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Childcare benefits and maternal labour supply: Evidence from discontinuities in subsidization

Erasmus School of Economics

Master's thesis Policy Economics

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Abstract

The present thesis investigates the causal link between maternal labour market outcomes and childcare benefits by exploiting variation in childcare prices from a discontinuous subsidization scheme introduced by the Luxembourgish government in 2009. A regression discontinuity-type analysis with multiple cut-offs does not suggest a clear pattern in the effect of higher childcare costs on maternal labour market outcomes at the intensive margin, while higher costs of formal childcare are generally associated with positive effects at lower income levels and adverse effects at higher income levels.

Keywords: Regression discontinuity (RD), maternal labour supply, childcare benefits

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Introduction

Women's labour market participation and intensity of work shows much wider cross-variation than men's, while the female workforce earns consistently lower wages. Not only does the labour market appear to penalise women relative to their male counterparts, also do working mothers earn systematically lower wages than childless women. Often advanced are the role of children, greater demand for labour flexibility, as well as less advancement to higher paying jobs within and across establishments for mothers to explain the above observations. As such, a growing body of research has emerged within the economic field, to investigate the effectiveness of various arrangements targeted at the removal of what is considered to hinder women's progress in the working world. A related policy that has been particularly prominent in many industrialized countries in recent years is that of subsidized childcare. The European Union's Europe 2020 strategy for example highlights the access to affordable, high quality childcare as a key policy to improve employment rates and reduce social exclusion and poverty risks among women with children, especially single mothers (European Commission, 2010). Figures suggest that personal or family reasons were the main originator of inactivity for 49.4% of women aged between 25 and 54 years, compared to only 7.6% for men within the same age range in the EU-27 in 2019 (Eurostat, 2020). This thesis adds to this policy debate by investigating the link between childcare benefits and labour market outcomes for women in a context, where the room for improvement is large for labour market participation, but limited by the number of day-care spots available. This is done by measuring the impact of government sponsored childcare provision on female part-time employment, and hours worked via the introduction of a large childcare subsidy program launched by the Luxembourgish government in 2009.

Establishing a causal link between a mother's employment outcomes and her child's childcare attendance is complicated by the fact that the latter is a choice variable, depending on factors such as preferences, availability of unpaid options and price of day care, which in turn may be correlated with maternal employment decisions. To overcome such endogeneity concerns, I exploit exogenous variation in the cost of childcare across comparable income groups within the Grand Duchy, resulting from the introduction of a childcare voucher system in 2009, which provides large and universal in-kind State subsidies for out-of-school care for children who are up to twelve years old. While the labour market participation of females has risen impressively in the country since 2009 (from 65.3% to 71.9% between 2009 and 2019 for active females aged between 20 and 64 years according to Eurostat (2020)), it is unclear how

much the availability of affordable childcare has contributed to this progress. It is ambiguous, whether the subsidy has effectively pushed more mothers into the labour market or whether the childcare benefit has merely acted as accommodating factor in women's aspirations for greater labour market participation, reflecting a widely observed societal move in that direction.

From a theoretical point of view, a simple economic framework with two goods suggests that mothers may choose between working and buying childcare or leisure and taking care of their children. Thus, the opportunity cost of remaining at home for one hour consists of the hourly wage rate minus the cost of formal childcare purchased. As such, the incentive for staying at home is larger for mothers earning lower wages, or having strong preferences for home care. The theoretical predictions of childcare subsidies in such a setting are ambiguous. On the one hand, the reduced cost will encourage more women to enter the labour market, as the subsidy increases the net wage and thus the income foregone for staying at home. On the other hand, it is unclear how the subsidy affects the number of hours worked for women already employed. If mother's working full-time decided to work less as a result of the reduced childcare costs, their income would remain unchanged, potentially causing a reduction in the amount of hours worked (income effect). At the same time, it is unclear whether mother's working a few hours would increase the number of hours worked to exploit the net wage gain (price effect), or whether they would substitute their labour for more time at home (substitution effect). Considering the fact that more recent studies suggest that women are no longer responsive to wage changes (Blau and Kahn, 2007; Heim, 2007), childcare subsidies might no longer have the ability to increase the labour supply for mothers at the margin. In general, longer working hours and higher rates of labour force participation may mean that the subset of mothers for whom subsidy has potential of both price and income effects is now smaller (Fitzpatrick, 2012).

This thesis will add to the existing literature by looking at the labour market effects of public childcare for children aged zero to twelve. Moreover, it will investigate the effect of childcare subsidies across the income distribution by exploiting multiple discontinuities in the cost of childcare that emerge under Luxembourg's benefit scheme. I exploit the Luxembourg Income Study (LIS), which combines microdata on 5.564 representative private households from the Luxembourgish territory, to compare labour market outcomes for mothers who are just above and just below the discontinuity points to estimate the sensitivity of maternal labour supply to childcare prices. This paper is, to the best of my knowledge, the first to look at childcare benefits and female labour supply decisions for mothers with children who are about

to enter high school. Furthermore, since I am using the same identification strategy across different income levels and subgroups, my results are easily comparable and allow to look at outcomes across the income distribution, and across various subpopulations.

The remainder of this thesis is organised as follows. In Section I, I provide a thorough review of related literature. Section II presents details about the institutional setting and the functioning of the childcare subsidy. Section III is devoted to the methodology, reviewing my identification strategy, my data set and descriptive statistics, as well as the identifying assumptions underlying the chosen methodology. Section IV presents the estimation results from the empirical estimates and provides further heterogeneity analysis. Section V concludes.

I. Related literature

While existing literature on the causal impact of childcare subsidies on maternal labour market decisions is relatively extensive, there is little consensus on the magnitude of the actual coefficient estimate, which varies largely across studies. This is unsurprising given the role of the institutional setting, the targeted population, as well as the availability and quality offered by childcare providers. In this section, which aims at providing an overview of relevant academic papers, I will therefore mainly focus on apparent common patterns emerging across studies. I will further highlight related studies that are informative about existing links between maternal labour supply decisions and other factors potentially impacting the effectiveness of reduced childcare prices.

Early literature on the causal impact of childcare subsidies on maternal labour market decisions mainly focusses on estimating labour market participation equations, capturing the responsiveness of female labour supply to childcare costs. An overview by Blau and Currie (2006) suggests that these probit models, which usually exploit variation in childcare costs across individuals or regions, as well as tax treatments of childcare expenditures, yield largely varying results with elasticities ranging from 0.06 to -3.6. Michalopoulos et al. (1992) or Ribar (1995) even estimate complete structural models, which are micro-economically founded using utility maximizing behaviour. These early studies suffer from endogeneity bias, often being based on women currently using childcare, are reliant on a set of assumptions regarding their functional form, and yield results that are sensitive to the way the cost of childcare is measured while regional price differences may simply reflect differences in consumer prices.

More recent literature mainly exploits natural experiments resulting from exogenous policy changes, which randomly separate a population into a treatment and a control group. Most of these studies apply a difference-in-difference method to exploit regional or temporal variation in childcare prices and/ or access to childcare (see for e.g Baker and Gruber, 2005; Berlinski and Galiani, 2007; or Lundin et al., 2008). A smaller number of studies uses an instrumental variable approach to estimate local average treatment effects rather than an intention-to-treat. Such papers usually exploit quarter of birth cut-offs, resulting from eligibility rules (see for e.g. Bauernschuster and Schlotter, 2015; Fitzpatrick, 2012; or Gelbach, 2002). While such studies are generally internally relatively robust, their scope for external use is often very limited. Their dependency on the institutional context, childcare market characteristics and the sub-population of interest makes it virtually impossible to pin down specific factors creating discrepancies across studies, as their findings are not generalizable to the entire population of mothers with children.

A first pattern that appears to be emerging across these studies, however, is the fact that the elasticity of female labour supply with respect to childcare costs is sensitive to the mother's relationship status and education level, as well as the number and age of the children. First of all, Kalenkoski et al. (2005) find that single parents spend more time in home childcare and less in the market, while there is virtually no difference between married and cohabiting couples. Furthermore, according to Meghir and Phillips (2010), it is a stylized fact of empirical labour economics that single parents are relatively more responsive to financial incentives, which is reflected by findings suggesting that married women are usually less responsive to childcare price reductions compared to single mothers (see for e.g. Anderson and Levine, 1999; Bettendorf et al., 2015; or Gelbach, 2002). The same applies to women without additional young children (see for e.g. Berlinski et al. 2011; Cascio, 2009; or Fitzpatrick, 2012), while women with younger children and lower incomes are usually more responsive to childcare cost reductions (Anderson and Levine, 1999). At the same time cross-country analysis suggest that parental child care is augmenting (Sayer et al., 2004), with larger increases being observed for more educated individuals (Ramey and Ramey, 2007). This is confirmed by an analysis by Guryan et al. (2008), which suggests that there is a strong positive relation between parental education (measured by earnings) and time spend with one's children, which holds across and within countries. At the same time it is a stylized fact that the elasticity of female labour supply with respect to childcare costs is not uniform across the skill distribution, but declining with skill level (Anderson and Levine, 1999). These findings further confirm that the effects of subsidizing childcare are expected to be largest for the least skilled, validating the theoretical

predictions that high childcare costs make home production more attractive for those with lower earnings potential. In addition, they suggest that childcare is more of a luxury good than other consumption commodities, as time spent with one's children appears to be valued more by individuals with a higher opportunity cost of time. These observations are reflected in a recent study by Ho and Pavoni (2020), which characterises the optimal childcare subsidy and nonlinear transfer scheme for single mothers with children below six years. In particular, the authors suggest that an optimal design of childcare subsidies provides larger subsidies to low income earners at rates declining with income level, including a kink as a function of childcare expenditures to account for differing marginal returns to household childcare across skill groups. The kink feature would allow to provide a positive subsidy for those with incomes below, and negative subsidies for those with incomes above the kink, reflecting the lesser need to discourage home care for the highly skilled.

Another pattern that is apparent across these studies is the fact that maternal labour supply does not seem to respond to further reductions in childcare prices in a context, where large subsidization was already in place prior to the reform, where female labour supply and day care attendance was already relatively high (Havnes and Mogstad, 2011; Lundin et al., 2008), or where available spots at childcare facilities remain severely rationed after the reform. Furthermore, as Bauernschuster and Schlotter (2015), or Havens and Mogstad (2011) point out, substantial employment effects will remain absent if newly available public childcare slots simply crowd out existing informal arrangements. In a context where spots remain rationed after the expansion, this might be particularly relevant if these new spots go to mothers already closely attached to the labour market, substituting informal with public arrangements. From an inequality point of view this might be even more relevant, when considering the fact that Graves (2013) suggests that the negative effects on maternal employment from less childcare availability are concentrated in low income households with school aged children. Based on the above reasons, as argued by for e.g. Cascio (2009) and Fitzpatrick (2012), studies that use data from a later period are therefore more likely to find smaller effects since childcare subsidies are then more likely to be inframarginal to the participation decision. A more recent study that does find large effects is that by Bettendorf et al. (2015), which applies a difference-in-difference method to exploit a Dutch law on cutting the fee for formal childcare in half for working parents. They find a 2.3 percentage point increase in the participation rate of women and an increase in maternal hours worked of 6.2%. There was however much room to grow at the intensive margin, since a lot of women work part-time, and these effects should be

interpreted as joint effects, as the government also increased EITCs for parents with young children over the same period.

At the same time, while there are numerous factors affecting the demand and supply of childcare, the quality of day care is given special attention in many relevant papers. It generally emerges that minimum quality standards are relevant for parent's decision of whether or not to place one's child in day care. While they are found to encourage the demand for childcare (Chipty and Witte, 1994), regulation could have adverse effects of pushing more children into unregulated informal care if costs are driven up (Currie and Hotz, 2001). Nevertheless, this suggests that families do consider whether or not public childcare is a good substitute for home care, which is in-itself arguably extremely variable in quality. This is reflected in the fact that there is evidence of a strong positive relation between education or earnings and time spend with one's children, suggesting that highly educated parents do view market-purchased childcare as poor substitutes for parental time (Guryan et al., 2008). Since Baker et al. (2019) emphasize the fact that positive impacts of universal early intervention programs are generally found to be concentrated in more disadvantaged children while evidence on broader benefits is generally inconclusive, it is indeed very likely that children from poor backgrounds benefit relatively more from publicly provided childcare. This is very relevant if investments in human capital have dynamic complementarities, since small learning gains in the short-run would have the potential to considerably improve the long-run prospects of children (Heckman, 2006). Governmental investment in early intervention provision is often justified based on equity and efficiency arguments, precising that liquidity constraints, information failures and externalities cause families to underinvest in early childhood education (Havnes and Mogstad 2011). Currie (2001) even argues such early investment to be more efficient in comparison to compensating for differences later in life. Based on the findings I have laid out above, State funded quality childcare might well have additional benefits beyond that. Regardless of what might drive parent's desire to stay at home to provide home based care (potential liquidity constraints, or the inability to effectively screen the quality provided due to information failure), State funded quality childcare might well be an effective mean to encourage more parents to send their kids to day care and enter the labour market.

Finally, I will turn my attention to a number of academic papers providing insights into how family policies might affect the relation between maternal labour supply and subsidized childcare via increased labour market opportunities for women. First of all, a growing body of academic research consistently finds policies aiming at reconciling work and family life to be most effective at raising fertility rates in high income countries (see for e.g. Doepke and

Kindermann, 2019; Feyrer et al., 2008). Del Boca (2002) finds large effects on the fertility rate from increasing the availability of free day care for young children in Italy, while Thévenon and Horko (2009) argue that policies aiming to facilitate work and family life have strong effects on fertility rates in France by creating confidence in the government's wish to support active women, reflected in the country's high full-time employment rate among women with a young child. These findings suggest that in modern societies with increased labour market opportunities for women, the opportunity cost of children does not necessarily increase with growing access to market work, if the State manages to guarantee reconciliation policies with unconstrained childcare supply. At the same time, generous maternity leaves appear to reduce the labour force attachment of mothers (Pettit and Hook, 2005), while Gonzàlez (2013) provides evidence that one-time financial allowances at birth have adverse effects on labour supply during the first year after giving birth (i.e. mother's tend to compensate the initial increase in income by staying at home).

II. Policy context

In this section, I will provide an overview of Luxembourg's institutional setting to provide a context for the policy relevance of my analysis for other countries, before I explain the childcare reform in greater detail.

A. *Institutional setting*

Misra et al. (2007) analyse different welfare State strategies in Europe and identify Luxembourg as a country explicitly valuing and rewarding women for care provision by compensating women for their effort and time they spend on care. This makes the nation comparable to countries such as Austria, the Netherlands, or Germany at the time of the intervention. Generous caregiver and family allowances, as well as policies encouraging in-home care (such as parental leave) make part-time employment an ideal strategy for women willing to work in such settings. When taking a closer look at the institutional context at the time of the intervention, three things stand out in particular: the universal provision of high quality childcare, the low day care attendance of young children, as well as the comparably low employment rates amongst women. It is important to note that this low day care attendance may reflect an excess demand for childcare provision in 2009, potentially affecting the room

for improvement of the subsidy program. Bousselin (2017) suggests that public and private childcare providers refused 61% and 29% of children, respectively, in the year of 2007. In addition, the existence of waiting lists in many facilities was suggestive of the lacking accessibility to day care at the time. In 2008, 26% of children less than three years old were cared for by formal arrangements other than by the family, compared to a Eurozone average of 30% (Eurostat, 2020). While there are no legal claims for a place in a collective facility, priority rules based on household characteristics are in place in public facilities, while commercially run providers mainly operate under first come first served principles. Before 2009, day care centres have already been subsidized, as long as they responded to criteria related to staff/ child ratios, group sizes, quality of employees, and characteristics of the facility under question (Mémorial A., 1998). While public childcare providers charged prices based on income and birth order of the child, private providers were free to set their own prices, generally making private childcare the more expensive option. To the extent that imposing structural regulations eliminates lower quality child care services, however, it was impossible for parents substitute away to lower childcare at a lower price, since the quality on offer in both private and public sector was relatively homogenous under commonly defined quality standards of the State law (Mémorial A., 2001). In addition, as I have explained in Section I, the provision of high quality childcare might economically matter as we may expect formal childcare to improve child outcomes, especially for children from poor socioeconomic backgrounds. In addition, formal childcare might thus be a substitute for home based care for children.

From Table I which depicts the number of available spots at childcare facilities per eligible child from 2009 to 2015, it becomes apparent that the universal availability of affordable childcare has been successful in stimulating the provision of childcare supply. In particular, the overall number of available spots per eligible child has increased by 96,9% from 2009 to 2015. Especially the number of private providers has seen an exponential increase after the reform, as previous affordability differences nearly vanished (see Table II.). While prior to the reform, the hourly price was on average 2,50 € and 4,90 € in public and private facilities, respectively, they averaged 1,40 € in both sectors after the reform (Bousselin, 2019), removing earlier mentioned pre-reform price discrepancies.

Table I. Available spots at childcare facilities per eligible child (2009-2015)

	2009	2010	2011	2012	2013	2014	2015
Number of available spots	24.648	32.340	37.833	42.582	46.377	48.682	51.124
Eligible population (0-12 years)	76.372	76.667	77.469	77.468	78.760	79.741	80.875
Available spots/ eligible child	0.32	0.42	0.49	0.55	0.59	0.61	0.63

Sources: Ministry of National Education, Childhood and Youth (2017); Ministry of Family Affairs, Integration and the Greater Region (2012; 2013)

In 2009, the Luxembourgish government has spent as much as 4.089% of its total GDP on family benefits, and the share has remained above 3% ever since. The government's financial support for families and children thereby largely exceeds that of other European Union countries, with countries like Germany, France or Austria spending between 2% and 3% of their total GDP on family benefits (OECD, 2020). In 2012, the total budget of the National Fund for Family Allowances (CNPF at the time) amounted to 1.076.254.779,20€ (Ministry of Family Affairs, Integration and the Greater Region, 2013), clearly showing the government's priority for family and childcare policy. I should note here that the Luxembourgish situation is very different from other countries, however, since large amounts of these family benefits (about 48% in 2016) go to non-residential families (Austria had the second largest share with 6.2%) (Ministry of Family Affairs, Integration and the Greater Region, 2018). The types of childcare available to parents are collective day care facilities or childminders, where the former involves publicly and privately owned infrastructures, available for children from the age of three months. At the same time, parents can choose to opt for an additional year of early learning, universally available for all children at the age of three, before they start mandatory pre-school at the age of four. Pre-school is then followed by six years of primary school, with children usually starting secondary school at the age of twelve.

Table II. Number of available spots at day care facilities and parental assistants (2009-2015)

	2009	2010	2011	2012	2013	2014	2015
*Public childcare**	20.308	25.777	29.470	32.063	34.053	35.053	37.440
*Private childcare***	2.734	4.425	5.793	7.664	9.194	10.371	10.406
Parental assistants	1.606	2.138	2.570	2.855	3.130	3.258	3.278

Sources. Ministry of National Education, Childhood and Youth (2017); Ministry of Family Affairs, Integration and the Greater Region (2012; 2013)

Notes. Public childcare facilities include maisons relais, day centers, crèches and day nurseries[1]. Private facilities include day centers, crèches and day nurseries. Available places may be occupied by multiple children if time slots differ.

When considering the evolution of employment rates in the Grand Duchy, it becomes quite apparent that the total employment rate has increased over the past two decades. In particular, the employment rate of residents aged between 20 and 64 was of 67.5%[2] in the year of 2000 and has increased to 72.8% in 2019. Luxembourg is thus 0.2 percentage points away from its employment target defined in the Europe 2020 strategy set by the European Council in 2010 (European Commission, 2010). What is particularly striking about this development is the fact that the employment rate of the male workforce was declining over that period. In other words, the increase of the employment rate of women is the main driving force behind the progress. The population's female employment rate has risen from 53.8% in 2000 to 68.1% in 2019. Within the European setting, Luxembourg's female employment rate started exceeding the Eurozone average only in 2010 with a rate of 62%, compared to an average rate of 61.8% in the Euro area. Though this is proof of convergence between male and female employment rates in the country, Luxembourg's gender employment gap was one of the highest in Europe in 2009 (17.5 percentage point difference), only exceeded by Czechia, Greece, Italy and Malta. Female employment rates in Luxembourg are highest for women with a tertiary education and no children. In 2009, 50.5% of the inactive female population aged between 20 and 64 have indicated family or caring responsibilities as their main reason for not seeking employment, one of the highest rates within the European Union, which had an of average 30.9%. Whilst the female labour supply was very similar for childless women, and mothers with one or two

[1] A more detailed explanation of these facilities is provided in the Appendices p. 48

[2] Figures for this paragraph are taken from Eurostat (2020).

children aged below six years in 2009, there is a stark contrast for women with three or more children. In particular, for women aged between 25 and 49 years with one young child (below six years), the employment rate was 77.1% in Luxembourg compared to 68% in the Euro area in 2009, while it was 44.6% compared to 46.8% for women with three or more children. When considering the average amount of usual weekly hours of work of women employed full-time, Luxembourg has remained fairly close to the Eurozone average since 2003, with between 39.5 to 40 hours a week. At the same time, average weekly hours of women working part-time have exceeded the Euro area average over the past two decades, with an increase in the average amount of 20.2 (2009) to 23.8 hours a week in 2019. At the same time, the percentage of women in part-time employment has decreased from 2008 (38.2%) to 2018 (31.8%) (STATEC, 2019).

B. *The childcare subsidy*

The childcare subsidy, also referred to as Chèque Service Accueil (CSA), is a financial in-kind assistance, or service voucher, paid by the Luxembourgish government to assist parents with their out-of-school care for children up to twelve years, or children who have not left primary education yet. The vouchers were introduced in March 2009, to provide guaranteed access to socio-educational facilities, to grant extra assistance to children in a state of precariousness or exclusion and to create identical criteria for all service providers regarding the financial participation of the parents. In addition, the subsidy aims to facilitate the reconciliation of family and work life, and to promote the non-formal development, education and learning of kids (Ministry of Family Affairs, Integration, 2010). In his State of the Nation speech in May 2008, then Prime Minister Jean-Claude Juncker also emphasized the government's ambitions to stimulate the quantity of day care offers via the voucher scheme, as additional places in childcare facilities were needed. While the CSA is a universal subsidy available for all children aged between zero and twelve, the amount granted is calculated on an individual basis. In particular, the subsidy divides households into different card categories which are expressed as a multiple of the minimum social wage (MSW), based on their taxable household income (see Table XIII. in the Appendices p.50 for an overview of the contributions payable by parents within the different card categories). As such, parents benefit from reduced rates in child care structures which are identified as CSA providers, where the reduced rate depends on taxable household income. In practice, the financial assistance is directly paid to the provider, resulting in a reduction in the amount of the invoice to be paid by the parents at

the end of the month. Taken into consideration for the calculations of the benefit are also the number of children for whom family allowances are being paid, as well as their ranking within the family group and the number of hours spend in childcare facilities during the month of observation. Another distinction is being made by the type of childcare facility involved, i.e. collective facility or parental assistant[3]. A detailed description of the tariffs applicable according to these criteria can be found in the Appendices p. 49. To provide an idea of the magnitude of the subsidy, consider the following scenario (calculations are based on rates applicable in 2009):

26 hours per week with 4 meals at a collective facility for an only child will cost parents:

- In receipt of the minimum guaranteed income (RMG):

(25*0) + (1*0,50) + 4*0 = 0.50 €/ week, or 0,50*4 = 2 €/ month

The minimum guaranteed income in January 2010 for a household composed of two adults and one child was 1.907,00 €. (FNS, 2011). Using the OECD-modified scale[4] as proposed by Haagenars et al. (1994), this represents 0.19 % of the standard of living (1.059,4 €/month) of the household. Since the minimum guaranteed income in January 2010 for a household composed of one adult and one child was 1.307,67 €, this represents 0.2% of the standard of living (1.005,9 €/ month) of the household.

- With an income <1.5*MSW[5]:

(3*0) + (21*0,50) + (2*0,50) + 4*0,50 = 13,5 €/ week, or 13,5*4 = 54 €/ month

The MSW in January 2010 was of 1.682,76 € (CCSS, 2020). The disposable income of a family earning 1.4*MSW in January 2010 would thus amount to 2.355,86 €. This represents 4.13% of the standard of living (1.308,81 €/ month) for a household where both parents are

[3] I may note that in 2012 a further distinction was made between private and public facilities, a distinction that was abolished with the reform in 2017.

[4] The OECD-modified scale allows to compare the standard of living of households of different sizes, taking into consideration economies of scale in consumption. The standard of living is calculated by dividing household disposable income by the number of consumers present in the household. A value of 1 is assigned to the household head, of 0.5 to each additional adult, and of 0.3 to each child (aged below 14).

[5] Minimum Social Wage

present vs. 2.78% of the standard of living (1.812,2 €/ month) for single mothers. For a family earning 1.4*MSW in January 2010 (2.355,86 €), this represents 2.29% of their income.

- With an income <4.5*MSW:

$$(3*0) + (21*3{,}00) + (2*6{,}50) + 4*2{,}00 = 84 \text{ €/ week, or } 84*4 = 336 \text{ €/ month}$$

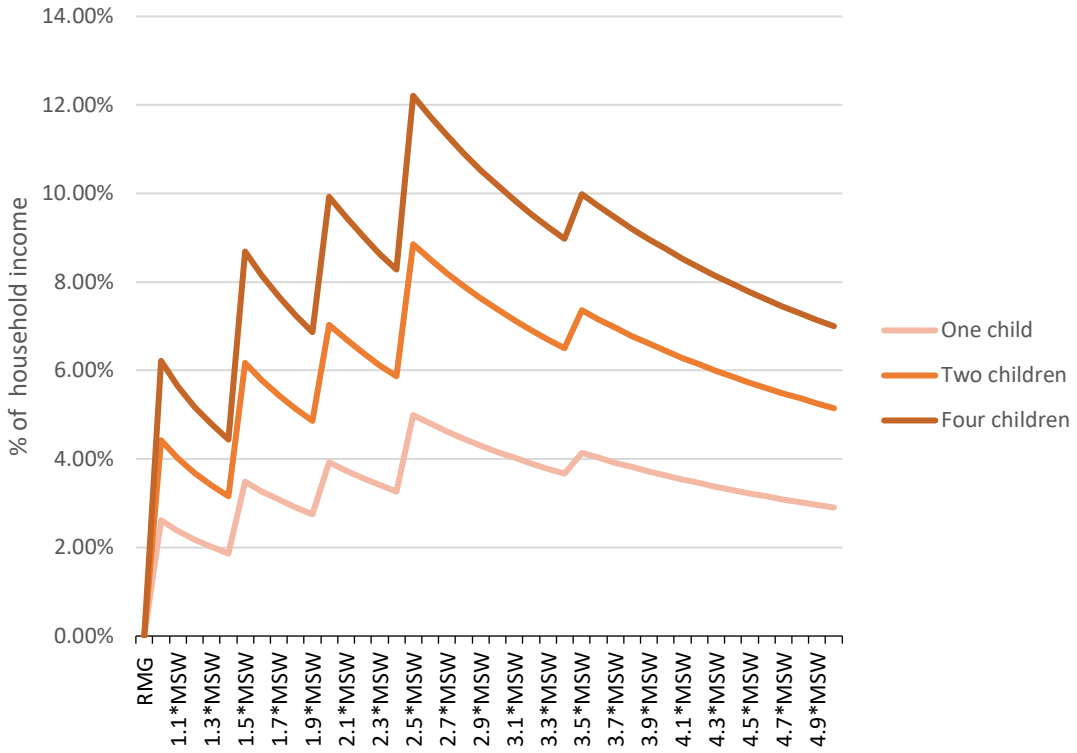
The disposable income of a family earning 4.4*MSW in January 2010 would thus amount to 7.572,42 €. Using the OECD-modified scale, this represents 7.99% of the standard of living (4.206,90 €/month) for a household where both parents are present vs. 5.77% of the standard of living (5.824,94 €/month) for single mothers. For a family earning 4.4*MSW in January 2010 (7.572,42 €), this represents 4.44% of their income.

Considering the fact that the average hourly price in a private facility was 4,90 € before the reform, 26 hours per week without any meals would have represented 48%, 39%, and 12% of the standard of living of households where both parents are present before 2009, respectively.

To provide a better overview of the subsidy, Figure I. provides a graphical representation of the cost of childcare as a function of monthly household income across the income distribution, based on the assumption that the child(ren) spend 20 hours per week[6] in day-care facilities, where they consume five meals a week. From the graph it becomes apparent that there is a large price difference for unemployed households in receipt of the minimum guaranteed income (RMG) and employed ones in receipt of the minimum social wage (MSW) (0% vs 4.4% of income with two children). What is also striking is the fact that the childcare cost is highest for those in the middle of the income categories (2.5*MSW), while it is decreasing to lower shares of household income for higher earners. Moreover, the function spikes when entering a new card category of the subsidy, before decreasing with income, and re-spiking when entering the next card category. Whether this might cause disincentives to work is up for investigation.

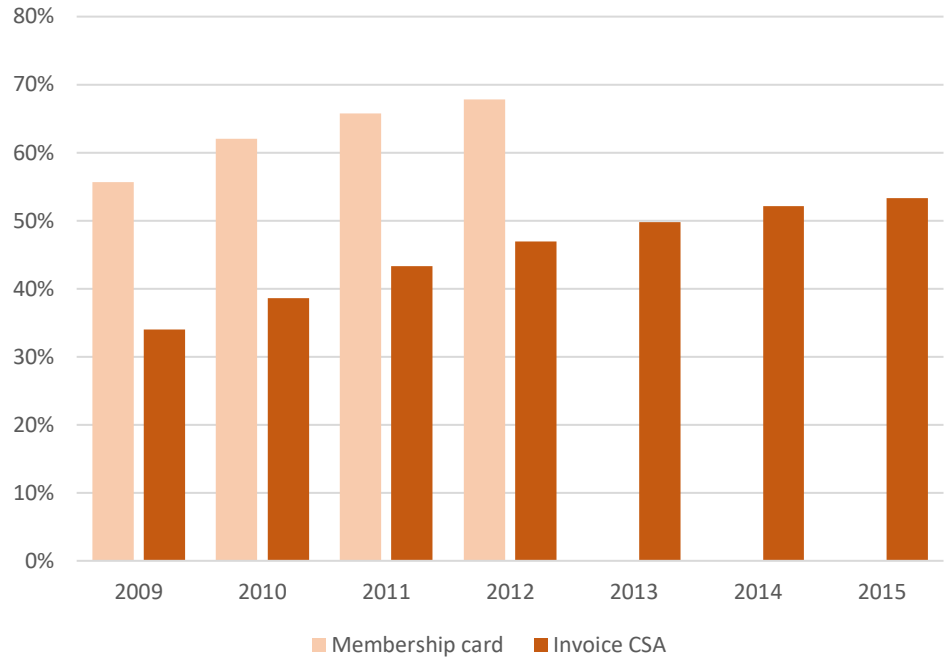
[6] Similar graphs under the assumption of spending 40 or 65 hours per week in daycare facilities can be found in the Appendices p. 51 (Figures VII. and VIII.).

Figure I. Cost of childcare as % of household income (Two-adult household, 20 hours/week)



From Figure II , which depicts the number of membership cards of children adhering to the CSA system vs. the number of invoices received by the eligible population (0 to 12 year olds), it becomes apparent that the demand is much higher than the number of children who actually benefit from formal childcare, although a convergence is observable in later years. Lastly, I may note that the CSA scheme has been adjusted three times since its introduction in 2009. In 2012, some minor adjustments were made, mainly concerning children from households of higher income levels. On September 5th 2016, the service voucher was made available to children of non-residents, where at least one of the parents works in the Grand Duchy. In 2017, the CSA scheme was made even more generous, launching a multilingual education programme in participating facilities, offering 20 hours of free care for children aged over one and not attending school yet.

Figure II. Number of membership cards and CSA invoices by eligible population



Sources. Ministry of National Education, Childhood and Youth (2019; 2015) & Statec (2020)
Note. Number of membership cards after 2012 are not available.

III. Methodology

A. *Identification strategy*

In the following section, I will motivate and describe the identification method I have chosen to analyse the policy effect of the childcare reform. Since this is a universal subsidy to all children below the age of 12, simultaneously introduced in the entire country, the design of the scheme does not lend itself to exploit any kind of natural cut-off, regional or temporal variation. Furthermore, the dataset that I am exploiting does not permit before and after comparisons as it does not allow for matching of individuals across time, or cover the years of 2008 or 2009. Although a panel regression interacting the months of maternal exposure to the reform with its treatment intensity would have provided additional insights regarding within group effects of the subsidy, identification would have been complicated by the fact that the Great Recession of 2008 might have impacted labour outcomes. To gain a more thorough understanding of the policy effect, I will thus focus on between group differences to compare

outcomes of similar individuals affected differently given the set-up of the benefit scheme. Since I do not effectively observe if and for how many hours each mother places their child(ren) in daycare, I will focus my analysis on the assumption that children spend on average 20 hours a week in childcare facilities, where they consume five meals a week. This choice is based on the fact that many children would spend about 4 hours in childcare during weekdays, if they have not reached school entering age yet and their mother works part-time, or if they are in school but both parents work full-time and send their kids to daycare after school. Moreover, I will assume that one child is currently placed in childcare, ranked number one in the family. As can be seen from Figure III, the cost of childcare ranges from 0% to almost 5% of household income under these assumptions. Furthermore, it becomes quite apparent that for adjacent income groups, the cost of childcare jumps up at certain income thresholds, creating multiple discontinuities in the set-up of the subsidy scheme. I will exploit this design by implementing a sharp regression discontinuity design (RD) to investigate whether any of these variations in the cost of childcare effectively impacts labour outcomes of mothers.

In a nutshell, regression discontinuity designs are generally used in settings where assignment rules can be exploited as natural experiments, i.e. where random variation is created around a certain cut-off, which is deterministic of an individual's treatment. In the setting under investigation, mothers with a taxable household income above a certain threshold are being exposed to higher childcare costs compared to those on the left of a certain cut-off (see Figure III, p. 21). Although not every mother to the right of this threshold will send their child to daycare, there is still full compliance in the sense that each mother to the right of the cut-off is subject to the same cost of childcare. In other words, the assignment to treatment is a deterministic function of my forcing variable. In this setting, the use of a sharp RD design is more appropriate compared to a fuzzy RD design, which would be exploiting a change in the probability of treatment at the cut-off[7]. In terms of regression, this translates into running regressions of the following type:

$$Y_i = \alpha_0 + \rho D_i + f(X_i) + \alpha_1 D_i f(X_i) + \alpha_2 V_i + \mu_i$$

where Y_i is the outcome for mother i (e.g. number of hours worked); D_i is a dummy variable equalling one if mother i's taxable household income is equal to-or exceeds threshold level c;

[7] I may note that my dataset does not contain information on whether or not mothers chose to send their children to daycare, while the PSELL3 (my preferred dataset) does. Such information could be exploited in an IV-style analysis, using the cut-offs as instruments for childcare attendance (provided childcare prices are relevant and effectively cause mothers within certain groups to place their child in formal childcare).

X_i is household taxable income; V_i is a vector of control variables for mother i; and μ_i are unobserved factors clustered at the regional level. These clusters capture Luxembourg's 12 cantons in addition to a cluster capturing the rural area of the country's capital. Sampling at this higher level essentially allows the standard errors of women sharing similar characteristics and a common environment to be correlated with each other. This is particularly relevant, if mothers in more densely populated areas of the country have a greater preference for work, or to account for the fact that the number of available spots in childcare facilities is much more limited in certain areas of the country. $f(.)$ is a smooth function of the running variable, allowing the true model to be non-linear. The inclusion of non-linearities in the relationship between Y_i and X_i basically reduces the risk of wrongfully mistaking a discontinuity at the threshold as an effective jump. At the same time, the interaction term between D_i and X_i further allows the slopes of the relation between my outcome and running variable to differ to the left and the right of the cut-off.

In terms of my regression specification, I will thus be comparing labour outcomes of mothers who are exposed to higher childcare costs ($D_i = 1$), since $X_i \geq c$ with those of mothers exposed to lower childcare costs ($D_i = 0$), since $X_i < c$. Given the different card categories, there are four discontinuities that I will exploit, i.e. I will compare outcomes for four control and four treatment groups, where 2 groups will be used as both control and treatment groups. I may note that the biggest jump occurs at the lower end of the income distribution: from 0% of household disposable income for households in receipt of the minimum guaranteed income to 2.61% of household disposable income for households with a taxable income equalling the minimum social wage. I will however not exploit this discontinuity as it would be hard to argue that mothers from unemployed households are comparable to women who are either employed, or live with an employed partner. Most likely, estimation results would pick up unobserved factors such as a greater preference for work, resulting in confounding estimation results. It would of course be interesting, however, to exploit the cut-off across time. Furthermore, I will adjust the control group to observations within the same income range from the cut-off (household taxable income ranging between -841 € and +841 € on either side of the cut-off). Table III. describes the treatment and control groups, as well as the number of observations I am thus left with. Figure III. additionally provides a graphical representation of those groups both for the price of childcare as a function of household taxable income, as well as for the effective cost per month.

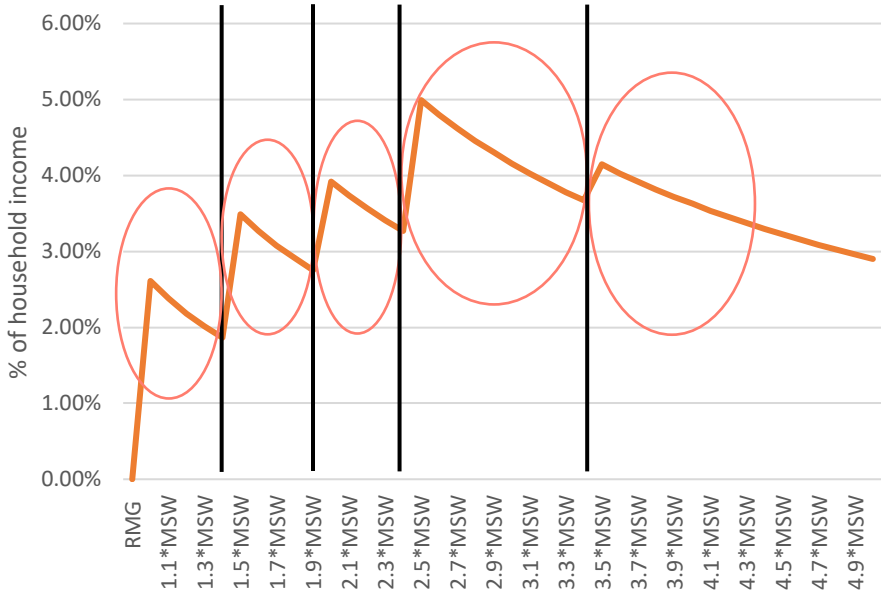
Table III. Treatment and control groups

Cut-off (C)	Control Group	Treatment Group	Observations
X_i =2.524 (1.5*MSW)	$1.683 \leq X_i < 2.524$	$2.524 \leq X_i \leq 3.365$	216
$X_i = 3.365$ (2.0*MSW)	$2.524 \leq X_i < 3.365$	$3.365 \leq X_i \leq 4.206$	289
$X_i = 4.206$ (2.5*MSW)	$3.365 \leq X_i < 4.206$	$4.206 \leq X_i \leq 5.047$	263
$X_i = 5.889$ (3.5*MSW)	$5.048 \leq X_i < 5.889$	$5.889 \leq X_i < 6.730$	150

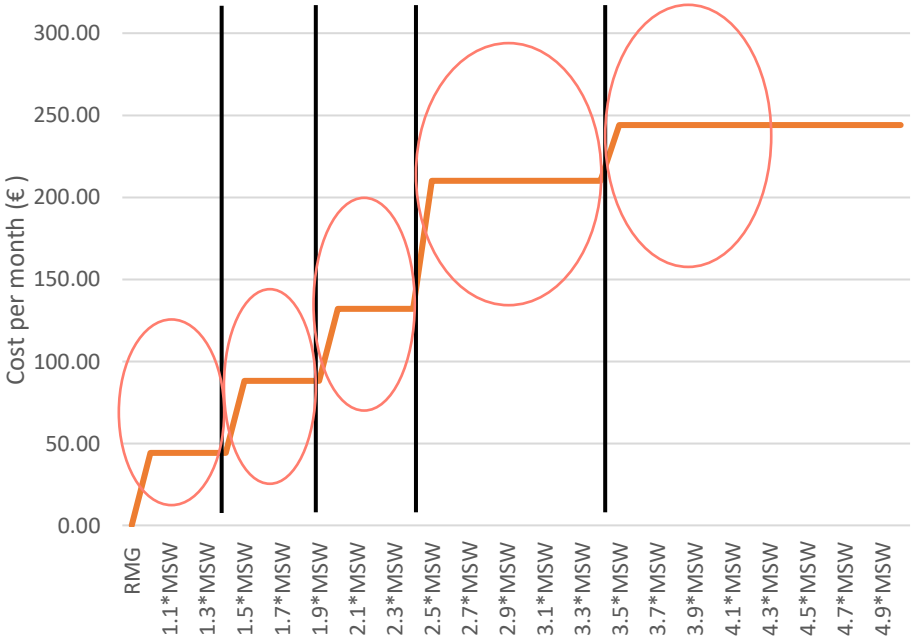
Note. Numbers represent household taxable income in €.

Figure III. Graphical illustration of treatment and control groups

(a) Treatment and control groups by cost of childcare as a % of household income



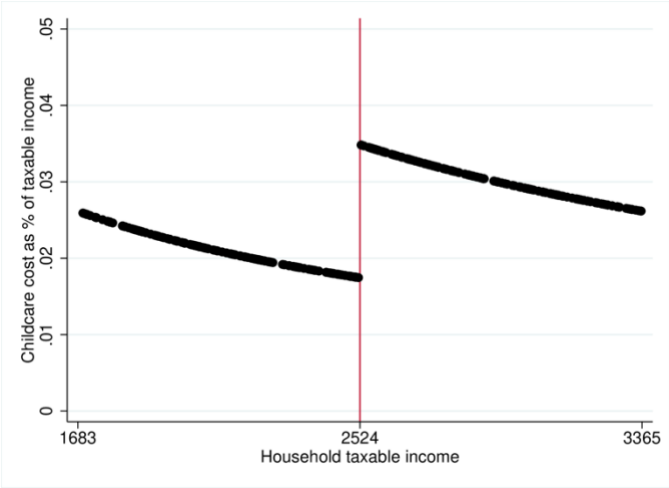
(b) Treatment and control groups as a function of the monthly cost of childcare



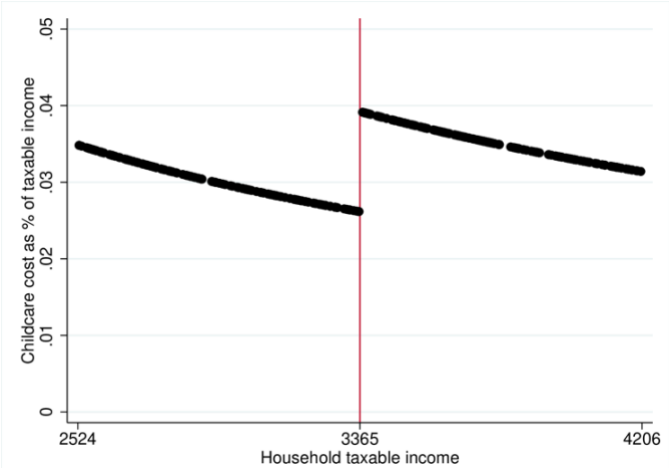
Note. Circles represent control and treatment groups, black lines represent the cut-off.

From Table III., it becomes apparent that the limited number of observations will be a major challenge in this identification design. While the number is already extremely limited for a bandwidth of 841 € to either side of the cut-off for the various groups, a regression discontinuity design comparing individuals whose household taxable incomes differ by up to 1.682 € could cause internal validity problems. I will further address this issue in later sections, I may note however that my main results will therefore be based on an array of different bandwidths and that we may expect the results to be extremely sensitive to those. For a data based graphical depiction of the cut-offs that I am exploiting, I have plotted the observed household taxable income as a function of the monthly childcare cost as a % of income for the various income groups in Figure IV.

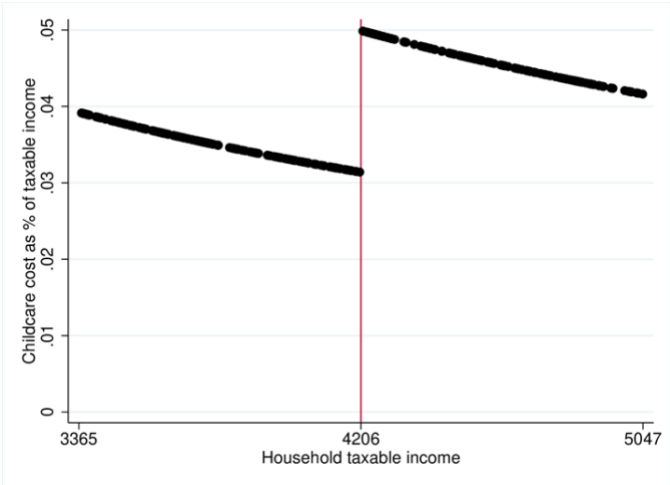
Figure IV. Observed household taxable income by childcare cost as % of income



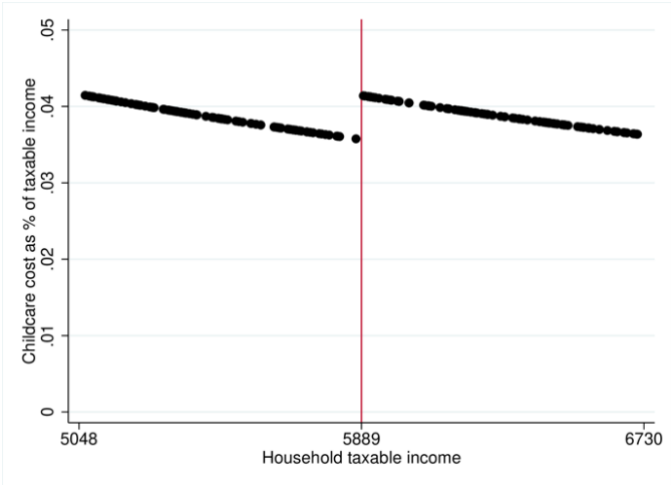
(a) Cut-off at 1.5*MSW



(b) Cut-off at 2.0*MSW



(c) Cut-off at 2.5*MSW



(d) Cut-off at 3.5*MSW

IV. *Data*

This thesis exploits data from the Luxembourg Income Study[8] (LIS), which harmonises existing cross-sectional microdata from external data providers into a common template. As such, the study provides the largest available income database , covering about 50 countries worldwide, with survey waves dating back to as far as 1980. LIS contains household- and personal level data on geography and housing, household composition and living arrangements, socio-demographic characteristics, as well as labour market outcomes. Since most data providers do not allow direct access to sensitive microdata, a remote-execution system (LISSY) is used to run estimation analysis directly online.

The database for Luxembourg was provided by both the CEPS/INSTEAD (Luxembourg Institute of Socio-Economic Research, LISER since December 2014) and the National Institute of Statistics and Economic Studies (STATEC). In particular, LIS combines microdata from the Socio-economic Panel[9] (PSELL 3) and the Survey on Income and Living Conditions (SILC), which are panel household surveys, studying private household's living conditions in relation to their income. The database's temporal coverage around the policy introduction includes survey waves for the years of 2004, 2007, 2010 and 2013. Since LIS does not provide identifiers linking households or persons across waves, and given the gaps in temporal coverage, I will however be unable to exploit the panel nature of the data. The study covers 5.564 representative private households from the Luxembourgish territory, gathered via stratified random sampling.

Since I am interested in labour market outcomes, I will restrict my sample to women of prime age, which I define as persons aged between 25 and 54 years, following the statistical range applied in the OECD's employment rate by age group indicator (OECD, 2020). I will further only consider mothers whose youngest own child living in the household is less than 13 years old. Given that the database does not report taxable household income directly, I have constructed my forcing variable (X) by calculating household monthly gross wage income from yearly gross wage income and deducting the health and pension insurance (since all current incomes reported in the dataset are gross of taxes and social security contributions), which amounts to 11.05% of gross income, capped at five times the minimum social wage (FEDIL,

[8] The Luxembourg Income Study may be consulted under the link provided in the Reference list p. 44 *Luxembourg Income Study (LIS) Database*.

[9] I may note that this thesis was initially planned under the use of the Socio-economic Panel, which would have been my preferred database given its superior data coverage (covering the years 2003 to 2014 and including microdata on the use of formal childcare). Unfortunately, LISER was unable to provide access to the Socio-economic Panel under the current circumstances of the COVID-19 pandemic.

2020). As dependent variables of interest (Y), I will use weekly hours worked in the main job and a binary outcome variable equalling one if the person works part-time. I may note that I initially planned to also include a binary variable, equalling one if the person is employed. However, there is not enough variability in this outcome variable to conduct RD-style regression analysis, causing me to focus my analysis on outcomes at the intensive margin. For the vector of control variables (V), I will consider mother i's age, years of education, years of work experience, the number of children, the age of the youngest own child, as well as two dummy variables indicating whether mother i has a partner or an immigration background.

IV. *Descriptive statistics*

To provide an overview of the characteristics of Luxembourg's prime aged females in 2010, Table XIV. (see Appendices p. 52) provides some general descriptive statistics, which suggest that the average prime aged woman during the year of observation is 41 years old, lives with a partner and one child aged about 10 years. In addition, more than half of these observed women have an immigration background, while they have on average 12 years of education and 16 years of work experience, working 34 hours a week for an hourly gross wage of 22 €. When taking a closer look at the employment rates of prime aged mothers (see Table IV.), it becomes apparent that women with young children less than 4 years old generally have the highest employment rates, while women whose youngest child is older than 12 are least likely to be employed (except for single women with an immigration background, where the employment rate is highest for mothers whose youngest child is older than 12). Overall, employment rates are higher for native females and single women relative to immigrated and partnered mothers. While the employment rates vary largely across sub-populations, the highest rate of 95% for single native women whose youngest child is less than four years old might reflect the fact that these women need to engage in paid work in order to provide for them and their child. Furthermore, it is important to note that the quasi-entirety of this sub-population works part-time (95%), while the share of part-time work among employed women is significantly lower for other population groups. To further provide some insights into our population of interest, Table XV. (see Appendices p. 53) characterises population of interest (prime aged mothers with child(ren) aged below 13 years) across the income distribution (based on taxable household income to be informative about our control and treatment groups). Women at the lower end of the income distribution tend to have more children living at home.

While nearly all women live with a partner, mothers from a household with a taxable household income between 1.0*MSW and 1.5*MSW are substantially less likely to live with a partner than all other income categories. At the same time, it appears as if females tend to work more hours on average as their gross hourly wage rate increases within the lower income categories, while the opposite holds for higher earners. Similar observations can be made regarding full-time employment. Lastly, the average outcomes for other observational variables appear to reflect the fact that we are observing older women with more work experience and years of education and slightly older children, as we move across the income distribution.

Table IV. Descriptive statistics- Employment of prime aged mothers

Population group			**Employment rate**	**Part-time employment rate among employed**
Natives	Single	Youngest child under 4	94.55%	95.44%
		Youngest child 4-12	79.35%	38.80%
		Youngest child >12	77.51%	42.70%
	Partnered	Youngest child under 4	83.00%	69.59%
		Youngest child 4-12	75.37 %	73.74%
		Youngest child >12	65.37%	62.78%
Immigrants	Single	Youngest child under 4	83.27%	56.86%
		Youngest child 4-12	66.35%	23.31%
		Youngest child >12	84.21%	43.02%
	Partnered	Youngest child under 4	69.78%	44.89%
		Youngest child 4-12	67.51%	54.63%
		Youngest child >12	60.45%	64.02 %

Note. Person-level weights are used to inflate to the total population of Luxembourg.

D. *Identifying assumptions*

My estimation results may be interpreted as causal, if the assignment rule randomly allocates mothers around the cut-off and if there are no confounding discontinuities at the threshold. The former implies that women cannot manipulate the cut-off and have imperfect control over where they will end up. This guarantees that the average outcome of females on the left of each cut-off is equal to the potential outcome of those on the right of the cut-off, would the cost of formal daycare at offer have been identical to that of the respective control group. In terms of the potential outcomes framework (see Imbens and Rubin, 2007), this means that the potential outcomes are independent of treatment: $E(Y_{0i}|D_i = 0, X_i = c) = E(Y_{0i}|D_i = 1, X_i = c)$. The latter condition implies that the jump at the thresholds is exclusively caused by taxable household income. As such, the assignment variable (X) is the only systematic determinant of treatment (D). To test whether this condition is fulfilled, Table V. summarises tests for balance in the covariates of my treatment and control groups for the full bandwidth ($h = 841$) and a smaller bandwidth ($h = 250$) around each cut-off. Overall, the observables appear to be well balanced around the thresholds, while imbalances occur mainly when considering the full bandwidth size. This is unsurprising given the fact that the inclusion of observations further away from the cut-off increases the probability of considering individuals who differ in a systematic way. Apart from the cut-off at 1.5*MSW, there is a statistically significant difference in the number of children around all the other thresholds. Years of education are also significantly different around cut-offs 2.0*MSW and 2.5*MSW, while random assignment around the latter is very questionable under the full bandwidth with discontinuities in four covariates. Given these observations, I will include regressions controlling for the full set of observables in my analysis to eliminate these confounding effects. To complement this analysis, I will directly check for manipulation of taxable household income, following McCrary (2008), who identifies sorting around cut-offs by testing for discontinuities in the conditional density of the forcing variable. When plotting the number of observations in each bin against the mid points (see Figure V.), there appears no discontinuity in the distribution of the running variable at cut-offs 1.5*MSW and 2.5*MSW. As such, there is no evidence suggesting that individuals are manipulating their taxable income around these thresholds. However, the cut-offs at 2.0*MSW and 3.5*MSW clearly exhibit jumps in the continuity of the density of taxable income, with p-values suggesting a statistically significant break in the conditional density functions. This suggests that individuals are indeed more likely to be observed to the right of either of these cut-offs which casts doubt on the validity of the

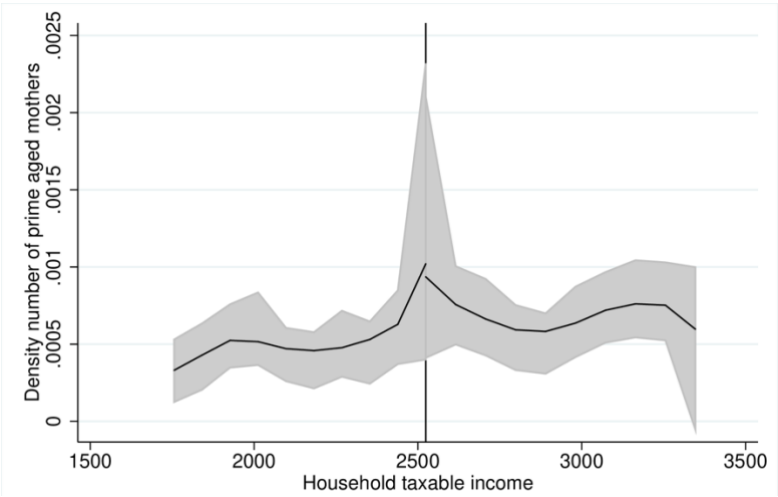
Table V. Balance in covariates

	post							
	Discontinuity at 1.5*MSW		Discontinuity at 2.0*MSW		Discontinuity at 2.5*MSW		Discontinuity at 3.5*MSW	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Age	-1.0054	.9274	.5498	1.1035	1.4457**	2.3274	.6621	3.5231
	(1.010)	(1.384)	(1.041)	(.738)	(.597)	(1.809)	(.834)	(2.095)
Living with a partner	.0857***	-.0355	.0172	-.0188	.0013	.0123	-.0092	-.0385
	(.027)	(.049)	(.025)	(.033)	(.029)	(.047)	(.021)	(.042)
Immigration background	.0039	-.0022	-.0043	-.0271	-.1166	-.0793	-.1188*	-.2231**
	(.037)	(.087)	(.055)	(.037)	(.0708)	(.093)	(.064)	(.079)
Years of education	-.0189	.058	1.3708*	1.6164*	1.2354***	.247	.5075	1.4923
	(.443)	(.721)	(.712)	(.787)	(.390)	(.495)	(.476)	(.927)
Years of work experience	.6705	1.5767	.2444	.3408	-.0201	1.6442	.3858	3.2308
	(1.181)	(1.215)	(.840)	(.670)	(.549)	(1.165)	(.933)	(3.187)
Number of children	-.2461	-.1893	-.2597*	-.1594	.1767**	.0907	.247**	.0908
	(.155)	(.170)	(.130)	(.134)	(.066)	(.124)	(.102)	(.125)
Age of youngest child	-.2213	.3874	.1433	-.1129	.7757**	1.6858**	-.6684	1.2754
	(.422)	(.452)	(.304)	(.742)	(.295)	(.758)	(.436)	(.787)
Observations	348	105	383	118	355	94	206	51

Notes. The dependent variable is indicated in each row header. The coefficients reported are for the binary indicator taking value one for taxable household income levels above the respective cut-off. Odd numbered columns consider the full bandwidth ($h = 841$), even numbered columns consider a smaller bandwidth ($h = 250$). Observations for years of work experience are 336, 103, 374, 115, 348, 93, 204 and 50, respectively. Standard errors are in parentheses and clustered at the regional level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

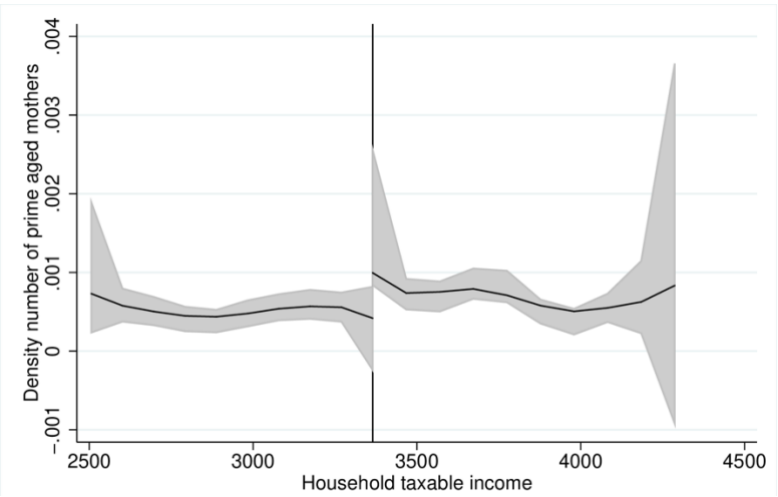
Figure V. McCrary density tests

1.5*MSW



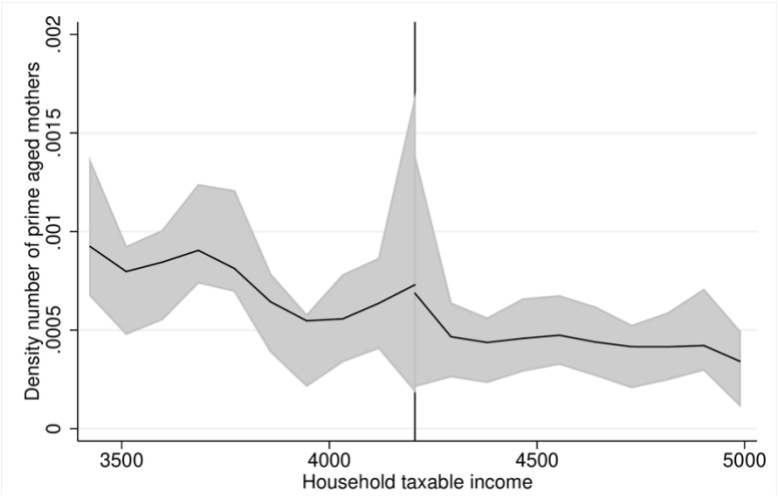
p-value=0.8745

2.0*MSW



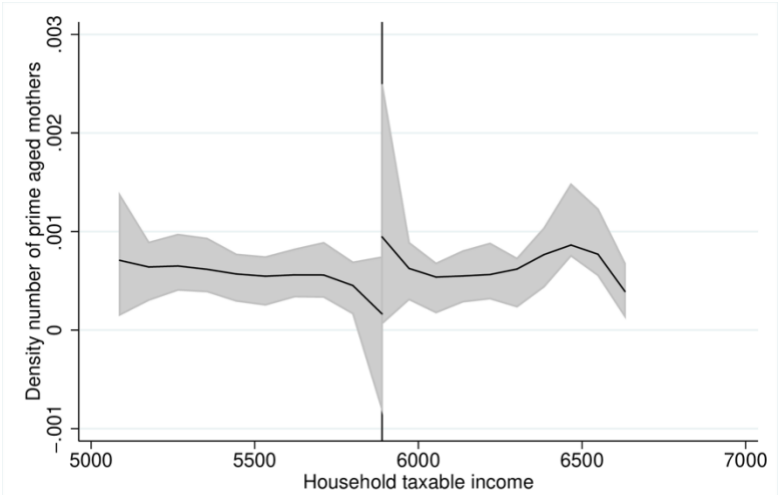
p-value=0.0081

2.5*MSW



p-value= 0.7906

3.5*MSW



p-value=0.0794

estimates at thresholds 2.0*MSW and 3.5*MSW. Lastly, I will formally investigate the internal validity of my set-up by running placebo tests in the traditional sense (where I check for discontinuities in the outcome variable at other values of my forcing variable), and I will further run placebo tests for the year of 2007, two years before the actual policy was introduced. My preferred method to check for effects at fake cut-offs would have been the one suggested by Imbens and Lemieux (2008) who test for discontinuities at the median of the two subsamples on either side of each of the cut-offs, as splitting the groups at their median increases the power of the test to find jumps. However, given the extremely limited number of observations this would yield, I will instead use arbitrarily chosen cut-off values to investigate whether such fake cut-offs exist at taxable income levels of $\pm$ 200 € from the actual threshold. The fact that one of these fake cut-off exhibits a statistically significant discontinuity in the outcome variables (see Table VI.) does cause concern regarding the internal validity of my research design. Table VII. reports estimation results considering fake cut-offs in 2007 (where I assume that the policy was present during that year and base my calculations on the MSW that was applicable at that time) for discontinuities at 2*MSW and 2.5*MSW (arbitrarily chosen) under various functional forms and bandwidths. The fact that none of the fake discontinuities at 2.0*MSW in 2007 is statistically significant mitigates some of my concerns. At the same time, the highly significant discontinuity in part-time employment at 2.5*MSW when using a data driven bandwidth with a local quadratic regression specification might simply reflect the fact that the number of observations is so limited (25 observations) that statistical inference is unreliable.

A further major concern in the setting under investigation relates to the fact that my estimation results might simply reflect that mothers with higher earning partners, or mothers with a greater earnings capacity, have a greater preference to stay at home, causing potential adverse effects in labour market outcomes as we move up the taxable household income distribution. At the same time, at the lower end of the income distribution, I might just be picking up the fact that taxable household income increases as mothers work more hours, or move into full-time employment. If the latter is observed in my estimation results (i.e. if I find a positive jump in the amount of hours worked and a negative jump in part-time employment at low income levels), then clearly the subsidy does not have adverse effects on labour market outcomes. This would mean that the fact that women in treatment groups at the lower end of the income distribution face formal childcare offers at higher prices does not cause them to work less. This would also cast doubt on whether any sort of adverse labour market outcomes at higher card categories are in any way related to the childcare subsidy. I will further address this issue in later sections.

Table VI. Fake cut-offs at ± 200 €

	Discontinuity at 1.5*MSW		Discontinuity at 2.0*MSW		Discontinuity at 2.5*MSW		Discontinuity at 3.5*MSW	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Hours worked	-3.4233	4.5743	-15.875**	-7.226	-.1361	-8.016	1.2695	3.9549
	(12.855)	(8.696)	(8.008)	(6.911)	(6.756)	(9.363)	(15.391)	(15.391)
Part-time employment	.3853	-.2496	.9371***	.3099	.0533	.2924	-.0766	-.039
	(.492)	(.403)	(.311)	(.364)	(.347)	(.446)	(.504)	(.668)
Observations	41/ 76	55/ 52	50/ 52	113/ 103	78/ 62	67/ 67	40/ 43	37/ 28

Notes. The dependent variable is indicated in each row header. Coefficients report bias corrected RD estimates with robust variance estimator. Estimates are calculated using optimal bandwidths based on robust bias-corrected confidence intervals under a local quadratic specification. Odd and even numbered columns consider fake cut-offs to the left of the right of the actual discontinuity (at ± 200 €), respectively. Observations reported in each column relate to hours worked and part-time employment, respectively. Standard errors are in parentheses and clustered at the regional level. * p < 0.10, ** p < 0.05, *** p < 0.01.

Table VII. Fake cut-offs in 2007

	Discontinuity at 2.0*MSW				Discontinuity at 2.5*MSW			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Hours worked	2.7071	.9557	1.2508	-1.3577	3.649	1.3239	4.3395	-19.689
	(3.130)	(3.853)	(5.274)	(6.129)	(5.126)	(6.935)	(7.255)	(13.455)
Part-time employment	-.12445	-.02947	-.09991	-.04621	-.04346	.26148	-.25979	1.2449***
	(.163)	(.183)	(.224)	(.311)	(.205)	(.286)	(.319)	(.326)
Observations	237/ 237	237/ 237	57/ 73	78/ 99	138/ 138	138/ 138	41/ 32	27/ 25

Notes. The dependent variable is indicated in each row header. Coefficients report bias corrected RD estimates with robust variance estimator. Estimates in columns (1), (2), (5) and (6) report results under the full bandwidth for 2007 ($h = 785$). Estimates in columns (3), (4), (7) and (8) are calculated using optimal bandwidths based on robust bias- corrected confidence intervals. Odd and even numbered columns report results for local linear and local quadratic specification, respectively. Observations reported in each column relate to hours worked and part-time employment, respectively. Standard errors are in parentheses and clustered at the regional level. * p < 0.10, ** p < 0.05, *** p < 0.01.

IV. Estimation results

A. *Main results*

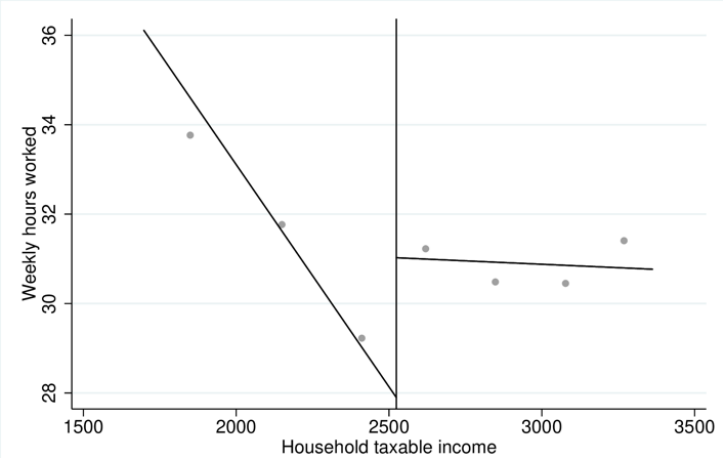
Prior to displaying estimation results for my coefficient of interest ρ, I will provide a graphical representation of the relationship of interest. Figure VI. plots maternal labour market outcomes and household taxable income around the respective cut-offs[10], where dots indicate local sample averages of my outcome variables within bins of taxable household income to illustrate the underlying regression functions of interest. Calonico et al. (2015) suggest that a data driven approach should be used to determine the number of bins, as an ad hoc choice may alter the information conveyed by such RD plots. Given the limited number of observations, the RD plots are thus based on quantile spacing (QS), a method forcing each bin to contain a nearly identical number of observations and thus emphasized by the authors when data is sparse. While visualising the data suggests that there are discontinuities in the relationship of interest at the respective cut-offs, it also becomes apparent that the data points are relatively dispersed. Considering the limited number of observations this suggests that the discontinuities observed in these graphs are extremely sensitive to the few observations around the thresholds. Moreover, the magnitude of the jumps is smallest for the cut-off at 2.0*MSW which employs the largest number of observations, while the jumps are very large at 3.5*MSW which employs the smallest number of observations and a discontinuity in the price of childcare of only 34 € further found to suffer from potential sorting in the McCrary test. Overall, these observations raise the question whether these visual jumps are a reflection of the variability in the data rather than any sort of treatment effect, making the more sophisticated formal regression analysis even more important. I may note that the graphical representations are already indicative of the fact that the discontinuities for both the number of hours worked and part-time employment do change sign at higher income levels. While there appears to be a positive jump in the amount of hours worked and a negative jump in part-time employment at the cut-offs MSW*1.5 and MSW*2.0, the thresholds 2.5*MSW and 3.5*MSW indicate jumps in the opposite directions.

[10] To save space, graphical representation, as well as estimation results for the cut-offs at 2.0*MSW and 3.5*MSW can be found in the Appendices pp. 54-58.

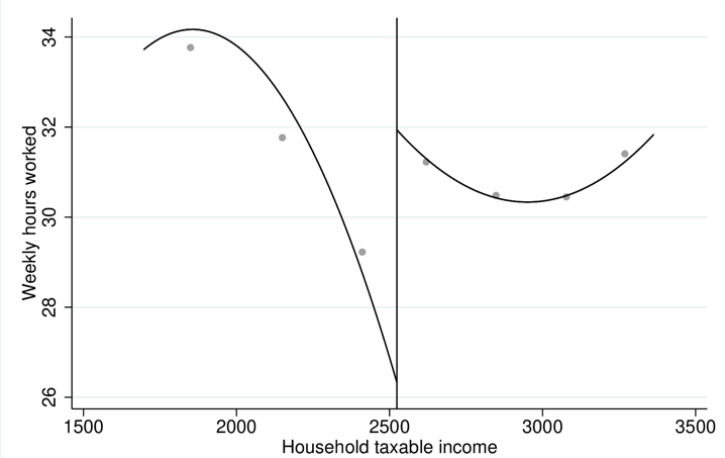
Figure VI. RD plots (Cut-offs at 1.5*MSW and 2.5*MSW)

1.5*MSW

(a) Weekly hours worked (Sample average within bin)

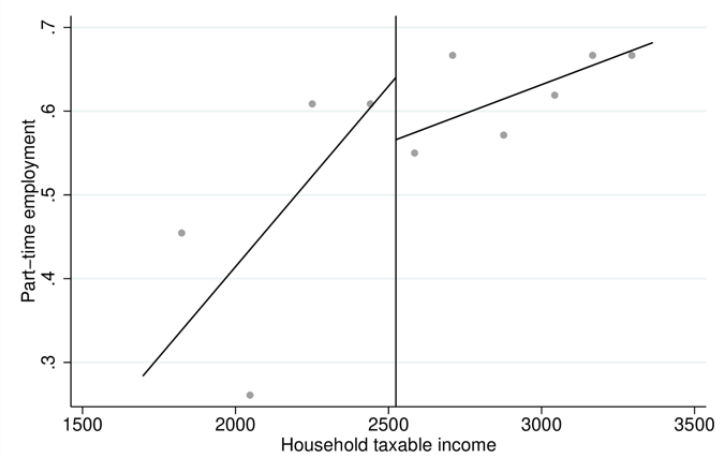


First-order polynomial fit

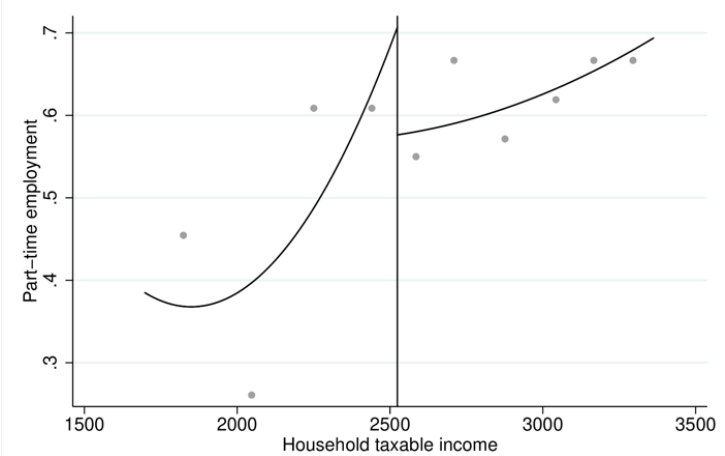


Second-order polynomial fit

(b) Part-time employment (Sample average within bin)



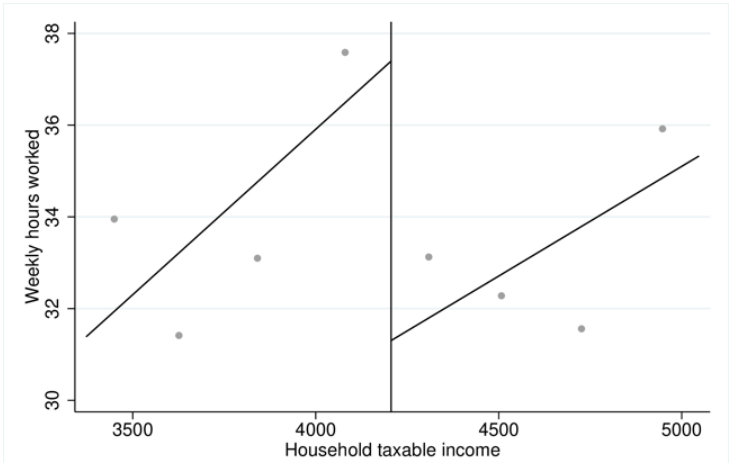
First-order polynomial fit



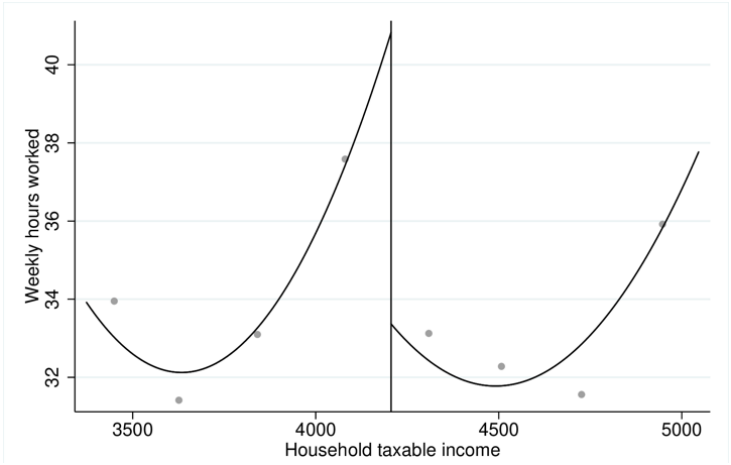
Second-order polynomial fit

2.5*MSW

(a) Weekly hours worked (Sample average within bin)

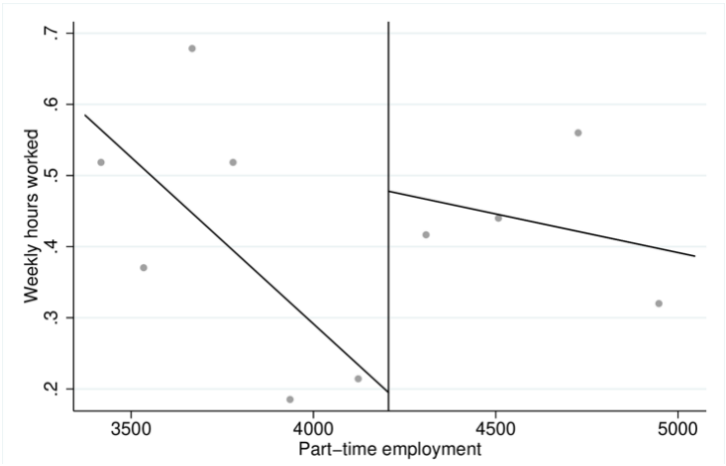


First-order polynomial fit

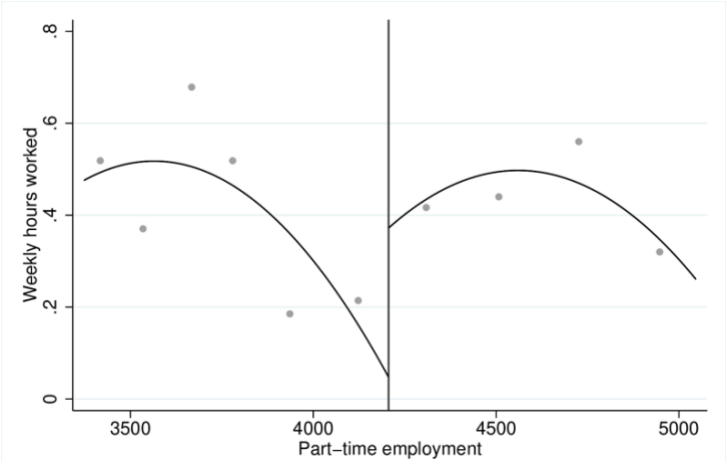


Second-order polynomial fit

(b) Part-time employment (Sample average within bin)



First-order polynomial fit



Second-order polynomial fit

Table VIII. and Table XI. (see Appendices pp. 57-58 Table XVII. and Table XVIII. for cut-offs at 2.0*MSW and 3.5*MSW) display the regression estimates of the coefficient of interest (ρ) at the cut-offs for both outcome variables under various bandwidths. While Table VIII. and Table XVII. present estimation results under the full bandwidth ($h = 841$) and half the full bandwidth ($h = 420$) for local linear and local quadratic regressions, Table XI. and Table XVIII. employ optimal data driven bandwidths[11] under the same functional forms. This approach suggests significantly lower bandwidths ranging between $h = 157$ and $h = 350$ for hours worked and between $h = 195$ and $h = 296$ for part-time employment. The average treatment effect of the cost of childcare for the number of hours worked under the arbitrarily chosen bandwidths ranges between 4.88 and 21.24 hours (1.5*MSW) and between 1.24 and 3.55 hours (2.0*MSW). As such, an increase in the monthly childcare costs of 44 € (or 4.25% of taxable household income) is associated with an increase in the amount of hours worked (for mothers of below 13 year olds with a taxable household income of 2.524,14 €) of between 4.88 and 21.24 hours. At the same time, an increase in the monthly cost of childcare of 44 € (or 3.07% of taxable household income) is associated with an increase in the amount of hours worked (for mothers of below 13 year olds with a taxable household income of 3.365,52 €) of between 1.24 and 3.55 hours. Analogously, increases in the monthly cost of childcare of 78 € (or 1.72% of taxable household income) and 34 € (or 0.47% of taxable household income) are associated with a decrease in the amount of hours worked (for mothers of below 13 year olds with a taxable household income of 4.206,9 € and of 5.889,66 €) of between 6.85 and 9.96 hours and between 5.08 and 13.77 hours, respectively. Under the same interpretation, the estimation results suggest that childcare costs are negatively associated with part-time employment for the lower income categories (mothers are between 10.6 and 74.0 percentage points less likely to work part-time at the lower income categories). For higher income categories, there appears to be a positive association between childcare costs and part-time employment with estimates ranging between 0.227 and 0.844 for the ad-hoc bandwidths. While overall the coefficient estimates appear to be quite sensitive to the choice of bandwidth (apart for the cut-off at 2.5*MSW which yields estimates that are relatively robust across the board), the data driven bandwidths are in line with the wider bandwidths in that they suggest that the positive effect on the number of hours worked is much larger at the lower cut-off (1.5*MSW) compared to the one at the income level (2.0*MSW), while the magnitude of the negative effect

[11] Table XVI. in the Appendices p. 56 provides an overview of these optimal data driven bandwidths for the different cut-offs and regression specifications. Optimal bandwidths are calculated from the covariate-adjusted and robust bias-corrected inference method designed by Calonico et al. (2017).

is not observably different at the higher income levels 2.5*MSW and 3.5*MSW (what magnitude is larger depends on the specification of the functional form). For part-time employment, both the ad hoc and the data driven bandwidths suggest that the positive effect on part-time employment are largest at the highest income cut-off (3.5*MSW), while the negative effects are larger at 2.0*MSW than at 1.5*MSW under the full bandwidth, but become significantly smaller for 2.0*MSW when considering smaller bandwidths. Unsurprisingly, the standard errors of the estimation results are very large under the limited number of observations and statistical significance is concentrated at the cut-offs exhibiting larger magnitudes in the coefficient estimates. In particular, I find statistical significance for both outcome variables at 1.5*MSW when considering bandwidths of 420 € or less; significance at 2.5*MSW for hours worked for all bandwidths when using local linear regression and statistical significance for virtually all estimates at 3.5*MSW. For the cut-off at 2.0*MSW, only the effect on part-time employment with the full bandwidth and a linear regression specification is statistically significant at the 10% level.

Furthermore, it generally emerges that the coefficient estimates are particularly sensitive to the inclusion of controls around the sparsely populated cut-offs (results at 3.5*MSW are especially sensitive to covariate-augmented specifications). This is unsurprising as I would expect covariates to be especially relevant in the present context to eliminate small sample biases and to improve the precision of my estimation results. The fact that the estimation results for the threshold at 2.5*MSW are relatively insensitive to the addition of controls reinforces trust in the fact that there are no confounding discontinuities at that cut-off.

Overall, given the very limited sample size, it is unlikely that these results are effectively recovering the average treatment effect at the respective cut-offs. The very large standard errors, which are increasing as I shrink the observation interval reflect an extremely large variance, casting doubt on the fact that the results are representative. Furthermore, the critical dependency of my results on a particular bandwidth choice casts doubt on the effective magnitude of the ATE. Especially given that the statistical significance of the coefficient of interest appears to be a function of the sample size and the functional form. When increasing the sample size by widening the bandwidth, I may hope to control for selection bias by including covariates. Indeed, the fact that the estimation results do not change substantially when using the full set of controls does suggest that these are not substantially different on either side of the cut-off. However, it remains questionable whether the same can be said about unobservable factors such as preference for work.

Table VIII. RD local regression estimates at 1.5*MSW and 2.5*MSW, ad hoc bandwidth

	Local linear		Local quadratic		Local linear		Local quadratic	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Discontinuity at 1.5*MSW								
Hours worked	6.0456 (4.4703)	4.8785 (3.4956)	7.5284 (4.702)	7.5352* (4.3073)	13.171** (6.2301)	13.231** (5.177)	19.397** (9.1909)	21.242* (7.5483)
Part-time employment	-.1505 (.15603)	-.10615 (.13004)	-.27462 (.17856)	-.28269* (.16288)	-.47737** (.19243)	-.4566* (.23952)	-.68029** (.32419)	-.74023*** (.24067)
Observations	216	214	216	214	106	105	106	105
Discontinuity at 2.5*MSW								
Hours worked	-7.4871* (4.4794)	-7.6521** (3.8116)	-7.143 (4.9527)	-6.8504 (4.5637)	-9.3028* (5.0648)	-8.7614* (4.6059)	-9.5839 (7.2541)	-9.9573 (6.5147)
Part-time employment	.2924 (.22299)	.30206 (.19301)	.22864 (.22554)	.2271 (.21776)	.35105 (.2421)	.34013 (.23855)	.39482 (.33002)	.42699 (.33812)
Observations	263	258	263	258	112	109	112	109
Controls	No	Yes	No	Yes	No	Yes	No	Yes

Notes. The dependent variable is indicated in each row header. Columns (1) – (4) report estimates for the full bandwidth ($h = 841$); columns (5) – (8) report estimates for $h = 420$. Coefficients report bias-corrected RD estimates with robust variance estimator. Columns (1)-(2) and (5)-(6) report results for a local linear specification. Columns (3)-(4) and (7)-(8) report results for a local quadratic specification. Even numbered columns include the full set of controls. Standard errors are in parentheses and clustered at the regional level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.bias-corrected RD estimates with a robust variance estimator.

Table IX. RD local regression estimates at 1.5*MSW and 2.5*MSW, data driven bandwidth

	Local linear		Local quadratic	
	(1)	(2)	(3)	(4)
Discontinuity at 1.5*MSW				
Hours worked	17.541** (7.6314)	17.717*** (6.2298)	22.458** (10.409)	27.289** (10.559)
Part-time employment	-.35413* (.20138)	-.45909** (.17711)	-.76599** (.32781)	-.87059*** (.30966)
Observations	52/ 73	51/ 64	64/ 68	60/ 64
Discontinuity at 2.5*MSW				
Hours worked	-8.8604* (4.9371)	-9.0686** (4.5281)	-9.9945 (6.9349)	-10.27 (7.043)
Part-time employment	.34321 (.2383)	.34569 (.22445)	.41173 (.34345)	.48621 (.36435)
Observations	84/ 80	78/ 78	80/ 73	64/ 70
Controls	No	Yes	No	Yes

Notes. The dependent variable is indicated in each row header. Even numbered columns include full set of controls. Coefficients report bias-corrected RD estimates with robust variance estimator. Columns (1)-(2) report results for a local linear specification. Columns (3)-(4) report results for a local quadratic specification. Even numbered columns include the full set of controls. Observations refer to hours worked and part-time employment, respectively. Standard errors are in parentheses and clustered at the regional level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

B. *Heterogeneity analysis*

To conclude my statistical analysis of the between effects of the service voucher, I will now consider the question of whether the policy exhibits heterogeneous effects for different sub-populations. To establish whether certain mothers benefit relatively more from reduced childcare costs, Table X. compares the number of hours worked at the cut-offs for various populations (see Table XIX. in the Appendices p. 59 for part-time employment). Since the heterogeneity analysis reduces my sample sizes even further, it is not surprising that the estimation results differ extremely under the different bandwidths (some samples, such as the sub-population of single mothers even become so small that calculations are impossible under an optimal bandwidth). As such, I will not go into greater detail about the actual magnitude of the effects. Instead, I will focus on generally emerging patterns that appear to hold under different bandwidth specifications. Given the very limited number of single mothers, as well as mothers with no immigration background, comparisons including these sub-populations are unfortunately impossible. Mothers of pre-school children (aged three years or less) appear to work significantly more at the lower end of the income distribution, while the effects are non-significant, but negative at the two highest cut-offs. At the same time, there are no significant effects for women with children having reached the school entering age, with the estimation signs changing randomly at the respective cut-offs, showing no clear pattern. When considering the number of own children, it appears as if the magnitude of the effects are consistently higher for women with two children compared to women with only one own child at the lower income levels. Meanwhile, the adverse effect for the higher earners appear to be more pronounced for females with two own children.

Table X. Heterogeneity analysis: Weekly hours worked

	Discontinuity at 1.5*MSW		Discontinuity at 2.0*MSW		Discontinuity at 2.5*MSW		Discontinuity at 3.5*MSW	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Living with a partner	9.50**	25.09**	2.81	1.59	-6.42	-10.00	-15.11***	-13.56**
	(4.699)	(11.705)	(5.191)	(6.652)	(5.512)	(7.205)	(4.986)	(6.605)
N	175	51	263	111	242	71	145	52
Single	.228		-9.62		-43.39***			
	(7.164)	.	(8.101)	.	(2.843)	.	.	.
N	41		26		21			
Native	5.76		-30.76***		-7.54			
	(10.774)	.	(9.215)	.	(10.553)	.	.	.
N	33		34		48			
Immigration background	7.23	25.99**	4.94	4.93	-6.01	-9.59	-12.04**	-4.26
	(4.713)	(10.464)	(4.258)	(5.621)	(5.681)	(6.400)	(5.436)	(4.851)
N	183	46	255	108	215	56	83	28
Youngest child <4	15.58**	31.84***	6.86	5.19	-10.53	-10.85	-17.95	
	(6.519)	(6.674)	(4.277)	(4.406)	(6.393)	(11.485)	(11.14)	.
N	103	35	142	57	121	29	77	
Youngest child 4-12	-2.19	12.62	-15.24	-13.21	-3.71	7.38	-9.31	-4.71
	(9.111)	(19.332)	(13.044)	(14.036)	(11.15)	(22.837)	(4.021)	(4.483)
N	113	36	147	44	142	44	73	20
Single own child	8.39	29.01***	-2.32		1.68	-2.54	-10.43	-16.21
	(6.915)	(5.484)	(7.629)	.	(9.309)	(12.812)	(11.736)	(14.63)
N	59	14	103		95	34	69	15
Two own children	10.31	60.16	6.93*	13.88**	-6.88	-11.25	-31.95***	
	(9.894)	(16.059)	(3.852)	(5.911)	(5.254)	(8.353)	(7.912)	.
N	96	20	134	37	131	41	65	
3+ own children	.160	2.82	-6.64	-.814	-25.90***			
	(4.460)	(6.63)	(9.891)	(10.992)	(5.709)	.	.	.
N	61	20	52	23	37			

Notes. The sub-population of interest is indicated in each row header. Coefficients report bias corrected RD estimates with robust variance estimator. Odd numbered columns report estimates using the full bandwidth ($h = 841$) and a local quadratic specification. Even numbered columns report estimates using optimal bandwidths based on robust bias-corrected confidence intervals under a local quadratic specification. Dots indicated where not enough observations for calculations. Standard errors are in parentheses and clustered at the regional level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

V. Conclusion

Using a regression discontinuity-style design, this thesis has investigated the between group effects on maternal labour market outcomes at the intensive margin of a universal, large-scale subsidization scheme launched by the Luxembourgish government in 2009. In particular, the set-up of the policy, which creates random discontinuities in the cost of childcare based on taxable household income is exploited to compare the number of hours worked, as well as outcomes for part-time employment for females aged between 25 and 54 years with one or more children who are less than 13 years old around multiple thresholds. While the estimation results suggest significant effects for certain cut-offs and functional forms, the results are questionable, given their sensitivity to the choice of bandwidth and functional form. The analysis arguably suffers under the limitations of the data, given the absence of any information of the actual use of childcare, as well as the extremely limited number of observations. Furthermore, the identifying assumptions do not appear to hold across all cut-offs, rendering the internal validity of the research design debatable. Overall, considering all these factors, it remains questionable whether the estimation results effectively pick up the policy effects and reflect the treatment effect resulting from differing costs of childcare. Instead, as I have pointed out earlier, the results might reflect adverse effects at the higher cut-offs, which result as mothers with a greater earnings capacity (or with higher earning partners) have a greater preference to stay at home or are more flexible as they can more easily support themselves and their family financially. At the same time, at the lower end of the income distribution, I might pick up on the fact that taxable household income increases as mothers work more hours, or move into full-time employment. The fact that the differences in the cost of childcare are relatively small across the card categories make it is almost certain that for women already employed (i.e. the population we are considering in this analysis), the earnings foregone by working less are higher than the monthly cost of childcare. Considering this fact in addition to the inconsistency of my estimation results leads me to conclude that the subsidy is most likely an irrelevant factor in labour outcomes for women already employed across the different treatment and control groups. While the differences in the cost of childcare might be to minimal to create between group effects, an investigation of within group effects across time would still be informative about the potential effects of the policy for the increase in female labour supply observed over the past years.

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VII. Appendices

Types of childcare facilities

Maisons relais are State run with more flexible opening hours compared to other facilities (7 a.m. to 7 p.m.) They provide childcare services, including supervision, meals, activities, and homework support for children of 3 or 4 up to 12 (up to 18 in some cases).

Crèches can be both State or commercially run and are available for pre-school children (i.e. for children aged between 3 months and 4 years).

Day nurseries (Garderies) can be both State or commercially run and look after children aged between 2 months and 8 years. They are more of an occasional solution for parents looking for day care for their child and the maximum attendance per week is set at 16 hours.

Day centres can be both State or commercially run and look after children aged between 4 and 12 years. They provide childcare support after class hours and during public school holidays. They offer lunch and homework support.

Note. This information is taken from the government of the Grand Duchy of Luxembourg. (2020). *Childcare*. Luxembourg. https://Luxembourg.public.lu/en/living/education/childcare.html

Detailed functioning of the childcare subsidy

Table XI. depicts the tariffs applied by the service vouchers, which are a function of the amount of weekly hours spend in childcare facilities. While the first three hours of childcare are free of charge, the parental contribution amounts to 3 € for hours 4 to 24. By signing a collaboration agreement, private SEA's are entitled to a State contribution, amounting to the difference in the hourly price rate set by the provider and the parents' financial contribution as stated in their CSA adherence. If the child spends more than 25 hours in care, the State's maximum contribution amounts to 7.50 €/ hour and 3.50 €/ hour for SEA's and childminders, respectively. Any exceeding hourly amount charged by private SEA's or childminders is payable in full by the parents. For children at risk of poverty or exclusion, or in receipt of the minimum guaranteed income (RMG), more generous tariffs apply (see Table XII.). Main meals are free of charge for children at risk of poverty or exclusion, or in receipt of the RMG. For all other income groups, the price to be paid for main meals is income dependant, but does not exceed 2 €. The reception of the 4th+ child is completely free of charge. Table XIII. provides an overview of the weekly contributions (max.) payable by parents within the CSA system.

Table XI. Applicable tariffs by hours and facility type

	Number of weekly hours	Maximum contribution/ hour SEA	Maximum contribution/ hour Parental assistant
Free of charge	0-3	-	-
Service voucher rate	4-24	3 €	3 €
Socio-family rate	25-60	7.50 €	3.50 €
Full rate	>60	7.50 €	3.50 €

Source. Mémorial A. (2009)

Table XII. Tariffs applicable for households in receipt of the RMG

	Number of weekly hours	Children at risk of poverty or exclusion	Number of weekly hours	Children from families in receipt of the minimum guaranteed income (RMG)
Free of charge	0 - 15	-	0 - 25	-
Service voucher rate	16 - 60	0.50 €	26 - 60	0.50 €
Socio-family rate	-	-	-	-
Full rate	> 60	7.50 €	> 60	7.50 €

Source. Mémorial A. (2009)

Table XIII. Scale of contributions payable by parents within the voucher system

Card category	Children in the household	Service voucher rate	Socio-family rate	Full rate	Meal Price
Children at risk of poverty or exclusion or in receipt of the minimum guaranteed income (RMG)	1 2 3 4+	0,50 € 0,30 € 0,15 € free	- - - -	7,50 € 7,50 € 7,50 € 7,50 €	free free free free
*Income < 1.5 x MSW**	1 2 3 4+	0,50 € 0,30 € 0,15 € free	0,50 € 0,30 € 0,15 € free	7,50 € 7,50 € 7,50 € 7,50 €	0,50 € 0,50 € 0,50 € 0,50 €
*Income < 2.0 x MSW**	1 2 3 4+	1,00 € 0,70 € 0,35 € free	1,50 € 1,10 € 0,55 € free	7,50 € 7,50 € 7,50 € 7,50 €	1,00 € 1,00 € 1,00 € 1,00 €
*Income < 2.5 x MSW**	1 2 3 4+	1,50 € 1,10 € 0,55 € free	2,50 € 1,80 € 0,90 € free	7,50 € 7,50 € 7,50 € 7,50 €	1,50 € 1,50 € 1,50 € 1,50 €
*Income < 3.0 x MSW**	1 2 3 4+	2,50 €** 1,80 €*** 0.90 €**** free	3,50 € 2,60 € 1,30 € free	7,50 € 7,50 € 7,50 € 7,50 €	2,00 € 2,00 € 2,00 € 2,00 €
*Income < 3.5 x MSW**	1 2 3 4+	2,50 € 1,80 € 0,90 € free	4,50 € 3,30 € 1,65 € free	7,50 € 7,50 € 7,50 € 7,50 €	2,00 € 2,00 € 2,00 € 2,00 €
*Income < 4.0 x MSW**	1 2 3 4+	3,00 € 2,20 € 1,10 € free	5,50 € 4,10 € 2,05 € free	7,50 € 7,50 € 7,50 € 7,50 €	2,00 € 2,00 € 2,00 € 2,00 €
*Income < 4.5 x MSW**	1 2 3 4+	3,00 € 2,20 € 1,10 € free	6,50 € 4,80 € 2,40 € free	7,50 € 7,50 € 7,50 € 7,50 €	2,00 € 2,00 € 2,00 € 2,00 €
*Income =/> 4.5 x MSW**	1 2 3 4+	3,00 € 2,20 € 1,10 € free	7,50 € 5,60 € 2,80 € free	7,50 € 7,50 € 7,50 € 7,50 €	2,00 € 2,00 € 2,00 € 2,00 €
Income not indicated	1 2 3 4+	3,00 € 2,20 € 1,10 € free	7,50 € 5,60 € 2,80 € free	7,50 € 7,50 € 7,50 € 7,50 €	2,00 € 2,00 € 2,00 € 2,00 €

Source. Mémorial A. (2009)

Notes. *Minimum social wage. **2,00 € for parental assistant. ***1,50 € for parental assistant. ****0,75 € for parental assistant. *****Maximum tariffs for parental assistants are not considered.

Additional Tables and Figures

Figure VII. Cost of childcare as % of household income (Two-adult household, 40 hours/week)

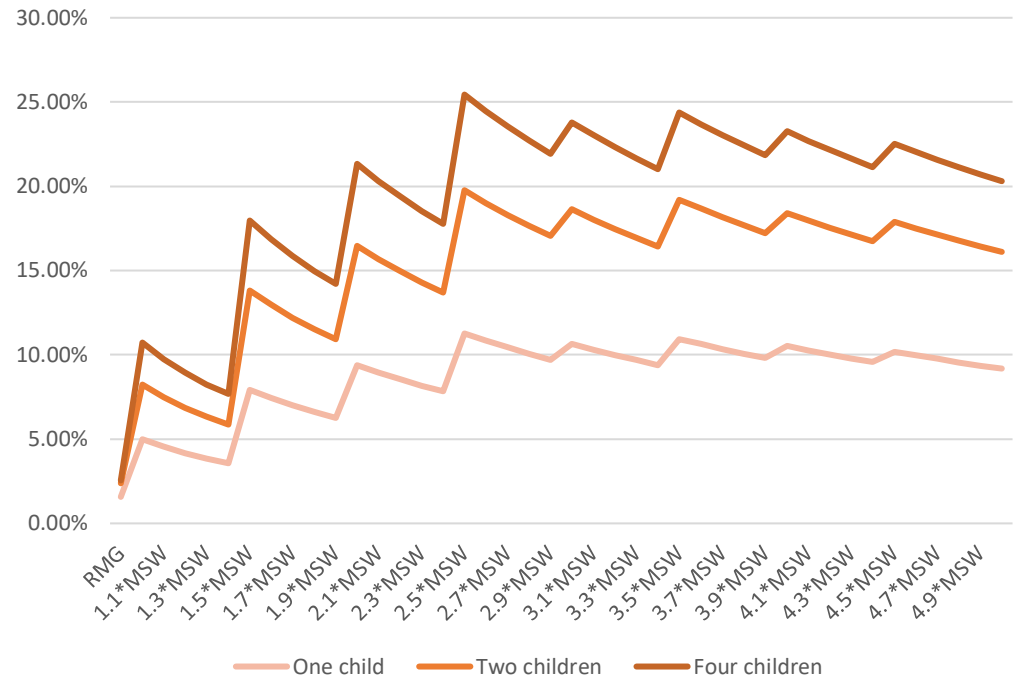


Figure VIII. Cost of childcare as % of household income (Two-adult household, 65 hours/week)

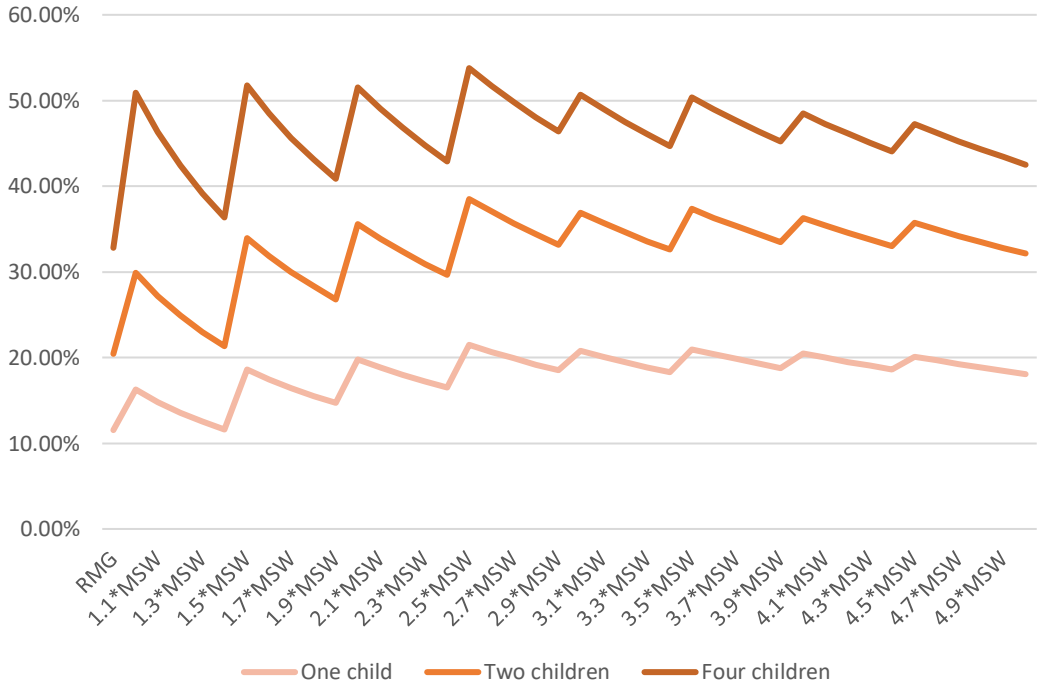


Table XIV. Descriptive statistics (Underlying female population)

Variable	Obs (weighted)	Mean	Std. Dev.	Min	Max
Age	105,782	40.71	7.99	25	54
Living with partner	105,782	0.79	0.41	0	1
Number of own children living in household	105,782	1.29	1.08	0	8
Age of youngest own child living in household	74,235	10.41	7.76	0	36
Immigration background	105,782	0. 64	0.48	0	1
Years since arrived in country	60,821	15.51	10.75	0	54
Years of education	105,262	11.69	4.35	0	21
Years of total work experience	103,761	16.26	8.85	0	43
Public sector, main job	77,049	0.12	0.33	0	1
Part-time employment, main job	76,958	0.43	0.50	0	1
Weekly hours worked, main job	76,924	34.27	11.73	2	99
Gross hourly wage, main job	70,704	22.44	13.70	3.7	241

Note. Person-level weights are used to inflate to the total population of Luxembourg.

Table XV. Descriptive statistics population of interest by income level

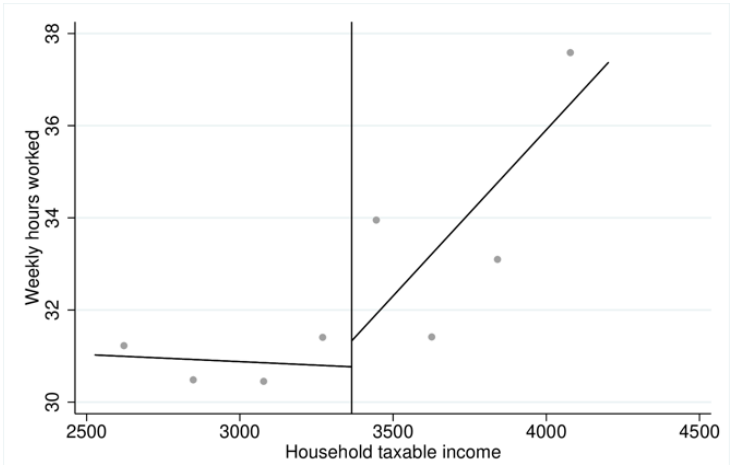
	1.0*MSW-1.5*MSW		1.5*MSW-2.0*MSW		2.0*MSW-2.5*MSW		2.5*MSW-3.5*MSW		>3.5*MSW	
Variable	Observations	Mean	Observations	Mean	Observations	Mean	Observations	Mean	Observations	Mean
Age	5.000	36.12	5.019	35.08	5.230	35.84	7.230	36.95	15.743	38.85
		(6.90)		(6.18)		(6.53)		(5.91)		(5.29)
Living with partner	5.000	.81	5.019	.94	5.230	.98	7.230	0.98	15.743	0.99
		(.39)		(.235)		(.151)		(.128)		(.86)
Number of own children living in household	5.000	2.07	5.019	2.03	5.230	1.69	7.230	1.93	15.743	1.87
		(.80)		(.756)		(.739)		(.771)		(.811)
Age of youngest own child living in household	5.000	5.04	5.019	5.14	5.230	4.72	7.230	5.24	15.743	5.42
		(4.38)		(3.84)		(3.85)		(3.76)		(3.88)
Immigrant	5.000	.77	5.019	.83	5.230	.86	7.230	.70	15.743	.58
		(.421)		(.380)		(.348)		(.457)		(.495)
Years of education	5.000	8.97	5.019	8.96	5.153	10.93	7.219	11.75	15.739	14.43
		(3.41)		(3.88)		(4.30)		(3.69)		(3.40)
Years of total work experience	4.673	13.54	4.950	12.74	5.153	13.34	7.199	14.07	15.684	15.19
		(7.32)		(6.71)		(6.29)		(7.35)		(6.29)
Employment	5.000	.66	5.019	.66	5.230	.81	7.230	0.71	15.742	0.84
		(.477)		(.476)		(.393)		(.457)		(.364)
Part-time employment, main job	3.137	.43	3.237	.72	4.194	.41	5.027	0.43	12.862	0.60
		(.498)		(.452)		(.494)		(.497)		(.491)
Weekly hours worked, main job	3.137	34.29	3.237	28.57	4.194	33.82	5.027	33.21	12.862	31.75
		(13.42)		(10.55)		(10.45)		(10.01)		(10.82)
Gross hourly wage, main job	2.887	13.44	2.958	12.00	3.888	14.92	4.693	18.86	12.126	31.32
		(4.94)		(3.82)		(7.35)		(11.16)		(16.59)

Notes. Person-level weights are used to inflate to the total population of Luxembourg. Standard deviation is in parenthesis.

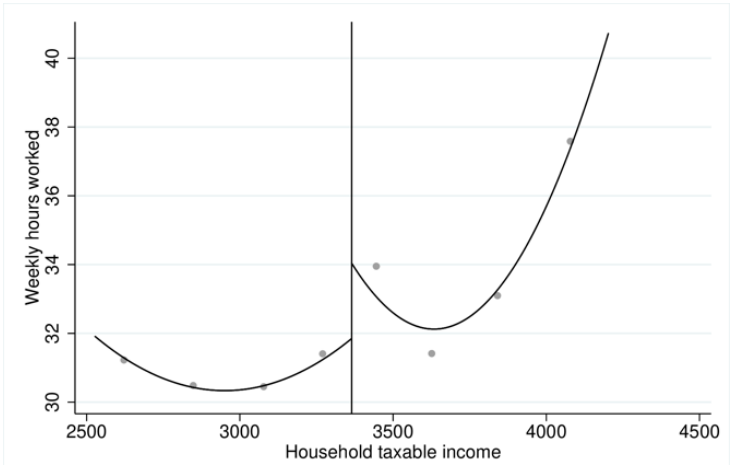
Figure XIV. RD plots (Cut-offs at 2.0*MSW and 3.5*MSW)

2.0*MSW

(a) Weekly hours worked (Sample average within bin)

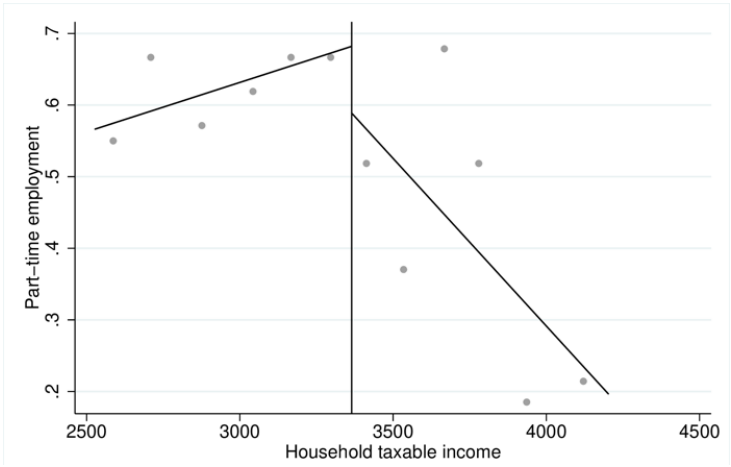


First-order polynomial fit

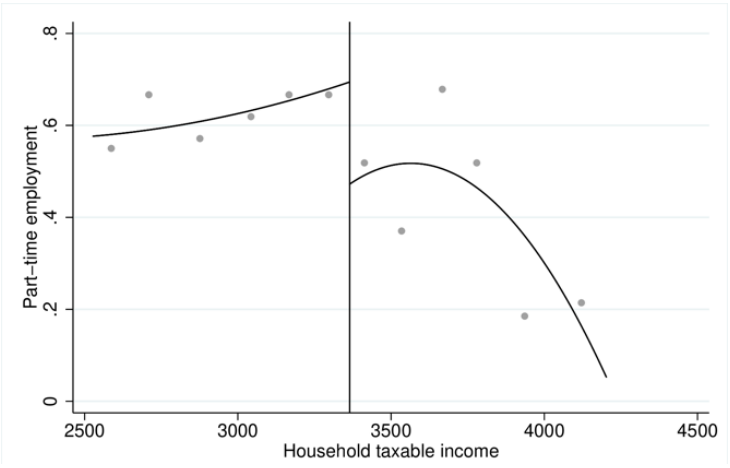


Second-order polynomial fit

(b) Part-time employment (Sample average within bin)



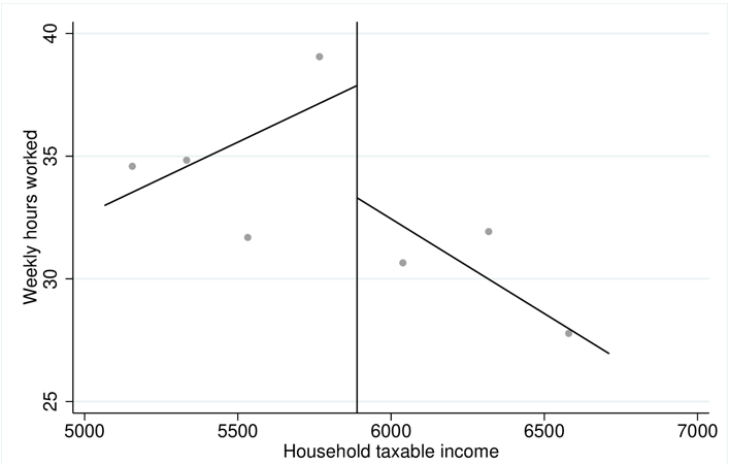
First-order polynomial fit



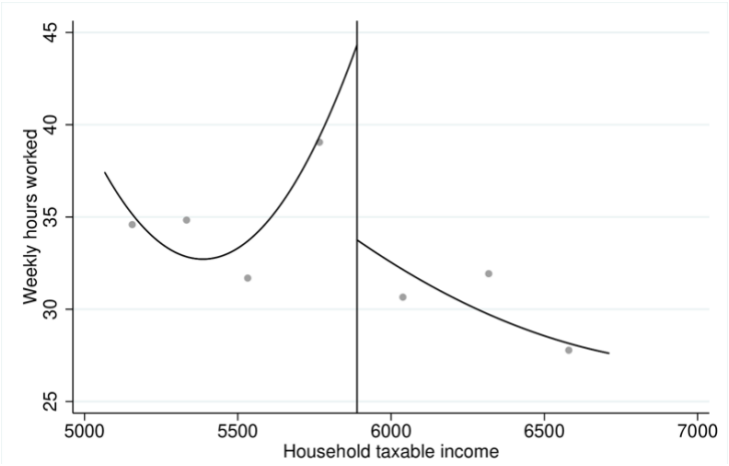
Second-order polynomial fit

3.5*MSW

(a) Weekly hours worked (Sample average within bin)

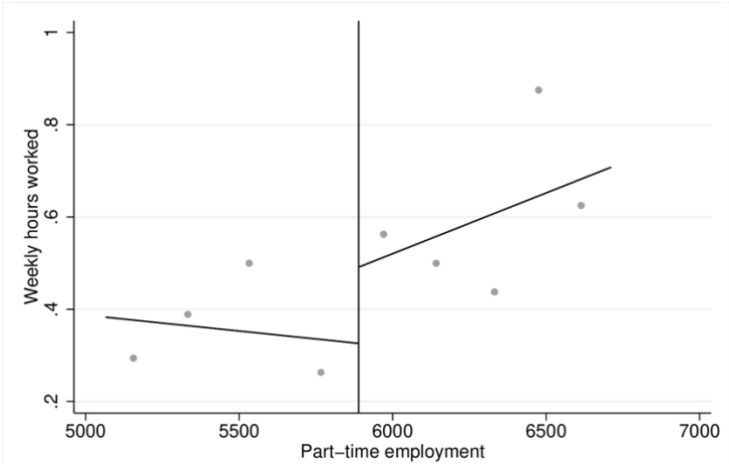


First-order polynomial fit

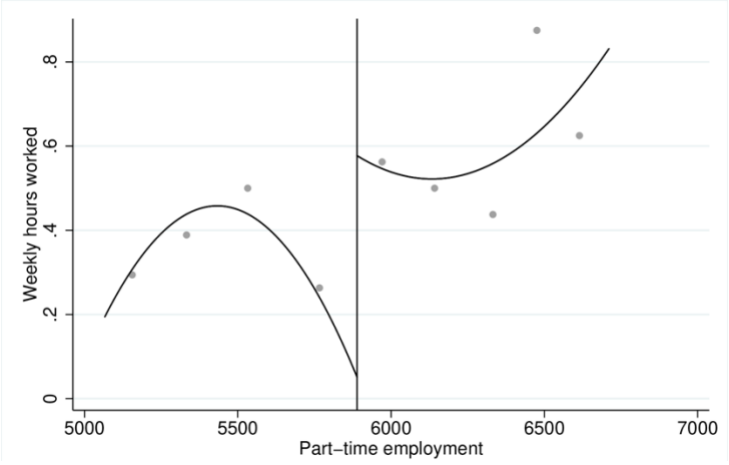


Second-order polynomial fit

(b) Part-time employment (Sample average within bin)



First-order polynomial fit



Second-order polynomial fi

Table XVI. Output from optimal bandwidth selection

	Local linear regression		Local quadratic regression	
	(1)	(2)	(3)	(4)
Discontinuity at 1.5*MSW				
Hours worked	171.573	178.589	216.638	200.853
Part-time employment	273.157	225.254	229.738	222.363
Discontinuity at 2.0*MSW				
Hours worked	182.835	173.307	298.798	275.668
Part-time employment	221.140	266.705	308.408	280.722
Discontinuity at 2.5*MSW				
Hours worked	312.186	280.628	350.332	315.588
Part-time employment	296.713	294.836	266.401	232.767
Discontinuity at 3.5*MSW				
Hours worked	217.508	157.999	318.505	257.240
Part-time employment	257.847	195.663	255.529	244.970
Controls	No	Yes	No	Yes

Notes. The dependent variable is indicated in each row header. The CER-optimal bandwidth selector (*cerrd*) (see Calonico et al., 2017) for robust bias-corrected inference using clustering with plug-in residuals at regional level is used. Columns (1)-(2) report optimal bandwidth under a local linear specification. Columns (3)-(4) report optimal bandwidths under a local quadratic specification. Even numbered columns include full set of controls.

Table XVII. RD local regression estimates at 2.0*MSW and 3.5*MSW, ad hoc bandwidth

	Local linear		Local quadratic		Local linear		Local quadratic	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Discontinuity at 2.0*MSW								
Hours worked	3.1877 (3.5281)	3.549 (3.782)	2.6745 (4.9912)	2.9375 (5.0883)	1.2585 (5.0312)	1.5321 (5.0989)	2.182 (6.5155)	2.2767 (6.1359)
Part-time employment	-.30282* (.18188)	-.34455* (.20227)	-.27358 (.23832)	-.31957 (.25742)	-.12092 (.22499)	-.22272 (.23316)	-.11339 (.24322)	-.19344 (.24313)
Observations	289	285	289	285	172	170	172	170
Discontinuity at 3.5*MSW								
Hours worked	-12.184*** (4.0589)	-8.1668*** (2.8907)	-13.765*** (5.0668)	-7.6996** (3.8556)	-10.477** (4.1762)	-6.719 (4.1251)	-12.851** (5.0232)	-5.0835 (3.9235)
Part-time employment	.66281*** (.25216)	.5259*** (.18962)	.81689** (.34377)	.60877** (.27313)	.68139** (.33625)	.48765** (.23839)	.84397** (.33208)	.49382** (.19594)
Observations	150	150	150	150	70	70	70	70
Controls	No	Yes	No	Yes	No	Yes	No	Yes

Notes. The dependent variable is indicated in each row header. Columns (1) – (4) report estimates for the full bandwidth ($h = 841$); columns (5) – (8) report estimates for $h = 420$. Coefficients report bias-corrected RD estimates with robust variance estimator. Columns (1)-(2) and (5)-(6) report results for a local linear specification. Columns (3)-(4) and (7)-(8) report results for a local quadratic specification. Even numbered columns include full set of controls. Standard errors are in parentheses and clustered at the regional level. * p < 0.10, ** p < 0.05, *** p < 0.01.bias-corrected RD estimates with a robust variance estimator.

Table XVIII. RD local regression estimates at 2.0*MSW and 3.5*MSW, data driven bandwidth

	Local linear		Local quadratic	
	(1)	(2)	(3)	(4)
Discontinuity at 2.0*MSW				
Hours worked	1.2397 (6.2957)	.6796 (6.5098)	1.3942 (6.4349)	1.0492 (6.35)
Part-time employment	-.07748 (.23343)	-.25106 (.24239)	-.07401 (.24821)	-.1678 (.24825)
Observations	70/ 85	66/ 105	118/ 119	109/ 109
Discontinuity at 3.5*MSW				
Hours worked	-12.567** (5.0934)	-8.1463* (4.2275)	.-12.644** (6.2441)	-5.2871 (3.9697)
Part-time employment	.7364** (.32974)	.76871*** (.16775)	.84382** (.33695)	.5502** (.22758)
Observations	35/ 41	25/ 30	53/ 41	41/ 39
Controls	No	Yes	No	Yes

Notes. The dependent variable is indicated in each row header. Even numbered columns include full set of controls. Coefficients report bias-corrected RD estimates with robust variance estimator. Columns (1)-(2) report results for a local linear specification. Columns (3)-(4) report results for a local quadratic specification. Even numbered columns include full set of controls. Observations refer to hours worked and part-time employment, respectively. Standard errors are in parentheses and clustered at the regional level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table XIX. Heterogeneity analysis: Part-time employment

	Discontinuity at 1.5*MSW		Discontinuity at 2.0*MSW		Discontinuity at 2.5*MSW		Discontinuity at 3.5*MSW	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Living with a partner	-.360**	-.827***	-.293	-.082	.192	.438	.932***	.924***
	(.160)	(.258)	(.236)	(.251)	(.251)	(.354)	(.349)	(.341)
N	175	57	263	111	242	61	145	40
Single	.014		.541					
	(.606)	.	(.612)	.	.	.	.	.
N	41		26					
Native	-.316				.668			
	(.756)	.	.	.	(.389)	.	.	.
N	33				48			
Immigration background	-.258	-.877***	-.346**	-.241	.107	.365	.582	.221
	(.180)	(.280)	(.170)	(.198)	(.312)	(.385)	(.407)	(.355)
N	183	51	255	100	215	62	85	38
Youngest child <4	-.636**		-.360	-.213	.331	.710	.786	
	(.261)	.	(.233)	(.274)	(.342)	(.461)	(.426)	.
N	103		142	57	121	33	77	
Youngest child 4-12	.109	-.439	-0.91	-.173	.092	.123	.758**	.583
	(.330)	(.754)	(.622)	(.828)	(.335)	(.460)	(.370)	(.366)
N	113	36	147	63	142	53	73	23
Single own child	-.396		-.462	.847	-.277	-209	.524	.486
	(.313)	.	(.419)	(.958)	(.392)	(.624)	(.521)	(.704)
N	59		103	26	95	33	69	14
Two own children	-.356	-.901*	-.354*	-.566**	.519*	.936*	.	.
	(.360)	(.492)	(.184)	(.238)	(.288)	(.539)		
N	59	30	134	42	131	33		
3+ own children	.135	-.300	.113					
	(.192)	(.281)	(.388)	.	.	.	.	.
N	61	20	52					

Notes. The sub-population of interest is indicated in each row header. Coefficients report bias corrected RD estimates with robust variance estimator. Odd numbered columns report estimates using the full bandwidth ($h = 841$) and a local quadratic specification. Even numbered columns report estimates using optimal bandwidths based on robust bias-corrected confidence intervals under a local quadratic specification. Dots indicated where not enough observations for calculations. Standard errors are in parentheses and clustered at the regional level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.