Does early centre-based care have an impact on child cognitive and socio-emotional development? Evidence from Chile

Marigen Narea

Contents

i

Centre for Analysis of Social Exclusion

The Centre for the Analysis of Social Exclusion (CASE) is a multi-disciplinary research centre based at the London School of Economics and Political Science (LSE), within the Suntory and Toyota International Centres for Economics and Related Disciplines (STICERD). Our focus is on exploration of different dimensions of social disadvantage, particularly from longitudinal and neighbourhood perspectives, and examination of the impact of public policy.

In addition to our discussion paper series (CASEpapers), we produce occasional summaries of our research in CASEbriefs, and reports from various conferences and activities in CASEreports. All these publications are available to download free from our website. Limited printed copies are available on request.

For further information on the work of the Centre, please contact the Centre Manager, Jane Dickson, on:

Telephone: UK+20 7955 6679
Fax: UK+20 7955 6951
Email: j.dickson@lse.ac.uk
Web site: http://sticerd.lse.ac.uk/case

Abstract

Worldwide, non-maternal child care during the first years of life has gradually become more prevalent. However, there is little evidence for Chile about the benefit of early attendance at centre-based care—especially universal early childhood programs for under-three-year-olds—and child development. This study explores the association between two-year-olds' attendance at day care and child development. Attendance at day care (versus maternal care) between the ages of 24 and 36 months is positively associated with child cognitive development and shows insignificant association with child socio-emotional development. In addition, more daily hours in centre-based care is positively associated with cognitive outcomes, but negatively associated with socio-emotional outcomes. Additionally, the association between attendance at centre-based care and socio-emotional outcomes is more negative for children of lower income households relative to children of higher income households. The analyses use a Chilean panel survey and control for child, maternal, and family characteristics as well as for unobserved individual fixed effects. The results are consistent using both OLS regressions and propensity score matching techniques. Implications for future research and social policies are discussed.

Key words: Early childhood; Centre-based care; Child care; Child development

JEL number: J130 J180 I210

Corresponding author: Marigen Narea (m.s.narea-biscupovich@lse.ac.uk)

1. Introduction

Traditionally, most mothers cared for their children under three years old at home. However, nowadays, in OECD countries, 51.4 per cent of mothers of children under three years old work (OECD Family database, 2013). This implies that at least half of the children are receiving some type of non-maternal care. In OECD countries, the average proportion of children under the age of three in child care is 25 per cent. This same proportion is more than 50 per cent in specific countries (for example, Denmark or Iceland) (UNICEF, 2008). In Chile, 18 per cent of toddlers[1] are in centre-based care[2] (Ministerio de Educacion de Chile, 2014). High-quality early childhood interventions set solid foundations for the future learning of children (EFA Global Monitoring Report 2007), hence, facilitating children to experience intellectual stimuli early in life is a key challenge for policy makers who are in charge of expanding and improving early childhood education and care (ECEC) provision.

The evidence from developed and developing countries on ECEC shows that attendance at high-quality preschool programs (relative to maternal care), has a positive impact on children's cognitive development (Burger, 2010; Camilli et al., 2010; Magnuson, Ruhm and Waldfogel, 2007). However, the impact on children's socio-emotional or behaviour outcomes is unclear. Some studies have found a positive association between attendance at centre-based care (compared to maternal care) and socio-emotional development (Sylva et al., 2004). In contrast, other studies have found that attendance at centre-based care is associated with more dysfunctional behaviour in children (Abner et al., 2013; Coley, Votruba-Drzal, Miller and Koury, 2013; Magnuson, Ruhm and Waldfogel, 2007). Most of this evidence is for children aged three to five years. Less is known about the association between early attendance at centre-based care—particularly in universal, publicly-funded early childhood programs in infant and toddler years (under three years old)—and child development.

On the one hand, neuroscientists, psychologists and behavioural scientists have concluded that high-quality ECEC (during infant or toddler years) could enhance child development. One of the mechanisms underlying the previous prediction is that critical aspects of children's brain architecture are formed during the infant and toddler years (Knudsen, 2004; National Research Council and Institute of Medicine, 2000). In addition, a stimulating environment could enhance the child's acquisition of learning and social skills (Shonkoff, 2010; National Scientific Council on the Developing Child, 2007).

On the other hand, there is a concern about possible detrimental effects of centre-based care (relative to maternal care) for children who enrol at centre-based care before the

---

[1] Terminology: The term 'toddlers' refers to children between the ages of one and three.

[2] Terminology: I use 'child care' as a general term for a set of programs and arrangements in the early education and care (ECEC) sector. The term 'centre-based care' refers to a group setting arrangement attended by children of age three and under (nursery and day care).

age of three. This concern is probably driven by the attachment theory and the inference from this theory that non-maternal care could affect mother-child interaction (Belsky, 2001) and also by the learning theory and its questioning of whether non-maternal care gives adequate child stimulation (Lamb and Ahnert 2006). However, the evidence for or against the inferences from the two previously mentioned theories is thin and there is a lack of consensus on whether early centre-based care is detrimental to child development.

Some researchers have found that the impact of centre-based care on child developmental outcomes is heterogeneous depending on the age at which the child enters into this type of care (Lekhal, 2012; Loeb et al., 2007). The association between early attendance at centre-based care and child development could also be heterogeneous depending on the time ('intensity') that the child spends in day care. For example, spending more hours in centre-based care is associated with more child behavioural problems (Belsky et al., 2007; NICHD Early Child Care Research Network, 1999, 2004; NICHD National Early Child Care Research, 2003). The level of vulnerability of the child's household could also be a relevant moderator in the relation between attendance at centre-based care and child development. Children from poor families or with mothers with a lower level of education benefit more from centre-based care than do their less vulnerable counterparts (NICHD Early Child Care Research Network. 2006; Burger, 2010; Peisner-Feinberg et al., 2001).

The aim of this study is to analyse the effect of centre-based care attendance at two years old on child cognitive and socio-emotional outcomes measured on children aged between three and four years old in Chile. I also explore whether the previous relation varies according to the intensity of centre-based care (full-time or part-time) or the level of vulnerability of the child's family. In this study, I use the two available waves (2010 and 2012) of the dataset Longitudinal Survey of Early Childhood (Encuesta Longitudinal de Primera Infancia, or ELPI in Spanish). My analyses use multivariate regressions, propensity score matching, and individual fixed effects techniques.

This paper is organised as follows. In Section 2, I review the results from previous studies about child care and child development in children under three years old, state hypotheses about some moderators in this association, and identify the gaps in the literature. In Section 3, I describe the dataset and the estimation method. In Section 4, I present the results and in Section 5, I discuss the results and conclude.

2.   Literature Review

An increasing amount of evidence highlights the positive impact of high-quality centre-based care on children's short-, medium-, and long-term development outcomes. In the USA, during the 1960s and 1970s, two small-scale field experiments called the HighScope Perry Preschool Program and the Abecedarian Project took place. Both experiments provide causal evidence that participation in such high-quality early childhood programs can improve children's future educational attainment, employment opportunities, and earnings and can decrease their probability of committing crimes

(Heckman, 2006; Heckman et al., 2010; Campbell et al., 2002). Recent evaluations of large-scale universal preschool programs also in the US corroborate the previously found large effects of high-quality centre-based care—especially in cognitive outcomes (Weiland and Yoshikawa 2013). In addition, international and UK-based observational studies also found that centre-based care improved child outcomes (Sylva et al., 2004; Sammons et al., 2007; Ruhm and Waldfogel, 2011).

Importantly, the quality of care provided by the centre is critical because attendance at low-quality early childhood educational programs can be detrimental to child development (Belsky, 2011; National Institute of Child Health and Human Development Early Child Care Research Network, 2003). Moreover, as mentioned in the introduction, children from more disadvantaged backgrounds (less educated, low income, or immigrant parents) benefit more from centre-based care than their wealthier peers (for some examples, see Ruhm and Waldfogel, 2011).

Although there is a wide consensus that ECEC represents a unique opportunity to boost children's abilities and learning, much of this evidence is for children aged three and above; hence, the impact of centre-based care on infants and toddlers still remains unclear.

2.1   Does exposure to centre-based care at two years old improve child development?

Theory is inconclusive on whether early centre-based care attendance (before three years old) is positive or negative for child development. Given that from age two onwards, children start interacting with their peers more actively, entry into centre-based care at two years old could be associated with positive outcomes in the cognitive and socio-emotional domains. The surge in children's ability to interact provides a perfect opportunity to learn from social interactions and to learn to solve conflicts with peers (Hartup and Moore 1990). At the same time, the development of a child's ability to interact with others helps the child to build more positive relationships with their care providers; the latter is a crucial element for children to benefit cognitively from the centre-based care experience (Pierrehumbert et al., 1996). If this were the case, early entry into centre-based care could foster child social and cognitive skills and better equip children for entry into school (Lamb and Ahnert 2006).

On the other hand, according to attachment theory, attendance at centre-based care for children between the ages of one and three may be problematic for their development. Attachment theory states that care by a single caregiver facilitates child development (Bowlby, 2008; Ainsworth and Bowlby, 1991). Given that centre-based care, especially early in life, implies separations for long hours from the child's primary attachment figure (mainly mothers) early enrolment in centre-based care may disrupt attachment bonds and, thus, have adverse effects on child socio-emotional development (Belsky and Rovine, 1988).

For children under three years old, the empirical evidence about the impact of centre-based care on child development is thin and inconclusive. Most of the evidence about the association between attendance at centre-based care and child development is for children aged three to five years old.

The evidence about the effect of attending centre-based care before three years old shows mixed results. One important source of evidence is the introduction in the province of Quebec (Canada) of publicly subsidised formal and informal care for children aged zero to four in 1997. Baker, Gruber and Milligan (2008), used a differences-in-differences model where children in Quebec were the treatment group and children from the rest of Canada were the control group. They found that the publicly-funded care had a significantly negative effect on children between zero and three years old on child motor and social skills—a significant decline of more than 10 per cent of a standard deviation. The authors explain this finding, arguing that the provision of publicly-funded care increased working mothers' employment rate; this could have implied a poorer adult-child relationship and worse parental health; in turn, both consequences are associated with lower child development indicators. In addition, Lefebvre, Merrigan and Roy-Desrosiers (2011) concluded that Canadian child care had a negative effect on children's vocabulary scores (using the Peabody Picture Vocabulary Test, or PPVT) measured at five years old. They suggest that for this negative effect could be that children under three years old spent too much time in low-quality child care.

In contrast, Felfe and Lalive (2012) using the German Socio-Economic Panel (GSOEP) found a small, positive effect of early centre-based care attendance (for children from zero to three years old) on language and social skills. They also found that younger children and children from lower socio-economic backgrounds benefitted more from centre-based care attendance compared to older and wealthier children respectively. To reach their conclusions, Felfe and Lalive (2012) exploited county-level differences in the availability of centre-based child care.

In addition, observational studies based in the UK found that attendance at early centre-based care is associated with better cognitive skills compared to children cared for by their mothers. Loeb et al. (2007), found that on average, starting at centre-based care between zero and four years old is associated with positive effects on pre-reading and mathematics skills. Specifically, they found that children who start centre-based care between two and three years old are the ones who benefit the most in cognitive terms. Loeb et al. used data from the Early Childhood Longitudinal Study (ECLS-K) and performed their analysis using OLS, matching and instrumental variable models. Hansen and Hawkes (2009) using data from the Millennium Cohort Study—a longitudinal survey of around 19,000 children born in the UK—also found a positive association between early child care (nine months) and child school-readiness test scores. Finally, Sammons et al. (2004), using data from the EPPE project in the UK, found that children who start preschool education before they were three years old presented higher cognitive achievement than those who start later; these gains continued through primary school.

On the other hand, there is an ongoing debate about the effects of centre-based care relative to maternal care during the first three years of life on child socio-emotional development. Studies show heterogeneous results such as negative as well as neutral effects of early attendance at centre-based care on child socio-emotional development. Using data from the EPPE project, Loeb et al. (2007) concluded that non-parental care during the first three years of a child's life is associated with detrimental effects on behavioural and social skills. Sammons et al. (2007) found that children who attended centre-based care before they were two years old had higher levels of antisocial behaviour than children who stayed at home. However, this relationship had disappeared by the age of ten. In contrast, some European studies concluded that attendance at a publicly-funded centre-based care before age three does not have a negative effect on children's social skills and school attainment. Barnes et al. (2010) based on a sample of 1,016 families in England, concluded that there was no evidence of adverse consequences of attending non-parental care (versus maternal care) during the first three years of life on child socio-emotional development at the age of three. Similarly, Hansen and Hawkes (2009) found no association between formal group care at nine months and problematic behaviour at age three.

In addition, Gupta and Simonsen (2010) using the Danish Longitudinal Survey of Children (DALSC) found that being enrolled in publicly-funded universal child care at age three versus being in maternal care does not have a significant effect on child behavioural skills. To reach this conclusion, Gupta and Simonsen (2010) exploited the variation in the take-up rate of preschools across municipalities. Additionally, in a recent study using data from the USA, Jaffee, Van Hulle and Rodgers, (2011) found no effect of attendance at centre-based care before three years old on children's behaviour problems.

Three studies using data from Chile found that attendance at publicly-funded child care before the age of three has a positive impact on child cognitive development but mixed results on socio-emotional development. Noboa-Hidalgo and Urzua (2012) found mixed results on the effect of publicly-funded child care expansion on child development. According to these authors, attendance at centre-based care during the first two years of life has a positive impact on emotional regulation and motor skills, and a negative effect on child-adult interactions, reasoning, and memory. Noboa-Hidalgo and Urzua (2012) point out the possibility that the low quality of some centre-based care could negatively affect child development. To reach these conclusions, the authors used a longitudinal dataset from Chile of 482 children younger than two years old; they also used a variety of methods for the estimation of the effects including ordinary least squares, instrumental variables, and control function approaches. In addition, Arnold (2013) using only a single wave of data from the survey used in this paper (ELPI 2010 survey) and a propensity score matching method, concluded that attendance at children aged two to five at publicly-funded centre-based care enhances both psychomotor and language development; however, he did not find a significant effect on child socio-emotional development. Finally, Cortazar (2011) based on a large administrative dataset from Chile found that children aged two to four who attended publicly-funded centre-

based care scored significantly higher on maths, reading, and social science tests at the age of 10 compared to children who did not attend centre-based care.

Based on the previously described theoretical and empirical evidence, there is no clear conclusion about the effect of early childhood education and child development during the first three years of life. In the context of an increasing incorporation of women into the labour market, and hence a necessity for non-parental child care, it is crucial to have evidence about the effect of non-parental care—in particular centre-based care because of its prevalence—on infant and toddler development.

2.1.1. Does the intensity of centre-based care matter for child development?

There is no clear consensus about the effect of the amount of hours per day of attendance at centre-based care ('intensity of care') on child development. The main source of information about the previously stated question comes from the US-based, large-scale National Institute of Child Health and Human Development (NICHD) Study of Early Child Care (SECC). This study analyses the effects of intensity of care for children aged three months to four and a half years on child development. The conclusion of the NICHD Early Child Care Research Network (2004) is that more daily hours of exposure to centre-based care during the toddler years is associated with better language skills measured at four and a half years old.

On the other hand, Jacob, (2009) in a critical review of studies published between 1998 and 2006, emphasized that the quantity of non-maternal care is the strongest and most consistent predictor of child socio-emotional problems. Regardless of child care quality, children who spend more than 30 hours per week in centre-based care tend to be less sociable and have more behaviour problems than children who spend less than 30 hours per week in centre-based care (NICHD Early Child Care Research Network 2003). This association is robust to long-term measurements of child development such as in Belsky et al. (2007) who had data until sixth grade. However, the previously mentioned association disappears by age 15 (Vandell et al., 2010).

McCartney et al. (2010) highlighted that there is a non-robust association between centre-based care hours and child socio-emotional problems. In some specifications, they find that exposure to higher intensity of centre-based care (as opposed to lower intensity) is associated with more externalizing problems. McCartney et al. (2010) found that the association between centre-based care hours and externalizing behaviour was modest, but increased when children were in low-quality centre-based care and when children spent most of the time with a large group of peers. However, this finding was not robust to different functional forms.

Attachment theory predicts that more intensity of centre-based care (as opposed to less intensity) is associated with worse child socio-emotional development. Specifically, attachment theory proposes that the quantity of attendance at ECEC, which is also time away from the mother, induces an insecure baby–mother attachment that could have a negative impact on the child's ability to regulate her emotions (Belsky, 2002).

However, the NICHD Early Child Care Research Network (2003) did not find evidence to support Belsky's (2002) assertion. Belsky (2001) also predicts that more hours per week of child care pose risks for infant–parent relationships and child behavioural adjustment. If parents are away from their children for longer hours, it might be more difficult for them to get to know their children well and to respond adequately to their children's necessities. This argument is supported by the evidence that more hours in child care are correlated with less sensitive mothers and children less engaged with their mothers (NICHD Early Child Care Research Network, 1999).

2.1.2. Early centre-based care attendance and child vulnerability

High-quality early childhood programs have a greater positive impact on children from disadvantaged backgrounds (low income or mother's low education) compared to the impact on children from wealthier households (Burger, 2010; Crosnoe et al., 2010; Felfe and Lalive (2012); Gilliam and Zigler, 2000; NICHD National Early Child Care Research Network and Duncan, 2003; Peisner-Feinberg et al., 2001). Moreover, Ruhm and Waldfogel (2011) concluded that only the most vulnerable children benefit from attending centre-based care. Similarly, Caughy, DiPietro and Strobino (1994) reported that centre-based care attendance in the first year of life is associated with future higher reading scores and mathematics scores for children from less educated households.

In a related strand of literature, Liu and Skans (2010) conclude that children of highly educated parents benefit in cognitive terms from delaying entry into centre-based care from 12 to 15 months. Likewise, Felfe and Lalive (2012) found that children from more advantaged backgrounds are the ones who benefit least from centre-based care attendance. In contrast, Cortazar (2011) using Chilean data, concluded that children aged two to four and of middle socio-economic status are the ones who seem to benefit most from attending centre-based care programs. Hence, Cortazar concludes that the children of low- and upper-middle income groups benefit little or not at all from attending centre-based care.

There are several hypotheses behind the findings about the heterogeneity of the impact of centre-based care attendance on child development by the child's level of vulnerability. The 'compensatory hypothesis' states that more vulnerable children could benefit more from high-quality early child care than children from wealthier backgrounds because child care could provide learning opportunities that more vulnerable children do not have at home (Geoffroy et al. 2010). In contrast, the 'lost-resources hypothesis' states that children from high- or middle-income households develop less when they attend centre-based care than when they are in maternal care because the environment is less stimulating in the former than in the latter type of care (Caughy et al., 1994; Desai, Chase-Lansdale and Michael, 1989).

2.2.   *Chilean context: Early childhood education and care policies*

The Economist Intelligence Unit (2012) ranks Chile 20th of 45 countries in the Starting Well Index, across the OECD and major emerging markets. Chile is above countries that have a significantly higher gross domestic product such as the USA (24th) and Canada (25th). Chile's high investment in increasing preschool coverage is key in its relatively high position in this ranking.

According to Chile's national socioeconomic household survey (*La Encuesta de Caracterización Socioeconómica Nacional*, or CASEN), the enrolment rate in centre-based care has increased considerably and consistently from 16 per cent in 1990 to 44 per cent in 2011. Since 2006, the Chilean government has been increasing access to centre-based care, especially for the most vulnerable children. In 2009, the Government enacted a law to create a comprehensive childhood protection system called "Chile Grows with You" ("*Chile Crece Contigo*", hereafter CCC). The aim of CCC is to foster the development of children from zero to four years of age via an integrated system of benefits, interventions and social services that support the child and her family. While the system focuses on health, it also guarantees free access to publicly-funded centre-based care for young children from the poorest 60 per cent of households (UNESCO 2010). Between 2006 and 2009, there was an increase in the number of day care centres in Chile from 781 to 4,300 (Economist Intelligence Unit 2012). In 2011, about 73 per cent of four-year-old children, and 93 per cent of five-year-old children attended centre-based care.

As in most countries, the enrolment in centre-based care of children under the age of three is lower than the enrolment of children between the ages of three and five. In 2010, only 10 per cent of one-year-olds and 33 per cent of two-year-olds attended centre-based care in Chile (CASEN, 2011). In addition, the levels of centre-based care participation are unequal across income levels. For example, in 2009, while only 16 per cent of children under four years old in households within the poorest income quintile attended centre-based care, the same proportion in households within the wealthiest income quintile was 34 per cent (CASEN, 2009).

Preschool provision in Chile is focused on children aged five and younger and it is organised in the levels shown in Table 1.

In the context of this study which analyses the association between centre-based care attendance at two years old and child development, my analysis is centred on attendance at the day care level ('*jardin infantil*').

In Chile, both the private and public sectors provide preschool education and care services to children between zero and five years old. Within this mixed provision of preschool education and care, depending on the type of administrator, there are three types of centre-based care: public, subsidised-private, which are administered privately but publicly-funded, and non-subsidised private centres, which are administratively and financially independent of government. Almost 90 per cent of day care centres receive

funding from the Chilean government. The two main public centre-based care providers are the National Board of Education (*Junta Nacional de Jardines Infantiles* or JUNJI) and the Integra Foundation; together, they account for about 50 per cent of preschool coverage in Chile. In addition, 40 per cent of the coverage is provided by subsidised-private entities and the remaining 10 per cent, by non-subsidised private entities (Ministerio de Educación de Chile, 2014).[3]

Table 1: Age and preschool arrangement in the Chilean system of early childhood education and care

Educational level's formal name	Educational level's common name	Age
Sala Cuna	*Sala cuna* (Nursery)	3-11 months
	Sala cuna (Nursery)	12-23 months
Nivel Medio	*Jardín infantil* (Day care)	Twenty-four to thirty-five months old
	Jardín infantil (Day care)	Thirty-six to forty-seven months old
Nivel de Transición	Prekinder	Forty-eight to fifty-nine months old
	Kinder	Sixty to seventy-one months old

Despite Chile's dramatic increase in preschool coverage during the period from 2006–2011, the improvement in quality is unknown and, most likely, limited (The Economist Intelligence Unit Starting Well Index, 2012). Chile does not have a national preschool curriculum, only national guidelines. In addition, the country has a lack of quality standards and regulations (OCDE 2011). Moreover, the entry into preschool teacher training is one of the least selective within university degrees in Chile (Tokman 2010). Finally, the results of the INICIA test, which is a voluntary test that measures disciplinary and pedagogical knowledge of recently graduated preschool teachers, indicate that more than 60 per cent of them obtained poor results (INICIA, 2012). Poor results in the INICIA test mean that preschool teachers do not have the knowledge or skills necessary to perform their duties to an adequate level.

3.   The Present Study

This study analyses three main research questions. The first research question is whether there is any association between entering into centre-based care at age two and child cognitive and socio-emotional development at ages three and four. Given that the

---

[3]   As a reference point: while in the UK a 71.2 per cent of preschool institutions are public, 11.1 per cent are subsidised-private and 17.7 per cent are non-subsidised private. In the US, while 55.2 per cent of preschool institutions are public, 44.8 per cent are private.

theory has an ambiguous prediction about the effect of attendance at centre-based care at two years old on child development and that the empirical findings yield ambiguous conclusions, in this article, I want to contribute to the understanding and integration of the disparate predictions and findings in the context of a middle-income country.

The second research question is whether the impact of early centre-based care (relative to maternal care) on child outcomes differs according to the intensity of centre-based care (part-time versus fulltime). Based on previous evidence, I hypothesise that more intense attendance at centre-based care (full-time relative to part-time) could have an increasingly negative effect on child development. Previous evidence that analyses the impact of early maternal employment on child development is in line with the hypothesis that the time that children spent away from their mother matters.

The third research question is whether the association between centre-based care and child development varies by child vulnerability. To measure child vulnerability I use low level of maternal education and whether the child's household is poor under Chile's standards as proxy variables. One of the Chilean government objectives of providing child care to the 60 per cent most vulnerable children in Chile is to reduce socioeconomic-based educational inequalities. Hence, this study analyses whether there are differences in the association between centre-based care attendance and child development outcomes depending on the child's level of household vulnerability.

The analysis presented in this paper seeks to provide unbiased estimates for all the previous questions. The individual fixed effects analysis allows me to control for unobserved fixed characteristics of the mother and the children, like innate ability, that could bias the cross-section estimates. In addition, the use of propensity score matching allows me to avoid restrictive assumptions (typically, linearity ones) about the relation between the covariates and the outcome variable (Drake, 1993). Moreover, the ELPI dataset of 15,000 Chilean households permits me to control for an extensive set of baseline characteristics where omission could introduce bias in my estimates in cases when these initial characteristics are correlated with both attendance at centre-based care and future child development maintaining an adequate power to detect relevant effects.

4. Method

4.1. Sample and Procedure

I use data from the Chilean panel survey, Longitudinal Survey of Early Childhood or 'Encuesta Longitudinal de la Primera Infancia' (ELPI)), a nationally representative sample of children between six months and five years old (born between 1st January, 2006 and 31st August, 2009). The ELPI dataset includes socio-demographic data with variables such as parental educational attainment, employment, socio-economic status, the child's characteristics at birth, and the child's history of child care. In addition, this

dataset includes the caregiver and children's physical, cognitive and social-emotional development assessments (see the Measures section below).

For this study I used the two waves from the ELPI dataset that are currently available (2010 and 2012). The sample used for this analysis consists of children who were cared for full-time by their mothers until at least two years old, who were less than two years old in 2010, and whose information was collected in both waves of the ELPI longitudinal survey. I restrict my sample in the described way for several reasons. First, I want to study the previously mentioned impact of entry at two years old at centre-based care on child development because the age range where there is less evidence is under three years of age. Second, before two years old most of the children were either with their mothers or in informal child care (relatives, grandparents). From two years old onwards, centre-based care starts being a more prevalent type of care. In total, this sample consisted of 1,589 children; however, depending on the missing values of the specific dependent variable (child development outcomes), the sample size fluctuates between 1,345 and 1,433 children. As depicted in Table 2, out of the previously described relevant sample, while 40 per cent of children were with their mothers, 44 per cent of children attended centre-based care, and 16 per cent attended other types of non-maternal care (grandparent, relative or non-relative care).

Table 2: Timing of entry into centre-based care

Child's age entering care	Centre-based care		Other type of care		Maternal care	
	Number	Percentage	Number	Percentage	Number	Percentage
0-3 months	83	0.75	757	6.80	10,289	92.45
3-6 months	524	4.71	1,440	12.94	9,168	82.36
6-12 months	1,229	11.03	2,127	19.09	7,787	69.88
12-18 months	1,945	17.44	2,460	22.06	6,745	60.49
18-24 months	2,615	23.44	2,347	21.03	6,196	55.53
24-36 months	4,873	43.69	1,855	16.63	4,425	39.68
36-48 months	6,940	67.12	940	9.09	2,460	23.79

Notes: Timing of entry into child care is divided into seven groups: 1) children who started attending between 0 and 3 months old; 2) children who started attending between 3 and 6 months old; 3) children who started attending between 6 and 12 months old; 4) children who started attending between 12 and 18 months old; 5) children who started attending between 18 and 24 months old; 6) children who started attending between 24 and 36 months old; and, 7) children who started attending between 36 and 48 months old.

There are three child care categories: 1) centre-based care that is in a group setting; 2) other types of care could be grandparent, relative, or non-relative care and 3) maternal care, in which the child stays with his or her mother all the time.

4.2 Measures

4.2.1 Dependent variables: Children's cognitive and socio-emotional skills

The present study uses the cognitive outcome measures available in both waves of the ELPI survey. In 2010, the ELPI survey included the cognitive tests the Battelle Developmental Inventory and the Psychomotor Development Evaluation Scale (*Escala Evaluación Desarrollo Psicomotor*, or EEDP). In 2012, the ELPI survey included the Battelle Screening Test and the Child Development Cognitive Test (*Test de Aprendizaje de Desarrollo Infantil*, or TADI').

The Battelle Developmental Inventory test (for children aged 12-24 months) is widely used in international studies. It is a semi-structured assessment that involves observation of the child, interviews with parents and caregivers, and interaction with the child using toys, questionnaires and tasks. The complete Battelle Developmental Inventory has 341 items and assesses five domains of development: adaptive behaviour, personal/social skills, communication, gross and fine motor ability, and cognitive skills (Berls & McEwen 1999). The Battelle Screening Test used in the 2012 ELPI survey is a subset of items from the full Battelle Developmental Inventory.

The EEDP (12-24 months) test is an instrument developed in Chile during the 1970s. This instrument is widely used in the country's public health centres and health research for measuring cognitive skill development (Bedregal 2008). The EEDP is the first standardised psychomotor development test made in Chile for infants between 0 and 24 months old. The EEDP test has 75 items in total and assesses four domains. Firstly, the EEDP assesses the motor domain by evaluating gross motor skills, body coordination, and postural reactions. Secondly, this test assesses the language domain by evaluating children's verbal comprehension as well as both verbal and nonverbal reactions to sounds. Thirdly, the EEDP assesses the social domain by evaluating the child's ability to react to people and to learn through imitation. Fourthly, the EEDP assesses the coordination domain by evaluating the child's ability to coordinate different functions (Rodriguez, Arancibia, & Undurraga, 2008).

The TADI test is a recently developed test in Chile for children from three months to six years old. One of the goals of the authors of the test was to have a valid, reliable, and pertinent instrument for the current Chilean context. The test evaluates four dimensions: motor, language, cognitive and social-emotional. The TADI is applied individually to children and requires the presence of an adult significant to the child. The TADI test has items divided into three formats: direct measurement of the child, observations by the test-taker, and asking the caregiver to undertake some joint tasks with the observed child. Each item has a score of 1 or 0 in relation to the achievement or non-achievement of aspect being assessed.

Finally, in the present study I use the socio-emotional outcome measures that are available in the 2010 ELPI survey for children aged 12 to 24 months and that were also conducted on the same children in 2012. More than half of the children between 12 and

24 months old in 2010 were measured by the 'Child Behavior Checklist' (CBCL) test. The children who were evaluated in ELPI 2010 by the CBCL test were 18 to 24 months old at the time. The CBCL test is one of the most widely-used standardised measures in child psychology for evaluating behavioural and emotional problems (Ivanova et al. 2007). In this test, mothers report aspects of their child's behaviour. The test assesses two broad socio-emotional problems, internalising (for example, anxious, depressive, and over-controlled) and externalising (for example, aggressive, hyperactive) behaviours. The CBCL test measures several sub-areas, including social withdrawal, somatic complaints, anxiety and depression, destructive behaviour, social problems, sleeping problems, attention problems, and aggressive behaviour (Achenbach & Ruffle, 2000). The CBCL has 100 items rated on a three-point scale from zero (not true about the child) to two (very true about the child).

Table 3: Child outcomes measurement 2010-2012

	2010	Child's age range	2012	Child's age range
Cognitive development	Batelle Inventory	12 to 23 months	Battelle Screening Test	36-48 months
	Escala Evaluación Desarrollo Psicomotor (EEDP)	12 to 23 months	TADI Tests	36–48 months
Socio-emotional development	Child Behavior Checklist (CBCL)	18 to 24 months	Child Behavior Checklist (CBCL)	36-48 months
	Ages & Stages Questionnaires: Social-Emotional (ASQ–SE)	9 to 17 months		

Note: The cognitive outcomes tests are the Battelle Inventory and Battelle Screening test which assess five domains: adaptive behaviour, personal/social skills, communication, motor ability, and cognitive skills. In addition the *Escala Evaluación Desarrollo Psicomotor* (EEDP) assesses the motor, language, social domain and coordination domains and the TADI (*Test de Aprendizaje de Desarrollo Infantil*, in English 'Child Development Cognitive Test') evaluates four dimensions: motor, language, cognitive, and social-emotional. One of the socio-emotional outcomes tests is the Child Behavior Checklist (CBCL) test that evaluates behavioural problems, externalizing problems, and internalising problems. This test was administered to children aged 18 to 24 months. The other socio-emotional outcomes test is the Ages & Stages Questionnaires: Social-Emotional (ASQ–SE) test that evaluates children's social and emotional behaviour through self-regulation, compliance, communication, adaptive functioning, autonomy, affect, and interaction with people. This test was administered to children aged 12 to 18 months.

The remaining 44 per cent of the children aged between 12 and 24 months in 2010 were measured in 2010 using the 'Ages & Stages Questionnaires: Social-Emotional (ASQ–SE)' test and in 2012 by the CBCL test. This group of children were aged 12 to 18 months in 2010. The ASQ-SE consists of questionnaires that are completed by parents or caregivers. This test evaluates children's social and emotional behaviour in the dimensions of self-regulation, compliance to rules, communication, adaptive functioning, autonomy, affect, and interaction with people (Reynolds et al., 2000). The ASQ-SE test has different versions depending on the age of the children. The ASQ-SE

12 months measures children between 9 months and 14 months old and the ASQ-SE 18 months measures children between 15 months and 17 months old.

To facilitate comparisons of my results with the rest of the literature, I work with standardised test scores. First, the Research Institute which runs the ELPI survey adjusted the raw test scores to account for the age of each child according to the conversion tables of each instrument. Second, I standardised these adjusted scores (zero mean and standard deviation unity).

4.2.2. Key variable: Early child care attendance

The first focus in the analysis is exploring whether early child care attendance is associated with child development. I exploit the fact that the ELPI survey has detailed information about the children's type-of-care history between zero and 60 months old. Using the question about the children's main type of care in each period between zero and 36 months old and whether the child attended centre-based care during the same period, I construct a variable that denotes transition from maternal care to centre-based care at 24 months old. See Appendix 1 for a detailed explanation of the previously mentioned variable construction.

4.2.3. Moderating variables: Intensity of care and child vulnerability

The second focus of this study is analysing whether the intensity of time (part-time or full-time) that the child spends in centre-based care at two years old moderates the association with child development. On average, full-time centre-based care implies a daily attendance at this type of care from 8:30 to 16:30. However, publicly-funded centre-based care has an extended schedule for working mothers from 8.30 to 19:30. Based on this information, full-time attendance could imply between 40 and 55 hours per week of attendance at centre-based care. While 60 per cent of children in centre-based care attended this type of care on a full-time basis, the rest attended part-time[5.]

Finally, this study analyses whether child vulnerability is a relevant moderator in the association between centre-based care attendance and child development. I measure child vulnerability using three proxy variables: maternal education, household poverty level and household income. I consider that mothers with a low education level are those ones with less than twelve years of education (i.e. who did not achieve a high school degree). According to this criterion, 43 per cent of mothers in the ELPI survey have a low level of education.

I test whether household socio-economic status moderates the association between centre-based care attendance and child development. First, I dichotomise household per capita income into poor and non-poor. I use Chile's 2010 poverty line (less than £70 or

---

[5]   Unfortunately, concerning intensity of care, the ELPI dataset only has information about attendance to part-time or full-time centre-based care. It does not include information about the number of hours per week spent in centre-based care.

64.000 Chilean pesos per capita per month[6]) to define poor households. Using this criterion, 58 per cent of households in the sample classify as poor[7.] A greater proportion of families that include children tend to be in poverty, especially those with children younger than three years old. In Chile, 26 per cent of households with children under six belong to the lowest quintile (Herrera et al., 2011). Second, to explore a potential heterogeneity in the impact of centre-based care depending on the whole income distribution, I divided family income into quintiles and performed separate analyses for children in each income quintile.

4.2.3. Explanatory variables

The regressions account for differences between children in different types of care across a comprehensive set of child, maternal, family, and geographic characteristics. All of them are predetermined because, while the outcome variable is from ELPI 2010 and 2012, I only use the explanatory variables from ELPI 2010. The set of child characteristics includes the child's gender, age, birth weight, whether she has an older sibling or was born prematurely. Maternal characteristics include the mother's age, marital status, years of education, whether she worked or had depressive symptoms before birth. In addition, The Wechsler Adults Intelligence Scale ('WAIS') measured maternal cognitive abilities. The test has 7 verbal subtests and 7 performance subtests (Kaplan & Saccuzzo 2009). The ELPI survey used only two out of the 14 subtests: vocabulary and digit span. The WAIS vocabulary subtest assesses mothers' ability to properly receive, store and use new information. On the other hand, the WAIS digit span subscale evaluates the mother's working memory and processing speed; additionally, it measures short-term memory, sequencing under distracters, capacity to deal with numbers and mental alertness.

Finally, I also controlled for maternal personality characteristics measured by the Spanish Big Five Inventory (henceforth, BFI). The BFI is a questionnaire of 44 items that assesses personality in the following dimensions: extraversion, agreeableness, conscientiousness, neuroticism, and openness (John et al. 2008). In addition, I also included whether the mother drank alcohol or smoked during pregnancy, was a teenage mother, had difficulties during pregnancy or breastfeeding as regressors in the analysis.

In addition, I also control for family characteristics such as the child's home learning environment measured using ELPI 2010. Additionally, I control for the score of the Home Observation for Measurement of the Environment ('HOME'). The ELPI 2010

---

[6]   Implicitly, Chile uses an equivalence scale where each child weights the same as every adult in the calculation of income per capita. Chile's poverty line is consistent with this implicit equivalence scale.

[7]   ELPI only selected families with at least one child between zero and six years old. Hence, the selected households have more children than the average Chilean household and, possibly, the breadwinners are younger than the average Chilean workers. Both factors imply a higher rate of poverty. In addition, due to underreporting of income in household surveys, household income in the ELPI survey is a lower bound for the real household income. It is worth mentioning that incomes in the ELPI survey were not rescaled to match the national accounts.

15

survey used the Infant-Toddler HOME test (zero to three years old), in which the information is obtained through observations and interviews with the child's primary caregiver at home. The Infant-Toddler HOME version comprises 45 items that are presented as statements to which the caregiver must respond yes (scoring one) or no (scoring zero). Higher total HOME scores indicate a more enriched home environment. I also controlled for average household income over the last twelve months from all sources of income. Finally, I also controlled for geographic variables such as region where the child lives and whether the area is rural or urban; both variables are intended to capture part of the heterogeneity of centre-based care coverage in different zones of the country. The coverage of centre-based care is higher in urban areas relative to rural areas. Centre-based care coverage is also higher in Santiago's Metropolitan area relative to the coverage in the north and south of Chile. (Ministerio de Educacion de Chile 2014)

4.3. Data Analysis

To respond to the research questions stated in section 2.3, I estimate the reduced-form association between early centre-based care attendance and short-term effect on child development, controlling for a broad set of explanatory variables. To do this, I conduct two main sets of analyses: a cross-sectional and a longitudinal one. Firstly, I analyse the development outcomes of children that started centre-based care at two years old.

$$D_{it} = \beta C_{it} + f_t + \alpha_i + \varepsilon_{it} \qquad i = 1,..,N \qquad (1)$$

Where
D_i= Child i's development outcome at time t (in this case 2012). This is the dependent variable. It varies depending on the test used to measure child cognitive or socio-emotional development. For information about the different measures, see Table 5

The independent variables are:
C_i= Dummy variable for centre-based care attendance at time t. Equals 1 if the child i entered centre-based care between 24 and 36 months old, 0 otherwise.
f_t= Time effect, representing common shocks to child development affecting all children at time t. In a cross-section, this term is the regression's constant.
α_i = Unobserved fixed characteristics of the child or her context (mother, family, geographic area) that do not change in time.
ε_i = Child i's development outcome error term (i.e. factors determining the child's development outcome that are unobserved to the researcher).

The coefficient of interest is β. I interpret this coefficient as the effect on child development of entry into centre-based care relative to continuing in maternal care.
The problem with equation (1) is that the unobserved (to the researcher) individual fixed effects α_i such as paternal intellectual ability or child temperament could be correlated with both the option for centre-based care and the child's development outcome. If this were the case, the coefficient of interest β would be biased. Given that I have information for two periods, I can control for individual fixed effects. This way, I

am able to control for unobserved fixed characteristics of children and the contexts which do not change over time, such as child temperament or genetic endowment.

Therefore, in a second set of regressions, I use a longitudinal approach to investigate the association between attendance at centre-based care (relative to maternal care) and child development outcomes using a difference in differences approach. When the researcher has two periods of data (in my case, t=2010 for the first period and t=2012 for the second period), a convenient way to rewrite equation (1) is in first differences:

$$D_{i2012} - D_{i2010} = \ \beta(C_{i2012} - C_{i2010}) + (f_{2012} - f_{2010}) + X'_{i2010}\gamma + \varepsilon_{i2012} - \varepsilon_{i2010}$$
$$i = 1,..,N\ ; \qquad (2)$$

The advantage of equation (2) over (1) is that, while the coefficient of interest β is still present, thanks to the first differences, the unobserved fixed-effects parameter α_i that was probably introducing omitted variable bias in equation (1) has been accounted for in equation (2). I also introduce predetermined baseline characteristics in equation (2), X'_{i2010}, which allow differential pre-existing development outcome trends along all previously mentioned child, maternal, family, and geographic characteristics.

Equation (2) assumes that the effect of centre-based care is homogeneous for all children. However, as explained before in subsection 2.1.3, there is evidence that such effect is more positive for disadvantaged children compared to wealthier children. Therefore, I investigate the moderating role of child's socioeconomic status on the association between attendance at centre-based care and child development outcomes. The empirical specification of the test on the moderators is as follows:

$$D_{i2012} - D_{i2010} = \ \beta_m M_{i2010}(C_{i2012} - C_{i2010}) + \beta_r(1 - M_{i2010})(C_{i2012} - C_{i2010})$$
$$+(f_{2012} - f_{2010}) + X'_{i2010}\gamma + \varepsilon_{i2012} - \varepsilon_{i2010} \qquad i = 1,..,N\ ; \qquad (3)$$

The independent variable not previously described is:

M_{i2010} = Dummy variables for the two different moderators. For maternal level of education, equals one if mother has low education (less than high school), zero if she has a high level of education. For household poverty, equals one if the child's household is below the poverty line, zero if it is above poverty line.

For both types of moderators, the coefficient of interest is the effect of early centre-based care attendance on child development for the different subgroups, β_m for children of mothers who are high school dropouts or poor children and β_r for children of mothers who are high school graduates or non-poor children. The magnitude of $\beta_m - \beta_r$ is the degree of heterogeneity in the effect of early centre-based care attendance on child development.

Equation (3) imposes strong parametric assumptions of additive linearity and lack of interactions in the relation between the covariates and child development (the model's dependent variable). Similarly, in an OLS regression I could be comparing children

who experience early centre-based care with children in maternal care regardless of how 'comparable' these children are. For example, given that they would have no counterparts in centre-based care, it would not be reasonable to include extremely poor children in the previous comparison if all the extremely poor children stay in maternal care.

To avoid the previous issues of assuming a specific functional form between the covariates and the outcome variable, I will use propensity score matching to compare the outcomes in first differences for those children who started child care early (the treated group) with those who remained in maternal care (the control group).

Hence, my final empirical specification combines the data in first differences with an analysis using Propensity Score Matching to create a 'counterfactual' group to the group of children who entered into early centre-based care out of the group of children who remained in maternal care. My preferred matching specification uses nearest neighbour matching to reduce bias. In addition, I check whether the treated and matched-counterfactual group are balanced in the mean of the covariates.

Hence, the assumption to get to a causal estimate of the effect of early centre-based care on child development outcomes is that, controlling for differential development outcome trends along child, maternal, family and geographic characteristics, there are no differential development trends for children who attended early centre-based care (the treated group) and those who stayed with their mother (the control group).

5.   Results

5.1. Descriptive statistics of child, family and maternal characteristics for children who attend centre-based care at age two and child cognitive and socio-emotional outcomes

Table 4 shows differences between mothers of children who, at two years of age, had moved into centre-based care and those who remained in maternal care. Mothers of children who remained in maternal care are older, more likely to be married, have lower education, lower mathematics and vocabulary skills, and were less likely to work before pregnancy compared to mothers of children who moved into centre-based care at the age of two. Similarly, children in the former group come from lower-income families and a less stimulating home environment (measured by the HOME test score) On the other hand, children in the sample who started centre-based care at the age of two have mothers who were more likely to have reported depression or to have smoked during pregnancy compared to children who remained in maternal care during the same period. The differences in these characteristics underline the importance of controlling for observed characteristics in the analyses.

Table 5 shows the means and standard errors of unconditional regressions of child cognitive and socio-emotional development on whether those children entered into

centre-based care at the age of two.[8] Children who remained with their mothers exhibit lower test scores (Batelle Inventory 2010, Battelle Screening 2012, and TADI 2012 test scores) in the cognitive domain compared to children who went to centre-based care. On the other hand, children who remained in maternal care present less externalising externalising problems (CBCL externalising 2010) compared to children who moved into centre-based care. Interestingly, children who attended centre-based care present less internalising problems compared to children who remained in maternal care at the age of two.

5.2. Does attendance at centre-based care at two years old improve child development?

Table 6 presents results from OLS models that examine the association between attendance at centre-based care at two years old and child cognitive and socio-emotional development. I present four models with increasing control variables to address potential selection effects. Column (1) in Table 6 contains the estimates from unconditional regressions of child development on the attendance at centre-based care at the age of two. The results in this column suggest that attendance at centre-based care is strongly associated with positive child cognitive development. Children that attended centre-based care at two years old have 18 per cent of one standard deviation (measured by the TADI test) and 17 per cent of one standard deviation (measured by the Battelle Screening test) higher cognitive skills compared to children who were not in centre-based care. Models 2 through 4 show that adding more covariates to the regression reduces the magnitude of the association between centre-based care and child cognitive development, especially after adding home environment and spatial characteristics (region and area where the child lives).

---

[8]
  I standardised the tests scores for the whole sample of children in each of the ELPI waves. In Table 5, I describe the sub-population of children in the sample of this study (see detailed description in subsection 4.1) who experienced maternal or centre-based care between 24 and 36 months old. Therefore, Table 5 does not include children who were in informal care (grandparent, relative or nonrelative) between 24 to 36 months old or who were not in the subsample described in subsection 4.1. This is why in some test scores (e.g. Battelle Inventory 2010) the average score of child development outcomes is negative in both groups (this is, for children in maternal and centre-based care).

Table 4: Differences in maternal, child, and family characteristics for children in centre-based care at two years old compared to maternal care.

	Maternal care only (1)	Centre-based care (2)	(1) versus (2)
Maternal characteristics			
Age	28.77	27.75	***
Married (%)	77.4	65.9	***
Years of education	10.68	11.86	***
Low level of education (%)	43.9	30.7	***
Teenager (less than 20 years old) (%)	13.77	17.25	***
Presented depression during pregnancy (%)	13.9	18.7	***
Worked before pregnancy (%)	23.4	45.5	***
Ability with numbers	6.59	7.10	***
Ability with vocabulary	7.47	8.43	***
Personality			
Extraversion	3.50	3.61	***
Agreeableness	3.83	3.81	
Conscientiousness	3.94	3.97	
Neuroticism	3.07	3.05	
Openness	3.75	3.85	***
Breastfed her children (%)	95.4	95.3	
Difficult pregnancy (%)	43.2	45.5	
Presented mental health problems during pregnancy (%)	14.47	19.55	***
Drank alcohol during pregnancy (%)	7.4	8.1	
Smoked during pregnancy (%)	8.6	11.5	**
Child characteristics			
Female (%)	49.0	49.7	
Low birth weight (%)	5.9	4.3	*
Premature (%)	7.5	5.9	
Had common disease (%)	53.2	59.1	***
Has older sibling (%)	62.6	50.7	***
Family characteristics			
Income per capita (£)	101.8	134.9	***
Family in poverty (%)	64.0	49.5	***
Number of people in household	5.03	4.84	***
Family below Chile's poverty line (%)	56.7%	41.5%	
HOME1 Score	14.98	15.36	***
Sample size	1,120	1,438	

Notes: *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses. (1) Home Observation Measurement of the Environment (HOME)

Table 5: Differences in cognitive and socio-emotional outcomes for children who experienced maternal care and centre-based care between 24 and 36 months old.

	(1) Maternal care only (s.d.)	(2) Centre-based care (s.d.)	(3) (1) versus (2)
	Cognitive development		
Battelle Inventory 2010	-0.142	-0.049	**
	(0.969)	(1.00)	
EEDP 2010	-0.068	-0.085	
	(0.972)	(1.023)	
Battelle Screening Test 2012	-0.603	-0.346	***
	(0.980)	(1.005)	
TADI 2012	-0.317	-0.099	***
	(0.846)	(0.833)	
	Socio-emotional development		
CBCL Total 2010	0.027	0.026	
	(0.960)	(0.946)	
Externalising problems score 2010	-0.005	0.098	*
	(0.981)	(0.987)	
Internalising problems score 2010	-0.053	-0.163	**
	(0.967)	(0.955)	
ASQ-SE 12 months 2010	0.016	-0.025	
	(1.034)	(1.002)	
ASQ-SE 18 months 2010	0.016	0.033	
	(1.044)	(1.017)	
CBCL Total 2012	0.083	0.088	
	0.975)	(1.003)	
Externalising problems score 2012	0.093	0.139	
	(0.977)	(1.008)	
Internalising problems score 2012	0.070	0.024	
	(0.978)	(1.008)	

Notes: The cognitive outcomes tests are: the Battelle Inventory and Battelle Screening tests which assess five domains: adaptive behaviour, personal/social skills, communication, motor ability, and cognitive skills. The TADI (*Test de Aprendizaje de Desarrollo Infantil*, in English 'Child Development Cognitive Test') that evaluates four dimensions: motor, language, cognitive, and social-emotional. One of the socio-emotional outcomes tests is the Child Behavior Checklist (CBCL) that evaluates behavioural problems, internalising problems (for example, anxious, depressive, and over-controlled behaviours), and externalising problems (for example, aggressive, hyperactive behaviours). This test was administered to children aged 18 to 24 months. The other socio-emotional outcomes test is the Ages & Stages Questionnaires: Social-Emotional (ASQ–SE) test that evaluates children's social and emotional behaviour through self-regulation, compliance, communication, adaptive functioning, autonomy, affect, and interaction with people. This test was administered to children aged 12 to 18 months. I converted children's outcomes into Z scores. For cognitive tests, a higher coefficient means higher cognitive development in contrast with socio-emotional outcomes for which a coefficient means more socio-emotional problems. The comparison in column (3) controls for children's age in a linear fashion proportional to months. *** $p<0.01$, ** $p<0.05$, * $p<0.1$. Standard deviations in parentheses.

Table 6: The association between centre-based care attendance at two years old and child outcomes at three and four years old: OLS estimates.

	Cognitive development							
	TADI test				Battelle test			
Variables	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Centre-based two-years old	0.178*** (0.0482)	0.139*** (0.0481)	0.128*** (0.0480)	0.117** (0.0480)	0.169*** (0.0570)	0.122** (0.0553)	0.117** (0.0561)	0.104* (0.0561)
Demographics		X	X	X		X	X	X
Home environment			X	X			X	X
Region and urban				X				X
Observations	1,465	1,338	1,281	1,281	1,473	1,346	1,289	1,289
R-squared	0.011	0.114	0.133	0.141	0.007	0.124	0.133	0.140

	Socio-emotional development							
	CBCL test total				Internalising problems			
Variables	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Centre-based two-years old	0.0592 (0.0534)	0.0864 (0.0560)	0.0899 (0.0573)	0.0918 (0.0573)	0.0116 (0.0539)	0.0661 (0.0557)	0.0674 (0.0569)	0.0728 (0.0572)
Demographics		X	X	X		X	X	X
Home environment			X	X			X	X
Region and urban				X				X
Observations	1,509	1,376	1,318	1,318	1,509	1,376	1,318	1,318
R-squared	0.001	0.095	0.097	0.099	0.000	0.080	0.083	0.087

Notes: All OLS regressions control for children's age. All columns show the magnitude of the key coefficient with s.e. in parentheses. Column (1) shows the results of a regression without controls. Column (2) shows the results of a regression controlling for demographic characteristics such as maternal characteristics: age (linear and square); years of education, low level of education, marital status, work status, teen pregnancy, difficulties during pregnancy, mental health problems during pregnancy, breastfeeding, alcohol consumption and smoking, depression, numeracy and vocabulary abilities, and personality. In addition, this regression controls for the child's characteristics: gender; presence of older sibling, premature birth; low weight; common disease, and age (linear and square). Colum (3) shows the result of regression in column (2) plus controls for home environment characteristics: family income per capita (linear and square), family under poverty line, and HOME test score. Column (4) shows the results for the regression in column (3) plus region and area (urban or rural) controls. The cognitive outcomes tests are the TADI (*Test de Aprendizaje de Desarrollo Infantil*, in English 'Child Development Cognitive Test') that evaluates four dimensions: motor, language, cognitive, and social-emotional and the Battelle Screening test that assesses five domains: adaptive behaviour, personal/social skills, communication, motor ability, and cognitive skills. One of the socio-emotional outcomes tests is the Child Behavior Checklist (CBCL) test that evaluates behavioural problems, internalising problems (for example, anxious, depressive, and over-controlled behaviours), and externalising problems (for example, aggressive, hyperactive behaviours). For cognitive tests a positive coefficient means higher cognitive development in contrast with socio-emotional outcomes for which a negative coefficient means fewer socio-emotional problems. I converted children's outcomes into Z scores. *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses

The results in column (4) in Table 6 are derived using the empirical specification in equation (1) and omitting the unobservable characteristics α_i. The covariates in column (4) include mother, child, family, and spatial characteristics. In this case, there is a small positive association between centre-based care attendance and child cognitive development. The effect size of this association is 12 per cent (measure by the TADI test) and 10 per cent of one standard deviation (measured by the Battelle Screening test).

However, attendance at centre-based care (relative to maternal care) at two years old is not associated with higher or lower child socio-emotional development. The addition of covariates has no effect on the association between attendance at centre-based care and socio-emotional and externalising problems.

All regressions only consider observations with no missing values in any included covariate. However, selection on missing values could be driving my results. In Table 1 in Appendix 2, I run the same analysis as in Table 6 but restricting my covariates to those with no missing values. This Table shows that the magnitudes (and statistical significance) of my coefficients do not change using the whole sample. This evidence supports the assumption that my results in Table 6 are not due to selection on missing values.

5.2.1. Individual fixed effects and propensity score matching

OLS model estimates suggest that centre-based care attendance is positively associated with child cognitive development but is not associated with child socio-emotional development. In order to address possible selection on fixed unobservable characteristics and misspecification bias, I conducted two alternative specifications analyses: individual fixed effects (FE) and FE plus Propensity Score Matching (PSM).

For ease of comparison, while the first row in Table 7 repeats the results of the most complete OLS model in Table 6, the second row presents the individual FE model. In column (1), where the dependent variable is the Battelle test score, the key coefficient is smaller (and not statistically significant) in the FE analysis compared to the OLS estimates. However, in column (2), where the dependent variable is the TADI test score, the coefficient of 23 per cent of one standard deviation suggests that, after controlling for unobserved fixed variables, centre-based care attendance is positively associated with child cognitive development. In addition, the fixed effects coefficient continues suggesting that attendance at centre-based care at two years old is not associated with child socio-emotional problems at three and four years old.

Finally, the results for the FE plus PSM model analysis are presented in the third row of Table 7. The PSM creates an experimental counterfactual group to the group of children who experienced early centre-based care. Hence, checking whether the distribution of the covariates in the matched sample is similar to the covariates in the treated group is vital. Appendices 3, 4 and 5 show that there are no significant differences in the means of the covariates between the treated and control groups. In this model of FE plus PSM,

the association between centre-based care attendance and child cognitive outcomes is even larger than in the OLS and FE analyses. Children who experienced early centre-based care have cognitive scores 13 per cent and 19 per cent of one standard deviation higher relative to children who remained in maternal care, measured by the Battelle and TADI tests respectively. This positive association between attendance at centre-based care and child cognitive development is robust to different types of analyses. This positive association is observed in the OLS, FE, and FE+PSM models. In addition, the same tendency is corroborated estimating both the average treatment effect (ATE) and average treatment effect on the treated (ATT) models. My preferred estimate (and the one I presented in the table) is the calculation of the ATT because its unbiased estimation requires a weaker assumption than the assumption required for an unbiased estimation of the ATE (Blundell & Costas Dias 2009)[9].

Table 7: The association between centre-based care attendance at two years old and child outcomes at three and four years old.
OLS, individual fixed effect and propensity score matching estimates.

	Cognitive development		Socio-emotional development
	(1)	(2)	(3)
	Battelle	TADI	CBCL Total
OLS	0.104*	0.117**	0.0918
	(0.056)	(0.048)	(0.057)
Observations	1,289	1,281	1,318
R-squared	0.140	0.141	0.099
Individual fixed effects (FE)	0.0658	0.225***	0.0858
	(0.079)	(0.069)	(0.069)
Observations	1,169	1,163	1,304
R-squared	0.082	0.076	0.051
Individual FE + propensity score matching (PSM)	0.132**	0.185***	-0.0662
	(0.058)	(0.054)	(0.051)
Observations	1,169	1,163	1,304

Note: All regressions in this table control for demographic, home environment, and regional characteristics. The cognitive outcomes tests are the TADI (*Test de Aprendizaje de Desarrollo Infantil*, in English 'Child Development Cognitive Test') that evaluates four dimensions: motor, language, cognitive, and social-emotional and the Battelle Screening test that assesses five domains: adaptive behaviour, personal/social skills, communication, motor ability, and cognitive skills. One of the socio-emotional outcomes tests is the Child Behavior Checklist (CBCL) test that evaluates behavioural problems. In the case of Individual fixed effects (FE) and the Individual FE + propensity score matching (PSM) models, TADI means TADI score minus EDDP score, Battelle means Battelle Screening test score minus Battelle Inventory score; and CBCL means CBCL 2012 score minus CBCL 2010 score. For cognitive tests a positive coefficient means higher cognitive development in contrast with socio-emotional outcomes for which a negative coefficient means fewer socio-emotional problems. I converted children's outcomes into Z scores. *** $p<0.01$, ** $p<0.05$, * $p<0.1$. Robust standard errors in parentheses.

---

[9]   While identification of the ATT requires that conditional on the set of observables the non-treated outcomes are independent of the treatment status, identification of the ATE requires that conditional on the set of observables both the treated and non-treated outcomes are independent of the treatment status (Blundell and Costa-Diaz, 2009)

On the other hand, early centre-based care attendance (relative to maternal care) is not associated with child socio-emotional problems. This result is not robust when I calculated the treatment effects on different sub-populations. The ATE yields a small negative association (7 per cent of one standard deviation) between attendance at centre-based care at two years old and child socio-emotional development (results non-shown, available upon request). In addition, a subsample analysis of all children measured with the CBCL test in both 2010 and 2012 suggests that children who attended centre-based care at two years old (relative to children in maternal care during the same period) showed fewer externalising and internalising problems at age three to four (for more information see appendix 6)10.

Taking the three analyses together, centre-based care attendance at two years old is positively associated with child cognitive development and not significantly associated with child socio-emotional development.

5.3. Does the impact of centre-based care on child outcomes differ according to the intensity of centre-based care?

Based on previous evidence, this study analyses whether the intensity of centre-based care attendance affects child development. Table 8 shows that part-time attendance at centre-based care (relative to maternal care) is positively associated with cognitive outcomes measured by the EEDP and TADI tests. The magnitude of this association is 17 per cent of one standard deviation. In addition, full-time attendance at centre-based care relative to maternal care is positively associated with cognitive outcomes (25 per cent of one standard deviation) but negatively associated with socio-emotional problems (17 per cent of one standard deviation). Children who attended full-time centre-based care present higher cognitive outcomes but more socio-emotional problems relative to children in maternal care.

Table 9 shows a sub-analysis of the differential impact of part-time and full-time attendance at centre-based care. The analysis shows that full-time (relative to part-time) attendance at centre-based care is positively associated with cognitive outcomes but is not associated with socio-emotional problems. In the present study, the association between attendance at centre-based care and cognitive development is between 35 and 37 per cent of one standard deviation higher for children who attended full-time to centre-based care relative to children who attended part-time. In addition, children who attended full-time at centre-based care show more socio-emotional problems relative to children who attended part-time; however, this association is not statistically significant.

---

[10]   To analyse the specific socio-emotional area I must refer to the subsample of children who took the CBCL test in both periods because children who took the ASQ-SE test in 2010 only have a general score.

Table 8: The association between centre-based care attendance and child outcomes by intensity of care: part-time, full-time compared with maternal care. Difference-in-differences estimates.

	(1) Battelle	(2) EEDP/TADI	(3) CBCL total
Part-time centre-based care at	0.0167	0.173**	-0.0112
2 years old	(0.103)	(0.087)	(0.090)
Full-time centre-based care at	0.0918	0.246***	0.173**
2 years old	(0.100)	(0.090)	(0.084)
Observations	1,169	1,163	1,304
R-squared	0.088	0.087	0.056

Note: The reference category is maternal care. All regressions in this table control for demographic, home environment, and regional characteristics. Battelle means Battelle Screening test score minus Battelle Inventory score; EEDP/TADI means TADI score minus EDDP score; and CBCL means CBCL 2012 scores minus CBCL 2010 score. For cognitive tests a positive coefficient means higher cognitive development in contrast with socio-emotional outcomes for which a negative coefficient means fewer socio-emotional problems. . I converted children's outcomes into Z scores. All OLS regressions control for children's age. *** $p<0.01$, ** $p<0.05$, * $p<0.1$. Robust standard errors in parentheses.

Table 9: The association between centre-based care attendance and child outcomes by intensity of care: part-time and full-time. Matching difference-in-differences estimates.

	(1) Battelle	(2) EEDP/TADI	(3) CBCL total
Full time centre-based	0.371***	0.353***	0.0338
care at two years old	(0.097)	(0.093)	(0.092)
Observations	437	436	489

Notes: The reference group is part-time attendance at centre-based care. All regressions in this table control for demographic, home environment, and regional characteristics. Battelle means Battelle Screening test score minus Battelle Inventory score; EEDP/TADI means TADI score minus EDDP score; and CBCL means CBCL 2012 scores minus CBCL 2010 score. For cognitive tests a positive coefficient means higher cognitive development in contrast with socio-emotional outcomes for which a negative coefficient means fewer socio-emotional problems. . I converted children's outcomes into Z scores. All OLS regressions control for children's age. *** $p<0.01$, ** $p<0.05$, * $p<0.1$. Robust standard errors in parentheses.

5.4. Impact of centre-based care on disadvantaged children

In this study I analyse the potentially moderating effect of child vulnerability using two proxies variables for 'vulnerability': whether the child has a mother with a low level of education (less than high school education) and whether the child's household is in income poverty (below Chile's poverty line). The only significant interaction indicates that the effect of centre-based care attendance (relative to maternal care) at two years old on child socio-emotional development (measured by the CBCL test) varies as a function of the family's poverty status. Panel B in Table 10, shows that the association between attending centre-based care at two years old and socio-emotional problems is significantly more negative for children from poor households than for children from non-poor households. The association between attendance at centre-based care at age two and child behavioural problems at age three to four was 26 per cent of one standard

deviation higher for children in income poor households compared to children from non-poor households. However, the association between centre-based care attendance at age two and child cognitive outcomes at age three to four does not differ depending on the level of poverty of the children's household.

Table 10: The association between centre-based care attendance and child outcomes by child vulnerability. Difference-in-differences estimates.

	Cognitive development		Socio-emotional development
	(1) Battelle n=1061	(2) EEDP/ TADI n=1055	(3) CBCL total n=1188
Panel A			
Centre-base care at two years old	0.109	0.177*	0.0647
	(0.120)	(0.0975)	(0.0905)
Low maternal education	0.107	-0.465	0.442
	(0.626)	(0.546)	(0.729)
Centre-base care at two years old * Low maternal education	-0.108	0.0627	0.0808
	(0.176)	(0.153)	(0.146)
Panel B			
Centre-base care at two years old	0.207*	0.248**	-0.0382
	(0.124)	(0.106)	(0.100)
Income Poor family	-0.0568	0.00391	-0.192*
	(0.115)	(0.105)	(0.0991)
Centre-base care at two years old * Poor family	-0.262	-0.0852	0.255*
	(0.176)	(0.148)	(0.145)

Notes: All regressions in this table control for demographic, home environment, and regional characteristics. In Panel A, the reference category is maternal care and maternal high education. In Panel B, the reference category is maternal care and non-poor families. The cognitive outcomes tests are the TADI (*Test de Aprendizaje de Desarrollo Infantil*, in English 'Child Development Cognitive Test') that evaluates four dimensions: motor, language, cognitive, and social-emotional and the Battelle Screening test that assesses five domains: adaptive behaviour, personal/social skills, communication, motor ability, and cognitive skills. One of the socio-emotional outcomes tests is the Child Behavior Checklist (CBCL) test that evaluates behavioural problems, internalising problems (for example, anxious, depressive, and over-controlled behaviours), and externalising problems (for example, aggressive, hyperactive behaviours). Battelle means Battelle Screening test score minus Battelle Inventory score; EEDP/TADI means TADI score minus EDDP score, and CBCL means CBCL 2012 scores minus CBCL 2010 score. For cognitive tests a positive coefficient means higher cognitive development in contrast with socio-emotional outcomes for which a negative coefficient means fewer socio-emotional problems. I converted children's outcomes into Z scores. *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses.

I performed separate analyses estimating the impact of centre-based care on child development for each household income quintile. Household income quintiles are described as low, middle-low, middle, upper-middle, and upper. This allows us to observe whether the estimated effects vary over the income distribution.

27

Table 11 presents the effects of centre-based care by quintiles. I find that children from the second poorest quintile who attended centre-based care at age two have a significantly greater negative impact on their socio-emotional development (measured by the CBCL test) compared to children from the richest quintile. The magnitude of the previously described heterogeneity in the effect of attendance at centre-based care is 43 per cent of one standard deviation. A sub-sample analysis with children who were measured with the same instrument in the socio-emotional domain in 2010 and 2012 (the CBCL test), also shows the previously described heterogeneous effect (results not shown, available upon request).

Table 11: The association between centre-based care attendance and child outcomes by family socio-economic quintile. Individual fixed effects estimates

	Cognitive development		Socio-emotional development
	(1) Battelle	(2) EEDP/TADI	(3) CBCL total
Centre-based care at two-years old * 1st income quintile	-0.292	-0.261	0.242
	(0.297)	(0.251)	(0.218)
Centre-based care at two-years old * 2nd income quintile	-0.0646	-0.210	0.426**
	(0.272)	(0.239)	(0.187)
Centre-based care at two-years old * 3rd income quintile	-0.232	-0.230	0.199
	(0.254)	(0.212)	(0.181)
Centre-based care at two-years old * 4th income quintile	0.155	-0.0731	0.152
	(0.233)	(0.221)	(0.175)
Observations	1,159	1,152	1,291

Notes: The reference category is attendance at centre-based care for the fifth quintile. All regressions in this table include the main effects (income quintiles and attendance at centre-based care at two years old) and control for demographic, home environment, and regional characteristics. The cognitive outcomes tests are the TADI (*Test de Aprendizaje de Desarrollo Infantil*, in English 'Child Development Cognitive Test') that evaluates four dimensions: motor, language, cognitive, and social-emotional and the Battelle Screening test that assesses five domains: adaptive behaviour, personal/social skills, communication, motor ability, and cognitive skills. One of the socio-emotional outcomes tests is the Child Behavior Checklist (CBCL) test that evaluates behavioural problems, internalising problems (for example, anxious, depressive, and over-controlled behaviours), and externalising problems (for example, aggressive, hyperactive behaviours). Battelle means Battelle Screening test score minus Battelle Inventory score; EEDP/TADI means TADI score minus EDDP score, and CBCL means CBCL 2012 scores minus CBCL 2010 score. For cognitive tests a positive coefficient means higher cognitive development in contrast with socio-emotional outcomes for which a negative coefficient means fewer socio-emotional problems. I converted children's outcomes into Z scores. *** $p<0.01$, ** $p<0.05$, * $p<0.1$. Robust standard errors in parentheses.

Hence, the previously described analyses suggest that there is some evidence that attendance at centre-based care at two years old has a more detrimental effect on the socio-emotional development of more vulnerable children than the same effect for more advantaged children.

6.   Summary, conclusions, and policy implications

The present study provides evidence about the short-term effects of centre-based care attendance on children's cognitive and socio-emotional development in Chile. Even though this is not the first study that addresses the question of whether centre-based care has an effect on child development, it is the first to focus on children who started attending centre-based care at 24 months old and remained in this type of care at least until 36 months old. I chose this age range because research is inconclusive about the benefits of early childhood intervention for children under three years old (Gambaro et al. 2014). In addition, at 24 months old many Chilean families start sending their children to centre-based care. Before this age, most children are cared for exclusively by their mothers or attend other types of informal care such as relative or non-relative care.

Even though Chile has greatly increased its centre-based care coverage, the coverage for children under three years old continues to be low: 10 per cent for children under two years old, and 41 per cent for two-year-olds (CASEN, 2011). In this context, before increasing early centre-based care coverage to the standard of most OECD countries, it is important to have a clear understanding of the effects of centre-based care attendance on child development.

The main finding of this study is that attending centre-based care at two years old is positively associated with child cognitive development and is not associated with child socio-emotional development. In the FE and PSM models, the (positive) effect of attending centre-based care on child cognitive development ranges between 13 to 19 per cent of one standard deviation (depending on the cognitive test) relative to children who stayed with their mothers. The magnitude of the previously mentioned effect in the literature is 34 per cent of one standard deviation (Nores and Barnett, 2010). According to Nores and Barnett (2010), the average effect size of attending early childhood interventions (relative to not attending early childhood interventions) is lower in low- and middle-low-income countries (average effect size of 25 per cent of one standard deviation) compared to the same effect in middle- and middle-high income countries (average effect size of 31 per cent of one standard deviation). Nores and Barnett, (2010) also note that studies that used propensity score matching techniques have smaller effect sizes (an average effect size of 13 per cent of one standard deviation) compared with randomized experiments (average effect size of 28 per cent of one standard deviation).

Hence, my findings in the cognitive domain are consistent with the effects found in previous international studies (Loeb et al., 2007; Sammons et al., 2004; Felfe and Lalive, 2012). More specifically, Ruzek, Burchinal, Farkas, and Duncan (2013) found that the effect of centre-based care relative to maternal care was 17 and 38 per cent of one standard deviation in medium-quality and high-quality centre-based care respectively. My findings in the cognitive domain are also consistent with Chilean studies that have found similar effect sizes when evaluating the relationship between preschool attendance and child attainment. Cortazar (2011) found that the effect of

attending centre-based care (relative to not attending centre-based care) at age two to four on cognitive standardised tests in fourth grade was positive. In addition, Arnold (2013), using the first wave of Chile's ELPI survey, found that the effect size of attending centre-based care between two and four years old was 12 to 23 per cent of one standard deviation depending on the specific dimension of child cognitive outcome.

When exploring a potentially heterogeneous effect of centre-based attendance (relative to maternal care) on child development, I find that, controlling for the usual covariates, children who attended centre-based care full-time benefit more on the cognitive domain (36 per cent of one standard deviation) than children who attended part-time. This finding is in line with the NICHD ECCRN study that found that more daily hours in centre-based care is positively associated with the development of language skills (NICHD Early Child Care Research Network 2004).

Secondly, I find that, controlling for a rich set of covariates and individual fixed effects, attendance at centre-based care at the age of two is not associated with socio-emotional problems. This finding is in line with some international studies that found a neutral effect of centre-based care attendance on child socio-emotional development and behaviour (Gupta & Simonsen 2010; Jaffee et al. 2011; Barnes et al. 2010). Moreover, my finding in the socio-emotional domain is also in line with other Chilean studies. For example, Arnold (2013) did not find an association between attendance at centre-based care and child socio-emotional development. In contrast, Noboa-Hidalgo and Urzua (2012) found a positive association between centre-based care and child socio-emotional skills. The difference between my finding and Noboa-Hidalgo and Urzua's findings could be explained because both studies use different child socio-emotional outcomes. Noboa-Hidalgo and Urzua (2012) found that the most significant effect of early centre-based attendance is in children's capacity to express feelings (1.15 standard deviations). In contrast, in the present study, the child socio-emotional outcomes measure socio-emotional problems.

Fathoming out the association between early centre-based care attendance and socio-emotional problems is relevant because even though I do not find a significant average effect, there is some evidence of a heterogeneous effect. Children who attended centre-based care full-time experienced more socio-emotional problems than children who stayed at home with their mothers. This suggests that the negative association with child socio-emotional development may not be with the centre-based care experience itself but with the numbers of hours per day that children spend in centre-based care. This is related to the results presented in NICHD National Early Child Care Research (2003), which indicating that children who spend more than 30 hours per week in centre-based care tend to be less sociable and have more behavioural problems than children who spend less than 30 hours per week in child care. Unfortunately, my data does not include the exact number of hours that children spent in centre-based care or the quality of the centre-based care they received. These two structural parameters of centre-based care could provide some insights on the channels through which centre-based care is affecting children's socio-emotional development.

A large number of studies have concluded that early education programs have a larger positive effect on more vulnerable children's cognitive development (Burger, 2010; Crosnoe et al., 2010; Felfe and Lalive (2012); Gilliam and Zigler, 2000; NICHD National Early Child Care Research Network and Duncan, 2003; Peisner-Feinberg et al., 2001). My findings are contrary to the previously cited studies. First, low level maternal education is not a relevant moderator in the association between centre-based care attendance and child cognitive or socio-emotional development. Second, I find that household income poverty is not a relevant moderator in the association between centre-based care attendance and child cognitive outcomes. Conversely, I find that the effect of attendance at centre-based care for children between 24 and 36 months old on socio-emotional development is significantly more negative for children from poor households compared to the same effect for children from non-poor households. Similarly, attendance at centre-based care had a stronger negative effect on the socio-emotional for children in the second income quintile (second poorest quintile) compared to children in the fifth income quintile. One potential mechanism underlying the previous finding is if the quality of centre-based care attended by children that are more vulnerable is worse compared to the quality of centre-based care attended by children that are more affluent. Unfortunately, I do not have data on centre-based care quality to test the relevance of this potential mechanism. Hence, even though attendance at a high-quality centre can compensate for less stimulating and more stressful home environments of vulnerable children (Peisner-Feinberg et al., 2001) low-quality centre-based care could worsen developmental delays of disadvantaged children (Votruba-Drzal et al., 2010)

6.1 Strengths and limitations

One of the strengths of this study is that it uses a novel panel survey for Chile. Its large sample size provides sufficient power to analyse the potentially heterogeneous association between centre-based care and child development depending on children's level of vulnerability. In addition, the ELPI dataset has both cognitive and socio-emotional assessments that offer a more complete picture on the impact of attendance at centre-based care on child development. Moreover, the ELPI survey samples children born between 2006 and 2009. In contrast with most other panel surveys that use cohorts born in previous decades, the ELPI survey enables us to have a more up to date assessment. A second strength of this study is that it uses a credible empirical strategy to control for fixed unobservable individual characteristics and to avoid misspecification bias.

This study also has limitations. First and more importantly, the ELPI dataset does not include information about centre-based care quality. More research about the quality of Chile's centre-based care provision is needed to know, for example, whether children from more vulnerable backgrounds access lower quality centre-based care compared to children from wealthier backgrounds. Due to the lack of information about quality of centre-based care, my current results regarding the association between centre-based care and child development are average effects which don't account for differences in quality. Unfortunately, due to data constraints, my results do not explore the

mechanisms underlying the previous association (for example, group size, quality of adult-child interactions etc.). Second, my research design is not able to exploit an exogenous source of variation in the selection into centre-based care. Hence, if the children or their families had unobservable characteristics that changed over time and that influenced both the decision of entry into centre-based care and the children's outcomes, this would induce a bias in my estimates. Although I cannot find any theoretical variable that meets the previously mentioned criteria, this is still a potential source of bias.

Even though this study contributes to an understanding of the relationship between early centre-based care attendance and child cognitive and socio-emotional development in middle-income countries, some important questions remain unanswered. The long-term implications of this positive association between centre-based attendance and child cognitive development are unclear. Barnett (2011) shows that attendance at a preschool program could have a fade-out effect over time. However, the magnitude and persistence of this effect on child cognitive outcomes differs greatly. Magnuson et al. (2007) concluded that part of the long-term effects of early childhood education depends on classroom experiences during the first years of school. More importantly, studying the long-term effects of early centre-based care attendance on child socio-emotional development is crucial. Children's ability to learn is closely related to their socio-emotional skills, which enable them to be in a classroom and interact with their peers and teachers (Thompson et al. 2007). In this study, I do not find, on average, that attendance at centre-based care is associated with socio-emotional problems. Hence, to uncover the long-term impact of early centre-based care on adult outcomes, the ELPI survey should follow the children into adulthood.

Considering the Chilean context of a dysfunctional institutional setting and not ideal structural quality standards, the fact that attendance at centre-based care at two years old has a positive association with child cognitive development and shows insignificant association with socio-emotional development relative to maternal care, is an encouraging result.

References

Abner, K. et al., 2013. Does child-care quality mediate associations between type of care and development? *Journal of Marriage and Family*, 75(October), pp.1203–1217.

Achenbach, T.M. & Ruffle, T.M., 2000. The Child Behavior Checklist and Related Forms for Assessing Behavioral/Emotional Problems and Competencies. *Pediatrics in Review*, 21(8), pp.265–71. Available at: http://www.ncbi.nlm.nih.gov/pubmed/10922023.

Ainsworth, M.D.S. & Bowlby, J., 1991. An Ethological Approach to Personality Development. *American Psychologist*, 46(4), pp.333–341.

Arnold, T., 2013. Impacto de asistir a Educación Parvularia. , 312(2006), pp.1–7.

Averdijk, M. et al., 2011. The relationship between quantity, type, and timing of external childcare and child problem behaviour in Switzerland. *European Journal of Developmental Psychology*, 8(6), pp.637–660. Available at: http://www.tandfonline.com/doi/abs/10.1080/17405629.2011.571846 [Accessed July 25, 2013].

Baker, M., Gruber, J. & Milligan, K., 2008. Universal Child Care, Maternal Labor Supply, and Family Well-Being. *Journal of Political Economy*, 116(4), pp.709–745. Available at: http://www.journals.uchicago.edu/doi/abs/10.1086/591908.

Barnes, J. et al., 2010. Experiences of childcare in England and socio-emotional development at 36 months. *Early Child Development and Care*, 180(9), pp.1215–1229. Available at: http://www.tandfonline.com/doi/abs/10.1080/03004430902943959 [Accessed March 13, 2013].

Barnett, W.S., 2011. Effectiveness of early educational intervention. *Science*, 333(6045), pp.975–8. Available at: http://www.ncbi.nlm.nih.gov/pubmed/21852490 [Accessed October 27, 2012].

Bedregal, P., 2008. Instrumentos de medición del desarrollo en Chile. *Revista Chilena de Pediatría*, 79(1), pp.32–36.

Belsky, J. et al., 2007. Are there long-term effects of early child care? *Child Development*, 78(2), pp.681–701. Available at: http://www.ncbi.nlm.nih.gov/pubmed/17381797.

Belsky, J., 2011. Child care and its impact on young children. *Encyclopedia on Early Childhood Development [online]*, (November 2003), pp.1–7.

Belsky, J., 2001. Emanuel Miller Lecture Developmental risks (still) associated with early child care. *Journal of Child Psychology and Psychiatry*, 42(7), pp.845–859.

Belsky, J., 2002. Quantity counts : Amount of child care and children's socioemotional development. *Developmental and Behavioral Pediatrics*, 23(3), pp.167–170.

Belsky, J. & Rovine, M.J., 1988. Nonmaternal care in the first year of life and the security of infant-parent attachment. *Child Development*, 59(1), pp.157–167.

Berls, A.T. & McEwen, I.R., 1999. Battelle Developmental Inventory. *Physical Therapy*, 79(8), pp.776–783.

Blundell, R. & Costas Dias, M., 2009. Alternative approaches to evaluation in empirical microeconomics. *The Journal of Human Resources*, 44(3), pp.565–640.

Bowlby, S.R., 2008. *Attachment , what it is , why it is important and what we can do about it to help young children acquire a secure attachment* QOC Volume. C. Clouder, B. Heys, & M. Matthes, eds., Belgium: European Council for Steiner Waldorf Education and the Alliance for Childhood European Network Group 2009/10.

Burger, K., 2010. How does early childhood care and education affect cognitive development? An international review of the effects of early interventions for children from different social backgrounds. *Early Childhood Research Quarterly*, 25(2), pp.140–165. Available at: http://linkinghub.elsevier.com/retrieve/pii/S0885200609000921 [Accessed August 26, 2010].

Camilli, G. et al., 2010. Meta-Analysis of the effects of early education interventions on cognitive and social development. *Teachers College Record*, 112(3), pp.579–620.

Campbell, F.A. et al., 2002. Early Childhood Education: Young Adult Outcomes from the Abecedarian Project. *Applied Developmental Science*, 6(1), pp.42–57.

Caughy, M.O., DiPietro, J.. A. & Strobino, D.M., 1994. Day-care participation as a protective factor in the cognitive development of low-income children. *Child Development*, 65(2), pp.457–71. Available at: http://www.ncbi.nlm.nih.gov/pubmed/8013234.

Coley, R.L. et al., 2013. Timing, extent, and type of child care and children's behavioral functioning in kindergarten. *Developmental Psychology*, 49(10), pp.1859–73. Available at: http://www.ncbi.nlm.nih.gov/pubmed/23244403 [Accessed February 6, 2013].

Cortazar, A., 2011. *Long-term Effects of Early Childhood Education on Academic Achievement in Chile*. Columbia University.

Crosnoe, R. et al., 2010. Family socioeconomic status and consistent environmental stimulation in early childhood. *Child Development*, 81(3), pp.972–87. Available at: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2892811&tool=pmcentrez&rendertype=abstract.

Desai, S., Chase-Lansdale, P.L. & Michael, R.T., 1989. Mother or market? Effects of maternal employment on the intellectual ability of 4-year-old children. *Demography*, 26(4), pp.545–561.

Economist Intelligence Unit, 2012. *Starting well Benchmarking early education across the world*,

EFA Global Monitoring Report, 2007. *Strong foundations. Early childhood care and education*, Paris.

Felfe, C. & Lalive, R., 2012. Early child care and child development: For whom it works and why. , (7100), pp.1–44.

Gambaro, L., Stewart, K. & Waldfogel, J. eds., 2014. *An Equal Start? Providing Quality Early Education and Care for Disadvantaged Children*, Bristol: University of Bristol Policy Press.

Geoffroy, M.-C. et al., 2010. Closing the gap in academic readiness and achievement: the role of early childcare. *Journal of child psychology and psychiatry, and allied disciplines*, 51(12), pp.1359–67. Available at: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=3283580&tool=pmcentrez&rendertype=abstract [Accessed March 20, 2013].

Gilliam, W. & Zigler, E.F., 2000. A critical meta-analysis of all evaluations of state-funded preschool from 1977 to 1998: implications for policy, service delivery and program evaluation. *Early Childhood Research Quarterly*, 15(4), pp.441–473. Available at: http://linkinghub.elsevier.com/retrieve/pii/S0885200601000734.

Gupta, N. & Simonsen, M., 2010. Non-cognitive child outcomes and universal high quality child care. *Journal of Public Economics*, 94(1-2), pp.30–43. Available at: http://linkinghub.elsevier.com/retrieve/pii/S0047272709001169 [Accessed March 26, 2012].

Hansen, K. & Hawkes, D., 2009. Early childcare and child development. *Journal of Social Policy*, 38(2), pp.211–239.

Hartup, W. & Moore, S.G., 1990. Early peer relations: Developmental significance and prognostic implications. *Early Childhood Research Quarterly*, 5(1), pp.1–17.

Heckman, J.J. et al., 2010. Analyzing social experiments as implemented: A reexamination of the evidence from the HighScope Perry Preschool Program. *Quantitative Economics*, 1(1), pp.1–46. Available at: http://doi.wiley.com/10.3982/QE8 [Accessed February 23, 2014].

Heckman, J.J., 2006. Skill formation and the economics of investing in disadvantaged children. *Science*, 312(5782), pp.1900–2. Available at: http://www.ncbi.nlm.nih.gov/pubmed/16809525 [Accessed April 5, 2011].

Herrera, S., Salinas, V. & Valenzuela, E., 2011. *Familia, pobreza y bienestar en Chile: un análisis empírico de las relaciones entre estructura familiar y bienestar*, Santiago, Chile.

Ivanova, M.Y. et al., 2007. Testing the 8-syndrome structure of the child behavior checklist in 30 societies. *Journal of Child and Adolescent Psychology*, 36(3), pp.405–17. Available at: http://www.ncbi.nlm.nih.gov/pubmed/17658984.

Jacob, J.I., 2009. The socio-emotional effects of non-maternal childcare on children in the USA: a critical review of recent studies. *Early Child Development and Care*, 179(5), pp.559–570. Available at: http://www.tandfonline.com/doi/abs/10.1080/03004430701292988 [Accessed June 7, 2014].

Jaffee, S.R., Van Hulle, C. & Rodgers, J.L., 2011. Effects of nonmaternal care in the first 3 years on children's academic skills and behavioral functioning in childhood and early adolescence: a sibling comparison study. *Child Development*, 82(4),

pp.1076–91. Available at: http://www.ncbi.nlm.nih.gov/pubmed/21679176 [Accessed March 19, 2013].

John, O.P., Naumann, L.P. & Soto, C.J., 2008. Paradigm shift to the Big Five trait taxonomy. History, measurement, and conceptual issues. In O.P. John, R. W. Robins, & L. A. Pervin, eds. *Handbook of Personality: Theory and Research*. New York: Guilford Press, pp. 114–158.

Kaplan, R.M. & Saccuzzo, D.P., 2009. The Wechsler Intelligence Scales: WAIS-III, WISC-IV and WPPSI-III. In J. Perkins, ed. *Psychological Testing. Principles, Applications and Issues.* Belmont, USA: Wadsworth, pp. 249–272.

Knudsen, E.I., 2004. Sensitive periods in the development of the brain and behavior. *Journal of Cognitive Neuroscience*, 16(8), pp.1412–25. Available at: http://www.ncbi.nlm.nih.gov/pubmed/15509387.

Lamb, M.E. & Ahnert, L., 2006. Nonparental child care: Context, concepts, correlates, and consequences. In D. W & L. RM, eds. *Handbook of Child Psychology*. Hoboken: Wiley, pp. 950–1016.

Lefebvre, P., Merrigan, P. & Roy-Desrosiers, F., 2011. Québec's Childcare Universal Low Fees Policy 10 Years After: Effects, Costs and Benefits. , pp.1–52.

Liu, Q. & Skans, O., 2010. The duration of paid parental leave and children 's scholastic performance. *The B.E. Journal of Economic Analysis & Policy*, 10(1), pp.1–33.

Loeb, S. et al., 2007. How much is too much? The influence of preschool centers on children's social and cognitive development. *Economics of Education Review*, 26(1), pp.52–66. Available at: http://linkinghub.elsevier.com/retrieve/pii/S0272775706000422 [Accessed March 14, 2013].

Magnuson, K., Ruhm, C. & Waldfogel, J., 2007. Does prekindergarten improve school preparation and performance? *Economics of Education Review*, 26(1), pp.33–51. Available at: http://linkinghub.elsevier.com/retrieve/pii/S0272775706000434 [Accessed October 8, 2010].

Magnuson, K.A., Ruhm, C.J. & Waldfogel, J., 2007. The persistence of preschool effects: Do subsequent classroom experiences matter? *Early Childhood Research Quarterly*, 22, pp.18–38.

McCartney, K. et al., 2010. Testing a series of causal propositions relating time in child care to children's externalizing behavior. *Developmental Psychology*, 46(1), pp.1–17. Available at: http://www.ncbi.nlm.nih.gov/pubmed/20053002 [Accessed March 7, 2013].

Ministerio de Educacion de Chile, 2014. *Estado del Arte de la Educación Parvularia en Chile*, Santiago.

National Research Council and Institute of Medicine, 2000. *From Neurons to Neighborhoods: The Science of Early Childhood Development. Committee on Integrating the Science of Early Childhood Development* J. P. Shonkoff & D. A. Phillips, eds., Washington, D.C: National Academy Press. Copyright.

National Scientific Council on the Developing Child, 2007. The Timing and Quality of Early Experiences Combine to Shape Brain Architecture. *Journal of the American Ceramic Society*, 1(12). Available at: http://doi.wiley.com/10.1111/j.1151-2916.1918.tb17232.x.

NICHD Early Child Care Research Network, 1999. Child care and mother-child interaction in the first 3 years of life. *Developmental Psychology*, 35(6), pp.1399–413. Available at: http://www.ncbi.nlm.nih.gov/pubmed/10563730.

NICHD Early Child Care Research Network, 2003. Does amount of time spent in child care predict socioemotional adjustment during the transition to kindergarten? *Child Development*, 74(4), pp.976–1005. Available at: http://www.ncbi.nlm.nih.gov/pubmed/12938694.

NICHD Early Child Care Research Network, 2004. Type of child care and children's development at 54 months. *Early Childhood Research Quarterly*, 19(2), pp.203–230. Available at: http://linkinghub.elsevier.com/retrieve/pii/S0885200604000389 [Accessed October 8, 2010].

NICHD Early Child Care Research Network., 2006. Child-Care Effect Sizes for the NICHD Study of Early Child Care and Youth Development. *American Psychologist*, 61(2), pp.99–116.

NICHD National Early Child Care Research, 2003. Does quality of child care affect child outcomes at age 4 1/2? *Developmental Psychology*, 39(3), pp.451–469. Available at: http://doi.apa.org/getdoi.cfm?doi=10.1037/0012-1649.39.3.451 [Accessed October 8, 2010].

NICHD National Early Child Care Research Network & Duncan, G.J., 2003. Modeling the Impacts of Child Care Quality on Children's Preschool Cognitive Development. *Child Development*, 74(5), pp.1454–1475. Available at: http://doi.wiley.com/10.1111/1467-8624.00617.

Noboa-Hidalgo, G.E. & Urzua, S.S., 2012. The effects of participation in public child care centers: Evidence from Chile. *Journal of Human Capital*, 6(1), pp.1–34.

Nores, M. & Barnett, W.S., 2010. Benefits of early childhood interventions across the world: (Under) Investing in the very young. *Economics of Education Review*, 29(2), pp.271–282. Available at: http://linkinghub.elsevier.com/retrieve/pii/S027277570900106X [Accessed September 6, 2010].

OCDE, 2011. *Mejores políticas para el desarrollo: Perspectivas OCDE sobre Chile.*, Paris: OECD Publishing.

Peisner-Feinberg, E.S. et al., 2001. The relation of preschool child-care quality to children's cognitive and social developmental trajectories through second grade. *Child Development*, 72(5), pp.1534–1553. Available at: http://doi.wiley.com/10.1111/1467-8624.00364.

Pierrehumbert, B. et al., 1996. Child care in the preschool years: Attachment, behaviour problems and cognitive development. *European Journal of Psychology of Education*, 11(2), pp.201–214.

Reynolds, C. et al., 2000. *Overview of the ASQ : SE*, Baltimore: Brookes Publishing.

Rodriguez, S., Arancibia, V. & Undurraga, C., 2008. *Escala de Evaluación Cognitivas de 0-24 meses.* 13th ed., Santiago: Cronopios.

Ruhm, C. & Waldfogel, J., 2011. Long-term effects of early childhood care and education. , (6149).

Ruzek, E. et al., 2013. The quality of toddler child care and cognitive skills at 24 months: Propensity score analysis results from the ECLS-B. *Early Childhood Research Quarterly*, pp.1–10. Available at: http://linkinghub.elsevier.com/retrieve/pii/S0885200613000732 [Accessed September 26, 2013].

Sammons, P. et al., 2007. *Influences on Children' s Development and Progress in Key Stage 2: Social/behavioural outcomes in Year 5*, London.

Sammons, P. et al., 2004. The impact of pre-school on young children's cognitive attainments at entry to reception. *British Educational Research Journal*, 30(5), pp.691–712.

Shonkoff, J.P., 2010. Building a new biodevelopmental framework to guide the future of early childhood policy. *Child Development*, 81(1), pp.357–67. Available at: http://www.ncbi.nlm.nih.gov/pubmed/20331672.

Sylva, K. et al., 2004. *The Effective Provision of Pre-School Education (EPPE) Project: Final Report. A Longitudinal Study Funded by the DfES 1997-2004*, London.

Thompson, R.A., Raikes, H.A. & Perry, D.F., 2007. The social and emotional foundations of school readiness. In R. K. Kaufmann & J. Knitzer, eds. *Social and emotional health in early childhood: Building bridges between services and systems*. Baltimore, MD, US: Paul H Brookes Publishing, pp. 13–35.

Tokman, A., 2010. Radiografía de la educación parvularia chilena: Desafíos y propuestas.

UNESCO, 2010. Early Childhood Care and Education Regional Report. Latin America and the Caribbean. *Organization*, pp.1–158.

UNICEF, 2008. *The child care transition. A league table of early childhood education and care in economically advanced countries*, Florence.

Vandell, D.L. et al., 2010. Do effects of early child care extend to age 15 years? Results from the NICHD study of early child care and youth development. *Child Development*, 81(3), pp.737–56. Available at: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2938040&tool=pmcentrez&rendertype=abstract.

Votruba-Drzal, E. et al., 2010. Child care and the development of behavior problems among economically disadvantaged children in middle childhood. *Child Development*, 81(5), pp.1460–74. Available at: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2941232&tool=pmcentrez&rendertype=abstract.

Weiland, C. & Yoshikawa, H., 2013. Impacts of a prekindergarten program on children's mathematics, language, literacy, executive function, and emotional skills. *Child Development*, 84(6), pp.2112–2130.

Appendices

Appendix 1: Data cleaning process

Two variables provide complementary information about the children's type of care when they were aged 24 to 36 months old. Variable j9 has information on each type of care (including maternal care and centre-based care). In addition, variable j10 has information on whether the mother sent her child to centre-based care in each specific period. While many mothers (31 per cent) stated that they were their child's main caregiver (variable j9), they also stated that they had sent their child to centre-based care during the same period (variable j10). I categorised those children whose mother stated that their child's main type of care was centre-based care (variable j9) and those whose mothers stated they sent their children to centre-based care (variable j10) as having attended centre-based care. I categorised those children whose mothers stated she was the main caregiver of her child (j09) and who also stated they did not send their child to centre-based care (variable j10) as children in maternal care.

Appendix 2: The impact of entry into centre-based care at two years old on child cognitive and socio-emotional development: OLS estimates. (Sample restricted)

	TADI				Battelle			
Variables	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Centre-based 2 years old	0.172***	0.137***	0.128***	0.117**	0.171***	0.123**	0.117**	0.105*
	(0.051)	(0.049)	(0.048)	(0.048)	(0.062)	(0.057)	(0.056)	(0.056)
Demographics		X	X	X		X	X	X
Home environment			X	X			X	X
Region and urban				X				X
Obs.	1,281	1,281	1,281	1,281	1,289	1,289	1,289	1,289
R-squared	0.010	0.117	0.133	0.141	0.007	0.123	0.132	0.139
	CBCL Total				Internalising problems			
Variables	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Centre-based two years old	0.082	0.087	0.089	0.091	0.043	0.062	0.064	0.070
	(0.058)	(0.057)	(0.057)	(0.057)	(0.058)	(0.057)	(0.057)	(0.057)
Demographics		X	X	X		X	X	X
Home environment			X	X			X	X
Region and urban				X				X
Obs	1,318	1,318	1,318	1,318	1,318	1,318	1,318	1,318
R-squared	0.002	0.095	0.096	0.098	0.000	0.080	0.082	0.086

Notes All OLS regressions control for children's age. All columns show the magnitude of the key coefficient with se. in parentheses. Column (1) shows the results of a regression without controls. Column (2) shows the results of a regression controlling for demographic characteristics such as maternal characteristics: age (linear and square); years of education, low level of education, marital status, work status, teen pregnancy, difficulties during pregnancy, mental health problems during pregnancy, breastfeeding, alcohol consumption and smoking, depression, numeracy and vocabulary abilities, and personality. In addition, this regression controls for child characteristics: gender; presence of older sibling, premature birth; low weight; common diseases, and age (linear and square). Column (3) shows the result of regression in column (2) plus controls for home environment characteristics: family income per capita (linear and square), family under poverty line and HOME test score. Column (4) shows the results for the regression in column (3) plus region and area (urban or rural) controls. The cognitive outcomes tests are the TADI (*Test de Aprendizaje de Desarrollo Infantil*, in English 'Child Development Cognitive Test') that evaluates four dimensions: motor, language, cognitive, and social-emotional and the Battelle Screening test that assesses five.

Appendix 3: The association between centre-based care attendance and child socio-emotional outcomes with the sample restricted to children that have the CBCL test measure in both 2010 and 2012: OLS, individual fixed effect and propensity score matching estimates.

	Socio-emotional development		
	CBCL Total	CBCL Externalising	CBCL Internalising
OLS	0.0786	0.0427	0.0802
	(0.0793)	(0.0812)	(0.0768)
Observations	728	728	728
R-squared	0.118	0.130	0.104
Individual fixed effects (FE)	0.0967	0.0840	0.114
	(0.0918)	(0.0920)	(0.0938)
Observations	728	728	728
R-squared	0.076	0.079	0.078
Individual FE + propensity score matching (PSM)	-0.147**	-0.185**	-0.123*
	(0.0744)	(0.0746)	(0.0733)
Observations	728	728	728

Note: All regressions in this table control for demographic, home environment, and regional characteristics. The socio-emotional outcomes test is the Child Behavior Checklist (CBCL) test that evaluates behavioural problems, emotional problems, internalising problems (for example, anxious, depressive, and over-controlled behaviours), and externalising problems (for example, aggressive, hyperactive behaviours). I converted children's outcomes into Z scores. *** $p<0.01$, ** $p<0.05$, * $p<0.1$. Robust standard errors in parentheses.