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childcare: Effects on childcare
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employment

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Expanding access to universal childcare: Effects on childcare arrangements and maternal employment*

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Abstract

In most OECD countries, subsidised childcare is a key instrument to support maternal employment. Using a large reform implemented in Luxembourg in 2009, I study the effect of expanding access to subsidised childcare on childcare and employment decisions of women in a context where childcare is universal and heavily subsidised, but bound by capacity constraints. The identification relies on temporal variation across child age groups. The results show that, in response to the reform, the employment rate of mothers increased by 4-7 percentage points and their hours of work by around 3 hours per week. Studying heterogeneous effects reveals a differential impact of the reform for more vulnerable mothers. Parents whose youngest child is under the age of 3 are found to use more daycare services, for longer hours, while the use of informal care remains unchanged. These results suggest that there is no crowding out effect of the new policy.

Keywords: Childcare; family policy; maternal employment

JEL classification codes: J13 ; J22; J18

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1 Introduction

Over the last decades, improving access to affordable Early Childhood Education and Care (ECEC) services has been a key policy in many OECD countries. Policy makers have based their policy on the belief that early childhood education and care policy can be a tool to reconcile work and family life, and thus support maternal employment and reduce gender inequalities (OECD, 2018). However, empirical evidence on the effectiveness of childcare policy to support maternal employment are mixed across countries and time. Answering this question is of critical importance for countries who are currently expanding childcare policy, by increasing the amount of subsidies, the number of free hours of care or the group of eligible children. For example, between 2000 and 2013, most states in West Germany adopted a free childcare policy. In 2017, in the UK, the number of free hours of childcare for 3- to 4-year-old was doubled from 15 hours to 30 hours per week for working parents. Also in 2017, Luxembourg started providing 20 hours of free daycare for all children between 1 and 4 years old. More recently, Japan decided to introduce a free daycare policy for children under the age of 5 in Autumn 2019.

This paper investigates the impact of a recent policy that increases the availability of affordable childcare in Luxembourg at a time when public childcare was universal and heavily subsidised, but with limited places. In 2009, the government introduced a childcare voucher. The childcare voucher is universal: all children under 13 years old are eligible, regardless of family's income and parent's job. The childcare voucher aimed at increasing the use of formal childcare (including before and after school care), helping parents to find a work-life balance and reducing socio-economic inequalities between children. The childcare voucher reform increased government's subsidies to childcare facilities. New providers entered the market, increasing the overall provision of subsidised childcare: the number of slots doubled between 2009 and 2014 (source: Ministry of Family, Ministry of Education, Luxembourg). Employing a Difference-in-Differences strategy, I estimate the effect of the reform on child and maternal employment outcomes using longitudinal data from the European Union - Statistics on Income and Living Conditions (EU-SILC) survey for the period 2004-2014. The treatment group consists of women aged 20 to 50 years old with a youngest child up to 13 years old. As a control group, I choose to use women of the same age group but whose youngest child is 13 years old or more, and childless women as the trends in outcomes are very similar before the reform. I provide graphical evidence, placebo estimates and tests on pre-reform difference in slopes to make sure that eligible mothers and non eligible mothers are comparable. I also exploit the difference in the intensity of the policy change between children's age over time as the increase in the number of places at childcare facilities was more pronounced for younger children than for older ones.

This setting has many interesting features. Firstly, I provide evidence on the effects of expanding access to existing subsidised childcare whereas much of the literature focuses on the role of the introduction of subsidised childcare or preschool programs for children up to three years old. Results from this literature may not be transferable to the case where existing subsidised childcare is expanded for different reasons. On the one hand, the contexts regarding maternal employment and childcare attendance are different. Likely, the group of women who might be sensitive to the incentives given by childcare policies differs from the group of women who might respond to the introduction of such policy. On the other hand, the impact found for parents of preschoolers may be different than the impact found for parents of younger children, mainly because preferences for childcare arrangements vary with

the age of the child. In contrast to most of the literature focusing on mothers' of preschool children, I provide evidence for mothers of children under the age of three. Provision of subsidised childcare for this age group is important for several reasons. From the mother's side, a poor provision of affordable childcare services may lead to withdraw from the labour market, with negative effects on future earnings potential. There is large evidence documenting the cost of motherhood on women's careers (Waldfogel, 1998, Lundberg and Rose, 2000, Sigle-Rushton and Waldfogel, 2007, Fitzenberger et al., 2013, Goldin, 2014, Angelov et al., 2016, Adda et al., 2017, Blau and Winkler, 2017, Rossin-Slater, 2018). From the child's side, the period 0-3 years is recognised as a sensitive period because early developmental outcomes may predict economic success later in life and interventions made in the early period of life may have higher return rate than later on interventions (Cunha et al., 2005, Mueller and Plug, 2006, Almond and Currie, 2011, Lindqvist and Vestman, 2011). Thirdly, the childcare voucher introduced in Luxembourg benefits all children less than 13 years old, regardless of family's income and parent's job. While most of the evidence relies on programs targeted at subgroups of the population, I can analyze the effect of the policy on the overall population which is of high interest for policy makers, as well on specific sub-groups.

The results indicate that the employment probability of women whose youngest child is under the age of three increased by 4-7 percentage points and the hours of work (including those who were not working before the reform) increased by around 3 hours per week. There is also evidence of heterogeneous responses, with more vulnerable mothers (less well educated, non-natives and single mothers) are found to be more responsive to the reform than the overall sample. In response to the expansion of subsidised places, parents whose youngest child is under three years old are more likely to use daycare, for longer hours, while their propensity to use informal care is unchanged, suggesting no crowding out effect of the new policy. The results confirm that in a context where employment of young mothers and daycare attendance were low, making affordable childcare more widely available is a way to increase the use of daycare and maternal employment. A back-to-envelope calculation suggests a 0.17 percentage point increase in the employment rate of mothers of a child aged 0-2 per percentage increase in daycare attendance rate.

This paper relates to a large literature in economics investigating the impact of the provision of subsidised childcare on maternal employment. The most recent papers exploit policy changes that provide exogenous variations in prices or access to childcare to identify the effect of lower childcare prices or higher access to outside household childcare on child and maternal outcomes. Most studies focus on preschool children (3-6 years old) and provide mixed empirical evidence. Some authors find positive and sizable effect of public childcare on maternal employment (Baker et al., 2008, Berlinski and Galiani, 2007, Lefebvre and Merrigan, 2008, Herbst, 2017, Cascio, 2009, Lefebvre et al., 2009, Nollenberger and Rodriguez-Planas, 2015). By contrast, other authors report small, if any, effects, which are applicable to specific sub-groups of mothers, such as single mothers or less-well educated mothers (Gelbach, 2002, Fitzpatrick, 2010, 2012, Goux and Maurin, 2010, Hardoy and Pal, 2013, Felfe et al., 2015, Givord and Marbot, 2015). Small effects are found when the reform leads to only marginal decreases in the costs of childcare (Lundin et al., 2008), in contexts of already high female employment and childcare attendance simply because the scope for policies is limited. Small to zero effects are also found if newly subsidised places crowd out existing private childcare arrangements, especially when there is still rationing after expansion (Bauernschuster et al., 2016, Cascio et al., 2015, Cattan, 2016). From a policy perspective, providing evidence on the role of policy that expand subsidised childcare is important while, in most OECD coun-

tries, supporting female employment is a key policy goal and the public expenses devoted to childcare interventions is growing.

Additionally, my analysis is related to a literature on the effect of the public provision of private childcare services by a voucher. Proponents of a voucher in the childcare market argue that vouchers may increase parents' choices and thus their satisfaction, and may also increase the quality of childcare by stimulating competition between providers (Bradford and Shaviro, 1999, Steuerle, 2000). But in a context of universal subsidised childcare, a childcare voucher may lead to non-negligible crowding out effects as the new subsidised childcare may substitute for private arrangements (Bergstrom et al., 1986). There is empirical evidence that a voucher increases the use of for-profit daycare by increasing affordable demand and encouraging new (for-profit) providers to enter the childcare market (Bassok et al., 2014, Warner and Gradus, 2009). This effect is found to be higher in areas that suffered from rationing before the introduction of the voucher (Viitanen, 2011). This paper provides additional evidence on this issue by investigating the role of a childcare voucher on parental choices in a context of universal public childcare with excess demand prior the reform.

The paper proceeds as follows. I first describe the institutional context and the 2009 childcare reform in Section 2. Section 3 and Section 4 respectively presents the data and identification strategy. The results, including robustness checks, are presented and discussed in Section 5. Finally, I conclude in section 6.

2 The institutional context and the 2009 childcare reform

In this section, I describe the institutional context in Luxembourg to underline to what extent my results could be relevant for other countries, before presenting the 2009 reform in question.

In Luxembourg, as in other OECD countries, employment rates are lowest for mothers of children aged zero to two years, for those with low education, and with a migration background (see the Appendix). To support working parents, Luxembourg provides paid maternity and parental leaves and subsidised high-quality public childcare. Paid maternity leave lasts for 16 weeks, of which 8 weeks must be taken by the mother before childbirth. Upon completion of maternity leave, the childcare options available to working parents are parental leave or paid care in a daycare centre (public or private), a childminder or unpaid care by relatives. There are no legal claims for a place. Daycare provision is mixed in Luxembourg: daycare centres can be either publicly or privately owned. Compulsory schooling starts at the age of 4 in Luxembourg. Most of children start secondary school when they turn 12. At the age of 3, children can enter preschool (*'Precoce'*), which is not mandatory and provided on a part time basis by municipality. Around the year of the reform, two-thirds of eligible children are in *'Precoce'* class (source: Ministry of Education).

Before the 2009 reform, daycare centres were subsidised as long as they satisfied a set of criteria established by law. These criteria related to the staff-child ratio, the group size, the education and training of the employees and the characteristics of the facilities. There were different types of grants (operating costs, equipment/materials, buildings). The price paid by the parents differed according to the type of provider. In public daycare centres, it was a function of their income and the birth order of the child. By contrast, private providers were free to set their own prices.

For many years in Luxembourg, childcare provision rates for children under 3 years of age were low, below the 33% target agreed at the 2002 Barcelona Summit, and there were waiting lists. To allocate the available places among families, priority rules were used. In public

childcare centres, priority rules were derived from family characteristics. In the private sector, priority rules were not defined by family characteristics: the available slots were allocated according to the rule 'first come, first served'. In 2007, 61% of public centres refused children because of limited numbers of places, compared to 29% of private daycare centres (Bousselin, 2017). This difference can be explained by a more important demand for public childcare: the public sector was more attractive than the private one because, on average, the former provided childcare at a lower price for a similar (or even higher) quality.

In 2009, the government passed a childcare reform, the so-called childcare voucher, to promote access to affordable childcare services (either public or private), help parents to find a work-life balance and reduce socio-economic inequalities between children (Ministry of Family, 2009). All children under 13 years old or not yet enrolled in secondary education are eligible. The government subsidises private facilities so that the price paid by parents is the same as the one they would pay in a public facility. This price, which is considerably lower than the price which used to be paid before the reform, depends on the family's income and children's birth order. On average, before the reform, the hourly price was 2.50 euros in the public and 4.90 euros in the for-profit sector, compared to 1.40 euros in both sectors after the reform.

The new policy acts as a huge boost for new private providers to enter the market, increasing the overall provision of childcare. In particular, the number of places quadrupled in private daycare and doubled in home-based care. It is not surprising as there are no barriers to entering the market and the reform increased the number of families who can afford formal childcare. Thus, private providers have had strong incentives to offer new slots. This increase in the number of places was much more pronounced for younger children than for older ones: the number of places for children aged 0-3 have been multiplied by 3.6; those for children aged 4-12 years old by 1.6 (see Table 1). This increase translates into a growth in daycare attendance (see Table 2). Due to the rise in subsidies and the rise in daycare attendance, the government expenses on early childhood and education and care rose from 0.42 percent of GDP in 2009 to 0.77 in 2013 (OECD family database). The budget devoted to the childcare policy has tripled over the period, growing from 87 millions in 2009 to 303 millions in 2015, which is now roughly half of public spending for family allowances (source: Ministry of Education and National Fund for Family Allowances).

Table 1: Number of places in ECEC in Luxembourg over the period 2008-2011

| | 2008 | 2009 | 2010 | 2011 |
|-----------------------|-------------|-------------|-------------|-------------|
| 0-3 years old | 2381 | 3986 | 5467 | 8636 |
| 4-12 years old | 16471 | 19056 | 24735 | 27401 |
| Total | 18852 | 23107 | 30202 | 36037 |

Source: Annual reports (years 2009-2012), Ministry of Family and Integration, Luxembourg

Table 2: Daycare attendance by age (in %) between 2004 and 2013 in Luxembourg

| | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
|----------------|------|------|------|------|------|------|------|------|------|------|
| 0-2 years old | 0.21 | 0.25 | 0.26 | 0.26 | 0.25 | 0.28 | 0.37 | 0.47 | 0.49 | 0.50 |
| 3-5 years old | 0.19 | 0.17 | 0.19 | 0.19 | 0.20 | 0.27 | 0.41 | 0.49 | 0.48 | 0.49 |
| 6-12 years old | 0.10 | 0.10 | 0.10 | 0.12 | 0.13 | 0.17 | 0.29 | 0.37 | 0.37 | 0.39 |

Note: Daycare attendance is the percentage of children cared for in a daycare centre (either public or private). Source: EU-SILC/PSELL3. Statistics are weighted using individual weights.

3 Data

In this paper, I use data from the Luxembourgish household panel survey (EU-SILC/PSELL 3). EU-SILC/PSELL 3 is an annual survey of the population in Luxembourg and the Luxembourgish component of the European Union-Statistics on Income and Living Conditions (EU-SILC). This survey collect timely and comparable cross-sectional and longitudinal multidimensional microdata on income, poverty, social exclusion and living conditions. While social exclusion and housing information are collected at the household level, labour, education, income and health information are collected at the individual level. The survey has been used to provide data on and monitor social inclusion and poverty in the European Union.¹ The Luxembourgish survey is representative of the whole population living in Luxembourg and affiliated to the national Social Insurance.

The main advantage of the EU-SILC/Psell 3 survey for my analysis is that it contains detailed information on both parents and children. The survey allows me to match women with their partner and their child(ren) and thus to identify families. Besides information related to job and hours of work, the survey also collects information on childcare arrangements for each child below 13 years old living in the household (e.g. the type of childcare and the intensity of care). This information is vital for studying to what extent making formal childcare more affordable increases the use of formal childcare and whether the policy change leads to crowding out effect (e.g. informal care being substituted by formal care). Another advantage of this data for my analysis is to provide five years of pre-reform data that enable me to do placebo tests (see section 5). I use the waves 2004-2014. I exclude data from 2003 because the definition of childcare arrangements is different from the other waves. I select women aged 20 to 50. The final sample is made up of 34287 women.

Outcome variables In the survey, individuals report their employment status over the year and, if they are working, the number of hours of work. The most frequent status over the year is used to define the employment status of the individual. I use this information to build a dummy variable for whether the person is employed. Employed means full or part-time employment including maternity leave and parental leave. In the survey, the working hours are by definition only reported by those who work in the labour market. I include the zero hours of work of mothers who do not work to avoid composition change when I estimate the effect of the reform on the number of hours of work (Angrist and Pischke, 2009). Related to change in mother's labour supply, one can expect change in father's labour supply. Similarly to mothers, I also investigate the effect of the reform on employment and hours of work of

¹For more information on EU-SILC survey, see <https://ec.europa.eu/eurostat/web/microdata/european-union-statistics-on-income-and-living-conditions>.

fathers.

Information on the type of childcare (daycare, home-based care, informal care or whether childcare is provided by a member of the household instead) is collected for all children below 13 years old. If childcare outside the household is used, the parents also report the number of weekly hours of this type of care. I use this information to build dummy variables for whether a household uses daycare, child-minder or informal care for child i . Unfortunately, there is no distinction between public and private daycare in the survey. Nevertheless, I can distinguish between different type of non maternal care, which will allow me to look at potential crowding out effects of the newly subsidised slots in daycare. In particular, I am interested in the use of non-maternal care and the intensity of this usage measured in hours per week. Non maternal care refers to daycare centre (either public or private), an official childminder and informal care (care provided for free by a relative or a non relative inside or outside child's home). Following what is done in previous literature, I focus attention on the youngest child in the household. I include the zero hours of non maternal care to calculate the hours of non maternal care to avoid composition change when I estimate the effect of the reform on the number of hours of non maternal care.

Control variables I use the age of the mother, a set of three dummies for the level education of the mother with the omitted category being the lower level of education. Regarding marital status, I define a dummy variable for being a single mother. Due to the limited number of cases, I am not able to distinguish between married mothers and cohabiting mothers. I will refer to married and non married-cohabiting mothers interchangeably throughout the remaining of the paper. As non natives are important share of the population in Luxembourg, I distinguish between them: I use the date of arrival in Luxembourg to make a distinction between non-natives arrived as a child and non natives arrived as an adult. I assume that the first subgroup is more willing to have migrated with their parents and thus to have more chance to rely on their parents (or extended family) for informal care than the latter one. It may also be the case that norms regarding maternal employment and non maternal childcare differ with respect to the time spent in the host country. I thus create a set of three dummies for the migration background: native (being the omitted category), non native arrived as a child and non native arrived as an adult. I also define a dummy for the presence of an inactive adult into the household to account for potential childcare giver into the household.

Descriptive statistics Table 3 provides a summary of descriptive statistics for the whole sample separately for the pre-reform period and the post-reform period. The employment rate of women whose youngest child is under 3 has increased by 9 percentage points between the pre-reform (2004-2008) and post-reform (2009-2014) period. This has gone along with an increase of hours of work (2.5 per week) and an increased of the incidence of part-time among employed (5 percentage points). Similarly to the whole population in Luxembourg, the share of non native is high among the group of mothers whose youngest child is under 3 years old: before the reform, almost half of them are non native; this figure has slightly increased after the reform. There are no significant changes in the level of education before and after, on the number of children, neither in the age of their partner and the partner's probability to work. The employment probability of mothers whose youngest child is 13 years old or more has also increased over the period (4 percentage points). Hours of work have slightly increased (less than 1 hour per week). The incidence of part-time work has also increased (7 percentage points). The post period sample is slightly older than the before period sample. For those who

are in couple, the employment probability of the partner has decreased (2 percentage points), that is not surprising given that this sample is getting older and employment decreases with age. uqoi on t

4 Identification strategy

In this paper, I use a large reform in Luxembourg that provides an exogenous change to the overall provision of subsidised childcare. The reform was announced in autumn 2008 and implemented quickly after its announcement (1 March 2009). It is plausible to assume that most of the families were not familiar enough with the reform early enough for the law to lead to ex ante reactionary behaviours. Also, new facilities needed time to establish and open. I expect that much of the effect triggered by the reform took place rapidly after its implementation. Given the uniform roll-out across the entire country simultaneously, all families with children of the same age are equally eligible, and I am unable to exploit regional variation in the timing of the reform (Havnes and Mogstad, 2011a,b, Felfe et al., 2015). Rather, I use the differential provision between children’s age over time in a standard Difference-in-Differences model.²

To estimate the effect of the reform, I compare the change in outcomes of those affected by the reform (the treatment group) before and after the reform, using the change in outcomes of those who are not affected by the reform (the control group) to control for common trend effects. Parents who are influenced by the change in the provision of subsidised places are parents whose youngest child is under 13 years old. The change in the provision of subsidised places differs with regard to children’s age. As explained in Section 2, the increase of the provision of subsidised places was much more pronounced for children under three years old than for older ones. I use this difference between children’s age over time to investigate the effect of the intensity of the treatment. I thus define mothers whose youngest child is 0-2 years old as the main treatment group while mothers whose youngest child is 3-5 years old and mothers whose youngest child is 6-12 years old are alternative treatment groups. Mothers whose youngest child is 13 years old or more are the control group: they do not benefit from the reform but are otherwise quite similar to the treated mothers. Women without a child, who are also not affected by the reform, will serve as another control group in a sensitivity analysis.

I use the years 2004-2008 as the pre-treatment years and 2009-2014 as the post-treatment years. The baseline model is shown by equation (1):

$$Y_{it} = \alpha + \beta_1(Treat_i \times Post_t) + \beta_2Treat_i + \beta_3Post_t + \varepsilon_{it} \quad (1)$$

where Y_{it} is the outcome of interest for individual i in year t , $Treat_i$ is a dummy variable which defines the treatment group, $Post_t$ is a dummy variable equal to one in the post reform period. The interaction term ($Treat_i \times Post_t$) enables me to derive an estimate of β_1 which is the coefficient of interest of the childcare policy impact. α is a constant and ε_{it} is an error term.

²In preliminary analysis, two matching models were estimated: (i) a propensity score matching model that implements nearest neighbor matching on an estimated propensity score based on a BIC-selected set of observed baseline characteristics and (ii) a matching model using Epanechnikov kernel weight and observed baseline characteristics. These matching models are versions of non-parametric Ordinary least squares (OLS) and condition on a set of variables as OLS. These models match women of a youngest child of a certain age after the reform with women of a youngest child of a same age before the reform based on similarities in observed characteristics. Similar results than those of the DiD models presented here are obtained.

Table 3: Summary statistics for mothers whose youngest child is under 3 years old and mothers whose youngest child is 13 years old or more before and after the 2009 childcare reform

| | Before | After | Difference | |
|---|--------|-------|------------|-----|
| Youngest child is under 3 | | | | |
| Employed | 0.57 | 0.66 | 0.09 | *** |
| Weekly hours of work (incl. zeros) | 17.25 | 19.75 | 2.5 | *** |
| Part-time employment | 0.46 | 0.51 | 0.05 | *** |
| Household income* | 4803 | 6024 | 1221 | *** |
| Age | 31 | 32 | 1 | *** |
| Lone mother | 0.06 | 0.07 | 0.01 | |
| Education: | | | | |
| - <i>Primary</i> | 0.36 | 0.31 | -0.05 | |
| - <i>Secondary</i> | 0.29 | 0.32 | -0.03 | |
| - <i>High school</i> | 0.35 | 0.37 | 0.02 | |
| Migration background: | | | | |
| - <i>Native</i> | 0.58 | 0.54 | -0.04 | *** |
| - <i>Migrant arrived when child</i> | 0.27 | 0.31 | 0.04 | ** |
| - <i>Migrant arrived when adult</i> | 0.14 | 0.14 | 0.00 | |
| No. of children | 1.91 | 1.95 | 0.04 | |
| Age of the partner | 35 | 36 | 1 | |
| Partner works | 0.93 | 0.91 | 0.01 | |
| Youngest child is 13 years old or more | | | | |
| Employed | 0.73 | 0.77 | 0.04 | ** |
| Weekly hours of work (incl. zeros) | 24.37 | 25.14 | 0.77 | * |
| Part-time employment | 0.28 | 0.35 | 0.07 | *** |
| Household income* | 4803 | 6024 | 1221 | *** |
| Lone mother | 0.06 | 0.07 | 0.01 | |
| Age | 41 | 43 | 2 | *** |
| Education: | | | | |
| - <i>Primary</i> | 0.35 | 0.35 | 0.00 | |
| - <i>Secondary</i> | 0.33 | 0.36 | 0.03 | ** |
| - <i>High school</i> | 0.232 | 0.29 | -0.03 | ** |
| Migration background: | | | | |
| - <i>Native</i> | 0.52 | 0.58 | 0.06 | ** |
| - <i>Migrant arrived when child</i> | 0.38 | 0.038 | -0.08 | * |
| - <i>Migrant arrived when adult</i> | 0.10 | 0.101 | 0.00 | |
| No. of children | 1.47 | 1.45 | -0.02 | |
| Age of the partner | 47 | 48 | 1 | |
| Partner works | 0.73 | 0.71 | 0.02 | * |

Source: EU-SILC/PSELL3. Statistics are weighted using individual weights. * household income is gross household income except mother's earnings from the labour market, in euros per month. The before period is years 2004-2008. The after period is years 2010-2014. Statistical significance is indicated by *p<0.1, ** p<0.05***p<0.01

I can improve further the specification of the model. First, I add a set of individual and household covariates to equation (1) to control for differences between the treatment and the control groups. I use age, education and migration background as well as the number of children in the household. All these characteristics are important determinant of external childcare and employment decisions. Second, I also include year dummies to account for time-varying patterns in the outcomes. This second model is:

$$Y_{it} = \alpha + \beta_1(Treat_i \times Post_t) + \beta_2Treat_i + \beta_3Post_t + \gamma X_i + \theta Year_t + \varepsilon_{it} \quad (2)$$

where X_i is a vector of observable characteristics and $Year_t$ is a vector of year dummies.

The key identifying assumption of the model is that the difference between outcomes between treatment and control mothers would have remained constant in the absence of the childcare voucher reform. It means that I assumed that there were no unobserved characteristics that may have changed over time and may have affected, in a different way, the outcomes of the treatment group compared to the outcomes of the control group. This assumption cannot be tested. However, I take advantage of having 5 years of pre-reform data to check whether the treatment and control mothers have a similar trend in the years preceding the reform. I check the plausibility of the common trend assumption in Section 5 by providing graphical evidence and more systematic support for it by means of placebo tests. An additional threat to identification is that the reform might affect mothers' work and childcare decisions before the implementation of the reform (*ex-ante* responses). Given that the reform has been set quickly after its announcement and that there were capacity constraints, there are little scope to *ex-ante* responses. Finally, the common trend assumption may be violated if the characteristics related to employment and childcare decisions within the group of mothers is not stable. In particular, it may happen if the 2009 reform affected the fertility behaviour since the treatment group is defined by having a child under 3 years old. As the reform decreases the opportunity cost of a child, the reform might have a positive effect on birth rate. Table 4 reports fertility indicators over the period 2004-2014. There is no support for a change in trends after the 2009 reform. Another concern with the difference-in-differences approach is the correct computation of the standard errors. In my estimates, the standard errors are clustered at the local level to account for cross-sectional within-commune dependence (Bertrand et al., 2004). By clustering at the commune level, I account for correlations within locality and I assume that the standard errors are not correlated across communes within regions.³

5 Results

This section presents my empirical findings. Section 5.1 shows graphical evidence on the common trend assumption and identify a further set of treatment and control groups. Section 5.2 discusses the results obtained from the Difference-in-Differences models for childcare and employment outcomes. In Section 5.3, I use alternative treatment groups, I discuss the placebo estimates and I test for differences between slopes of outcomes in the pre-reform period.

³There is 102 communes in Luxembourg in 2018.

Table 4: Fertility indicators-Luxembourg, 2004-2014

| | Total fertility rate | Total fertility rate by age 40 | Mean ages at birth |
|------|----------------------|--------------------------------|--------------------|
| 2004 | 1.662 | 1.621 | 29.71 |
| 2005 | 1.628 | 1.585 | 29.79 |
| 2006 | 1.648 | 1.604 | 29.97 |
| 2007 | 1.610 | 1.562 | 30.22 |
| 2008 | 1.607 | 1.555 | 30.54 |
| 2009 | 1.589 | 1.532 | 30.67 |
| 2010 | 1.628 | 1.557 | 30.79 |
| 2011 | 1.523 | 1.460 | 30.80 |
| 2012 | 1.574 | 1.506 | 30.96 |
| 2013 | 1.550 | 1.475 | 31.30 |
| 2014 | 1.497 | 1.431 | 31.41 |

Note: The total fertility rate is the average number of children born per woman over lifetime given current age-specific fertility rates and assuming no female mortality during reproductive years

Source: Human Fertility Database. Max Planck Institute for Demographic Research (Germany) and Vienna Institute of Demography (Austria). Available at www.humanfertility.org (data downloaded on June, 2019).

5.1 Graphical results

I compare the employment trends of mothers whose youngest child is under 3 years old (main treatment group), mothers whose youngest child is 3-5 years old and mothers whose youngest child is 6-12 years old with two potential control groups: mothers whose youngest child is 13 years old or more and women living without a child. Figure 1 plots the employment rate over the period for each group of women. The left-hand of Figure 1 shows the evolution of the employment rate of treated mothers compared to that of mothers whose youngest child is 13 years old or more. The employment rate of all groups increased in a similar way between until 2008, except a stronger increase in 2007 for mothers whose youngest child is 3-5 years old. Then, for all groups, the employment rate declined with the 2008 crisis. After 2009, the employment rate of mothers whose youngest child is 13 years old or more flattened out until 2012 and increased after this point. By contrast, after 2009, the employment rates of mothers whose youngest child is 0-2 years old and 3-5 years old increased steadily until 2012 and decreased slowly after this point. The evolution of the employment rate of mothers whose youngest child is 6-12 years old was noisy after 2009. The increase of employment rates of mothers of young children coincided with the childcare voucher reform in the year 2009. The right-hand of Figure 1 shows the evolution of the employment rate of treated mothers compared to the second potential control group which are women living without a child. The pre-trend in this measure for this control group is similar to that of the treatment groups. There was an increase in the employment rates in all groups until 2008; after this point, there was a decrease in the employment rate in all group. After 2009, the employment rates of mothers increased while that of women living without a child was still decreasing until 2012. Mothers whose youngest child is 13 years old or more and women living without a child can be used as control groups as they exhibit quite similar pre-trends to the treatment groups.

Figure 2 shows the evolution of hours of work (including zeros) between 2004 and 2014. The left-hand of Figure 2 shows the evolution of hours of work for the treated mothers and for mothers whose youngest child is 13 years old or more. The right-hand of Figure 2 shows

the evolution of hours of work of treated mothers compared to control group of women living without a child. From 2004 to 2008, the evolution of this measure for the two control groups is quite similar to that of the treatment group of mothers whose youngest child is 0-2 years old and 3-5 years old. Once again, there is suggestive evidence that mothers whose youngest child is 13 years old or more and women without a child can be used as potential control groups.

One can expect that the effect of the policy change will be different with respect to children’s age while the growth of subsidised places varies with children’s age. As an attempt to investigate the role of the intensity of the treatment in the heterogeneity of the response to the childcare policy, I now compare the employment trends of mothers whose youngest child is 0-2 and 3-5 years old with that of 6-12 years old (who were less affected by the growth of subsidised places). Employment pre-trend of mothers whose youngest child is 0-2 years old and mothers whose youngest child is 6-12 years old are similar. By contrast, the trend in the employment and hours of work of mothers whose youngest child is 3-5 years old is dissimilar. Therefore, in the following of the paper, I compare mothers whose youngest child is 0-2 years old with mothers whose youngest child is 6-12 years old to investigate the heterogeneity of the response to the intensity of the policy change.

Finally, Figure 3 shows how childcare outcomes evolve over the period for mothers whose youngest child is under 13 years old. I choose to exclude other women, that is women with older children and children living without a child. This choice is made to guarantee that the groups are comparable in terms of their childcare choice. The left-hand of Figure 3 shows how daycare attendance evolved between 2004 and 2014. The daycare attendance increased between 2004 and 2009. After 2009, the daycare attendance increased steadily for the group of mothers whose children is 3-5 and flattened out after 2012. The right-hand of Figure 3 shows the evolution of the hours of daycare (including zeros) between 2004 and 2014. Until 2009, the number of hours spent in daycare increased slowly in each group. After this point, the hours of daycare for mothers whose youngest child is 0-2 years old and 3-5 years old increased until 2012 and flattened out after this point. This increase was stronger for the group with youngest child aged 0-2 years old. By contrast, the hours spent in daycare for older children increased slightly after 2008. Therefore, women whose youngest child is 6-12 years can serve as a control group to evaluate the effect of the childcare voucher reform on childcare decisions.

Figure 1: Employment of different groups of women between 2004 and 2014 in Luxembourg, by presence of children/age of the youngest child

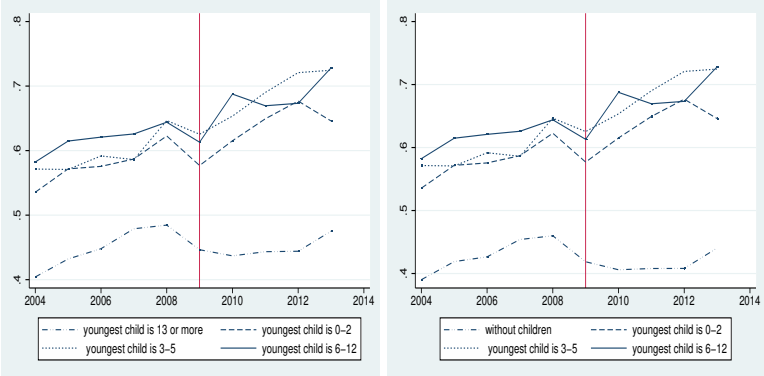
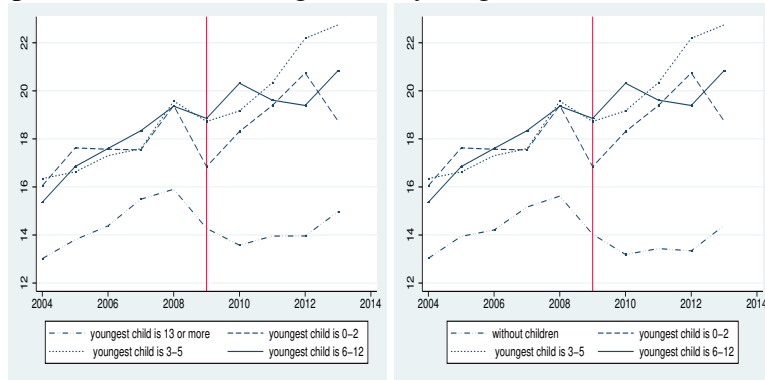
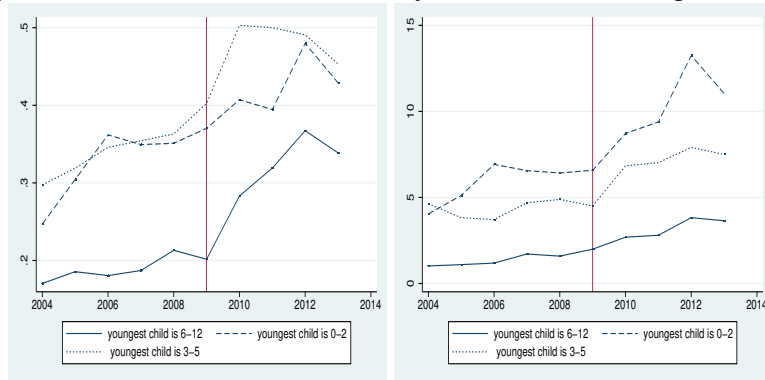


Figure 2: Hours of work per week of different groups of women between 2004 and 2014 in Luxembourg, by presence of children/age of the youngest child



Source: Eu/Silc-PSELL 3 (2004-2014)

Figure 3: Daycare attendance and hours of daycare in Luxembourg between 2004-2014



Source: Eu/Silc-PSELL 3 (2004-2014)

5.2 Difference-in-differences results

The previous section shows suggestive evidence that mothers whose youngest child is under three were more likely to work or to work more after the childcare voucher reform. Mothers whose youngest child is 13 years or more and women living without a child may be good control groups for a Difference-in-Differences analysis of labour supply as the pre-reform trends in employment and hours of work are quite similar for all these groups. I complement this analysis by investigating to what extent the response to the policy varies with the intensity of the treatment using different treatment groups. To evaluate the effect of the voucher on childcare decisions, I use a Difference-in-Differences analysis between mothers whose youngest child is 0-2 years old with mothers whose youngest child is 6-12 years old while they exhibit similar pre-trends in childcare outcomes.

I use a linear probability model⁴ with robust standard errors to estimate the model described in equations (1) and (2). For each outcome, I run three different regressions. First, I estimate the baseline specification in column (1), then I add individual and household controls presented in column (2) and a time trend in column (3).

⁴Although the childcare arrangement and employment variables are dichotomous, I use a linear probability model which can be easily estimated via ordinary least squares rather than a logit or probit model. Indeed, the DiD coefficient (interaction term) is readily interpretable while it is much more complicated with logit or probit.

5.2.1 Effect on maternal labour supply outcomes: employment and hours of work

Table 5 reports the results of the Difference-in-Differences estimates for employment and hours of work when treated mothers are mothers whose youngest child is 0-2 years old. The treatment effect is the coefficient β_1 from Equation 1. The treatment effect is the effect of the treatment on the treated that is the effect of the childcare voucher on mothers whose youngest child is 0-2 years old after the implementation of the reform. The first panel of Table 5 present the effect of the reform when mothers whose youngest child is 0-2 years old are compared to mothers whose youngest child is 13 years old or more. Panel B shows the effect of the childcare reform when the control group is women living without a child and Panel C shows the effect of the reform when the control group is mothers whose youngest child is 6-12 years old.

The effect of the childcare voucher is positive and significant in all specifications. The employment rate of mothers whose youngest child is less than 3 years old increased by 4-7 percentage points after the reform. The magnitude of these estimates remains constant after adding further controls and a time trend (see columns (2) and (3) of Table 5).

Now, I look at the effect of the reform on the hours of work. To avoid change in the sample composition, I estimate a linear model with the same sample of mothers that I use in the employment equation. In other words, I estimate Equation (1) with y being the number of hours of work, potentially zero. I also find a positive significant effect of the childcare voucher reform on the number of hours of work. In response to the reform, women whose youngest child is under 3 years old increased their hours of work by around 3 hours per week after the reform. Results are similar after adding further controls and a time trend (see columns (2) and (3) of Table 5), while the size of the estimate is reduced.

5.2.2 Effect on childcare outcomes: type of childcare and hours of care

I now assess how the childcare voucher reform affects the childcare arrangements (type of childcare and weekly hours) of the youngest child in the family. I compare the change in childcare outcomes of mothers the most affected by the reform (whose youngest child is under three) before and after the reform, using the change in outcomes of those who are slightly affected by the reform (mothers whose youngest child is 6-12 years) to control for common trend effects. I exclude mothers whose youngest child is 4-5 years old to avoid having mothers that belong to both control and treatment groups over the period. Table 6 reports the results where the dependent variables are dummy variables indicating whether the youngest child attends daycare, has a childminder or informal childcare (care provided by relatives, neighbours or friends for free) and the continuous variables measure the average weekly hours of care in these different types of arrangements.

I find that with the childcare voucher reform, mothers whose youngest children are under 3 years old are more likely to use daycare (+4 percentage points). Controlling for additional covariates, as well for a time trend, do not change the magnitude of this effect. Previous literature showed that the newly available places may crowd out existing private places (Havnes and Mogstad, 2011a) or comparable public childcare arrangements (Fitzpatrick, 2010). I now look at the impact of the reform on the propensity to use a childminder or informal care (care provided for free by grand-parents, relatives or friends). Estimates from Table 6 show that the use of a childminder or informal care is not affected by the reform, suggesting no significant crowding out effect. However, the effect of childcare subsidies on informal care may go in opposite direction depending on whether informal and formal care are substitutes (Busse and

Table 5: Results of the reform on maternal employment- Treatment group= mothers whose youngest child is 0-2 years old

| | (1) | (2) | (3) |
|---|-------------------|------------------|------------------|
| Panel A: Control group=mothers whose youngest child is 13 years old or older | | | |
| Employment | | | |
| Treatment Effect | 0.05** (0.03) | 0.04** (0.01) | 0.05** (0.01) |
| R^2 | 0.02 | 0.33 | 0.33 |
| Work hours | | | |
| Treatment Effect | 2.91*** (0.75) | 1.93** (0.73) | 2.01** (0.73) |
| R^2 | 0.06 | 0.35 | 0.36 |
| N | 34287 | 33834 | 33834 |
| Panel B: Control group=women living without a child | | | |
| Employment | | | |
| Treatment Effect | 0.07** (0.03) | 0.06** (0.01) | 0.06** (0.02) |
| R^2 | 0.02 | 0.38 | 0.38 |
| Work hours | | | |
| Treatment Effect | 3.53** (0.77) | 2.58** (0.74) | 2.62** (0.74) |
| R^2 | 0.01 | 0.40 | 0.41 |
| N | 26320 | 26016 | 26016 |
| Panel C: Control group=mothers whose youngest child is 6-12 years old | | | |
| Employment | | | |
| Treatment Effect | 0.04** (0.01) | 0.04** (0.01) | 0.04** (0.01) |
| R^2 | 0.09 | 0.32 | 0.32 |
| Work hours | | | |
| Treatment Effect | 2.92* (0.82) | 0.96* (0.53) | 1.07 (0.53) |
| R^2 | 0.05 | 0.34 | 0.34 |
| N | 28046 | 27697 | 27697 |

The treatment effect is β_1 in equations 1 and 2

(1) baseline model, (2) with extra controls (age, education, nationality, no. of children)

(3) with a time trend (series of year dummies)

Robust standard errors are in parentheses

Statistical significance is indicated by *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Gathmann, 2018). On the one hand, for some parents, informal and formal care are substitute childcare arrangements. The reform has substantially decrease the price of formal childcare, making it relatively more attractive than in the past. Then, for that group of parents, the use of informal care may decrease in response to the reform. On the other hand, some parents may use informal care as a complement to formal care. For that group of parents, the use of informal care and formal may jointly increase in response to the reform. Likely, the non-significant effect of the reform found on informal care is actually the sum of two effects that go in opposite direction, suggesting that caution must be taken with the interpretation on the crowding out effect of the new policy.

Besides the effect on the propensity to use childcare (daycare, childminder or informal care), I am also interested in the effect on the hours of that type of childcare. I estimate Equation (1) with average hours of childcare (daycare, childminder, informal care), potentially zeros, as the outcome variable. The results show a positive impact of the reform on the hours of daycare, which increased by almost 3 hours per week. The magnitude of this effect is unchanged after adding further individual controls and a time trend.

After the reform, parents of children under the age of three are thus more likely to use daycare and for longer hours. As daycare has become cheaper and more widely available with the reform, parents may have now more incentives to use daycare than in the past. These results suggest that the voucher policy reach its (primary) goal of increasing the use of daycare services.

5.2.3 Effect on paternal labour supply outcomes: employment and hours of paid work

The reform has positively impacted mother's employment and use of daycare. I now investigate if the reform affect father's employment outcomes. I estimate the model from equation 1 where y_i is the employment probability of fathers and their hours of work (including the zeros), respectively. The treatment group is fathers whose youngest child is aged 0-2 years old. The control group is fathers whose youngest child is 13 years old or more as the trends in employment outcomes are similar before the childcare reform (see Figure 4). Table 7 reports the results of the Difference-in-Differences estimates for fathers. I do not find a significant effect of the reform on employment of fathers whose youngest child is less than 3 years old. This result is in line with previous related literature (Bettendorf et al., 2015, Eckhoff Andresen and Havnes, 2018). There is indeed little empirical evidence on within couple adjustments of labour supply given estimates of own and cross labour elasticities of married men closed to zero (Bargain et al., 2014).

Table 6: Results of the reform on childcare arrangements- Control group=mothers whose youngest child is 6-12 years old

| | (1) | (2) | (3) |
|-------------------------------|-------------------|-------------------|-------------------|
| Use of daycare | | | |
| Treatment Effect | 0.04*** (0.01) | 0.04*** (0.01) | 0.05*** (0.01) |
| R^2 | 0.08 | 0.15 | 0.15 |
| Hours of daycare | | | |
| Treatment Effect | 2.80*** (0.41) | 2.92*** (0.42) | 3.02*** (0.42) |
| R^2 | 0.11 | 0.16 | 0.16 |
| Use of childminder | | | |
| Treatment Effect | 0.002 (0.01) | 0.003 (0.01) | 0.002 (0.01) |
| R^2 | 0.02 | 0.05 | 0.06 |
| Hours of childminder | | | |
| Treatment Effect | 0.42 (0.28) | 0.42 (0.28) | 0.42 (0.37) |
| R^2 | 0.12 | 0.18 | 0.18 |
| Use of informal care | | | |
| Treatment Effect | -0.001 (0.01) | -0.002 (0.01) | -0.001 (0.01) |
| R^2 | 0.05 | 0.11 | 0.11 |
| Hours of informal care | | | |
| Treatment Effect | 0.04 (0.27) | 0.06 (0.27) | 0.06 (0.27) |
| R^2 | 0.05 | 0.12 | 0.12 |
| N | 28046 | 27697 | 27697 |

The treatment effect is β_1 in equations 1 and 2.

(1) baseline model, (2) with extra controls (age, education, nationality, no. of children)

(3) with a time trend (series of year dummies)

Robust standard errors are in parentheses

Statistical significance is indicated by *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Figure 4: Employment and work hours of different group of men in Luxembourg between 2004-2014, by age of the youngest child

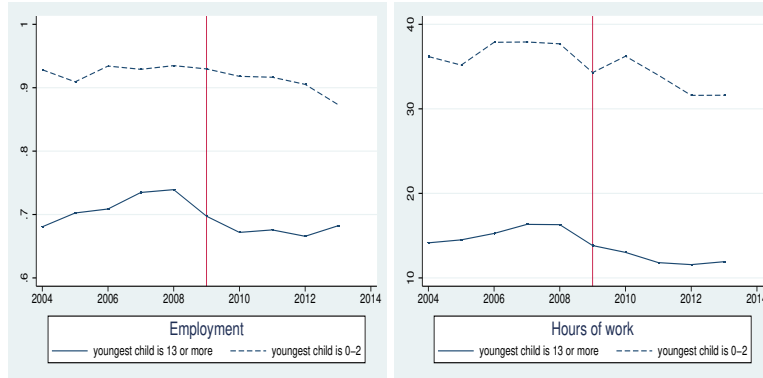


Table 7: Results of the reform on fathers-Treatment group: fathers whose youngest child is 0-2 years old

| | (1) | (2) | (3) |
|---|------------------|-----------------|-----------------|
| Control group=fathers whose youngest child is 13 years old or more | | | |
| Employment | | | |
| Treatment Effect | 0.01 (0.01) | 0.01 (0.01) | 0.01 (0.01) |
| R^2 | 0.05 | 0.27 | 0.27 |
| Work hours | | | |
| Treatment Effect | -0.35 (0.103) | -1.22 (0.15) | -1.27 (0.19) |
| R^2 | 0.10 | 0.23 | 0.23 |
| N | 18988 | 18786 | 18786 |

The treatment effect is β_1 in equations 1 and 2

(1) baseline model, (2) with extra controls (age, education, nationality, no. of children)

(3) with a time trend (series of year dummies)

Robust standard errors are in parentheses

Statistical significance is indicated by *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

5.3 Sensitivity analysis

In this section, I use a further set of treatment groups and I discuss the common trend assumption by means of a standard placebo test and a test of differences in slopes' outcomes in the pre-reform period.

Alternative treatment groups Now, I re-estimate the Difference-in-Differences models described in equation 1 and 2 using two alternative treatment groups: mothers whose youngest child is 3-5 years old and mothers whose youngest child is 6-12 years old. Results are similar to the baseline results, while the estimates are higher (see Tables 8 and 9). Employment probabilities of mothers whose youngest child is 3-5 years old increased by 8-10 percentage points after the reform. They are found to work more hours, by around 3-4 hours per week. The figures are similar for the other treatment group. The employment probability of mothers whose youngest child is 6-12 years old increased by 5-10 percentage points after the reform while their hours of work increased by 3-4 hours per week.

Table 8: Results of the reform on maternal employment- Treatment group= mothers whose youngest child is 3-5 years old

| | (1) | (2) | (3) |
|---|-------------------|-------------------|-------------------|
| Panel A: Control group=mothers whose youngest child is 13 years old or older | | | |
| Employment | | | |
| Treatment Effect | 0.08*** (0.02) | 0.06** (0.02) | 0.06** (0.02) |
| R^2 | 0.02 | 0.36 | 0.33 |
| Work hours | | | |
| Treatment Effect | 3.31*** (0.71) | 2.46** (0.66) | 2.55*** (0.66) |
| R^2 | 0.01 | 0.39 | 0.39 |
| N | 32435 | 31978 | 31978 |
| Panel B: Control group=women living without a child | | | |
| Employment | | | |
| Treatment Effect | 0.10*** (0.02) | 0.07*** (0.02) | 0.08*** (0.02) |
| R^2 | 0.02 | 0.43 | |
| Work hours | | | |
| Treatment Effect | 3.80*** (1.03) | 2.44** (1.00) | 2.49 (0.97) |
| R^2 | 0.01 | 0.34 | 0.35 |
| N | 24129 | 23836 | 23836 |

The treatment effect is β_1 in equations 1 and 2

(1) baseline model, (2) with extra controls (age, education, nationality, no. of children)

(3) with a time trend (series of year dummies)

Robust standard errors are in parentheses

Statistical significance is indicated by *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 9: Results of the reform on maternal employment- Treatment group= mothers whose youngest child is 6-12 years old

| | (1) | (2) | (3) |
|---|-------------------|-------------------|-------------------|
| Panel A: Control group=mothers whose youngest child is 13 years old or older | | | |
| Employment | | | |
| Treatment Effect | 0.05** (0.02) | 0.02 (0.01) | 0.02 (0.14) |
| R^2 | 0.02 | 0.35 | 0.33 |
| Work hours | | | |
| Treatment Effect | 2.51*** (0.56) | 1.27** (0.52) | 1.30** (0.52) |
| R^2 | 0.01 | 0.38 | 0.39 |
| Panel B: Control group=women living without a child | | | |
| Employment | | | |
| Treatment Effect | 0.10*** (0.02) | 0.07*** (0.02) | 0.08*** (0.02) |
| R^2 | 0.02 | 0.43 | |
| Work hours | | | |
| Treatment Effect | 3.80*** (1.03) | 2.44** (1.00) | 2.49** (0.97) |
| R^2 | 0.01 | 0.34 | 0.35 |
| N | 30787 | 30342 | 30342 |

The treatment effect is β_1 in equations 1 and 2

(1) baseline model, (2) with extra controls (age, education, nationality, no. of children)

(3) with a time trend (series of year dummies)

Robust standard errors are in parentheses

Statistical significance is indicated by *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Falsification tests The main threat to my identification strategy consists of deviations from a common trend between the treatment and the control groups in the years preceding the actual treatment. In Section 5.1, I have showed graphical evidence that the treatment and the control mothers show similar trends. I now assess more directly the validity of the key identification strategy of my model (that the treatment and the controls follow the same time trend over the period, even though they have different characteristics). To do that, I start by estimating a placebo effect: I shift the introduction of the policy 4 years prior the 2009 reform. Table 10 and 11 show the results for both treatment groups and the control groups. The placebo effects from these models are insignificant, confirming that there were no systematic differences between the treatment and the control mothers before the 2009 reform.

In addition, I test whether the slopes of the outcome are different across the treated and control groups over time by interacting the treatment variable with year dummies (Pischke, 2005). In equation 1, I include the interactions of the year dummies and the treatment dummy for the first four pre-treatment years (e.g for the years 2004 to 2007). The interaction for the last year of the pre-reform period is excluded from the model to avoid the dummy trap. The coefficients of these interaction terms should be non significant if the outcome trends between the treatment and control groups are similar. Table 12 presents the results of the test of the difference in differences assumption. While none of the year-treatment coefficients is significantly different from zero, one can conclude that the difference in differences is not significantly different between the two groups in the pre-treatment period.⁵

⁵I obtain the same results when the treatment group is mothers whose youngest child is 3-5 years old (see Table 13).

Table 10: Results of placebo reform on maternal employment-Treatment group= mothers whose youngest child is 0-2 years old

| | (1) | (2) | (3) |
|--|----------------|----------------|----------------|
| Panel A: Control group= mothers whose youngest child is 13 years old or older | | | |
| Employment | | | |
| Placebo reform | 0.03 (0.03) | 0.04 (0.03) | 0.04 (0.03) |
| R^2 | 0.07 | 0.32 | 0.30 |
| Work hours | | | |
| Placebo reform | 1.09 (0.27) | 1.42 (0.92) | 1.52 (0.93) |
| R^2 | 0.05 | 0.36 | 0.13 |
| N | 34287 | 33834 | 33834 |
| Panel B: Control group= mothers without a child | | | |
| Employment | | | |
| Placebo reform | 0.03 (0.03) | 0.04 (0.03) | 0.04 (0.03) |
| R^2 | 0.07 | 0.32 | 0.30 |
| Work hours | | | |
| Placebo reform | 1.09 (0.27) | 1.42 (0.92) | 1.52 (0.93) |
| R^2 | 0.05 | 0.36 | 0.13 |
| N | 26320 | 26016 | 26016 |
| Panel C: Control group= mothers whose youngest child is 6-12 years old | | | |
| Employment | | | |
| Placebo reform | 0.03 (0.03) | 0.04 (0.03) | 0.04 (0.03) |
| R^2 | 0.07 | 0.32 | 0.30 |
| Work hours | | | |
| Placebo reform | 0.68 (0.98) | 0.24 (0.77) | 0.24 (0.78) |
| R^2 | 0.05 | 0.13 | 0.13 |
| N | 28046 | 27697 | 27697 |

Placebo reform: 2005: baseline year; 2007: placebo post-treatment year

(1) baseline model, (2) with extra controls (age, education, nationality, no. of children)

(3) with a time trend (series of year dummies)

Robust standard errors are in parentheses

Statistical significance is indicated by *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 11: Results of placebo reform on maternal employment-Treatment group= mothers whose youngest child is 3-5 years old

| | (1) | (2) | (3) |
|--|----------------|----------------|----------------|
| Panel A: Control group= mothers whose youngest child is 13 years old or older | | | |
| Employment | | | |
| Placebo reform | 0.03 (0.37) | 0.02 (0.04) | 0.02 (0.04) |
| R^2 | 0.02 | 0.36 | 0.37 |
| Work hours | | | |
| Placebo reform | 1.92 (1.33) | 1.41 (1.22) | 1.42 (1.22) |
| R^2 | 0.01 | 0.39 | 0.39 |
| N | 32435 | 31978 | 31978 |
| Panel B: Control group= mothers without a child | | | |
| Employment | | | |
| Placebo reform | 0.05 (0.04) | 0.04 (0.04) | 0.04 (0.04) |
| R^2 | 0.03 | 0.43 | 0.30 |
| Work hours | | | |
| Placebo reform | 2.09 (1.86) | 0.48 (1.75) | 0.46 (1.75) |
| R^2 | 0.01 | 0.35 | 0.35 |
| N | 24129 | 23836 | 23836 |

Placebo reform: 2005: baseline year; 2007: placebo post-treatment year

(1) baseline model, (2) with extra controls (age, education, nationality, no. of children)

(3) with a time trend (series of year dummies)

Robust standard errors are in parentheses

Statistical significance is indicated by *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 12: Results of testing differences in slope's outcomes in the pre-reform period-Treatment group= mothers whose youngest child is 0-2 years old

| | Employment | Work hours |
|---|-------------------|-------------------|
| Panel A: Control group= mothers whose youngest child is 13 years old or over | | |
| Treatment effect*2004 | -0.03 (0.03) | -1.3 (1.49) |
| Treatment effect*2005 | 0.01 (0.03) | -0.46 (1.47) |
| Treatment effect*2006 | 0.01 (0.03) | 0.12 (1.47) |
| Treatment effect*2007 | 0.03 (0.03) | 0.20 (1.41) |
| Panel B: Control group= women without a child | | |
| Treatment effect*2004 | -0.06 (0.05) | 0.07 (2.24) |
| Treatment effect*2005 | -0.06 (0.04) | -0.74 (2.01) |
| Treatment effect*2006 | -0.04 (0.04) | -1.84 (1.94) |
| Treatment effect*2007 | -0.04 (0.04) | 0.45 (1.93) |

Robust standard errors are in parentheses

Statistical significance is indicated by ***p<0.01, **p<0.05, *p<0.1

Table 13: Results of testing differences in slope's outcomes in the pre-reform period- Treatment group= mothers whose youngest child is 3-5 years old or over

| | Employment | Work hours |
|---|-------------------|-------------------|
| Panel A: Control group= mothers whose youngest child is 13 years old or over | | |
| Treatment effect*2004 | -0.04 (0.05) | -2.25 (1.60) |
| Treatment effect*2005 | - 0.04 (0.04) | -1.98 (1.53) |
| Treatment effect*2006 | -0.02 (0.04) | -1.29 (1.47) |
| Treatment effect*2007 | 0.03 (0.04) | -1.01 (1.42) |
| Panel B: Control group= women without a child | | |
| Treatment effect*2004 | -0.06 (0.05) | 0.07 (2.24) |
| Treatment effect*2005 | - 0.06 (0.04) | -0.74 (2.01) |
| Treatment effect*2006 | -0.04 (0.04) | -1.84 (1.94) |
| Treatment effect*2007 | -0.04 (0.04) | 0.45 (1.93) |

Robust standard errors are in parentheses

Statistical significance is indicated by ***p<0.01, **p<0.05, *p<0.1

5.4 Heterogeneity of effect for sub-groups

Until now, I have assumed that the effect of the reform on childcare arrangements and maternal employment is homogeneous. Now, I explore whether the effect of the reform is heterogeneous across different groups of mothers. Providing estimates of heterogeneous effects is important given the likely heterogeneity in gains from selecting into childcare and into the labour market (Cornelissen et al., 2016, Kottelenberg and Lehrer, 2017). For example, for women who were not working before the reform, the reduction of childcare costs induced by the reform lowers the reservation wage: a positive effect of the reform on labour market participation may be expected. For women who were already working before the reform, the effect depends on the number of hours of work.

Providing estimates of heterogeneous effects is also important for policy-makers' point of view since early childhood education and care policy is often used as an instrument to reduce inequalities between children. Investigating the effect of the childcare policy on vulnerable sub-groups of families is thus highly relevant. I will also look at heterogeneous response of the reform on the following subgroup: non native, less educated and single mothers.

To test for heterogeneity in treatment effect across subgroups, I use the baseline model but I now allow the coefficient of the treatment effect to vary for mothers' subgroups (Abadie, 2005). The subgroups are defined by prior employment status, education level, migration background and marital status. In further regressions, I thus estimate the following model:

$$\begin{aligned}
Y_{it} = & \alpha + \beta_1(Treat_i \times Post_t) + \beta_2Treat_i + \beta_3Post_t \\
& + \beta_4G_i + \beta_5(G \times Treat_i) + \beta_6(G \times Post_t) \\
& + \beta_7(G \times Treat_i \times Post_t) + \varepsilon_{it}
\end{aligned} \tag{3}$$

where G_i is a dummy that defines the sub-group of mothers. The coefficient β_7 on the triple interaction between the dummy for the sub-group of mothers, the treatment dummy and the post-reform dummy indicates whether mothers in the sub-group react systematically different to the childcare reform compared to the overall sample of mothers. Table 14 reports the results for the treatment group being mothers whose youngest child is 0-2 and control group being mothers whose youngest child is 13 years old or more.

Heterogeneous effects by initial employment status I start by evaluating whether the reform has generated different responses with respect to mother's initial employment status. Likely, the overall effect found in the previous section hides different responses according labour market participation and work hours before the reform. I define a dummy variable for whether the mother is working or not before the reform. Panel A of Table 14 shows the results of heterogeneous effect of the reform by initial employment status. While the employment response to the reform is the same irrespective of the initial employment status, the effect on hours of work is much more important for mothers who were already working before the reform than for the overall sample. The hours of work of mothers working before the reform increase by almost 6 hours per week, which is roughly three times the estimates found for the overall group of treated mothers. To complement these results, I also look at different responses according hours of work before the reform. I define a dummy variable whether the mother was working part-time before the reform (less than 30 hours per week). The sample is thus restricted to working mothers before the reform. Panel B of Table 14 shows estimates of a heterogeneous effect of the reform on hours of work by prior part time. I do not find support for a heterogeneous response on hours of work by prior part time.

Heterogeneous effects by education level, migration background and marital status of mothers I also analyse whether the reform has led to different response with respect to mother's education. To do that, I define a dummy equal to one for education less than secondary school level. Estimates are reported in Panel C of Table 14. There is no evidence of a heterogeneous response by mother's education level. Low educated mothers may have lower access to subsidised childcare in case of rationing because, for example, they are less able to cope with waiting lists. In that case, they could be more responsive to the increase of subsidised places than the average mother. To look at this, I estimate Equation 3 with y_{it} being childcare outcomes. In the model for childcare outcomes (both use and hours of childcare), the treatment group is mothers whose youngest child is 0-2 years old and the control group is mothers whose youngest child is 6-12 years old. Table 15 presents the estimates of heterogeneous effects of the reform on childcare use. Less well-educated mothers are more likely to use daycare for their youngest child: this increase is equal to 6 percentage points, which is 2 percentage points more than the increase estimated for the average mother. But they do not use more hours of daycare than the average mother in response to the childcare reform.

I now look at heterogeneous responses to the childcare reform by migration background. I define a dummy variable for whether the mother is non native. Panel D of Table 14 shows

the results. There is no evidence of a heterogeneous response on the employment probability while the effect of the reform on hours of work is smaller for non natives compared to the effect found on the overall sample of mothers. When estimating the model for childcare outcomes, with the control group is mothers whose youngest child is 6-12 years old, I do not find support for heterogeneous response on childcare use and hours of childcare (see Panel C of Table 15).

Finally, I investigate whether the reform has led to different responses with respect to mother's marital status (see Panel E of Table 14). As observed for non natives, there is no evidence of a heterogeneous response on the employment probability while the effect of the reform on hours of work is smaller for single mothers compared to the effect found on the overall sample of mothers. There is also no evidence of a heterogeneous response on childcare outcomes with marital status (see Panel D of Table 15).

To sum up, there is evidence that hours of work of more vulnerable mothers are more responsive to the reform than that of the overall sample. In particular, the effect on hours of work is higher for low educated than for the overall sample while the effect is lower for non natives and single mothers than for the overall sample.

Table 14: Results of heterogeneous effects- Control group=mothers whose youngest child is 13 years old or more

| | Employment | Work hours |
|--------------------------------------|-------------------|--------------------|
| Panel A: prior employment | | |
| Treatment effect | 0.04** (0.12) | 0.15 (0.9) |
| Treatment effect* prior employment | 0.01 (0.12) | 5.82** (2.02) |
| <i>Pvalue</i> | 0.1 | 0.001 |
| <i>R</i> ² | 0.53 | 0.53 |
| Panel B: prior part time | | |
| Treatment effect | 0.06** (0.19) | 0.15 (0.9) |
| Treatment effect* prior part time | 0.01 (0.35) | 0.02 (2.79) |
| <i>Pvalue</i> | 0.58 | 0.047 |
| <i>R</i> ² | 0.08.6 | 0.05 |
| Panel C: education | | |
| Treatment effect | 0.05** (0.02) | 3.84*** (0.98) |
| Treatment effect*low educated | -0.01 (0.33) | -2.34 (0.10) |
| <i>Pvalue</i> | 0.085 | 0.161 |
| <i>N</i> | 34287 | 22918 |
| <i>R</i> ² | 0.07 | 0.08 |
| Panel D: marital status | | |
| Treatment effect | 0.06** (0.02) | 5.6*** (1.05) |
| Treatment effect*lone mother | -0.07 (0.06) | -7.86** (0.02) |
| <i>Pvalue</i> | 0.08 | 0.49 |
| <i>R</i> | 0.05 | 0.01 |
| Panel E: migration background | | |
| Treatment effect | 0.38 (0.145) | 5.51 *** (1.37) |
| Treatment effect* non-native | 0.25 (0.44) | -3.16** (0.66) |
| <i>Pvalue</i> | 0.001 | 0.017 |
| <i>R</i> ² | 0.05 | 0.04 |

Robust s.e. in parentheses

Statistical significance is indicated by ***p<0.01, **p<0.05, *p<0.1

Table 15: Results of heterogeneous effects- Control group=mothers whose youngest child is 6-12 years old

| | Employment | Work hours | Daycare | Hours of day-care |
|--------------------------------------|------------------|-------------------|------------------|-------------------|
| Panel A: prior employment | | | | |
| Treatment effect | 0.02 (0.02) | 0.19 (0.94) | 0.02 (0.10) | 2.49*** (0.53) |
| Treatment effect*prior employment | 0.01 (0.03) | 3.73* (0.94) | 0.06** (0.03) | 0.97 (0.83) |
| <i>Pvalue</i> | 0.18 | 0.02 | 0.00 | 0.00 |
| <i>R</i> ² | 0.56 | 0.48 | 0.08 | 0.12 |
| Panel B: education | | | | |
| Treatment effect | 0.05** (0.01) | 1.09 (0.69) | 0.02 (0.10) | 2.49*** (0.53) |
| Treatment effect*low educated | -0.00 (0.03) | 0.41 (1.14) | 0.06** (0.03) | 0.97 (0.83) |
| <i>Pvalue</i> | 0.09 | 0.10 | 0.00 | 0.00 |
| <i>R</i> ² | 0.07 | 0.05 | 0.08 | 0.12 |
| Panel C: migration background | | | | |
| Treatment effect | 0.04 (0.03) | 0.62 (0.93) | 0.04* (0.02) | 3.01*** (0.58) |
| Treatment effect* nonnative | 0.02 (0.03) | 1.15 (0.33) | -0.01 (0.03) | -0.45 (0.79) |
| <i>Pvalue</i> | 0.003 | 0.012 | 0.079 | 0.000 |
| <i>R</i> ² | 0.03 | 0.03 | 0.09 | 0.18 |
| Panel D: marital status | | | | |
| Treatment effect | 0.02 (0.016) | 2.67*** (0.43) | 0.02 (0.84) | 2.60*** (0.43) |
| | | | | .../... |

| | | | | | |
|------------------------------|-----------------|-------------------|----------------|-----------------|--|
| .../... | | | | | |
| Treatment effect*lone mother | -0.06 (0.05) | -7.76** (3.54) | 0.02 (0.06) | -0.36 (2.13) | |
| <i>P</i> value | 0.47 | 0.10 | 0.51 | 0.28 | |
| <i>R</i> ² | 0.076 | 0.11 | 0.08 | 0.11 | |

Robust s.e. in parentheses. Statistical significance is indicated by ***p<0.01, **p<0.05, *p<0.1

6 Conclusion

This paper has focused on the role of the expansion of subsidised childcare on childcare arrangements and maternal employment in Luxembourg. I have exploited a recent reform that has substantially increased the number of subsidised places for children under 3 years of age. I show that the employment of mothers whose youngest child is under 3 increased by 4-7 percentage points in response to the reform while their hours of work increased by around 3 hours per week. The magnitude of this effect falls within a similar range as effects found in studies on the role of the expansion of subsidised childcare in the Netherlands (Bettendorf et al., 2015) or Spain (Nollenberger and Rodriguez-Planas, 2015). Studying heterogeneous effects reveals a differential impact on hours of work for more vulnerable mothers (less well educated, non-natives and single mothers). I also show that parents whose youngest child is under three years old modify the childcare arrangement: they are more likely to rely on daycare, with an average increase of 3 hours per week. I do not find that parents substitute the new subsidised places to informal care arrangements, suggesting that there is no crowding out effect of the reform.

This paper contributes to the literature on childcare policy in two interesting ways. The first contribution is to provide empirical evidence of the impact of the expansion of access to universal childcare at a time when most of OECD countries are going to (still) improve access to their early childhood education systems. Since the European Council held in Barcelona in 2003, and more recently the new strategy for employment EU2020, member states of the European Union are strongly encouraged to continue providing subsidised childcare in order to reconcile work and family lives, enhance child development and reduce inequalities among children. My results are in line with this recommendation as I show that the expansion of subsidised childcare positively affects the use of childcare services as well as the employment and the hours of work of mothers whose youngest child is 0-3 years old. The second contribution of the paper is that, while most of the evidence relies on programs targeted at various subgroups of the population, the paper analyzed the effect of the policy on the overall population, which is of high interest for policy makers, as well on specific subgroups.

In Luxembourg, as in most of OECD countries, there are both public and private childcare providers. As public and private providers are likely heterogeneous in terms of quality, opening days, opening hours and location, it is highly relevant to account for heterogeneity in the provision of childcare when analyzing the effect of childcare policy on child and parent's outcomes. Moreover, there is little evidence on the effect of government provision in and regulation of the early childhood care sector on the supply side, e.g. on workers and firms of this industry. Yet, it is crucial to understand how childcare supply responds to government intervention to understand the welfare implications, including both the consequences for access to and affordability of the policy. Both are interesting topics for future research.

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Appendix

Maternal employment in Luxembourg, between 1999 and 2014

| | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
|--------------------------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| No children aged 0-14 | 46.6 | 46.9 | 47.3 | 47.0 | 47.8 | 47.6 | 49.0 | 50.5 | 51.8 | 49.7 | 50.7 | 51.1 | 50.9 | 53.0 | 53.1 | 53.1 |
| At least one child aged 0-14 | 52.0 | 56.2 | 57.7 | 60.2 | 57.3 | 60.8 | 63.6 | 64.3 | 66.1 | 66.1 | 68.4 | 69.0 | 69.2 | 72.5 | 72.1 | 74.8 |
| <i>by age of the youngest child:</i> | | | | | | | | | | | | | | | | |
| -Youngest child aged 0-2 | 45.6 | 53.7 | 57.8 | 62.9 | 56.4 | 57.5 | 61.6 | 65.3 | 65.8 | 64.3 | 66.9 | 70.5 | 68.8 | 71.6 | 70.4 | 71.6 |
| -Youngest child aged 3-5 | 48.9 | 57.4 | 55.6 | 59.2 | 53.5 | 58.7 | 62.5 | 61.5 | 67.1 | 62.0 | 66.4 | 65.4 | 65.8 | 70.3 | 71.3 | 79.7 |
| -Youngest child aged 6-14 | 58.4 | 57.4 | 58.6 | 58.7 | 59.7 | 63.6 | 65.3 | 64.8 | 65.9 | 69.2 | 70.1 | 69.9 | 70.9 | 74.2 | 73.4 | 74.5 |
| <i>by education level:</i> | | | | | | | | | | | | | | | | |
| - Low education | 44.3 | 51.3 | 53.2 | 55.7 | 55.3 | 54.3 | 59.1 | 58.2 | 59.5 | 57.6 | 61.5 | 67.2 | 63.5 | 69.8 | 62.7 | 67.0 |
| - Medium education | 53.5 | 54.8 | 56.4 | 59.5 | 56.6 | 61.0 | 60.9 | 62.9 | 64.7 | 63.1 | 65.6 | 66.6 | 67.0 | 69.9 | 70.2 | 72.5 |
| - High education | 71.0 | 72.9 | 76.0 | 76.3 | 67.6 | 72.8 | 74.4 | 76.9 | 77.7 | 80.0 | 77.7 | 74.0 | 76.6 | 76.8 | 78.5 | 79.1 |
| <i>by migration background:</i> | | | | | | | | | | | | | | | | |
| - Born in country of residence | 49.6 | 52.4 | 55.0 | 55.3 | 54.2 | 60.0 | 65.1 | 65.7 | 65.5 | 68.2 | 72.8 | 73.6 | 74.8 | 78.8 | 79.6 | 83.4 |
| - Born outside country of residence | 54.8 | 59.9 | 60.5 | 64.8 | 60.3 | 61.5 | 62.3 | 62.9 | 66.6 | 64.7 | 65.1 | 66.0 | 65.5 | 69.0 | 67.8 | 70.1 |

Source: OCDE Family database

