**ORIGINAL RESEARCH**

# An Empirical Assessment of the Drivers of Formal and Informal Childcare Demand in European Countries

**Laurène Thil[1]** · **Laté A. Lawson[2]** · **Mathieu Lefebvre[3]**

## Abstract

How does the mother's labour supply affect the household's demand for childcare? And thus are formal and informal childcare substitutable? In this paper, we address these two questions using micro-data for 14 European countries observed over the period between 2010 and 2017. Relying on a Control Function Approach to account for the endogeneity between childcare and the mothers' labour supply, we identify different factors affecting the demand for formal and informal childcare. The results show that the mother's labour supply is a key element in understanding the demand for childcare and suggest that the more the mother participates in the labour market, the higher the household's demand for childcare services. Moreover, our results support the substitutability hypothesis between formal and informal childcare. Policymakers aiming to promote mothers' employment should increase the availability of formal childcare services, as this will increase labour supply by mothers and reduce the use of informal care arrangements.

✉ Laurène Thil
laurene.thil@kuleuven.be

Laté A. Lawson
late-lawson@gmx.de

Mathieu Lefebvre
mathieu-julien.lefebvre@univ-amu.fr

[1] HIVA & KU Leuven, Leuven, Belgium

[2] BETA, University of Strasbourg, Strasbourg, France

[3] Aix Marseille University, CNRS, AMSE, Marseille, France

## 1 Introduction

The demand for childcare varies in terms of childcare hours, childcare subsidies and type of childcare. Indeed, childcare can be informal, i.e. given by family members or neighbours, or formal in public or private institutions. Understanding the determinants of childcare choices are of the greatest interest from a public policy perspective. First, family-oriented programs such as the provision of subsidised formal childcare services have been shown to be efficient in facilitating female employment and reducing employment gender gaps (Olivetti & Petrongolo, 2017). Second, providing high-quality childcare services is important from a developmental perspective as early childhood programs impact future educational success of children (Adams & Rohacek, 2002).

One important question is the interconnection between childcare services use and labour supply of parents (Heckman, 1974; Blau & Robins, 1988, 1989). In this paper we specifically look at the effect of formal and informal childcare services use and labour supply of mothers. To do so, we estimate the effect of several potential determinants of childcare demand using data for 14 European countries from the European Survey on Income and Living Conditions (EU-SILC). We focus on mothers since they are usually the primary caregiver and because results from previous studies have shown how childcare is important to understand female labour supply. We rely on a Control Function Approach (CFA) to account for the reverse causality (endogeneity) between the hours of childcare and labour supply and identify the role of several factors that explain the choice of childcare. Finally, we distinguish between formal and informal care and look at the possible complementarity/substitution between both types of childcare.

The drivers of childcare decisions are numerous and, given the variety of childcare options in most countries, the type of childcare used by a family is the result of a decision process that involves individual, household and policy characteristics. A large body of literature in economics and social sciences has identified several determinants of the demand for childcare at three different levels: individual, household and institutional levels.

First, at the individual level, the choice of a specific type of care may reflect a broader social and cultural context as well as parental values and occupations (Kuhlthau & Mason, 1996; Meyers & Jordan, 2006; Kim & Fram, 2009). In particular, the level of parents' education, and especially the one of the mother, has been shown to affect the type of childcare arrangements.[1] An important driver of choice is the maternal employment (Powell, 2002; Coneus et al., 2008; Carlin et al., 2019; Ravazzini, 2018). Mothers working full-time are more likely to select centre/formal care (Connelly & Kimmel, 2003)[2]. On the contrary, mothers with irregular or non-standard work hours are more likely to select informal care and other types of home-based care (Davis & Connelly, 2005; Morrissey, 2008). However, decisions about employment and childcare use are often made jointly. While some parents make childcare decisions according to their work schedules, some might arrange their work

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[1] Interestingly, educated parents are more likely to use institutionalized types of care which offer a school-like setting (Kim & Fram, 2009; Coley et al., 2014; Carlin et al., 2019). This may be "a product of cultural norms about socialization, cognitive stimulation, and the importance of preparing even very young children for later academic success" (Johansen et al., 1996). This might also be linked to income or potential wages on the labour market that allow educated women and in general educated parents to pay for this type of care.

[2] In their paper (Connelly & Kimmel, 2003) use an ordered probit model to study the importance of child care costs on the choice among three employment states and a multinominal logit estimation strategy to investigate the role that child care expenditures have on the type of child care chosen.

around their childcare facilities.[3] This raises the question of endogeneity in estimating the effect of employment (working hours) on childcare use (see e.g. Blau and Hagy (1998) using OLS, Powell (2002) using instrumental variables approach, Coneus et al. (2008) using both a mixed logit and universal logit choice model).

Second, at the household level, the composition and the marital status are important. Single parents may rely more on formal care as they cannot depend on a partner's financial support to stop working to care for their children (Blau & Hagy, 1998; Coley et al., 2014; Krapf, 2014). Having a greater number of children is related to higher rates of informal care, likely due to the higher costs of formal settings for multiple children (Banfi et al., 2009; Coley et al., 2014; Carlin et al., 2019). Aside from the number of children, the age of the child is very strongly associated with the type of childcare parents use. Informal and home-based care arrangements are used more often for infants and toddlers, and formal centre-based care are used more often during the preschool years starting around age 3 (Lehrer, 1983; Leibowitz et al., 1988; Kim & Fram, 2009). Low-income families tend to rely more on informal child care (Li-Grining & Coley, 2006) and as family income increases, parents use more expensive types of care, such as formal centre-based care (Banfi et al., 2009; Coley et al., 2014). The presence of grandparents in the household, and especially of grandmothers, increases the probability of the mother to work and is predictive of higher use of informal care, especially for low-income families (Davis & Connelly, 2005; Del Boca et al., 2005; Du & Dong, 2010). Childcare options are also likely to vary based on geographic region and urban city. Given the limited formal child care options available to rural families, rural families are far more likely to use informal care by relatives than urban families and households in more densely populated areas (Coneus et al., 2008; Banfi et al., 2009; Carlin et al., 2019).

Finally the institutional characteristics and the availability of different types of care explain also families' selection of childcare (Chevalier & Viitanen, 2004; Davis & Connelly, 2005; Coley et al., 2014). Public spending on childcare varies a lot across countries, and so does the distribution between public and private facilities. The criteria to receive subsidies as well as their amount also differ across countries or regions OECD (2020). Public formal centre-based facilities often have a limited number of places available so that even if the family can afford formal types of care, they often face long waiting lists and must look for other alternatives. The costs of childcare also influence the types of care chosen, especially for low-income families and single mothers who prefer cheaper informal care (Banfi et al., 2009; Connelly & Kimmel, 2010). Besides cost and availability, quality is another important aspect of childcare that also matters (Banfi et al., 2009; Morrissey, 2008; Del Boca, 2015).

Given these evidence, the contribution of our work is fourfold. First, we address the existing reverse causality between the labour supply of mothers and childcare services use, since both childcare and labour supply decisions simultaneously occur. Other authors already discussed this issue ( Connelly and Kimmel (2003) and Coneus et al. (2008)) and reported overestimated parameters when the endogeneity issues are not properly addressed. We address this issue by using the regional unemployment rate as an instrumental variable for mothers' labour supply. Second, another methodological contribution is the use of

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[3] Empirical results are mixed. Some studies suggest that the availability of formal childcare services near the household increases the probability of women's labour force participation (Del Boca et al., 2005; Du & Dong, 2013), and formal childcare costs usually negatively affect the labour force participation of mothers of young children (Blau & Hagy, 1998; Wrohlich, 2004; Du & Dong, 2013).

count data models. Indeed, these models allow us to account for the fact that the variable giving the number of hours of childcare is strongly right-skewed, meaning that the variable has a huge number of zero. Third, contrary to most existing studies, we consider both the types (formal and informal) and the intensity of childcare use for 14 European countries to estimate the determinants of childcare. Finally, we assess the potential complementarity (substitutability) between formal and informal childcare. The results of our analysis help draw a portrait of the determinants of childcare use in European countries. Anticipating our results, we find that the labour supply of the mothers, whether single or living with a partner, is a key element in understanding childcare use, and we identify diverging factors driving formal and informal care use. In particular, the age of children has a different impact on formal and informal care, which increases when the partner works. Finally, our results confirm the existence of a substitution effect between formal and informal childcare.

The remainder of this paper is organized as follows. Section 2 presents the data and descriptive statistics. The empirical strategy is detailed in Sect. 3. Our main results follow in Sect. 4. Section 5 presents some heterogeneity analysis and robustness checks and Sect. 6 draws conclusions.

## 2 Data and Descriptive Statistics

To assess the determinants of the demand for formal and informal childcare services use across European countries, we use data from the (EU-SILC Microdata). It is a cross-sectional and longitudinal sample survey, coordinated by the statistical office of the European Union (Eurostat) and based on data from the European Union member States. Our final dataset includes 14 European countries and provides comparable cross-sectional and multidimensional household-level data on income, social exclusion and individuals' living conditions.[4] The selection of these countries is based on the availability of the different databases used in this paper, namely EU-SILC and the regional unemployment rates from Eurostat between 2010 and 2017. We pooled cross-sectional data from the period between 2010 and 2017. Among all households, we focus on women with at least one child under 10 years old and obtain a sample of 188 669 mothers over the period between 2010 and 2017. We select this age threshold as it includes pre-school children as well as children who most likely need and attend centre-based childcare services at school.

### 2.1 The Demand for Childcare

The demand for childcare services is measured by the weekly hours of childcare reported by households. The EU-SILC data distinguishes 4 types of childcare: i) childcare at centre-based services, ii) at day-care centres, iii) childcare by a professional child-minder and iv) childcare by grandparents, relatives, friends or neighbours. Centre-based services are used by children *outside school hours*. The services can be organized or not at the school place. Day-care centres include all kinds of care organised or controlled by a structure (public or private). This means that there are no direct arrangements between the carer and

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[4] The countries are Austria (AT), Belgium (BE), Bulgaria (BU), Czech Republic (CZ), Greece (EL), Spain (ES), Finland (FI), France (FR), Hungary (HU), Italy (IT), Poland (PL), Romania (RO), Sweden (SE) and United Kingdom (UK).

**Table 1** Early childhood education (ECE) settings

| | Earliest starting age of ECE programmes (2015) | Usual starting age of ECE (2015) | Ages at which children have free access entitlement (2018) | Number of hours per week with free access to ECE entitlement to ECE (2018) |
|---|---|---|---|---|
| AT | 3 | 3 | 5 | 20 |
| BE | 2,5 to 3 | 3 | 2,5 to 5 | 23 |
| BG | n.a. | n.a. | 5 | n.a. |
| CZ | 3 | 3 | 3 to 5 | 45 |
| EL | 4 | 4 | 4 to 5 | 50 |
| ES | 0 | 2 to 3 | 3 to 5 | 25 |
| FI | 0 | 1 | 6 | 20 |
| FR | 2 | 2 to 3 | 3 to 5 | 24 |
| HU | 3 | 3 | 3 to 5 | 20 |
| IT | n.a. | n.a. | 3 to 5 | 37 |
| PL | 3 | 3 | 3 to 6 | 25 |
| RO | n.a. | n.a. | n.a. | n.a. |
| SE | 1 | 1 to 2 | 3 to 5 | 15 |
| UK | 0 | 3 | 3 to 4 | 20 |

OECD 'Education at a Glance 2020' and 'Education at a Glance 2017' and the 13th International Review of Leave Policies and Related Research 2017

the parents[5]. When childcare is delivered by a professional child-minder, there are direct arrangements between the carer and the parents. The care can be at the child's home or at the childminder's home. These three types of childcare are considered formal care in this study[6]. The last type of care refers to informal care, which is (likely) unpaid. Thus, we categorise childcare as informal when it is provided by grandparents, relatives, friends or neighbours. Otherwise, it is considered as formal.

When looking at the demand for childcare, it is also important to recall that early childhood education (ECE) programs vary across countries. The later the children enter the education system, the longer they will need childcare. The number of hours per week dedicated to ECE programs also matters and big differences can be observed among countries. Table 1 presents some comparative figures about the ECE settings in Europe. The earliest

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[5] According to EU-SILC definition, these kinds of care are often delivered within the social welfare system, especially for children under 3, but it should be noted that the way childcare facilities are founded varies a lot across countries. In some countries, such as in the UK, the childcare system relies a lot on the private sector. In other countries, like in the Nordic countries or in France, public childcare facilities are more common. Some subsidies can also be available for parents, especially for those belonging to vulnerable groups such as single parents or low income-households.

[6] This classification uses the definition by the OECD about formal and informal care.

starting age of ECE programs can be found in Spain, Finland and in the United Kingdom where children can in theory start ECE programs within their first year of age. On average, the earliest starting is around 3 years old. This corresponds to Austria, Belgium, Czechia, Hungary and Poland. The usual starting age of ECE differs in particular for those countries which offer ECE programs within the first year of age. In reality, most children attend their first ECE programs at around 3 years old in nearly all selected countries. In Greece, the starting age is at 4 years old, whereas children in Finland and in Sweden start following ECE programs at 1 year old. Another interesting indicator to consider is the age at which children have free access entitlement to ECE. In our sample of countries, children have, on average, free access entitlement to ECE between 3 and 5 years old. Finally, the number of hours per week with free access entitlement to ECE also plays an important role on the number of hours needed for childcare. Three countries offer a particularly high number of hours per week: Italy (37 hours), Czechia (45 hours) and Greece (50 hours). The lowest number of hours is observed in Sweden, with 15 hours per week. For the other countries, the number of hours varies between 20 and 25.

In Table 2, we present details of formal and informal childcare settings in Europe in 2017. Regarding formal childcare, huge differences can be observed across countries for children aged less than 3 years old: from 6,8% in Czechia to 58,8% in Belgium. Five Eastern European countries have a share of less than 20% (Czechia (6,8%), Poland (10,1%), Romania (15%), Hungary (15,6%) and Bulgaria (19,9%). The highest shares are observed in Sweden (52,7%), France (53,4%), Spain (54,9%) and Belgium (58,8%). For children aged between 3 years old and the minimum compulsory school age, the majority of children have a share of children attending formal childcare and education above 90%. The share is especially lower in the United Kingdom (44,5%) and Poland (61,3%). Regarding informal childcare, the share for children aged 0 to 2 is the lowest in Nordic countries (Sweden (2,2%) and Finland (3,8%). Other countries are close to or above 50% like in Romania (50,4%) and Greece (51,2%). For older children aged between 3 years old and the minimum compulsory school age, the share is on average higher than for younger ones. The share is the lowest in Nordic countries (Sweden (0,8%) and Finland (2,1%) but also in Spain (5%). Some eastern European countries on the contrary are close to or above 50% like in Poland (48,3%), Czechia (49,5%) or in Romania (59,8%). Greece also has one the highest share (56%). The last two columns of Table 2 represent the share of children cared only by their parents, for two age categories (0 to 2 and 3 to the minimum compulsory school age). Younger children are more often only cared by their parents. The lowest share is observed in Belgium (37,2%) and the highest in Bulgaria (80,5%). These huge differences may reflect the variety of maternity, paternity and parental leaves schemes available across countries. Older children are more often involved in formal childcare and education programmes and their share cared only by their parents is thus lower. However, some countries still have relatively high shares, such as in the United Kingdom (20%), Bulgaria (20,2%) and in Poland (21,5%).

In our regression analysis below, the dependent variable will be the count of weekly hours of childcare. It will have consequences for our empirical strategy presented in Section 3. Contrary to previous studies that often rely on dummy variables, the counts of weekly hours stand for the effective formal and informal childcare participation and further provide hints on the intensity of childcare participation and its composition (formal versus informal). Figure 1 shows the different components of the total hours of childcare use as reported in our sample. Figure 1 indicates that there is a high heterogeneity among European countries in terms of childcare service use. The highest level of childcare services use is observed in Finland, Romania, and Bulgaria, whereas the lowest rates are observed in

**Table 2** Formal and informal childcare settings in Europe in 2017

| | Children in formal childcare or education (% of children aged 0 - 2 yo) | Children in formal childcare or education (% of children aged 3 - min compulsory school age) | Children in informal childcare (% of children aged 0 - 2 yo) | Children in informal childcare (% of children aged 3 - min compulsory school age) | Children cared only by their parents (% of children aged 0 - 2 yo) | Children cared only by their parents (% of children aged 3 - min compulsory school age) |
|---|---|---|---|---|---|---|
| AT | 21,9 | 88,3 | 33,6 | 47 | 57,9 | 7,1 |
| BE | 58,8 | 99,3 | 21,5 | 24,5 | 37,2 | 0,5 |
| BG | 19,9 | 88,5 | 10,6 | 17,7 | 80,5 | 20,2 |
| CZ | 6,8 | 79,4 | 38,6 | 49,5 | 57,8 | 11,3 |
| EL | 25,7 | 94,1 | 51,2 | 56 | 38,7 | 7,3 |
| ES | 54,9 | 98,3 | 13,6 | 5 | 43,3 | 4 |
| FI | 37,7 | 88,2 | 3,8 | 2,1 | 63 | 12,6 |
| FR | 53,4 | 95,5 | 25,9 | 21,2 | 38,9 | 3,8 |
| HU | 15,6 | 91,4 | 34,6 | 42,3 | 57 | 5,2 |
| IT | 30,8 | 93,2 | 34 | 29,1 | 49,2 | 9,7 |
| PL | 10,1 | 61,3 | 44,8 | 48,3 | 48 | 21,5 |
| RO | 15 | 74,8 | 50,4 | 59,8 | 41 | 12,8 |
| SE | 52,7 | 96,5 | 2,2 | 0,8 | 45,1 | 2,4 |
| UK | 28 | 44,5 | 39,9 | 43,7 | 41,4 | 20 |

In Eurostat's classification, contrary to the one from the OECD (and thus our classification), childcare by a professional child-minder at child's home or at child-minders's home is not considered as formal childcare.

*Source:* Eurostat database: ILC_CAINDFORMAL; ILC_CAINDOTHER; ILC_CAPARENTS
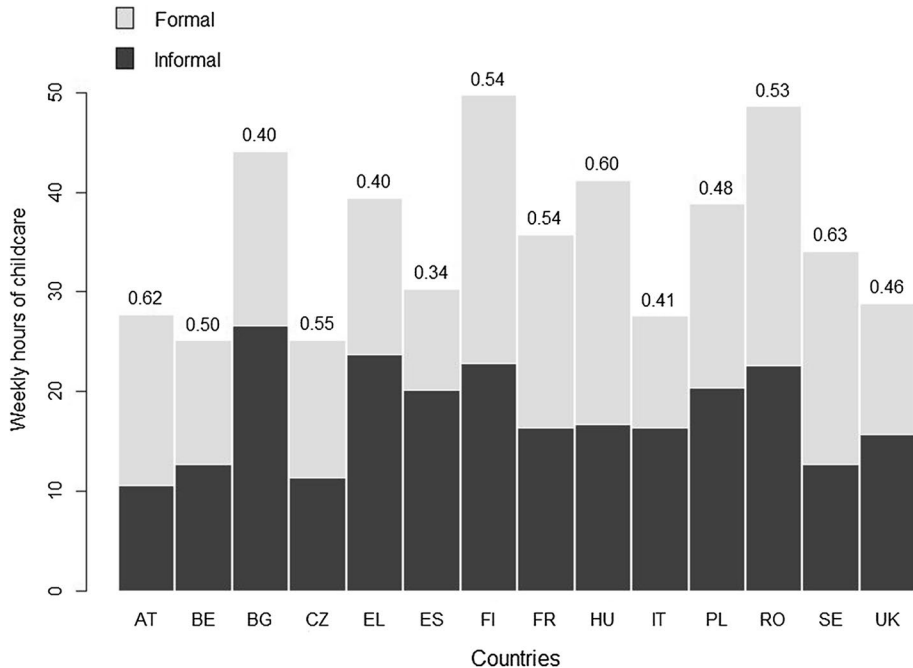
**Fig. 1** Average childcare services use (in hours) in European countries. Note: Authors' calculations based on EU-SILC data between 2010-2017. The reported statistics correspond to the shares of formal childcare service use.

Belgium, Czech Republic and Austria. Looking at formal versus informal use, we note that the largest formal childcare service use is observed in Sweden, Austria and Hungary.

## 2.2 The Determinants of Childcare Use

As indicated by existing literature, individual and household characteristics are determinants in the demand for childcare services. Hence, we consider three kinds of variables that may explain the use of childcare, namely (i) mother's characteristics, (ii) partner's characteristics and iii) household's characteristics. Table 3 provides a definition for each variable that will be used as an explanatory variable in our estimations. We take into account the age, the education level and the labour supply of the mother and her partner. We also include households' characteristics such as the household's income, its size, the presence of grandparents, the level of urbanization and *the number of children and their age.*

Table 4 reports descriptive statistics of the variables involved in our analysis. On average, households weekly hours of childcare use vary from 2.2 in Spain to 15.3 in Sweden. The average working hours of mothers ranges between 14.1 in Austria to 27.3 in Sweden per week. Regarding income, households in Romania show lower incomes, while higher incomes are observed in Austria. The average age of mothers ranges between 35 years old in the United Kingdom (UK) to 40.3 in Bulgaria. Their partners are on average older, with 38.5 years old in the UK and 42.1 years old in Greece. Household sizes are larger in Bulgaria and smaller in the UK. Finally, grandparents can be found in nearly half of

**Table 3** Variables' description

| | | |
|---|---|---|
| Mother's characteristics | Mother's age | Continuous variable: Number of years |
| | Mother's level of education | Categorical variable: Highest level of education attained coded 0 if primary education, 1 if secondary education and 2 if post-secondary and tertiary education level |
| | Mother's labour force participation | Continuous variable: Number of hours usually worked per week in the main job |
| Partner's characteristics | Partner's age | Continuous variable: Number of years |
| | Partner's level of education | Categorical variable: Highest level of education attained coded 0 if primary education, 1 if secondary education and 2 if post-secondary and tertiary education level |
| | Partner's work status | Categorical variable: Coded 0 when unemployed, 1 when part-time and 2 for full-time work. The distinction between full-time and part-time work is based on a spontaneous response by the respondent |
| | | *Continuous variable: Number of hours usually worked per week in main job |
| Household's characteristics | Household's income | Continuous variable: Equivalised disposable monthly income in euros |
| | Household size | Continuous variable: Number of persons living in the household |
| | Number of children per age category | Continuous variable: Number of children in three categories: Below 3 years old ; between 4 and 6 years old ; and between 7 and 10 years old |
| | Presence of grandparents | Dummy variable: coded to 1 if at least one grandparent is present in the household |
| | Level of urbanisation | Categorical variable: Coded to 0 if thinly populated area, to 1 if intermediate and to 2 if densely-populated area |

*Both categorical and continuous options were tested, the results from the continuous variable is available in the Appendix

**Table 4** Descriptive statistics

| | Childcare | | Labour supply | | HH. Income/in € | | Age (M.) | | Age (P.) | | HH size | | Grandparents | N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | Mean | SD | Mean | SD | Mean | SD | Mean | SD | % of HH without | |
| AT | 7.0 | 10.0 | 14.1 | 15.8 | 4020.3 | 2142.9 | 36.4 | 9.2 | 39.4 | 8.2 | 4.1 | 1.2 | 93 | 7990 |
| BE | 7.0 | 11.1 | 22.3 | 17.7 | 3983.4 | 1975.6 | 35.3 | 8.0 | 38.8 | 7.7 | 4.1 | 1.3 | 96 | 9200 |
| BG | 5.4 | 12.3 | 20.6 | 20.8 | 749.2 | 666.4 | 40.3 | 14.7 | 41.5 | 12.3 | 5.2 | 2.2 | 55 | 8869 |
| CZ | 7.5 | 9.1 | 19.7 | 19.9 | 1522.4 | 857.1 | 35.8 | 9.5 | 38.6 | 8.0 | 4.0 | 1.1 | 91 | 11522 |
| EL | 10.9 | 14.3 | 18.1 | 20.3 | 1598.3 | 1168.9 | 38.7 | 10.3 | 42.1 | 8.7 | 4.2 | 1.2 | 86 | 12828 |
| ES | 2.2 | 7.4 | 18.6 | 18.9 | 2707.2 | 1824.2 | 38.8 | 10.4 | 41.4 | 8.4 | 4.2 | 1.3 | 87 | 21178 |
| FI | 12.8 | 15.0 | 22.8 | 18.7 | 4843.9 | 2658.5 | 35.9 | 7.5 | 38.8 | 7.3 | 4.3 | 1.5 | 99 | 14839 |
| FR | 8.4 | 13.6 | 24.0 | 17.7 | 3902.2 | 2979.3 | 35.6 | 7.4 | 38.6 | 7.3 | 4.1 | 1.2 | 98 | 16713 |
| HU | 15.2 | 15.1 | 16.2 | 19.3 | 900.2 | 498.8 | 36.8 | 11.5 | 39.2 | 9.0 | 4.6 | 1.7 | 82 | 14361 |
| IT | 7.2 | 11.6 | 18.2 | 18.1 | 3052.2 | 2177.9 | 38.8 | 9.6 | 41.9 | 7.9 | 4.0 | 1.1 | 89 | 25196 |
| PL | 7.9 | 13.6 | 18.4 | 19.9 | 1164.9 | 680.9 | 38.3 | 13.7 | 40.0 | 11.2 | 4.8 | 1.6 | 73 | 16387 |
| RO | 12.0 | 14.2 | 18.6 | 20.2 | 493.1 | 357.2 | 39.5 | 14.0 | 41.3 | 11.0 | 4.9 | 1.8 | 64 | 7068 |
| SE | 15.3 | 13.7 | 27.3 | 16.1 | 4564.8 | 2814.3 | 35.8 | 7.1 | 39.1 | 7.1 | 4.1 | 1.1 | 99 | 9476 |
| UK | 7.3 | 12.7 | 17.4 | 17.1 | 3561.3 | 2533.9 | 35.0 | 8.3 | 38.5 | 7.9 | 3.9 | 1.2 | 97 | 13042 |

Own calculations based on EU-SILC data from 2010 to 2017. Sample: women with at least one child below 10 years old
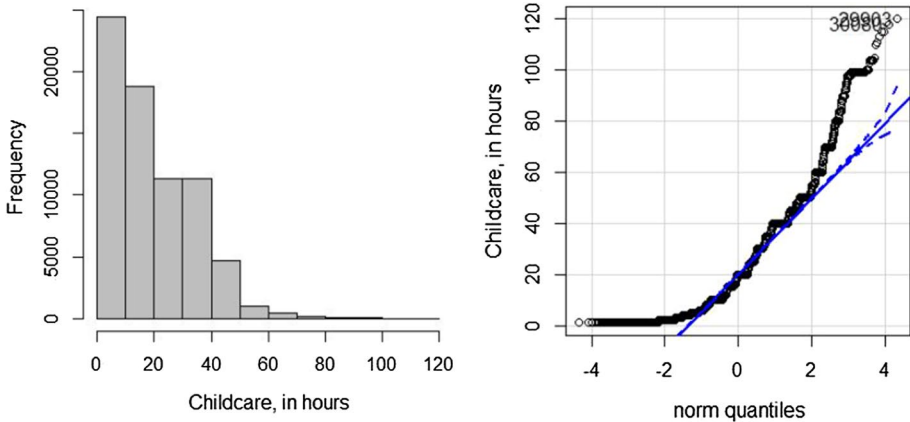
**Fig. 2** Histogram and Q-Q plot of the hours of childcare use

the Bulgarian households. These statistics highlight very different realities in Europe. For example, while mothers work more hours on average in Nordic countries, they can rely less on the presence of grandparents in the household to look after the children. On the contrary, in Bulgaria, Romania and Poland the presence of grandparents is greater, which could imply larger informal childcare, especially as incomes are on average lower.

## 3 Empirical Strategy

To estimate the determinants of childcare use, we rely on a count data modelling strategy as our explained variable is the count of weekly hours. Indeed, when we look at the histogram of the weekly hours of childcare as displayed in Figure 2, it clearly appears that the dependent variable is strongly right-skewed. Furthermore, the Quantile-Quantile plot of the series confirms the skewness of the data, which does not quite support normality. The descriptive statistics in Table 4 show also large differences between the mean and variance of hours of childcare, which violate the assumption of the Poisson distribution. Therefore, using count data regression methods, we will allow for overdispersion in the response variable and account for reverse causality (endogeneity).

Specifically, let consider the following regression model relating the effective childcare use, $y$, to labour supply of the mother, $x$ and to a set of other explanatory variables, $W$:

$$y_i = \beta_o + \beta x_i + W_i \beta_w + \varepsilon_i, \quad i = 1, \ldots, N, \text{ and } \varepsilon_i \sim iid(0, \sigma^2) \tag{1}$$

where $\varepsilon_i$ stands for the idiosyncratic error terms and $\beta_o$, $\beta$ and $\beta_w$ are the parameters. $y_i$ being a count data, we intend to use a Poisson-Gamma mixture model as suggested by Winkelmann (2008) and Cameron and Trivedi (2013). However, because of characteristics of the Poisson distribution that assumes equality between the mean and the variance (equidispersion), we need to check if this assumption holds given our data. To do so, we

**Table 5** Test of equi-dispersion in the Poisson model

| | Test statistic | Std. Err | Test decision |
|---|---|---|---|
| Test based on total sample | 13.087 | 0.085 | Reject $H_0$ |
| Test based on couples | 14.175 | 0.201 | Reject $H_0$ |
| Test based on single mothers | 12.723 | 0.092 | Reject $H_0$ |

The null-hypothesis is the mean-variance equality (equi-dispersion). The regression model surrounding the test links total childcare use to labour supply

follow Dean and Lawless (1989) and Hilbe (2011) who have proposed a Z-score test for overdispersion in the Poisson model.[7]

Table 5 presents the results of the equi-dispersion test applied to the total sample, sample of couples and of single mothers. The results suggest rejecting the null-hypothesis. More specifically, Hilbe (2011) argues that the test shows whether the data should be modeled as Poisson or negative binomial. Based on the latter consideration and the test results, we estimate a model relaxing the mean-variance equality assumption: a Negative Binomial model. If we consider that the weekly hours of childcare are Negative Binomial (NB) distributed, $y_i \sim NegBin(\mu_i, \theta)$, the adjusted regression model deriving from equation (1) is the following:

$$\mu_i \equiv E[y_i | x_i, W_i] = exp(\beta_o + \beta x_i + W_i \beta_w), \tag{2}$$

which will be used in estimating the determinants of childcare services use.[8]

An important issue in our estimation is related to the potential for endogeneity. In particular, the mother's labour status may be endogenous since both childcare and labour supply decisions simultaneously occur. This has been intensely discussed, among others, by Connelly and Kimmel (2003) and Coneus et al. (2008) who reported overestimated parameters when the endogeneity issues are not properly addressed. One way to address this issue is to use an instrumental variable that is unrelated to our response variable (childcare use) but related to our explanatory variable (mother's labour supply).

In our context and given our data, it is difficult to find individual-level valid instruments. Therefore, we use the regional unemployment rate as an instrumental variable for mothers' labour supply. On the one hand, the unemployment rate is an indication of economic conditions in that region and has been shown to be an important determinant of women's labour supply (Blundell et al., 1987, 1998; Gaddis & Klasen, 2014). On the other hand, it is unlikely to be related to the choice of childcare service, at least in the short run. In the long run, one could expect that a high unemployment rate leads to a reorganisation of childcare services in order to foster women's employment. *One important aspect of access to formal childcare is the employment status. In several countries, unemployed women have*

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[7] Overdispersion is the case where the variance is higher than the mean.

[8] One aspect of our data is that they are nested by nature, i.e. mothers are nested in European regions that are nested in countries. This multi-level dimension can be interesting to account for in our empirical strategy. However, it has been shown that in the case of negative binomial approach, the multilevel specification that accounts for the clustering of units at higher levels does not influence much the estimated fixed effects (Tseloni, 1999). Furthermore, in our case, a multi-level approach is hardly feasible given the nature of the explained variable (count data), its Negative Binomial distribution, combined with the issue of reverse causality

*privileged access to childcare. In our empirical strategy, this is part of the effect of mothers' labour supply on the demand for childcare.*

Practically we rely on the Control Function Approach (CFA) for non-linear models as discussed in Wooldridge (2015). If $x_i$ is the endogenous regressor (the mother's labour status) and $z_i$ is the reliable instrument (the regional unemployment rate), the approach consists in estimating a first stage linear model, $E(x_i|z_i, W_i) = (\gamma_0 + \gamma z_i + W_i \rho_w)$, and then introducing its residuals, $\hat{v}_i = x_i - \hat{x}_i$, into equation 2. Doing so, the regression model to be estimated is finally:[9]

$$\mu_i \equiv E(y_i|x_{it}, W_i) = exp\big(\beta_o + \beta x_i + W_i \beta_w + \beta_v \hat{v}_i\big). \tag{3}$$

The parameters of the model will be estimated using maximum likelihood method.

## 4 Main Results

We present the results of our analysis in two steps. First, we look at the drivers of the total demand for childcare, being either formal or informal. Particularly, we are interested in the occupation characteristics of the mother and her spouse. In a second step, we identify the diverging factors between formal and informal childcare by using the same specification for each type of childcare. Since we also intend to assess the potential complementarity (substitutability) between formal and informal childcare, we run an additional regression analysis.

### 4.1 A Global Perspective

Table 6 presents the results of estimating the parameters of a regression model linking the reported total hours of childcare use to the mother's and her household's characteristics. We start from a basic model where we only look at the effect of the mother's labour supply on the demand for childcare services. We then improve our specification by successively introducing covariates relating to the mother, her spouse and household. The results of this robustness exercise correspond to the specifications (1) to (3) in Table 6. Using the log-likelihood (and AIC) as a selection criterium, specification (3) is preferred and will be used in the discussion of our results. We also assessed the case of single mothers in Table 6 (see specification (4)). In the discussion of our results, we largely focus on our main regressor: The mother's hours of labour supply.

Before discussing our main results, it is important to mention the first-stage regression reported in Table 6. The latter has been introduced to solve for reverse causality in the childcare-labour supply nexus. As previously justified, we use the regional unemployment rate as an excluded instrumental variable for the mother's labour supply. For the sake of space, we only present the effect of the instrumental variable and report all other results in the appendix. Overall, in all our specifications, the regional unemployment rate is statistically significant and has the expected sign. Also, the F-statistics confirms the global significance of the first-stage regression.

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[9] The parameter of the observed residuals simultaneously produce a heteroskedasticity robust endogeneity test for $x_i$. See Wooldridge (2015) for further discussions on the CFA.

**Table 6** Determinants of the total demand for childcare

| | *Explained variable: Number of childcare hours* | | | Single mothers |
| --- | --- | --- | --- | --- |
| | (1) | (2) | (3) | (4) |
| Mother's labour supply | 0.242*** (0.027) | 0.262*** (0.034) | 0.132*** (0.048) | 0.107 (0.139) |
| Age of the mother | | 0.009*** (0.002) | 0.014*** (0.002) | −0.0003 (0.002) |
| Educ. level of the mother | | 0.0003 (0.0002) | 0.0004** (0.0002) | 0.0004 (0.0004) |
| Age of the partner | | −0.008*** (0.002) | −0.010*** (0.002) | |
| Educ. level of the partner | | −0.00001 (0.0002) | −0.0001 (0.0002) | |
| Partner working part-time (ref = Unemployed) | | −0.057 (0.038) | −0.041 (0.037) | |
| Partner working full-time (ref = Unemployed) | | 0.025 (0.019) | −0.006 (0.017) | |
| Children 0-2 | | | 0.216*** (0.019) | 0.217*** (0.028) |
| Children 3-6 | | | −0.055*** (0.012) | −0.032 (0.041) |
| Children 7-10 | | | −0.271*** (0.015) | −0.211*** (0.041) |
| Household monthly income | | | 0.0001*** (0.00002) | 0.0003*** (0.0001) |
| Grandparents | | | 0.401*** (0.021) | 0.185*** (0.028) |
| Household size | | | −0.084*** (0.010) | −0.090** (0.042) |
| Highly populated areas (ref = Low density) | | | −0.008 (0.015) | 0.013 (0.030) |
| Mid populated areas (ref = Low density) | | | −0.013 (0.014) | −0.014 (0.034) |
| Countries fixed effects | ✓ | ✓ | ✓ | ✓ |
| Time effects | ✓ | ✓ | ✓ | ✓ |
| First-stage residuals | −0.050* (0.028) | −0.043 (0.034) | 0.091* (0.048) | 0.025 (0.139) |
| Constant | 1.406*** (0.053) | 1.252*** (0.064) | 1.494*** (0.088) | 2.007*** (0.339) |
| Observations | 188,643 | 146,903 | 146,864 | 34,838 |
| Log Likelihood | −491,364.700 | −382,050.200 | −380,595.900 | −93,229.880 |
| Akaike Inf. Crit. | 982,775.400 | 764,158.500 | 761,265.700 | 186,525.800 |

**Table 6** (continued)

*Explained variable: Number of childcare hours*

| | (1) | (2) | (3) | Single mothers (4) |
|---|---|---|---|---|
| | *First stage regressions for numbers of hours worked* | | | |
| Regional unemp. | −0.052*** (0.001) | −0.047*** (0.001) | −0.033*** (0.001) | −0.024*** (0.002) |
| Included instruments | ✓ | ✓ | ✓ | ✓ |
| Countries fixed effects | ✓ | ✓ | ✓ | ✓ |
| Time effects | ✓ | ✓ | ✓ | ✓ |
| Adjusted $R^2$ | 0.043 | 0.068 | 0.145 | 0.141 |
| F Statistic | 408.755*** | 401.098*** | 713.570*** | 184.867*** |

$^*p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$. Negative Binomial model with control function. Bootstrap standard errors are in parentheses. Extended results for the first-stage regression are presented in the appendix. The reference for highly and mid populated areas is areas with low density. The reference for working part-time and full-time is not working. As instrument for labour supply of the mother we use one-year lag of women regional unemployment rate and for formal childcare, the enrollment rates in early childhood education

The upper panel of Table 6 presents our second-stage regression linking childcare service use to mothers' labour supply, where the residuals of the first-stage regression $\hat{v}_i$ is also introduced as control variable (CFA). As mentioned before, the discussion are based on specification (4) since the latter shows higher predictive power, compared to the first three. First, we isolate the effect of the mother's labour supply, among other covariates, and observe that while its quadratic term is not significant, the hours of the mother's labour supply in level are a significant predictor of childcare services use. In fact, there is nothing unusual about such a result, which simply rejects non-linearity but suggests that increases in the mother's labour supply (working hours) lead to increasing childcare services use. Consistently across our different specifications, our result on the relationship between childcare use and mothers' labour supply shows that the more the mother works, the more childcare services her household requires. The latter conclusion holds for both single mothers and mothers living with a partner.

Regarding control variables relating to the mother and her household, we observe positive and significant impacts of the education level and age for mothers living with a partner. Also, the demand for childcare increase with partner's occupation but decreases with the age of the children and the size of the household. For both single mothers and mothers in couple, the larger the household size, the less childcare hours the family needs. This could indicate that in large families with young children, women tend to work less (or not at all), thus decreasing the need for childcare. Additional steps dissociating formal from informal childcare will help assess whether our main result holds independently of the type of childcare.

## 4.2 Dissociating Formal from Informal Care

Our initial analysis does not differentiate between formal and informal childcare. However, there is evidence that demands for the two types of childcare may be driven by different factors (Davis & Connelly, 2005; Del Boca et al., 2005; Du & Dong, 2010; Coley et al., 2014). This may be also true in our analysis. Furthermore, informal care is probably less costly than formal care arrangements and parents may finally prefer it. Table 7 presents the results of considering formal and informal childcare separately.

**Case of mothers in couple.** Though a non-linear relationship appears again in the childcare-labour supply nexus for mothers with partners, the overall result, after a turning point around 2 hours per week, suggests a positive effect of the mother's labour supply on the household's demand for formal childcare. Considering informal care, a positive effect also appears. These results imply that, whether we focus on formal or informal care, households with both parents increasingly demand childcare the more the mother participates in the labour market. Among control variables relating to mother's characteristics, it appears that the older the mother is, the more childcare hours of both types the household uses. Also, the education level of the mother significantly drives only formal care. Finally, while contrasting results for both type of care are observed considering covariates relative to children and partners, the size of the household is negatively linked to the demand for childcare.

**Case of single mothers.** Our analysis of the link between childcare and the labour supply of single mothers shows that labour market participation increases the demand for formal care. Considering control variables related to the mother and her household, while the mother's age shows a positive effect on the demand for formal care, no statistically significant impact appears for the size of the household. Regarding informal childcare, no significant result is observed for the mother's labour supply, age and household's size.

**Table 7** Determinants of formal and informal childcare demand

| | Explained variable: Number of childcare hours | | | |
| --- | --- | --- | --- | --- |
| | Formal | Single mothers | Informal | Single mothers |
| Mother's labour supply | 0.151** (0.066) | 1.169*** (0.210) | 0.233*** (0.069) | 0.123 (0.187) |
| Age of the mother | 0.007*** (0.003) | 0.012*** (0.003) | 0.017*** (0.003) | 0.003 (0.003) |
| Educ. level of the mother | 0.001*** (0.0002) | −0.001 (0.001) | 0.0001 (0.0002) | 0.0001 (0.001) |
| Age of the partner | −0.001 (0.002) | | −0.016*** (0.002) | |
| Educ. level of the partner | −0.0001 (0.0003) | | −0.0001 (0.0003) | |
| Partner working part-time | 0.098*** (0.024) | | −0.032 (0.025) | |
| Partner working full-time | 0.069 (0.053) | | −0.152*** (0.059) | |
| Children 0-2 | 0.246*** (0.026) | 0.110*** (0.041) | 0.216*** (0.027) | 0.234*** (0.038) |
| Children 3-6 | 0.106*** (0.017) | −0.170*** (0.062) | −0.206*** (0.018) | −0.112** (0.056) |
| Children 7-10 | 0.225*** (0.020) | 0.153** (0.061) | −0.467*** (0.022) | −0.422*** (0.056) |
| Household monthly income | 0.0001*** (0.00003) | −0.0002* (0.0001) | 0.00003 (0.00003) | 0.0002** (0.0001) |
| Grandparents | 0.037 (0.030) | −0.127*** (0.043) | 0.600*** (0.030) | 0.284*** (0.038) |
| Household size | −0.181*** (0.014) | 0.171*** (0.063) | −0.047*** (0.015) | −0.067 (0.056) |
| Mid populated areas | −0.167*** (0.021) | −0.088** (0.045) | 0.164*** (0.022) | 0.084** (0.041) |
| Highly populated areas | −0.217*** (0.020) | 0.025 (0.051) | 0.240*** (0.021) | 0.123*** (0.047) |
| Countries fixed effects | ✓ | ✓ | ✓ | ✓ |
| Time effects | ✓ | ✓ | ✓ | ✓ |
| First-stage residuals | 0.080 (0.067) | −1.034*** (0.210) | 0.004 (0.069) | 0.039 (0.187) |
| Constant | 0.632*** (0.112) | −1.440*** (0.511) | 0.845*** (0.118) | 1.313*** (0.457) |
| Observations | 146,864 | 34,799 | 146,808 | 34,799 |
| Log Likelihood | −248,021.700 | −52,868.610 | −220,064.400 | −63,529.190 |
| Akaike Inf. Crit. | 496,117.400 | 105,803.200 | 440,202.900 | 127,124.400 |
| | *First stage regressions for numbers of hours worked* | | | |
| Regional unemp | −0.033*** (0.001) | −0.024*** (0.002) | −0.033*** (0.001) | −0.024*** (0.002) |
| Included instruments | ✓ | ✓ | ✓ | ✓ |
| Countries fixed effects | ✓ | ✓ | ✓ | ✓ |
| Time effects | ✓ | ✓ | ✓ | ✓ |
| Constant | 1.488*** (0.038) | 2.483*** (0.065) | 1.490*** (0.038) | 2.483*** (0.065) |
| Observations | 146,864 | 34,799 | 146,808 | 34,799 |
| $R^2$ | 0.145 | 0.142 | 0.146 | 0.142 |
| Adjusted $R^2$ | 0.145 | 0.141 | 0.146 | 0.141 |
| F Statistic | 713.570*** | 184.997*** | 715.311*** | 184.997*** |

*$p < 0.1$; **$p < 0.05$; ***$p < 0.01$. Bootstrap standard errors are in parentheses. The reference for highly and mid populated areas is areas with low density. The reference for working part-time and full-time is not working. As instrument for labour supply of the mother we use one-year lag of women regional unemployment rate and for formal childcare, the enrollment rates in early childhood education

Though the EU-SILC data does not provide any information about relatives living close to the surveyed household and that can potentially help with childcare, it contains data on the presence of grandparents in the household. The latter variable shows divergent effects for

both types of childcare. While the presence of grandparents in the household reduces formal care use, it positively impacts informal care use.

Throughout this study so far, it appears that mothers' participation in the labour market drives households' childcare services use. Our results also indicate that independently of the type of childcare, the older the mother is, the more childcare services the household demands. Concerning the control variables such as the age of children and the presence of grandparents in the household, among others, contrasting results are observed when formal and informal care are considered. In the following, we question the substitutability between formal and informal care and propose some heterogeneity analyses.

## 5 Substitutability and Heterogeneity Analysis

### 5.1 Formal Versus Informal Care: The Substitutability Hypothesis

To assess the potential for substitution between both types of care, we estimate the causal effect of the demand for formal childcare on informal care. Doing this, the main problem that arises is the direction of causality in the relationship between formal and informal care. One may argue that the decisions to use informal and/or formal childcare are made simultaneously and there are unobserved characteristics that explain the demand for both cares at the same time. To address this econometric challenge, we rely on a similar empirical strategy as before by using as an excluded instrumental variable for formal childcare which is the enrollment rate in formal care (for children under 2 years old). By definition, the enrollment rate in early childhood education and care services for 0-to 2-year-old is the percentage of children aged 0-2 enrolled in or using early childhood education and care services. If the enrollment rate is high, it may result in congestion in the access to formal care and so it reduces the demand for formal childcare and consequently impacts the demand for informal childcare.[10]

Our argument testing the substitutability hypothesis posits that if formal care and informal care are substitutable, increases in one should lead to a decrease in the other. Table 8 reports the results of testing the latter hypothesis, as well as the first-stage regressions introduced to solve endogeneity issues. Once again, our analysis dissociates single mothers from mothers with partners and use the same covariates are previously. The control variables produce results similar to those obtained primarily. As before, the mother's participation in the labour market (hours of labour supply) drive informal childcare only for couples. Also, as before, the mother's age and the presence of grandparents in the household positively and significantly drive the use of informal childcare in households with both parents (couples).

The result relating to the substitutability hypothesis, as conjectured, indicates that the more a household uses formal care, the less it relies on informal care, whether this concerns households with both parents or single mothers. Such a result suggests that formal childcare is a substitute for informal arrangements and implies that in countries where affordable and available childcare services are scarce, households will turn to informal care provided by relatives. As noted by Arpino et al. (2010), this is probably the case in some

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[10] One could also see the level of enrollment as an indicator of access to formal care. In this case, the effect would be positive. Our first-stage results shows that the congestion is more important.

**Table 8** Substitution between formal and informal childcare

| | Explained variable: Hours of informal childcare | |
| --- | --- | --- |
| | | Single mothers |
| Hours of formal care | −0.029*** (0.002) | −0.028*** (0.004) |
| Mother's labour supply | 0.120 (0.083) | −0.048 (0.213) |
| Age of the mother | 0.020*** (0.003) | −0.0005 (0.004) |
| Educ. level of the mother | 0.0003 (0.0003) | 0.001 (0.001) |
| Age of the partner | −0.020*** (0.003) | |
| Educ. level of the partner | −0.0003 (0.0004) | |
| Partner working part-time | 0.004 (0.032) | |
| Partner working full-time | −0.221*** (0.073) | |
| Children 0-2 | 0.178*** (0.029) | 0.277*** (0.047) |
| Children 3-6 | −0.195*** (0.023) | −0.052 (0.069) |
| Children 7-10 | −0.464*** (0.026) | −0.346*** (0.065) |
| Household monthly income | 0.0001*** (0.00003) | 0.0003** (0.0001) |
| Grandparents | 0.537*** (0.037) | 0.287*** (0.047) |
| Household size | −0.056*** (0.020) | −0.121* (0.064) |
| Mid populated areas | 0.176*** (0.027) | 0.143*** (0.051) |
| Highly populated areas | 0.211*** (0.026) | 0.140** (0.057) |
| Countries fixed effects | ✓ | ✓ |
| Time effects | ✓ | ✓ |
| First-stage residuals (1) | 0.030*** (0.004) | 0.020*** (0.006) |
| First-stage residuals (2) | 0.108 (0.083) | 0.202 (0.213) |
| Constant | 1.046*** (0.158) | 1.776*** (0.531) |
| Observations | 84,476 | 19,929 |
| Log Likelihood | −140,659.800 | −40,139.400 |
| Akaike Inf. Crit. | 281,395.600 | 80,346.810 |
| | *First stage regression for labour supply (1)* | |
| Regional unemp | −0.036*** (0.002) | −0.028*** (0.003) |
| Included instruments | ✓ | ✓ |
| Countries fixed effects | ✓ | ✓ |
| Time effects | ✓ | ✓ |
| Adjusted $R^2$ | 0.138 | 0.145 |
| F Statistic | 399.446*** | 113.965*** |
| | *First stage regression for formal childcare (2)* | |
| Enrolment in formal care 0-2yo | −0.031*** (0.004) | −0.041*** (0.010) |
| Included instruments | ✓ | ✓ |
| Countries fixed effects | ✓ | ✓ |
| Time effects | ✓ | ✓ |
| Log Likelihood | −125,936.500 | −25,812.120 |
| Akaike Inf. Crit. | 251,943.000 | 51,686.230 |

*$p < 0.1$; **$p < 0.05$; ***$p < 0.01$. Bootstrap standard errors are in parentheses. The reference for highly and mid populated areas is areas with low density. The reference for working part-time and full-time is not working. As instrument for labour supply of the mother we use one-year lag of women regional unemployment rate and for formal childcare, the enrolment rates in early childhood education

**Table 9** Determinants of formal and informal childcare demand with working mothers

| | Explained variable: | | | |
|---|---|---|---|---|
| | Formal childcare | | Informal childcare | |
| | | Single mothers | | Single mothers |
| Mother's labour supply | 2.077 (1.675) | 257.628*** (78.792) | 0.233*** (0.069) | 0.123 (0.187) |
| Age of the mother | −0.001 (0.003) | −0.317*** (0.098) | 0.017*** (0.003) | 0.003 (0.003) |
| Educ. level of the mother | 0.001*** (0.0002) | 0.027*** (0.008) | 0.0001 (0.0002) | 0.0001 (0.001) |
| Age of the partner | 0.002 (0.003) | | −0.016*** (0.002) | |
| Educ. level of the partner | 0.00002 (0.0003) | | −0.0001 (0.0003) | |
| Partner working part-time | 0.151*** (0.025) | | −0.032 (0.025) | |
| Partner working full-time | 0.170 (0.115) | | −0.152*** (0.059) | |
| Children 0-2 | 0.404*** (0.064) | 7.685*** (2.260) | 0.216*** (0.027) | 0.234*** (0.038) |
| Children 3-6 | 0.091* (0.054) | 4.316*** (1.315) | −0.206*** (0.018) | −0.112** (0.056) |
| Children 7-10 | 0.108** (0.048) | 3.595*** (1.025) | −0.467*** (0.022) | −0.422*** (0.056) |
| Household monthly income | 0.00004 (0.0001) | −0.026*** (0.008) | 0.00003 (0.00003) | 0.0002** (0.0001) |
| Grandparents | 0.013 (0.050) | −2.829*** (0.833) | 0.600*** (0.030) | 0.284*** (0.038) |
| Household size | −0.214*** (0.012) | 1.059*** (0.378) | −0.047*** (0.015) | −0.067 (0.056) |
| Mid populated areas | −0.147*** (0.026) | 2.033*** (0.677) | 0.164*** (0.022) | 0.084** (0.041) |
| Highly populated areas | −0.218*** (0.025) | −0.428*** (0.093) | 0.240*** (0.021) | 0.123*** (0.047) |
| Countries fixed effects | ✓ | ✓ | ✓ | ✓ |
| Time effects | ✓ | ✓ | ✓ | ✓ |
| First-stage residuals | −1.605 (1.675) | −257.300*** (78.791) | 0.004 (0.069) | 0.039 (0.187) |
| Constant | −4.809 (5.288) | −829.339*** (254.126) | 0.845*** (0.118) | 1.313*** (0.457) |
| Observations | 88,737 | 14,715 | 146,808 | 34,799 |
| Log Likelihood | −182,955.000 | −27,597.120 | −220,064.400 | −63,529.190 |
| Akaike Inf. Crit. | 365,984.000 | 55,260.230 | 440,202.900 | 127,124.400 |
| | *First stage regression for labour supply* | | | |
| Regional unemp | 0.002*** (0.0003) | −0.0001 (0.001) | −0.033*** (0.001) | −0.024*** (0.002) |
| Included instruments | ✓ | ✓ | ✓ | ✓ |
| Countries fixed effects | ✓ | ✓ | ✓ | ✓ |
| Time effects | ✓ | ✓ | ✓ | ✓ |
| Observations | 88,737 | 14,715 | 146,808 | 34,799 |
| $R^2$ | 0.135 | 0.177 | 0.146 | 0.142 |
| Adjusted $R^2$ | 0.135 | 0.176 | 0.146 | 0.141 |
| F Statistic | 396.196*** | 102.172*** | 715.311*** | 184.997*** |

$^*p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$

Southern European countries where grandparents provide care on a daily basis compared to countries such as Germany, Austria and Nordic countries where formal care is more available and affordable.

## 5.2 Working at Least One Hour

In the EU-SILC dataset, some mothers have indeed reported zero working hours per week.[11] Thus, in addition to the results presented above, we assess the case of mothers who have reported that they participate in the labour market at least one hour per week. The results of the case study considering mothers working at least one hour are reported in Table 9 where we also dissociate formal from informal care.

Regarding formal childcare, no major differences appear between single mothers and mothers with a partner. As previously, the effect of mothers' labour supply is positive and statistically significant, indicating that the more a mother participate in the labour market, the more formal childcare service the household uses. The working status of the partner also affects the demand for formal childcare as the latter increases when the partner is working (part-time or full-time) compared to the situation where he does not participate in the labour market. The presence of grandparents in the household negatively impacts the demand of formal care only for single mothers. Finally, compared to less populated areas, living in densely populated areas significantly reduces the demand for formal child care.

Considering informal care, while in households with both partners a positive relationship is observed between mothers' labour supply and informal childcare use, a negative link appears in households with single mothers. For two-parent households, as previously noted, the presence in the household of grandparents and children under three years of age increases the use of informal childcare services. Finally, for two-parent households, compared to less populated areas, living in high populated geographic areas positively affect households' demand for informal care.

## 5.3 Country Analysis

Our sample is constituted by 14 European countries, which are probably heterogeneous and present very different institutional and economic situations. Although we have introduced country fixed-effects in our previous regressions, we provide additional information on the relationship between childcare use and labour supply of mothers by separately assessing the case of each country. In doing so, we use the same econometric specification, instrumental variable and method (CFA) as previously.

The results of the individual country analysis are reported in Table 12 and 13 in the Appendix. Concerning our main regressor, the mother's hours of labour supply, it significantly affects the household demand of childcare services in 10 of the fourteen 14 countries considered. Specifically, these countries are Austria, Belgium, Bulgaria, Finland, France, Hungary, Italy, Romania, Sweden and United Kingdom. Among these 10 countries, while negative effects are observed in Finland and Hungary, an increasing relationship between mothers' participation in the labour market and childcare services use is noticeable in the remaining eight (8) countries. Besides the childcare and labour supply nexus, the older the mothers are, the fewer hours of childcare services households demand in Austria, Bulgaria and France, contrary to Finland, Hungary, Italy, Poland, Romania and Sweden where the results show a positive effect of the mother's on childcare services use.

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[11] The variable *mother's hours of labour supply* is not dominated by zero to motivate a zero inflated model though.

Finally, control variables such as the level of education of the mother (and her partner's characteristics), the size of the household, the presence of grandparents in the household, among others, have been used in the country case studies. As one can expect it, these indicators show divergent effects depending on the country. For instance, while the presence of grandparents in the household and the size of the household show positive in some countries, a negative link appears in other countries so that a unique conclusion regarding our control variables is almost impossible.

## 6 Concluding Remarks

This paper assesses the relationship between mothers' participation in the labour market and households' demand for childcare services in 14 European countries using the EU-SILC dataset. Particularly, we are interested in how the labour supply by mothers in couple and single mothers drives formal and informal childcare use, as well as the substitutability between formal and informal care in European countries.

Considering the total demand for childcare, our results suggest that the more mothers participate in the labour market, the higher households' demand for childcare services is. Indeed, the availability and the use of childcare services affect households' work-life balance and such an observation also holds for both mothers in couple and single mothers (see Table 6). Additional analyses separating formal from informal childcare mostly shows similar results (see Table 9). Overall, based on the results, we can rightly state that the positive link between mothers' labour supply and households' demand for childcare is indisputable whether this concerns the total demand, formal or informal childcare.

Regarding the substitutability between formal and informal childcare, we conjecture that if the two types of childcare are substitutable, increasing the demand for formal care will lead to decreasing informal care use. The result of our regression analysis, by showing a negative parameter estimate in regression models linking formal to informal care use, fully supports the substitutability hypothesis (see Table 8). Specifically, for both mothers in couple and single mothers, the more households rely on formal care, the less their demand for informal childcare services is.

Throughout the paper, the discussion of our different results mostly focuses on our main regressor, the mother's labour supply, in order to offer a clear picture of the relationship that our study aims to assess but our analysis also accounts for most characteristics relating to the mother, her partner, her household, among others, as identified in existing literature. We observe that the size of the household as well as the age of the children decrease the total demand for childcare. The total demand for childcare decreases because informal childcare is less needed when children grow old, while the demand for formal childcare remain high until the age of 10. One can think of after-class activities for example. Not surprisingly, the partner's occupational status is an important determinant of the demand for childcare, especially formal childcare.

The policy implications of our analysis are straightforward. As it is established that the number of the mother's working hours has a positive effect on the use for childcare, the increasing labour force participation of women will inevitably lead to an increase of the demand. It means that in order to accompany the mothers' increasing activity, a development of childcare policies will be required. Policy interventions should consider

both formal and informal care since both appear to be substitutable. The question of the right balance between formal and informal care in the parents' portfolio asks for further research. We do not know exactly what options parents have open to them and we do not know much about the attributes of those options which are in parents' choices sets. Better individual dataset would be needed.

# Appendix

## Endogeneity Test

See Table 10, 11, 12 and 13.

**Table 10** Endogeneity test

|  | Explained variable: the total hours of childcare | | |
|---|---|---|---|
|  | Total sample | Couples | Single mothers |
| Mother's labour supply | 0.242*** (0.027) | 0.320*** (0.066) | 0.291*** (0.081) |
| Residual | −0.050* (0.028) | −0.103* (0.066) | −0.139* (0.081) |
| Constant | 1.406*** (0.053) | 1.093*** (0.154) | 1.707*** (0.154) |
| Countries fixed effects | ✓ | ✓ | ✓ |
| Time effects | ✓ | ✓ | ✓ |
| Observations | 188,643 | 152,393 | 36,250 |
| Log Likelihood | −491,364.700 | −394,362.300 | −96,574.510 |
| Akaike Inf. Crit. | 982,775.400 | 788,770.600 | 193,195.000 |
|  | Explained variable: the total hours of mother's Labour supply | | |
|  | Total sample | Couples | Single mothers |
| Regional unemp. | −0.052*** (0.001) | −0.024*** (0.001) | −0.040*** (0.002) |
| Constant | 1.837*** (0.022) | 2.390*** (0.008) | 1.885*** (0.052) |
| Countries fixed effects | ✓ | ✓ | ✓ |
| Time effects | ✓ | ✓ | ✓ |
| $R^2$ | 0.044 | 0.010 | 0.025 |
| Adjusted $R^2$ | 0.043 | 0.010 | 0.024 |
| F Statistic | 408.755*** | 1,583.606*** | 43.462*** |

$^*p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$. Standard errors are in parentheses

**Table 11** Results considering partner's hours of labour supply

| | *Explained variable: the total hours of childcare* | | | |
| | volh | | | |
| | (1) | (2) | (3) | Single mothers |
|---|---|---|---|---|
| Mother's labour supply | 0.242*** (0.027) | 0.283*** (0.037) | 0.134*** (0.052) | 0.107 (0.139) |
| Age of the mother | | 0.008*** (0.002) | 0.014*** (0.002) | −0.0003 (0.002) |
| Educ. level of the mother | | 0.0002 (0.0002) | 0.0004** (0.0002) | 0.0004 (0.0004) |
| Age of the partner | | −0.008*** (0.001) | −0.010*** (0.002) | |
| Educ. level of the partner | | −0.00001 (0.0002) | −0.0001 (0.0002) | |
| Partner's labour supply | | −0.036*** (0.011) | 0.002 (0.010) | |
| Children 0-2 | | | 0.217*** (0.019) | 0.217*** (0.028) |
| Children 3-6 | | | −0.055*** (0.012) | −0.032 (0.041) |
| Children 7-10 | | | −0.271*** (0.015) | −0.211*** (0.041) |
| Household monthly income | | | 0.0001*** (0.00002) | 0.0003*** (0.0001) |
| Grandparents | | | 0.401*** (0.020) | 0.185*** (0.028) |
| Household size | | | −0.084*** (0.010) | −0.090** (0.042) |
| Mid populated areas | | | −0.009 (0.015) | 0.013 (0.030) |
| Highly populated areas | | | −0.013 (0.014) | −0.014 (0.034) |
| Countries fixed effects | ✓ | ✓ | ✓ | ✓ |
| Time effects | ✓ | ✓ | ✓ | ✓ |
| First-stage residuals | −0.050* (0.028) | −0.060 (0.038) | 0.091* (0.052) | 0.025 (0.139) |
| Constant | 1.406*** (0.053) | 1.393*** (0.048) | 1.485*** (0.067) | 2.007*** (0.339) |
| Observations | 188,643 | 146,992 | 146,953 | 34,838 |
| Log Likelihood | −491,364.700 | −382,236.500 | −380,785.400 | −93,229.880 |
| Akaike Inf. Crit. | 982,775.400 | 764,529.100 | 761,642.700 | 186,525.800 |

*Notes:* $^*p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$. Compared to our other results, where we considered the partner's labour supply as a categorical variable, this analysis uses the effective labour supplied by the partner (in hours). Bootstrap standard errors are in parentheses. The reference for highly and mid populated areas is the area with low density

**Table 12** Country-level analysis: results of the second-stage regressions

| | (AT) | (BE) | (BG) | (CZ) | (EL) | (ES) | (FI) |
|---|---|---|---|---|---|---|---|
| *Explained variable: the total hours of childcare* | | | | | | | |
| Mother's labour supply | 2.133*** (0.341) | 0.012 (0.123) | 1.834*** (0.573) | −0.877 (1.111) | 0.487 (0.388) | 0.404 (0.379) | −7.732*** (2.268) |
| Control variables | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Time effects | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| First-stage residuals | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Constant | 0.856*** (0.242) | 1.934*** (0.227) | −2.369*** (0.514) | 1.725** (0.836) | 1.625*** (0.213) | 0.339 (0.547) | 2.450*** (0.242) |
| Observations | 6,543 | 7,141 | 6,494 | 9,001 | 11,233 | 16,577 | 12,761 |
| Log Likelihood | −16,396.100 | −19,279.440 | −10,411.230 | −25,001.060 | −33,131.660 | −16,125.540 | −37,101.920 |
| Akaike Inf. Crit. | 32,838.190 | 38,604.880 | 20,868.470 | 50,048.130 | 66,309.320 | 32,297.080 | 74,249.840 |

$*p < 0.1$; $**p < 0.05$; $***p < 0.01$. See below for details

**Table 13** Country-level analysis: results of the second-stage regressions

| | (FR) | (HU) | (IT) | (PL) | (RO) | (SE) | (UK) |
|---|---|---|---|---|---|---|---|
| | *Explained variable: the total hours of childcare* | | | | | | |
| Mother's labour supply | 1.446*** (0.415) | −2.201*** (0.685) | 0.231*** (0.056) | −1.111 (0.868) | 10.851*** (3.109) | −0.454* (0.273) | −0.837 (0.991) |
| Control variables | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Time effects | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| First-stage residuals | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Constant | 0.497 (0.586) | 2.385*** (0.135) | 1.047*** (0.146) | 2.948** (1.380) | −7.480*** (2.840) | 2.648*** (0.140) | 2.985** (1.315) |
| Observations | 13,626 | 10,438 | 20,730 | 10,419 | 5,290 | 8,216 | 8,395 |
| Log Likelihood | −43,085.610 | −35,830.490 | −51,052.440 | −24,185.010 | −51,460.240 | −61,198.610 | −20,510.610 |
| Akaike Inf. Crit. | 86,217.220 | 71,706.970 | 102,150.900 | 48,416.010 | 102,966.500 | 122,443.200 | 41,065.220 |

$*p < 0.1$; $**p < 0.05$; $***p < 0.01$. Bootstrap standard errors are in parentheses. The same control variable and procedure have been adopted as in the main analysis. The countries are Austria (AT), Belgium (BE), Bulgaria (BU), Czech Republic (CZ), Greece (EL), Spain (ES), Finland (FI), France (FR), Hungary (HU), Italy (IT), Poland (PL), Romania (RO) Sweden (SE) and United Kingdom (UK)

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