613318

CARE

Curriculum Quality Analysis and Impact Review of European ECEC

Instrument: Collaborative project
Call Identifier: FP7-SSH-2013-2
Early childhood education and care: promoting quality for individual, social and economic benefits

D5.4: Report on costs-benefits estimations of ECEC

DUE DATE OF DELIVERABLE: 31/08/2016
ACTUAL SUBMISSION DATE: 31/08/2016

Start date of project: 01-01-2014 Duration: 36 Months

CARE contractor:
Utrecht University

Title: A Cost-Benefit Analysis of Universal Preschool Education

Organisation: Utrecht University
Authors (main authors in bold): **Thomas van Huizen, Lisa Dumhs & Janneke Plantenga**
Email: t.m.vanhuizen@uu.nl
Number of PM: 3
Dissemination Level: PU

Version	date	Authors	status	changes
0.1		Thomas van Huizen		
0.2		Lisa Dumhs		
0.3		Janneke Plantenga		

Project co-funded by the European Commission within the Seventh Framework Programme (2014-2017)		
Dissemination Level		
PU	Public	
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

Executive Summary

There are two main (efficiency) arguments that justify public investments in ECEC. First, investments in ECEC may increase maternal employment. Second, investments in ECEC may improve child development. Given the evidence on the effects of ECEC on maternal employment and child development (see CARE report T4.4), this report provides a cost-benefit analysis of universal (non–targeted) ECEC.

This report is the first to provide a comprehensive, causal evidence based cost-benefit analysis of expanding universal access to preschool. We analyse one policy reform in more detail: the LOGSE reform in Spain. In the early 1990s, the Spanish government introduced a reform that lowered the age of universal eligibility for publicly subsidized childcare by one year, from age 4 to age 3. As most of the cost-benefit analysis focus on small scale targeted programs instead of a national extension of preschool arrangements, the Spanish reform is an interesting and relevant case from a cost-effectiveness point of view as the costs of a universal program are likely to be higher and the benefits more dispersed. Our cost-benefit analysis therefore aims to contribute to understanding of the dilemmas and challenges of expanding high-quality ECEC in Europe.

The LOGSE preschool expansion is one of the few cases where evidence is available on the causal effects on both maternal employment and child development. First, the reform increased maternal employment: for ten additional children aged 3 in ECEC, approximately two mothers took up employment (Nollenberger and Rodríguez-Planas, 2015). Second, the reform reduced grade retention rates in primary school and improved students reading (but not match) scores at age 15 (Felfe et al., 2015). In our cost-benefit analysis we take into account the effects on both maternal employment and child development.

We present the calculations of the benefits and costs of the ECEC reform as a one-time investment in one cohort of 3-year old children, using 1997 as the base year. Hence, we compare the costs of increasing public spending on ECEC for this cohort with the benefits gained by encouraging the labour supply of the mothers of this cohort of children, plus the benefits gained by improving the cognitive skills of this cohort of three-year-olds. This strategy allows us to estimate the benefit-cost ratio of the investment and the results provide insights in whether the ECEC investment pays off: how many euros (in present value terms) does the society receive back for each euro invested in ECEC? Moreover, the analysis demonstrates the main benefits and identifies the main beneficiaries of the investment. The analysis also provides insight in the sensitivity of the results to particular parameters.

Our base results indicate that the benefit-cost ratio is over 4. Although this ratio is lower than those typically found for targeted ECEC interventions, the findings indicate sizeable net returns of (expanding) universal access to ECEC for all 3-year-olds. Sensitivity tests show that under most cases the estimated benefit-cost ratio is higher than 1, indicating a positive net present value for society. Furthermore, our cost-benefit analysis shows that the gains for children are the major driver of the total societal gains of universal ECEC. The maternal employment effects play a relatively small role: one of the striking findings is that the benefit-cost ratio is not substantially affected when the maternal employment effect is varied from the lowest to the highest estimate found in the literature.

The Spanish case illustrates that expansions of high-quality preschool programs for 3-year-olds may generate substantial returns in the long run. Our cost-benefit analysis provides support for investing in high-quality ECEC, not in extending coverage rates per se. Previous literature (Melhuish et al., 2015; Van Huizen and Plantenga, 2015) shows that ECEC quality levels should be sufficient to generate improvements in (non-)cognitive skills. ECEC arrangements of low to mediocre quality levels are likely to produce insignificant results or may even be harmful to child development. Since our analysis indicates that the lion’s share of the total societal benefits of ECEC investments are the result of child development gains, it is crucial to invest in quality in order to obtain positive net returns for society.

Table of contents

1. INTRODUCTION

Today, the majority of children in developed countries participate in Early Childhood Education and Care (ECEC) before entering primary school. In 2014, on average across EU countries over 80 percent of children between age 3 and the mandatory schooling age were enrolled in ECEC (Eurostat, 2016), while in the US around 65 percent of the 3- to 5-year-olds attended a preprimary program (NCES, 2015). As these arrangements are generally to a large extent publicly funded, public spending on ECEC has increased substantially during the past decades to 0,8 percent of GDP on average across OECD countries (OECD, 2014). There are two main (efficiency) arguments that justify these public investments in ECEC. First, investments in ECEC may increase parental employment: available and affordable childcare services allow parents to return to work after a period of leave and are therefore frequently considered as important determinants of high (female) employment rates (Jaumotte, 2003; Attanasio et al., 2008). Second, investments in ECEC may improve child development: various scholars claim that (high-quality) ECEC improves school readiness, increases children's performance in school and improves well-being and labor market outcomes during adulthood (Gormley et al., 2005; Barnett, 2011; Reynolds and Ou, 2011; Duncan and Magnuson, 2013; Elango et al., 2015). However, there is little evidence on whether public investments in ECEC are in fact cost effective: do the (long-run) societal benefits outweigh the costs of ECEC?

This study aims to evaluate the cost-effectiveness of such programs and is the first to provide a comprehensive, causal evidence based cost-benefit analysis of expanding universal access to preschool. Existing cost-benefit analyses are based on relatively small-scale randomized controlled trials (RCTs) of targeted interventions in the US (e.g. Barnett and Masse, 2007; Heckman et al. 2010; Reynolds et al., 2002; 2011; Temple and Reynolds, 2007). The cost-benefit analyses based on RCTs of targeted interventions generally provide support for expanding ECEC for disadvantaged children. However, these results have limited applicability to universal ECEC (for the general population) because targeted interventions concern different programs (content-wise) for a specific part of the population. Universal ECEC cannot be evaluated by RCTs and estimating the causal impact of childcare policies on maternal employment and child development is challenging due to endogeneity issues.[1] In order to deal with this issue, scholars have exploited natural experiments, generally based

[1] Selection into ECEC arrangements is voluntary: parents and children do not randomly select into ECEC arrangements and therefore it is likely that there are (unobservable) differences between users and non-users.

on national policy reforms, to estimate the causal effects of childcare and preschool on maternal employment and child development. Since the natural experiment studies allow for a stronger claim of causality, we base our analysis on the evidence provided by these studies.

In our cost-benefit analysis of expanding access to ECEC, we focus on the LOGSE reform. This reform, implemented in Spain in the early 1990s, lowered the age of universal eligibility for publicly subsidized preschool from age 4 to age 3. The Spanish reform provides an interesting case for cost-benefit analysis of universal ECEC for several reasons. First, it represents one of the few cases where evidence from a natural experiment is available on the effects on both maternal employment and child development: Nollenberger and Rodríguez -Planas (2015) and Felfe et al. (2015) examined the effects of LOGSE on the employment rate of mothers and the cognitive development of children, respectively. Hence, this case allows us to take into account the societal benefits in both domains. Second, the estimated effects are consistent with the overall findings in the recent natural experiment literature. Our cost-benefit analysis represents therefore a rather general case.[2] Third, Felfe et al. (2015) provide evidence on effects on cognitive achievement in the long run (at age 15). Many studies report child development effects measured in early childhood, but these effects potentially fade out during primary school (e.g. Barnett, 2011; Duncan and Magnuson, 2013). Compared to short-term gains, long-term gains can be more reliably extrapolated to increases in lifetime earnings.

The LOGSE reform is not only an interesting case because of the available 'natural experiment' evidence, but is also highly relevant from a policy perspective: it concerns a recent reform[3] that extended eligibility of universal ECEC. Such reforms have been implemented recently or are currently discussed in various European countries (e.g. UK, Poland). Furthermore, although the program can be considered as high-quality (though not necessarily as a best practice), the program is not exceptionally expensive and represents a feasible policy option for most European countries. Our cost-benefit analysis therefore aims to contribute to understanding of the dilemmas and challenges of expanding high-quality ECEC in Europe. In addition, we believe that in the era of evidence-based policy it is imperative to examine not only whether ECEC reforms generate benefits in terms of child development and maternal employment, but also to assess whether the potential benefits outweigh the costs.

The remainder of the study is structured as follows. Section 2 provides a short overview of the LOGSE reform and its effects on maternal employment and child development; section 3 describes the

---

These (unobserved) differences may be related to the employment probability of mothers and to child development.

[2] Nollenberger and Rodriguez-Planas (2015) report positive effects on maternal employment and the size of the estimated effect is around the average effect size found in recent studies. Moreover, based on the existing literature, positive effects on child development (driven by lower SES children) may be expected as it concerns a relatively high-quality preschool program: this is consistent with the findings of Felfe et al. (2015).

[3] For instance, Havnes and Mogstad (2011a; 2011b) provide evidence about the effects of a 1970s reform.

methodology to calculate the costs and extrapolate the benefits of the universal preschool expansion. Section 4 presents the main results from the cost-benefit analysis; the final section concludes.

2. INVESTING IN UNIVERSAL ECEC: THE SPANISH CASE

2.1 THE LOGSE REFORM

In 1990 Spain implemented a major educational reform: the Ley Orgánica de Ordenación General del Sistema Educativo (LOGSE). This reform had an impact on the organization of the entire education system, ranging from preschool to high school. For this study we are mainly concerned with the impact of the LOGSE reform on preschool arrangements (see for more details Felfe et al., 2015; Nollenberger and Rodríguez –Planas, 2015).

Before the LOGSE reform children of 4 and 5 years of age were covered by free universal public preschool education.[4] The reform increased the eligibility of preschool services to 3-year-olds, leading to a dramatic increase in public preschool enrollment rates (from 8.5% in 1990 to 42.9% in 1997 and to 67.1% in 2002[5]). Preschools were generally integrated within primary schools and had the same hours as compulsory schools. The preschool program was based on a full-day schedule, implying 9 am to 5 pm on workdays (except for a total of 14 weeks of school vacation per year). Furthermore, the reform not only increased the availability of preschool services for the 3-year-olds, but also had an impact on the quality of the service by regulating educational content, group size and the educational requirements of the staff. For example, under the new system preschool teachers of 3-year-olds were required to have a college degree in pedagogy and the maximum class size was set at 20 for 3-year-olds (and 25 for 4- and 5-year-olds).

When the reform took place, female labor market participation in Spain was low: 34% of all women were active on the labor market, considerably below the EU average of 46%. Unemployment rates were high (20%) and average unemployment duration was about two years. The use of childcare and preschool for 3-year-olds was limited because of a lack of supply and a mismatch between supply and demand. Possibilities to adjust working hours were rare: part-time employment was virtually non-existent in Spain and there were limited possibilities to vary start/end times of work for family reasons

[4] Public preschool education is free except for a small fee as contribution for meals
[5] Coverage of 3-year-olds in (public or private) ECEC reached 93 percent in 2002.

(Mills et al. 2014). In effect, only approximately 10 percent of the youngest age group (0-4) made use of child care facilities. In short, the Spanish case concerned a reform of a public ECEC system with low (initial) coverage rates against a background of a slack labor market, limited possibilities for family-work reconciliation and low levels of female labor force participation.

2.2 ESTIMATED EFFECTS OF THE REFORM

To identify the causal effects of LOGSE on maternal employment and child development, Nollenberger and Rodríguez-Planas (2015) and Felfe et al. (2015) exploit variation in the speed of implementation between regions using a difference-in-differences (DiD) approach. Such a DiD has been applied in various other studies on this topic (Bauernschuster and Schlotter 2015; Havnes and Mogstad, 2011a; 2011b) and allows for a stronger claim of causality (see Angrist and Pischke (2008) for a methodological discussion of DiD). In the Spanish case, the variation in the speed of expansion varied substantially between regions: in high-intensity regions the public preschool coverage rate increased from less than 10 percent to 44 percent during the three years after the introduction of the reform, whereas in that same period the coverage rate rose from 7,4 to 15,3 percent in low-intensity regions (Felfe et al., 2015; p.400-401). Interestingly, the enrollment of 3-year-olds in private childcare followed the same trend in high-intensity and low-intensity regions (both experienced a slight increase in the 1987-2002 period), indicating that the increase in public enrollment did not crowd out private preschool. Moreover, Felfe et al. (2015) argue that the additional public childcare places substituted mainly for parental care rather than informal childcare as most children of working mothers were enrolled in formal (public and private) care in the pre-reform period.

In their analysis of the impact of the reform on female labor force participation, Nollenberger and Rodríguez-Planas (2015) estimated that offering public childcare increased maternal employment by 9.6%. This implies that for ten additional children aged 3 in ECEC, approximately two mothers took up employment. This employment-to-enrollment ratio of nearly 0.2 is in between the relatively low (e.g. Havnes and Mogstad, 2011a) and high (Bauernschuster and Schlotter, 2015) estimates found in the literature. However, given that public childcare mainly substituted for maternal care, this effect is rather modest. The authors attribute this relatively small employment effect to the Spanish labor market conditions during this time period in general and to the family unfriendly working conditions in particular.

Using the 2000-2009 waves of the Programme for International Student Assessment (PISA), Felfe et al. (2015) estimated the effects on child development. In their preferred specification, they estimated that the reform increased students reading scores at age 15 by around 0,154 standard deviations, but had no effect on children’s math achievement. This is in line with the expectations because “activities undertaken in public child care stimulate children’s social and emotional competencies and thus their language and reading skills but not necessarily their math skills” (Felfe et al 2015: 411). In addition, the results also indicate a decline of 2.4 percentage points in the grade retention rate during primary education. Compared to the pre-reform situation, this implies a decrease in the incidence of retention of almost 50%.

The effects presented by Felfe et al. (2015) are reported as intention-to-treat (ITT) effects, comparing all (not just those enrolled in preschool) children in low-intensity regions with children in high-intensity regions. Following the DiD literature (e.g. Baker et al., 2008; Havnes and Mogstad, 2011b), we calculate the treatment-on-the-treatment (TOT) effect by dividing the ITT with the relative increase in public preschool coverage (25,8 percent). Accordingly, the TOT with respect to PISA reading scores is (0,154/0,258=) 0,597; the TOT with respect to grade retention is (-0,024/0,258=) -0,093.

Table 1 provides an overview of the estimated effects on maternal employment and on child development (including the 90 percent confidence interval). For our cost-benefit analysis, these TOT effects are the central parameters as they indicate the effects of reform per child in preschool on post-reform cohorts of students in high-intensity regions. In the next section we discuss how we use these TOT effects to extrapolate the benefits for parents, children and taxpayers.

Table 1: Summary of the main DiD results

Beneficiary	Domain	Effect size	Lower bound (90% CI)	Upper bound (90% CI)
Mother	Employment	0,181 (0,029)	0,011 (0,004)	0,350 (0,0537)
Child	PISA reading score	0,5969 (0,1540)	0,1697 (0,0438)	1,0241 (0,2642)
	PISA math score	NS	-	-
	Grade retention Primary school	0,0932 (0,0240)	0,0101 (0,0026)	0.1759 (0,0454)
	Grade retention Secondary school	NS	-	-

Note: Effect sizes are presented as TOT (ITT between parentheses): the effect per additional 3-year old child in public preschool. The employment effect is expressed in additional mothers in employment per additional child in preschool. The effects on PISA reading scores are expressed in percentage change in standard deviations of the achievement scores.
Source: Felfe et al. (2015); Nollenberger and Rodríguez-Planas (2015); own calculations

3. METHODOLOGY

3.1 GENERAL APPROACH

In our cost-benefit analysis, we distinguish between three groups of beneficiaries of the Spanish ECEC reform: parents (mothers), children, and taxpayers (the general public). We estimate how the causal effects (summarized in Table 1) translate into higher lifetime earnings of parents and children. Parents have gained from the LOGSE preschool expansion as it allowed mothers to stay employed after childbirth and thereby positively affected their earnings. Moreover, as mothers will be able to stay active or return to work sooner, the reform had a positive effect on human capital and thereby maternal earnings in the longer run. Children have benefited from the preschool reform due to improved skill levels (and reduced grade retention), which will translate into higher expected lifetime earnings. Finally, taxpayers gain as the gross lifetime earnings of mothers and children increase. Since additional taxes on earnings are 'derived' benefits', taxes only affect the distribution and not the size of the total level of benefits to society. In addition to increased earnings taxes, taxpayers also benefit from the reduction in primary school grade retention, as this will decrease public expenditure on education.

In our cost-benefit analysis, the main challenge is to quantify these benefits for parents, children and taxpayers into (monetary) present value terms. Existing cost-benefit analyses are based on randomized controlled trials (RCTs) of targeted ECEC interventions (e.g. Heckman et al. 2010). These RCTs provide TOT estimates of the effects of the program, which are used to extrapolate the benefits of the ECEC program. We follow this approach and use the TOT effects (rescaled from the ITT effects; see Table 1) in our cost-benefit analysis, using 1997 as base year. Hence, we compare the costs of one additional 3-year old in preschool with the average benefits gained by encouraging the labor supply of mothers plus the average benefits gained by improving the cognitive skills of a three-year-old. This strategy allows us to estimate the benefit-cost ratio of the investment and the results provide insights in whether the ECEC investment pays off: how many euros (in present value terms) does the society receive back for each euro invested in ECEC? Moreover, the analysis indicates the main benefits, the main beneficiaries and the sensitivity of the results to specific parameters.

We quantify the TOT effects using a base earnings scenario for parents and children. The base scenario is derived from average annual wages as provided by the Eurostat Structure of Earnings Survey (Eurostat, 2002; 2006; 2010; 2014). This data is provided every four years from 2002 until 2014 and contains gender- and age-specific[6] average annual earnings. Missing data are imputed either by assuming smooth wage growth between known data points, or by using the average annual real

[6] Average annual earnings are provided in 10-year age groups.

wage growth for total average earnings as derived from the OECD average annual wages dataset (OECD, 2016a). To estimate age-specific annual wages, we use a linear transformation of the average wage per age-group, taking the average to be reached exactly in the midpoint of the age category. To estimate the base scenario for mothers, we use age-specific female wages, corrected for age-specific female employment rates to take into account that not all women are employed. We derive the base scenario for children in the same way, except that we use average total (male plus female) annual earnings and employment rates. Moreover, assuming that the relevant cohort has the potential to be active on the labor market between age 16 and 70[7], the relevant years are 2010 (when the cohort is 16) until 2064 (when the cohort is 70). We correct for future wage growth using a 0.8% growth rate per year in real wages.[8] Again we use age-specific employment rates, and use the EU projections on future employment rates (European Commission, 2015) to take into account expected changes in the employment rate[9].

As discussed above, all the benefits for children and some of the benefits for parents materialize in the future (from the perspective of the investment year). The benefits are expressed in real terms, using 1997 as the base year. Following previous CBAs of targeted ECEC interventions (Heckman et al., 2010; Nores et al., 2005; Reynolds et al., 2002; 2011) as well as studies on the returns to investments in education (Hanushek and Woessmann, 2011; 2012), we calculate the present value of these future streams of benefits using a 3 percent discount rate. In section 4.2 we assess to what extent the main results are sensitive to the specific discount rate.

In the next sections we provide our calculations of the costs of universal preschool (3.2) and discuss our strategy to extrapolate the benefits for the three groups of beneficiaries (3.3-3.5).

3.2 COSTS OF THE ECEC

The benefits of the Spanish reform are expressed as additional benefits per child: we will compare these with the additional costs per child. In cost-benefit analyses of RCTs, costs per child can relatively easily be calculated as the total program costs divided by the number of participants. Estimating the additional costs per child of large scale (nationwide) expansions is generally more difficult. A problem is that the additional costs per child due to the reform are not necessarily equal to the average (post-reform) costs per child. However, we can demonstrate (see Appendix A) that, in the

[7] Note that the average wages of the youngest and oldest groups hardly influence the cumulative lifetime earnings as the employment rates of these groups are low.
[8] This is the average real wage growth in the period 1990-2015 in the OECD average annual wages dataset (OECD, 2016a).
[9] In European Commission (2015: p.322) country specific projections for employment rates (age 20-64) in five-year intervals are provided. We assume that the employment rate increases linearly from 2015 (our last data point) until 2020, from 2020 to 2025, etc. Next, for the years 2016-2064 we calculate a correction factor by dividing the projected average employment rate by the actual average employment rate (age 20-64) in 2015. We use this correction factor to calculate the age-specific employment profiles.

case of the Spanish ECEC expansion, we can approximate the reform costs per child by the costs per child in the post-reform period.

In the Spanish case, data on the cost per child of public preschool education in Spain in the relevant time-period is not available in international or Spanish public datasets. Based on data from the Spanish Ministry of Education on expenditure on preschool and primary and on total enrollment, Nollenberger and Rodríguez-Planas (2015) and Felfe et al. (2015) estimate that in 1997 annual expenditure per child was €2405. However, as not all expenditures are included (e.g. infrastructure costs), this is likely to be an underestimation of the actual costs. Furthermore, about one out of three children are enrolled in private (pre)schools, which are partially publicly funded. Public spending per child (based on all children) is therefore lower than the public spending per child in a public school.

Given these issues, we base our estimate of the costs per child on the 2007 estimates of the annual public expenditure per student provided by Rogero-Garcia and Andrés-Candelas (2014). We use the OECD CPI to account for inflation and estimate the 1997 costs per child. We calculate the costs per child in preschool as the costs for preschool and primary education associated with teaching activities plus the average additional costs per child.[10] Accordingly, the total costs per child in preschool is €3544 (€4762 in 2007 prices). Interestingly, based on an alternative source (European Commission et al., 2014: p.82) providing information on the direct public expenditure per child in public preschool (ISCED 0) in 2010, we obtain a rather similar estimate of the costs per child (€3614; €5130 in 2010 prices).

Finally, we should take into account an important caveat when using this estimate of the costs for one additional 3-year old child in preschool. Theoretically, the expansion of public preschool may have crowded out private preschool and childcare arrangements (see, for example, Blanden et al. (2016) for an analysis of the UK case). However, Nollenberger and Rodríguez-Planas (2015) and Felfe et al. (2015; p. 410) show that the reform did not significantly affected private preschool coverage of 3-year-olds. This is crucial for our cost-benefit analysis because if the expansion of public preschool would have crowded out private preschool, the additional societal costs would be lower. In fact, in case of a perfect substitution, the reform would simply redistribute costs from parents to taxpayers rather than increase overall societal costs. In the case of the LOGSE reform, however, the additional costs (and benefits) arise because a larger number of children is enrolled in preschool.

[10] Unfortunately, we cannot distinguish between expenditure on preschool and expenditure on primary school. The average additional costs per student is based on all students in public schools (including secondary schools) and consist of, for example, social security contributions and supplement services. However, we do not include spending on ‘scholarships and grants for textbooks and material’, as this is unlikely to be relevant for preschool children.

3.3 EXTRAPOLATION OF BENEFITS FOR PARENTS

We distinguish between two types of (related) benefits for parents: 1) A short-term employment effect: higher earnings due to positive employment effects; 2) A long-term wage effect: higher earnings due to higher human capital levels (as mothers will be able to return to work sooner). The central parameter to estimate the first effect is 0,181 (i.e. indicating the additional mothers in employment per additional 3-year old in preschool). The second effect is an indirect effect and depends crucially on the size of the first effect, since this effect is only relevant for the group of mothers who are encouraged to (re-)enter the labor market as a result of the ECEC expansion.

Short-term employment effect

The Spanish reform encouraged the employment of mothers, generating a short-term employment effect: on average maternal employment increases by nearly 0,2 for every additional child in ECEC (Table 1). Estimating the monetary benefits of this short-term employment effect is rather straightforward: to calculate the benefits per child, we multiply this employment effect parameter with the base earnings of women aged 32[11] (for the base year 1997).

Long-term wage gains

A second, indirect effect of the ECEC expansion is that it decreases the length (and frequency) of mothers' career interruptions, and thereby positively affects their human capital stock and basically reduces the motherhood penalty. It may not be surprising that larger motherhood penalties are found in countries that provide relatively limited support to working mothers (Gash, 2009). Given that there is no direct evidence available on how ECEC policies reduce the motherhood penalty, we base our estimate of the longer run wage effect of ECEC on three streams of literature, focusing on; 1) career interruptions; 2) parental leave; and 3) returns to experience (after childbirth).

First, evidence shows that career interruptions are harmful to wages (e.g. Mincer and Ofek 1982; Kunze 2002, Felfe 2012). Spivey (2005) provides evidence (based on NLSY) that career interruptions[12] decrease wages of women up to nine years after re-entering employment. These effects are substantial but decline over time: whereas wages are 7.6 percent ($p<0.01$) lower in the first year after re-entry, this negative effect is substantially smaller and in some cases insignificant in the five to nine years following the interruption (with a 2.8 percent ($p<0.05$) loss nine years after the

[11] The average age of mothers of a 3-year-old child is 32 (Nollenberger and Rodriguez-Planas, 2015).
[12] These concern career interruptions of at least a full calendar year. Maternity leave is therefore not considered as a career interruption.

interruption).[13] Mincer and Ofek (1982) also document that wage levels restore rather quickly upon re-entry.

Second, because the expansion of childcare facilities reduced the mother's time away from work, the long-term earnings effects may be similar to the effect of a reduction in the duration of maternity or parental leave. Most of the literature examined the effects of parental leave extensions rather than reductions and shows relatively small negative effects on wages that fade out within several years (e.g. Schönberg and Ludsteck, 2014). These negative wage effects of extending parental leave duration may be considered as a lower bound of exiting the labor market, as parental leave generally involves job protection during the leave period. The positive wage effects of providing ECEC services may therefore be higher than the wage effects (in absolute terms) of changes in parental leave.

Third, a period out of employment negatively affects labor market experience. A large body of literature estimates the returns to experience using Mincer earnings equations. Consistent with the findings on the motherhood penalty and career breaks, a general result is that there are diminishing returns of experience. Interestingly, Ejrnæs and Kunze (2013) show that women's returns to experience before and after childbirth are different. After childbirth, the rate of return is around 0,025 per year; before childbirth the returns are larger but diminishing. However, as women aged above mid-40s are excluded, it is not clear whether this negative effect diminishes in the long run.

Our conclusion from these three strands of literature is that career interruptions decrease wages and that this effect diminishes with time since re-entry. We take the results of Spivey (2005) as our frame of reference in our extrapolation of the longer term wage gains of mothers due to ECEC expansions. The reasons to use this study are threefold: Spivey explicitly models the dynamics of wage losses after a career interruption; the results are consistent with the idea of large but diminishing negative effects; and the estimates are within the range of most other studies. As not all the coefficients of the career interruption penalty are significant 5-9 years after the interruption, we use the average effect of these five years for the parameters to calculate the effect on post-entry wages.[14] To calculate these effects, we multiply the number of additional mothers in employment (0,18 per child in preschool) with the change in the base wages for the relevant ages (33-41, years 1998-2006) and account for future career interruptions by correcting for the relevant age and gender specific employment rates.

[13] Using German data, Felfe (2012) shows that wages of women are reduced by 4 percent by a career interruption. However, the persistence of this effect is not modeled explicitly (and women above age mid-40s are excluded). Similarly, Kunze (2002) shows that a period of non-work reduces German women's wages around 5% in the first years after re-entering employment, but the effect size declines over time and is not significant 6 years after the career break (parental leave effects are larger and more persistent, but are likely to capture a motherhood effect).

[14] Insignificant effects are considered 0. Wage differences (in percentage) between treatment and control in the nine years after re-entering the labor market are 7.6; 4.6; 2.9; 2.0; and 1.6 for the last five years.

3.4 EXTRAPOLATION OF BENEFITS FOR CHILDREN

In our cost-benefit analysis, we estimate how the gains in PISA reading achievement and the reduction in grade retention probability increase lifetime earnings of children. We focus on three effects: 1) A wage effect: by improving the skill level of participating children, their human capital stock increases and so will their future productivity level and wage rate; 2) An employment effect: higher skill levels not only have an effect on wages of employed individuals but also positively affect employment probabilities and thereby increase future earnings. 3) A grade retention effect: ECEC reduced the retention rate, which (ceteris paribus) decreases the age of entry into the labor market and thereby increases the participant's expected lifetime earnings (due to a longer potential duration in employment).

Wage effect

Felfe et al. (2014) document that the Spanish ECEC expansion significantly increased age 15 PISA reading scores, but had no effect on their numeracy skills. How to convert these test score benefits measured in adolescence into monetary benefits over the entire life course is one of the crucial steps in our cost-benefit analysis. The central assumption is that higher test scores reflect a higher level of accumulated cognitive skills and that the gains in skill level will result in higher wages and lifetime earnings (directly or indirectly through higher educational attainment). A number of studies provide support for this assumption.

Early studies (mainly based on US data) report a relation between cognitive skill tests and earnings of around 12 percent. For instance, Lazaer (2003) finds that a one standard deviation (SD) higher test score of 8th grade students (around age 13) predicts a 12 percent higher earnings at age 25. Mulligan (1999) finds that individuals with a 1 SD higher test score have 11 percent higher wages (while controlling for years of schooling). Using two US datasets, Murnane et al. (2000) test the predictive value of math scores (measured in the senior year of high school) for earnings of workers in their late 20s and early 30s and decompose the total effect of skills on wages into a direct effect of ability and an indirect effect of years of schooling. They found that the effect of skills on wages was higher for males than females (10-15 percent versus 9-12 percent) and that the effect was mainly direct for males and mostly indirect for females.[15]

Due to data availability, the focus has been on predicting wages rather early in the career. However, several recent studies show that the returns to skills increase over the lifecycle: the results based on early career wages may substantially underestimate the relevance of skills for lifetime

[15] Bertschy et al. (2009) also concluded that the main channel through which PISA scores lead to better labor market outcomes was via better training and educational attainment. PISA scores are also found to be a good predictor of timely graduation and final exam results (Fischbach et al., 2013).

earnings.[16] Lin et al. (2016) show for the US that the AFQT score (a composite cognitive test score) measured between age 16 and 23 predicts total earnings and hourly wages several decades later, with stronger effects for older individuals. In line with previous studies (reporting an increase in earnings of around 12 percent per SD increase in the skill measure), Lin et al. (2016) show that a SD increase in skills increases wages by 13 percent by age 28. However, returns to skills per SD increase to 16 and 18 percent by age 38 and 48, respectively.[17] The effects appear to be somewhat stronger when cognitive skills are measured at an early age (16-18). Interestingly, the estimate for the UK is close to this US estimate: a SD higher cognitive test score (at age 11) is associated with a 19.4 percent higher hourly wages (at age 42) (Carneiro et al., 2007: p.36). Given this evidence on longitudinal data we consider 12 percent as a lower bound for the US.

As we aim to convert the gains in PISA reading score by Spanish children into increased lifetime earnings, we should take into account that the US results are based on general or composite skill measures. It is plausible that more general cognitive skill measures are better predictors of earnings than a score in a single cognitive domain (i.e. literacy in our case). Moreover, returns to skills are different from one country to another: institutional factors, the country's wage structure (i.e. the extent to which wages are compressed) and labor market conditions determine returns to skills. As returns to skills tend to be relatively high in the US (e.g. Hanushek and Zhang, 2009, Hanushek et al., 2015), we consider the US estimates as an upper bound for Spain. To correct for the difference in returns to skills between the US and Spain as well as the empirical finding that LOGSE affected reading but not math skills, we use the comparative evidence provided by Hanushek et al. (2015). Using cross-sectional (PIAAC) data for 23 countries, including Spain and the US, Hanushek et al. (2015) estimate the relations between wages and numeracy as well as literacy skills.[18] These results show that returns to skills in Spain are about 80 percent of the returns in the US.[19] In addition, we derived the relative share of returns to literacy skills by using the estimation results decomposing the overall returns to skills in returns to numeracy (13.7 percent) and literacy (10.5 percent). This suggests that around 43.4 percent of the total returns can be attributed to literacy skills. Combining these estimates, we use the conservative US parameter for a general skill measure (0.12) to derive the

[16] Lifetime earnings is rather weakly correlated with earnings at the start of the career, but strongly with prime-age earnings (Böhlmark and Lindquist, 2006; Haider and Solon, 2006). This is an important issue in cost-benefit analysis as (changes in) lifetime earnings determine the benefits.
[17] The relation with annual labor income is a lot stronger, varying from 17 percent at age 28 to 26 percent at age 48. This can be explained by an effect of skills on the employment rate and on working hours.
[18] It is likely that we would substantially overestimate the return to literacy skills if we would use the coefficient for Spain on the relation between literacy skills (time *t*) and wages (time *t*) directly. According to the US results reported by Hanushek (2015: p.125), a 1 SD increase in numeracy (literacy) skills increases wages by 28 (27) percent. The fact that this is substantially higher than the 12 to 18 percent found in longitudinal studies suggests that the relation between adult wages and skills measured in childhood/ adolescence is substantially weaker than the relation between time *t* wages and skills measured at time *t*.
[19] In models including either numeracy or literacy skills, the coefficient of numeracy (literacy) skills is 0.279 (0.271) for the US and 0.228 (0.220) for Spain (Hanushek et al., 2015: p.125).

returns to literacy skills parameter for Spain (0.042 = 0.12*0.8*0.434). We use this single parameter for all ages since returns to skills do not appear to increase significantly with age in Spain (Hanushek et al., 2015: p.112). Since US longitudinal evidence indicates that 12 percent per SD is probably an underestimation of the effect, as an alternative we could use 16 percent per SD, which is the average return for the various ages (Lin et al., 2016). This would imply a 5.5 rather than a 4.2 percent increase in wages per SD increase in literacy skills. In our sensitivity analysis, we demonstrate how the results depend on the specific value used to estimate returns to skills.

Employment effect

Higher skill levels may not only increase wages for those in employment, they may also positively affect employment rates. Estimates on the relation between skill levels and employment rates are scarce, however. Providing longitudinal evidence for the UK, Carneiro et al. (2007) report that individuals with a 1 SD higher (age 11) cognitive test score are 3.6 percent more likely to be employed at age 42.[20] The cognitive skills measure is a composite test score (including maths, reading, copying, and general ability) which is significantly related to age 42 literacy and math scores (with a regression coefficient of around 0.6). Since we are primarily interested in how PISA (age 15) reading skills are related to employment probabilities in adulthood and the evidence on this relation is scarce, we use the more conservative estimate provided by Carneiro et al. (2007). Because the estimate is based on a composite score, we multiply the effect size (0.036) with 0.5 (=0.018) to derive our central parameter for the effect of a 1 SD increase in PISA reading scores on employment rates.

Grade retention effect

Felfe et al. (2014) demonstrate that the Spanish preschool expansion for 3-year-olds reduced grade retention in primary school, probably because ECEC participation increases school readiness of young children. This result implies that, ceteris paribus, affected children are able to graduate and enter the labor market at a younger age. We estimate the benefits for children of reduced grade retention by multiplying the wage at age 21 (the average age of finishing education in Spain in 2009 (OECD, 2011)) with this age group's employment rate of individuals not in education. We use the employment rate of individuals not in education instead of the (lower) overall employment rate as we aim to calculate the benefits of completing education (i.e. not being in education anymore) earlier versus later.

[20] Using cross-sectional data, Hanushek et al. (2015) reports substantially stronger associations between skills and employment: in Spain, a one SD increase in (numeracy) skills is associated with a 14 percent higher employment probability (10 percent in the UK). However, the longitudinal evidence predicting adult wages with skills measured in childhood/adolescence is more relevant for our study.

3.5 EXTRAPOLATION OF BENEFITS FOR TAXPAYERS

Taxpayers gain as the lifetime earnings of mothers and children increase. We use tax rates on gross labor income provided by the OECD (2016b) to calculate the benefits for taxpayers. We do not consider social security contributions as benefits for taxpayers, as these are related to entitlements (unemployment benefits, pensions) of parents and children. In addition to increased taxes, which are derived benefits that affect the distribution of benefits but not the size of the total societal benefits, taxpayers also benefit from the reduction in primary school grade retention. In the Spanish educational system children spend 6 years in primary school (age 6-12) if they do not retain a grade. This implies that the children aged 3 in 1997 who are not retained due to the reform finished primary school in 2005 instead of 2006. To calculate the grade retention benefits for taxpayers, we multiply the discounted costs per child in preschool and primary school per child[21] by the estimated TOT effect of not retaining a grade.

3.6 LIMITATIONS

In our cost-benefit analysis, we focus on the benefits in terms of lifetime earnings of parents and children and we thereby exclude several benefits that may be relevant. First, there may be other benefits for parents. For instance, providing childcare services frees up parental time that may be used for other purposes than paid employment: leisure, education, informal labor (household production), community services, etc. This free-time benefit has been included in cost-benefit analyses (e.g. Reynolds et al. 2002), using the minimum wage to compute the monetary value of the time benefit. While we do not include the value of time for mothers that did not enter employment explicitly in our CBA, we would like to note that presumably such non-monetary benefits exist for parents. Furthermore, by analyzing the benefits for one specific cohort, we may underestimate the longer run benefits. For instance, in the post-reform period (future) mothers may anticipate that they do not have to leave the labor market as childcare services are available: this increases incentives to invest in human capital. Similarly, increasing childcare availability may, in the long run, change or redefine the cultural background that determines female labor supply decisions.

Second, we do not include all benefits for children that are potentially relevant. For instance, unlike some studies on targeted interventions (e.g. Heckman 2010; Reynolds et al. 2011; Barnett and Masse 2007), we do not include the benefits of reduced crime rates, improved health and increased income of future generations (i.e. the children's children). As the LOGSE reform affected the general

[21] We use here our estimate of the costs per child in preschool and primary education: see section 3.2 for a more extensive discussion. €4633 for the 7th year of primary school in 2006 (€4762 in 2007 prices) implies a discounted value of €3551.

population rather than disadvantaged children, the gains in terms of crime reductions and health improvements may be rather limited in this case.

4. RESULTS

4.1 BASE RESULTS

The main results are presented in Table 2. The net benefits of the ECEC investments for society in present value are substantial: about €12.000 per 3-year old child in preschool, implying a benefit-cost ratio of over 4. In other words, for every euro invested in ECEC, society gets back more than 4 euro. While this indicates that universal ECEC expansions may generate significant benefits for society, it should be noted that the benefit-cost ratio is substantially lower than benefit-cost ratios found in cost-benefit analysis of targeted interventions. For example, the benefit-cost ratios of the Perry Preschool program and the preschool program of the Child-Parent Centers are around 11 (Heckman et al., 2010; Reynolds et al., 2011). This difference in benefit-cost ratio seems to make sense, however, given the evidence that children from lower socio-economic status families mostly benefit from ECEC (Elango et al., 2015; Melhuish et al., 2015; Van Huizen and Plantenga, 2015).

To illustrate the total economic benefits of extending preschool eligibility to 3-year-olds, we aggregate the societal costs and benefits of one entire cohort. In the academic year 1997-1998, 154.063 3-year old children were enrolled in public preschool. The total estimated costs of ECEC for these children are €546 million, but according to our baseline results this investment generated a €2,35 billion societal benefit in (1997) present value terms (i.e. €1,81 billion net benefits). The net benefits of the investment account for 0,35 percent of GDP.

In addition to the size of the total benefits, the analysis provides insights in the distribution of the benefits. It is clear that children are the main beneficiaries of the ECEC expansion (see Figure 1). The result that children mainly benefit from ECEC is because they are able to profit from improved cognitive skill levels during their entire working life. This is illustrated in Figure B1 (Appendix B), which shows the estimated effects attending ECEC due to the reform, assuming that the individual is employed from age 21 to age 65 (in our analysis individuals are potentially active between age 16 and 70, using age-specific employment rates as weights). These benefits accumulate over the entire life cycle and translate into substantial lifetime earnings gains.

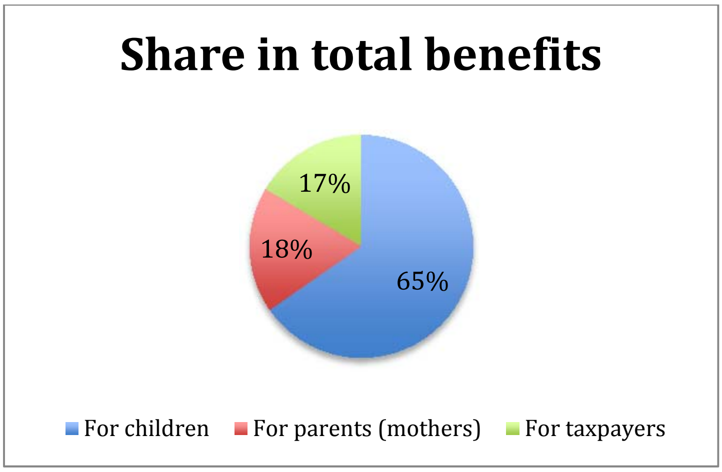
Table 2: Costs and benefits of universal ECEC

	For children	For parents	For taxpayers	For society
Measured effects				-
Maternal employment effect				-
Earnings mothers		2.450,96		2.450,96
Taxes on earnings			418,21	418,21
Grade retention (costs prim. school)			330,30	330,30
Projected effects				-
Earnings mother				-
Reduced wage penalty		336,68		336,68
Taxes on earnings			57,45	57,45
Grade retention				
Earnings child	331,65			331,65
Taxes on earnings			56,59	56,59
Improved skill effect				-
Earnings child (wage)	6.701,16			6.701,16
Earnings child (employment)	2.943,92			2.943,92
Taxes on earnings			1.645,76	1.645,76
Total benefits	9.976,73	2.787,64	2.508,31	15.272,69
Total costs			- 3.544,45	- 3.544,45
Net present value	9.976,73	2.787,64	- 1.036,14	11.728,23
Benefit-cost ratio			0,71	4,31

Note: Costs and benefits are presented in 1997 euros; present values are calculated using a discount rate of 3 percent.

To indicate the relative importance of the benefits for children and parents, we calculated the benefit-cost ratio in case there would be either no significant child development gain or no significant increase in maternal employment. If there would be no significant benefits for children the benefit-cost ratio drops below 1 (to 0,92), implying that the ECEC investment results in a societal loss. In this case, costs should drop by almost 80 percent to an implausible value of €760 per child to obtain the same benefit-cost ratio as in our base result. On the other hand, if there would be no significant gains in terms of maternal employment, the benefit-cost ratio declines to 3,4 (and costs should decrease to around €2800 to maintain the original benefit-cost ratio) and there would still be substantial net societal benefits.

Figure 1: Distribution of benefits



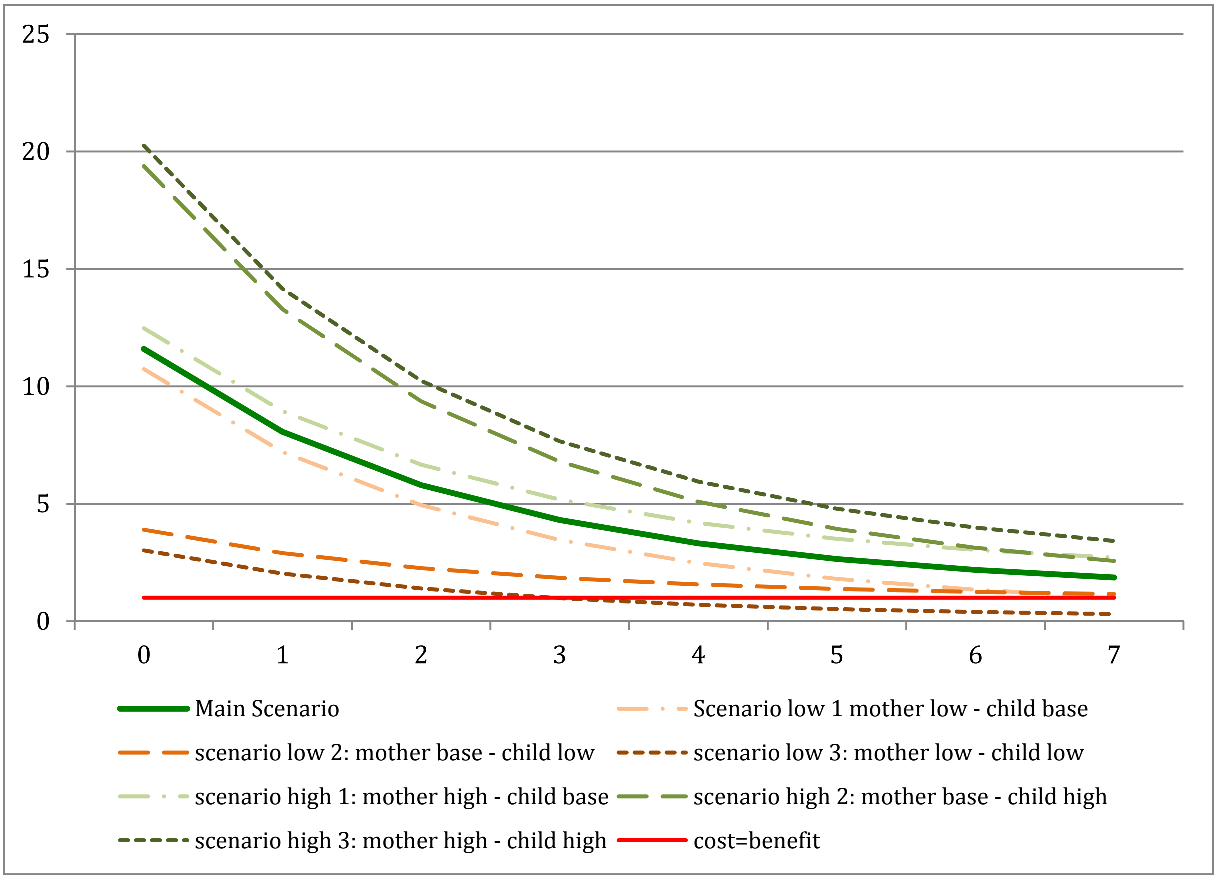
Finally, it should be noted that the distribution (but not the size) of the benefits depends crucially on the tax rate. In our base results, taxpayers receive 71 cents back for every euro invested in universal ECEC, implying a negative impact on the government budget balance. However, this result is highly sensitive to the estimated tax rate and whether or not social security contributions are included. For example, taxpayers receive more than 1 euro back for every euro invested when using the tax rate estimated by Nollenberger and Rodríguez-Planas (2015).

4.2 SENSITIVITY ANALYSIS

We examined the sensitivity of our main results using a series of tests. First, as our cost-benefit analysis is based on the estimated causal effects on maternal employment and child development, we vary the effect sizes using the lower and upper bound of the 90 percent confidence intervals (see Table 1). We calculate the benefit-cost ratios under six alternative scenarios:

- Low 1: Lower bound maternal employment effect; base effects for child development;
- Low 2: Lower bound child development effect; base effects maternal employment;
- Low 3: Lower bound maternal employment and child development effect;
- High 1: Upper bound maternal employment effect; base effects for child development;
- High 2: Upper bound child development effect; base effects maternal employment;
- High 3: Upper bound maternal employment and child development effect.

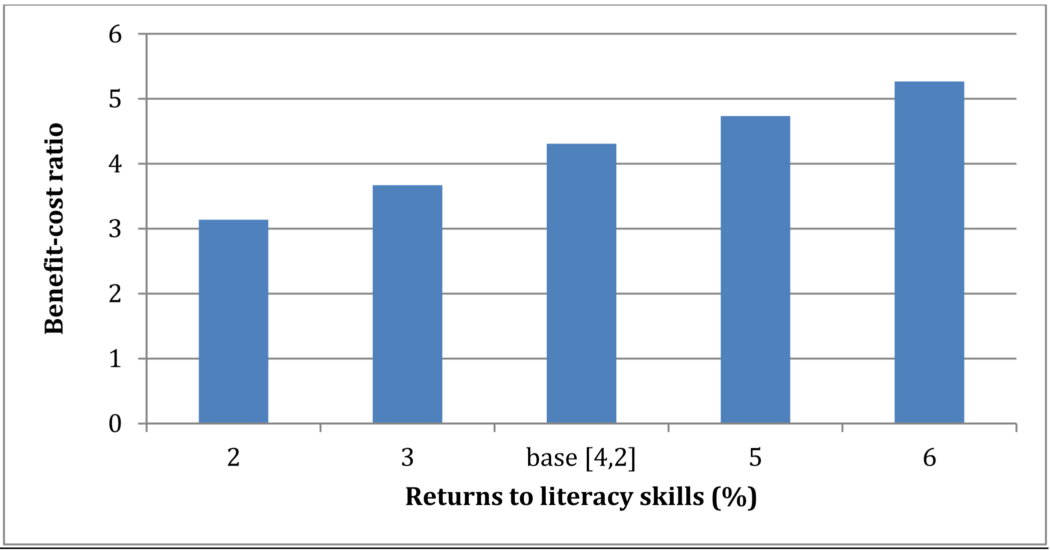
Figure 2: Different scenarios



The benefit-cost ratios of these six different scenarios (plus the baseline) using discount rates within the range 0-7% (as in e.g. Reynolds et al., 2002) are presented in Figure 2. The figure indicates three striking results. First, the benefit-cost ratio is above 1 in all scenarios, except for 'Low 3' assuming a discount rate of 3 (when the ratio is just below 1) or higher. Hence, under most scenarios the analysis indicates that the ECEC investment generated positive net benefits to society. Second, it is clear that the discount rate matters to a large degree. This is consistent with our main result that the child development benefit is the major determinant of the benefit-cost ratio: this benefit materializes in the longer run and so its present value is directly affected by the discount rate. Third, in line with our base results, the benefit-cost ratio appears to be highly sensitive to the benefits for children but rather insensitive to variation in the estimated maternal employment effect. This finding is especially remarkable because the child development effect is more precisely estimated than the maternal employment effect. The confidence interval around the maternal employment effect is therefore rather large: from almost no (economically significant) effect to a substantial effect. In fact, the higher bound used in our sensitivity analysis (0,35) is close to the main result of Bauernschuster and Schlotter (2015) for Germany (0,37), an estimate that is in the upper range of the estimates found in the quasi-experimental literature. In other words, the scenarios (Low 1 and High 1) cover basically the entire literature on causal effects of universal ECEC on maternal employment.

As children are the main beneficiaries of the ECEC investment, it is plausible that the specific value of the returns to skills parameter is crucial for the net present value of the investment. We therefore examine whether our results are robust to using different parameter values. Figure 3 presents the benefit-cost ratios for different returns to skills parameters. As discussed in 3.4, instead of the 4,2 percent return that we use in our baseline calculations, a 5,5 percent return is also plausible. The benefit-cost ratio increases to around 5 if this value is used. Furthermore, even in the extreme case that returns to literacy skills are 2 percent, the benefit-cost ratio is still above 3.

Figure 3: Benefit-cost ratios and returns to literacy skills



4.3 HETEROGENEOUS CHILD DEVELOPMENT EFFECTS

Our main analysis uses estimated child development effects that are based on the pooled sample of children to extrapolate the benefits for children. Existing literature indicates that children from lower socio-economic status (SES) parents benefit most (or only) from ECEC (Elango et al., 2015; Melhuish et al., 2015; Van Huizen and Plantenga, 2015). Consistent with the existing literature, Felfe et al. (2014) show the effect on PISA reading scores is significant in the sample of children whose both parents do not have a secondary school degree and not significant in the sample of children from families in which at least one parent has a secondary school degree. Accounting for these heterogeneous effects is important in our analysis, as on the one hand larger benefits can be expected due to the larger effect size for this specific group (ITT of 0,168 instead of 0,154), but on the other hand benefits will be smaller as the gains are calculated over a much smaller number of children (the low SES group represents about ¼ of the total sample).

We recalculate the benefits of the ECEC expansion using the relevant, larger effect size and correcting for the lower share of children benefiting from the investment. In our calculation of the TOT we assume that the expansion increased coverage rates equally among the different SES groups. If the reform increased the use of ECEC services more among lower SES families than among higher SES families, this will lead to an underestimation of the TOT effect and thereby to an underestimation of the societal benefits (and to an overestimation if higher SES families were more affected). Furthermore, we use the same base earnings scenario as in our main results (i.e. using average wages and employment rates). Since lower SES groups have below average wages and employment rates, the benefits are calculated over a smaller base wage and employment rate and so the total benefits will actually be smaller. Hence, we should interpret these findings cautiously.

The results allowing for heterogeneous child development effects are presented in Table 3. The table shows that if only lower SES children benefit from the ECEC expansion the societal benefits decline by more than 50 percent . However, the benefit-cost ratio is still substantially above 1.

Table 3: Costs and benefits: heterogeneous child development effects

	For children	For parents	For taxpayers	For society
Measured effects				-
Maternal employment effect				-
Earnings mothers		2.450,96		2.450,96
Taxes on earnings			418,21	418,21
Grade retention (costs prim. school)			330,30	330,30
Projected effects				-
Earnings mother				-
Reduced wage penalty		336,68		336,68
Taxes on earnings			57,45	57,45
Grade retention				
Earnings child	331,65			331,65
Taxes on earnings			56,59	56,59
Improved skill effect				-
Earnings child (wage)	1.990,50			1.990,50
Earnings child (employment)	859,43			859,43
Taxes on earnings			486,29	486,29
Total benefits	3.181,58	2.787,64	1.348,84	7.318,07
Total costs			-3.544,45	-3.544,45
Net present value	3.181,58	2.787,64	-2.195,61	3.773,61
Benefit-cost ratio			0,38	2,06

Note: Costs and benefits are presented in 1997 euros; present values are calculated using a discount rate of 3 percent.

5. CONCLUSION AND DISCUSSION

This study examined the cost effectiveness of investments in universal preschool education: do these investments pay off in the long run? Our starting point in answering this question is the Spanish LOGSE reform. This reform reduced the age of eligibility for universal publicly provided preschool from age 4 to age 3 and led to a strong increase in the enrollment rate of 3-year-olds in these arrangements. Existing evidence shows that the reform had a positive impact on maternal employment and improved child development. We extrapolate the societal benefits on the basis of these estimated causal effects, taking into account these benefits for parents and children.

Our base results indicate that the benefit-cost ratio is over 4. Although this ratio is lower than those typically found for targeted ECEC interventions, the findings indicate sizeable net returns of (expanding) universal access to ECEC for all 3-year-olds. Sensitivity tests show that under most cases the estimated benefit-cost ratio is higher than 1, indicating a positive net present value for society. Furthermore, our cost-benefit analysis shows that the gains for children are the major driver of the total societal gains of universal ECEC. The maternal employment effects play a relatively small role: one of the striking findings is that the benefit-cost ratio is not substantially affected when the maternal employment effect is varied from the lowest to the highest estimate found in the literature.

Our analysis shows that the net present value of ECEC investments not only depends critically on whether children (on average) benefit, but also on which children benefit (most) from ECEC. Consistent with most previous evidence from natural experiments (Elango et al., 2015; Van Huizen and Plantenga, 2015), only children from lower educated parents have benefitted from the Spanish preschool expansion. The limited use of (high-quality) ECEC services by lower SES families, whose children actually benefit most from participating in such services, is an issue that should be further addressed by public policy. Encouraging lower SES families to use high-quality ECEC services may be costly in the short-term but may boost the benefit-cost ratio of ECEC investments in the long-run.

The Spanish case illustrates that expansions of high-quality preschool programs for 3-year-olds may generate substantial returns in the long run. Our cost-benefit analysis provides support for investing in high-quality ECEC, not in extending coverage rates per se. Previous literature (Melhuish et al., 2015; Van Huizen and Plantenga, 2015) shows that ECEC quality levels should be sufficient to generate improvements in (non-)cognitive skills. Mediocre level ECEC arrangements are likely to produce insignificant results or may even be harmful to child development. Since our analysis indicates that the lion's share of the total societal benefits of ECEC investments are the result of child development gains, it is crucial to invest in quality in order to obtain positive net returns for society.

R E F E R E N C E S

Angrist, J. D., Pischke, J.-S. (2008). Mostly harmless econometrics: An empiricist's companion. Princeton, Princeton University Press.

Attanasio, O., Low, H., and Sanchez-Marcos, V. (2008). Explaining Changes in Female Labor Supply in a Life-Cycle Model. American Economic Review, 98(4): 1517-1552.

Baker, M., Gruber, J., Milligan, K. (2008). Universal child care, maternal labor supply, and family well-being. Journal of Political Economy, 116 (4), 709–745.

Barnett, W.S. (2011). Effectiveness of Early Educational Intervention. Science, 333(6045): 975-978.

Barnett, W.S. and Masse, L.N. (2007). Comparative benefit–cost analysis of the Abecedarian program and its policy implications. Economics of Education Review, 26: 113–125.

Bauernschuster, S. and Schlotter, M. (2015). Public child care and mothers' labor supply - Evidence from two quasi-experiments. Journal of Public Economics, 123: 1–16.

Berlinski, S., Galiani, S., and Gertler, P. (2009). The effect of pre-primary education on primary school performance. Journal of Public Economics, 93, 219–234.

Bertschy, K., Cattaneo, M.A., and Wolter, S.C. (2009). PISA and the Transition into the Labour Market. Labour, 23(s1): 111–137.

Blanden, J., Del Bono, E., McNally, S. and Rabe, B. (2016). Universal Pre-school Education: The Case of Public Funding with Private Provision. Economic Journal, 126: 682–723.

Böhlmark, A. and Lindquist, M.J. (2006). Life-Cycle Variations in the Association between Current and Lifetime Income: Replication and Extension for Sweden. *Journal of Labor Economics*, 24(4): 879–896.

Carneiro, P., Crawford, C., and Goodman, A. (2007). The Impact of Early Cognitive and Non-Cognitive Skills on Later Outcomes. CEE Discussion Paper No. 92.

Duncan, G.J. and Magnuson, K. (2013). Investing in Preschool Programs. Journal of Economic Perspectives, 27(2): 109-132

Ejrnæs, M. and Kunze, A. (2013). Work and Wage Dynamics around Childbirth. Scandinavian Journal of Economics, 115(3): 856–877.

Elango, S., Garcia, J.L., Heckman, J.J. and Hojman, A. (2015). Early childhood education. IZA Discussion Paper No. 9476.

European Commission (2015). The 2015 Ageing Report. Economic and budgetary projections for the 28 EU Member States (2013-2060). European Economy, 3, 2015.

European Commission, EACEA, Eurydice, Eurostat (2014). Key Data on Early Childhood Education and Care in Europe. 2014 Edition. Eurydice and Eurostat Report. Luxembourg: Publications Office of the European Union.

Eurostat (2002, 2006, 2010, 2014). Structure of earnings survey: annual earnings. Available from: http://ec.europa.eu/eurostat/data/database.

Eurostat (2016). Formal childcare by age group and duration. Available from: http://ec.europa.eu/eurostat/data/database.

Felfe, C. (2012). The motherhood wage gap: What about job amenities? Labour Economics, 19: 59–67.

Felfe, C., Nollenberger, N. and Rodríguez-Planas, N. (2014). Can't buy mommy's love? Universal childcare and children's long-term cognitive development. Journal of Population Economics, 28: 393–422.

Fischbach, A., Keller, U., Preckel, F., and Brunner, M. (2013). PISA proficiency scores predict educational outcomes. Learning and Individual Differences, 24: 63–72.

Gash, V. (2009). Sacrificing Their Careers for Their Families? An Analysis of the Penalty to Motherhood in Europe. Social Indicators Research, 93(3), 569–586.

Gormley, W.T., Gayer, T., Phillips, D., and Dawson, B. (2005). The effects of universal Pre-K on cognitive development. Developmental Psychology, 41, 872–884.

Haider, S. and Solon, G. (2006). Life-Cycle Variation in the Association between Current and Lifetime Earnings. American Economic Review, 96(4): 1308–1320.

Hanushek, E.A. and Woessmann, L. (2011). How much do educational outcomes matter in OECD countries? Economic Policy, 26(67): 427–491.

Hanushek, E.A. and Woessmann, L. (2012). The Economic Benefit of Educational Reform in the European Union. CESifo Economic Studies, 58: 73–109.

Hanushek, E.A. and Zhang, L. (2009). Quality-Consistent Estimates of International Schooling and Skill Gradients. Journal of Human Capital, 3(2): 107–143.

Hanushek, E.A., Schwerdt, G., Wiederhold, S. and Woessmann, L. (2015). Returns to skills around the world: Evidence from PIAAC. European Economic Review, 73: 103–130.

Havnes, T. and Mogstad, M. (2011a). Money for nothing? Universal child care and maternal employment. Journal of Public Economics, 95: 1455–1465.

Havnes, T. and Mogstad, M. (2011b). No Child Left Behind: Subsidized Child Care and Children's Long-Run Outcomes. American Economic Journal: Economic Policy, 3(2): 97–129.

Heckman, J.J., Moon, S.H., Pinto, R., Savelyev, P.A. and Yavitz, A. (2010). The rate of return to the HighScope Perry Preschool Program. Journal of Public Economics, 94: p114–128.

Jaumotte, F. (2003). Female Labour Force Participation: Past Trends and Main Determinants in OECD Countries. OECD Working Paper No. 376.

Kunze, A. (2002). The Timing of Careers and Human Capital Depreciation. IZA Discussion Paper. No. 509, Bonn.

Lazear, E.P. (2003).Teacher incentives. Swedish Economic Policy Review, 10(2),179–214.

Lin, D., Lutter, R. and Ruhm, C.J. (2016). Cognitive Performance and Labor Market Outcomes. IZA Discussion Paper No. 10075.

Melhuish, E, Ereky-Stevens, K, Petrogiannis, K, Ariescu, A, Penderi, E, Rentzou, K, Tawell, A, Slot, PL, Broekhuizen, M, and Leseman, P. (2015). A review of research on the effects of Early Childhood Education and Care (ECEC) upon child development. CARE project research report.

Mills, M., Tsang, F., Präg, P., Ruggeri, K., Miani, C., & Hoorens, S. (2014). Gender equality in the workforce: Reconciling work, private and family life in Europe. European Commission.

Mincer, J. and Ofek, H. (1982). Interrupted work careers: Depreciation and restoration of human capital. Journal of Human Resources, 17(1): 3-24.

Mulligan, C. (1999). Galton versus the human capital approach to inheritance. Journal of Political Economy, 107: S184–S224.

Murnane, R., Willett, J., Duhaldeborde, Y. and Tyler, J.H. (2000). How important are the cognitive skills of teenagers in predicting subsequent earnings? Journal of Policy Analysis and Management, 19: 547–568.

Nollenberger, N. and Rodríguez-Planas, N. (2015). Full-time universal childcare in a context of low maternal employment: Quasi-experimental evidence from Spain. Labour Economics, 3: 124–136.

NCES (2015). Digest of Education Statistics. Table 202.10: Enrollment of 3-, 4-, and 5-year-old children in preprimary programs, by age of child, level of program, control of program, and attendance status.

Nores, M., Belfield, C.R., Barnett, W.S., Schweinhart, L. (2005). Updating the Economic Impacts of the High/Scope Perry Preschool Program. Educational Evaluation and Policy Analysis, 27(3): 245–261.

OECD (2011). Education at a Glance: OECD Indicators. Paris: OECD Publishing.

OECD (2014). Public spending on childcare and early education. OECD Family Database.

OECD (2016a). Average annual wages – Dataset. http://stats.oecd.org/

OECD (2016b). Tax Database, Table I.5. Average personal income tax and social security contribution rates on gross labour income. http://stats.oecd.org/

Reynolds, A.J., and Ou, S.-R. (2011). Paths of Effects From Preschool to Adult Well-Being: A Confirmatory Analysis of the Child-Parent Center Program. Child Development, 82(2): 555–582.

Reynolds, A.J., Temple, J.A., Robertson, D.L., and Mann, E.A. (2002). Age 21 Cost-Benefit Analysis of the Title I Chicago Child-Parent Centers. Educational Evaluation and Policy Analysis, 24(4): 267–303.

Reynolds, A.J., Temple, J.A., White, B.A.B., Ou, S.-R., and Robertson, D.L. (2011). Age 26 Cost–Benefit Analysis of the Child-Parent Center Early Education Program. Child Development, 82(1): 379–404.

Rogero-García, J., and Andrés-Candelas, M. (2014). Family and State Spending on Education in Spain: Differences between Public and Publicly-Funded Private Educational Institutions. Revista Española de Investigaciones Sociológicas, 147: 121–132.

Schönberg, U., and Ludsteck, J. (2014). Expansions in Maternity Leave Coverage and Mothers' Labor Market Outcomes after Childbirth. Journal of Labor Economics, 32(3): 469–505.

Spivey, C. (2005). Time off at what price? The effects of career interruptions on earnings. Industrial and Labor Relations Review, 59(1): 119–140.

Temple, J. A., and Reynolds, A. J. (2007). Benefits and costs of investments in preschool education: Evidence from the Child-Parent Centers and related programs. Economics of Education Review, 26(1): 126–144.

Van Huizen, T., and Plantenga, J.(2015). Universal Child Care and Children's Outcomes : A Meta-Analysis of Evidence from Natural Experiments. USE Discussion Paper No.15-13.

Appendix A

The total relative increase in costs between low- and high intensity regions ΔK can be expressed as:

$$\Delta \mathrm{K} = \left[cN_{1,h} - (c-q)N_{0,h}\right] - \left[cN_{1,l} - (c-q)N_{0,l}\right] \qquad (1)$$

where c represents the costs per preschool child in the post-reform period, q the additional costs due to post-reform quality improvements, N indicates the coverage in low-intensity (l) and high-intensity (h) regions in the pre-reform (0) and post-reform period (1). Equation (1) can be rewritten as an expression of the additional costs per child due to the reform:

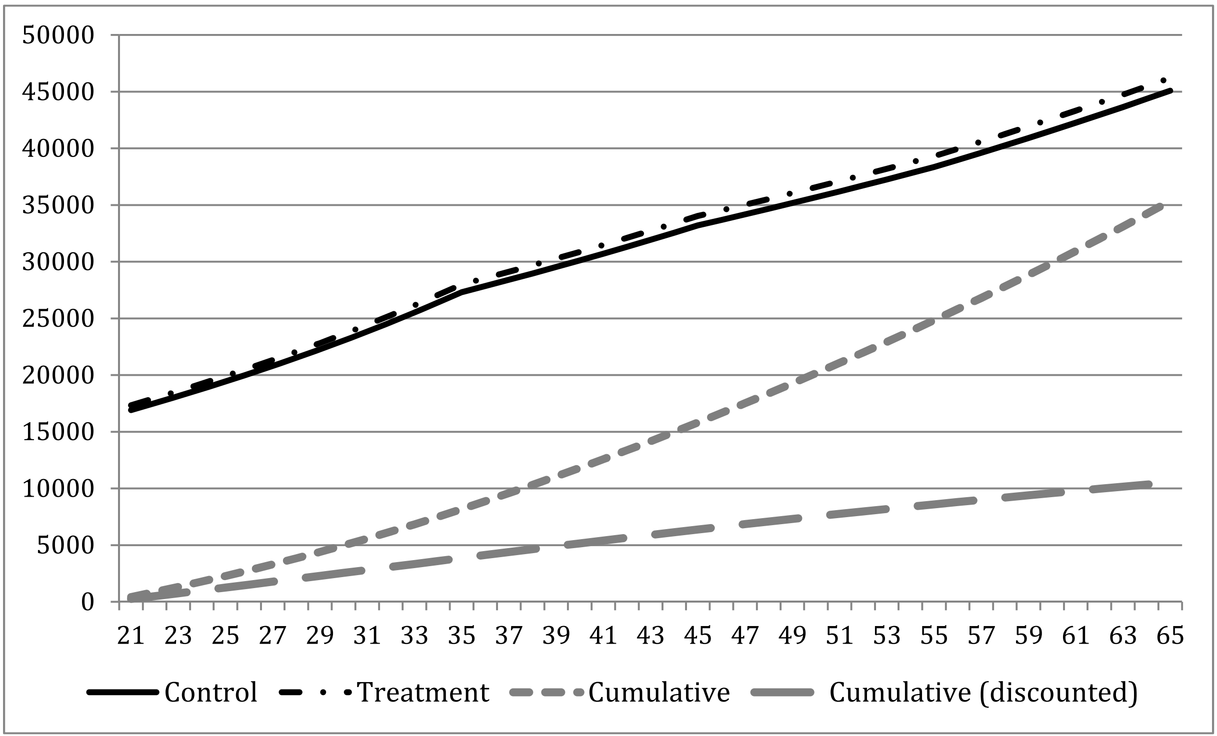
$$\frac{\Delta \mathrm{K}}{[\Delta N_h - \Delta N_l]} = c + \frac{q[N_{0,h} - N_{0,l}]}{[\Delta N_h - \Delta N_l]} \qquad (2)$$

where ΔN_h and ΔN_l represent the change in coverage in the high-intensity and low-intensity regions, respectively. Equation (2) shows that the additional costs per child due to the reform (left-hand-side) are exactly equal to the average (post-reform) costs per child c when there is no increase in costs due to higher quality levels ($q = 0$) and/or if there is no difference between low-intensity and high-intensity regions in the pre-reform coverage rates ($N_{0,h} - N_{0,l} = 0$).

As discussed above, LOGSE implied substantial improvements in preschool quality standards and so it is likely that costs per child in preschool increased significantly during the expansion period ($q > 0$); the exact increase in costs per child in public preschool is unknown unfortunately. Moreover, pre-reform coverage of 3-year-olds was slightly higher in the high-intensity (9,9%) than in the low-intensity (7,4%) region ($N_{0,h} - N_{0,l} > 0$). The intuition is that the reform increased the total costs in the high intensity-region not only because of a faster increase in the coverage rate, but also because of a (2,5%) larger base coverage that required larger investments due to quality improvements. Hence, by using the average post-reform cost per child we underestimate the reform costs per child. However, we argue that this bias is negligible because of the minor pre-reform difference between the high- and low-intensity regions. In fact, we can derive that even if the costs per 3-year old in preschool would have increased by 40 percent during the reform, the reform costs per child would be only 1 percent higher than the average post-reform cost per child.

Appendix B

Figure B1: Estimated future earnings profiles of children (control versus treatment)



Note: this figure is based on an individual who is employed during the entire life cycle (in our cost-benefit analysis we correct for employment rates); Treatment-on-the-treated (TOT) effects are used to calculate the earnings profiles of the treatment group.