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Parental beliefs, perceived health risks, and time investment in children: evidence from COVID-19

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Abstract

When deciding how to allocate their time among different types of investment in their children, parents weigh up the perceived benefits and costs of different activities. During the COVID-19 outbreak parents had to consider a new cost dimension when making this decision: the perceived health *risks* associated with contracting the virus. What role did parental beliefs about risks and returns play for the allocation of time with children during the pandemic? We answer this question by collecting rich data on a sample of first-time parents in England during the first lockdown, including elicitation of perceived risks and returns to different activities via hypothetical scenarios. We find that parents perceive their own time investment to be (i) more productive and (ii) less risky than the time spent by their children in formal childcare or with peers. Using open-ended questions about their pandemic experience and detailed time use data on children's daily activities, we then show that parental beliefs are predictive of actual investment choices, and are correlated with parental feelings derived from sentiment analysis. Lastly, we show that less educated parents perceive both lower returns and lower risks from investments, potentially causing a further widening of pre-existing inequalities in early years development, and suggesting the need for targeted informational interventions.

Keywords: parental beliefs, health risks, time investments, childcare, text data, coronavirus.

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1 Introduction

Early years investments are crucial for children's health, cognitive and socio-emotional development, which are in turn important predictors of lifecourse well-being and socio-economic outcomes (see Currie and Almond (2011) and Almond, Currie, and Duque (2018) for reviews). Since parents are the primary providers of care and stimulation in the early years, the role that their investments play in the process of human capital formation is fundamental. Recent studies have shown that parental beliefs about the technology of skill formation, including the returns to different inputs, influence the type and level of investments that parents make in their children (Cunha et al., 2013; Boneva and Rauh, 2018).

The COVID-19 outbreak has led to school closures worldwide (UNESCO, 2020), with significant learning and developmental losses for children (Engzell et al., 2021; Maldonado and De Witte, 2021). With schools being closed, the choices parents have made about the specific ways to invest in their children's human capital have become even more salient. Indeed, differences in parental inputs during lockdown have been associated with differences in children's outcomes (Davies et al., 2021). Although it is now accepted that COVID-19 infection in children appears to be less widespread and severe than in adults (Boast et al., 2020; Lavezzo et al., 2020; Park et al., 2020; Oster and Alter, 2021; Thompson and Rasmussen, 2021; Christophers et al., 2022), the potential transmission of the virus between children and adults, and the role played by schools in this process, has remained uncertain for most of 2020. Therefore, besides the monetary costs of different investments, parents had also to consider a new dimension: the health *risks* associated with the various activities, i.e. the chances of contracting COVID-19. In this context, parents may be less likely to send their child to formal childcare if they perceive a greater health risk from childcare relative to other activities, or if they believe they can substitute formal childcare with other investments, such as parental play. These expectations might also be heterogeneous across people with different characteristics, potentially leading to different investment responses to the COVID-19 outbreak.

In England and elsewhere, the provision of home learning during lockdown has not been equal across families, with children in better-off households enjoying more home learning activities, and being twice as likely to return to school after its reopening (Andrew et al., 2020; Cattan et al., 2021; Kate et al., 2021; Oppermann et al., 2021). These inequalities in inputs are concerning, since they might lead to further widening of pre-existing inequalities in child development - especially for small children, for whom school attendance is not compulsory until age five. In England, the COVID-19 pandemic has impacted the Early Childhood Education and Care (ECEC) sector in a number of ways, including temporary and permanent closures of ECEC settings, reduced demand for ECEC places and workforce challenges (La Valle et al., 2022); related deterioration in children's development and mental health has been documented for disadvantaged children and children with Special Educational Needs and Disabilities (SEND), as well as vulnerable children (Hobbs and Bernard, 2021). However, while parental investment choices during the pandemic have been documented (and their consequences are just starting to be investigated), the

underlying perceptions of the benefits and costs associated with them have not been examined to date.

This paper presents the first evidence on the beliefs parents had about risks and returns to different types of investment during the COVID-19 pandemic, and on how these beliefs relate to actual investment choices. We collected new survey data from a sample of over 500 first-time parents in England, during the course of the first COVID-19 wave. We interviewed the same parents twice: our baseline survey was administered on the 31st of May 2020, the day before nurseries and childcare centres were allowed to reopen, while our follow-up survey took place between July and August 2020. The data includes detailed information on family time during and after the lockdown collected with time use diaries, which we use to study parental investment decisions during the pandemic. To gain a better understanding of parents' decision making processes regarding children human capital investments, we collected information on parental beliefs, building on the seminal work by Cunha, Elo, and Culhane (2013). We used hypothetical scenarios which vary in terms of the level of different types of investments.[1] While previous research on parental beliefs has focused exclusively on the role of perceived returns, we expand this approach to elicit direct information about the perceived COVID-19-related health *risks* associated with different types of investments.[2] We focus on three specific types of investments which could have been made by parents during lockdown, and which might entail a substantially different trade-off between risks and returns: formal childcare, parental play, and child play with friends. Finally, we asked open-ended questions to the parents, which we analyse using natural language processing (NLP) techniques, to understand what were their main concerns in relation to their families and their children's development during the first COVID-19 wave and to examine how parental sentiments (derived from the analysis of textual data) relate to time investments and beliefs.

We use this rich and novel data to improve our understanding of parental decision-making in a situation of high health risk and uncertainty. Using the time use survey, we start by documenting a significant decline in the use of formal childcare since the start of the first lockdown in England, and confirm the official figures that this decrease was large even among children of key workers and vulnerable children, who were eligible for childcare throughout the pandemic. We then show that, despite nurseries and playgroups reopened on the first of June 2020 and offered holiday care over the summer break (Department for Education, 2020a), the use of these services did not increase to pre-lockdown levels by the end of summer 2020.

We then study parental beliefs and document several novel facts. First, parents believe that childcare, parental play (with child), and child play with friends all improve child development. At the same time, each activity is also perceived to increase the risk of contracting COVID-19. On average, among these different types of investments, parental play is perceived to improve child development the most, and to

[1] In the context of parental human capital investment decisions, other studies have used this approach to study expected returns to health investments (Biroli et al., 2020), the perceived relative productivity of early and later investments (Boneva and Rauh, 2018), the perceived returns to and effort costs of breastfeeding and stimulation for newborns (Bhalotra, Delavande, Gilabert, and Maselko, 2022), and parental decisions on how to allocate resources between siblings (Giannola, 2022). In the context of COVID-19, Conti and Giustinelli (2022) use hypothetical scenarios to elicit subjective expectations about costs and benefits of compliance to COVID-19 social distancing regulations in the UK.

[2] One exception is Bhalotra, Delavande, Gilabert, and Maselko (2022) who consider the role of expected effort costs.

increase the likelihood of catching COVID-19 the least; furthermore, parental play is perceived to be a partial substitute for preschool. The NLP analysis of open-ended questions suggests that, although for many parents the lack of socialization was a key concern in relation to their child development, they indeed felt they could handle childcare themselves.

Second, we show substantial heterogeneity in parental beliefs, and investigate whether perceived returns and risks vary systematically with socio-economic status. On the one hand, similarly to Boneva and Rauh (2018), we find that less educated parents, on average, perceive lower returns to investments; on the other hand, we provide some suggestive evidence that less educated parents, on average, also systematically perceive lower health risks from the same investments. Our analysis of the open-ended questions further shows that parents who express greater concerns and more negative feelings in their answers about how the COVID-19 outbreak is affecting their life also perceive, in general, lower returns from human capital investments.

Third, we show that expected returns and risks associated with different types of investments are predictive of actual choices. Parents who perceive a greater return from childcare are more likely to send their child to childcare in the summer of 2020. Conversely, a larger perceived health risk from childcare attendance has a significant negative association with childcare use. At the same time, a higher expected benefit from parental play is significantly positively associated with the time spent by the parents (both the mother and the father) playing with the child. Finally, a higher perceived return (risk) to play with friends is associated with an increase (decrease) in playground use in July 2020.

Our study makes four key contributions to the various strands of literature studying the determinants of parents' investment in child human capital. First, we contribute to the small but growing literature studying the role of parents' subjective beliefs in the process of human capital formation of their offspring (Cunha et al., 2013; Boneva and Rauh, 2018; Attanasio et al., 2019, 2020; Dizon-Ross, 2019; Bhalotra et al., 2022; Giannola, 2022), which has mostly focused on the role of perceived returns to investments. We advance this literature by showing that, at a time of high uncertainty and risk due to the COVID-19 pandemic, the perceived health *risks* associated with different types of investments are equally relevant to understand parents' behaviour. In this respect, this paper is close to the work by Dupas (2011), Miller, De Paula, and Valente (2020) and Arni, Dragone, Goette, and Ziebarth (2021), who analyse, respectively, the role of perceived risks to understand sexual behaviour, demand for contraception, and risky health investments (such as smoking).

Second, this study relates to the recent literature investigating childcare arrangements and (home) schooling during the COVID-19 pandemic (Andrew et al., 2020; Bol, 2020; Sevilla and Smith, 2020; Cattan et al., 2021; Musaddiq et al., 2021; Agostinelli et al., 2022), and in particular the heterogeneous responses of parents by socio-economic status. One common explanation that has been proposed to rationalise them is the differential availability of educational options (in-person or virtually) across socio-economic groups (Camp and Zamarro, 2022). Our results suggest the existence of a complementary explanation: the heterogeneity in perceived risks and returns about different types of investments - including formal

childcare attendance - across socio-economic groups. This heterogeneity implies that parents could have selected different types of investments even when provided with the exact same educational opportunities. These results contribute to our understanding of the differential impacts of the pandemic on children's developmental outcomes by socioeconomic status – for which evidence is growing (Engzell et al., 2021; Hobbs and Bernard, 2021; Maldonado and De Witte, 2021) – and suggest important avenues for targeted informational interventions.

Third, this study relates to a large body of work demonstrating the importance of parental time investment in the process of human capital formation (Kalil et al., 2012; Del Boca et al., 2014; Fiorini and Keane, 2014; Del Boca et al., 2017). We collect detailed data at the child level from time use diaries, which includes information on parental time investments for under fives – a group for which surprisingly little time use data is collected, despite the widely accepted view that these first years constitute a crucial time for development.

Finally, this is the first paper we are aware of to apply machine learning methods to analyse text data in order to understand parental investment decisions in the human capital of their children. Similar techniques have been recently used to understand, for example, peoples' attitudes towards taxation (Ferrario and Stantcheva, 2022) or women's agency (Jayachandran et al., 2023). While we apply this technique to understand parental first-order concerns in relation to the COVID-19 outbreak, our insightful results suggest that this type of analysis can be more broadly applied to open up the black box of parental decision-making.

The remainder of this paper is structured as follows. Section 2 presents a simple theoretical framework that motivates our analysis. Section 3 describes the data collection, the survey instruments, the sample, and the empirical methods used. Section 4 presents descriptive results on childcare, time use during and after the lockdown, and parents' first-order concerns derived from the text analysis. We present the results on parental beliefs in Section 5, and in Section 6 we study whether these beliefs are predictive of actual investment decisions. Section 7 concludes.

2 Theoretical framework

In this section we present a stylized model to highlight the basic trade-off a parent faces when deciding how to invest in her child's human capital during the COVID-19 pandemic.[3] In our framework, the parent's investment choices have two distinct effects: on the one hand, they enhance child development; on the other hand, they entail a health risk for the parent (and potentially the child). Therefore, when weighing up the perceived benefits and costs of different alternatives when making her investment decisions, in this setup, in addition to the standard monetary costs of investment, the parent needs also to consider a health risk.

As in standard models of investment in human capital, we assume that the parent cares about her own

[3] We assume a unitary model of the household.

consumption C_i and leisure L_i, and about the development of her child K_i (see for example Attanasio (2015)). We augment this standard framework by assuming that the parent also cares about her own health status H_i (as in Grossman (1972)), and express her utility function as $U(C_i; L_i; K_i; H_i)$.

The parent of child i, then, allocates her total available time T to her own leisure L_i (that does not directly promote child human capital), work τ_i, as well as to different types of activities that promote the development of her child: parental play with the child I_{Pi} and child play with friends I_{Fi} (Cunha et al., 2010; Del Boca et al., 2014; Attanasio et al., 2020).[4] The parent can spend her earnings on her own consumption and on formal childcare I_{Si} (such as nursery or preschool), which is also assumed to promote child development. Formally, we express the budget and time constraints by the following equations (1) and (2):

$$C_i + p_S I_{Si} = w_i \tau_i \tag{1}$$

$$T = L_i + \tau_i + I_{Pi} + I_{Fi} \tag{2}$$

where w_i is the hourly wage, the price of consumption is normalised to one, and p_S is the relative price of formal childcare services.[5]

The parent also faces a technological constraint, which maps investment choices to child outcomes. Instead of assuming that the parent knows the process of human capital formation, we follow Cunha, Elo, and Culhane (2013), and assume that the parent has some beliefs about it. More specifically, we assume that the parent perceives each activity to have a potentially different return in terms of child development. We express the *perceived* production function as follows:

$$K_i = \tilde{f}(I_{Pi}, I_{Si}, I_{Fi}, Z_i, \epsilon_i) \tag{3}$$

where Z_i are child characteristics, such as her human capital stock, and ϵ_i is a random shock.[6]

In addition to promoting child human capital, these various types of investments (I_{Pi}, I_{Si}, I_{Fi}) are also assumed to be associated with different perceived risks of catching COVID-19. Here we assume that if the child gets infected, she will transmit COVID-19 to her parent.[7] In our framework, we model COVID-19 as a direct shock to parental health:

$$H_i = \tilde{g}(covid_i, X_i, \omega_i) \tag{4}$$

where $\tilde{g}(.)$ is the perceived health production function, $covid_i$ is COVID-19 infection, X_i are other variables affecting parental health, and ω_i is a random shock. We assume $\delta\tilde{g}/\delta covid_i < 0$, i.e. the parent

[4] Given the young age of the children we study, we assume this play activity to be supervised by the parent, and to happen outside formal childcare (e.g. in the playground).

[5] In our framework, we abstract from monetary investments that help children develop (such as toys or books) for simplicity: for example, a parent willing to read the child could always borrow a book from the local library. Regardless, the model could be easily extended to accommodate them.

[6] Agostinelli et al. (2022) also consider the role of parents, peers and schools in the production of human capital during the pandemic.

[7] Recall that at the time of the survey, in the summer of 2020, there was still high uncertainty about COVID-19 transmission and fatality rate, with no vaccine available.

believes that COVID-19 would negatively impact her health status.[8] As mentioned above, $covid_i$ in equation (4) partly depends on the investments the parent chooses for her child: I_{Pi}, I_{Si} and I_{Fi}.

Hence, the parent faces a trade-off when deciding how to invest in her child's human capital: on the one hand, she might want to select the types and levels of investments which she perceives to be the most productive. On the other hand, she might want to avoid investments that are perceived too risky for her own health, in terms of the likelihood of catching COVID-19. The policy function of the parent is therefore a function of her preferences, her resources and the prices she faces, as well as her beliefs about the returns and risks of different types of investments.

In the following, we will use this simple theoretical framework to guide our empirical analysis, and shed light on the role of perceived returns and risks in shaping parental investment decisions in their child human capital during the COVID-19 pandemic.

3 Data and Empirical Strategy

3.1 Participants

We recruited survey participants through Prolific Academic (PA), an online platform for web-based research. PA is considered to be extremely reliable, and of superior quality compared to alternative platforms such as Amazon Mechanical Turk (MTurk) (Peer et al., 2017); it also allows to follow the same respondents over time. We conducted the baseline survey just before the end of the first lockdown in England, at the end of May 2020; we then followed up the respondents in mid-July 2020.[9]

Our sample consists of 560 first-time parents, living in England, with a child younger than five years of age, who had not started primary school or reception pre-lockdown.[10] In each household, we surveyed only one parent, who was the biological mother of the child in 78% of the cases (the remaining respondents were the biological father (21%), or the legal mother or father of the child (0.72%)). We focused on first-time parents because we expected them to be less experienced and so in the greatest need of parenting support - and as such more likely to have suffered from pandemic-related formal childcare closures, health visitors redeployment (Conti and Dow, 2020), or unavailability of grandparents.

3.2 Sample characteristics

Table 1 reports descriptive statistics of our sample. Almost 80% of respondents were female, 11% were non-white, and their average age was 31. The average age of the child was 1.4 years at the baseline, and 51% of children were boys. 30% of respondents in our sample were key workers, that is, employed in health

[8] COVID-19 could also directly affect child human capital, in which case it would enter (3) as a child health shock (Condliffe and Link, 2008; Currie and Almond, 2011). We assume this channel away because our data suggests that at this time parents were mostly concerned about their own health status rather than their child's: when we asked parents whose health status they were mostly concerned with when thinking about these investments in terms of COVID-19 risks, 18% only mentioned the child, and 56% mentioned themselves or another family member (the rest of the parents thought that there were no health risks altogether associated with contracting COVID-19).

[9] The first lockdown took place between March 23 and June 1, 2020.

[10] We focused on England since the lockdown restrictions differed across the United Kingdom.

Table 1: Descriptive Statistics

	Mean	S.D.	N
Panel A: Child characteristics			
Child is a boy	0.513	0.500	557
Child age in years	1.356	1.000	559
Panel B: Respondent characteristics			
Age	31.439	5.082	551
Female	0.785	0.411	559
White	0.886	0.319	559
Key worker	0.301	0.459	559
Lives with partner	0.852	0.356	559
Education:			
- GCSE or lower	0.073	0.260	549
- Further education	0.260	0.439	549
- Higher	0.448	0.498	549
- Postgraduate	0.219	0.414	549

Notes: Some variables are missing as respondents were allowed to choose not to answer some questions. GCSE stands for General Certificate of Secondary Education. Further education corresponds to A-Levels, or other similar qualification. Higher education corresponds to an undergraduate university degree. Postgraduate corresponds to e.g., a Master Degree or higher. S.D. = Standard Deviation. N = sample size.

and social care and in other key sectors (such as those essential to the running of the justice system, or workers employed in charities and delivering key frontline services). This is slightly higher than the 22% figure reported in Farquharson, Rasul, and Sibieta (2020), which refers to all UK working-age individuals. Children of key workers and vulnerable children were eligible to attend formal childcare throughout the lockdown period (Department for Education, 2020c). In terms of socio-economic characteristics, 85% of respondents lived with their partner; 7% of respondents reported a level of education equivalent to the General Certificate of Secondary Education (GCSE) or lower, 26% had completed further education, and the rest had some tertiary education.[11]

To gauge the representativeness of our sample, we extract data on parents with a single child from the Millennium Cohort Study (MCS), the most recent nationally representative cohort study in the UK, which follows a cohort of children born in 2000. In the MCS, 82% of the respondents report living with their partner, and 54% of the mothers report having continued their education after compulsory schooling;[12] the corresponding figures for our sample are, respectively, 85% and 64%, hence the mothers in our sample seem to be slightly more educated than those in the MCS.

[11]The General Certificate of Secondary Education (GCSE) is equivalent to High School Diploma in the United States. A student typically studies for GCSE between the ages of 11-16 and this qualification grants access to further education. The GCSE is the main school-leaving certificate in England, Wales, and Northern Ireland. Once a student completes the GCSE certificate, they have the option to extend into further education to take their A-Levels, or other similar qualification. UK students planning to go to college or university must complete further education. A-Levels are qualifications within the further education section and are taken between the ages of 16-18. Gaining these allows access to a university. Further details on the UK education system can be found here: https://www.scholaro.com/db/Countries/United-Kingdom/Education-System.

[12]The MCS does not record the mother's level of education, however it is possible to compute whether she continued schooling past the compulsory age, based on her year of birth: school leaving age in England was increased from 14 to 15 in 1947 and from 15 to 16 in 1972.

3.3 Time use diaries

Besides the respondent's background characteristics, during the follow-up survey we collected detailed information on the childcare arrangements used before, during and after the lockdown: both formal ones (such as nursery, preschool or creche), and informal ones (such as nannies, friends, grandparents and other relatives).

We also asked respondents to complete a detailed time use diary for their child. This is a unique feature of our survey, since time use data for children under five is rarely collected.[13] Respondents were first asked to choose a weekday in April 2020 (during the first lockdown in England), and a weekday in the week commencing 6 July 2020 (after the easing of the social distancing restrictions).[14] For both days, the time use diary was composed of 1-hour slots between 6:00 am and 11:00 pm, amounting to 17 1-hour slots. In each of these 1-hour periods, respondents were asked to report the activities the child was doing ("*What was your child doing at this time?*") and who was involved in the activity with the child ("*Who was actively involved in what the child was doing?*").

For each of these questions, parents were asked to select among a pre-specified set of options (e.g. for the activities: playing games, personal care, sleeping). Each option could be chosen if it had occurred at any point during the 1-hour slot - i.e., the child did not have to be doing that activity for the entire hour. Respondents were allowed to choose multiple options at the same time (e.g. between 7:00 and 8:00 the child may have been doing personal care and eating). We also asked respondents the number of times they took their child to the playground in the July time use diary (not in the April one since this activity was not allowed during lockdown).

3.4 Open-ended questions

Another unique feature of our survey is the inclusion of open-ended questions, which have received little attention by economists until recently (e.g., Ferrario and Stantcheva (2022); Jayachandran et al. (2023)). Specifically, respondents were told the following: *"Please use the space below to express in your own words the main ways the Coronavirus outbreak has affected your life and/or your loved ones so far, and what you think the effects might be in the future. You can write as much or little as you like, and cover any topic you choose"*. Over 90% of the sample replied. We perform different types of text analysis on the responses to these open-ended questions to understand parents' first-order concerns when thinking about the COVID-19 pandemic, in relation to their life and their children. To do so, we proceed in steps.

First, we construct *world clouds*, which are useful to quickly visualise the data to provide information on the most recurring themes, and which represent a starting point for a more in depth analysis (Heimerl et al., 2014). In a word cloud the font size of each element is proportional to the frequency with which

[13] Two notable exceptions are the Child Development Supplement of the Panel Study of Income Dynamics (CDS-PSID, see e.g. Del Boca et al. (2014)) and the Longitudinal Study of Australian Children (LSAC, see e.g. Fiorini and Keane (2014)).

[14] We checked that the day chosen when answering the time use questions does not correlate with respondent observable characteristics.

that element was mentioned in the open-ended answers.[15]

While word clouds are informative about word frequency, they are not appropriate to identify the key topics recurring in the answers. Therefore, as a second step we conducted *topic analysis* (Blei, 2012). More specifically, we used Latent Dirichlet Allocation (LDA), a hierarchical Bayesian factor model used to extract recurring topics from a given body of text (Blei et al., 2003). Intuitively, LDA is similar to principal component analysis, in that it seeks to reduce the dimensionality of the data and to increase its interpretability, while at at the same time minimizing information loss.

Third, we performed *sentiment analysis* (SA) of the answers to the open-ended questions. Sentiment analysis is a natural language processing technique used to classify or rate text data to determine the person's attitude and emotional states when writing (Liu et al., 2010). Among the several methodologies available for quantifying sentiments from text data, here we use the *Lexical methodology*, which relies on a pre-specified set of words, called lexicons or dictionaries, that are associated with particular sentiments.[16] We analyse the open-ended questions to understand the respondents' most recurring sentiments: to this end, we compute a continuous *sentiment index*, where a higher score represents a more positive attitude in the answer. Lastly, we analyse how the sentiment score relates to individual perceived returns and risks associated with different types of investments, whose construction we describe in details in the next section.

3.5 Beliefs

3.5.1 Measurement

We collected respondent's perceived returns and health risks associated with different type of parental investments in child human capital in the second round of the data collection in July 2020. We followed Cunha, Elo, and Culhane (2013), and presented respondents with a series of hypothetical investment scenarios, asking them to state what they believed the outcome would be. By varying the characteristics of the scenarios one at a time, while keeping other factors constant, one can identify the perceived returns and risks associated with different types of investments. Our scenarios vary according to three investments with two levels of intensity each: (i) parental play with child (frequent vs. rare), (ii) formal childcare attendance (attending vs. not attending), and (iii) child play with friends (frequent vs. rare).[17] We describe in more details the scenarios later in this section.

To collect subjective expectations about probabilities (e.g. the chance of catching COVID-19) we employed a frequentist approach, and asked parents to think about "100 children the same age as yours"

[15] As a preliminary stage, before conducting any analysis, we cleaned the open-ended answers by removing punctuation, correcting typos and eliminating stop-words (i.e. words carrying no intrinsic meaning such as "and"). We then lemmatized similar words, i.e. grouped them to reduce the number of individual items in the text (e.g. job and jobs, Covid and Coronavirus).

[16] We use the *syuzhet* dictionary and related R-package, developed by the Nebraska Literary Lab (Jockers, 2017). This includes over 10,000 words with an associated sentiment value going from negative (value of -1) to positive (value of $+1$). See Naldi (2019) for a review of the different dictionaries available.

[17] As previously mentioned, playing with friends refers to child play with friends outside of formal childcare, under parental supervision.

Table 2: Overview of outcomes and scenarios

	Parental play: I_P		Formal childcare: I_S		Play with friends: I_F	
Returns: Reaching a Good Level of Development by September 2020	Frequent: F	Rare: R	Yes: A	No: N	Frequent: F	Rare: R
Risks: Contracting and transmitting COVID-19 by September 2020	Frequent: F	Rare: R	Yes: A	No: N	Frequent: F	Rare: R

Notes: The Table summarizes for each outcome (realised by September 2020) the different intensity level of investments. These questions were asked in the follow-up survey in July 2020. "Parental play" refers to parents play with the child; "Formal childcare" refers to attendance at a formal childcare setting (e.g. nursery or preschool); "play with friends" refers to child playing with her friends (e.g. at the playground).

when reporting their answers.[18] Using frequencies rather than probabilities (e.g. "what percentage of children") has the advantage of being easier to understand and to visualise (Hoffrage et al., 2000; Bhalotra et al., 2022; Biroli et al., 2020).

Hypothetical scenarios. Each respondent was presented with eight hypothetical scenarios. To collect information on the perceived returns associated with different types of investments, we asked parents to *"Imagine 100 children of the same age as yours, living in England"*, and to report how many out of these children were expected to *"Reach a good level of development (GLD) by September 2020"*. The Good Level of Development (GLD) indicator is a performance measure used at the end of reception by the Department for Education to determine school readiness of preschool aged children, and falls within the Early Years Foundation Stage (EYFS) statutory framework.[19] According to the EYFS profile 2022 handbook: "Children are defined as having reached a Good Level of Development (GLD) at the end of the EYFS if they have achieved at least the expected level for the Early Learning Goals (ELGs) in the prime areas of learning and the specific areas of mathematics and literacy. This helps teachers and parents to understand broadly what a child can do in relation to national expectations." and "The EYFS profile is also used to inform parents about their child's development." (Department for Education (2022) p.6). Hence, we can assume parents to be reasonably familiar with the GLD concept. Similarly, to collect information on the perceived risks associated with different types of investments, we asked parents to report how many out of the "100 children the same age as your child" they expected *"Would contract and transmit COVID-19 by September 2020"*.

For each of the two outcomes (perceived risks and benefits), we varied the intensity level of each type of investment across the 8 scenarios and asked respondents to report their answer using a clickable slider ranging from 0 to 100 with the multiples of 10 labelled. For example, the first scenario (with high levels of the three investments) read as *[...if] "They currently attend nursery or other early years provider, their parent/s spends time reading and playing with them frequently and they have playdates with friends frequently"*.[20] We summarize the eight different scenarios in Table 2: as shown, they vary in terms of intensity level of (i) parental play I_P, (ii) formal childcare attendance I_S, and (iii) play with friends I_F.

[18] Different methods exist for collecting these expectations (see Delavande (2014) for a systematic review).

[19] The EYFS framework sets the standards that school and childcare providers must meet for the learning, development and care of children from birth up to age five (Department for Education, 2021, 2022).

[20] For simplicity, we refer to the time spent with parents simply as "parental play".

3.5.2 Perceived returns and risks

Comparing parental answers across scenarios, we can identify the perceived returns and risks to different types of investments. For example, by comparing the expected numbers of children catching COVID-19 when attending or not formal childcare, holding fixed the level of *all* other investments, we can identify the perceived (health) risks associated with formal childcare attendance.

More formally, for the econometric implementation we use the following specification, which we estimate via Ordinary Least Squares (OLS):

$$y_{ij}^k = \delta_0^k + \delta_1^k I_{Pj} + \delta_2^k I_{Sj} + \delta_3^k I_{Fj} + \gamma_i + u_{ij}^k \tag{5}$$

where y_{ij}^k is the answer of parent i, in scenario j to the question eliciting beliefs about outcome type k (child development or COVID-19 risk). The variables I_{Pj}, I_{Sj}, and I_{Fj} are dummy variables for each of the three types of investments (parental play, formal childcare attendance, play with friends), and take value 1 if in scenario j the level of investment is high, and 0 otherwise. γ_i is a respondent fixed effect and u_{ij}^k is an error term. The coefficients δ_1^k, δ_2^k, and δ_3^k are the perceived returns or risks (depending on the outcome) associated with each type of investment.

To further understand whether parents think of these investments as complements or substitutes, we expand equation (5) and estimate the following specification:

$$y_{ij}^k = \phi_0^k + \phi_1^k I_{Pj} + \phi_2^k I_{Sj} + \phi_3^k I_{Fj} + \phi_4^k I_{Pj} \times I_{Sj} + \phi_5^k I_{Sj} \times I_{Fj} + \phi_6^k I_{Fj} \times I_{Pj} + \gamma_i + u_{ij}^k \tag{6}$$

where the coefficients ϕ_4^k, ϕ_5^k, ϕ_6^k, capture the perceived complementarity or substitutability between the different inputs in the process of child development or for the risks associated to COVID-19.

3.5.3 Beliefs heterogeneity

Equations (5) and (6) estimate *average* beliefs. To uncover potential heterogeneity in them, and study whether they vary with respondents' observable characteristics, the literature has used two distinct approaches. In the following, we use them both and compare the results.

First, we follow Boneva and Rauh (2018) and Attanasio, Boneva, and Rauh (2020), and compute perceived returns and risks for each respondent i. We do so by comparing each individual's answer in the scenario where the level of investment is high, with the corresponding answer in the scenario where the level of investment is low, while holding fixed the levels of all other inputs. For example, we compute the perceived returns to formal childcare attendance (I^S) as follows:

$$return_i^S = \frac{(y_{i,A,F,F} - y_{i,N,F,F}) + (y_{i,A,R,F} - y_{i,N,R,F}) + (y_{i,A,F,R} - y_{i,N,F,R}) + (y_{i,A,R,R} - y_{i,N,R,R})}{4} \tag{7}$$

where $y_{i,m,n,l}$ is the outcome reported by respondent i in a scenario with a level m of childcare attendance (A: attend, N: not attend), a level n of parental play (F: frequent, R: rare), and a level l of play with friends (F: frequent, R: rare). As shown in equation (7), when taking the difference we contrast the scenario where the child attends formal childcare, with the corresponding scenario where she does not (i.e. holding fixed the levels of the other investments). In a similar way we compute the perceived returns to parental play ($return_i^P$) and to play with friends ($return_i^F$), and the risks for each type of investment ($risk_i^S$, $risk_i^P$, $risk_i^F$) and each individual in the sample.

The second approach used in the literature to estimate beliefs heterogeneity is via a random coefficients model (Attanasio et al., 2019; Cunha et al., 2020), which we implement via the following equation:

$$y_{ij}^k = \delta_{0i}^k + \delta_{1i}^k I_{Pj} + \delta_{2i}^k I_{Sj} + \delta_{3i}^k I_{Fj} + u_{ij}^k \tag{8}$$

where y_{ij}^k, I_{Pj}, I_{Sj}, and I_{Fj} have been previously defined, and where we allow for individual-level heterogeneity in the coefficients δ_{0i}^k, δ_{1i}^k, δ_{2i}^k, and δ_{3i}^k. We estimate the random coefficients model using the Swamy (1970) estimator, and compare it to the estimates we obtain using the formula in (7).[21]

4 Descriptive evidence

4.1 Childcare usage during the first COVID-19 lockdown

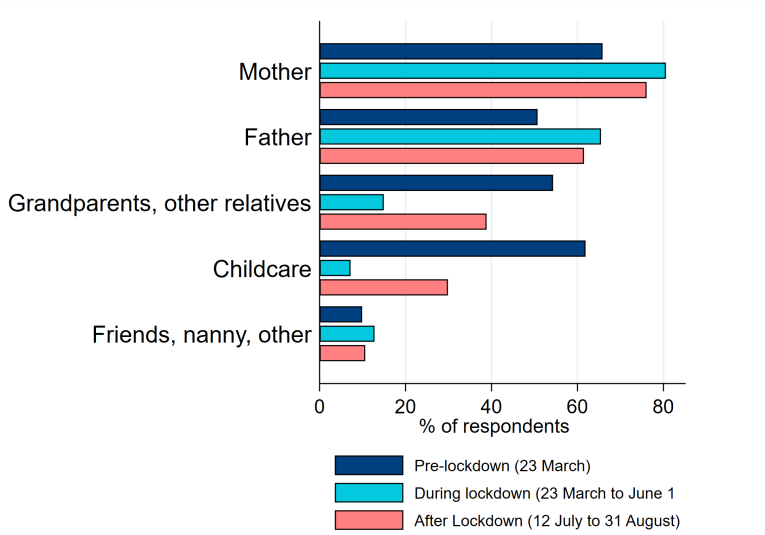
As mentioned in section 3, during the first lockdown (23 March to 1 June, 2020) only the children of key workers and the vulnerable children were eligible to attend formal childcare (Department for Education, 2020c). Official data published by the Department for Education shows that the number of children attending early years settings during the first lockdown was approximately 5% of those usually attending during term time; this number rose to 10% by 4 June and to 20% by 25 June 2020 (early years setting were open to *all* children from June 1^{st}). The vast majority of children attending during the first lockdown were children of key workers (87%), and the remainder were vulnerable children. As a consequence of the decreased demand for childcare, as well as to avoid health risks for the carers, two thirds of childcare centres closed during the first lockdown.[22]

In our baseline survey, we asked respondents whether their children were eligible for attending an early years setting during lockdown, and, if so, whether they attended it. As seen in Table 1, 30% of our respondents were key workers, hence their children were eligible to attend an early years setting; however, only one third of them (hence 10% of the total sample) did so at some point during the lockdown. Our sample, therefore, shows a higher formal childcare attendance during the lockdown (10%) compared to

[21] The Swamy (1970) estimator proceeds in two steps. In the first step, an OLS regression of equation (8) is estimated for each individual i. The estimates in the first step are used in the second step to obtain the average mean and variance of the coefficients. These are used to obtain an efficient linear estimator of δ_{0i}^k, δ_{1i}^k, δ_{2i}^k, and δ_{3i}^k, following Judge, Judge, Sons, Griffiths, Hill, Lütkepohl, and Lee (1985).

[22] Using data from the Department of Education, we report in Panel A of Appendix Figure A1 the number of children attending early years settings during the first lockdown, and in Panel B the number of centres that were closed during the same period.

Figure 1: Type of childcare usage pre-, during and post-lockdown



Notes: The Figure shows the types of childcare used by respondents at different points in time during the pandemic. Respondents were asked "Does your child currently use and did she/he previously use any of the following options? Please select all that apply" for the periods pre-lockdown, during lockdown and post lockdown (current). Dark blue is for before the first lockdown, light blue is for during the lockdown, and the final category is for after the restrictions were lifted in July and August 2020. The "Grandparents, other relatives" category includes non-resident parents. Childcare refers to nursery, preschool, creche, and childminder ("formal" childcare). A childminder is somebody who provides childcare for children in their own home for more than two hours a day. In England childminders must be registered with the Office for Standards in Education, Children's Services and Skills (Ofsted).

the official figures reported by the Department of Education (5%). As mentioned in the data section, key workers are slightly over-represented in our sample, which could partly contribute to the higher attendance rates.

In the same baseline survey, we also asked parents of eligible children the reasons for not sending their child to formal childcare. The most common answer given reflects the fact that parents were concerned about the health risks to their child and their family, but also able to look after their child at home. For example, respondents explained: *"I had concerns over safety and preferred to keep him at home"* and *"I could work from home so deemed it safer to have him with me";* and *"I preferred not to take the risk"*.

The first of June marked the wider re-opening of early years settings to *all* children. In the baseline survey, we also asked all respondents whether they had the intention to send their child back to nursery or preschool on June 1^{st}, and their reasons if they did not intend to do so. Even though all children were now eligible to attend nursery or preschool, only 17% of parents did plan to send their child back, which is only 7 percentage points higher than those who sent their children during lockdown in our sample. Additionally, while only 17% of parents reported intending to send their child back to formal childcare in June, they believed that 44% of other parents would do so in June, and that 80% would do so in September (2020). Contrary to parents' beliefs, data from the Department of Education shows that, instead, only 37% of the children who had been usually attending early years childcare during term time were attending by 10 September 2020 (Department for Education, 2020b). Therefore, for both June and September, parents overestimated the number of other parents who would be sending their child back to nursery or preschool.

In the follow-up survey, we asked respondents a detailed history of different types of childcare use pre-lockdown, during the first lockdown, and at that point in time, post-lockdown. Figure 1 shows the percentage of respondents reporting using each type of childcare. The use of formal childcare, such as nursery, preschool, creche, childminder and playgroups, decreased dramatically during the first lockdown.[23] Average attendance in our sample was 62% pre-lockdown, and only 8% during lockdown (the difference in attendance between the two periods is statistically significant at the 1% level, as reported in Appendix Table B1). There was a recovery in the percentage of parents using formal childcare at the end of lockdown, with 30% of parents reporting using it, but clearly formal childcare attendance did not raise back to pre-COVID-19 levels by July 2020.[24] In Appendix Figure A2 and Appendix Table B2 we show that this decline was strong even among children of key workers, who were eligible for childcare throughout the pandemic.[25]

On the other hand, the percentage of respondents reporting mothers or fathers as the main childcare providers increased substantially during lockdown: from 65% to 81% for mothers, and from 50% to 65% for fathers. The figures remain significantly higher at the end of the lockdown compared to pre-lockdown levels (Appendix Table B1). Finally, the patterns in Figure 1 are also consistent with the fact that parents acted on the public health message that health risks of COVID-19 to the elderly were much higher than to any other demographic group (Boast et al., 2020). Indeed, the use of grandparents experienced a large reported fall: from 54% pre-lockdown to 14% during lockdown. After the lockdown, in July 2020, this percentage bounced back to 39%.

4.2 Time-use diaries

In this section, we present descriptive evidence on the different types of activities the child was involved in a typical weekday during and after the lockdown (April and July 2020, respectively) from the time-use diaries.[26]

Figure 2 reports the proportion of respondents who report each activity, for each hour of the day ranging from 6:00 am to 11:00 pm. The routine of the activities playing, sleeping and eating shows patterns that we would expect for this age group: long play time in the morning and afternoon, three distinct meal times at around 8:00, 12:00 and 17:00, the majority of children are asleep between 19:00 and 6:00 and many also have a nap after lunch at around 14:00.

[23] A childminder is somebody who provides childcare for children in their own home for more than two hours a day. In England childminders must be registered with the Office for Standards in Education, Children's Services and Skills (Ofsted).

[24] We also asked parents the reasons for not sending their child back to formal childcare. We have only 131 answers to this question. Of these, 50% of these reported fear of infection and contagion as the reason and 33% reported that they felt they could handle childcare themselves.

[25] Specifically, Appendix Figure A2 shows, separately for eligible children (Panel A) and non-eligible children (Panel B) the percentage of respondents reporting using each type of childcare. We observe the same general patterns among these two groups. Pre-lockdown, 58% of eligible respondents reported using formal childcare; this percentage fell to 11% during lockdown. A smaller proportion of the non-eligible group used formal childcare pre-lockdown (31%); this fell to 0% during lockdown, which is expected given that none of the children in this group was eligible for it. For both groups, these differences in the usage pre- and during lockdown are statistically significant at the 1% level (Appendix Table B2). There was a recovery in the percentage of parents using formal childcare at the end of lockdown, but this did not raise back to pre-COVID-19 levels in July 2020. The recovery in childcare usage post lockdown was somewhat stronger among eligible children compared to the non-eligible ones (Appendix Table B2).

[26] Appendix Table B3 reports the summary statistics for the time use variables.

Figure 2: Time-use diaries

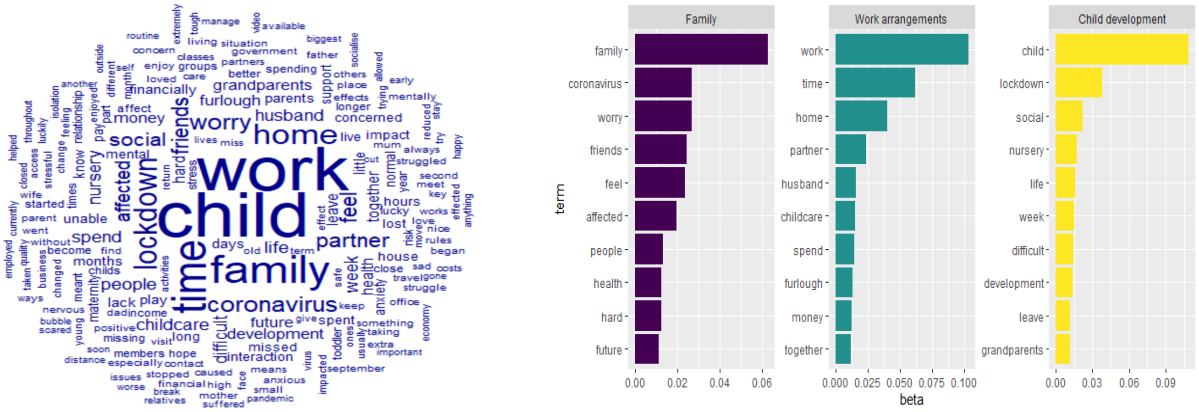
Notes: Each sub-Figure shows a specific activity the child was doing and who she was with for each 1-hour interval between 6:00 am and 11:00 pm for two weekdays: a weekday in April 2020, and a weekday in the week commencing the 6^{th} of July 2020. The top row shows the percentage of respondents who reported their child was engaged in playing, eating/being fed and sleeping over each hour. The bottom row shows the percentage of respondents who reported their child was actively in the company of their mother, father or other children.

Looking at the differences in time use during and after lockdown (also see Table B4 for regression results), we see that children are spending more time with their parents in April than July, by a difference of 0.7 hours with the mother and of 0.5 hours with the father. Conversely, children spend 0.3 hours more with other children in July than they did in April. Looking at different activities, we see that on average parents play with the child for roughly 6 hours in April 2020, while they decrease the amount of play time by half an hour in July 2020. Similarly, children are asleep for 0.5 hours less in July after lockdown than they were during lockdown. Finally, there are no differences in the time children spend eating.

Figure 2 also plots who the child is spending time with throughout the day, and shows that there are important difference between time spent with the mother and the father at both points in time. The time spent with the mother is significantly higher (the average is 12 hours during lockdown) and also more consistent, with around 70-80% of respondents reporting that the child is with the mother when awake. The time spent with the father is on average lower (the average is 6 hours during lockdown), and fluctuates more throughout the day.[27] Around 30% of respondents report that the child is with the father during day time, with a 60% peak at 6:00 pm, which is on average the time children are getting

[27]The fact that mothers spend twice as much time as fathers in activities with under-fives is consistent with both the evidence reported in Villadsen et al. (2020) for the first lockdown (based on the COVID-19 sweep of the Next Steps cohort), and that reported in Wishart et al. (2019) for 2015 (based on the UK Time Use Survey). In our survey, the majority of respondents report that their relationship with the child has improved since the lockdown began (46%), and also that their partner is more involved with the child as compared to before lockdown (53%).

Figure 3: Text Analysis



(a) World Cloud (b) LDA

Notes: The Figure plots the world cloud (Panel A) and LDA model results (Panel B) from the text analysis of the answers to the following prompt: *"Please use the space below to express in your own words the main ways the Coronavirus outbreak has affected your life and/or your loved ones so far, and what you think the effects might be in the future. You can write as much or little as you like, and cover any topic you choose."*

ready for bed.[28]

The amount of time spent by the child in company of other children is on average very low in both time periods, but - as expected - it is higher in July (0.6 hours) than in April (0.25 hours). As it happens during daytime and the respondents are first-time parents, this is likely time spent playing with other children outside the home.

4.3 Open-ended question

We now examine the answers to the open-ended question. We start in Panel A of Figure 3 by showing the word cloud of the most popular words used in the answers. Respondents often mention the words "work", "child", "family", "time" and, to a smaller extent, "social", "worry", "coronavirus", "friends", and "development".[29]

To better understand the most recurring *topics*, we present the results from the Latent Dirichlet Allocation (LDA) in Panel B of Figure 3. We identify three main topics from the text data. The first topic evokes concerns related to family life during lockdown, and also about the future: this topic is characterized by words like "family", "worry", "coronavirus", "health", "future", and "hard". The second topic is related to work and childcare arrangements during the lockdown. The third topic we identify is specifically related to the children and to concerns regarding their development: this topic is associated with words like "child", "social", "development", and "grandparents". Interestingly, inspection of individual answers reveals that most parents mention social and emotional development as their key

[28] There are no statistical differences in the time spent on activities (play, eat/feed, sleep, etc.) by the respondent's gender, but there are statistical differences in the time spent by the child in activities involving only one of the parents. Namely, both male and female respondents report spending more time with the child than their partner. Because we have more mothers than fathers responding to our survey, this might results in an under-reporting of the time fathers are involved with their child. However, such pattern might also be expected if the respondent is the main caregiver (so in cases of male respondents, the fathers would be the main caregivers).

[29] Figure A3 presents the frequency of the 20 most used words.

concern when thinking about their child, and believe that the lack of socialization brought about by the lockdown would negatively impact their child social skills and ability to interact with others. For example, some respondents stated: "*I am concerned about the lack of interaction with other children for social learning with an only child*", "*It really affected my son being off nursery, missing the social interaction. I found it hard to get him to focus on the schoolwork that was sent for him to do. I hope that his behaviour improves when he settles back to nursery*", and *"I worry about the lack of socialisation for my son the most, he has become very clingy and dependent of us (his parents) over lockdown to the point he won't sleep in his own bed anymore"*.[30]

5 Parental beliefs

We now move to the analysis of parental beliefs about returns and risks to different types of investments.

5.1 Perceived returns to investment

We start in Figure 4 by presenting average perceived returns for each of the eight hypothetical scenarios listed in Table 2 (for brevity we refer to "formal childcare" as "childcare"). Here the outcome variable is the number of children (out of 100) who are expected to reach a good level of development. The pattern of answers is meaningful in the sense that perceived returns are increasing in investments. More specifically, on average parents believed (in July 2020) that only 23% of children would reach a good level of development by September 2020 if all investments were low, while they believed that 83% of them would if all types of investment were high.[31]

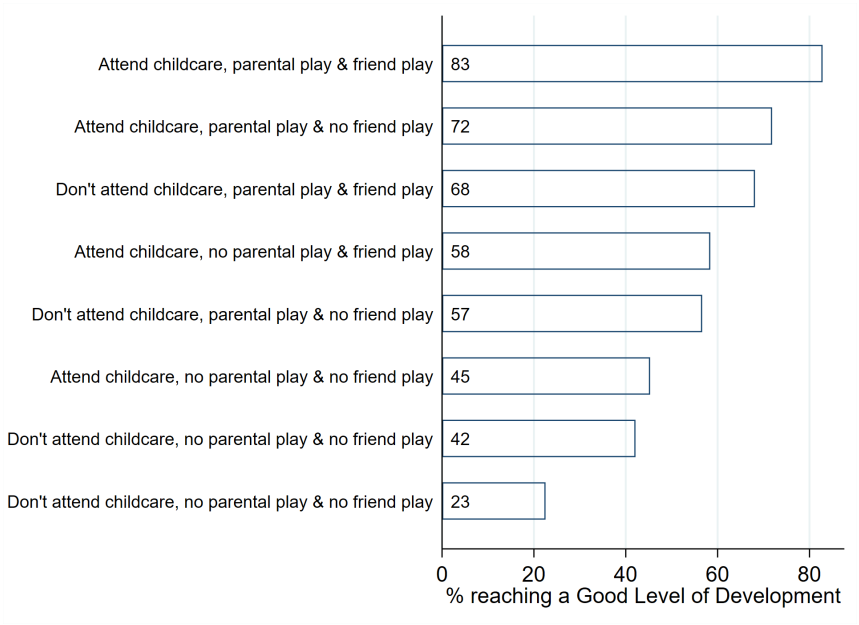
Table 3 reports the estimated coefficients of equations (5) and (6). In the first column, we impose that the interactions between different types of investments are zero, while we allow for complementarity/substitutability between them in column (2). All regressions include respondent fixed effects, and standard errors are clustered at the respondent level.

First, consistently with Figure 4, we notice that on average parents believe that if all types of investment were low, only 23-26% of children would reach a good level of development by September 2020 (the constant term in column 1 and 2). Parents also perceive that formal childcare attendance, parental play and play with friends all improve child development. For instance, formal childcare attendance is believed to increase the proportion of children reaching a good level of development by 17 percentage points (65 percent). Similarly, frequent parental play and frequent play with friends are believed to increase the share of children with a good level of development by 28 percentage points (105 percent) and 14 percentage points (50 percent), respectively. Therefore, although all activities are perceived to improve child development, respondents believe that parental play has a significantly larger effect than

[30] Byrne et al. (2022) have documented worsening social communication skills in children born during the lockdown as compared to a historical cohort in Ireland, on the basis of parental reports.

[31] When asked which dimension of child development they had in mind when answering this question, most parents reported language and cognitive development, followed by socio-emotional development.

Figure 4: Returns: Average Response by Scenario



Notes: The figure shows for each scenario the percentage of children that respondents believe would reach a Good Level of Development by September 2020 (asked in July 2020), averaged across respondents. The scenarios are as in Table 2: attend formal childcare yes/no; parental play with child frequent/rare; child play with friends frequent/rare.

formal childcare attendance or play with friends (these differences are statistically significant at the 1% level).

Column 2 of Table 3 reports negative and significant coefficients on the interactions between the various type of investments. This implies that respondents believe that parental play, play with friends, and formal childcare attendance are partially substitute activities; for example, they believe that childcare attendance is more productive for a child who receives little stimulation from parental play. These results suggest that parents believe they can substitute formal childcare and play with friends by increasing their own time with the child.[32]

5.2 Perceived risks of investment

Figure 5 presents average perceived risks for each of the eight hypothetical scenarios; here, the outcome variable is the number of children (out of 100) who are expected to catch and transmit COVID-19 by September 2020. On average, parents believed that 13% of children would contract and transmit COVID-19 by September 2020 if all investments were low; this figure would increase to 47% when all types of investment were high. Table 4 reports the estimated coefficients of equations (5) and (6). As before, in the first column we impose that the interactions between different types of investments are zero, and we allow for complementarity/substitutability between them in column (2). All the regressions include respondent fixed effects, and standard errors are clustered at the respondent level.

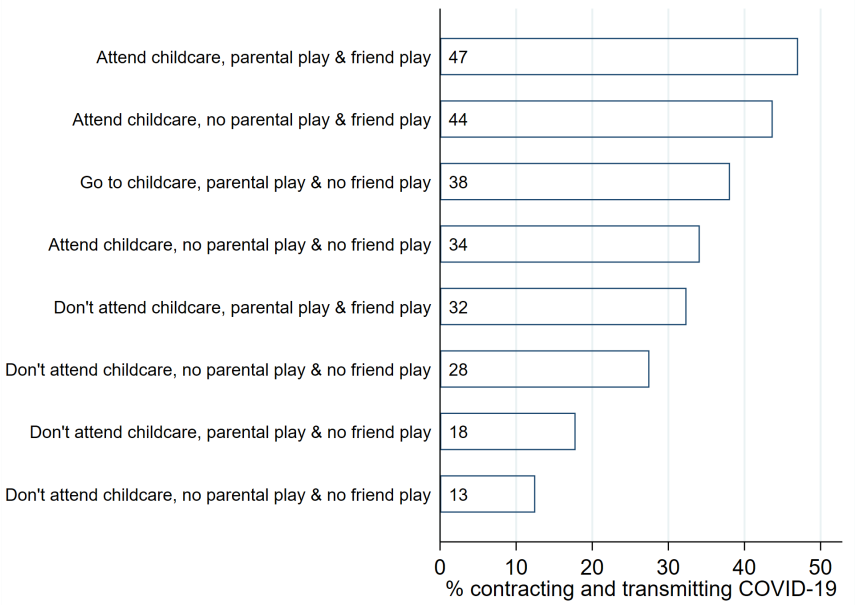
[32] In the Appendix Table B5, we estimate the same relationship with a median regression as a robustness check and find very similar results.

Table 3: Perceived Returns to Investments

	Number of children out of 100 expected to reach a Good Level of Development by September 2020	
	(1)	(2)
Investment: Attend childcare	17.252***	21.317***
	(0.763)	(0.906)
Investment: Parental play	27.862***	32.708***
	(0.770)	(1.006)
Investment: Friends play	13.826***	18.125***
	(0.457)	(0.665)
Friends play × Parental play		-5.079***
		(0.637)
Attend childcare × Parental play		-4.613***
		(0.802)
Friends play × Attend childcare		-3.518***
		(0.644)
Constant	26.468***	23.165***
	(0.647)	(0.747)
Observations	4448	4448
R^2	0.548	0.555
Fixed effects	Yes	Yes

Notes: The dependent variable is the number of children (out of 100) expected to reach a Good Level of Development by September 2020, asked in July 2020. "Investment: Attend childcare" is a binary variable equal to one in the scenario where children are attending a formal childcare setting (versus not attending). "Investment: Parental play" is a binary variable equal to one in the scenario where parents frequently play with the child (versus rare parental play). "Investment: Friends play" is a binary variable equal to one in the scenario where the child frequently plays with friends (versus rare play with friends). All regressions include respondent fixed effects. Standard errors are clustered at the individual level. *** p<0.01, ** p<0.05, * p<0.1.

Figure 5: Risks: Average response by Scenario



Notes: The figure shows for each scenario the percentage of children that respondents believe would contract and transmit COVID-19 by September 2020 (asked in July 2020), averaged across respondents. The scenarios are as in Table 2: attend formal childcare yes/no; parental play with child frequent/rare; child play with friends frequent/rare.

Respondents believe that attending formal childcare, frequent play with parents, and frequent play with friends all increase the likelihood of contracting and transmitting COVID-19: by 18 percentage points, 4 percentage points and 12 percentage points, respectively. The perceived risk of catching and transmitting COVID-19 associated with formal childcare attendance is more than four times as large as the perceived impact of parental play; this difference in perceived risks is significant at the 1% level. Play with friends is also perceived to be significantly riskier than parental play (this difference is also significant at the 1% level), but not as risky as attending childcare.

Turning to the interaction terms, we find that, conditional on childcare attendance, parents believe that the likelihood of catching and transmitting COVID-19 would decrease if they play with their child more frequently. This may be because they perceive increased parental play to be crowding out other riskier activities; for example, parents might believe that the child would be attending childcare more often or for longer periods of time if they played with her rarely. Higher childcare exposure might therefore increase the chances of catching and transmitting COVID-19. We find a similar result for the interaction between childcare attendance and play with friends. On the other hand, we find no significant interaction between parental play and play with friends. However, when we estimate the same relationship with a median regression for robustness, we find that only the coefficients on attending a formal childcare setting and playing frequently with friends retain statistical significance (see Appendix Table B6).

5.3 Heterogeneity in perceived returns and risks

Tables 3 and 4 present *average* beliefs about returns and risks in our sample. Following the procedure outlined in Section 3.5.2, we compute for each respondent in our sample her individual-specific perceived risk and return associated with each type of investment: $return_i^S$, $return_i^P$, $return_i^F$ and $risk_i^S$, $risk_i^P$, $risk_i^F$ (see equation (7)).

We report the cumulative distributions of individual beliefs in Figure 6: the left panel reports the distribution of perceived returns, and the right panel the distribution of perceived risks. The Figure shows several interesting patterns. First, there is a substantial degree of heterogeneity in the beliefs about the returns and risks of different types of investment in our sample. Second, the distribution of perceived returns associated with parental play first-order stochastically dominates that of play with friends or childcare attendance (Panel A). At the same time, parental play is also perceived to increase the risk of catching and transmitting COVID-19 by the least (Panel B). Third, we note that the distribution of perceived risks associated with parental play has a large mass at zero, implying that most parents believe that this is essentially a risk-free activity. Finally, play with friends is perceived to improve child development by the least, but to increase the risk of catching and transmitting COVID-19 less than attending formal childcare.

Given these results, parental play appears to be the most productive investment to improve child development, while at the same time limiting the health risks associated with COVID-19. These results

Table 4: Perceived Risks to Investments

	Number of children expected to contract and transmit COVID-19 by September 2020	
	(1)	(2)
Investment: Attend childcare	18.202***	21.649***
	(0.762)	(0.949)
Investment: Parental play	4.358***	5.323***
	(0.389)	(0.500)
Investment: Friends play	12.054***	15.070***
	(0.525)	(0.726)
Friends play × Parental play		-0.533
		(0.426)
Attend childcare × Parental play		-1.397***
		(0.456)
Friends play × Attend childcare		-5.497***
		(0.606)
Constant	14.364***	12.507***
	(0.614)	(0.705)
Observations	4448	4448
R^2	0.416	0.423
Fixed effects	Yes	Yes

Notes: The dependent variable is the number of children out of 100 expected to catch and transmit COVID-19 by September 2020 asked in July 2020. "Investment: Attend childcare" is a binary variable equal to one in the scenario where children are attending a formal childcare setting (versus not attending). "Investment: Parental play" is a binary variable equal to one in the scenario where parents frequently play with the child (versus rare parental play). "Investment: Friends play" is a binary variable equal to one in the scenario where the child frequently plays with friends (versus rare play with friends). All regressions include respondent fixed effects. Standard errors are clustered at the individual level. *** p<0.01, ** p<0.05, * p<0.1.

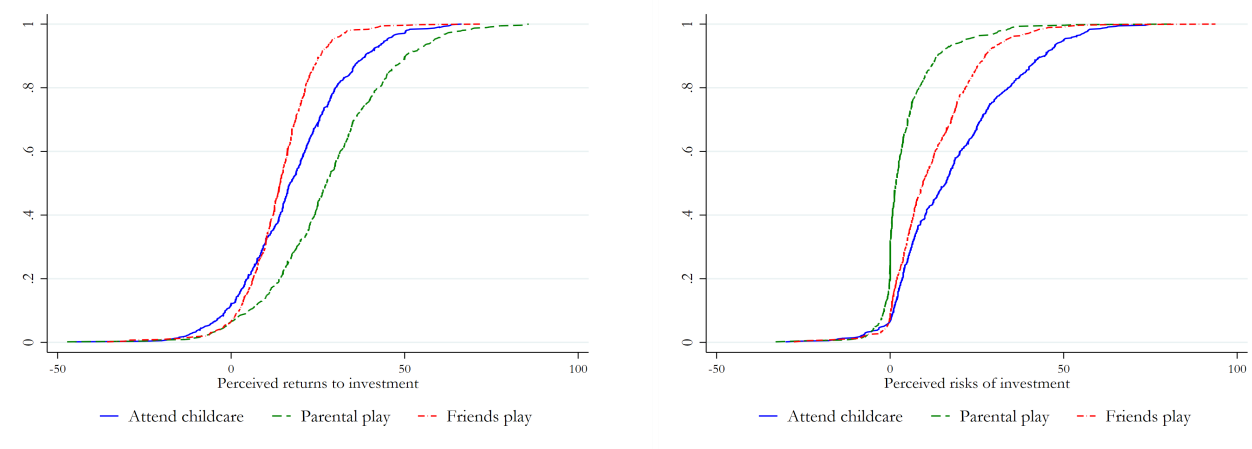
help rationalising the evidence investigating the determinants of parental childcare choices during the pandemic (and might also be relevant to explain choices for older children in school). More specifically, our finding that parents perceive formal childcare attendance to be substantially riskier than time spent with them can help rationalising the evidence showing that public school enrollment declined sharply during the pandemic (even when schools were open to all students), and homeschooling increased noticeably during the same period (Cattan et al., 2021; Musaddiq et al., 2021).

In Appendix Table B7 we then report the correlations between individual perceived returns and risks of different types of investment. The table shows that the perceived returns are not very correlated, with the exception of the returns to parental play and play with friends which are positively correlated (significant at the 1% level), so that parents who believe that playing with their child has a higher return also perceive a higher return to playing with friends. On the other hand, perceived risks seem to be more strongly correlated: a respondent who perceives a high risk for any given type of investment is also more likely to perceive other investment options to be riskier (the correlation coefficients are all significant at the 1% level). This latter result might be explained by the individual-level heterogeneity in the perceived risks associated with the severity of the COVID-19 pandemic and the infectiousness of the virus (Akesson et al., 2020; Fan et al., 2020). This heterogeneity across respondents translates - at the individual level - in a high correlation in perceived risks across different types of investment.[33]

Finally, we compare individual beliefs computed using the two procedures described in Section 3.5.2. Appendix Figure A6 reports the estimated cumulative density function of the Swamy (1970) estimates of

[33] In Appendix Figure A4 we report for each type of investment the joint distribution of the associated perceived risks and returns. In Appendix Figure A5 we report the joint distribution of returns (Panel A) and risks (Panel B) for any two types of investment.

Figure 6: Cumulative distributions of individual beliefs of returns and risks



(a) Returns

(b) Risks

Notes: The Figure plots the cumulative distribution of individual perceived returns in terms of Good Level of Development (GLD) and risks of investments in terms of likelihood of catching Covid-19. Panel A plots the distribution of perceived returns, while panel B plots the distribution of perceived risks computed as in equation (7).

the random coefficient model (equation 8) for perceived returns (Panel A) and risks (Panel B), alongside the empirical CDF for perceived returns and risks resulting from formula (7). The figure shows that the two distributions are virtually identical. Appendix Figure A7 further shows the scatter plot of individual perceived returns (Panel A) and risks (Panel B) for formal childcare attendance computed using the two methods: there is a strong linear relation between the two estimates, demonstrating (reassuringly) that the two approaches used in the literature produce fairly consistent results.

5.4 Explaining parental beliefs

Next, we investigate whether the perceived returns and risks vary with the characteristics of the respondent, in particular with socioeconomic status, as proxied by her level of education. In Table 5 we present OLS results from a regression of the individual-specific measures of returns (Panel A) and risks (Panel B) computed using equation (7) on observable characteristics of the respondent; each column reports the results for the outcome variable indicated in the header.[34]

Several patterns emerge. First, consistently with previous findings (e.g. Boneva and Rauh (2018)), we document that lower-SES respondents perceive lower returns from parental play. More specifically, our point estimates suggest that there is a gradient in perceived returns to parents' play, with parents with more education perceiving these returns to be 23%, 34% and 31% higher than parents with GCSE-level or lower education. We do not find statistically significant differences in the perceived returns to formal childcare or to play with friends by respondent's education, although the coefficient are always positive for more educated parents.[35] At the same time, compared to higher-SES ones, lower-SES respondents perceive a significantly lower risk of catching COVID-19 from formal childcare attendance

[34] Results obtained using median regression are reported in Appendix Table B8.

[35] The coefficients on play with friends achieve statistical significance when we use median regression, see column (3) in Appendix Table B8.

Table 5: Determinants of perceived returns and risks

Panel A		**Returns**	
	Formal childcare	Parental play	Play with friends
	(1)	(2)	(3)
Respondent education: Further education	2.852	6.524**	2.185
	(2.773)	(3.139)	(2.400)
Respondent education: Higher	0.302	9.689***	2.624
	(2.591)	(2.936)	(2.336)
Respondent education: Postgraduate	0.332	8.838***	1.130
	(2.800)	(3.197)	(2.428)
Female respondent	-2.434	-1.684	1.382
	(1.760)	(1.952)	(1.136)
Key worker	0.971	-2.605	-0.654
	(1.439)	(1.641)	(0.985)
Attended childcare pre-pandemic	7.331***	-0.989	-1.136
	(1.285)	(1.539)	(0.896)
Observations	554	554	554
Unconditional mean outcome	17.974	27.986	13.963
R^2	0.060	0.028	0.012
Panel B		**Risks**	
	Formal childcare	Parental play	Play with friends
	(4)	(5)	(6)
Respondent education: Further education	5.989**	1.524	-0.361
	(2.742)	(1.625)	(2.782)
Respondent education: Higher	6.131**	1.351	0.027
	(2.531)	(1.531)	(2.707)
Respondent education: Postgraduate	4.108	0.229	-0.911
	(2.771)	(1.572)	(2.838)
Female respondent	2.526	-1.612	1.081
	(1.771)	(1.175)	(1.317)
Key worker	-1.851	1.581*	-0.611
	(1.601)	(0.881)	(1.145)
Attended childcare pre-pandemic	-3.405**	-0.224	-2.557**
	(1.443)	(0.796)	(1.042)
Observations	552	552	552
Unconditional mean outcome	18.604	4.428	12.179
R^2	0.025	0.016	0.013

Notes: Each column displays results from a separate regression. The dependent variables are individual perceived returns (Panel A) and risks (Panel B) associated with each type of investment (indicated in the column header). These are computed as in equation (7). Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

(Panel B column 1). Second, respondents who were already using formal childcare pre-pandemic perceive significantly higher returns and lower risks from childcare attendance. Consistently with the fact that play with friends is an activity that requires interactions with other children, these same respondents also perceive a lower risk associated with this activity. Third, consistently with the fact that key workers were allowed to continue working outside their homes throughout the first lockdown, and were therefore potentially more exposed to the virus, we find that these respondents perceived parental play to be a riskier activity compared to non key workers.

We then test the robustness of these results to the inclusion of additional controls. We first add race of the respondent, sex and age of the child, and formal childcare quality (Appendix Table B9), and show that the results are qualitatively the same, with the exception of the perceived returns to play with friends, for which we uncover a more pronounced gradient by socio-economic status.[36] We also studied whether the quality of the early years settings available to the respondents at the Local Authority level,

[36]Interestingly, we find that the respondent perceives, on average, lower returns to parental play in case her child is a boy, as compared to a girl (col. (2); recall we had told the respondent *"Imagine 100 children of the same age as yours"*, without specifying anything about the gender), differently from Attanasio et al. (2020), who find no differences in perceived returns by the gender of the child (also in an English sample).

as measured by the Office for Standards in Education, (OFSTED) matters to explain heterogeneity in expected returns and risks;[37] while the coefficients go in the expected direction, so that higher preschool quality predicts higher perceived returns, they are never statistically significant at conventional levels. We further examined whether perceived returns and risks are associated with the number of COVID-19 cases (measured in the two weeks before the survey) in the Local Authority where the respondent resides, finding that this is generally not the case (Appendix Table B10).[38] On the other hand, we find that the relationship between the number of COVID-19 deaths (measured in the two weeks before the survey) and parental beliefs goes in the expected direction, with parents perceiving lower returns and higher risks from investments when the number of COVID-19 deaths are higher in the Local Authority where they reside, although the coefficients are imprecisely estimated (Appendix Table B10).

Finally, we examine whether the sentiment score computed from the text data relates to perceived returns and risks. We find that, on average, a higher sentiment score is associated with higher perceived returns, particularly for parental play and play with friends; on the other hand, we do not find any systematic relationship between the sentiment score and perceived risks (Appendix Table B11).[39]

6 Do beliefs predict investment decisions?

The final question we turn to is whether actual investment decisions made by parents are correlated with their beliefs about the returns and risks of such investments. In line with the theoretical framework outlined in Section 2, we model parents' investments decisions in terms of a trade-off between the perceived risks of catching and transmitting COVID-19 and the perceived returns for their child's development, and regress realised investment choices on elicited beliefs about these risks and returns, controlling for other respondent's characteristics.

Table 6 reports the results. Overall, the sign of the coefficients on parents' perceived returns and risks goes in the expected directions. On the one hand, a higher perceived return to formal childcare is positively associated with its use (in July 2020); on the other hand, a higher perceived risk to formal childcare is negatively associated with its use (column 1). Looking at the time parents spend playing with the child from the time use diaries (columns 2 to 4), we find that the parents who perceived a higher return to parental play were more likely to spend time with their child in July 2020; this is true both if we look at general child play (column 2), and if we look at the time spent by the mother or the father actively playing with the child (columns 3 and 4). We also find that a higher perceived return to play with friends is significantly positively associated with playground use in July (column 6), but not with the

[37] The Office for Standards in Education (OFSTED) typically inspects the quality of early years settings every year and gives an inspection rating on a four-point scale: 1: outstanding, 2: good, 3: requires improvement, and 4: inadequate. The OFSTED data is available here: https://www.gov.uk/government/collections/early-years-and-childcare-statistics#providers-and-inspections. The ratings are at the provider level; for the analysis, we aggregate them and use the average rating in the Local Authority where the respondent resided, since we did not ask the name of the early years setting attended.

[38] We used the official data from the Office for National Statistics, which is available here: https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/conditionsanddiseases#datasets.

[39] The Table report results by terciles of the empirical distribution of the sentiment score. Alternative specifications of the sentiment score (median split, using quartiles, or a continuous measure) produce qualitatively similar results.

Table 6: Parental beliefs and actual investments

	Formal childcare atten-dance	Play	Play-actively involved mother	Play-actively involved father	Play with other child	Playground use
	(1)	(2)	(3)	(4)	(5)	(6)
Return to formal childcare	0.007***	-0.010	-0.016**	-0.013**	0.014**	0.002
	(0.001)	(0.008)	(0.008)	(0.006)	(0.006)	(0.004)
Return to parental play	0.001	0.017**	0.013**	0.012**	0.006	-0.002
	(0.001)	(0.007)	(0.007)	(0.006)	(0.006)	(0.003)
Return to play with friends	-0.001	-0.032**	-0.023*	-0.013	-0.003	0.015***
	(0.002)	(0.013)	(0.012)	(0.010)	(0.011)	(0.006)
Risk of formal childcare	-0.004***	0.002	0.016**	0.003	-0.007	0.005
	(0.001)	(0.008)	(0.007)	(0.006)	(0.005)	(0.004)
Risk of parental play	-0.001	-0.013	-0.019	-0.006	0.000	-0.003
	(0.002)	(0.012)	(0.012)	(0.009)	(0.010)	(0.006)
Risk of play with friends	-0.000	0.011	0.011	-0.004	-0.003	-0.016***
	(0.001)	(0.013)	(0.011)	(0.009)	(0.008)	(0.005)
Respondent education: Further education	0.071	-0.084	-0.441	0.680*	0.150	0.252
	(0.064)	(0.487)	(0.502)	(0.355)	(0.229)	(0.233)
Respondent education: Higher	0.034	-0.127	-0.554	0.607*	0.364	0.082
	(0.060)	(0.468)	(0.476)	(0.329)	(0.242)	(0.220)
Respondent education: Postgraduate	0.109	-0.355	-1.058**	0.718**	0.364	0.640**
	(0.067)	(0.504)	(0.507)	(0.355)	(0.283)	(0.281)
Female respondent	0.019	-0.576*	0.404	-1.744***	-0.043	-0.129
	(0.044)	(0.314)	(0.297)	(0.278)	(0.220)	(0.158)
Key worker	0.125***	0.450*	0.260	0.316	0.023	0.006
	(0.042)	(0.273)	(0.263)	(0.215)	(0.200)	(0.133)
Observations	548	548	547	547	548	548
Unconditional mean outcome	0.241	5.338	4.055	1.976	0.577	0.777
R^2	0.109	0.033	0.046	0.125	0.021	0.042

Notes: The dependent variables are: an indicator variable for whether the child attends formal childcare in July 2020 (column 1), the number of hours her child spent playing in the July time use diary (column 2), the number of hours the respondent reported the mother spent actively playing with her child in the July time use diary (column 3), the number of hours the respondent reported the father spent actively playing with her child in the July time use diary (column 4), the number of hours the respondent reported the child being actively involved with another child in the July time use diary (column 5), and the number of times the child was taken to the playground in a week in July 2020 (Column 6). Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

time spent with other children, as reported in the time use diaries (column 5). At the same time, a higher perceived risk of play with friends is negative correlated with the likelihood of going to the playground. Lastly, a higher perceived return to play with friends and a higher risk of formal childcare attendance are, respectively, negatively and positively associated with more time spent playing with the mother, but not with the father; this last result aligns with the vast evidence documenting the increased burden on women's time experienced during the pandemic as consequence of limited availability of alternative childcare options (see e.g. Sevilla and Smith (2020)).

Interestingly, the results in Table 6 also show that the gradients in the time the mother and the father spend in active play with the child go in opposite directions: respondents with higher levels of education report that, in their household, the mother spends *less* time actively playing with the child (column 3), while the father spends *more* time in this activity (column 4), as compared to those with lower levels of education.[40] Although we did not elicit returns to parental play separately for mothers and fathers, the greater involvement of fathers might be one of the reasons behind the higher developmental returns to

[40]The greater involvement in childcare of more educated fathers has been previously shown (Dotti Sani and Treas, 2016; Sundström and Duvander, 2002). Similarly, it has been documented that more educated mothers spend more time with their children (Kalil et al., 2012; Guryan et al., 2008); however postgraduate education in the existing studies is usually combined with college-level education in one single category: the evidence we show here suggests it might be useful to consider it separately.

parental play perceived by more educated respondents (Table 5).[41]

Taken together, these findings show that parental choices are correlated with both the perceived benefits and risks associated with different types of investments, consistently with previous work (e.g. Attanasio et al. (2020)).

7 Conclusions

We extend a growing literature looking at the role of parental subjective beliefs about the returns to different activities promoting child development (e.g. Cunha, Elo, and Culhane (2013)), by showing that, in a time of high uncertainty brought about by the COVID-19 pandemic, individual perceived health *risks* associated with different types of investments are equally relevant in the household decision making process. We do so by analysing newly collected data on first-time parents of under-fives in England surveyed during the first COVID-19 wave. Our rich survey includes measures of subjective beliefs on returns and risks to three different types of investments (formal childcare attendance, parental play, and child play with friends), as well as detailed time use data on children's daily activities, and open-ended questions, that we analyse using natural language processing techniques to gain a better understating of parents' first order concerns in relation to COVID-19.

Several key results have emerged. First, we have documented that - consistently with official figures - the use of formal childcare decreased significantly since the start of the first lockdown, at the end of March 2020. We have also shown that, despite the reopening of early years settings in June 2020, their use did not increase to pre-lockdown levels by summer 2020. The analysis of textual data suggests that, although the lack of socialization was a key concern for many parents, they perceived they could partly substitute childcare with their own time investments.

Second, we have found that respondents believe that formal childcare, parental play, and play with friends all improve child development. At the same time, each activity is perceived to increase the risk of contracting COVID-19. On average, parental play is perceived to improve child development by the most, and to increase the likelihood of catching COVID-19 by the least. The analysis of beliefs data demonstrates that parents perceive their own time to be a partial substitute for formal childcare, in accordance with the explanations given to us when we asked them directly about the reasons for not sending the child to an early years setting.

Third, we have documented a significant socioeconomic gradient in beliefs, with lower-SES respondents generally perceiving lower returns to parental play and lower health risks from formal childcare attendance. Using natural language processing techniques to analyse the open-ended questions, we have further shown that parents who expressed greater concerns and more negative feelings in their answers generally perceived lower returns from human capital investments.

[41] Father involvement has been shown to be a significant determinant of child cognitive development, see e.g. Rollè et al. (2019) for a review.

Finally, we have shown that perceived returns and risks associated with different types of investments are predictive of actual choices. Parents who perceive a greater return to formal childcare are more likely to send their child to an early years setting in summer 2020. Conversely, a larger perceived health risk of sending a child to formal childcare has a significant negative association with its use. At the same time, a higher expected benefit from parental play is associated with more time spent playing with the child.

These last two results are important as they suggest that beliefs heterogeneity by socio-economic status could contribute to further widening of pre-existing inequalities in early years development, and are consistent with recent evidence demonstrating differential impacts of the pandemic on children's learning outcomes by socioeconomic status (Engzell et al., 2021; Maldonado and De Witte, 2021). Our findings both remark the importance of studying the sources of parental beliefs,[42] and also suggest the need for timely and targeted provision of information on the actual returns and risks to different forms of investments - fruitful avenues of future investigations.

[42] Most respondents in our sample report getting information related to COVID-19 and its risks through online newspapers, social-media, or the official government website. Notably, respondents who consult the government website, on average, perceive higher risks associated with childcare attendance, while those who consult social media perceive, on average, a lower risk associated with play with friends.

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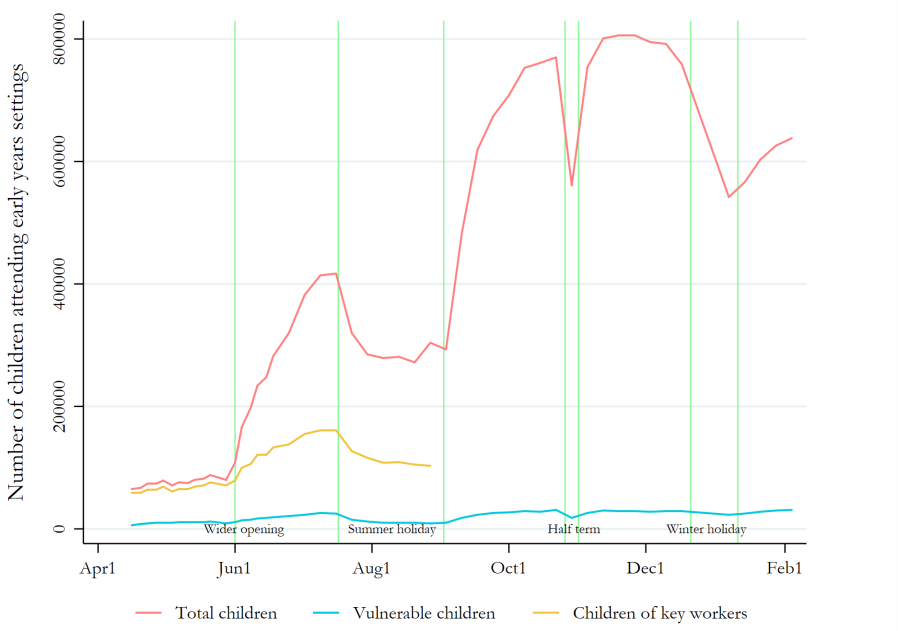
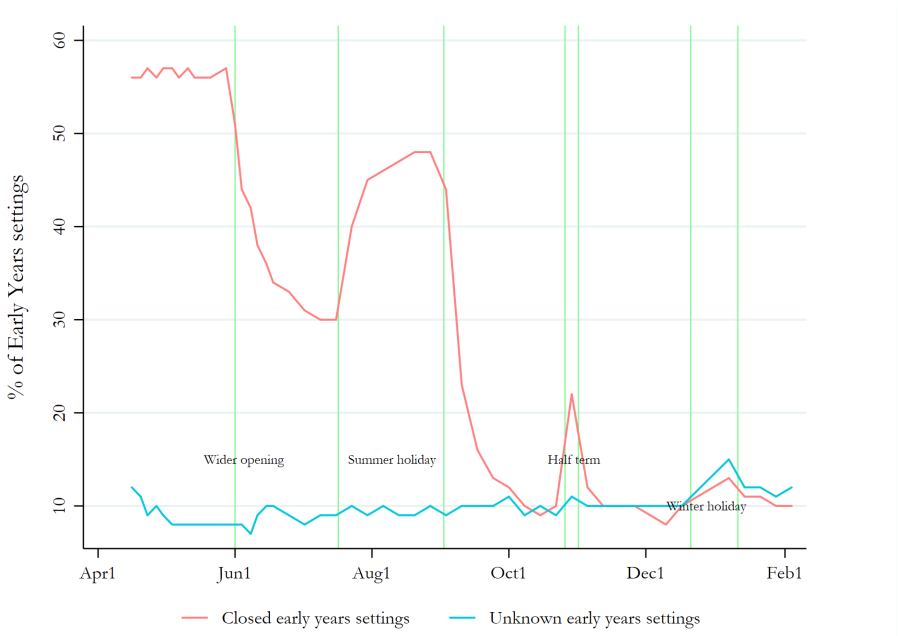
Appendix

A Appendix Figures

Figure A1: Early years settings in England during the first year of COVID-19 (April 2020-February 2021)



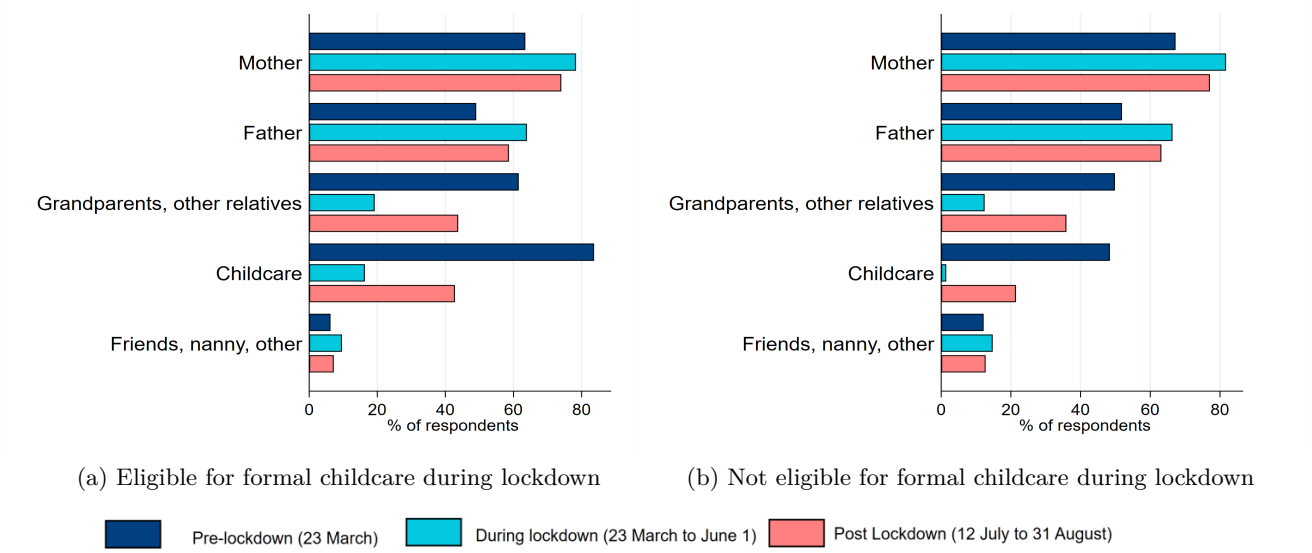
(a) Early years settings attendance in England over time



(b) Percentage of early years settings closed over time

Notes: Panel A shows the number of children attending early years settings over time. The statistic on children of critical workers was discontinued after the last week of August 2020. Panel B shows the proportion of early years settings reporting being closed or having unknown status. Source for both figures: Department for Education 'Attendance in education and early years settings during the coronavirus (COVID-19) outbreak'. https://explore-education-statistics.service.gov.uk/find-statistics/attendance-in-education-and-early-years-settings-during-the-coronavirus-covid-19-outbreak.

Figure A2: Type of childcare usage pre-, during and post-lockdown, by eligibility

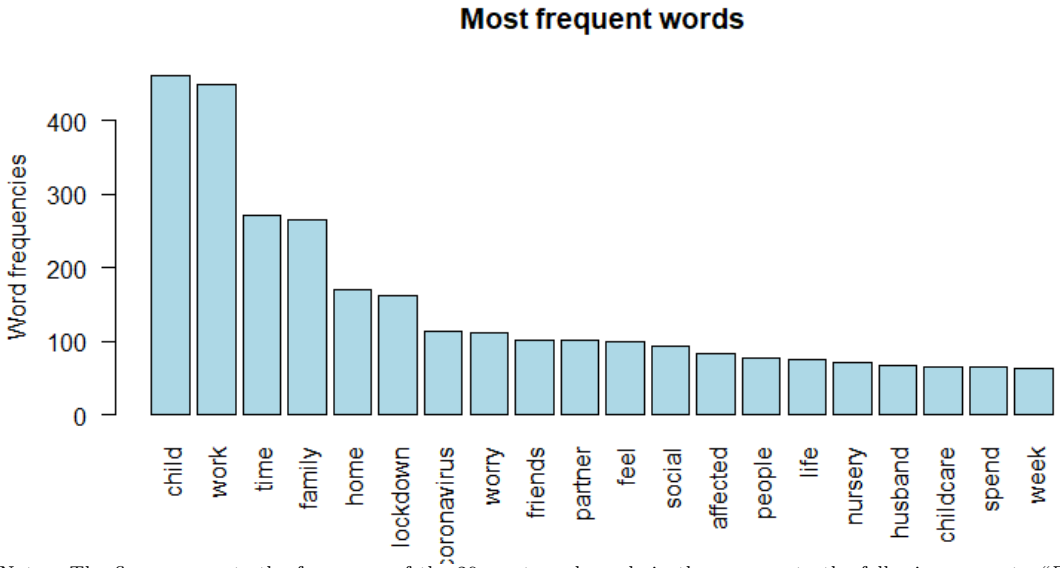


(a) Eligible for formal childcare during lockdown

(b) Not eligible for formal childcare during lockdown

Notes: The Figure shows the types of childcare used by respondents at different points in time during the pandemic. Respondents were asked "Does your child currently use and did she/he previously use any of the following options? Please select all that apply" for the periods pre-lockdown, during lockdown and post lock-down (current). Dark blue is for before the first lockdown, light blue is for during the lockdown, and the final category is for after the restrictions were lifted in July and August 2020. The "Grandparents, other relatives" category includes non-resident parents. Childcare refers to nursery, preschool, creche, and childminder (i.e. formal childcare).

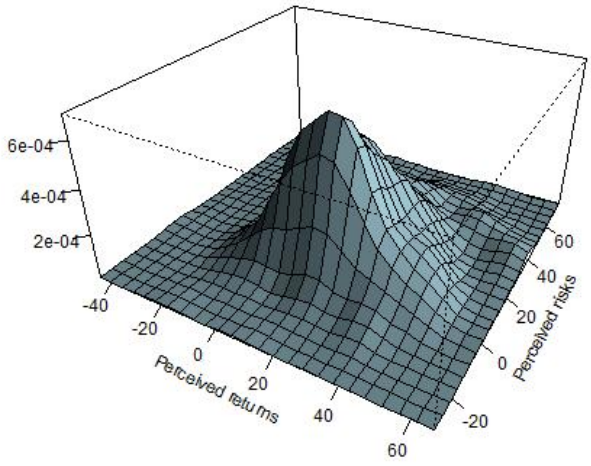
Figure A3: Frequency of the 20 most used words



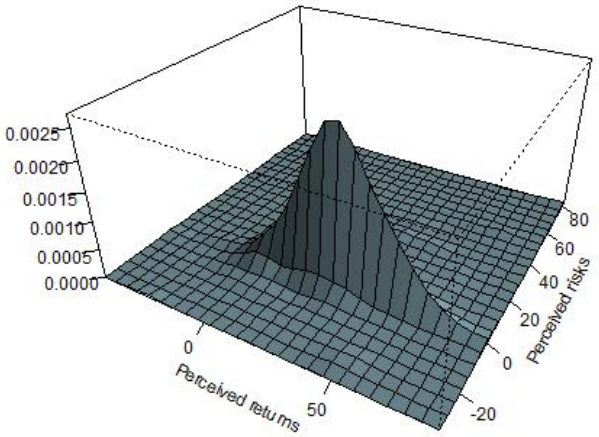
Notes: The figure presents the frequency of the 20 most used words in the answers to the following prompt: *"Please use the space below to express in your own words the main ways the Coronavirus outbreak has affected your life and/or your loved ones so far, and what you think the effects might be in the future. You can write as much or little as you like, and cover any topic you choose."*

Figure A4: Joint density plots of perceived returns and risks of the different investments

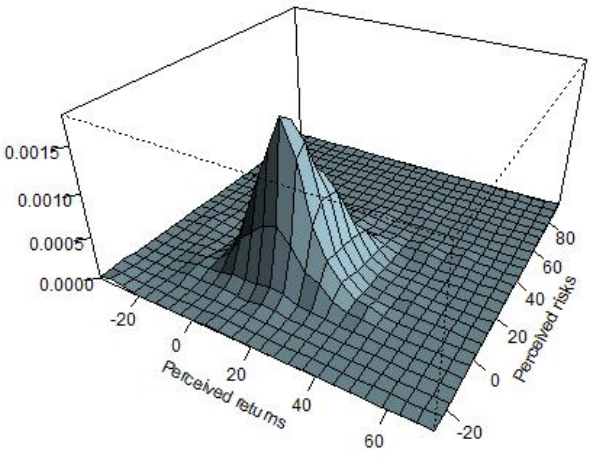
Formal childcare



Parental play

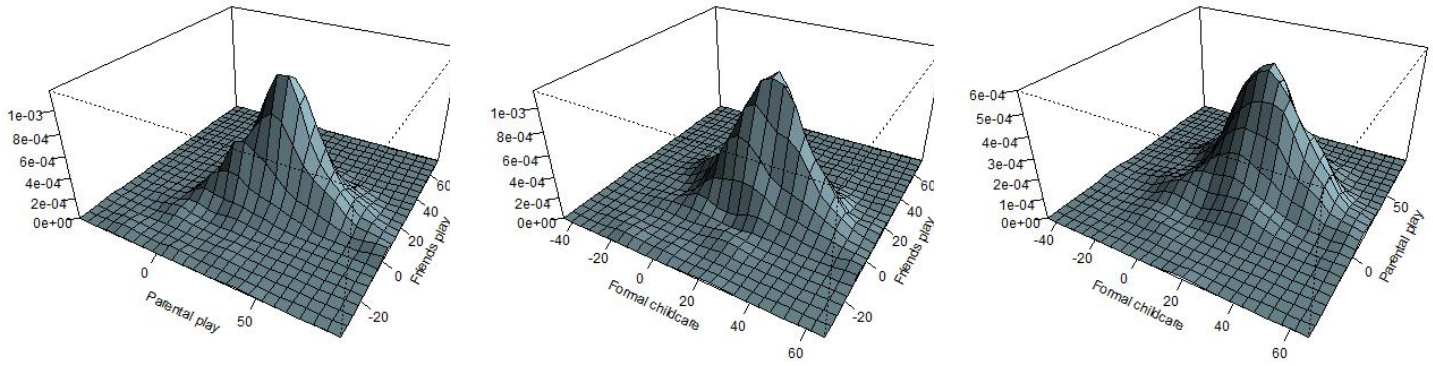


Friends play

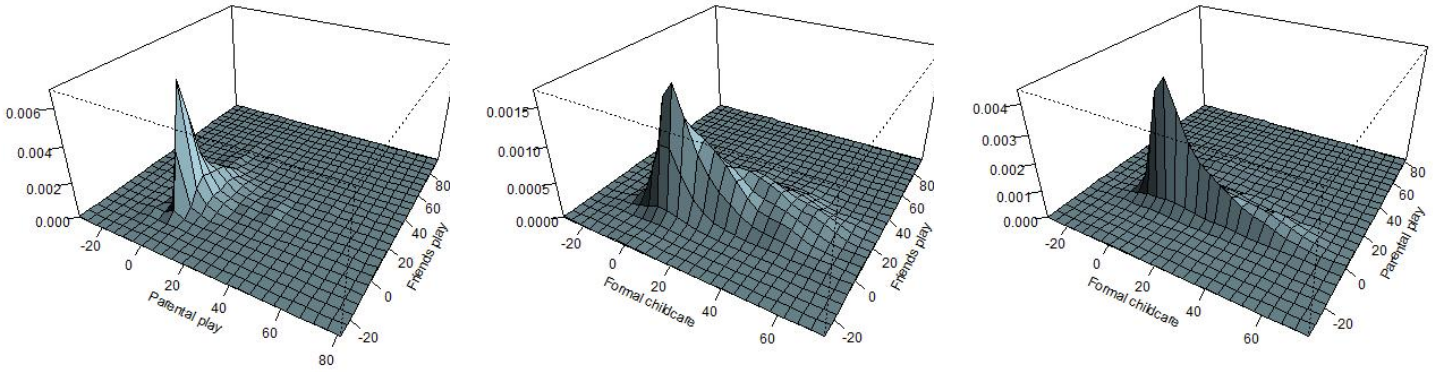


Notes: The figures plot separately for each type of investment the joint density of perceived returns and risks.

Figure A5: Joint density plots of different types of investment



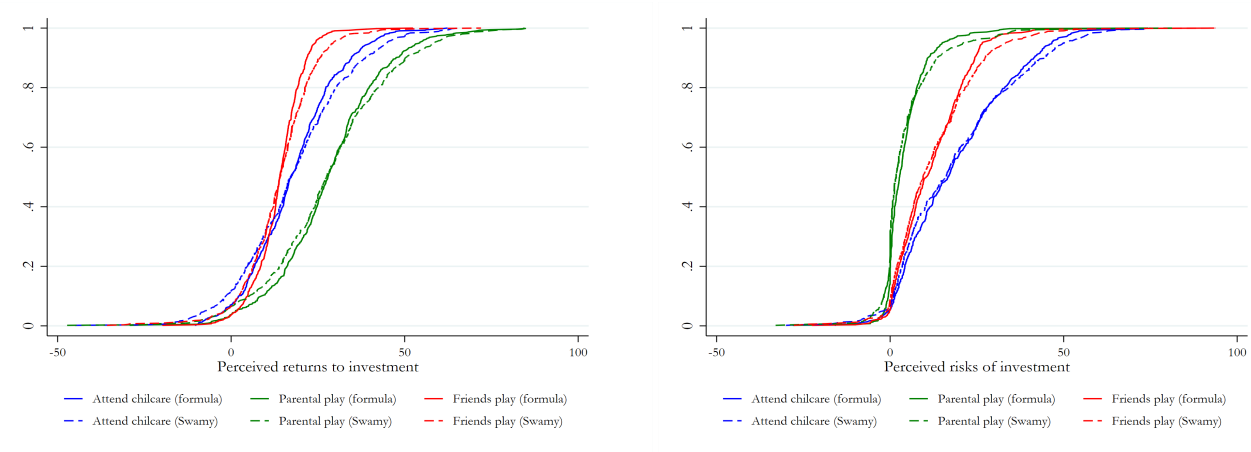
(a) Returns



(b) Risks

Notes: The figures plot the joint densities of individual perceived returns to and risks of investment. Each figure plots the joint distribution of two different pairs of returns (Panel A) or risks (Panel B).

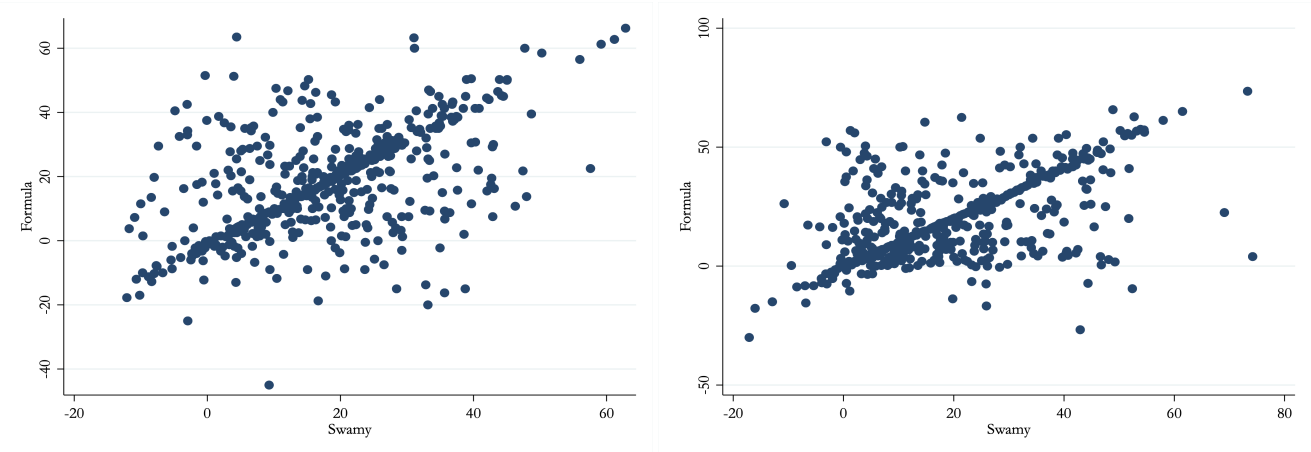
Figure A6: Cumulative distributions of individual beliefs (Swamy (1970) estimates vs formula (7))



(a) Returns (b) Risks

Notes: The Figure plots the cumulative distributions of individual perceived returns (Panel A) and risks (Panel B) estimated using the formula in (7) (solid line) and using the Swamy (1970) random coefficient model in equation (8).

Figure A7: Scatter plot of individual beliefs related to formal childcare attendance (Swamy (1970) estimates vs formula (7))



(a) Returns (b) Risks

Notes: The Figure shows the scatter plot of perceived returns (Panel A) and risks (Panel B) to formal childcare attendance estimated using the formula in (7) (y-axis) and using the Swamy (1970) estimates of the random coefficient model in equation (8) (x-axis).

B Appendix Tables

Table B1: Type of childcare use: pre-, during and post-lockdown

	Mother	Father	Grandparents, relatives	Childcare	Friends, nanny, other
	(1)	(2)	(3)	(4)	(5)
During lockdown	14.748***	14.748***	-39.388***	-54.676***	2.878*
	(1.689)	(1.764)	(2.298)	(2.621)	(1.480)
Post-lockdown	10.252***	10.791***	-15.468***	-32.014***	0.719
	(1.562)	(1.586)	(1.979)	(2.502)	(1.299)
Observations	1668	1668	1668	1668	1668
Mean pre-lockdown (%)	65.827	50.719	54.317	61.871	9.892
R^2	0.020	0.016	0.114	0.185	0.002

Notes: The table presents the differences in childcare use during and after lockdown, as compared to before. Childcare refers to nursery, preschool, creche, and childminder (i.e. formal childcare). Standard errors are clustered at the individual level. *** p<0.01, ** p<0.05, * p<0.1.

Table B2: Type of childcare use: pre-, during and post-lockdown, by eligibility

	Mother	Father	Grandparents, relatives	Childcare	Friends, nanny, other
	(1)	(2)	(3)	(4)	(5)
Pre-lockdown × Eligible for childcare	-3.785	-2.846	11.683***	35.248***	-5.924**
	(4.197)	(4.398)	(4.326)	(5.209)	(2.438)
During lockdown × Non-eligible for childcare	14.493***	14.493***	-37.391***	-46.957***	2.609
	(2.070)	(2.189)	(2.917)	(3.182)	(1.855)
During lockdown × Eligible for childcare	11.119***	12.058***	-30.624***	-32.060***	-2.559
	(3.822)	(4.291)	(3.845)	(4.113)	(2.704)
Post-lockdown × Non-eligible for childcare	9.855***	11.304***	-13.913***	-26.957***	0.580
	(1.898)	(1.940)	(2.588)	(2.905)	(1.694)
Post-lockdown × Eligible for childcare	6.792*	6.770	-6.105	-5.617	-4.962**
	(3.962)	(4.357)	(4.378)	(4.754)	(2.519)
Observations	1659	1659	1659	1659	1659
Mean pre-lockdown (%)	67.246	51.884	49.855	48.406	12.174
R^2	0.021	0.017	0.121	0.241	0.009

Notes: The table presents the differences in childcare use before, during and after lockdown. Childcare refers to nursery, preschool, creche, and childminder (i.e. formal childcare). Standard errors are clustered at the individual level. *** p<0.01, ** p<0.05, * p<0.1.

Table B3: Descriptive statistics of time use variables

	N	Mean	Std. Dev.	Min	Max	p25	p75
Hours playing in April	556	5.79	3.07	0	18	4	8
Hours playing in July	557	5.37	2.85	0	14	3	7
Hours sleeping in April	556	7.61	1.95	0	18	6	9
Hours sleeping in July	557	7.12	1.79	1	13	6	8
Hours eating in April	556	3.76	1.62	0	14	3	5
Hours eating in July	556	3.67	1.48	0	11	3	5
Hours actively with mother in April	556	11.92	4.88	0	18	9	18
Hours actively with mother in July	557	11.18	4.76	0	18	8	15
Hours actively with father in April	556	6.08	5.35	0	18	2	9
Hours actively with father in July	557	5.50	4.72	0	18	2	8
Hours actively with another child in April	556	0.25	1.42	0	18	0	0
Hours actively with another child in July	557	0.57	2.00	0	14	0	0
Number of times taken to the playground in July	557	0.77	1.52	0	11	0	1

Table B4: Time-use diaries

	Play	Sleep	Eat/Feed	Activity with mother	Activity with father	Activity with other child
	(1)	(2)	(3)	(4)	(5)	(6)
Post lockdown (July 2020)	-0.436***	-0.491***	-0.080	-0.729***	-0.588***	0.307***
	(0.110)	(0.065)	(0.064)	(0.159)	(0.188)	(0.084)
Constant	5.796***	7.614***	3.754***	11.916***	6.112***	0.259***
	(0.129)	(0.082)	(0.068)	(0.206)	(0.227)	(0.062)
Observations	1120	1120	1120	1120	1120	1120
R^2	0.005	0.017	0.001	0.006	0.003	0.008

Notes: The table presents the differences in activities after lockdown (July 2020), as compared to during it (April 2020). Standard errors are clustered at the individual level. *** p<0.01, ** p<0.05, * p<0.1.

Table B5: Perceived Returns - median regression

	Number of children out of 100 expected to reach a Good Level of Development by September 2020	
	(1)	(2)
Investment: Attend childcare	17.226***	21.312***
	(0.503)	(0.886)
Investment: Parental play	27.869***	32.704***
	(0.501)	(0.889)
Investment: Friends play	13.819***	18.106***
	(0.501)	(0.867)
Friends play x Parental play		-5.043***
		(1.004)
Attend childcare x Parental play		-4.627***
		(1.000)
Friends play x Attend childcare		-3.522***
		(0.999)
Observations	4448	4448
Fixed effects	Yes	Yes

Notes: The dependent variable is the number of children (out of 100) expected to reach a Good Level of Development by September 2020 asked in July 2020. "Investment: Attend childcare" is a binary variable equal to 1 in the scenario where children are attending a formal childcare setting (versus not attending). "Investment: Parental play" is a binary variable equal to one in the scenario where parents frequently play with the child (versus rare parental play). "Investment: Friends play" is a binary variable equal to one in the scenario where the child frequently plays with friends (versus rare play with friends). All regressions include respondent fixed effects. Robust standard errors are reported in parentheses and are computed as in Machado and Silva (2019) *** p<0.01, ** p<0.05, * p<0.1.

Table B6: Perceived Risks - median regression

	Number of children expected to contract and transmit COVID-19 by September 2020	
	(1)	(2)
Investment: Attend childcare	18.166***	22.069***
	(0.417)	(3.721)
Investment: Parental play	4.352***	5.459
	(0.416)	(4.111)
Investment: Friends play	12.010***	15.507***
	(0.417)	(3.699)
Friends play x Parental play		-0.664
		(4.147)
Attend childcare x Parental play		-1.528
		(4.147)
Friends play x Attend childcare		-6.073
		(4.011)
Observations	4448	4448
Fixed effects	Yes	Yes

Notes: Dependent variable is the number of children out of 100 expected to catch and transmit COVID-19 by September 2020 asked in July 2020. 'Investment: Attend childcare' is a binary variable equal to one if the individual currently attends a formal childcare setting. 'Investment: Parental play' is a binary variable equal to one if the scenario contained frequent parental play (versus rare parental play). 'Investment: Friends play' is a binary variable equal to one if the scenario contained frequent play with friends (versus rare play with friends). All regressions include respondent fixed effects. Robust standard errors are reported in parentheses and are computed as in Machado and Silva (2019). *** p<0.01, ** p<0.05, * p<0.1.

Table B7: Correlations between perceived returns and risks

	Return: childcare	Return: play with parents	Return: play with friends	Risk: childcare	Risk: play with parents	Risk: play with friends
Return: childcare	1					
Return: play with parents	-0.0388	1				
Return: play with friends	-0.0202	0.322***	1			
Risk: childcare	0.139**	0.173***	0.102*	1		
Risk: play with parents	0.0296	0.111**	0.0739	0.158***	1	
Risk: play with friends	-0.0388	0.121**	0.317***	0.388***	0.218***	1

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table B8: Determinants of perceived returns and risks - median regression

Panel A		**Returns**	
	Formal childcare	Parental play	Play with friends
	(1)	(2)	(3)
Respondent education: Further education	1.500	8.500**	3.250*
	(3.286)	(3.519)	(1.675)
Respondent education: Higher	-1.250	10.750***	2.750*
	(3.105)	(3.326)	(1.583)
Respondent education: Postgraduate	-0.500	11.000***	1.000
	(3.362)	(3.601)	(1.714)
Female respondent	-3.000	-1.500	-1.000
	(2.037)	(2.182)	(1.038)
Key worker	0.500	-2.250	-0.250
	(1.837)	(1.967)	(0.936)
Attended childcare pre-pandemic	7.750***	-1.000	-0.750
	(1.703)	(1.824)	(0.868)
Observations	554	554	554
Unconditional mean outcome	17.974	27.986	13.963
Panel B		**Risks**	
	Formal childcare	Parental play	Play with friends
	(4)	(5)	(6)
Respondent education: Further education	7.625*	1.750*	1.250
	(4.377)	(0.965)	(2.957)
Respondent education: Higher	6.250	0.750	1.500
	(4.121)	(0.909)	(2.784)
Respondent education: Postgraduate	4.875	0.250	-1.750
	(4.479)	(0.988)	(3.025)
Female respondent	2.375	-0.250	0.750
	(2.732)	(0.602)	(1.845)
Key worker	-2.125	1.250**	-0.500
	(2.489)	(0.549)	(1.681)
Attended childcare pre-pandemic	-2.375	-0.500	-3.250**
	(2.302)	(0.508)	(1.555)
Observations	552	552	552
Unconditional mean outcome	18.604	4.428	12.179

Notes: Each column displays results from a separate median regression. The dependent variables are individual perceived returns (Panel A) and risks (Panel B) associated with each type of investment (indicated in the column header). These are computed as in equation (7). Robust standard errors are reported in parentheses and are computed as in Machado and Silva (2019). *** p<0.01, ** p<0.05, * p<0.1.

Table B9: Determinants of perceived returns and risks (additional controls)

Panel A		**Returns**	
	Formal childcare	Parental play	Play with friends
	(1)	(2)	(3)
Respondent education: Further education	1.251	7.511**	5.529**
	(3.095)	(3.503)	(2.219)
Respondent education: Higher	-1.301	10.841***	6.029***
	(2.935)	(3.285)	(2.127)
Respondent education: Postgraduate	-1.174	9.702***	4.378*
	(3.134)	(3.548)	(2.259)
Female respondent	-2.752	-1.255	1.843
	(1.775)	(1.959)	(1.124)
Key worker	0.964	-3.023*	-0.584
	(1.468)	(1.659)	(0.986)
Attended childcare pre-pandemic	6.644***	0.637	-0.387
	(1.437)	(1.643)	(0.973)
Gender of child (1=male, 0=female)	0.234	-3.569**	-0.763
	(1.353)	(1.555)	(0.888)
Child's age in years	0.705	-1.062	-0.772
	(0.749)	(0.928)	(0.517)
OFSTED quality	-2.504	-1.074	-3.467
	(12.843)	(12.848)	(7.237)
Respondent is white	-0.466	3.590	1.129
	(2.447)	(2.829)	(1.780)
Observations	554	554	554
Unconditional mean outcome	17.974	27.986	13.963
R^2	0.066	0.046	0.059
Panel B		**Risks**	
	Formal childcare	Parental play	Play with friends
	(4)	(5)	(6)
Respondent education: Further education	7.393**	2.169	3.316
	(2.935)	(1.703)	(2.503)
Respondent education: Higher	7.546***	1.729	3.539
	(2.742)	(1.585)	(2.403)
Respondent education: Postgraduate	5.365*	0.687	2.571
	(2.972)	(1.653)	(2.556)
Female respondent	2.739	-1.571	1.420
	(1.754)	(1.203)	(1.320)
Key worker	-1.642	1.859**	-0.255
	(1.627)	(0.893)	(1.167)
Attended childcare pre-pandemic	-3.131*	-0.615	-2.786**
	(1.681)	(0.882)	(1.204)
Gender of child (1=male, 0=female)	-0.030	0.539	-0.352
	(1.502)	(0.803)	(1.049)
Child's age in years	-0.147	0.367	0.326
	(0.843)	(0.485)	(0.577)
OFSTED quality	-18.605	1.242	-7.831
	(13.275)	(6.770)	(8.391)
Respondent is white	-1.158	-4.779**	-3.534
	(2.398)	(1.898)	(2.337)
Observations	552	552	552
Unconditional mean outcome	18.604	4.428	12.179
R^2	0.036	0.046	0.056

Notes: Each column represents a separate regression. The dependent variable are individual perceived returns (Panel A) and risks (Panel B) associated with each type of investment (in column header). Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table B10: Determinants of perceived returns and risks with number of covid-19 cases and deaths

Panel A			**Returns**			
	Formal childcare		Parental play		Play with friends	
	(1)	(2)	(3)	(4)	(5)	(6)
Respondent education: Further education	1.141	1.223	7.619**	7.595*	5.662**	5.674**
	(3.236)	(3.244)	(3.834)	(3.846)	(2.324)	(2.323)
Respondent education: Higher	-1.390	-1.336	10.711***	10.756***	6.063***	6.106***
	(3.105)	(3.097)	(2.838)	(2.845)	(2.059)	(2.057)
Respondent education: Postgraduate	-1.347	-1.384	9.838***	9.868***	4.546*	4.552*
	(3.542)	(3.542)	(3.222)	(3.218)	(2.314)	(2.316)
Female respondent	-2.591	-2.423	-1.559	-1.533	1.699	1.767
	(1.862)	(1.855)	(2.020)	(2.010)	(1.151)	(1.143)
Key worker	0.877	0.905	-2.514*	-2.546*	-0.465	-0.475
	(1.539)	(1.538)	(1.367)	(1.375)	(1.101)	(1.102)
Attended childcare pre-pandemic	7.334***	7.321***	-0.983	-0.998	-1.141	-1.153
	(1.168)	(1.183)	(1.653)	(1.658)	(0.899)	(0.897)
Average covid-19 cases (previous 2 weeks)	0.019		-0.073		-0.036	
	(0.041)		(0.102)		(0.039)	
Average covid-19 deaths (previous 2 weeks)		-0.112		-0.043		-0.060
		(0.072)		(0.080)		(0.038)
Observations	554	554	554	554	554	554
Unconditional mean outcome	17.974	17.974	27.986	27.986	13.963	13.963
R^2	0.064	0.066	0.030	0.029	0.048	0.049
Panel B			**Risks**			
	Formal childcare		Parental play		Play with friends	
	(4)	(5)	(6)	(4)	(5)	(6)
Respondent education: Further education	7.567***	7.487***	2.226	2.137	3.370	3.338
	(2.655)	(2.648)	(1.831)	(1.822)	(2.088)	(2.081)
Respondent education: Higher	7.691***	7.639***	2.024	1.974	3.795*	3.734*
	(2.639)	(2.649)	(1.629)	(1.640)	(2.171)	(2.171)
Respondent education: Postgraduate	5.657**	5.676**	0.891	0.917	2.856	2.843
	(2.492)	(2.485)	(1.664)	(1.659)	(2.372)	(2.370)
Female respondent	2.682	2.552	-1.534	-1.671	1.419	1.326
	(1.828)	(1.828)	(1.232)	(1.255)	(1.390)	(1.386)
Key worker	-1.766	-1.797	1.628*	1.591*	-0.442	-0.446
	(1.356)	(1.346)	(0.941)	(0.947)	(1.215)	(1.213)
Attended childcare pre-pandemic	-3.406**	-3.391**	-0.224	-0.209	-2.566**	-2.548**
	(1.344)	(1.341)	(0.681)	(0.684)	(1.086)	(1.088)
Average covid-19 cases (previous 2 weeks)	-0.017		-0.028		0.037	
	(0.057)		(0.030)		(0.056)	
Average covid-19 deaths (previous 2 weeks)		0.101		0.102*		0.092
		(0.090)		(0.057)		(0.090)
Observations	552	552	552	552	552	552
Unconditional mean outcome	18.604	18.604	4.428	4.428	12.179	12.179
R^2	0.028	0.029	0.019	0.023	0.048	0.049

Notes: Each column represents a separate regression. The dependent variable are individual perceived returns (Panel A) and risks (Panel B) associated with each type of investment (in column header). Covid-19 cases and deaths are at the local authority level. Robust standard errors clustered at the local authority level are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table B11: Relationship between sentiment score and perceived returns and risks of investment

Panel A:	**Returns**					
	Formal childcare		Parental play		Play with friends	
	(1)	(2)	(3)	(4)	(5)	(6)
Second tercile of sentiment score	0.801	0.312	2.204	2.431	3.295**	3.366***
	(1.801)	(1.783)	(2.011)	(2.012)	(1.284)	(1.289)
Third tercile of sentiment score	0.448	-0.012	3.026*	2.627	1.993**	1.949**
	(1.608)	(1.579)	(1.764)	(1.754)	(0.983)	(0.986)
Observations	499	499	499	499	499	499
Unconditional mean outcome	18.115	18.115	29.195	29.195	14.655	14.655
Other controls	No	Yes	No	Yes	No	Yes
Panel B:	**Risks**					
	Formal childcare		Parental play		Play with friends	
	(1)	(2)	(3)	(4)	(5)	(6)
Second tercile of sentiment score	1.810	1.884	1.809*	1.715	1.734	1.794
	(1.986)	(1.990)	(1.077)	(1.066)	(1.499)	(1.501)
Third tercile of sentiment score	0.180	-0.096	0.344	0.115	0.577	0.717
	(1.716)	(1.709)	(0.927)	(0.941)	(1.157)	(1.163)
Observations	495	495	495	495	495	495
Unconditional mean outcome	18.101	18.101	29.194	29.194	14.575	14.575
Other controls	No	Yes	No	Yes	No	Yes

Notes: Each column presents results from a separate regression. The dependent variables are individual perceived returns (Panel A) and risks (Panel B) associated with each type of investment (attending formal childcare, parental play and play with friends) computed as in equation (7). The sentiment score is obtained by using the *syuzhet* lexicon applied to the answers to the following prompt: *"Please use the space below to express in your own words the main ways the Coronavirus outbreak has affected your life and/or your loved ones so far, and what you think the effects might be in the future. You can write as much or little as you like, and cover any topic you choose."* The sentiment score has been standardized to have mean 0 and standard deviation 1, and a higher value corresponds to more positive sentiments. Columns 2, 4 and 6 include the same set of controls in Table 5: indicators for the respondent being female, indicator for being a key worker, education; an indicator for whether the child attended a formal childcare setting pre-pandemic. The sample size is reduced because not all respondents answered the open ended question. Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table B12: Parental beliefs and actual investments (mother and father's education)

	Formal childcare attendance	Play	Play-actively involved mother	Play-actively involved father	Play with other child	Playground use
	(1)	(2)	(3)	(4)	(5)	(6)
Return to childcare	0.007***	-0.011	-0.017**	-0.012**	0.014**	0.003
	(0.001)	(0.008)	(0.008)	(0.006)	(0.006)	(0.004)
Return to parental play	0.001	0.016**	0.014**	0.010*	0.007	-0.001
	(0.001)	(0.007)	(0.007)	(0.006)	(0.006)	(0.004)
Return to play with friends	-0.001	-0.032**	-0.023*	-0.014	-0.003	0.016***
	(0.002)	(0.013)	(0.012)	(0.010)	(0.011)	(0.006)
Risk of childcare	-0.003***	0.002	0.015**	0.004	-0.006	0.006
	(0.001)	(0.008)	(0.007)	(0.006)	(0.005)	(0.004)
Risk of parental play	-0.001	-0.012	-0.021*	-0.004	0.001	-0.003
	(0.002)	(0.012)	(0.012)	(0.009)	(0.010)	(0.006)
Risk of play with friends	-0.000	0.011	0.012	-0.004	-0.004	-0.016***
	(0.001)	(0.013)	(0.011)	(0.009)	(0.008)	(0.005)
Mother's education: Further education	0.002	-0.382	0.265	-0.143	-0.230	0.423**
	(0.065)	(0.449)	(0.464)	(0.339)	(0.311)	(0.205)
Mother's education: Higher	-0.020	-0.252	0.007	0.051	-0.070	0.212
	(0.061)	(0.435)	(0.443)	(0.331)	(0.319)	(0.202)
Mother's education: Postgraduate	0.077	-0.446	-0.450	0.050	0.065	0.818***
	(0.070)	(0.494)	(0.488)	(0.390)	(0.369)	(0.256)
Father's education: Further education	0.094*	0.323	-0.469	1.026***	0.097	-0.331**
	(0.051)	(0.325)	(0.328)	(0.254)	(0.249)	(0.166)
Father's education: Higher	0.015	0.132	-0.296	0.822***	0.096	-0.195
	(0.049)	(0.357)	(0.346)	(0.254)	(0.233)	(0.201)
Father's education: Postgraduate	0.105	0.141	-0.482	0.832**	0.038	-0.039
	(0.065)	(0.453)	(0.442)	(0.328)	(0.299)	(0.242)
Female respondent	0.025	-0.520	0.322	-1.564***	-0.015	-0.204
	(0.045)	(0.336)	(0.317)	(0.286)	(0.216)	(0.165)
Key worker	0.124***	0.443	0.248	0.297	0.042	0.015
	(0.042)	(0.269)	(0.260)	(0.210)	(0.203)	(0.134)
Observations	548	548	547	547	548	548
Unconditional mean outcome	0.241	5.338	4.055	1.976	0.577	0.777
R^2	0.123	0.035	0.049	0.150	0.020	0.055

Notes: The dependent variables are: an indicator variable for whether the child attends formal childcare in July 2020 (column 1), the number of hours her child spent playing in the July time use diary (column 2), the number of hours the respondent reported the mother spent actively playing with her child in the July time use diary (column 3), the number of hours the respondent reported the father spent actively playing with her child in the July time use diary (column 4), the number of hours the respondent reported the child being actively involved with another child in the July time use diary (column 5), and the number of times the child was taken to the playground in a week in July 2020 (Column 6). Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.