers' labour market participation.<sup>5</sup>

This framework has been widely used to investigate **the role of childcare prices or subsidies on mothers' labour supply**. While empirical findings support the expected positive effect of childcare subsidies on mothers' labour force participation, this effect is actually quite small (Blau and Currie, 2010). In contrast, not much is known about **the role of the spatial access to childcare services**.

Yet when there are no slots available close to a family location (because all the available slots near the family's home have already been allocated or because existing available slots are located far away), policies that aim at providing subsidized childcare would have little, if any, effect on maternal and child

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<sup>4</sup>In this framework, the provision of childcare is analyzed as a reduction in childcare costs. As reducing childcare costs lowers the reservation wage, it may have a positive effect on labour market participation. The effect of the provision of childcare on hours worked combines a substitution effect (increasing the number of hours worked) and an income effect (increasing the leisure time). The net effect on hours worked depends on which effect prevails.

<sup>5</sup>For the same reason, the provision of childcare services is also expected to have a positive effect on fertility. Empirical evidence is mixed. Del Boca (2002a) for Italy, Baizan (2009) for Spain or Bauernschuster et al. (2016) for Germany conclude with a positive effect on the local provision of childcare on fertility. By contrast, Hank (2003) finds no significant effect on fertility for women living in the Lander of the former West Germany.



outcomes. In addition, reducing childcare costs in a context where there are no available slots may increase the rationing problem while the demand for childcare will increase (given that childcare is a normal good). In such a context, where childcare is subsidized, geographic constraints on access to childcare services may thus play a more important role in childcare and labour supply decisions than childcare prices do (Berger, 2013).

Moreover, spatial access restrictions to formal childcare may induce some families to use informal childcare. As informal childcare is (generally) perceived as provided at a lower level of quality than formal childcare, the use of informal childcare is not desirable for policy makers who wish to encourage the use of formal childcare because of its expected positive effect on child outcomes later in life.<sup>6</sup>

Previous empirical evidence on the role of the local availability of childcare on maternal employment are mixed: whilst some authors find a positive relationship between labour supply and local childcare availability, in other cases, the positive relationship does not exist. The literature can be divided into two parts, regarding the empirical approach used. A first strand of the literature estimates structural models of mothers' labour supply (or its reduced form). Most of these studies find a positive effect of the availability of childcare services on mother's labour supply, with the magnitude of this effect (when reported) being in a large range of estimates. A second strand of the literature makes use of a policy change to identify the causal effect of childcare availability on mothers' labour supply. Most of these studies conclude on small, if any, effects of increasing local provision of childcare on maternal employment (Fitzpatrick, 2010, Havnes and Mogstad, 2011, Nollenberger and Rodriguez-Planas, 2015).

### **3 Mother's employment and childcare in Luxembourg**

This section gives some brief information about motherhood and employment and describes the childcare system in Luxembourg.

Luxembourg combines both a low fertility rate and maternal employment. The fertility rate was 1.52 in 2011, far from the 2.1 required for the generation to be renewed (source: Census). Table 1 shows that the employment rate of mother is below that of women without children and that of their male counterparts; the gender difference increases with the number of children.

Under the classification of family policy regimes proposed by Gauthier (2002), Luxembourg is classified as a conservative regime (like other north-western European countries such as Germany, the Netherlands or France), that combine medium to high support for parents (according to their employ-

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<sup>6</sup>See Ruhm (2004) for a survey on the effect of childcare policies on child outcomes.

ment status) with a quite traditional view of the gender role. As regards support for working parents, Luxembourg provides paid maternity and parental leave and highly subsidized high-quality public childcare, though with limited number of places. *Paid maternity leave* is compulsory and lasts for 16 weeks, of which 8 weeks must be taken by the mother before childbirth. Breastfeeding extends maternity leave by 4 weeks. Upon completion of maternity leave, the childcare options available to working parents are parental leave or paid care in a day care centre (public or private), a childminder or unpaid care by relatives.<sup>7</sup>

Turning now to the **childcare system**, childcare provision is mixed in Luxembourg: day care centres can be either publicly or privately owned. Formal childcare is strongly subsidized, irrespective of the nature of the provider, through an in-kind benefit (*Chèque-Service accueil*, CSA) which reduces childcare fees for children under 13 years old or not yet enrolled in secondary school.<sup>8</sup> There are no strong barriers to entry into the market.

Table 2 shows that more than two thirds of children less than 4 years old were minded by adults other than their parents in 2011. Among these children, 30% were cared for in a day care centre, 9% by a child minder and 24% by relatives at zero cost. This latter type of care is called informal care, in contrast to formal care also known as institutional care.<sup>9</sup>

Table 3 shows that the public sector provides the large majority of existing places, mainly because it provides a large number of slots in before/after school care. But for children not yet at school, the number of places in the public sector is about half the number in the private sector.

In the public sector, in case of excess demand, the slots are allocated according to priority rules devised around family characteristics, similar to those existing in most other OECD countries (Humblet and Amerijckx, 2008). The priority rules are set at the national level. Priority is given to:

- children with special needs (children with disability )
- children living in a single-parent family
- children where both parents are in full-time paid work

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<sup>7</sup>Parental leave has been instituted in Luxembourg in 1999. Its consists of six months full-time leave or twelve months part-time leave for the eligible parent. Eligible parents are parents of children born after 1 January 1999 and who are employees affiliated to the national social security system. The eligible parent is entitled to a monthly flat-rate benefit: 1178.31 euros for full-time leave, 889.15 euros for part-time leave. In comparison, the minimum wage in Luxembourg in 2013 was 1900 euros per month. Parental leave is mainly taken by mothers in Luxembourg: after the birth of their first child, when 46% of eligible mothers take parental leave, the take up rate among eligible fathers is only 11% (Valentova and Bia, 2013).

<sup>8</sup>As long as they obtain the license for providing childcare services, providers (either public or private) are subsidized. To obtain the license, providers have to satisfy various criteria set by the law. These criteria relate to child-staff ratios, group size, education and training of employees and characteristics of the facilities.

<sup>9</sup>Formal childcare refers to public and private centres for children up to 3 months old, and official child minders (eg persons who take care of children at their own home and have a governmental endorsement).

- children from low income families
- children living in the city where the childcare centre is located
- children with a sibling already minded in the centre

In the private sector, the slots are generally allocated according to the rule *first come, first served*. One can also imagine that private providers select the families according to some criteria (income for example) but no information on that kind of selection is available. We also have no information on *queue jumping* that could well have happened.

There is no rationing in terms of hours in Luxembourg, in contrast to the situation observed in some European countries such Italy or Germany where childcare centres are open for a limited period of the day. In general, day care centres, either public or private, are open from 7:00 to 19:00, from Monday to Friday, with a few weeks of closure during summer. The opening hours are consistent with a full-time job with standard hours (full time is 40 hours per week in Luxembourg).

Table 4 gives summary statistics for the number of existing slots for 100 children less than 4 years old, by locality and by type of provider. The average local provision rate, irrespective of the type of services, is 25%. It ranges between 8% and 93%. At a first glance, a provision rate close to 100% is surprising. It may reflect localities that provide slots for children who do not live in it, such as localities with company daycare centres.

The public provision rate does not vary much across localities: the standard deviation is close to the mean. The median of 28 is much less than the mean, reflecting the skewness of the data. This is not surprising if one considers that the government aims at promoting an equal access to public childcare services all over the country. On the contrary, the private provision rate varies a bit more across localities. This result may reflect the location strategy of private providers, who mainly choose to locate where local demand conditions are favourable (Herbst and Barnow, 2008).

## 4 Theoretical framework

In this section, we present a simple theoretical model of mother's labour supply and childcare choices, relying on models developed by Del Boca and Vuri (2007) and more recently Brilli et al. (2016) which explicitly cope with rationing. It aims at helping the specification of the empirical model and the interpretation of the results.

#### 4.1 A simple individual static labour supply model

The model is a simple individual static labour supply model, in which childcare is introduced as explained below. The labour supply of the partner is exogenous (it enters into the model through the household income). This assumption is *a priori* quite restrictive. However, in many couples, a gender division of tasks, allocating family tasks to women, still persists. The childcare choice is made by the mother for the whole family.

Childcare quality is assumed to be homogenous, which allows us to ignore the effect of childcare choices on child outcomes. At a first glance, this assumption is restrictive regarding the recent empirical evidence on the effect of childcare quality on child outcomes. However, our interest is here on the effect of spatial constraints on access to childcare services. We believe that, in our case, it makes sense to ignore childcare quality because it is in line with the idea that, in case of access restrictions due to rationing, parents will use the childcare options that are available, irrespective of their quality. The idea is that, in a context of rationing, the parents will act as if they are indifferent to the quality of childcare services when they decide to use childcare or not: they use the place which is actually available. Of course, the more childcare options are available, the more parents will consider the quality of these childcare options to actually decide which childcare options they will use.

To simplify, only one child (the youngest) needs to be cared for. This child needs to be cared for all the time that the mother spends in the labour market:  $h = h_f + h_{inf}$ , with  $h \geq h_f$  and  $h_{inf} \geq 0$  ( $h$  denotes the time the mother spends in the labour market,  $h_f$  and  $h_{inf}$  are formal care and informal care respectively). The utility function of the mother is given by  $U(C, L)$ : the mother is assumed to derive satisfaction from the consumption of a composite good  $C$ , leisure  $L$  and the quality of the child  $Q$ . The mother allocates her available time, denoted  $T$  between work and leisure:  $T = L + h$ . The composite good  $C$  can only be obtained through the market (no household production is allowed in this simple model). Quality of the child is a function of the time the mother spend with her child ( $L$ ), formal child care ( $h_f$ ) and informal child care ( $h_{inf}$ ), and a vector of exogenous characteristics ( $\theta$ ) affecting the production of child quality:  $Q = Q(L, h_f, h_{inf}, \theta)$ .

Let the budget constraint be given by:  $C = Y + wh - p_f h_f - p_{inf} h_{inf}$ ; where  $Y$  is non labour income (included income from the partner),  $w$  is the hourly wage rate,  $p_f$  is the hourly price of formal childcare and  $p_{inf}$  is the hourly price of informal childcare.<sup>10</sup>

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<sup>10</sup>Without setting an implicit price on informal childcare, it will never be optimal to choose another mode of childcare. Indeed, since the informal care has no monetary cost, it is more advantageous than either formal childcare (whose price is  $p_f$ ) and maternal childcare (whose opportunity cost is  $w$ ). Two solutions are commonly used in the related literature: set a maximum quantity of informal care in the time constraint or setting an implicit price on informal care in the budget constraint.

The labour supply and the childcare choices are assumed to sum up in a discrete choice: the mother chooses between working or not and using or not formal childcare. She will choose the combination work/childcare that provides her with the highest satisfaction.

Rationing enters into the model by reducing the possibilities for using childcare. As in previous works, we thus assume that the probability of using childcare (and thus coping with rationing) depends on the number of places and on demand. But we also take into account other elements, which have been ignored so far: the priority rules used to allocate slots in case of rationing and the local dimension of rationing, as we will explain below.

## 4.2 Priority rules and local dimension of rationing

A key problem with much of the literature on the role of the local provision of childcare on maternal employment is that two important dimensions of childcare rationing are ignored: **the priority rules** used to allocate available slots and the **spatial** dimension of rationing. To take into account these two important dimensions in our analyze, we rely on the framework of a *discrete rationing model with priority rules* (Moulin, 2001). This theoretical framework is well suited to the childcare rationing issue since it is a slot that is being provided/demanded, rather than a perfectly divisible quantity of childcare, and because the allocation of available places between the different applicants follows priority rules. Relying on this framework will allow us to improve the definition of the local availability of childcare services.

Let  $N$  be a set of families ( $i = (1, 2, \dots, N)$ ), defined by a series of individual demands  $X = (x_1, x_2, \dots, x_N)$  with  $x_i = (0; 1)$  and a global and fixed number  $q$  of slots in childcare services to be shared between families. The number of slots  $q$  is not sufficient to satisfy all the demands:

$$q < \sum_{i=1}^N x_i$$

The way in which the number of places  $q$  is allocated to  $N$  families is defined by the **rationing method**. The rationing method, denoted  $r$ , determines for each of the  $N$  families whether or not she actually gets the place she has applied for ( $z_i$ ). The rationing method is based on the priority rules. In the standard case, there is one priority order, that allows us to rank families by priority order.

Let  $\sigma$  be the priority order of all families.  $\sigma(1) = i$  means that the family  $i$  has the priority of rank 1 amongst all families,  $\sigma(2) = j$  means that the family  $j$  has the priority of rank 2 amongst all families, ... As soon as the number of places  $q$ , the series of individual demands  $X$  and the priority order  $\sigma$  of  $N$  are known it is possible to know who has been allocated a slot ( $z_i = x_i$ ) and who has therefore not been

rationed as well as those who are not allocated a slot ( $z_i < x_i$ ) and who has therefore been rationed (Moulin, 2001).

Here, there are two specific rationing methods, providing two priority orders which could be different. While the priority rules are not the same in both sectors, the family  $i$  may have a priority rank in the public sector (denoted  $\sigma$ ) that is different from their rank in the private sector (denoted  $\eta$ ).

In the *public sector*, priority rules are based on individual and family characteristics, which are not ranked in a hierarchical order. Collating all these characteristics together leads to defining  $t = 1, \dots, T$  types of family who are given priority or not. Although the government has set the priority rules, it is the directors of the centres who actually decide on the allocation of the available places in their center. Some directors may give more value to one priority criterion than to another one. The rationing method would thus differ according to the director. Since this information is unknown, there is likely some variation in the allocation of available slots at the local level and with respect to the director. In the public sector, the rationing method is a function of the number of available slots in the public sector ( $q_{public}$ ), the number of families ( $N$ ), the demand<sup>11</sup> ( $X$ ), the type of families  $t$  and the distribution of the type of families within the local population ( $g(t)$ ). Each public director may choose which weight to put on a specific priority criterion, which adds more or less uncertainty into the process of allocation of slots. To account for it, we add a random component to the rationing method. The rationing method in the public sector associated with the priority order  $\sigma$  may thus be written in the following way:  $r_{\sigma}(N, q_{public}, X, t, g(t), \epsilon_{public})$ .

In the *private sector*, the rationing method is defined by the position in the queue, and in this way it is possible to rank the families. In theory, this rationing method allows to know who is rationed and who is not. But some slots may be obtained thanks to pass through. Additionally, one cannot exclude that private directors may choose applicants in the queue according to some of their characteristics (such as income or working schedules). In that case, families cannot be ranked according to the existing priority rules, and one cannot conclude whether family  $i$  is actually rationed or not. The rationing method in the private sector may thus be defined as a function of the number of families  $N$ , the number of available slots in the private sector  $q_{private}$  and the demand  $X$  and a random component to allow for queue jumping that are not observable. Let  $r_{\eta}(N, q_{private}, X, \epsilon_{private})$  be the rationing method in the private sector associated with the priority order  $\eta$ .

As the rationing methods in both sectors introduce some part of randomness in the allocation of

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<sup>11</sup>To simplify, we assume that the family demands one slot, irrespective of the type of provider. At a first glance, it a restrictive assumption. But as we assume that parents do not care about quality of care provided, we also assume that the care provided is homogenous in quality.

available slots, we will consider rationing as probabilistic.

Turning now to the local dimension of rationing, we assume that for commodity reasons, parents prefer to have their child taken care of close to their home. If slots are available but at a distance that the parents judge too high, these slots will not be used even if they are available.

Previous work on Luxemburgish data has shown that slots in childcare services located above a threshold would not be used by parents, even if these slots are available (Bousselin, 2015). In theory, the threshold may depend on a family's characteristics (such as household income, the workplace in case the parents are working, location of the grand-parents). In particular, close proximity of the provision to a family's home is a key criterion to choose a childcare service, but this criterion is much more important for low-income families (Herbst and Barnow, 2008). In order to keep things simple, we will use a unique threshold for all families.

To sum up, we assume that the probability that a family  $i$  uses childcare, and thus copes with rationing, depends on:

- the rationing method in the public sector  $r_\sigma(N, q_{public}, X, t, g(t), \epsilon_{public})$
- the rationing method in the private sector  $r_\eta(N, q_{private}, X, \epsilon_{private})$
- the distance between the family's home  $i$  and the childcare facilities  $c(d_{ic})$

## 5 Empirical strategy

In this section we present our empirical strategy to estimate the effect of the local availability of childcare services on childcare and employment decisions, focusing on the role of spatial access. Before presenting the econometric model, we start by explaining how we compute the accessibility measure.

### 5.1 The accessibility measure to available childcare services

Relying on the literature on accessibility measures (Luo and Wang, 2003), we compute the accessibility to childcare services at location  $j$  in the following manner.

$$LACC_j = \sum_{j=1}^J f(d_{ij}) \times \frac{q_j}{N_j} \quad (1)$$

where  $q_j$  is the number of slots in the locality  $j$  ( $j = 1, \dots, J$ ),  $N_j$  is the number of children in the locality  $j$ ,  $d_{ij}$  is the distance between the family location  $i$  and the locality  $j$  ( $i, j \in J$ ). To account explicitly for the distance between childcare slots and the family's home, more distant places

are discounted using a distance decay function  $f(d_{lj})$ . A larger  $LACC_i$  implies better accessibility to available childcare services.

We now explain how we measure the distances and how we define the decay function.

### 5.1.1 Measure of travel time distances

We use travel times to measure the distances between localities.

In a first step, we created a database containing the locality of each childcare provider in Luxembourg. Then, the location of childcare providers was geocoded, using the locality to assign latitude and longitude coordinates to each childcare provider. The next step was to compute the distances in travel time by car between the location of the families and the location of each childcare provider. Travel time distances are the shortest road journey between the locality's geographic centres (the centroid). The shortest road journey between origins and destinations have been computed using Google Maps. The distance measure is based on locality because residential addresses are not available in the data. Travel times with public transport were not calculated because the use of public transport in daily journeys is rare in Luxembourg (Klein and Schmitz, 2011).

Our measure of travel time distances has two limitations. Firstly, the travel time distances are measured between the centres of localities. Ideally, we would have the exact addresses of households and childcare services to compute the travel times, but this information is not available. Instead, data is aggregated by locality and travel times are computed between the centroids. This leads to a measurement error, called *spatial aggregation error*, that may affect the measurement of spatial accessibility. Travel times between a family's home and the childcare services located in the same locality are underestimated because travel times are arbitrarily set to 0 due to lack of information on the exact addresses of a family's home and childcare providers. For families living close to a locality's borders, the travel time to reach childcare services located in other localities are overestimated (and this overestimation is more important for large size localities).

Urban literature has shown that the spatial aggregation error depends on the type of amenity under investigation. It is particularly problematic when measuring spatial access to amenities that are abundant and have highly localized service areas (Hewko et al., 2002). In our case, as the country is small in size, and thus the localities too, we believe that the measurement error of spatial access to childcare services due to spatial aggregation is low.

Secondly, as time distances are averaged by day, congestion during peak hours that could dramatically increase travel time was ignored. To overcome this limitation, we added an explicit control for the size of the locality, which is likely highly correlated with traffic jam.



Despite these two limitations, using travel times to measure distance represents a useful alternative to Euclidian distances (the as-the-crow-flies distances) traditionally used in the literature as our measure of distance fits the reality better than do Euclidian distances.

In our sample, the travel times between a family's home and childcare services are comprised between 0 (when the childcare service is located in the same locality as the family's home) and 98 minutes, with a mean of 26 minutes (Table 8).

### **5.1.2 The choice of the decay function**

As stressed before, a key element of childcare use is the ease with which families can access to these childcare services. In urban studies, potential access refers to *availability* and *accessibility*. In our case, the availability accounts for the provision of childcare services within a given area while the accessibility accounts for interactions between supply and demand located in different areas. We will account for these two components in our analysis, as explained hereafter.

We assume that, for commodity reasons, parents prefer to have their child taken cared for close to their home. This assumption allows us to ignore for now the relationship between the parents' workplaces, home and the location of childcare services.

It is a simplifying assumption. Indeed, to account for the possibility that working parents may use the places located on their commute or close to their workplace requires the modeling of choice of workplace of each parent, which will make the analysis much more complex. In our sample, 29% of working mothers have been working in their locality of residence; the figure is a bit lower for their partner (21%). In addition, the parents may have different places of work, each in opposite directions. More than 50% of the working mothers work in a locality which is different from that of their partner. In such a case, it is likely that only one of the parents will be in charge of picking up the child to the childcare services. Such an arrangement may put pressure on the parent in charge of the child(ren). Additionally, this arrangement would be not convenient in cases of unexpected events such as, for example, extra hours at work or traffic jams .... It seems to us that parents prefer to have a childcare option in a location that is common to both of them.

We also assume that even if places are available, these places may not be used if the parents judged them too far from their home. More precisely, we assume that parents would not use childcare services if they are located above a threshold distance from their home.

Relying on accessibility measures developed in urban sciences (Luo and Wang, 2003), we use the following decay function:

$$f(d_{lj}) = \begin{cases} d_{lj}^{-\beta} & \text{if } d_{lj} < \overline{D} \\ 0 & \text{otherwise} \end{cases}$$

We used different values for  $\beta$ , ranging from 1 to 3 by 0.20. For the distance threshold  $\overline{D}$ , we used different values ranging from 5 to 30, by 5. Table 9 presents the results of the sensitivity analysis of our accessibility measure. Higher values of the travel friction coefficient  $\beta$  provide higher variance of the accessibility measure. It is not surprising: it suggests that families are not willing to support long travel times to obtain a childcare slot and that they are more willing to look for slots provided close to their residential location. On the contrary, higher values of the threshold travel time  $\overline{D}$  provide lower variance of the accessibility measure: as the threshold increases, more and more slots are weighted equally, smoothing the differences between available slots.

We cannot rely on prior studies to choose the distance threshold because to our knowledge, this study is the first that uses travel time between residential locations of families and childcare service locations to compute accessibility measures. One can argue that we could rely on observed data to choose the value of the parameters. But with this solution, the risk is that the estimates reflect the distribution of childcare providers rather than the travel constraints of families.

Based on the results of the sensitivity analysis, we thus decide to choose reasonable values for the parameters:  $\beta=1.8$  and  $\overline{D} = 5$ . At first glance, the travel time threshold may seem low. But it is important to keep in mind that it is the time spent to reach the closest childcare options outside the locality of residence while the travel time from home to a childcare service located in the same locality is arbitrary set to 0 due to the lack of the exact addresses.

## 5.2 The empirical model

Following the theoretical framework, the employment and childcare choices are assumed to sum up in a discrete choice (work or not/ use childcare or not) and to be made simultaneously. Let the employment and childcare equations be:

$$\begin{aligned} y_{work}^* &= \beta_1 X + \alpha_1 Z + \delta_1 LACC + \epsilon_{work} \\ y_{cc}^* &= \beta_2 X + \alpha_2 Z + \delta_2 LACC + \epsilon_{cc} \end{aligned}$$

$$y_{work} = \begin{cases} 1 & \text{if } y_{work}^* > 0 \\ 0 & \text{otherwise} \end{cases}$$

$$y_{cc} = \begin{cases} 1 & \text{if } y_{cc}^* > 0 \\ 0 & \text{otherwise} \end{cases}$$

where  $y_{work}^*$  and  $y_{cc}^*$  are latent variables for which only the dichotomous variables  $y_{work}$  (work) and  $y_{cc}$  (childcare) can be observed. Work means being employed and not in full-time parental leave. Use of childcare means using formal childcare (daycare centre or childminder) for the youngest child in the family. The vector  $X$  includes exogenous individual and household control variables. The vector  $Z$  includes local characteristics, except the local availability of childcare services denoted by  $LACC$ . The error terms  $\epsilon_1$  and  $\epsilon_2$  are joint normal with means zero, variance one and correlation  $\rho$ .

The model is a Seemingly Unrelated Model (SUR): the same controls are used to explain the probability of being employed and the probability of using childcare. The relationship between both equations is assumed to be captured by the correlation of their two error terms. The idea is that there exists some unobservable characteristics that jointly affect the woman's decisions to be employed and to use childcare. One example is a traditional view of gender role: some women prefer to stay at home, taking care of their children, because they believe that domestic tasks and looking after children is part of their role. These women are not willing to be employed and to rely on external childcare.

But as stressed before, parents who have strong preferences for work and formal childcare may have chosen to live close to childcare services. In addition, childcare providers may have decided to locate where the local demand for childcare services is high (eg where working parents with young children have decided to live). Because of self selection in residential location, identifying the effect of the local availability of childcare services is challenging. To tackle this issue, there are different empirical strategies: (i) use a simultaneous equations model or an IV approach, in which the residential location is an endogenous variable, (ii) use panel data to control for unobserved heterogeneity, (iii) use a quasi experimental setting (a policy change) which randomly assigns households to locations with different local provision of childcare services.

Here, we follow the first approach. We take advantage of (having) access to very rich data to build a data set that allows us to :

- explain not only the labour supply and the childcare choices of women with young children but also their location choices
- account for two important elements of childcare availability: proximity to the family's home and priority rules.

We use a simultaneous equations approach to estimate the employment and childcare use conditionally to the fact that employment and childcare options are chosen by women who have access to

available childcare close to their home. More precisely, we estimate a fully observed recursive **mixed-process model** (Roodman, 2009). This kind of model must satisfy two properties:

- *Recursivity*: it means that the model has clearly defined stages, with one or more equations in each stage. In our case, the first stage is the residential location choice while the second stage is the employment and childcare choices.
- *Full observability*: it means that endogenous variables appears on the right side of the equations only as observed. In our case, the employment and childcare choices are included as dummy endogenous variables in the equations system ; the local availability of childcare services is modeled as a continuous endogenous variable (see hereafter).

As we assume that women who would like to be employed and to use formal childcare have chosen to live close to available childcare services, we make it conditionnal on local availability of childcare services by simultaneously specifying an equation for the local availability of childcare services. The local childcare availability equation is:

$$LACC = \beta_3 X_3 + \alpha_3 A + \epsilon_{lacc}$$

The vector  $X_3$  includes exogenous individual and household control variables and the vector  $A$  includes local amenities.

We assume joint normality of the error terms of the employment equation, the childcare equation and the local childcare availability equation ( $\epsilon_{work}, \epsilon_{cc}, \epsilon_{lacc}$ ), each with a mean of zero and variance-covariance matrix  $V$ , where  $V$  has values of 1 on the main diagonal and correlations  $\rho_{jk} = \rho_{kj}$  as off-diagonal elements ( $j \neq k$ ).

The identification is as follows. Local amenities are assumed to affect the location choices (and then the local availability of childcare services) but not employment and childcare use decisions.

One limitation of our strategy is that local amenities are likely to be correlated with other local characteristics, such as local job offers, and then with the probability of getting a job and being employed. But given the small size of Luxembourg (which had 570 000 inhabitants in 2016), there is most likely only one labour market instead of several local labour markets. It would mean that local unemployment varies little across localities (the average local unemployment rate was 5.7 in 2010, very close to the median 5.24).

A second limitation is that, as the provision of childcare services is a local amenity, it may be highly correlated with other local amenities. Indeed, it is likely that where local amenities are abundant, the

provision of childcare services is high. We believe that it is an issue for the childcare services provided by the private sector, but not for those provided by the public sector. Indeed, private providers of childcare are expected to locate where the local conditions are favourable, just as other companies providing goods and services will do. By contrast, the location decision of public providers may be driven by other motives (such as promoting access to childcare to all families, irrespective of their location). Public childcare services are expected to be more widespread, and this may reduce the correlation with the other local amenities. As Table 4 shows, the provision of public childcare varies little by locality, in contrast to the provision of private childcare services.

The model is estimated by the *limited-information maximum likelihood* (LIML) method (Roodman, 2009).

## **6 Data and descriptive**

### **6.1 Data**

We use individual data and household data in conjunction with data on childcare provision, amenities provided at the local level and data on travel time distances between residential location and childcare services.

Data on household and individual characteristics come from the Luxembourg Socio-Economic Panel *Liewen zu Letzebuerg* (PSELL3), an annual household survey representative of the population in Luxembourg and the Luxembourgish component of the European Union-Statistics on Income and Living Conditions (EU-SILC). This survey contains detailed information on labour supply, household's income and household's composition, childcare choices, and living conditions. In the survey, parents are asked about the type of childcare used for all of their children aged less than 13. Parents report whether they use non parental childcare (daycare centre, either public or private, a childminder or care by relatives at zero costs). Using this information, we create a dummy variable indicating whether parents use or not formal childcare for each of their children. As regards labour supply, individuals report their status on the labour market each month and, if they are working, the number of worked hours. We create a dummy variable indicating whether the mother is working or not (not working means unemployed, out of the labour force or in full-time parental leave).

*Individual characteristics:* We use the age of the mother, a set of three dummies for the education

with the omitted category being the lower level of education.<sup>12</sup> As non natives represent an important proportion of the population in Luxembourg, we also distinguish between them: we use the date of arrival in Luxembourg to make a distinction between non natives who arrived as a child and non natives who arrived as an adult. We assume that the first subgroup is more likely to have migrated with their parents and thus to have greater chance of relying on their parents for informal care than the latter one. We thus create a set of three dummies for nationality: native (being the omitted category), non native arrived as a child and non native arrived as an adult.

*Households' characteristics:* We use a set of dummies to account for the presence of children by age-group (0-3 years old, 4-12 years old and 13 years and more). We add non labour income (included income from the husband) with a quadratic term to allow for a non linear effect of non labour income. We also add a dummy for the presence of an inactive adult into the household to account for a potential childcare giver within the household.

In addition to data on mothers and their families, we use additional sources of data.

Data on childcare slots (daycare centres and childminders) for children less than 4 in each locality come from a survey among childcare providers conducted by LISER (Luxembourg Institute of Socio-Economic Research). The survey was launched in the last semester of 2010 among all existing childcare providers (441 day care centres and 342 official child minders). It provides detailed information on childcare providers, regarding the characteristics of the care provided (age of the children cared of, number of children cared for, number of existing slots, schedules and hours of opening services over the year and during holidays) and as regards the staff (gender, age, level of education, wages, schedules, seniority).

The number of children less than 4 by locality come from the Census, as well as the size of the locality (number of inhabitants).<sup>13</sup>

Data on local amenities have been registered by LISER. This data set provides information on a large range of amenities provided locally:

- education (primary schools, secondary schools, higher education institutes)
- shops and services (supermarkets, pharmacies, banks and cash machines)

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<sup>12</sup>We tested a quadratic effect for the age of the mother. The effect was no significant and we decided to remove it. Previous specifications of the model included the age of the partner and their nationality. Both variables had no significant effects. We also added a dummy for a partner doing extra hours in case they worked (more than 95% of partners work). The variable had no significant effect. We decided to remove all these variables from the final version of the model.

<sup>13</sup>In a previous specification of the model, we also used the local female employment rate to account for local characteristics. The variable was not significant. We decided to remove it to estimate a more parsimonious model.

- restaurants and leisure equipment (cafe and restaurants, swimming pools, sports centres)
- administrative and community services (post offices, police stations, fire stations, employment agencies, social security centre)
- health care and social services (welfare centre, medical and social centre, hospitals, day care centre for the elderly)

Data on travel time distances between localities in Luxembourg have been computed using Google maps (*supra*).

We restrict the sample to *women living with a partner and having at least one child under 4 years old*. The final sample contains 689 observations. Table 5 gives the definition of each variable, while Table 6 provides descriptive statistics.

## 6.2 Descriptive

Table 6 shows summary statistics for the sample of women living with a partner and with at least one child under 4 years old. The woman is on average 4 years younger than her partner (32 compared to 36). In line with national statistics for Luxembourg, the large majority of the sample is of non luxembourgish nationality (65%). The percentage is much higher among women who are not employed (78 compared to 59). As expected, women who are not employed are, on average, less educated than the other women: only 27% have a college degree against 47% of women who are employed.

The average household income is 5 590 euros per month; with no significant differences regarding the employment status of the women. Almost half of the sample own their home. The percentage is slightly lower among women who are not employed.

The quasi totality of the women in our sample have a partner who is employed (more than 95%); for one third of them, the partner regularly works hours.

There is no difference among the employment status of women as regards the presence of an inactive adult in the household. But, and not surprisingly, there is a strong link between the presence of children and employment status: unemployed women have on average more younger children than employed women have. There is also a strong link between the employment status of mothers and the use of formal childcare services. Table 7 shows that among women who are employed, 85% use a formal childcare arrangement, against only 15% among those who are not employed.

## 7 Results

In this section, we present the empirical results. First, we present the results of a simultaneous model of employment and childcare with exogenous residential location. Second, we account for endogenous location by using a simultaneous equations system of location, employment and childcare choices. Finally, to make sure that our results are credible, we estimate the model with alternative definitions of the accessibility to childcare services.

### 7.1 Baseline specification

Table 10 reports the result of the estimates of employment and childcare use probabilities, without accounting for the endogeneity of residential location. The coefficient of correlation of the two equations  $\rho$  is statistically significant, with a large positive value (0.68). This is rather intuitive and expected: women who are more willing to be employed are also more willing to use formal childcare.

As a whole, the **control variables** have the expected effect. More educated women are more likely to be employed than women with a low level of education. More educated women are more willing to use formal childcare than the less educated but we find no statistically significant differences between averagely educated women and those with lower education only. The number of children, irrespective of their age, is negatively related to the probability of being employed and the probability of using formal childcare. We also found a negative effect of the household income on the probability of being employed, with the quadratic terms also being significant. Wealthier women are less willing to work than other women. But the household income has no significant effect on the probability of using childcare, which may reflect the affordability of childcare services in Luxembourg due to large subsidies. The presence of an inactive adult in the household is unrelated to both probabilities, which suggests that the availability of an informal care giver into the household is unrelated to the employment status, nor the childcare use.

Looking at the **variable of interest**, we find a positive and significant effect of local childcare availability on probability of childcare use, while no effect is found on employment probability. The provision of childcare services close to home is not related to maternal employment, but only to childcare use.<sup>14</sup> It is coherent with what has been found in previous similar studies (Del Boca and Vuri, 2007, Bousselin, 2015).

One explanation for this result may be the rise of female employment over the last decade in Lux-

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<sup>14</sup>We also run the model with different values of the parameters  $\beta$  and  $\bar{D}$ , ranging from 1 to 3, by 0.2 and ranging from 0 to 30 by 5 respectively. Our main finding is unchanged. Results of these checks are available from the author on request.



embourg. Indeed, the employment rate of women has increased from 53.8% in 2000 to 64.1% in 2012 (source: STATEC). This increase may have reduced the subset of women who might be sensitive to the work incentives given by childcare policies. As women are no longer as responsive to wage change as before, childcare policies that decrease (monetary and non monetary) childcare costs may have smaller impact on women's labour force participation today than in the past.

Moreover, it is likely that women decide their future professional career before the birth of their first child. Those who would like to be employed while having children would look after and find a way of reconciling both career and child rearing. This group of women, with strong attachment to the labour market, would have worked even if access to formal childcare was limited. One way of coping with a limited access to formal childcare is to rely on informal care. Another way is to reduce the worked hours, the worked days, or to share time spent looking after children with the partner. In our sample, more than one third of women works part-time; the large majority of them has chosen part-time in order to reconcile work and family life. In addition, the large increase of the female employment rate in Luxembourg is mainly due to the rise of part-time jobs over the last decades (Guastalli et al., 2011).

The other women may have decided to stay at home because they feel that it is best for them and their family. Likely these women do not trust external childcare and believe that maternal childcare is the best for the well-being of their child. Moreover, women who do not work are on average less qualified than women who are employed. The alternative to staying at home is likely having a low-skilled job, which probably provides much less satisfaction than taking care of children.

Another explanation is that there is a significant deadweight: the new provision of formal childcare have crowded out the informal care to a significant extent. Graphic 1 shows that over the last decade, informal care has been halved while formal care has more than doubled, suggesting a large crowding out effect.

## **7.2 Heterogeneous effects**

### *Interaction terms between the number of children and the LACC measure*

In this paper, fertility choices are disregarded: the decision to have children is assumed to be exogenous to the mother's employment and childcare choices. This assumption is quite strong since one cannot exclude that women who have decided to have children, and raise them while continuing working have likely unobservable characteristics that make them more prone to choose paid work and external childcare. In particular, attitudes towards fertility, maternal employment and external childcare may affect the employment and childcare choices (Schober, 2013). In addition, we can reasonably argue that the preferences of households with different number of children are quite distinct. For exam-

ple, mothers of an only child could have chosen to have only one child because, for them, this choice is more consistent with a professional career and these women may prefer external childcare because it is a way of socializing their child. As a consequence, we can expect that the role of proximity to available childcare services differs with respect to the number of children.

To test this idea, we add interaction terms between the number of children and the LACC measure in our model of employment and childcare use. None of the interaction terms is significant, with the main effect of LACC still being significant in the childcare equation.<sup>15</sup> This results suggests that the effect of local availability of childcare services does not differ with the number of children in the household.

#### *Nationality*

Informal childcare, generally provided by the grandparents (namely the grandmother), is more or less a substitute for formal childcare. In particular, previous literature has shown that the use of grandchildcare is positively related to female employment, and that this effect differs across countries. This difference can be explained by differences in childcare policies, but also by differences in attitudes towards childcare and maternal employment (Aassve et al., 2012, Arpino et al., 2014).

To test this idea, we run the model separately on three subsamples of mothers: (a) the native, (b) the non native who migrated during childhood and (c) the non natives who migrated after childhood.

Our previous estimates remain unchanged, except for the subsample (a) of native mothers. For them, the local availability of childcare has no effect either on employment or childcare decisions. In other words, making childcare services more widely available for native women is not a mean to encourage them to work and to use childcare services while their employment and childcare decisions do not respond to the available childcare options close to their residential location.

This result may be explained by the persistence of the traditional view of the family amongst the natives: among the luxembourgish, the family model in which only the male provides the income dominates over other kinds of family model (Hausman and Reinstadler, 2011).

#### *Mother's education*

Attitudes regarding maternal employment and formal childcare may affect the effect of the local availability of childcare services, given that those who have the most traditional attitudes would never use formal childcare, even if it is widely accessible. In order to test our idea, we estimate the model separately on three subsamples of mothers: (i) mothers with a low education, (ii) mothers with a middle education and (iii) mothers with a high education. Our assumption is that attitudes and norms differ ac-

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<sup>15</sup>Results are not presented here but are available from the author upon request.

cording to the level education; with the more educated more willing to share the more modern attitudes and views about maternal employment and formal childcare.

Our previous estimates are not affected when the model is estimated on the subsample (i) low educated mothers, nor on the subsample (ii) of average educated mothers. For the (iii) higher educated mothers, however, the LACC has no effect on either employment or childcare use probabilities. It may reflect the fact that the more educated women will work and find a childcare option for their children, no matter what their proximity to available childcare services.

### **7.3 With explicit controls for the time spent in current home and for location choice determinants**

As explained above, it is likely that some parents may have chosen to live close to childcare services because they expected that they would be using it. One way to account for this issue is to control for the date of arrival in the current dwelling. The idea is the following: it is likely that the selection issue due to residential mobility arises for families who have moved to a date closer to the birth of their child.

Table 11 presents the results of the bivariate model of employment and childcare use controlling for the time spent in the current dwelling. The time spent in the current dwelling is not related to the probability of being employed, nor to the probability of using childcare services. Previous results are not affected by the introduction of this new covariate. In particular, the local availability of childcare services is still positively related to the probability of using childcare but not to the probability of being employed.

Another way to account for the selection issue arising here is to add explicit controls for the determinants of residential location choices (*control function* approach). The literature on location choices has shown that local amenities are related to the choice of a residential location (Roback, 1982). We take advantage of having access to data on a large range of amenities for all the localities in Luxembourg to add explicit controls for the location choice in our model.

One issue to be mentioned is the correlation of the local availability of childcare with other local amenities and the correlation between each local amenity. In particular, localities where the provision of childcare services is high are likely to provide other services devoted to families with children, such as preschool and public school. The correlation with other local amenities would be lower because the other local amenities are provided for all inhabitants and would be used by all rather than only by the subgroup of families with children. Another issue to be mentioned is that it is likely that one finds more amenities in big cities than in small ones, irrespective of the composition of the population.

Table 12 shows that gross correlations between local amenities are low, except the correlation be-

tween the provision of cultural facilities and the size of the local population.

To address the first issue, we choose to use the following local amenities to control for the location choices: cultural and sports facilities, shops and restaurants and health services. As regards the second issue, we compute, for each of these amenity, the mean centered around the national mean (a useful way to reduce multicollinearity resulting from using correlated variables in a regression model). The size of the local population to the model allows to account for the size effect.

Table 13 presents the results of the bivariate model of employment and childcare use with explicit controls for location choices. Previous result are not affected once we control for the determinants of the location choice. In particular, the local availability of childcare services is still significantly positively related with childcare use probability, but not with employment probability.

Nevertheless, even if we can control for a large range of individual, family and local characteristics, this *control function* approach may not be sufficient to account for the selection of parents (and their children) into localities. Most likely, the selection of families into location depends not only on their observable characteristics but also on their unobservable ones. We then attempt to solve the endogeneity issue by jointly estimating location, employment and childcare choices.

#### **7.4 Model of employment and childcare decisions with endogenous residential location**

Table 14 presents the results of the model of childcare and employment probabilities with endogenous location choices.

The correlation coefficient between employment and childcare is still statistically significant, with a large positive value between the residuals of the employment and childcare equation which is equal to 0.7. In contrast, the correlation coefficients between local availability and employment, and local availability and childcare are not statistically significant.

As regards the *control variables*, the sign and the significance of the effects are the same as those previously found. It means that controlling for the endogenous location choice does not affect the role of the control variables in explaining the employment and childcare use decisions.

Turning now to the *variable of interest*, with this specification, the local availability of childcare services does not have any significant effect on either the probability of using childcare or on the probability of being employed. In other words, when conditioning on the location choices, the local availability of childcare is no longer related to the employment and childcare decisions. For mothers of young children, the decision to work after giving birth seems not to be affected by the proximity of available childcare services. At a first glance, this result may be surprising. It may suggest, however, that these

women have already made their employment/career decisions before giving birth.

## **7.5 Robustness checks**

To make sure that our results are credible, we estimate a set of models. First of all, we check whether our results depend on the measure of the local availability of childcare services we used. Then, we try to take into account the possibility that local availability of informal childcare may be endogenous to childcare, employment and location choices. Finally, we look at the effect of the local availability of childcare services on the hours of work.<sup>16</sup>

### **7.5.1 Different definitions of the local availability of childcare services**

To check whether our results depend on the measure of the local availability of childcare services we used, we computed the following measures:

- a dummy variable equal to 1 if the family lives in one of the 10% of localities with highest availability of childcare services
- a dummy variable equal to 1 if the family lives in a locality where the local provision rate of childcare services is higher than the national average (27%)
- the local provision rate that is traditionally used in the literature (the number of places divided by the number of children under 4 years old in the locality of residence)

With the first alternative measure, the local availability of childcare services has now a significant positive effect on both employment and childcare probabilities (Table 15).

With the second alternative measure, we obtain the same results as we got from the model estimated by means of a continuous measure of availability (Table 16).

Finally, with the local provision rate, which is traditionally used in the literature, we found no effect on either employment or childcare probabilities (Table 17). This is not surprising given that our measure of availability allows for a larger provision of childcare than the traditional measure does (since the provision of neighbourhood localities enters into our measure).

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<sup>16</sup>Detailed results are available from the author on request.

### 7.5.2 Endogenous proximity to grandchildcare

Previous literature provides empirical evidence that informal childcare, which is mainly provided by grand-mothers, has a substantial positive effect on mother's employment (Del Boca, 2002b, Dimova and Wolff, 2011, Compton and Pollak, 2014). Some parents may thus have taken into account the proximity to their parents and/or parents in law when they have chosen where to live. In particular, the literature on the geography of family suggests that the residential location choices of young adults is linked to family ties (Løken et al., 2013). Living close to a grand-mother may thus be endogenous to labour market and childcare choices as young adults may anticipate the need or desire to use grandchild care when choosing both residential and workplaces locations. We can then expect that women with high preferences for grandchild care are those who have chosen to live close to their parents and also those who use informal childcare, irrespective of the formal childcare services provided close to their home.

To account for the potential endogenous proximity to informal caregiver, we estimate the model on the sub sample of non native mothers who migrated in Luxembourg when they were adults. We assume that these women, who were adults when they arrived in Luxembourg had left their parents in their country of origin. Thus, for this sub-group of women, the choice of a residential location may not be motivated by the proximity to their parents. In other words, we can assume that choice of residential location is exogenous to that of their parents.

Our previous results are unchanged. The correlation coefficient between employment and the use of childcare equations is still positive and high ( $\rho_{23} = 0.55$ ). The other correlation coefficients are not significant, meaning that the local availability of childcare is uncorrelated with employment and childcare probabilities. The effect of the local availability of childcare services on the employment and childcare equations is not significant.

### 7.5.3 Effect on hours worked

Until now, we have focused on binary labour choices, i.e. the labour market participation choices of mothers. Yet, one can argue that the decisions at the intensive margins are more affected by childcare policies than the decisions at the extensive margins are. Indeed, many mothers may prefer to reduce their number of hours worked rather than leaving the labour market altogether. In our sample, half of the employed mothers were working part-time, mainly due to family reasons (73% of them).

As the number of hours takes only positive values and is only observed for women who are employed, and therefore not randomly selected from the whole population of mothers, we use a *tobit*

*model with selection* to check whether the local availability of childcare services plays a role on hours worked. More precisely, we estimate a two-equations model that comprises a selection equation, the employment equation for  $y_{work}$ , such that:

$$y_{work} = \begin{cases} 1 & \text{if } y_{work}^* > 0 \\ 0 & \text{otherwise} \end{cases}$$

$y_{work}^*$  is a latent variable such as:

$$y_{work}^* = \beta X + \alpha Z + \delta LACC + \epsilon$$

Let be the outcome equation for the observed number of hours worked be  $y_{hours}$ .  $y_{hours}$  is observed only when  $y_{works}^* > 0$ .

$$y_{hours} = \begin{cases} y_{hours}^* & \text{if } y_{works}^* > 0 \\ - & \text{if } y_{works}^* \leq 0 \end{cases}$$

where - means that  $y_{hours}$  is observed to be missing. The errors between the two equations are assumed jointly normally distributed and homoskedastic.

The local amenities are used as exclusion restrictions: local amenities are assumed to be related to job opportunities, and thus to the employment probability, but not to the number of hours worked. With this model, we find that the local availability of childcare services has a non significant effect on the hours worked. In other words, living close to available childcare services seems to be unrelated to the number of hours the mothers spent in the labour market.

Rather than assuming that mothers choose a continuum of hours worked, it is more realistic to look at the choice between no job, a part time job and a full time one. Figure 2 shows the distribution of the hours of work per week. We see that there are 2 peaks: one at 20 hours (part time) and another one at 40 hours (full time). We thus assume that mothers choose between (1) not working in the labour market, (2) working part-time or (3) working full-time. We set  $y_{work} = j$  if the outcome is the  $j$ th alternative, with  $j = 1, 2, 3$ . With this model, the local availability of childcare services still has a non significant effect on the probability of working part-time and on the probability of working full-time respectively compared to stay at home. Our main conclusion thus remains the same: the time the mother spends in the labour market appears not to be influenced by the provision of childcare services close to the family's home.

## 7.6 Discussion

Our results suggest that, when conditioning on location choices, the provision of childcare services close to the family home might have no effect on maternal employment and childcare use for children not yet at school. This is in line with recent empirical evidence drawn from a similar context (Fitzpatrick, 2010, Bauernschuster and Schlotter, 2015). Indeed, one cannot expect great impacts from childcare policies that make childcare more widely accessible when employment rates and childcare attendance rates are already high. In addition, if the newly accessible slots simply substitute for informal childcare arrangements, one cannot expect large employment effects. Moreover, Bauernschuster and Schlotter (2015) argue that crowding-out might be particularly relevant in case of persistent rationing: indeed, in that case, the newly provided slots are given as a priority to women already working, and these mothers would then just substitute informal childcare arrangements with formal ones. In Luxembourg, despite the large expansion of childcare slots that occurred during the last decade, the number of slots provided still seems to be insufficient to satisfy the whole demand. In particular, 75% of daycare centres report insufficient slots to satisfy demands (source: Survey among childcare services in Luxembourg, LISER, 2010). In addition, non labour income (through partner's earnings) are especially high in Luxembourg, resulting in high reservation wage and income effect, that could explain why increasing access to childcare have no effect on maternal employment, at the extensive and at the intensive margins.

With respect to policy implications, our results suggest that improving spatial access and availability of childcare services may not be sufficient for encouraging inactive mothers to enter into the labour market. Most likely it may help women who have already decided to work to stay in the labour market after childbirth.

Maternal employment, and formal childcare, may be perceived by some women as having negative effects on child well-being. In Luxembourg, a traditional model of households organization, in which the male is the breadwinner and the female is in charge of the domestic sphere, is still persistent, even in young couples (Valentova, 2013). In that case, if the government aims at encouraging inactive women to enter the labour market and to use formal childcare, one way of achieving this goal might be to influence the traditional beliefs regarding maternal employment and maternal childcare. This can be achieved by still continuing to promote access to childcare services of high quality, as peer effects may play a determinant role in employment and childcare decisions.

In addition, as our results suggest that mothers who were already working benefit from the provision of childcare, it might raise concerns not only about the effectiveness of the provision of childcare in promoting maternal employment but also about its adverse distributional effect (Van Lancker and Ghysels, 2011).



Finally, our results might raise a concern about spatial inequalities. Indeed, working parents may choose to live in the localities that provide most childcare services, which will increase the income of these localities and will encourage the arrival of further providers of childcare as well as families in which both parents are working. It might thus create (and increase) the income gap between localities.

A first limitation of our work is that we use an individual labour supply model because the unitary approach is widely challenged by empirical evidence. A natural extension would be to use the collective labour supply with home production of child well-being (Blundell et al., 2005), though this model focuses on labour supply choices at the intensive margin.

A second limitation is that we do not account for the proximity of childcare services to the parental workplaces. To account for this element requires to model the job location choices of the parents, in conjunction with the labour supply, childcare and residential location decisions. While childcare policies that make childcare more widely accessible may affect the bargaining power of women, it could be interesting to model the within-family joint decision processes that lead to residential and workplace location choices. Until recently, the literature on residential and job locations relies on unitary models, in which the decisions depend on aggregated individual preferences and constraints. As preferences and constraints differ among the household, ignoring this heterogeneity may explain why there are little conclusive empirical results on a residential mobility depending on childcare opportunities.

A third limitation is that childcare is assumed to be homogenous in quality. Related to this assumption, we do not distinguish between public and for-profit provision of childcare. Yet, as public and for-profit providers are expected to behave differently, one can expect that the childcare provided differs (in quality) regarding the type of providers, and that this may, in turn, affect the childcare and employment decisions of parents. Another interesting avenue for future research is thus to account for heterogeneous childcare services and to model a family's decisions in conjunction with the decisions of childcare providers (location, quantity and quality provided). In particular, from a policy point of view, it may be important to distinguish between the different reasons why nearby childcare services are preferred. If time and money are to some extent substitutable, a subsidy may make the household indifferent in choosing between the more expensive (but closer) childcare service and the cheaper (but more distant) alternative. In contrast, trust issues may be more difficult to compensate for by means of subsidies.

Turning now to the limitations of our empirical framework, a first limitation is that it relies on a poor proxy for the availability of informal childcare (the nationality). In theory, informal childcare is, to some extent, a substitute for formal childcare. It is also a useful complementary option to formal childcare in case of unexpected events such as child's illness, which are frequent events when children

are young. In the future, it would be interesting to take into account the fact that proximity of grand parents is likely to be endogenous to employment, childcare and location choices of parents with young children.

A second limitation of our empirical analysis is that we use the centroid of the localities to compute the distances between a family's residence and a providers' location. As explained above, our measure of distances would have been more accurate if we had obtained the exact addresses of families and providers (rather than the centroid of the localities where the families live/ the childcare provider is located).

## **8 Conclusion**

The aim of this paper was to document the relationship between the provision of childcare and maternal employment, focusing on one aspect that has been largely ignored in the previous literature: the proximity to childcare services. Deviating from existing studies, the spatial structure of the choice problem is taken into account more seriously. Instead of defining availability of childcare services per locality of residence, we implement a refined measure of availability, which takes commuting times into account. We ran a simultaneous equations approach to estimate the employment and childcare use probabilities and a selection equation, to control for the fact that mothers who are employed and use childcare services have chosen to live close to available childcare services. We used a very rich data set, which matches data from the Luxembourgish households survey in conjunction with data on the characteristics of the localities (childcare services and other local amenities) and travel time distances.

Our results suggest that, when conditioning on location choices, the provision of childcare services close to the family home might have no effect on maternal employment and childcare use for children not yet at school. This is in line with recent empirical evidence drawn from similar contexts, in which both female employment and formal childcare attendance are already high due to large increases in the past. In such contexts, childcare policies that make childcare services more widely accessible do not appear to be an effective tool for making women with young children more willing to participate in the labour market. It is likely that the newly available childcare slots simply substitute for informal arrangements. In addition, this crowding out effect may be even more important due to the method used in allocating available slots: the newly available slots are given in priority to women already working as the employment status is a top priority criterion for getting a slot, and these women would now simply substitute an informal arrangement for a formal one.

These results underline not only the ineffectiveness of childcare policies that make childcare more widely available in promoting maternal participation in the labour market, but also their potential ad-

verse distributional effects since the policies mostly benefit women who are already engaged in the labour market.

This study only focuses on the labour supply and childcare decisions of the mother. A natural extension would be to use the collective labour supply framework, with home production of child quality. As childcare policies that aims at increasing access to childcare services may affect the bargaining power of women, one might expect that the choice problem of the women could be affected. Additionally, it may be interesting to model the within-family joint decision processes that lead to residential and workplace location choices. Finally, we have assumed that childcare is homogenous in quality and we did not distinguish between public and for-profit providers of childcare. It could also be interesting to relax these assumptions and to document further the behaviours of families and childcare providers, allowing for heterogeneous quality of childcare and public and for-profit provision of childcare.

## References

- Aassve, A., Arpino, B., and Goisis, A. (2012). Grandparenting and mothers' labour force participation: A comparative analysis using the generations and gender survey. *Demographic Research*, 27(3):53–84.
- Arpino, B., Pronzato, C. D., and Tavares, L. P. (2014). Mothers' labour market participation: Do grandparents make it easier? *European Journal of Population*, 30:369–390.
- Baizan, P. (2009). Regional childcare availability and fertility decisions in Spain. *Demographic Research*, 21(27):803–842.
- Barrow, L. (2002). School choice through relocation: evidence from the Washington, D.C. area. *Journal of Public Economics*, 86(2):155–189.
- Bauernschuster, S., Hener, T., and Rainer, H. (2016). Children Of A (Policy) Revolution: The Introduction Of Universal Child Care And Its Effect On Fertility. *Journal of the European Economic Association*, 14(4):975–1005.
- Bauernschuster, S. and Schlotter, M. (2015). Public child care and mothers' labor supply Evidence from two quasi-experiments. *Journal of Public Economics*, 123(C):1–16.
- Bayer, P., Ferreira, F., and McMillan, R. (2007). A Unified Framework for Measuring Preferences for Schools and Neighborhoods. NBER Working Papers 13236, National Bureau of Economic Research, Inc.
- Bayer, P. J. and McMillan, R. (2010). Tiebout Sorting and Neighborhood Stratification. Working Papers 10-48, Duke University, Department of Economics.
- Becker, G. S. (1965). A theory of the allocation of time. *The Economic Journal*, 75(299):493–517.
- Becker, G. S. and Lewis, G. H. (1973). On the interaction between the quantity and quality of children. *The Journal of Political Economy*, 81(2):S279–S288.
- Berger, E. M. (2013). Happy working mothers? investigating the effect of maternal employment on life satisfaction. *Economica*, 80(317):23–43.
- Blau, D. and Currie, J. (2010). *Pre-School, Day Care, and After-School Care: Who's Minding the Kids?*, volume 2 of *Handbook of the Economics of Education*, chapter 20, pages 1163–1278. Elsevier.
- Blundell, R., Chiappori, P.-A., and Meghir, C. (2005). Collective Labor Supply with Children. *Journal of Political Economy*, 113(6):1277–1306.

- Bousselin, A. (2015). Emploi des mères et recours à un mode de garde payant : le rôle de la proximité des services de garde denfants et de leur coût. un exemple à partir de données luxembourgeoises. *Economie et Prévision*, (206-207):91–115.
- Brilli, Y., Del Boca, D., and Pronzato, C. (2016). Does child care availability play a role in maternal employment and childrens development? Evidence from Italy. *Review of Economics of the Household*, 14(1):27–51.
- Compton, J. and Pollak, R. A. (2014). Family proximity, childcare, and womens labor force attachment. *Journal of Urban Economics*, 79(C):72–90.
- Del Boca, D. (2002a). The Effect of Child Care and Part Time Opportunities on Participation and Fertility Decision in Italy. *Journal of Population Economics*, 15:549–573.
- Del Boca, D. (2002b). The effect of child care and part time opportunities on participation and fertility decisions in italy. *Journal of Population Economics*, 15(3):549–573.
- Del Boca, D. and Vuri, D. (2007). The mismatch between employment and child care in italy: The impact of rationing. *Journal of Population Economics*, 20(4):805–832.
- Dimova, R. and Wolff, F.-C. (2011). Do downward private transfers enhance maternal labor supply? Evidence from around Europe. *Journal of Population Economics*, 24(3):911–933.
- Epple, D. N. and Romano, R. (2003). Neighborhood Schools, Choice, and the Distribution of Educational Benefits. In *The Economics of School Choice*, NBER Chapters, pages 227–286. National Bureau of Economic Research, Inc.
- Fitzpatrick, M. D. (2010). Preschoolers enrolled and mothers at work? the effects of universal prekindergarten. *Journal of Labor Economics*, 28(1):51–85.
- Gauthier, A. (2002). Family policies in industrialized countries: Is there convergence? *Population*, 57(3):447–474.
- Gronau, R. (1977). Leisure, home production, and work . the theory of the allocation of time revisited. *The Journal of Political Economy*, 85(6):1099–1124.
- Guastalli, E., Lejealle, B., and Vanni, L. (2011). Les femmes et les hommes sur le marché de l’emploi. Report for the luxembourgish ministry for equal opportunities, LISER.
- Hank, K. and Kreyenfeld, M. (2003). A multilevel analysis of child care and fertility decisions in western germany. *Journal of Marriage and Family*, 65(3):584–596.

- Hausman, P. and Reinstadler, A. (2011). Représentation de la famille et opinion sur la politique familiale. Report for the luxembourgish ministry for family, LISER.
- Havnes, T. and Mogstad, M. (2011). Money for nothing? universal child care and maternal employment. *Journal of Public Economics*, 95(11-12):1455–1465.
- Heckman, J. J. and Masterov, D. V. (2007). The Productivity Argument for Investing in Young Children. NBER Working Papers 13016, National Bureau of Economic Research, Inc.
- Herbst, C. and Barnow, B. (2008). Close to home: A simultaneous equations model of the relationship between child care accessibility and female labor force participation. *Journal of Family and Economic Issues*, 29(1):128–151.
- Hewko, J., Smoyer-Tomic, K. E., and Hodgson, M. J. (2002). Measuring neighbourhood spatial accessibility to urban amenities: does aggregation error matter? *Environment and Planning A*, 34(7):1185–1206.
- Humblet, P. and Amerijckx, G. (2008). Typologies et indicateurs des d’éducation et d’accueil des jeunes enfants (eaje) en europe. *Brussels Economic Review-Cahiers économiques de Bruxelles*, 51(2-3):347–365.
- Klein, S. and Schmitz, F. (2011). Modeling and simulating accessibility within the luxembourg cross-border area. Technical report, Proceedings of the BIVIC/GIBET Transport Research Day 2011.
- Løken, K., Lommerud, K., and Lundberg, S. (2013). Your Place or Mine? On the Residence Choice of Young Couples in Norway. *Demography*, 50(1):285–310.
- Luo, W. and Wang, F. (2003). Measures of spatial accessibility to health care in a GIS environment: synthesis and a case study in the Chicago region. *Environment and Planning B: Planning and Design*, 30(6):865–884.
- Moulin, H. (2001). Priority rules and other asymmetric rationing methods. *Econometrica*, 68(3):643–684.
- Mulder, C. and Wagner, M. (2001). The connexions between family formation and first-time home ownership in the context of west germany and the netherlands. *European Journal of Population*, 17(137-164):2.
- Nollenberger, N. and Rodríguez-Planas, N. (2015). Full-time universal childcare in a context of low maternal employment: Modest but persistent effects. *Labour Economics*, 36:124–136.

- Öst, C. (2012). Housing and children: simultaneous decisions? a cohort study of young adults' housing and family formation decision. *Journal of Population Economics*, 25(1):349–366.
- Rhode, P. W. and Strumpf, K. S. (2003). Assessing the Importance of Tiebout Sorting: Local Heterogeneity from 1850 to 1990. *American Economic Review*, 93(5):1648–1677.
- Roback, J. (1982). Wages, Rents, and the Quality of Life. *Journal of Political Economy*, 90(6):1257–78.
- Roodman, D. (2009). Estimating Fully Observed Recursive Mixed-Process Models with cmp. Working Papers 168, Center for Global Development.
- Ruhm, C. J. (2004). Parental Employment and Child Cognitive Development. *Journal of Human Resources*, 39(1).
- Schober, P. (2013). the parenthood effect on gender inequality: Explaining the change in paid and domestic work when british couples become parents. *European Sociological Review*, 29:74–85.
- Valentova, M. (2013). Sex and Age Differences in Gender Role Attitudes in Luxembourg Between 1999 and 2008. *Work, Employment and Society*, 27(4):639–657.
- Valentova, M. and Bia, M. (2013). Parental leave among single child parents take up and labor market effects. Report for the luxembourgish ministry of family and integration, Liser.
- Van Lancker, W. and Ghysels, J. (2011). Who reap the benefits? the social distribution of public childcare in sweden and flanders. Gini discussion paper 10.

## 9 Appendix

Table 1: Employment rate by gender and by number of children in Luxembourg (in %)

Number of children	Female	Male	Diff.
0	78.9	87.9	9.00
1	72	81.2	9.20
2	69.4	95.0	25.20
3 or more	53.1	93.1	40.00

Source: Eurostat-2009

Table 2: Types of childcare arrangement for children 0-3 years old

Type of childcare arrangement	Percentage
Parents	32
Daycare (public or private)	30
Childminder	9
Informal childcare (care by relatives)	24
Mixed of non parental childcare arrangement*	4
<b>Total</b>	<b>100</b>

\*Most frequent: daycare center+informal care. Source : Eu-Silc/Psell3-2011

Table 3: Number of slots in day care and before/after school daycare in 2015

Sector	day care	before/after school care	Total
Public	5 158	32 282	37 440
Private	9 040	1 366	10 406

Source: Survey among child care providers, LISER-2010



Table 4: Number of existing slots for 100 children aged 0-4 in 2010, by type of services and by localities

<b>Type of services</b>	<b>Mean</b>	<b>Median</b>	<b>Minimum</b>	<b>Maximum</b>	<b>Std Dev</b>
public sector	31.98	28.42	7.68	97.65	21.98
for-profit sector	38.64	33.77	3.63	93.75	25.52
home based care	11.44	9.40	1.97	44.11	7.84
Total	25	16.74	2.89	93.10	19.81

Source: Survey among childcare providers, LISER-2010

Table 5: Definition of variables

<b>Variable</b>	<b>Definition</b>	<b>Data</b>
Mother's working status	dummy equal to 1 if the mother works	EU-SILC-PSELL-2011
Use formal childcare	dummy equal to 1 if the mother uses formal childcare for her youngest child (daycare center or childminder)	EU-SILC-PSELL-2011
Availability of childcare	number of places in childcare services (daycare center and childminder) for children less than 4 years old divided by the number of children less than 4 years old, weighted by the proximity of childcare services to family's home	administrative data on childcare places, CENSUS and geodata
Age	age in years of the mother	EU-SILC-PSELL-2011
Native	dummy equal to 1 if the mother is a native	EU-SILC-PSELL-2011
Non native arrived during childhood	dummy equal to 1 if the mother migrated in Luxembourg when she was under 18 years old	EU-SILC-PSELL-2011
Non native arrived after childhood	dummy equal to 1 if the mother migrated in Luxembourg when she was 18 years old or more	EU-SILC-PSELL-2011
Low education	dummy equal to 1 if the mother has a primary school degree	EU-SILC-PSELL-2011
Middle education	dummy equal to 1 if the mother has a secondary school degree	EU-SILC-PSELL-2011
High education	equal to 1 if the mother has a college education degree	EU-SILC-PSELL-2011
Partner's extra hours worked	dummy equal to 1 if the partner often works more hours than fixed in his labour contract	EU-SILC-PSELL-2011
Household's income	household income except from the mothers, in thousands of euros per month	EU-SILC-PSELL-2011
Child 4-6	dummy equal to 1 if there is at least one child between 4-6	EU-SILC-PSELL-2011

Child 7-12	dummy equal to 1 if there is at least one child between 7-12	EU-SILC-PSELL-2011
Child 13 or more	dummy equal to 1 if there is at least one child between 13 or more	EU-SILC-PSELL-2011
Potential care giver into household	dummy equal to 1 if there is an inactive adult (not the mother) in the household	EU-SILC-PSELL-2011
Local unemployment rate	percentage of unemployed over active by locality	Statec (National office of Statistics)
Size of the local population	Number of inhabitants in the locality of residence in 2011	CENSUS
Local provision of public services	number of public services per 1000 unhabitants	LISER data-2011
Local provision of cultural facilities	number of cultural facilities per 1000 unhabitants	LISER data-2011
Local provision of health equipments	number of health equipments per 1000 unhabitants	LISER data-2011
Local provision of shops	number of shops per 1000 unhabitants	LISER data-2011
Local provision of restaurants	number of restaurants per 1000 unhabitants	LISER data-2011

Table 6: Summary statistics for women with a partner and at least one child under 4

Variable	All mothers			Work			Does not work		
	Mean	St. Dev	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.	
Mother's characteristics									
Age	32.30	(5.22)	32.48	(5.24)	31.94	(5.17)			
Age of the partner	35.94	(5.97)	35.79	(5.74)	36.26	(6.39)			
Native	0.35	(0.46)	0.41	(0.49)	0.22	(0.39)			
Non native arrived during childhood	0.22	(0.40)	0.19	(0.39)	0.27	(0.42)			
Non native arrived after childhood	0.43	(0.48)	0.39	(0.48)	0.51	0.47			
Mothers' education:primary school	0.32	(0.46)	0.27	(0.44)	0.43	(0.47)			
Mothers' education: secondary school	0.31	(0.45)	0.31	(0.46)	0.30	(0.43)			
Mothers' education: college	0.37	(0.47)	0.42	(0.49)	0.27	(0.42)			
Family's characteristics									
Household income* (in thousands of euros per month)	5.59	(4.12)	5.43	(4.08)	5.941	(4.20)			
Partner does extra worked hours	0.33	(0.46)	0.34	(0.47)	0.33	(0.46)			
Number of children aged 4-6	0.29	(0.47)	0.24	(0.43)	0.40	(0.51)			
Number of children child aged 7-12	0.26	(0.52)	0.21	(0.45)	0.38	(0.61)			
Number of children aged 13 or more	0.33	(0.46)	0.08	(0.33)	0.12	(0.34)			
Presence of an inactive adult in the household**	0.16	(0.36)	0.16	(0.36)	0.18	(0.36)			
Owner of the dwelling	0.51	(0.49)	0.54	(0.49)	0.44	(0.47)			
Year of the tenure	5.46	(5.81)	5.20	(5.56)	5.95	(6.22)			
Locality's characteristics									
Local provision of childcare services	42.12	(42.34)	42.17	(34.46)	37.10	(39.79)			
Size of the locality (in thousands of inhabitants)	26.65	(31.87)	25.89	(32.28)	28.17	(31.12)			
Local unemployment rate	6.92	(2.13)	6.84	(2.15)	7.09	(2.08)			
Local provision of public services	0.47	(0.31)	0.47	(0.27)	0.42	(0.30)			
Local provision of health services	0.18	(0.33)	0.18	(0.32)	0.20	(0.53)			
Local provision of cultural facilities	0.87	(1.35)	0.86	(1.35)	0.86	(1.14)			
Local provision of sport facilities	0.80	(0.51)	0.80	(0.51)	0.71	(0.43)			
Local provision of shops	2.04	(1.12)	2.04	(1.12)	2.05	(1.15)			
Local provision of restaurants	2.82	(3.18)	2.81	(3.18)	2.71	(3.49)			

\*except mother's income from the labour market

\*\*not the mother

N= 689 observations

Source: EU C/PSF 1.3.2011 Author's computations

Table 7: Employment and use of formal childcare (in %)

	Does not use formal childcare	Uses formal childcare
Not employed	71	15
Employed	29	85
Total	100	100

N= 682 observations

Women in couple and with at least one child aged 0-3

Source: EU-SILC/PSELL 3-2011-Author's computations

Table 8: Time distances from family's residential location to childcare services

Variables	Mean	Median	Minimum	Maximum	Std Dev
mean of time distances	26.02	23.006	14.55	70.205	60.37
maximum of time distances	76.67	75.006	51.005	98.005	59.28
minimum of time distances	1.66	0	0	19.00	21.59

Observations=689

Source: EU-SILC/PSELL 3-2011 and travel-time distances, Author's computations

Table 9: Sensitivity analysis of the accessibility to childcare services measures

travel time threshold	std	travel time friction parameter	std
5	21.5451557	1.0	2.1676278
10	18.9660573	1.2	2.8772718
15	15.4938036	1.4	3.7184375
20	11.6154223	1.6	4.6733749
25	9.3703073	1.8	5.6968955
30	7.9033554	2.0	6.7420473
		2.2	7.7799782
		2.4	8.7987452
		2.6	9.7932022
		2.8	10.7584461
		3.0	11.6884780

Table 10: Estimates from the baseline model: the bivariate model of employment and childcare use probabilities

Variables	work	childcare
age	0.0273** (0.0119)	0.0230* (0.0134)
low educ	<i>ref.</i>	<i>ref.</i>
middle educ	0.208* (0.113)	0.120 (0.116)
high educ	0.414*** (0.135)	0.298* (0.161)
native	<i>ref.</i>	<i>ref.</i>
arrived as a child	-0.262* (0.150)	-0.177 (0.150)
arrived as an adult	-0.200* (0.103)	-0.176 (0.146)
nb of children 0-3	-0.293** (0.129)	-0.380*** (0.110)
nb of children 4-6	-0.347*** (0.104)	-0.263** (0.127)
nb of children 7-12	-0.331*** (0.0800)	-0.317*** (0.0843)
nb of children 13 and more	-0.244* (0.131)	-0.399** (0.157)
presence of an inactive	-0.188 (0.159)	-0.223 (0.149)
household income	-0.129*** (0.0353)	-0.0481 (0.0311)
household income square	0.00370*** (0.00136)	0.00191* (0.00106)
LACC	-0.00285 (0.0265)	0.0511* (0.0285)
Constant	0.745 (0.921)	-1.108 (0.916)
Rho	.6774433*** (0.0988291)	

Robust standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

LACC: local availability of childcare services

Table 11: Estimates from the bivariate model of employment and childcare use probabilities with control for the time spent in the current housing

Variables	work	childcare
age	0.0276** (0.0116)	0.0263** (0.0129)
low educ	<i>ref.</i>	<i>ref.</i>
middle educ	0.208* (0.114)	0.110 (0.112)
high educ	0.399*** (0.136)	0.278* (0.154)
native	<i>ref.</i>	<i>ref.</i>
arrived as a child	-0.285* (0.162)	-0.157 (0.152)
arrived as an adult	-0.236** (0.111)	-0.165 (0.149)
nb of children 0-3	-0.297** (0.131)	-0.374*** (0.110)
nb of children 4-6	-0.347*** (0.107)	-0.283** (0.126)
nb of children 7-12	-0.316*** (0.0787)	-0.325*** (0.0838)
nb of children 13 and more	-0.235* (0.136)	-0.438*** (0.160)
presence of an inactive	-0.147 (0.166)	-0.229 (0.152)
household income	-0.122*** (0.0356)	-0.0472 (0.0301)
household income square	0.00345** (0.00136)	0.00189* (0.00104)
LACC	0.000138 (0.000842)	0.00334** (0.00160)
years spent in the dwelling	-0.0130 (0.00962)	0.00115 (0.00726)
Constant	0.698 (0.5585729)	0.295 (0.4653973)
Rho	.6827905 *** (.040069)	

Robust standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

LACC: local availability of childcare

Table 12: Correlation between local availability of childcare (LACC) and other local characteristics

LACC	LACC 1.0000	public services	shops	culture	health services	health employees	sport equipment	restaurants	size of the population
public services	-0.1583	1.0000							
shops	-0.1249	0.3168	1.0000						
culture	-0.1289	0.4161	0.2977	1.0000					
health services	-0.1194	0.1633	-0.0312	0.2010	1.0000				
health employees	0.1582	0.0450	0.1487	0.0909	-0.2499	1.0000			
sport equipment	-0.1733	0.1703	-0.0557	0.1210	0.0097	-0.2584	1.0000		
restaurants	-0.0191	-0.1513	-0.1238	0.0154	0.3266	-0.3074	0.2029	1.0000	
family equipments	-0.0538	0.4029	0.2207	0.2495	0.0324	0.3049	0.1571	-0.1071	1.0000
size of the population 1.0000	0.0556	-0.2272	0.0422	0.0217	-0.2505	0.7346	-0.2385	-0.3102	0.1000



Table 13: Estimates from the bivariate model of employment and childcare use probabilities with local amenities

Variables	work	childcare
age	0.0275** (0.0122)	0.0255** (0.0128)
low educ	<i>ref.</i>	<i>ref.</i>
middle educ	0.196* (0.110)	0.0735 (0.110)
high educ	0.461*** (0.132)	0.261* (0.158)
native	<i>ref.</i>	<i>ref.</i>
arrived as a child	-0.263* (0.158)	-0.178 (0.146)
arrived as an adulte	-0.161 (0.111)	-0.146 (0.150)
nb of child 0-3	-0.314** (0.137)	-0.405*** (0.108)
nb of child 4-6	-0.374*** (0.105)	-0.293** (0.131)
nb of child 7-12	-0.342*** (0.0860)	-0.312*** (0.0821)
nb of child 13 and more	-0.286** (0.138)	-0.442*** (0.162)
presence of an inactive	-0.162 (0.162)	-0.232 (0.144)
household income	-0.135*** (0.0343)	-0.0564* (0.0336)
square of household income	0.00397*** (0.00133)	0.00221* (0.00113)
LACC	-5.39e-05 (0.00106)	0.00348** (0.00164)
Population size (in 1000)	0.00115 (0.0228)	0.00683 (0.0209)
<i>Local amenities</i>		
Culture and environment	-0.00625 (0.0163)	0.0239* (0.0136)
Health sector	-0.00134 (0.00284)	-0.00309 (0.00206)
Restaurants, coffees and shops	-0.00176 (0.00128)	-0.00127 (0.00118)
Sport	0.0268 (0.0193)	-0.000665 (0.0261)
Constant	0.643 (0.790)	0.262 (0.692)
Rho	.6907888*** (0.042138)	

Robust standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Local amenities are local average centered around the national mean

Table 14: Estimates from the simultaneous model of location, employment and childcare use

Variables	LACC	work	ccuse
age	0.212 (0.440)	0.0283** (0.0127)	0.0258** (0.0129)
low educ	<i>ref.</i>	<i>ref.</i>	<i>ref.</i>
middle educ	0.105 (4.376)	0.210 (0.131)	0.105 (0.128)
high educ	4.210 (4.919)	0.438*** (0.162)	0.267 (0.176)
native	<i>ref.</i>	<i>ref.</i>	<i>ref.</i>
arrived as a child	-0.899 (4.821)	-0.244* (0.148)	-0.153 (0.148)
arrived as an adult	4.734 (4.085)	-0.184 (0.137)	-0.171 (0.131)
nb of children 0-3	-0.0704 (3.846)	-0.290** (0.115)	-0.379*** (0.116)
nb of children 4-6	6.751* (3.685)	-0.328*** (0.126)	-0.292** (0.116)
nb of children 7-12	1.161 (2.652)	-0.327*** (0.0875)	-0.327*** (0.0920)
nb of children 13 and more	-2.684 (4.291)	-0.251* (0.151)	-0.436*** (0.137)
presence of an inactive	1.189 (4.787)	-0.187 (0.139)	-0.228* (0.137)
household income	-1.605** (0.705)	-0.132*** (0.0378)	-0.0446 (0.0378)
household income square	0.0174** (0.00752)	0.00367** (0.00147)	0.00183 (0.00142)
<i>local amenities</i>			
culture and environment	0.123*** (0.0418)		
health sector	0.656 (2.073)		
restaurants, coffees and shops	-0.152*** (0.0468)		
<b>LACC</b>		-0.00313 (0.00893)	0.00441 (0.00900)
constant	36.60** (15.65)	0.732 (0.506)	0.280 (0.530)
Rho12	0.1401663	(0.3756047)	
Rho13	-0.0474564	(0.3831413)	
Rho23	0.6668759***	(0.0844855)	

Robust standard errors in parentheses

\*\*\* p&lt;0.01, \*\* p&lt;0.05, \* p&lt;0.1

Table 15: Robustness check A: Estimates from the simultaneous model of location, employment and childcare use, with a dummy equal to 1 for local availability in the top 10%

Variables	High LACC	work	ccuse
age	-8.84e-05 (0.0146)	0.0250** (0.0118)	0.0256** (0.0116)
low educ	<i>ref.</i>	<i>ref.</i>	<i>ref.</i>
middle educ	-0.00204 (0.162)	0.189 (0.128)	0.117 (0.127)
high educ	0.140 (0.182)	0.380** (0.151)	0.269* (0.147)
native	<i>ref.</i>	<i>ref.</i>	<i>ref.</i>
arrived as a child	-0.0354 (0.188)	-0.248* (0.149)	-0.156 (0.147)
arrived as an adult	0.153 (0.154)	-0.159 (0.123)	-0.120 (0.121)
nb of children 0-3	0.0315 (0.145)	-0.308*** (0.114)	-0.387*** (0.114)
nb of children 4-6	0.240* (0.127)	-0.386*** (0.106)	-0.362*** (0.106)
nb of children 7-12	0.0158 (0.107)	-0.320*** (0.0868)	-0.317*** (0.0855)
nb of children 13 and more	-0.130 (0.199)	-0.265* (0.143)	-0.478*** (0.147)
presence of an inactive	0.0304 (0.183)	-0.159 (0.141)	-0.153 (0.139)
household income	-0.0591** (0.0265)	-0.116*** (0.0361)	-0.0448 (0.0352)
household income square	0.000537 (0.000387)	0.00352** (0.00144)	0.00216 (0.00147)
<i>local amenities</i>			
culture	-0.0142*** (0.00346)		
health	-0.0640 (0.0565)		
restaurants, coffees and shops	-0.00380 (0.00242)		
<b>high LACC</b>		0.848*** (0.227)	1.229*** (0.219)
constant	-1.191** (0.512)	0.563 (0.424)	0.264 (0.415)
rho12	.1574295	(.3246096)	
rho13	-.0466622	(.3272251 )	
rho23	.6617794***	(.0783884 )	

Robust standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 16: Robustness check B: Estimates from the simultaneous model of location, employment and childcare use, with a dummy equal to 1 for local availability greater than the national mean

Variables	Mean LACC	work	ccuse
age	0.00143 (0.0142)	0.0260** (0.0121)	0.0254** (0.0120)
low educ	<i>ref.</i>	<i>ref.</i>	<i>ref.</i>
midlle educ	0.0849 (0.157)	0.183 (0.131)	0.0939 (0.130)
high educ	0.398** (0.175)	0.411** (0.162)	0.214 (0.160)
native	<i>ref.</i>	<i>ref.</i>	<i>ref.</i>
arrived as a child	-0.0277 (0.180)	-0.268* (0.152)	-0.203 (0.151)
arrived as an adult	0.121 (0.147)	-0.193 (0.126)	-0.191 (0.125)
nb of children 0-3	0.0500 (0.138)	-0.312*** (0.118)	-0.387*** (0.117)
nb of children 4-6	0.193 (0.122)	-0.336*** (0.108)	-0.284*** (0.108)
nb of children 7-12	0.0250 (0.103)	-0.324*** (0.0895)	-0.304*** (0.0883)
nb of children 13 and more	0.103 (0.172)	-0.240* (0.142)	-0.456*** (0.149)
presence of an inactive	-0.235 (0.181)	-0.204 (0.143)	-0.200 (0.141)
household income	-0.0412 (0.0257)	-0.124*** (0.0367)	-0.0466 (0.0363)
household income square	0.000715 (0.000455)	0.00356** (0.00146)	0.00195 (0.00152)
<i>local amenities</i>			
culture	0.0325*** (0.00436)		
health	0.0816 (0.0556)		
restaurants, coffees and shops	-0.0128*** (0.00233)		
<b>Mean LACC</b>		-0.0279 (0.159)	0.343* (0.170)
constant	-0.290 (.494518)	0.706 (.4320036)	0.420 (.4279172)
rho12	-.007676	.1015788	
rho13	-.0094225	.1168909	
rho23	.5888592***	.0452734	

Robust standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 17: Robustness check C: Estimates from the simultaneous model of location, employment and childcare use, with a local provision rate

Variables	Local provision rate	work	ccuse
age	0.281 (0.449)	0.0284** (0.0127)	0.0257** (0.0128)
low educ	<i>ref.</i>	<i>ref.</i>	<i>ref.</i>
middle educ	-1.361 (4.511)	0.204 (0.132)	0.113 (0.128)
high educ	2.221 (5.009)	0.431*** (0.156)	0.278* (0.165)
native	<i>ref.</i>	<i>ref.</i>	<i>ref.</i>
arrived as a child	-0.174 (4.986)	-0.242 (0.148)	-0.154 (0.147)
arrived as an adult	4.844 (4.116)	-0.183 (0.134)	-0.170 (0.129)
nb of child 0-3	0.144 (4.131)	-0.289** (0.115)	-0.380*** (0.116)
nb of child 4-6	6.646* (3.710)	-0.327*** (0.122)	-0.288** (0.113)
nb of child 7-12	1.434 (2.667)	-0.325*** (0.0877)	-0.328*** (0.0918)
nb of child 13 and more	-2.179 (5.000)	-0.249* (0.151)	-0.441*** (0.137)
presence of an inactive	1.851 (5.107)	-0.185 (0.140)	-0.230* (0.137)
household income	-1.699** (0.713)	-0.130*** (0.0376)	-0.0455 (0.0371)
household income square	0.0185** (0.00762)	0.00361** (0.00147)	0.00186 (0.00142)
<i>local amenities</i>			
culture	0.131*** (0.0400)		
health	0.629 (1.942)		
restaurants, coffees and shops	-0.173*** (0.0449)		
<b>local provision rate</b>		-0.00313 (0.00757)	0.00395 (0.00751)
constant	35.48** (16.14)	0.724 (0.485)	0.297 (0.502)
rho12	.1574295	(.3246096)	
rho13	-.0466622	(.3272251)	
rho23	.6617794**	(.0783884)	

Robust standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Figure 1: Main childcare arrangement from 2004-2013 (source: EU-SILC/PSELL 3)

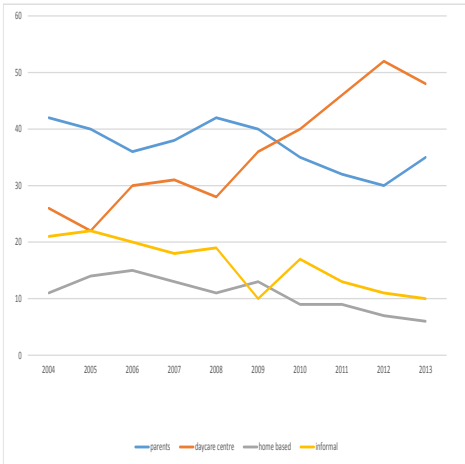


Figure 2: Histogram of mother’s hours of work (source: EU-SILC/PSELL 3–2011)

