Uneven Pathways: Three Novel Mechanisms of Intergenerational Transmission of (Dis)Advantages

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Para Pepe y Carmina

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This thesis is a reflection of the tricky balance between what we do for others and what we do for ourselves. My interest in inequality was born out of the injustices that growing up in a mining area in the north of Spain made me witness. However, during this process, I have discovered a genuine interest in research and in understanding inequality from its foundations. The rest is history. But history needs to be told, so here it goes.

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ABSTRACT

This thesis advances the understanding of the socioeconomic inequalities in children's development by examining three novel mechanisms of intergenerational transmission of (dis)advantages. These channels are founded on a dynamic understanding of the process of social reproduction. Each one is illustrated with reference to the cases of the UK or the US.

The first empirical chapter examines how parents respond to their children's early physical health problems and delves into the enduring consequences of these parental responses. Using twins fixed effects models, the findings reveal that, on average, parents exhibit negative responses when their children face early health problems, and that these responses have a lasting negative impact on the children's educational achievements. Surprisingly, the effect of health problems on parental responses does not vary across socioeconomic groups. The second study examines whether mothers adapt their level of cognitive stimulation as a response to children's developmental declines, and whether this is a socially stratified process. The results obtained from a series of two-way fixed effects and fixed effects counterfactual models indicate that, on average, mothers respond to their children's skills declines by reducing their cognitive stimulation. This pattern is especially pronounced within impoverished families or those with low educational levels. In the final empirical chapter of this thesis, attention shifts to exploring whether mothers' occupation-specific skills influence the process of development of their children. Exploiting changes in mothers' jobs during their children's upbringing, the results suggest that mothers' mathematical occupation-specific skills have a positive effect on children's mathematical ability and that high-SES children especially benefit from the skills upgrading of their mothers.

This dissertation discusses the substantive implications of each of these mechanisms and tests them empirically. It is only by disentangling the complex combination of channels through which inequality is transmitted across generations that appropriate policy responses can be elaborated.

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Chapter 1

Introduction

Before reaching school age, the gap in development between children from high and low socioeconomic backgrounds is already visible (Heckman & Carneiro, 2003). Far from disappearing, this gap grows during the children's trajectories (DiPrete & Eirich, 2006) and eventually affects their life prospects (Almond & Mazumder, 2013).

Several genetically transmitted factors as well as social structures, such as the family, the school, or the neighbourhood, are responsible for the diverging developmental trajectories between low and high socioeconomic status (SES hereafter) children (McLanahan, 2004). However, not all these factors are equally relevant to explain children's outcomes. Whereas school-level factors account for 20% of the children's achievement, individual factors and family background explain around 50% of the educational success of the students (Maloney et al., 2015).

This hints that the socioeconomic background of the family significantly impacts the lives and achievements of children (Ballarino & Bernardi, 2016; Torche, 2016). This phenomenon has been conceptualised as the intergenerational transmission of advantages and disadvantages[1]. From a normative perspective, the fact that children from different socioeconomic backgrounds systematically fare differently in life directly challenges the core principle of equality of opportunity (Roemer & Trannoy, 2015).

Besides, it is noteworthy that over the past few decades, despite the significant technological and economic growth witnessed in Western countries,

[1]Note that previous literature and this dissertation use interchangeably the terms *social reproduction* and *intergenerational transmission* to refer to this phenomenon.

the intergenerational transmission of (dis)advantages has not been substantially diminished. Using Norwegian administrative data, Wiborg and Hansen (2009) show that the impact of parental resources on children's outcomes has remained stable over time. Similarly, and echoing McLanahan (2004), Reardon (2013) shows that the income-based gap in children's performance has been, if something, increasing in the last decades.

Once the existence of the phenomenon is established (Merton, 1987), the necessary next step is finding which are the mechanisms or routes through which parents exert their influence over their children in a way that their socioeconomic status gets reproduced. This task can be understood as opening the black box of the family (Swift, 2009), and it is relevant for several reasons. Firstly, it builds upon and extends a significant line of research pioneered by Bourdieu (Bourdieu, 1993; Bourdieu & Passeron, 1990), which underscores the critical importance of scrutinizing the interactions taking place inside the family to gain insight into the mechanisms underlying social reproduction. Secondly, from an empirical standpoint, delving into the mechanisms behind social processes enhances the ability to establish causal relationships, as emphasized by Hedstrom and Ylikoski (2010). Lastly, considering the normative dimension, it is essential to recognize that each of the conduits through which intergenerational transmission occurs gives rise to distinct moral considerations (Jencks & Tach, 2005; Swift, 2009). Consequently, the policy implications associated with these different mechanisms require specific and targeted attention.

Hereby, this thesis contributes to this strand of research by uncovering three innovative mechanisms of intergenerational transmission of (dis)advantages in the UK and the US. The three chapters are complementary and autonomous research papers, each of them exploring a different channel, but with shared theoretical and methodological roots.

In the next sections of this chapter, I first assess the phenomenon under study, namely, the process of intergenerational transmission of advantages and disadvantages. Following this, I introduce the overarching research question that drives this dissertation. Thirdly, I delve into the elements involved in the process of social reproduction that have been explored in the existing literature and present the theoretical framework of this thesis. Fourth, I provide an overview of the three empirical chapters. Finally, I present some important methodological considerations for this dissertation.

1.1 Understanding the phenomenon

The literature on the primary effects[2] of social class has traditionally sustained that children from high-SES families perform better in school and attain higher levels of education at the end of their educational trajectories than low-SES children (Boudon, 1974). This suggests that there is a process of transmission of (dis)advantages from parents to their offspring that can be responsible for the diverging paths of high- and low-SES children. As a result, a classic question in sociological research has been how much

[2] I am following here the distinction by Boudon (1974) between primary and secondary effects of social origins. Whereas the former account for those inequalities that result in academic performance differences, the latter examine the differences in educational choices between high- and low-SES given a level of performance (Bukodi et al., 2021).

parental socioeconomic background influences children's development and socioeconomic trajectories.

The most intuitive way of descriptively quantifying social reproduction is by measuring how similar children and parents are. Intergenerational correlations give us an idea of how much parents and children resemble each other in a particular trait, with higher correlations suggesting more intergenerational transmission. These correlations vary depending on the outcome chosen and the specific country. Bjorklund and Jantti (2000) present a meta-analysis showing that the magnitude of the correlation revolves around a range of 0.3-0.5 in the case of income, and around 0.4-0.5 when they look at the occupational status of fathers and sons using Ganzeboom et al. (1992) International Socio-Economic Index (ISEI hereafter). For education, measured as years of schooling, Hertz et al. (2008) find that parents and children present correlations of 0.46 in the US and 0.31 in the UK case.

A second type of measure that helps to draw the picture of the intergenerational transmission of (dis)advantages is siblings' correlations. Siblings' similarity in socioeconomic outcomes has been usually understood as an *omnibus measure* of the parental impact on their children (Anger & Schnitzlein, 2017; Erola, 2012; Graetz et al., 2021). Since it captures both the observed and unobserved characteristics of the family, it has been considered a broader measure of parental influence than the intergenerational association in outcomes (Solon, 1999). Graetz et al. (2021) present the siblings' correlations for three different educational outcomes, namely cognitive skills, school grades and educational attainment across different countries and social groups. The authors find important country variation, with the United States and Germany showing the highest siblings' correlations for the final educational outcomes, and Norway and Sweden presenting the largest correlations in siblings' school grades.

Instead of employing correlational measures that produce an overall measure of inequality of opportunity, a different approach has focused on the causal effect of certain parental characteristics on children's outcomes (Bjorklund & Jantti, 2000). Since lots of different factors (such as parental income, education, school choices, or neighbourhood) intertwine with each other in determining children's lives, this literature has tried to directly measure the impact of particular parental aspects on children's outcomes. With this purpose, different causally oriented analytical strategies such as instrumental variables, adopted families, or educational reforms have been employed.

The most common finding across these studies is that parental education positively influences children's performance and achievement (Carneiro et al., 2013; Chevalier, 2004; Oreopoulos, 2006). Nonetheless, some of the studies only find a modest (Holmlund et al., 2011; Sacerdote, 2002) or a partial (Black et al., 2005; Lundborg et al., 2014) effect of parents' education. While relatively less prevalent in the sociological literature, it is noteworthy that beyond the intergenerational transmission of education, there has been research exploring how various other components of parents' socioeconomic status, including parental occupation (Gregg et al., 2005;

Parcel & Menaghan, 1994; Waldfogel et al., 2002) or income (Chevalier et al., 2013; Jenkins & Schluter, 2002; Mayer, 1997) play a role in shaping the socioeconomic outcomes of their children.

1.2 Research question and motivation

Once the importance of the phenomenon of social reproduction has been established, the logical follow-up enquiry is to understand how this process occurs. This is where the contribution of this thesis lies. The overall research question that drives this dissertation is *which are the mechanisms through which the process of intergenerational transmission of (dis)advantages occurs?* Throughout this thesis, I understand *mechanisms* as the channels through which the process of social reproduction operates. While previous research examining the primary effects of social origin has uncovered a substantive part of the complex combination of channels responsible for social reproduction, I suggest three novel mechanisms that remain unexplored in the literature and could be relevant to the understanding of intergenerational transmission of inequalities.

There are three main reasons that justify the focus of this thesis on the mechanisms behind the process of social reproduction:

Firstly, it is inspired by the advocacy of Bourdieu (1993) about the relevance of the commonest details of family life to understand the process of social reproduction. Moreover, a later strand of literature has revealed that the subtle aspects of familial dynamics can have profound implications for the perpetuation of social inequalities (Lareau & Conley, 2008). Also, from a substantive point of view, the focus on the mechanisms increases the range of potential explanans that researchers will ultimately consider to explain a phenomenon (Elster, 1989), thus necessarily fostering sociological imagination.

Secondly, there has been an increasing trend within the social sciences to offer mechanism-based explanations to understand causal processes, which is also the aim of this thesis. Hedstrom and Ylikoski (2010) state that, in the era of the causal inference revolution, making explicit a mechanism helps with the process of identification. In the words of the authors "the knowledge that there is a mechanism through which X influences Y supports the inference that X is a cause of Y. In addition, the absence of a plausible mechanism linking X to Y gives us a good reason to be suspicious of the relation being a causal one" (pg. 54).

On top of these substantive and methodological reasons to focus on the mechanisms behind the persistence of social inequality, there are normative and policy justifications too. As suggested by Swift (2009), some of the mechanisms of intergenerational transmission might be legitimate, whereas others go against the normative principle of equality of opportunity. Along these lines, only by evaluating each of these channels in an isolated way, targeted policy interventions could be effectively designed.

1.3 Elements involved in the process of intergenerational transmission

Having articulated the importance of social reproduction and the necessity to focus on the underlying mechanisms, the next step involves conducting a comprehensive review of the existing academic literature on the particular elements involved in the process of intergenerational transmission of (dis)advantages.

Although there is a plurality of elements through which socioeconomic status is transmitted from parents to children, the most common ones can be classified into three groups: parental resources, child-rearing behaviours and parental preferences. Notably, these factors do not usually operate in an isolated manner, but it is the combination of several of the elements that drive the process of social reproduction.

1.3.1 Parental resources

Parental resources can be understood as any material or non-material supply that parents have which facilitates the developmental, educational, or, in general, socioeconomic achievements of their children. The previous literature has mostly focused on six types of resources: time, economic or material investments, information, genes, networks, and skills.

Time spent with the parents is crucial because, as recent evidence from the psychological literature shows, no institution can fully replace the developmental benefits of interacting with the parents in the preschool period (0-3 years) (Fort et al., 2020). However, not all types of time investment are equally effective. Hsin (2012) differentiates between time invested in cognitively stimulating activities (such as reading, playing, or doing homework together) and the total time spent with the children. The former is expected to have an especially positive effect on children and is usually more present among high-SES families (Kalil et al., 2012).

Regarding economic investments, it is also necessary to distinguish between the general resources invested and those which could positively affect the development of the child. Good examples of the latter are investments in cultural or formative activities that help to provide a stimulating learning environment for the child (also known as *shadow education*) (Yeung et al., 2002). Furthermore, parents from higher socioeconomic backgrounds not only have more resources in absolute terms, but they also have resources which are better suited for the development of cognitive and non-cognitive skills compared to those received by children in disadvantaged families (Baier, 2019; Conger et al., 2010). Moreover, parents may combine different resources and, for instance, invest more economic resources in a high-ability child and try to compensate the less-endowed siblings with alternative human resources, such as time or parental closeness (Graetz & Torche, 2016).

Third, information plays an important role in the parents' ability to identify the children's needs in the developmental process and adapt their actions accordingly (Kalil et al., 2012). This is relevant because the boundaries between different stages of development are sometimes blurred. For instance, some children with slow-talking development know how to talk, but they have to exert more effort (Glascoe, 2000). Therefore, parents might find it challenging to assess the level of difficulty that certain activities imply for their children. Also, not all the elements comprising the maturation process are physically visible, so parents must rely on very intangible signs. These informational resources are often more present among advantaged families (Berkule-Silberman et al., 2010).

A particular type of resource that is transmitted from parents to children is genes. Genetic endowments are a good predictor of children's educational success. Although part of the effect of genes has been shown to work through parental or contextual activation (i.e., nurture) (Anger & Heineck, 2010), there is an important part of these attributes that are directly passed from parents to children (Toga & Thompson, 2005). Intergenerational transmission of genes has been shown to be especially relevant to understand children's cognitive abilities (Turkheimer et al., 2003) and children's health (Ahlburg, 1998), which are two fundamental components of the children's human capital.

Parental networks are useful channels through which children can have access to contacts, information, or even material resources. Previous literature has sometimes referred to this type of mechanism as favouritism (Ballarino & Bernardi, 2016). Most of the literature on this topic points out that the effect of networks is strictly relevant to children's entry into the labour market, but not to developmental, educational, or long-term socioeconomic outcomes (Homel et al., 1987; Kramarz & Skans, 2014; Plug et al., 2018).

Finally, the intergenerational transmission of skills has been shown to impact children's outcomes (Blanden et al., 2007; Gronqvist et al., 2010). This is true both for the cognitive (Agee & Crocker, 2002; Anger & Heineck, 2010; Hanushek et al., 2023) and the non-cognitive skills (Attanasio et al., 2020; Mayer et al., 2004), since both are highly rewarded in the educational and occupational systems. However, it has been pointed out that although the effects of both types of skills are substantively relevant, the impact of cognitive abilities is three times higher than that of non-cognitive abilities (Hsin & Xie, 2017).

1.3.2 Parental child-rearing behaviours

Parents' child-rearing behaviours are all those actions that parents implement with their offspring that affect children's life prospects. They are usually classified into three types: emotional support, cognitive stimulation and discipline behaviours. It has been found that these three factors are crucial to understanding children's home environments and explain up to half of the association between parental SES and children's cognitive abilities (Kalil, 2015).

Parental cognitive stimulation is usually understood as a group of parental behaviours or interaction patterns that improve the executive function and cognitive abilities of children (Cabrera et al., 2020). These types of behaviours are usually associated with activities such as reading to the child or encouraging the child to read, helping with educational activities, having intellectually challenging conversations at home, or bringing the child to extra-curricular activities such as music or other artistic lessons.

Parental emotional support speaks about the closeness of the parent-child relationship and the parental availability and ability to help children with their emotions. This type of support has been shown to be positively related to children's psychological and physical well-being, as well as their educational and developmental trajectories (Amato, 1994; Hubbs-Tait et al., 2002; O'Keefe & Rodgers, 2022).

Parental discipline encompasses the physical (i.e., spanking) and non-physical (i.e., time-outs) methods implemented by the parents (Ryan et al., 2016). It has been considered a maladaptive parental strategy given its negative effects on children's development (Grusec et al., 2017), and it is usually implemented by parents in situations of personal distress, being more common among low-SES families (Masarik & Conger, 2017).

1.3.3 Parental preferences

The role of parental preferences for the intergenerational transmission of (dis)advantages is rooted in the psychological literature. Some works have suggested that parents with lower educational levels have more difficulty discounting future preferences (Abufhele et al., 2017; Ardila et al., 2005). For instance, giving up leisure in the present for a far return on children's human capital might be less likely for certain groups with a series of environmental constraints. A related argument is that low-SES parents might experience fewer positive gains from interacting with their children, although there is no consensus in the literature in this respect (Kalil et al., 2012).

Close to parental preferences, a line of research inspired by the Wisconsin model of status attainment (Sewell et al., 1970) has examined the impact of parental aspirations on children's outcomes (Spera et al., 2009). As pointed out by Ballarino and Bernardi (2016), one potential concern associated with aspirations-based mechanisms is their susceptibility to align with culturalist explanations of inequality, which frequently depend on circular reasoning. These explanations often posit that low-SES families remain disadvantaged due to socialisation into specific values, which, in turn, perpetuate their economic hardship.

1.4 Theoretical framework

The traditional study of social reproduction has compared parents' and children's characteristics within the same time frame, and often assumed that parental investments are invariant despite their children's characteristics or the previous parental inputs. This could be considered a static approach to the intergenerational transmission of (dis)advantages.

However, more recent literature has suggested that social reproduction is intrinsically a dynamic process that occurs within the family, over time, and across different skills dimensions. The core theoretical bases underpinning the three mechanisms in this thesis revolve around this dynamic understanding of the intergenerational transmission of (dis)advantages, which has been partially overlooked by the previous literature.

This dynamic character plays out differently in each of the chapters.

In **Chapter 2**, I account for the possibility of children's health problems impacting later parental responses, which introduces a dynamic approach to parenting by acknowledging the existence of bidirectional influences between parents and children. This chapter also accounts for the multidimensional character of skills by exploring the cross-influences between health and education. **Chapter 3** focuses on analysing how the fluctuations over time in children's cognitive development influence the level of parental cognitive stimulation. Therefore, not only the bidirectional aspect of parenting is accounted for, but also an explicit recognition of the existence of feedback loops across time between parental inputs and children's development. **Chapter 4** exploits over-time variations in mothers' employment patterns and how newly acquired occupation-specific skills are later transmitted to the children. It highlights the multidimensional character of skills by focusing on a traditionally overlooked type of skills derived from the occupational context. Moreover, it delves into the cumulative character of skills by differentiating between skills upgrading and downgrading.

Notably, there are four strands of literature that have accounted for this dynamic character of intergenerational transmission, and on which the theoretical frame of this thesis is based. In order of importance for this dissertation, the first and most relevant branch of literature is the compensatory advantage mechanism (Bernardi, 2014). Secondly, the literature on bidirectional influence and sensitivity in parenting from the developmental psychology research (Bell, 1968; Kalil, 2015). Third, the research on dynamic complementarities, which also introduces the idea of cumulative and multidimensional skills (Cunha & Heckman, 2008; DiPrete & Eirich, 2006). Fourth, the literature on dynamic models of cultural reproduction (Bourdieu, 1990; Jaeger & Breen, 2016). I review the main elements of each of these theories and their influence on the theoretical grounds of this thesis below.

1.4.1 Compensatory advantage framework

Firstly, as described by Bernardi (2014), "[the] compensatory advantage is a general mechanism of stratification, due to which individuals from advantaged social backgrounds are buffered against the negative consequences of a prior adverse outcome" (p. 84). Following this logic, low-SES parents, by not developing protective strategies that shelter their children, will contribute to reinforcing the existing disadvantages, which will be conducive to the intergenerational transmission of disadvantages.

The compensatory advantage mechanism combines different elements from existing theories (such as relative risk aversion or effectively maintained inequality) and has been shown to be a very versatile approach to social reproduction. It can be considered an improvement from previous rationality-based theories that understand that educational inequalities are the product of parents' costs and benefits evaluations (Boudon, 1974) because it does not assume the strict rationality of the parents. This is congruent with recent sociological approaches that have questioned the rational assumption by suggesting that the costs and benefits of parental actions only become visible years after the investments have been made, and therefore, it cannot be the primary reason for high- and low-SES parents to implement different parental responses (Kalil, 2015). Thus, the theoretical frame of this dissertation is closer to the concept of subjective rationality formalised by Cunha (2015), which assumes that parents hold different levels of information that limit their choices and that not all the behaviours are conscious and the product of rational decision making.

The compensatory advantage framework also draws from the literature on the intra-family allocation of resources that suggests that to understand how inequalities are transmitted across generations it is important to analyse how the resources get distributed within the family unit (i.e., which sibling gets more of what and why). This introduces a dynamic component to the study of social reproduction that is based on how the different units within the family relate to each other. Within this literature, there have been two main findings. On the one hand, Becker and Tomes (1976) suggest that parents are mainly concerned with maximizing the total efficiency of the family, and therefore, will invest more resources in the better-endowed child. On the other hand, and distancing themselves from this efficiency paradigm, Behrman et al. (1982) point out that some parents are more concerned about the equity among their children, and thus, try to compensate for the initial differences by investing more in the child with a lower level of endowments. This literature and its focus on the internal dynamics of the family unit is especially relevant for **Chapter 2**, which analyses how differences in ability between twins affect parental responses.

A share of the compensatory literature has focused on the role of educational transitions and choices in determining social inequalities (Bernardi & Triventi, 2020; Herbaut, 2021). These studies would be closer to the secondary effects of social class than to the primary effects analysed in this thesis. However, a large part of the compensatory advantage literature has set the focus on family dynamics and, more specifically, on parental responses (Graetz & Bernardi, 2017; Graetz & Torche, 2016; Halla & Zweimuller, 2014; Restrepo, 2016; Rosales-Rueda, 2014).

The expectation held in most of the existing studies is that high-SES parents, as a response to a disadvantage experienced by their children, increase their parental investments, which would be considered a compensatory strategy. However, the flip side of this would be that low-SES parents are less able to compensate for those disadvantages, which means that the initial handicap might eventually be reinforced. **Chapters 2** and **3** of this dissertation are crucially inspired by this idea, since both examine whether high- and low-SES parents differently respond to a disadvantage experienced by their children (health problem or cognitive decline respectively) and whether these parental responses contribute to the perpetuation of socioeconomic inequalities.

The types of disadvantages that have been examined in the literature as triggering factors for parental responses are broad. Probably the most dominant one has been children's birth weight (Cozzani et al., 2021; Hsin, 2012; Restrepo, 2016). This has been understood as a net measure for initial variations of endowments since a low birth weight is usually associated with a slower process of maturation as well as a higher propensity towards health and developmental problems during childhood (Almond et al., 2005). A good example of this practice is Hsin (2012), which explores if more and less educated mothers respond differently to the low birth weight of their children. Using time diaries of siblings pairs in the United States, results show that whereas mothers with high education invest more time in the sibling with the lower birth weight, less educated mothers follow the opposite strategy. This means that mothers from lower SES could be reinforcing the pre-existing within-family differences.

Similarly, Restrepo (2016) finds that compensatory strategies are more present between highly educated mothers whereas reinforcing patterns are usually found among the low-educated ones as a response to low birth weight. This work broadens the operationalization of parental responses by including not only time but also monetary investments. Further, the author explores the magnitude of these responses: when the number of low-birth-weight siblings increases, low-educated mothers increase their investment in the child with higher birth weight. This effect, however, is not found among highly educated families. This introduces the idea of how the intensity of these parental responses could be higher at the low end of the educational distribution (Gil-Hernandez, 2019; Restrepo, 2016).

Another set of triggering factors examined has been developmental milestones as a way of capturing early variations in ability (first-time walking, sitting without support, pulling to stand, etc.). Following this approach, Graetz and Torche (2016) show that highly educated parents provide more cognitive stimulation to the higher-ability twin, whereas low-educated ones do not respond to these early differences. This result contradicts previous ones, by revealing a scenario in which high-SES parents reinforce the initial gaps in endowments instead of compensating for them. This divergence in the results could also be partially explained by the fact that the model presented by Graetz and Torche (2016) uses a twin design, whereas the previous ones only considered siblings.

A third main group of analyses explores the effect of children's genotypes as triggering factors for parental responses. Breinholt and Conley (2023), using British data on children's polygenic scores and cognitively stimulating parenting, conclude that the genetic predisposition of the children is less decisive for high-SES parents, which could be partially explained by the fact that they already invest more in the children independently of their initial conditions. However, low-SES parents reinforce the low ability of their children.

To sum up, the studies examining parental responses from the lenses of the compensatory advantage theory have found mixed evidence for the existence of reinforcing and compensatory parental responses, although with a slightly larger presence of reinforcement. This inconclusiveness in the results could be explained by the type of endowment and parental responses considered (Ayalew, 2005; Yi et al., 2015), as well as contextual factors (i.e., type of welfare state, educational system, low vs. high-income countries, etc.) (Savelyev et al., 2020).

1.4.2 Developmental psychology literature

The second pillar of this thesis is the developmental psychology literature on parenting. These studies offer a dynamic perspective of the parent-children interactions that is central to understand how the process of intergenerational transmission of inequalities plays out. Within this literature, there are two ideas that are especially relevant for this dissertation.

First, Bell and Chapman (1986) suggest that parenting is a bidirectional process, meaning that parental actions are not solely driven by their individual decisions; rather, these actions are influenced by the responses evoked by their children. This phenomenon was originally labelled as bidirectional influence and it is relevant to understand **Chapters 2** and **3** in this dissertation. This concept gave rise to the study of the transactional models of parenting. These models posit that the developmental process of children occurs through ongoing interactions with their parents (Crockenberg, 1981; Lugo-Gil & Tamis-LeMonda, 2008; Sameroff & Mackenzie, 2003).

Secondly, Kalil et al. (2012) suggest that parents tailor their child-rearing strategies to the specific developmental stage of their children to optimize the resources they invest. This idea, named sensitivity in parenting, is relevant for **Chapter 3**, which examines the possibility of low- and high-SES parents responding heterogeneously to fluctuations in their children's relative ability over time.

1.4.3 Dynamic complementarities

Cunha and Heckman (2007) suggest a model of human capital production by which early investments in child development will positively increase subsequent investments. Thus, operating under the premise that skills foster further skills, this literature underscores the critical importance of early-life investments in facilitating the cumulative and amplifying effects of skills throughout childhood and the life course. This is also connected to what DiPrete and Eirich (2006) know as the cumulative advantage mechanism, which states that those children who start their lives from a relatively favourable position will get more gains over time. A spin-off of this literature has focused on the multidimensional character of skills, suggesting that these dynamic complementarities also occur across different skills' dimensions (Kejriwal et al., 2020).

The literature on dynamic complementarities has an impact on the three empirical chapters of this dissertation. **Chapter 2** accounts for these complementarities between early skills and parental investments by focusing on variations in early human capital (i.e., the health of the kid at ages 1 to 3) as well as the long-term impact of parental actions on children's skills net of initial endowments. **Chapter 3**, although restricted to ages 5 to 15 because of data limitations, exploits relative variations in skills over time as the main source of variation and how parental investments are conditioned by these accumulation patterns. Finally, **Chapter 4** speaks to the multidimensional character of skills by incorporating occupation-specific skills and their heterogeneous effect for different educational levels into the equation. It also accounts for the cumulative character of skills by examining how these accumulate over time so that the more time the mother spends in a new job the larger the impact on children's skills.

1.4.4 Dynamic models of cultural reproduction

The overarching motivation of this thesis is to examine which are the family-level mechanisms that foster the process of intergenerational transmission of (dis)advantages. This idea is crucially linked to Bourdieu's theory of reproduction (Bourdieu & Passeron, 1990), which explains how the transmission of cultural capital from parents to children is produced. Despite the focus of this dissertation is not on cultural capital but on other types of parental assets and skills, the logic of reproduction outlined by Bourdieu has a marked influence in this thesis. The basic idea of this theory is that parents pass their cultural capital to their children thanks to a combination of norms, manners, skills, and expectations (namely, *habitus*) that individuals acquire from their family, which significantly affects their educational trajectories.

This approach has also influenced the work of Lareau (2011) and the later literature on the stratified logics of parenting (Baier, 2019), which rely on a similar idea: advantaged parents implement a logic of concerted cultivation, which is based on active parenting practices that foster the cognitive and non-cognitive development of the children. This style of parenting has been noticed to be more child-specific, which means that parents from higher SES better exploit their children's potentialities. Parents from disadvantaged backgrounds, however, usually employ strategies of natural growth, which are associated with less structured activities and more self-organisation by their children. This usually means that these children do not get to develop certain skills that will be later relevant to their educational and labour trajectories.

The influence of the dynamic models of cultural reproduction on this thesis becomes evident in **Chapter 3**. This chapter follows the same rationale that current applications of the cultural reproduction models such as Blaabaek (2021) or Jaeger and Breen (2016), since it examines how the interrelations between parental investments and children's endowments over time impact children's future outcomes. The difference, however, is that while these works focus on the transmission of cultural capital, I focus on children's cognitive endowments and parental stimulation instead.

1.5 Overview of the chapters

Each of the empirical chapters of this dissertation provides an answer to the question stated above: *which are the mechanisms through which the process of intergenerational transmission of (dis)advantages occurs?* In this section, I present an overview of each of them, which should be understood as independent but complementary research papers.

1.5.1 Chapter 2: Parental Responses to Children's Early Health Disadvantages and their Long-Lasting Effects: Evidence from a British Twin Study

The first empirical chapter of this dissertation answers three questions. First, how do parents respond to the early physical health disadvantages suffered by their children? Second, do these parental responses have a long-term effect on children's outcomes? Third, do parents from high- and low-socioeconomic backgrounds respond differently to their children's early health problems?

I examine parents' emotional and discipline-related responses. These two types of parental responses are crucial because (a) they have been noted to get triggered by children's related stressors (Barnett et al., 2003; Leerkes & Augustine, 2019); and (b) they impact the process of child development (Knafo & Plomin, 2006; Tocu, 2014; Viding et al., 2009). Parental emotional responses are conceptualized in this paper as the feelings of anger, frustration, impatience, or non-attachment that parents develop elicited by their children. Parental discipline responses are understood as a series of behaviours such as smacking, telling off, making a joke out of the children's misbehaviour, asking someone else to deal with a situation related to the children, avoiding explaining or reasoning with the children, and being lax with them.

Using data from the Twins Early Development Study (hereafter TEDS), a longitudinal database following twins in England and Wales for more than 20 years, I implement a series of within-twins fixed-effects models. I measure early health disadvantages during the first 18 months of life of the twin through the Twin Medical Risk Scale; parental responses at three different points of the childhood period (ages 3, 4, and 7), and children's educational and health outcomes at ages 16 and 21.

The findings show that parents respond negatively to their children experiencing early health problems, both by developing negative emotional responses such as frustration, anger, or impatience, but also by implementing harsher discipline behaviours. This suggests that parents reinforce existing disadvantages within the family. In the long term, these parental responses have a negative effect on the children's educational performance but do not seem to affect their health status. Surprisingly, there are no socioeconomic differences in how parents respond to early health problems, whether socioeconomic status is measured as parental education, occupation, or household income.

This paper contributes to the existing literature in four ways. First, it delves into the effect of early health problems on two previously unexplored parental responses, namely, emotional, and discipline-related behaviours. The scarce previous literature on this topic had focused mostly on parental monetary investments (Savelyev et al., 2020; Yi et al., 2015). Moreover, this paper expands previous methodological approaches to the study of parental responses employing twins' fixed effects by adding a longitudinal design with repeated measures of parental responses and long-term outcomes. This allows me to test whether these parental responses play a role in children's future lives, as well as to examine different timings for parental responses over the childhood period. Third, exploring the UK case adds to existing research exclusively focused on the US and China, where public health systems are much more limited in their scope, which might condition the effect of early health problems. Finally, this paper adds to the previous literature exploring parental responses to health disadvantages by opening the door to heterogeneous SES effects, which has been noted to be a crucial dimension to understand parental responses to other types of early child disadvantages.

1.5.2 Chapter 3: *Learning by Parenting:* How do Mothers Respond to Their Children's Developmental Declines?

Despite a child's developmental process is rarely a linear process, the literature on intergenerational transmission has overlooked how parents respond to the fluctuations in their children's skills over time. To fill this gap, this chapter examines (i) how children's developmental declines impact the level of cognitive stimulation implemented by their mothers, and (ii) whether this effect varies by the socioeconomic status of the family. I expect parents to respond to declines in their children's abilities by increasing their cognitive stimulation, especially in the case of high-SES parents. The intuition behind this is that the moments when the child's development is more stagnant are precisely when a parental boost is needed the most, and parents from more privileged backgrounds are especially aware of this. This chapter aims to generate a dialogue between the developmental psychology literature exploring which parental practices are more beneficial for the child's developmental process and the compensation literature focused on whether parents from different socioeconomic backgrounds respond heterogeneously to their children's disadvantages.

These questions are answered using data from the National Longitudinal Survey 1979-Children and Young Adults Supplement (NLSY79-CYA), which provides information about mothers and each of their children (aged 5 to 15 years old) in the US from 1986 to 2018. I implement a series of two-way fixed effects models (TWFE) and fixed effects counterfactual models (FEct). I test whether the declines in child development during the previous periods affect subsequent maternal cognitive stimulation and whether these effects vary by the socioeconomic background of the family. Declines in children's developmental processes are measured as the negative changes in their mathematical and reading skills from time *t-1* to time *t*. Maternal cognitive stimulation is measured through the child-specific HOME-SF inventory on its cognitive dimension.

The findings show a partially surprising scenario. First, on average, mothers reduce their cognitive engagement when their children exhibit diminishing mathematical abilities. Second, this pattern is especially pronounced among mothers with non-tertiary education and those situated at the lower end of the income spectrum. These results suggest that this mechanism might play a significant role in explaining the developmental disparity between children from high- and low-SES. Nonetheless, mothers do not seem to respond to declines in their children's reading skills.

This chapter brings noteworthy contributions to the existing literature. First, it delves into the dynamic aspect of child development, showing that parents are not only sensitive to the total level of skills of their children but also respond to fluctuations that take place during the process of child development by modifying their parental actions accordingly. Second, it adds to the existing literature on compensatory and reinforcing parental effects by examining whether mothers from different socioeconomic backgrounds exhibit heterogeneous responses to their children's developmental declines. This adds depth to our understanding of how parental responses intersect with socioeconomic contexts. Lastly, the paper engages in the discussion of the potential merits and drawbacks of employing two-way fixed effects models in the analysis of dynamic social processes and recommends the exploration of novel models such as the fixed effects counterfactuals, which have largely been overlooked in the sociological literature thus far.

1.5.3 Chapter 4: *Skills Beget Skills:* Addressing the Role of Mothers' Occupation-Specific Skills on Children's Developmental Process

The last empirical chapter of this dissertation investigates how mothers' occupation-specific skills impact their children's development. While a substantial body of literature on human capital formation has concentrated on the influence of parental education on child development (Anger & Heineck, 2010; Guryan et al., 2008; Rowe et al., 2016), the role of parental occupation in nurturing children's skills has largely remained under-explored.

Mothers' occupations can be relevant for children's development for two reasons. Firstly, mothers continue to be the primary caregiving agents and hold significant responsibility for children's developmental outcomes (Huston & Rosenkrantz Aronson, 2005). Secondly, with the considerable growth of women's engagement in the labour market over the past decades, mothers' occupations now assume a pivotal role in their lives, subsequently influencing household dynamics (Ruhm, 2004).

Occupation-specific skills encompass the competencies acquired by workers through effective on-the-job learning. These skills have been observed to shape labour market trajectories and outcomes (Kwon & Meyersson Milgrom, 2014; Lagoa & Suleman, 2016), along with influencing preferences and attitudes in the realm of politics (Emmenegger, 2009; Ortega & Polavieja, 2012). Therefore, following Jonsson et al. (2009) and Barg and Klein (2023), and recognizing the pivotal role that occupation-specific skills play within individuals' skill sets, I suggest that they might also wield significant influence in the intergenerational transmission of skills.

I integrate data from the US National Longitudinal Survey and the Children's Supplement with the O*NET dataset. The former tracks mothers and their children over multiple decades, providing valuable insights into mothers' occupational histories (with biennial observations) and evaluating children's skills across various dimensions. The O*NET dataset provides information on the specific skill levels required for different jobs. I quantify mothers' occupation-specific skills through two indices capturing (i) mathematical skills and (ii) literacy skills. Children's skills are assessed using the age-specific Peabody Individual Achievement tests, conducted by external evaluators across the same two dimensions: mathematical and literacy. The sampled children are aged between 5 and 15 years.

The analytical strategy of this study leverages changes in mothers' occupational trajectories that lead to fluctuations in the required level of occupation-specific skills. Thus, I estimate the impact of variations in mothers' occupation-specific skills at time *t-1* on their children's skills at time t. This entails employing a series of two-way fixed effects models coupled with inverse probability weighting, alongside asymmetric fixed effects models.

The primary finding of this study underscores that an increase in maternal occupation-specific mathematical skills at time *t-1* has a positive effect on the mathematical skills of her child at time t, with an effect size approximately equivalent to one-ninth of a standard deviation. These results are robust, even upon incorporation of inverse probability weighting techniques. However, concerning literacy skills, the results exhibit a less consistent trend, with significant positive effects appearing in certain models but diminishing upon accounting for potential selection via inverse weighting.

Furthermore, the results also provide insights into the potential mechanism underlying this effect. Firstly, the positive influence of mothers' skill improvements becomes more pronounced with the number of years mothers are in their jobs. Secondly, skill transmission occurs in a dimension-specific manner, implying that increases in mothers' mathematical skills do not affect their children's literacy abilities, but exclusively impact their mathematical ones (and vice versa). Lastly, through the application of asymmetric two-way fixed effects models, I disentangle the direction of the primary causal effect. Further analyses show that high-SES children obtain higher returns from these variations in their mothers' occupation-specific skills than low-SES ones.

This study makes four pivotal contributions to the existing literature. Firstly, it is, to the best of my knowledge, the first empirical approach to whether variations in maternal occupation-specific skills influence the offspring's skills formation. While prior works have tackled this issue theoretically (Jonsson et al., 2009) and in an associational manner (Barg & Klein, 2023), this study provides the first empirical test of the effect. Secondly, by using the asymmetric causal models, this chapter manages to differentiate between the effect of skills upgrading and downgrading. Third, it investigates the stratified nature of intergenerational transmission of occupation-specific skills, which has significant implications for understanding the process of social reproduction. Lastly, this paper explores the US case, which has been previously overlooked despite the rich available data.

1.6 Methodological considerations

The empirical approach of this dissertation is congruent with the core theoretical bases outlined in the previous sections. First, this thesis focuses on examining the mechanisms behind the process of intergenerational transmission of (dis)advantages. As pointed out by Hedstrom and Ylikoski (2010), to produce mechanism-based explanations is to understand causal processes. Therefore, the three chapters of this thesis are aimed at identifying causal effects. Second, given the dynamic character of the processes that these papers aim to examine, the empirical strategies used in this dissertation are designed to exploit different sources of dynamism within the family (i.e., twin fixed-effects) or across time (two-way fixed-effects, fixed-effects counterfactual models, etc.).

The identification of causal effects (and especially, in dynamic contexts) is usually subject to some common problems and biases, that the analytical strategies used in this dissertation aim to tackle. Below, I address several recurring issues encountered throughout the chapters and elucidate the strategies I've employed to mitigate them:

First, there is an issue of potential **omitted variable bias** derived from the fact that many unobserved factors are shared by the parents and the children within a household unit. Observational data, however, is limited in its scope and does not offer a complete depiction of all these aspects. In **Chapter 2**, I account for unobserved family heterogeneity by exploiting within-twins variation. I also control for several characteristics that vary between the twins and could be influencing parental responses to children's health problems, such as the gender or the early cognitive ability of the child. In **Chapters 3** and **4**, I use individual and time-fixed effects models (i.e., two-way fixed effects, TWFE hereafter) to account for the sources of individual and time-specific heterogeneity that could lead to an issue of omitted variable bias. On top of this, in **Chapter 4**, given that I am exploiting changes in mothers' occupations, there is an extra risk of omitted variable biases, since several other factors can change with a new job that could be responsible for the increase in children's skills. To account for this possibility, I include controls for time-varying children's characteristics, family-related characteristics, and job characteristics.

Second, there are potential issues of **reverse causality** when we consider the relationship between parental responses and children's characteristics. This gets quite visible if we think that the child disadvantage that triggers a parental response can be a product of a previous in-time parental action. The most intuitive way of accounting for this in the three papers is by including a time dimension. In **Chapter 2**, the main predictor is children's health problems measured during the first 18 months of life. The outcome variables, parental emotional and discipline responses, are measured at three different time points: ages 3, 4, and 7. This necessarily implies that the health problem was in place before the parental responses occurred.

In **Chapter 3**, I exploit changes in children's abilities two years before measuring parental responses and I run a test for parallel trends that shows that the previous behaviours of those mothers whose children show developmental declines and those who experienced developmental increases were similar. However, this does not directly discard the possibility of reverse causality. Thus, I also implement a dynamic panel data model that includes lagged values of the main outcome variable, so the main effect is compared among individuals with the same baseline levels. These models have been shown to produce consistent estimates in the presence of reverse causality (Arellano & Bond, 1991; Bond, 2002).

Chapter 4 is also challenging in terms of reverse causality since mothers might have changed their jobs as a response to certain children's characteristics such as low skills. The analytical strategy of the paper addresses this in five ways: (i) taking into account the temporal order between the treatment and the outcome and leaving a two years gap between both; (ii) using asymmetric models that differentiate between skills downgrading (more likely to be the product of children's characteristics) and skills upgrading; (iii) controlling for alternative pathways that could have made parents change their work arrangements as a response to variations in children's development; (iv) including controls of observed parental working arrangements such as working hours, and (v) running robustness analyses to directly test the impact of children's skills, health limitations, learning disabilities or behavioural problems at time *t-1* on the likelihood of a mother changing her job at time *t*.

Third, **selection** might also play a role in this dissertation. Regarding **Chapter 2**, it is possible that health problems do not randomly occur across families. This would mean that there are unobservable characteristics that affect parental responses and children's health, such as housing conditions, neighbourhood etc. A different scenario would be that parents who have had an ill child make fertility decisions based on this. In this case, it would be a matter of selection on observables. To overcome both types of selection, I exploit within-family variation, i.e., scenarios in which only one twin experiences the health condition so that all the unobserved characteristics of the family are accounted for, and since twins share the same birth date, I also make sure that fertility decisions are not affected by previous events.

In **Chapter 4**, the risk of selection comes from the possibility of mothers who already present more skills (i.e., who are highly educated), being also more likely to select themselves into changing occupations. In this case, the selection would be on unobservables and would upwardly bias the estimates. What I do to address this is using inverse probability weighting techniques. I follow Breinholt and Holm (2020) to obtain cross-sectional weights and, I also compute different types of weights based on time-varying characteristics, such as household income, job quality, or working hours of the mother and her partner.

A fourth type of bias that is often found in the literature on the intergenerational transmission of inequalities is **measurement error**. It is a specific subtype of **reporting bias**, and it is common when parents are the main providers of information about their own parental responses or their children's conditions. For instance, in **Chapter 2**, if some parents are more likely to report health problems than others, this would upwardly bias the results. However, the use of within-twins estimators should be reassuring since I am looking at the reports made by the same parents for each of their children. It would be still possible for parents to show some reporting bias with specific responses (i.e., only when the child is ill). In this case, the within-family comparison would not overcome the problem. However, that is why I use objective measures of health such as birth weight, days stayed in the hospital, or time spent in special care, which reduces the room for parents to incorporate their own biases into their children's health assessments.

In **Chapter 3**, the reporting bias problem has to do more with the fact that the main outcome of interest is parental cognitive stimulation, which would easily get misjudged by the parents. Nevertheless, what the NLS data providers do is combine information reported by the parents and the interviewer, which increases the reliability of the index they construct. In general, in the three chapters, I use high-quality national-representative data, which has been recurrently used in previous research and is based on strong psychological bases. Moreover, in all the databases used, the respondents are surveyed close in time to the moment in which the specific parental responses or child's condition is taking place, which prevents **recalling bias**, another common cause of measurement error.

A consequence of measurement errors, especially in the within-family analytical strategies (such as **Chapter 2**), is that it can generate **attenuation bias**, which would bias the estimates towards zero (Griliches, 1979). However, in the TEDS data I used in **Chapter 2**, parents are explicitly asked about the differences between the siblings, which significantly reduces the probability of underestimating the twins' differences. Moreover, the fact that the models produce statistically significant estimates suggests that there is not a problem of attenuation bias in the chapter.

The **dynamic character of the treatment** is especially daunting in **Chapter**

3, which exploits variations in the relative cognitive ability of the children over time. This issue has been usually omitted in the sociological literature exploring children's developmental processes which has mostly employed TWFE models. However, as I argue in detail in that chapter, the TWFE estimator requires that the treatment effect is constant over time. However, the treatment I am considering, experiencing developmental declines, has a staggered nature, since not all the treated children in the analytical sample experience the decline at the same time. Moreover, some of the children switch between being treated and untreated several times across the period studied (i.e., withdrawals are possible). To account for these complex dynamic patterns of treatment, I use the fixed effects counterfactual estimators developed by Liu et al. (2022), which are based on taking the observations under treatment as missing and using those under the control condition to get counterfactuals of treated observations.

Finally, this thesis also delves into the idea of **asymmetric causal effects** (Lieberson, 1985). In **Chapter 4**, I suggest that the effect of the predictor (changes in mothers' occupation-specific skills) might have a different effect on the outcome (children's skills) when I differentiate between increases or decreases in skills. Theoretically, I sustain that once mothers attain a certain skills level, the likelihood of skills loss is minimal, especially given their cumulative character (Cunha & Heckman, 2007; DiPrete & Eirich, 2006). Consequently, I expect that the overall impact of changes in occupation-specific skills on children's development is more likely to stem from skills increases rather than declines. To investigate this hypothesis, I employ a series of asymmetric two-way fixed effects models (ASYM-TWFE) developed by Allison (2019).

To sum up, the three studies of this thesis seek to uncover three theoretically relevant mechanisms of intergenerational transmission of advantages and disadvantages. To achieve this goal, I employ a combination of traditional analytical approaches such as within-family fixed effects or two-way fixed effects models, alongside more innovative methods like fixed effects counterfactuals or asymmetric fixed effects models. The overall methodological purpose of these empirical chapters is to make the most of the rich household panel datasets available in the US and the UK while exploring cutting-edge methods that have the potential to enhance the field of social stratification research.

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Chapter 2

Parental Responses to Children's Early Health Disadvantages and their Long-Lasting Effects: Evidence from a British Twin Study

Abstract

Health problems encountered during the early years of life can have enduring consequences throughout the entire lifespan. Nevertheless, the way parents respond to these problems can notably influence their children's future prospects. This paper examines three questions. First, how do parents respond to the early physical health disadvantages suffered by their children? Second, do these parental responses have an effect on children's later-in-life outcomes? And finally, do parents from high- and low-socioeconomic backgrounds respond differently to their children's early health problems? Using longitudinal data from the Twins Early Development Study (TEDS), I implement a series of within-twin fixed-effects models and find that, on average, parents develop more negative emotional responses and implement harsher discipline behaviours when their children experience an early health disadvantage. Moreover, these parental responses have a long-term negative effect on the educational outcomes of these children, although they do not affect their later-in-life subjective health. Surprisingly, the effect of health problems on parental responses does not differ by the socioeconomic status of the family. With some nuances, this evidence suggests that parental responses reinforce early-in-life health problems.

2.1 Introduction

The consequences of a health problem experienced in early life may in many instances extend into adulthood. This is why both the short-run (Currie, 2009) as well as the long-term effects (Smith, 2009) of early health problems have been extensively explored. This relationship between early health disadvantages and later-in-life outcomes operates through two channels (Yi et al., 2015). First, through a direct or biological pathway whereby health problems experienced in the first years of life might persist until later ages and increase the likelihood of developing other conditions. Second, studies reveal an indirect channel by which the effect of children's early human capital on later outcomes may be influenced by how parents respond to these early disadvantages (Currie & Almond, 2011).

In this paper, I focus on this indirect pathway and examine how parents respond to the early health problems suffered by their children. Although there is a growing literature exploring the formation and impact of parental responses on their children's lives, it is still unclear the specific role that parents play when the disadvantage in question is health-related (Rosales-Rueda, 2014; Yi et al., 2015). This study aims to fill this gap by shedding light on the determinants and consequences of parental responses to early health physical problems in England and Wales.

This paper is organised around three independent but related questions. First, I study *how parents respond to the early health disadvantages suffered by their children*. Second, to assess the long-term relevance of these parental responses on children's lives, I examine *whether these parental responses have a long-term effect on children's human capital net of initial health problems*. Finally, following the existing evidence showing that more socioeconomically advantaged parents are more likely to compensate for early problems suffered by their children (Hsin, 2012; Restrepo, 2016; Torche, 2018), I study *whether parents from high- and low-socioeconomic backgrounds respond differently to their children's early health problems*.

Using data from the Twins Early Development Study (hereafter TEDS), a longitudinal database following twins in England and Wales for more than 20 years, I implement a series of within-twins fixed-effects models. This allows me to measure the effect that early physical health problems have on parental emotional and discipline responses, as well as the impact of these parental responses on the later outcomes of the children. I measure early health disadvantages during the first 18 months of life of the twin through the Twin Medical Risk Scale; parental responses at three different points of the childhood period (ages 3, 4, and 7); children's educational and health outcomes at ages 16 and 21; and the moderator, parental SES, through a dichotomous measure of parental education.

The findings show that parents respond negatively to their children experiencing early health problems, both by developing negative emotional responses and by implementing harsher discipline behaviours. This suggests that parents reinforce existing disadvantages within the family. In the long term, these parental responses have a negative effect on the children's educational performance but do not seem to affect their subjective health status. Surprisingly, there are no socioeconomic differences in how parents respond to early health problems, whether socioeconomic status is measured as parental education, such as in the main analyses, or as occupation or household income as in the robustness section.

This paper adds to the existing literature in several ways. First, it makes a substantive contribution by delving into the effect of early health problems on two previously unexplored parental responses, namely, emotional, and discipline-related behaviours. While previous literature has focused on monetary investments (Savelyev et al., 2020; Yi et al., 2015), I examine parents' emotional and discipline-related responses. These two types of parental strategies have been noted to be a good proxy of the parent-child relationship, as well as crucial influences in the process of child development (Knafo & Plomin, 2006; Tocu, 2014; Viding et al., 2009). Second, this paper expands previous methodological approaches to the study of parental responses employing twins' fixed effects by adding a longitudinal design with repeated measures of parental responses and long-term outcomes. Third, by exploring the UK case, this paper adds to the existing research exclusively focused on the US and China, where public health systems are much more limited in their scope, which might condition the effect of early health problems. Finally, this paper contributes to the previous literature exploring parental responses to health disadvantages by opening the door to heterogeneous SES effects, which has been noted to be a crucial dimension to understand parental responses to other types of early child disadvantages.

2.2 Theoretical background

2.2.1 Parental responses to early disadvantages

Early health problems have a long-lasting impact on children's cognitive development, later health, or educational attainment (Currie & Almond, 2011). As Yi et al. (2015) acknowledged, early health problems do not only operate through a direct biological channel but also through an indirect pathway in which parental responses play an important role. Therefore, how parents respond to these health disadvantages can be crucial to mitigating or amplifying the effect of these early problems on later outcomes.

The idea of parents responding to their children's disadvantages is directly linked to the literature on developmental psychology that proposes that parenting constitutes a bidirectional process, indicating that parental behaviours are not solely dictated by individual decisions. Instead, these behaviours are shaped by the responses elicited from their children (Bell & Chapman, 1986). This phenomenon, initially termed bidirectional influence, laid the foundation for the exploration of transactional models in parenting. These models assert that children's developmental processes unfold through continuous interactions with their parents (Crockenberg, 1981; Lugo-Gil & Tamis-LeMonda, 2008; Sameroff & Mackenzie, 2003)

Previous literature exploring parental responses to children's endowments (i.e., cognitive skills, developmental milestones, or birth weight) has found mixed evidence of the existence of reinforcing and compensatory responses. A reinforcing response means that parents (consciously or unconsciously) reduce their investments in their children when they show some developmental problems, which eventually reinforces the original difficulty (Almond & Mazumder, 2013; Datar et al., 2010; Frijters et al., 2013; Garcia-Hombrados & Masset, 2022). In the case of compensatory responses, parents increase the investments in the aggrieved child, in an attempt to compensate for that initial handicap (Bharadwaj et al., 2017; Fan & Porter, 2020; Halla & Zweimuller, 2014; Restrepo, 2016; Sanz-de-Galdeano & Terskaya, 2019). The ambiguity in these results can be explained by the type of endowment (i.e., cognitive vs. non-cognitive skills) and parental response considered (i.e., monetary investments or emotional support) (Ayalew, 2005; Yi et al., 2015), the socioeconomic status of the family (Graetz & Torche, 2016; Restrepo, 2016) or the type of population explored (i.e., low- vs. high-income countries) (Savelyev et al., 2020).

When considering parental responses to health problems, which is an essential dimension of human capital, the previous results show three possible scenarios: reinforcement, compensation, or mixed results. Among those detecting evidence of reinforcing parental responses, Ayalew (2005) suggests that parents, on average, invest fewer resources in their children when they experience a health problem. According to the author, there are two reasons for parents to do so. First, it might be that parents put more resources into their children when they believe they are more likely to have large human capital returns. That is usually the argument that justifies parental heterogeneous human capital investments in male and female children (Kornrich & Furstenberg, 2013). In this case, it could be understood as the larger expected returns that a healthy child would bring to their parents. Second, it can be that parents vary their human capital investments between healthy and sick children because of the differential costs of the investments. For instance, guaranteeing education for a healthy child is less costly than doing it for a sick child who requires some special assistance.

Contrary to that first group, three studies find evidence of compensatory parental responses to health disadvantages. First, Savelyev et al. (2020) show that, among a sample of US twins, health problems are compensated for by the parents, who increase their educational investments. Second, Terskaya (2019) presents evidence of compensatory effects for parents with children suffering from congenital disabilities in Mexico. It is important to notice, though, that the outcome in Terskaya's paper does not directly capture parental responses but the final years of schooling of the children. Third, Bharadwaj et al. (2017) also find that parents compensate for initial health disadvantages between siblings, but they do not do so between twins.

Finally, a third group of studies finds mixed evidence of compensatory and reinforcing parental responses. Rosales-Rueda (2014), using US data, does not find differences in the parental responses when the children suffer a physical health problem. However, the author finds evidence of reinforcing parental behaviour when children experience mental health problems. Yi et al. (2015) use Chinese data and a twins' design and show that the sick twin receives more health investments but fewer educational resources than the healthier twin. A potential explanation for this is that health inputs are often related to questions of survival, especially in deprived contexts. However, in the case of educational resources the counterfactual of not receiving those inputs is not that decisive for children's lives.

The vast majority of these studies come from the field of health economics and present two common limitations. First, they examine an essentially economic outcome, namely parental monetary investments as the main form of parental responses (Savelyev et al., 2020; Yi et al., 2015). However, from the broader sociological literature, it is well-known that parental responses can take multiple forms such as cognitive stimulating behaviours (Price & Kalil, 2019), parent-children quality interactions (Graetz & Torche, 2016), or parental closeness (Kalil et al., 2012), all of them very relevant to explain children's development and life trajectories (Bornstein et al., 2018; Schiffrin & Liss, 2017; Smeeding et al., 2011).

The second limitation of these studies is that they usually work under the assumption that parenting is a rational process, and that parents will base their investment decisions on the costs and benefits (Becker & Tomes, 1976). Recent sociological approaches such as Kalil (2015) question this paradigm and suggest that parents cannot fully decide their parenting based on costs and benefits because these are only visible years after the investments have been made.

In this paper, I focus on the effect of early health disadvantages on parental emotional responses and discipline-related behaviours, which differ in their nature from monetary investments, and which have been noted in the sociological and psychological theory to be crucial elements of the parent-child interaction dynamics (Glover et al., 2010; Larsson et al., 2008; Mackenbach et al., 2014).

2.2.2 Parental negative emotional responses

As defined by Leerkes and Augustine (2019), "parenting is an inherently emotional task" (p.620). That is why, children's characteristics and behaviours might elicit certain feelings among their parents that are conceptualised as parental emotions. In this paper, I focus particularly on negative emotional responses, such as experiencing anger, frustration, impatience, or non-attachment.

Several children's characteristics have been shown in the literature to trigger negative parental emotional responses. Mullineaux et al. (2009) show that parents exhibit more negative emotions during middle childhood when the child has experienced more conduct problems in the early years of life. Also, Stewart et al. (2017) prove that child developmental disorders produce negative emotions and stress in their parents.

As suggested by Leerkes and Augustine (2019), the process by which these negative emotional responses are produced follows some steps. First, a stressor associated with the child emerges. Second, parental empathy is activated through a complex neurobiological process. Third, this triggers the emergence of negative emotions such as anger or frustration. Fourth, in some cases, parents can regulate these emotions to adapt them to the children's situations, although this will depend on the parental-specific abilities.

According to the existing research, one of the most important children-related stressors found is children's health. As pointed out by Barnett et al. (2003) it is well known that children's medical problems foster "unique emotional and physical demands that stress and strain parents" (p. 185). Those parents whose children go through an illness deal with high levels of uncertainty, frequent medical visits, and a caring workload. This all has an impact on parents' mental health, being responsible for high levels of stress (Teti et al., 1996).

Since, especially stress, is highly associated with negative emotions, children's health problems might activate parental negative emotional responses (Leerkes & Augustine, 2019). Therefore, the first hypothesis of this paper suggests that (**hypothesis 1a**) *parents will develop negative emotional responses when their children experience early health problems.*

2.2.3 Parental negative discipline responses

Parental discipline strategies are also considered a central component of the socioemotional interactions that parents and children hold (Laskey & Cartwright-Hatton, 2009). The term parental discipline usually encompasses two different types of behaviours: (i) a corporal one which includes physical punishment like spanking that causes pain for the children; and (ii) a non-physical one which usually includes "time-outs" or penalising the child in different ways (Ryan et al., 2016).

Although there have been attempts to reframe the concept towards a more positive or effective understanding of the term, the most common terminology (and the one used here) still refers to maladaptive parental discipline (Grusec et al., 2017). The conceptualisation used in this paper encompasses the following behaviours: smacking, telling off, making a joke out of the children's misbehaviour, asking someone else to deal with a situation with the child, avoiding explaining or reasoning with the children, and being lax with them.

Among the determinants for parental discipline, some studies point out the relevance of children's misconduct or noncompliance, personal distress (Masarik & Conger, 2017), or family problems (Rodriguez, 2016). Therefore, health problems might work as a stressor that increases parental irritability, which is a key predictor of harsh disciplined parenting (Greenwald et al., 1997). Moreover, negative emotions, when not appropriately regulated (Lunkenheimer et al., 2023), also foster harsher parental discipline (Lorber, 2012), so this could also be an indirect channel through which children's health impacts parental harsh discipline behaviour.

Therefore, I suggest that (**hypothesis 1b**) *parents will respond to the early health problems of their children by implementing harsh discipline behaviours.*

2.2.4 Long-term effects

Taking a life-course perspective, the challenges faced in early childhood will accumulate and eventually lead to additional adverse outcomes in children's adult lives (DiPrete & Eirich, 2006). On top of this, parental emotional and discipline responses might deepen this negative impact on children's later-in-life outcomes.

Negative parental emotional responses can affect child outcomes in two ways. First, through a direct pathway, the exposure of the children to the negative emotional states of the parents affects the process of child development and eventually children's outcomes (Kurtz-Nelson & McIntyre, 2017). Leerkes and Augustine (2019) claim that the process through which this occurs "is complex and involves cognition, physiology, and neurology" (p. 623). For instance, Glover et al. (2010) show that parents' negative emotional responses positively correlate with children internalising and externalising behaviours during the early teenage period. Not only are these emotional responses associated with behavioural problems, but also with learning abilities and the cognitive developmental process of the children (Park et al., 2005).

The second way in which parental emotional responses affect child outcomes is through their impact on parental behaviours. Dix (1991) describes the process through which emotional responses regulate parental behaviour in the following terms: once parental emotional responses are activated (first step), they work as a motivator of goal-directed behaviour (second step). For instance, parental joy fosters affection and praise, and parental anger usually promotes the use of discipline behaviours, which eventually impacts children's outcomes (Del Vecchio et al., 2016).

Following this, I suggest that (**hypothesis 2a**) *parental negative emotional responses during the childhood period will negatively influence the long-term ed-*

ucational and health outcomes of their children, net of early health problems.

In the long term, punitive parental discipline impacts the sense of autonomy of the child (Mackenbach et al., 2014), as well as the security and availability of parental support (Laskey & Cartwright-Hatton, 2009). This lack of parental support has been shown to impact children's self-esteem and educational performance in the long term (Wong, 2008). Pasternak (2012) also shows that punishment and parental discipline have a negative effect on academic achievement.

Consequently, I suggest that (**hypothesis 2b**) *parental discipline responses during the childhood period will negatively influence the long-term educational and health outcomes of their children, net of early health problems.*

2.2.5 Heterogeneous SES responses

The compensatory advantage literature (Bernardi, 2014; Bernardi & Graetz, 2015; Erola & Kilpi-Jakonen, 2017) has suggested that exploring the average parental responses to children's disadvantages might camouflage inequalities across families from different socioeconomic positions. For instance, high-SES parents are more likely to compensate with their actions and resources for the negative events experienced by their children than low-SES parents (Torche, 2018). Therefore, children from socioeconomically advantaged contexts are less dependent on prior negative outcomes, as compared to those from disadvantaged family contexts (Restrepo, 2016).

Yet, it remains mostly unknown whether this is the case for parental responses to early health problems. There are several specific reasons to think that parental socioeconomic background might condition parental responses to children's health problems.

First, Cunha (2015) shows that high-SES parents are more likely to have health-related knowledge, as well as have more resources to pay for private health care, which implies that they are more in contact with professionals and are more likely to receive anticipatory guidance from healthcare institutions. However, low-SES parents are more prone to turn to their extended family or community networks to ask for health advice, which usually implies less updated and rigorous information flows (Berkule-Silberman et al., 2010). This is important because holding more accurate knowledge about child development has been linked to more realistic expectations, less frustration and anger, and in general less negative emotional responses and harsh discipline behaviours (Leerkes & Augustine, 2019).

Second, applying the overall logic of the family stress model paradigm (Masarik & Conger, 2017), it is also reasonable to expect higher levels of susceptibility to health problems in low-SES contexts. In these environments, parental self-efficacy is usually lower (Whitbeck et al., 1997), which also increases the likelihood of experiencing irritability, and triggers negative parental emotional responses (Ryan et al., 2016), and particularly, harsh discipline behaviours (Conger et al., 2010).

Following all this, I expect that **(hypothesis 3a)** *low-SES parents will develop more negative emotional responses* and **(hypothesis 3b)** *implement harsher discipline behaviours as a response to early health problems than high-SES parents.*

2.3 Data and methods

2.3.1 Data

The data used for this paper comes from the Twin Early Development Study (TEDS), a longitudinal data collection that follows more than 10,000 pairs of twins born in England and Wales between 1994 and 1996 during their childhood, adolescence, and early adulthood (Rimfeld et al., 2019). Information on twins' health, parental responses, and long-term outcomes is available across six waves from age 1 to age 21[3]

There are three main advantages of this dataset. First, the longitudinal character of the data allows me to capture the health status of the children at a very early age, as well as the parental responses several times during the childhood period up until early adulthood. Secondly, it follows an extended twin family structure, meaning that it contains individual information about each of the two twins and their parents. Finally, the variables presented in the data combine self-reported measures (provided by the twins themselves) with parental reports, which increases their reliability.

[3]The TEDS families were originally identified through the Office of National Statistics. Of the 30,350 multiple births in England and Wales between 1994 and 1996, 18,810 expressed interest in taking part (Lockhart et al., 2023). Regarding the representativeness of the TEDS study participants, 91.7% of the twins contacted in the first wave were white, 50.1% were female, and 43.1% had employed mothers. These numbers go in line with the total UK population: according to the 2001 census, 91.3% of the British population was white, 51% were female, and around 40% of the mothers with very young children (such as those in the TEDS sample) were employed. These percentages have varied slightly across time, with 93.5% of white participants at age 16, 55.3% of female twins and 47.2% of employed mothers. A detailed discussion of representativeness can be found here: `https://www.teds.ac.uk/datadictionary/studies/representativeness.htm`.

Individual twins nested in families are the main units of observation. The sample size varies across waves, with *25,801* twins with health records at age 1, *11,595* individuals with parental responses information at age 3, *15,295* at age 4, and *14,745* at age 7. Later-in-life outcomes are measured at ages 16 and 21, with information for *6,905* and *4,992* individuals respectively on education and health outcomes. Explorations of attrition patterns show that the experience of health problems during childhood does not predict the likelihood of a family unit leaving the sample. In a similar way, the twin pairs who experienced more negative emotional or discipline parental responses during their childhood are not especially likely to abandon the TEDS sample in their adolescence.

Moreover, it is important to understand this study in the context of the UK, where the National Health System (NHS) offers a comprehensive service to the citizens, and therefore, it might be easier for parents to detect early health problems than in other contexts without universal health care.

2.3.2 Variables

The independent variable of this study is the Twin Medical Risk Factors Scale, a twin-specific health composite index measured during the first 18 months of life of the twin, originally developed by Pike et al. (2006), and later introduced as part of the core TEDS derived variables. This variable aims to capture the underlying health status of the twins by including four factors that increase the vulnerability of the children during their first years of life: (i) days in special care, (ii) medical problems at birth, (iii) low birth weight, and (iv) days in the hospital after birth.

The first item contributing to the composite, days in special care, captures the total number of days that the child has spent in the neonatal care area as well as the paediatric special care units during the first year and a half of life, with a minimum of 0 days and a maximum of 100 days. The second item is a binary indicator that measures whether the twin has experienced medical problems at birth. The low-birth-weight variable (reversed) measures the weight of the twin at birth in grams, ranging from 400 to 4500. Finally, the days in hospital variable measures the days the twin stayed in the hospital after birth, with a minimum value of 0 days and a maximum of 60. The four items were originally selected through a process of exploratory factor analysis[4] and the level of internal consistency is 0.87 (Cronbach Alpha)[5].

The process of construction of the variable by the TEDS data centre[6] is the following: (i) twins with unknown zygosity or gender information, as well as those who experienced very severe perinatal problems are excluded, (ii) the four items contributing to the twin medical risk scale are standardised and outliers are removed, (iii) the standardised version of the four variables are summed, and (iv) the final composite for each twin is standardised

[4]The single-factor solution presented an eigenvalue of 2.62 and accounted for 65.67% and 65.68% of the variance for the first and second-born twins respectively (Pike et al., 2006).

[5]It is also reassuring that the TEDS 1st Contact Questionnaire includes a Medical Records Consent Form that allows the TEDS data managers to double-check with the hospital and consultant's records the medical information.

[6]Detailed in the TEDS data dictionary section: `https://www.teds.ac.uk/datadictionary/studies/derived_variables/1c_derived_variables.htm#atwmed`. Note that the TEDS data provider oversees the construction of this variable following the steps that I reproduce here.

obtaining a scale ranging from -3 to 6 with mean 0 and standard deviation 1. The individuals with higher values in this variable are those with a worse health status (i.e., larger medical risk).

This composite measure has several advantages when compared to other health measures or proxies used in the literature. The most popular alternative would be to use an indicator of birth weight exclusively. However, there are three good reasons to opt for the twins' medical risk composite instead of the birth weight measure. First, when exploring parental responses, it is important to consider that more explicit health problems will be more easily identified by the parents. Hence, including other risk-related factors on top of birth weight, such as days in the hospital or time in special care, will more likely capture the underlying health status of the child. Second, birth weight is generally low among twins, given their particular gestational process, and therefore, it should be judged using different standards (Gielen et al., 2007). Low birth weight among twins does not necessarily reflect a particularly worse health status on its own. Third, whereas birth weight is measured at an isolated point in time, the medical risk composite is extended during the first 18 months of the life of the children, which increases the amount of information provided about the health status of the twins. In any case, I rerun all the main models for the raw birthweight measure only (instead of the index with the four combined measures) in the sensitivity analyses section.

Finally, it is relevant to notice that the Twin Medical Risk Factor Scale has been previously used in the literature exploring early developmental processes (see Asbury et al. (2005) for an example) and it has been found to increase the risk of developing other health conditions during the later childhood and adult life (Koeppen-Schomerus et al., 2000; Ronald et al., 2010, for examples using TEDS).

The main dependent variable is child-specific parental responses, operationalized with two indicators: negative emotional responses and discipline behaviours.

First, I measure negative parental emotional responses towards the children at ages 3, 4, and 7 through a derived composite index offered as part of the TEDS core dataset. Parents are asked to rate from 1 (definitely untrue) to 5 (definitely true) if sometimes they feel (i) angry, (ii) frustrated, (iii) impatient, or (iv) non-attached to the twins. The answers to the four items are standardized, and the mean is computed for each twin[7]. The final index presents a mean of 0 and a standard deviation of 1, ranging from -6 to 6. Higher values capture stronger negative emotional responses. At age 3 the four items present an internal consistency of alpha of 0.83; at age 4 of 0.84, and at age 7 of 0.80.

During the survey, parents are asked to provide the answers for the first-born twin, and immediately afterwards, they are asked if they feel more or less that way with the second-born twin, to what they can choose from 1 (a lot more) to 5 (a lot less). This implies that parents do necessarily focus

[7]Note that I am reproducing here the process of construction of the composite as described by the TEDS data centre for the two operationalizations of the dependent variable, but the dataset provided already contains the final variable, so I do not personally implement these steps.

on the potential differences between the two children (Viding et al., 2009). This is an important advantage for the methodological design of this study, which exploits within-family variation. Despite the question being framed in terms of the differences between the twins, the TEDS data provides a final value on the same scale for each of the twins (i.e., the value reported for *twin 1* and the difference reported by the parents regarding *twin 2* are used to compute the absolute value for *twin 2*, which is the value they provide). The Intraclass Correlation Coefficient[8] (ICC hereafter) is 0.61 at age 3; 0.60 at age 4, and 0.55 at age 7, which suggests that there is enough variation for this study to exploit within-family differences.

Before being incorporated as part of the TEDS survey, this composite was originally developed by Deater-Deckard (2000) through a process of exploratory factor analysis to measure the relevance of parental emotional responses for the child developmental process, and it has been extensively used in the parenting literature since then, becoming the standardized way of measuring parental emotional responses (Asbury et al., 2006; Fontaine et al., 2010; Viding et al., 2009).

The second operationalization of parental responses is through a composite measuring parental discipline at ages 3, 4, and 7. Parents are asked how often they implement these actions with each of the twins (from never to usually): (i) giving a smack or slap, (ii) telling off or shouting at the twin, (iii) making a joke out of the children's misbehaviour, (iv) asking

[8]The ICC measures the level of similarity between individuals from the same group, in this case twins nested into families, for a specific trait. Higher coefficients capture more similarity within the family.

someone else to deal with the situation (for example, another parent), (v) explaining to the child, or reason with the child, and (vi) being firm and calm with child. The first two dimensions, giving a smack or slap, constitute harsh discipline behaviours. The second pair, making a joke or asking someone else to deal with the situation are considered displacement behaviours in the literature (Knafo & Plomin, 2006). Finally, the third pair, reasoning with the child and being calm are understood as positive discipline behaviours. Therefore, and after having computed the mean of each sub-scale and standardised them, the first and second subscales are summed and the third one is subtracted. The final composite presents a mean of 0 and a standard deviation of 1, ranging from -6 to 6, with higher values capturing more negative parental discipline. The internal consistency of the six standardized measures included in this composite is 0.79 (Cronbach Alpha) at age 3, 0.82 at age 4, and 0.80 at age 7.

As in the previous composite, parents are also asked first about the first-born twin and then how that compares to the second-born twin (although absolute values on the same scale are provided by the TEDS data). This again ensures enough variation within the family in the levels of parental discipline, with ICCs of 0.67 at age 3; 0.68 at age 4; and 0.55 at age 7. Moreover, this composite has also been extensively used in the literature exploring parental discipline (Choe et al., 2013; Locke & Prinz, 2002; Lysenko et al., 2013), especially using TEDS data (Asbury et al., 2006; Deater-Deckard et al., 1998; Fontaine et al., 2010).

In the second stage of the analysis, I aim to measure the impact of these parental responses on children's long-term outcomes. I operationalize these long-term outcomes as educational performance and subjective health.

Educational performance is measured at age 16, and it is the mean grade of the core GCSE examinations (English, Maths, and Science scores), which is the academic qualification taken in England and Wales at the end of the Secondary Education period[9]. The resulting variable ranges from 4 to 11 , with a mean value of 8.9.

The negative subjective health variable is measured at age 21. The twins are asked "*In general, would you say your health is?*", to what they can answer poor, fair, good, very good, or excellent (1 to 5). I reverse the variable so that larger values capture worse health problems, in line with the independent variable, the twins' medical risk scale. The mean of this negative subjective health variable at age 21 is 2.67.

For the last set of hypotheses exploring SES heterogeneous effects, I operationalize family socioeconomic background through a dominance version of parental education, namely, I account for the highest qualification attained by the mother or father in the family. This is a dichotomous variable with a value of 0 if both parents have achieved less than tertiary education and 1 if any of the parents has achieved a tertiary education degree. In the English and Welsh context, this implies that in category 0 are included

[9]All the details about the process of recording the GCSE exam results are explained here: `https://www.teds.ac.uk/datadictionary/studies/rawdata/16yr_exam_results.htm`. The TEDS operationalization follows the guidelines of the ofqual (Office of Qualifications and Examinations Regulations). Although the twins individually answer to their questionnaires, they both receive the questions at the same time (as well as their parents), what suggests that they can serve as an external control mechanism to ensure as much reliability as possible in the answers.

all those with (a) no qualification, (b) GCSE levels, (c) Vocational training (HNC or HND), or (d) A/S levels. Those with some sort of (a) Undergraduate Degree or (b) Postgraduate Degree are part of category 1. I replicate the main analyses in the sensitivity analyses section using a more disaggregated operationalization of parental education with six categories, as well as a measure of mothers' occupations and household income.

Given the characteristics of the within-twins estimators, I can only include twin-specific control variables in the main analyses, which is the case of twins' gender. In the OLS specifications, I also control for relevant factors that vary between families such as parental education, the age of the mother when the children were born, and the number of siblings in the family (including the twins). Further sensitivity tests include controls for the cognitive ability of the twin at age 3, the zygosity of the twins' pair, and the gender of the parent responding to the survey. Descriptive statistics of all the variables are presented in **Table A.1**.

2.3.3 Analytical strategy

Health problems do not randomly occur across children and families, which creates a problem of selection because there might be unobservable characteristics that are related to both the parental responses and the health problems of the children (Rosales-Rueda, 2014). Examples of these unobservable factors would be housing conditions, neighbourhood-related factors, or health problems experienced by the parents themselves. Therefore, to overcome this selection problem, I exploit within-family variation, which allows me to also control for observed and unobserved family characteristics. Another advantage of this specific design is that, as compared to siblings' models, twins share parental age at birth and the timing of most of their early life events (Abufhele et al., 2017).

The analytical strategy of this paper has three interrelated parts. The first stage aims to capture the effect of early health disadvantages on parental responses (*hypotheses 1a and 1b*). First, I present an OLS regression to have a baseline estimate of the relationship between the variables of interest, followed by a series of within-twins fixed effects linear models, which are the central part of the analyses.

These twin-fixed effects models compare twins living in the same household by performing a family demeaning transformation, which means that each variable represents how much each twin deviates from that variable's mean at the family level. The data presents a value of parental responses for each individual twin, on a scale from -3 to 6. Therefore, if *twin 1* has a value of -1 on parental responses, and *twin 2* has a value of 3, the average of the family parental responses would be 1. What the twin-fixed effects model does is, then, for each individual twin, check whether the deviation from the family-mean on the twin medical risk (the main predictor) is associated with the deviation from the family-mean on the parental responses variable (the outcome). The crucial advantage of this model is that it eliminates the bias derived from observed and, especially, unobserved family-specific heterogeneity. Formally, the resulting model for this first stage of the analysis is:

$$\Upsilon_{pt} - \bar{\Upsilon}_p = \delta\left(X_{pt} - \overline{X}_p\right) + \theta\left(C_{pt} - \overline{C}_p\right) + \left(\varepsilon_{pt} - \bar{\varepsilon}_p\right) \quad (1)$$

where Υ_{pt} is the main outcome, parental responses; subscript p refers to the twins-pair and t to the individual-twin; X refers to the children's early health disadvantages, the main predictor, and C to the control variables. The main estimate of interest is δ.

The second stage of the analysis focuses on the effect of parental responses on later-in-life educational and health outcomes (*hypotheses 2a and 2b*). *Equation (2)* below details the specificities of this second stage, based also on within-twins estimates:

$$P_{pt} - \bar{P}_p = \varphi\ \left(\Upsilon_{pt} - \bar{\Upsilon}_p\right) + \beta\left(X_{pt} - \overline{X}_p\right) + \alpha\left(C_{pt} - \overline{C}_p\right) + \left(u_{pt} - \bar{u}_p\right) \quad (2)$$

where P represents children's educational performance and health status at ages 16 and 21 respectively; Υ_{pt} refers to the parental responses implemented during the childhood period, X to the early health disadvantages, and C to the control variables. The main estimate of interest, in this case, is φ .

Finally, I examine whether the effect of early health disadvantages on parental responses varies by the socioeconomic background of the family, as suggested in *hypotheses 3a* and *3b*. *Equation (3)* introduces an interaction term between early health problems (X) and parental education (S)[10]:

[10]Under normal circumstances, characteristics that do not vary between the twins, such as parental socioeconomic status could not be part of the within-twins fixed effects models. However, I am using the exception contemplated by Allison (2009) in his seminal

$$\Upsilon_{pt} - \bar{\Upsilon}_p = \delta\left(X_{pt} - \overline{X}_p\right) + \omega\left(X_{pt} - \overline{X}_p\right) * S_p + \theta\left(C_{pt} - \overline{C}_p\right) + \left(\varepsilon_{pt} - \bar{\varepsilon}_p\right) \tag{3}$$

where, as in *Equation 1*, Υ_{pt} is the main outcome, parental responses; X captures children's early health disadvantages, and S the socioeconomic status of the family. The main estimate of interest in this case is ω. All the analyses have been performed with R Studio (package *plm*).

In the **Appendix A**, I discuss in depth the potential biases and sources of error that could be playing a role in these models, and how I address them.

2.4 Results

2.4.1 Descriptives

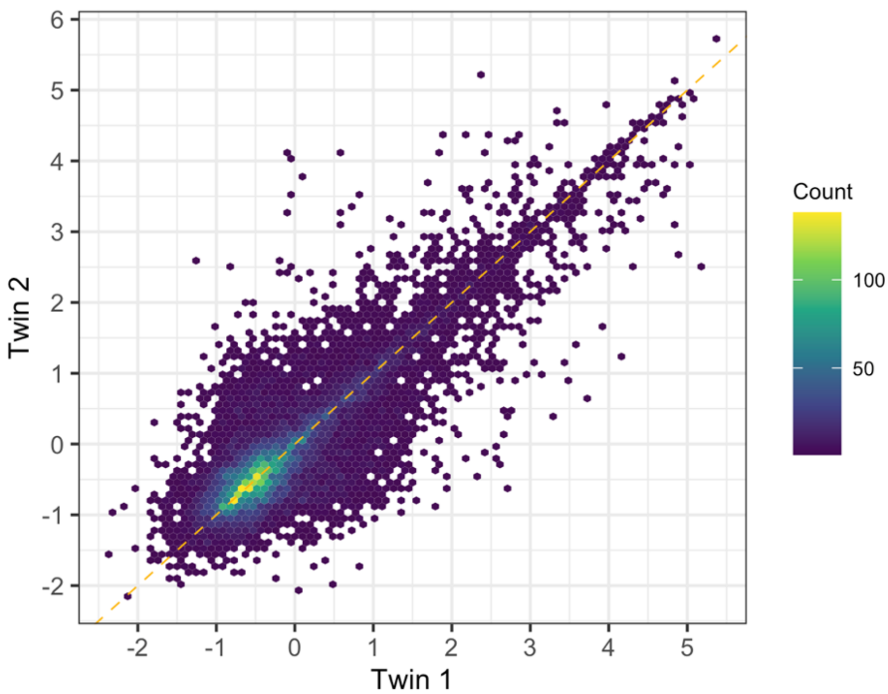
The within-family estimators measure the deviation of each twin-exclusive characteristic from the specific mean of the twin pair. Thus, the underlying assumption of the model is that the twins should present some variation in their health status. The Twin Medical Risk Scale, the main independent variable, presents an ICC of 0.63 in this sample.

On top of the ICCs, it is important to look at the within-family variation across different points of the distribution of the medical risk scale. As shown in **Figure 2.1**, although there is an evident correlation between the twins' health status, all the hexagons located out of the main diagonal

work about fixed effects to test these moderation effects: an invariant variable might be introduced if and only if it interacts with a variant variable (in this case, one which varies between twins, such as early health problems).

provide enough variation to sustain this analysis. 13% of the twins-pairs in the sample have exactly the same medical risk value, 50% of the twins-pairs show differences above 0.3 points (1/3 of the standard deviation), and 20% of the pairs present differences larger than 1 standard deviation.

Figure 2.1: Hexbin Chart: Twin Medical Risk Scale.



Regarding parental emotional and discipline behaviours, between 30% and 36% of the parents provide the same responses for both twins (the proportion varies slightly based on the specific variable, parental responses or discipline, and the age, 3, 4 or 7). This implies that at least 64% of the parents report different parental responses between their twins. Both parental emotional responses and discipline behaviours are more similar when the twins are younger, and they become more distinguishable once the twin gets older. There are no differences between SES groups in the level of twins' similarity: for all the variables employed the ICCs across groups overlap.

2.4.2 OLS regressions

The OLS results in **Table 2.1** show that a worse health status during the first year and a half of life is related to more negative emotional responses by the parents at all ages, and with more negative discipline behaviour at ages 4 and 7. Moreover, the male twins in the sample receive more negative parental responses in all the models. For the parental education variable, the results are different when looking at emotional and behavioural responses. Tertiary-educated parents in the sample (as compared to non-tertiary-educated ones) show more negative emotional responses on average, whereas they show fewer harsh discipline behaviours, which is consistent with previous literature (Ryan et al., 2016). Finally, in terms of family structure, younger mothers are more likely to implement disciplinary behaviours, and the larger the household size (i.e., more siblings), the more likely it is to see those harsh disciplinary parental responses at ages 4 and 7. The small R^2 of these OLS models suggests that there is a lot of variability in parental responses that is not explained just by looking at the between families level or with the variables included.

Table 2.1: Parental Responses. OLS Models.

	Dependent Variables					
	Negative Emotional Responses			**Negative Discipline Behaviours**		
	Age 3 (1)	Age 4 (2)	Age 7 (3)	Age 3 (4)	Age 4 (5)	Age 7 (6)
Twin Medical Risk Scale	0.039*** (0.010)	0.044*** (0.009)	0.034*** (0.009)	-0.001 (0.010)	0.016* (0.009)	0.033*** (0.009)
Male	0.126*** (0.020)	0.139*** (0.017)	0.130*** (0.017)	0.130*** (0.019)	0.185*** (0.017)	0.266*** (0.017)
Tertiary-Educated	0.058** (0.022)	0.057** (0.019)	0.094*** (0.019)	−0.269*** (0.022)	−0.242*** (0.019)	−0.090*** (0.019)
Mother's Age at Birth	0.003 (0.002)	0.002 (0.002)	-0.0001 0.002)	−0.017*** (0.002)	−0.008*** (0.002)	−0.008*** (0.002)
Number of Siblings	-0.012 (0.058)	-0.060 (0.044)	-0.019 (0.044)	0.095 (0.056)	0.128** (0.043)	0.158*** (0.044)
Constant	−0.168* (0.070)	−0.125* (0.061)	-0.090 (0.062)	0.555*** (0.069)	0.243*** (0.061)	0.129* (0.061)
Observations	10,154	13,542	13,066	10,154	13,542	13,066
R^2	0.006	0.008	0.007	0.032	0.026	0.024

Note: standard errors are in parentheses. $^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

2.4.3 Twins Fixed-Effects Regressions

Table 2.2 presents the main results of this study. When family unobserved characteristics are accounted for, having a worse health status (i.e., higher values in the twin medical risk scale) increases the negative emotional responses of parents at ages 3, 4, and 7. As compared to the healthier twin, the twin with worse health during the first year and half of life will receive 0.046 SDs more negative emotional responses from their parents at age 3. This effect becomes more intense in the consecutive years (0.061 and 0.055 SDs at ages 4 and 7), showing similar sizes to the effects found by Rosales-Rueda (2014) for parental emotional and cognitive responses to mental health problems (i.e., 0.08 SD).

These estimates are slightly larger than the ones presented in the OLS specifications, which suggests that the between-family comparison could be underestimating the effects of early health problems on parental responses. In this sense, the literature has shown that less advantageous families are less likely to detect health problems and also to modify their parental emotions and behaviours according to these (Rosales-Rueda, 2014). Since low-educated families are overrepresented in this sample in terms of being the majority group (73% of the sample), this could be confounding the OLS results.

In the case of parental discipline responses, the pattern is similar: parents implement harsher discipline behaviours with the twin with worse health status. The exception is discipline responses at age 3, which remain unaffected by the twin medical risk scale. This is also the case in the between-families model and suggests that parental responses might be shaped at different rates, namely whereas the emotional responses are already activated at age 3, the behavioural ones seem to take some more time. Finally, it is noticeable and remains constant across all the model specifications that the male twin will receive more negative emotional responses and discipline behaviours from their parents in all cases.

Table 2.2: Parental Responses. Twins Fixed Effects Models.

	Dependent Variables					
	Negative Emotional Responses			**Negative Discipline Behaviours**		
	Age 3	Age 4	Age 7	Age 3	Age 4	Age 7
	(1)	(2)	(3)	(4)	(5)	(6)
Twin Medical Risk Scale	0.046** (0.020)	0.061*** (0.018)	0.055** (0.019)	-0.011 (0.018)	0.034** (0.015)	0.042** (0.019)
Male	0.161*** (0.020)	0.155*** (0.018)	0.149*** (0.019)	0.249*** (0.018)	0.241*** (0.015)	0.310*** (0.019)
Observations	11,525	15,295	14,745	11,525	15,295	14,745

Note: standard errors are in parentheses. $^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

2.4.4 Long-term outcomes

In the second stage of the analysis, I examine whether these parental responses have a long-term effect on children's outcomes, net of initial health problems and employing twins fixed-effects models. As shown in **Table 2.3**, the twin experiencing more negative emotional responses at age 3 will obtain 0.12 points less than their twin on the GCSE examinations. This estimate varies slightly between -0.08 to -0.13 depending on when the parental response was received and which type of response it was. Emotional responses present larger effect sizes than discipline ones.

Moreover, **Table 2.3** also shows that early health problems have a direct negative effect on long-term educational performance: the twin with a worse health status during the first years of life obtains, on average, between 0.12 and 0.15 points less on the GCSE examinations at age 16 than the healthier twin (around one tenth and one ninth of a standard deviation).

Table 2.3: Long-Term Educational Performance.

	Dependent Variable: Educational Performance at Age 16					
	(1)	(2)	(3)	(4)	(5)	(6)
Neg. Emotional Responses Age 3	-0.120^{***} (0.019)					
Neg. Emotional Responses Age 4		-0.098^{***} (0.016)				
Neg. Emotional Responses Age 7			-0.129^{***} (0.015)			
Neg. Discipline Age 3				-0.084^{***} (0.021)		
Neg. Discipline Age 4					-0.117^{***} (0.018)	
Neg. Discipline Age 7						-0.112^{***} (0.014)
Twin Medical Risk Scale	-0.120^{***} (0.029)	-0.128^{***} (0.025)	-0.141^{***} (0.024)	-0.127^{***} (0.029)	-0.126^{***} (0.025)	-0.144^{***} (0.024)
Male	-0.135^{***} (0.029)	-0.153^{***} (0.025)	-0.155^{***} (0.024)	-0.133^{***} (0.030)	-0.141^{***} (0.025)	-0.138^{***} (0.024)
Observations	6,905	6,905	6,905	6,905	6,905	6,905

Note: standard errors are in parentheses. Each predictor is introduced in a different model to avoid collinearity, given the high correlations between the parental responses at different ages. $^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Regarding the second long-term outcome, subjective health, the results are fairly different (**Table 2.4**). First, and surprisingly, early health problems do not seem to have a direct effect on long-term subjective health in a within-family setting. Moreover, the twin experiencing more negative emotional and discipline responses at ages 3 and 4 does not show a worse health status in the long term. An exemption from this pattern is that the twin exposed to harsher parental responses at age 7, both in the emotional and behavioural dimensions, is more likely to present a negative subjective-health status at age 21. This suggests that later in parental responses (as compared to earlier ones) might have a larger impact on long-term outcomes.

Table 2.4: Long-Term Negative Subjective Health.

	Dependent Variable: Negative Subjective-Health at age 21					
	(1)	(2)	(3)	(4)	(5)	(6)
Neg. Emotional Responses Age 3	0.031 (0.025)					
Neg. Emotional Responses Age 4		−0.020 (0.025)				
Neg. Emotional Responses Age 7			0.062* (0.024)			
Neg. Discipline Age 3				0.012 (0.034)		
Neg. Discipline Age 4					0.032 (0.029)	
Neg. Discipline Age 7						0.068* (0.024)
Twin Medical Risk Scale	0.048 (0.047)	0.014 (0.039)	-0.003 (0.039)	0.053 (0.047)	0.008 (0.039)	0.001 (0.039)
Male	−0.161*** (0.049)	−0.151*** (0.040)	−0.131** (0.041)	−0.168*** (0.050)	−0.165*** (0.041)	−0.144*** (0.041)
Observations	4,992	4,992	4,992	4,992	4,992	4,992

Note: standard errors are in parentheses. Each predictor is introduced in a different model to avoid collinearity, given the high correlations between the parental responses at different ages. ***$p < 0.001$; **$p < 0.01$; *$p < 0.05$

2.4.5 Heterogeneous SES responses

The last stage of the analysis aims to examine whether parents from high- and low- socioeconomic status respond differently to the early health disadvantages of their children. **Table 2.5** shows that there are no consistent differences across groups in their emotional and discipline responses to health problems. Even though tertiary-educated parents are slightly more likely to develop negative responses than lower-educated ones at ages 3 (model 1) and 4 (model 5), this pattern is not constant.

Table 2.5: Parental Responses by family SES.

	Dependent Variables					
	Negative Emotional Responses			**Negative Discipline Behaviours**		
	Age 3 (1)	Age 4 (2)	Age 7 (3)	Age 3 (4)	Age 4 (5)	Age 7 (6)
Medical Risk (ref. cat.: Non-Tertiary)	0.013 (0.026)	0.053* (0.023)	0.059* (0.025)	-0.029 (0.023)	0.005 (0.020)	0.061* (0.025)
Medical Risk x Tertiary-Educated	0.107* (0.047)	0.046 (0.040)	-0.020 (0.043)	0.043 (0.041)	0.081* (0.035)	-0.075 (0.043)
Tertiary-Educ Coefficients	0.121** (0.040)	0.100** (0.034)	0.041 (0.036)	0.017 (0.036)	0.086** (0.031)	-0.012 (0.036)
Observations	10,240	13,678	13,198	10,240	13,678	13,198

Note: standard errors are in parentheses .Controls: gender of the twin. The tertiary-educated coefficients are computed by adding the reference category coefficients to the interaction term ones. The standard errors for these coefficients are calculated in the stratified sample (i.e., re-running the models only for those with tertiary-educated parents).
$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

2.4.6 Robustness, sensitivity and implication analyses

I run several additional analyses to increase the reliability of the main results.

First, I introduce a control for early cognitive ability. Given that previous literature has pointed out that parents respond to the levels of cognitive skills of their children, I want to dismiss the possibility of health problems just being a signal of lower cognitive skills for the parents. These results are presented in **Table A.2** in the Appendix A, which shows that the main estimates remain the same, with some small variations in their size. The fact that the effect of early health problems does not disappear when I introduce a cognitive ability measure suggests that health problems and cognitive skills have different implications for the parents and that parents respond to health issues not only because of the cognitive skills devaluation that they might carry.

The second sensitivity check implemented aims to evaluate the effect of birth weight on parental responses since it is the most common alternative measure to the twin medical risk composite. **Table A.3** presents the main models with the birth weight variable instead of the twin medical risk. The twin with a larger birth weight receives less negative parental emotional responses and discipline behaviours at age 3, which is congruent with the results for the twin health risk variable. However, these effects are substantially smaller and stop being significant at ages 4 and 7. This means that the other factors that are part of the twin medical risk index (i.e., the ones that measure poor health more directly) are the ones driving the main effects presented in this paper.

To explore this option, I rerun the main analyses in **Table A.4** including the three remaining factors (i) days in special care, (ii) medical problems at birth, and (iii) days in the hospital after birth. These results show that, when introduced separately, each of these components has a smaller impact on parental responses than the twin medical risk index, although the effects found are consistent with the previous ones. It is the accumulation of several of these risk factors that seems to trigger parental reactions more than just the presence of one specific isolated problem.

Given the relevance of gender in all the models, I rerun the results including a gender interaction effect (**Table A.5**). The goal of this is to examine whether parents respond differently if a male or female twin is experiencing a health disadvantage. Despite male twins are, in general, more likely to receive negative parental responses, there are no differences in how parents respond to health problems regarding the gender of the twin. Similarly, **Table A.6** shows the main results when accounting for the specific parent (mother or father) answering the questionnaires about twins' health and parental responses. The results stay unaffected.

Since the zygosity of the twins has been shown to affect parental responses in previous literature (Asbury et al., 2003; Viding et al., 2009), in **Table A.7** I present the main results with an interaction term for monozygotic twins, who are 33% of the whole dataset. On average, there do not seem to exist significant differences in how parents respond emotionally and in terms of discipline behaviours regarding the zygosity of the twins.

I dig deeper into the heterogeneous SES effects on parental responses and rerun the models using (i) an extended operationalization of parental education with six categories (**Table A.8**), (ii) a variable measuring maternal occupation (**Table A.9**), and (iii) household income (**Table A.10**). In all three cases, the results are in line with the results found for the reduced version of parental education. Moreover, it might be the case that the twins-fixed effects are not the best approach to capture SES group differences. To account for this possibility, I rerun the interaction model between health and parental socioeconomic status in **Table A.11** exploiting between-families differences. Although these OLS results cannot be interpreted in causal terms, it is important to notice that they are consistent with the main results from **Table 2.2**.

An alternative explanation for these null results in the stratified analyses is that some of the parental responses analysed in this paper are more socially classed than other. This would be the case if, for instance, certain behaviours were very common among high-SES families. In that case, it could be that parents were not modifying their parental behaviour as a response to their children's health simply because it is a very central part of their parenting and, therefore, quite inelastic to children's characteristics (Bernardi & Triventi, 2020; Breinholt & Conley, 2023). To account for this possibility, **Table A.12** (*Panel B*) replicates the stratified analyses for each of the sub-scale that form the parental discipline scale. Results shows that there are not relevant differences by group despite considering individually each of the discipline items.

The different nature of each of the sub-scales of the discipline index, as explained above, underscores the importance of investigating whether the main analyses show different patterns across them. **Table A.12**, *Panel A* shows the main results for the discipline variable disaggregated by each sub-scale. These results show that the twin medical risk scale does not have an isolated effect on each of the different sub-scales, despite it does have a global effect on the overall discipline index. This aligns with the findings of Asbury et al. (2006), Deater-Deckard et al. (1998) and Knafo and Plomin (2006), all of whom emphasise the need to create a comprehensive index that encompasses disciplinary responses rather than relying on isolated measures of specific behaviours.

The primary focus of this paper is the examination of parental responses to their children's early health, with a particular emphasis on identifying potential socioeconomic disparities in these responses. Within the framework of the compensatory advantage model, the assumption is that high socioeconomic status (SES) families, by shielding their children from early disadvantages, will ultimately mitigate the negative impact of these challenges. To explore this possibility, which could be understood as an implication analysis, I present the results in **Table A.13** including an interaction term between twins' medical risk and parental SES in relation to long-term educational and health outcomes.

Model (1) of this table shows that there is a negative impact of early health problems on long-term educational performance, which is observed for non-tertiary educated families (the reference category). This effect is not mirrored in the long-term subjective health outcome. These results align with the main analyses presented in **Table 2.3** and **Table 2.4**. However, the non-significant interaction terms within these models indicate that there are no significant differences between SES groups regarding the long-term effects of early health problems. This implies, consistently with the heterogeneous SES results highlighted main results section (**Table 2.5**), that there is insufficient evidence to substantiate the compensatory advantage model based on these findings.

Further exploration of the relevance of these findings implies checking whether parental responses mediate at all the effect of early health problems on later-in-life outcomes. To examine this, I implement a mediation model using the Structural Equation Modelling (SEM) framework, with previously demeaned variables, to capture within-family variation, and with standard errors clustered at the family level, emulating a twin's fixed-effects approach (Kalmijn & Leopold, 2019; Wood et al., 2021). Therefore, the results produced by this model must be understood as how much of the variation of later health and education between twins is explained by the different parental strategies implemented, net of initial differences in the early health of the twins. The results presented in **Table A.14** and **Table A.15** suggest that the parental responses are not relevant mediators of the direct effect of early health problems on later outcomes. Therefore, the long-term impact of parental responses presented in **Table 2.3** and **Table 2.4** should be interpreted with caution.

An issue that requires further consideration is also raised in **Table 2.4** and it is the fact that early health risks do not consistently show a negative impact on later-in-life health in my results[11]. This contradicts previous research on the long-term impact of early health problems (Smith, 2009) and questions the reliability of the current measure of long-term health. To address this aspect, I replicate in **Table A.16** the analysis of **Table 2.4**

[11]Note that this is also the case if I use birth weight as an early health predictor instead of the twin medical risk scale.

with four alternative measures of long-term health available in the TEDS dataset. These results show that having experienced a health problem early in life only has a consistent impact on one of the four operationalizations of subjective health at age 21, which is the perception of getting sick easier than others. Moreover, similar to the main results presented in **Table 2.4**, there is not a clear pattern of how parental responses affect later health outcomes.

There are several reasons that could explain why there are not consistent negative effects of early health problems on the five different subjective health indicators employed. First, it could be an issue of selection, meaning that the twins that were more likely to present early health problems abandon the sample before being surveyed at age 21 (i.e., attrition). However, as discussed in the data section, the fact that a twin experiences an early health problem does not increase the likelihood of the family abandoning the sample in later waves. Second, these null results could be explained by the exclusion by the TEDS data providers of those respondents who experienced very health severe problem when they were born. It is likely that it is in those cases where the long-term effect of health is more visible. Third, it is important to acknowledge that all the long-term measures employed here, and for reasons of data availability, are only capturing the subjective character of health. Further studies should consider expanding these analyses to other data with objective measures of health. Finally, the fact that the NHS, a far-reaching and publicly driven health system, is available in England and Wales might explain why adults' subjective health is not affected by earlier health problems or parental responses. This would suggest that the estimates presented here could be a lower bound for the effects of parental responses on long-term health in contexts with less comprehensive health systems.

2.5 Discussion and conclusions

Experiencing an early health problem crucially impacts a child's prospects (Almond & Currie, 2011). However, the role that parental responses to these early health problems play in this whole picture remains unclear (Rosales-Rueda, 2014; Yi et al., 2015). Using rich TEDS data that follows twins over their childhood and young adulthood and implementing a series of within-twins fixed effects models, this paper aims to answer three questions that shed light on this issue.

First, how do parents respond to the early health disadvantages suffered by their children? The empirical evidence offered here suggests that parents develop more negative emotional responses (impatience, frustration, lack of attachment, or anger) with the twin who has had a worse health status during their first 18 months of life. This is constant both in a within family (twins fixed effects) and between family (OLS models) context, as well as across the whole childhood period (ages 3, 4, and 7). Likewise, parents also implement harsher discipline behaviours with the sick twin, as compared to the healthier one. In both cases, this evidence suggests that parents are reinforcing early disadvantages by implementing less stimulating and supportive parental strategies when their children experience health problems.

This is congruent with the literature on bidirectional influence that suggests that parents respond to the disadvantages experienced by their children, so that parental actions are not exclusively driven by individual decisions of the parents (Bell & Chapman, 1986), as well as with the literature finding reinforcing parental responses (Fan & Porter, 2020; Restrepo, 2016).

These results are robust to the implementation of several specifications, including controls for early cognitive ability or birthweight. Regarding the effects sizes, in a family in which a twin presents a risk score of -1 (better health) and the other twin of 1 (slightly worse health), the difference in parental responses would be of around 0.122, which is one tenth of a standard deviation of the outcome variable. This effect size is not negligible, especially when found in the context of an intra-family estimation. Moreover, the magnitude of the effect increases over time, which suggests that parental responses could get more important in later phases of children's life cycles. These results are similar to the findings of Rosales-Rueda (2014).

The second question of this paper aims to examine whether negative emotional and discipline-related responses have a long-term effect on children's human capital, net of the direct effect of health on later-in-life outcomes. The results show that both parental emotional and discipline responses experienced during childhood have a negative impact on the long-term educational performance. This is consistent with the previous results showing that parental emotional and discipline responses impact children's developmental outcomes (Grusec et al., 2017; Lysenko et al., 2013). Nevertheless, additional analyses examining the implications of these results reveal that, despite the existence of a negative effect of both early health and parental responses factors on long-term outcomes, parental responses do not serve as a mediating factor in the influence of early health problems on later educational performance and health. Therefore, future research should delve into exploring the significance of parental responses in shaping long-term educational and health outcomes. Ideally, this research could involve continuous monitoring of health throughout childhood and adolescence to gain a more comprehensive understanding of the evolution of these long-run patterns.

Moreover, parental responses do not consistently impact later-in-life subjective health. These results go in line with Savelyev et al. (2020) and Yi et al. (2015) advocacy of the importance of accounting for multidimensional human capital effects when studying parental responses, since it is likely that parental responses in one dimension have spillovers on other crucial dimensions of human capital, such as education in this case.

Finally, the third question of this paper addresses whether parents from high- and low-SES respond differently to their children's early health problems. The results go against what I expected: parents from more and less advantaged backgrounds respond to their children's health disadvantages similarly. This is true regardless of the chosen SES operationalization (i.e., parental education, occupation, or income). An explanation for these results might be that, whereas previous literature has examined direct monetary investments, I am focusing on parental emotional and discipline responses, which are less resource dependent. Although surprising, these results are coherent with previous studies such as Graetz and Torche (2016), which does not find stratification in parental responses to birth weight. In line with these results, the implications analysis presented in the robustness section indicates a lack of long-term differences in how health problems impact children's outcomes by SES. Taken together, these findings suggest an absence of compensatory patterns wherein high-SES children are more shielded against the negative consequences of early health problems compared to their low-SES counterparts.

This paper makes four contributions to the literature. First, it examines how two previously overlooked types of parental responses, namely, emotional responses and discipline behaviours are affected by early health problems. Second, it does so by using a twin longitudinal dataset from the UK, where all the population has access to a comprehensive public health system. Third, the TEDS data has allowed me to consider repeated measures of parental responses over childhood, which opens the door to examining different rates at which parental responses are shaped as well as long-term outcomes. Finally, this paper adds to the previous literature exploring parental responses to health disadvantages by considering heterogeneous SES effects, which has been noted to be a crucial dimension to understanding parental responses to other types of early child disadvantages.

This study also has some limitations. First, similarly to most of the literature studying parental responses with observational data, this paper does not observe which is the exact factor that triggers the response. Although the sensitivity test including early cognitive abilities suggests that parents are not interpreting health problems as pure cognitive skills measures, there is still a possibility that parental responses are originated as a response to unobserved factors.

There are some challenges derived from the population selected for this analysis, namely twins, that should be discussed.

First, it is likely that when parents develop negative responses to a twin's health problem this has spillovers into the other twin, whose home environment will also be affected by the stressful event. In this case and given that the twin fixed-effects model exploits differences within the twins, the obtained estimates would be underestimating the effect of children's health disadvantages on parental responses. However, this also means that the exact magnitude of the effects found in this paper must be interpreted with caution.

Second, and related to this point, it could be the case that spillovers of parental emotions or behaviours are more common between twins than between other siblings, which would compromise the external validity and generalisability of these results (Abufhele et al., 2017). A positive note in this sense is that the between-OLS models estimated also show that health problems trigger more negative responses, which suggests that this relationship does not only operate on an intra-family but also an inter-family level. Moreover, from a theoretical perspective, one would expect parents to find it harder to detect differences between twins than between other siblings. Therefore, also in this case, this suggests that the estimates presented here would be underestimating the effect that early health problems have on parental responses.

Third, given social desirability bias, parents of twins might be less likely to answer to a survey question by pointing out differences between the children, especially among monozygotic twins (Abufhele et al., 2017). This would produce a problem of measurement error that can eventually lead into an attenuation bias. However, the way these questions are formulated in the TEDS survey, emphasising the difference in treatment between the twins, ensures a certain level of accuracy. Thus, the risk of the results from this paper being attenuated by the presence of measurement error is unlikely. In addition, and as shown in the results section, the estimates are not biased toward zero, which is reassuring.

Therefore, the results obtained here can be understood an extreme case scenario: the average siblings' population should show larger effects than the findings obtained in these analyses from a twins' sample. Moreover, it is important to notice that the twins' design has crucial advantages, such as the fact it makes use of a quasi-natural experiment in which the only observable varying characteristic between the twins is the health problem (once I account for several controls). Another important advantage compared to other alternative models is that it also addresses potential selection biases that could be driven by fertility decisions based on the previous children experiencing a health problem, which is something that siblings-designs cannot deal with and that is crucial for this paper [12].

Future research could also explore whether parental responses are sensitive to different gradients of severity in health disadvantages by accounting for parental responses to more extreme health problems, which are omitted from this study. Besides, further research should examine whether, on top of the negative long-term effect of parental responses on children's outcomes found here, these responses actually alleviate or aggravate the natural development of the health problem. For this endeavour, it would be ideal to have recurrent observations of the health of the children throughout the whole childhood and early adulthood period, so that the evolution of the health problem can be closely followed.

Policies targeted to improve the living conditions and prospects of ill children could benefit from implementing a more comprehensive family approach. For instance, policy interventions designed to help parents to apply more cognitively stimulating parenting have shown beneficial results on children's cognitive development. Similarly, public interventions could provide parents with more information on how they should respond to their children experiencing a health disadvantage to reduce its long-term impact on the children's lives.

[12] Note that I also discuss the potential biases and benefits of the overall design more in-depth in Appendix A.

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Chapter 3

Learning by Parenting:

How do Mothers Respond to Their Children’s Developmental Declines?

Abstract

Children's developmental processes are not always linear. During the childhood period, children usually experience ups and downs in their skills, and how parents respond to these changes can crucially condition the subsequent process of development of the children. This paper examines (1) how children's developmental declines impact the level of cognitive stimulation implemented by the mothers, and (2) whether these effects vary by socioeconomic groups. Using longitudinal NLSY79-CYA data from the US, I implement a series of two-way fixed effects and fixed effects counterfactual models. Findings show that mothers respond negatively to the declines in their children's mathematical skills by decreasing their levels of cognitive stimulation. This is particularly evident among mothers with low levels of education or those at the bottom part of the income distribution. All in all, this evidence suggests that mothers reinforce existing disadvantages by decreasing their cognitive stimulation when their children show developmental declines and that this mechanism could be responsible for broadening the developmental gap between children from low- and high-socioeconomic backgrounds.

3.1 Introduction

A child's developmental process is rarely a completely smooth process (Woodhead, 2009). There are fluctuations in children's skills that can be both genetically or socially determined (Bronfenbrenner, 1981). When these changes are negative, and therefore children show developmental setbacks, how parents respond to these difficulties can either exacerbate or ameliorate the initial disadvantage.

This paper examines, first, how children's developmental downturns impact the level of cognitive stimulation implemented by their mothers, which has been noted to be a crucial dimension for the long-term human capital of the child (Cabrera et al., 2020; Cook et al., 2011; Hubbs-Tait et al., 2002; Votruba-Drzal, 2003). Second, given that there is a large developmental gap between children from high and low socioeconomic backgrounds (hereafter SES) (Feinstein, 2003; Lee & Burkam, 2002; Linberg et al., 2019), this paper assesses whether there are heterogeneous socioeconomic effects in the association between developmental declines and maternal cognitive stimulation.

Using data from the National Longitudinal Survey 1970-Children and Young Adults Supplement (NLSY79-CYA), which provides information about mothers and each of their children (aged 5 to 15 years old) in the US from 1986 to 2018; I implement a series of two-way fixed effects models (TWFE) and fixed effects counterfactual models (FEct). I test whether the declines in child development during the previous periods affect subsequent maternal cognitive stimulation and whether these effects vary by the socioeconomic background of the family. Declines in children's developmental processes are measured as the negative changes in their mathematical and reading skills from time *t-1* to time *t*. Maternal cognitive stimulation is measured through the child-specific HOME-SF inventory on its cognitive dimension.

The results obtained suggest that, on average, mothers decrease their cognitive stimulation when their children show declines in their mathematical skills. This is particularly the case for non-tertiary-educated mothers and those at the bottom of the income distribution, which suggests that this mechanism could be relevant to understanding the developmental gap between children from low- and high-socioeconomic backgrounds. However, mothers do not seem to respond to declines in their children's reading skills.

This paper contributes to the existing literature in several ways. First, it explores the dynamic nature of child development and suggests that parents are not only sensitive to the total level of skills of their children, but they also respond to fluctuations that take place during the process of child development by modifying their parental actions accordingly. Second, it adds to the existing literature on compensatory and reinforcing parental effects by examining whether mothers from different socioeconomic backgrounds respond differently to their children's developmental declines. Third, this paper discusses the possible advantages and disadvantages of two-way fixed effects models for analysing dynamic social processes and suggests exploring new models based on fixed effects counterfactuals that have been mostly overlooked so far in the sociological literature.

3.2 Theoretical frame

3.2.1 A dynamic approach to parental responses

Child development is a complex and multi-faceted process that is influenced by several genetic and environmental factors (Bronfenbrenner, 1981). There are well-known milestones through which the children pass as they grow up and mature, but this process is not always linear. It is precisely at times when the children experience developmental setbacks that parental actions (or lack of actions) can be more influential.

The first theoretical approach to the idea that parents respond with their actions to their children's problems comes from the developmental psychology literature and suggests that parents do not implement a particular action because they unilaterally decide to do so, but that this process is conditioned by what the children evoke among them. In this line, Bell (1968) suggested that the hegemonic understanding of the socialization process as parent-to-child interactions was leaving out part of the story and labelled this phenomenon as bidirectional influence (Bell & Chapman, 1986).

This idea of how distinct characteristics or situations of the children activate different parental responses gave rise to the study of transactional models of parenting, which state that it is in the continuous interactions between children and their parents that the developmental process of the children occurs (Crockenberg, 1981; Lugo-Gil & Tamis-LeMonda, 2008; Sameroff & Mackenzie, 2003). These approaches introduce the idea of dynamism as a fundamental component of parenting and parenthood. A good example of this is the work from Pomerantz and Eaton (2001), which shows how maternal support varies based on children's daily academic reports of failures and successes.

There are three main ways in which this dynamic component of parenting has been partially addressed in the sociological literature. First, it has been considered when exploring parental responses to their children's disadvantages (Karraker & Coleman, 2005) - i.e., responses to low birth weight (Hsin, 2012), slow developmental process (Graetz & Torche, 2016), low cognitive ability (Tucker-Drob et al., 2013), children's genotypes (Breinholt & Conley, 2023) or health conditions (i.e., Chapter 2 of this dissertation). The rationale behind this literature is that children's disadvantages work as signals that trigger parental responses and that these responses can alleviate some of these developmental problems and foster the child's development to higher standards.

Another form of dynamism has been found in how parents tailor their child-rearing strategies to the specific developmental stage of the children (Kalil, 2015). This idea, which has been named sensitivity in parenting, explores how parents try to optimise the process of child development by varying the composition of the time and resources they put into each child according to the developmental needs of each stage. This approach also suggests that the information on which investments should be made at each period is heterogeneously distributed across socioeconomic groups.

Thirdly, a branch of literature has insisted on the necessity of understanding the cumulative character of parenting (Cano, 2022; DiPrete & Eirich, 2006; Lugo-Gil & Tamis-LeMonda, 2008; Tiberio et al., 2016). The most important contribution in this sense comes from the dynamic complementarities in the skill formation literature (Cunha & Heckman, 2007; Johnson & Jackson, 2019; Muslimova et al., 2020) which suggests a model of human capital production by which early investments in child development will positively increase subsequent investments. Therefore, under the premise that skills beget skills (Cunha & Heckman, 2007) this literature aims to emphasize the importance of investing in the early life of the child to foster cumulative and multiplying effects of skills during the whole childhood period.

To advance in the understanding of the dynamic approach to parental responses, I suggest that parents do not only adapt their parenting based on (i) the continuous interaction between them and their children (*transactional parenting hypothesis*), (ii) the specific developmental period they are in (*sensitivity in parenting hypothesis*) or (iii) the impact of previous parental investments (*dynamic complementarities hypothesis*) but also, based on the changes they observe in their children's developmental process.

I understand the developmental process as the specific path through which the child's development is produced. Even if developmental processes usually present an overall increasing trend, i.e., from the moment of birth to adulthood individuals are expected to progressively increase their skills, there are some periods when the rate of development might be lower or even negative. For instance, a child might show exceptionally high levels of reading skills at age 3 but become stagnant during the next two years. This does not imply that the child reads worse at age 5 than she used to at age 3. However, it means that the child who was in a very good position for the expected developmental level of children at age 3 is not in such a good situation for what is expected at age 5. Then, in this specific example, the developmental process of the child between ages 3 and 5 would be showing a decline.

Inspired by the *developmentally effective parenting* concept (Kalil et al., 2012), I suggest that (**hypothesis 1**) *parents will respond to declines in their children's development by increasing their cognitive stimulation*. That is, if parents perceive some developmental delays in their children, materialised through decreases in their skills, I expect them to subsequently increase their cognitive stimulation, which can be considered effective parenting from a developmental perspective. The underlying intuition is that the moments when the child's development is more stagnant are precisely when a parental boost is needed the most.

This idea has important implications for the levels of inequality at the societal level: only if parents manage to detect their children's developmental needs and increase their effective parenting accordingly will the likelihood of those children being left behind be reduced. In other words, developmentally effective parental practices might be a way to break the disadvantages trap that some children experience during their childhood and that affects their later-in-life outcomes.

3.2.2 Theoretical connections

This approach to the concept of developmentally effective parenting can be understood in dialogue with four existing streams of literature, to which this paper aims to contribute.

First, this approach speaks to the compensatory effects literature (Bernardi, 2014; Erola & Kilpi-Jakonen, 2017): if some parents respond to decreases in their children's developmental processes by increasing their parental stimulation, it is likely that in the long run, these parents are more likely to compensate for those initial developmental disadvantages. However, as opposed to what has been hypothesised, if as a response to declines in children's development, parents decrease their parental stimulation, they will eventually reinforce these existing disadvantages (Fan & Porter, 2020). This paper attempts to complement this literature by delving into the specific mechanisms behind parental compensation and reinforcement.

Second, the theoretical bases of this paper connect directly to the dynamic models of cultural reproduction (Blaabaek, 2021; Jaeger & Breen, 2016) which explore how the transmission of cultural capital from parents to children is produced. This approach draws from Bourdieu's theory of reproduction (Bourdieu & Passeron, 1990) and advocates for the relevance of studying within-family dynamics to understand the perpetuation of social inequalities (Lareau, 2011). Whereas these studies focus on the transmission of cultural capital, this paper examines parental cognitive stimulation as a response to declines in skills. The latent rationale is similar insofar as both approaches rely on the assumption that parental actions are cumulative and triggered by children's endowments.

Third, a broad literature on parental investments has explored how these vary as a response to children's academic performance (Cobb-Clark et al., 2019; Li et al., 2022; Yurk Quadlin, 2015). The main drawback of this approach is that examining academic performance instead of children's development reduces the substantive scope of the analyses and opens the door to teacher-related biases in the estimated results (Dee & Gershenson, 2017). Moreover, parental investments are essentially an economic outcome, but from the sociological literature, it is well-known that parental responses can take multiple forms, such as emotional support, cognitive stimulation or time spent together (Price & Kalil, 2019; Restrepo, 2016; Yeung et al., 2002).

Finally, exploring how parents respond to declines in children's development might contribute to the understanding of the processes of intrahousehold allocation of resources (Becker & Tomes, 1976; Behrman et al., 1982). In multi-children households, it can be the case that one of the decisive factors for parents to invest their resources in one or another child comes from the fluctuations experienced in the developmental process by each of them.

3.2.3 Why some parents are more likely to respond to their children's developmental declines than others?

At this point in the theoretical argumentation, it is important to acknowledge that some parents will be more skilful than others in (a) evaluating the specific necessities of their children based on the declines experienced in their developmental process, as well as in (b) adjusting their subsequent parental practices to these. Therefore, I suggest several factors that might condition the ability of the parents to respond to declines in their children's development by increasing their cognitive stimulation.

First, there are informational asymmetries in place. Some parents have more knowledge of what their children need during their developmental process (Bornstein et al., 2020), and consequently, could be more likely to adjust their practices accordingly. Following Cunha (2021), information about the technology of skills formation plays a relevant role in determining parental investment choices. Bergman (2021) shows, through a field experiment, that providing information to parents about school functioning increases the frequency of communications and the general involvement of the parents with the education of their children. Another parent-directed intervention by Leffel and Suskind (2013) shows that when parents are informed about the relevance of talking to their children in the process of brain development, they increase the amount of conversation per hour by almost 50 per cent.

Parental cognitive skills could also affect the ability of the parents to implement more cognitively stimulating responses when the child has experienced developmental decreases. Cognition has been shown to condition parents' ability to parent, mainly through the choices parents make about their investments (Anger & Heineck, 2010; Johnston et al., 2018). Although most of the evidence on this point comes from the literature exploring how cognitive skills are transmitted from parents to children (Anger, 2012; Gronqvist et al., 2010), some authors have studied the effect of cognitive skills on parental practices (Byford et al., 2012). These works suggest that it is usually within families with higher cognitive skills that a stimulating intellectual environment is built for the children, and therefore it is more likely that parents eventually implement cognitively stimulating practices.

A specific sub-type of skills to consider is information processing skills, which help individuals analyse, remember and transform information into valuable choices and actions (Kail & Bisanz, 1982). Therefore, it is not only about having adequate knowledge about children's development but also the ability to process this information. For instance, these information processing skills have been noted to affect the cultural investments parents make in their children (Blaabaek, 2021; Norton, 2020).

There is also a series of soft skills that might be relevant here. First, there are communication skills that could increase the regularity and depth of parent-to-child interactions (Landry et al., 2006), and, as a result, the ability of the parents to detect declines in their children's development. Second, critical thinking and decision-making skills can also improve how parents make complex choices that will end up affecting the developmental process of the child (K. Anderson & Minke, 2007). Third, stress and conflict management skills might help parents deal with difficult situations and prioritise the most effective resolution for the welfare of the child (Webster-Stratton & Hammond, 1999). Fourth, resourcefulness, creativity, and adaptability are also good qualities that might help parents to come up with effective solutions when their children's development is at risk (Kienhuis et al., 2010).

Finally, parental preferences have been repeatedly pointed out as a factor behind parental practices (Bonke & Esping-Andersen, 2011). One relevant example of this for this study would be future discounting preferences, by which some parents will be more likely to emphasise immediate outcomes over future ones (Mayer et al., 2015). This means that some parents will not necessarily address the immediate developmental declines to avoid long-term negative externalities[13].

3.2.4 Stratified parental responses

There are behavioural and informational asymmetries in how parents from different socioeconomic statuses deal with the developmental process of their children (Carneiro & Ginja, 2014; Cobb-Clark et al., 2019; Ramey & Ramey, 2009; Waldfogel & Washbrook, 2011; Yeung et al., 2002). These imbalances become noticeable in the specific child-rearing practices that

[13] Note that this paper studies parental responses from a behavioural and not a normative perspective (Mayer et al., 2015). This means that I do not make assumptions about how much parents care about their children's development or how well they generally do in their parenting, but solely how effective for the child's development is the content and timing of their parental cognitive stimulation.

more and less educated parents implement, which are responsible for a large part of the developmental gap between children from high- and low-socioeconomic backgrounds. Therefore, the resources and elements described in the previous section are also potential pathways through which parental SES could affect how parents respond to the developmental declines experienced by their children.

First, regarding information asymmetries, Rowe and Goldin-Meadow (2009) shows that low-SES parents might put less time into talking to their children because they are unaware of the relevance of talking for their children's development. Benasich and Brooks-Gunn (1996) and Morawska et al. (2009) also find an association between parental education and parental developmental-related knowledge. Second, according to Hsin and Xie (2017), cognitive skills are an important mediator for the effect of parental education on children's academic performance, so it would not be unlikely that they also affect development. Third, there are influential differences in the information processing (Pressley et al., 1989) and soft skills (Heckman & Kautz, 2012) of high- and low-SES individuals, which can make the former more likely to effectively respond to developmental setbacks experienced by their children. Finally, parents from high and low socioeconomic backgrounds might discount the future at different rates (Breen et al., 2014).

Building on all this, *I expect high SES parents to respond to declines in their children's development by increasing their cognitive stimulation* (**hypothesis 2a**). However, I expect *low SES parents to decrease their cognitive stimulation when* *their children experience developmental declines* **(hypothesis 2b)**.

3.3 Data and methods

3.3.1 Data

The data used for this paper come from the National Longitudinal Survey of Youth 1979-Children and Young Adults Supplement (NLSY79-CYA). This is a nationally representative US cohort-based data collection that follows the children of those women who were originally part of the NLSY79 database. These are women who were born between 1957 and 1964, and at the time of the first interview in 1979 were 14 to 22 years old and lived in the US. The children born to these women were interviewed for the first time in 1986, and then every two years until 2014. These interviews consisted of a set of assessments to follow the children's cognitive, physical, and socio-emotional development.

The main units of analysis are child-year observations. The children are between 5 and 15 years old during their participation in the sample and live with their mothers. This age range responds to restrictions of the outcome variable (which is only collected for children aged 15 or younger) as well as the predictors (which are measured from age 5 onwards). The final analytical sample comprises 23,293 units of observation for a total of 9,570 individuals. The minimum number of observations per child is 2. These 9,570 children are born from 4,182 mothers of the NLS79 original sample.

There are two main advantages of using this database for this study. First, the high frequency of the data and the use of repeated measures make it possible to observe how parental cognitive stimulation changes throughout the childhood period. Second, the measures employed to operationalize cognitive stimulation and child development are the product of the interviewers' and mothers' responses, which increases the reliability of these analyses by combining two independent sources of observation.

3.3.2 Variables

The dependent variable of this study is mothers' cognitive stimulation, which is a child-specific measure that is part of the HOME-SF index (Home Observation Measurement of the Environment-Short Form). It was created by the developmental psychologists Bradley and Caldwell (1984) and measures how conducive the environment where the child lives and the parent-child relationship are for the cognitive stimulation of the child. It has been extensively used to explore parental cognitive stimulation both in developmental psychology and sociology (Mott, 2004). The existing literature has shown the high reliability of the index to capture the necessary conditions for the process of skills formation and children's development (Cunha, 2021).

The information about the detailed list of items of the mothers' cognitive stimulation index (26 in total) can be found in **Table B.1** in the **Appendix B**. This table also includes information about who was the person reporting each of the items (mother or interviewer). Some examples of these items are the regularity with which the mother reads to the child, the engagement of the mother in conversations with the child, the cultural outings that the mothers and children do together, or the help the mothers give to the children to learn the numbers, the alphabet, or the shapes.

Another two positive elements of this cognitive stimulation index are: (i) it is adapted to the different developmental stages and ages of the children, in the sense that what is considered an appropriate parental practice for a 5-year-old child is different from a 10-year-old one; and (ii) as noted before, it combines mothers' self-reported measures with the observations of the interviewers in a single index. This partially addresses the concerns about measurement error related to parenting variables that Cunha and Heckman (2008) discuss in depth. The measures employed here are continuous standardised scores ranging from 0 to 1500, where children were normed and weighted based on their age group.

The main independent variable captures the declines in children's developmental processes, which are measured through the negative changes in development that occurred in the period between the last observed time (*t*) and the previous time point available (*t-1*):

$$D_{i,t} = \Delta \, \mathrm{Dev} = \mathrm{Dev}_{i,t} - \mathrm{Dev}_{i,t-1} \tag{1}$$

The resulting variable is a dichotomous measure that takes value 1 when a child has been *treated*, i.e., has experienced a developmental decline from *t-1* to *t*; and value 0 if a child's development has remained stable or has increased (*non-treated*). Children's developmental process (and, consequently, declines in this developmental process) are measured in two dimensions: mathematical and reading skills. Both measures are part of the Peabody Individual Achievement Test (PIAT), which are standardized measures of development and achievement implemented from the moment the children turn 5 years old. In both cases, the assessments are implemented by the interviewer.

It is important to highlight three points. First, I assume that parents become aware of their children's developmental declines based on, primarily, the day-to-day interactions with their children, as well as on the school and teachers' reports and the informal communication with the interviewers about the development assessments. However, one limitation of this paper is that with the available data, there is no complete certainty about how parents observe changes in development. Therefore, if some parents are more likely than others to detect these variations, this could be inducing some biases in the analyses (Dizon-Ross, 2019).

Second, due to constraints in available data, it is not possible to investigate declines in school performance as an alternative to tests of abilities, which currently serve as the independent variable. Although the NLS survey introduced a school-specific module in 1995, this was a one-time occurrence, preventing the examination of relative variations over time. Nevertheless, it is reassuring to note that, leveraging information from the school achievement data in 1995, the correlation between school performance and the results of ability tests conducted by the NLS is approximately 0.8 points.

This suggests a coherence between children's academic performance in schools and their performance in the tests used as proxies for abilities in this analysis.

Third, it is important to notice that the PIAT tests are designed to capture children's development at different ages and the scores are relative to the other children of the same age. For instance, a child might score 100 points at age 5 but 50 points at age 7, and this would not mean that the total developmental level of the child has declined over time (which would not be congruent with a conventional developmental process). However, it would mean that whereas the child was ranked at the top of the distribution of development among the same-age children at age 5, she has moved to the medium part of the distribution at age 7. This is the source of variation exploited in this study.

The moderator variable of this study is family socioeconomic background, which is measured in two ways. First, through the highest education achieved by the mothers, with a dichotomous operationalization differentiating between tertiary and non-tertiary educated mothers[14]. The former includes all those with a Bachelor of Arts or Science Degree, a Master's Degree, a Professional Degree, or a Doctoral Degree; the latter includes those without any school qualification, a High School Diploma, or an As-

[14] Although it would be ideal to consider fathers' education too, the available data only interviews the mothers of the children. In some cases, there is a possibility of incorporating information about the partner of the mother, but the regularity of these measures is not enough for the implementation of the models based on biennial observations. Despite this, it is important to remark that mothers have been considered the main agents in the developmental process of children and that there is a high congruence between mothers' and fathers' parenting choices (Augustine, 2014).

sociate Degree. The choice of a dichotomous operationalization responds to one substantive and one methodological reason. First, college degrees have been usually pointed out in the parenting literature as the borderline between different types of parental practices (Lareau, 2011). Second, the research design of this study imposes several requirements in terms of the regularity, longitudinal nature, and family structure of the data. Therefore, employing more categories would significantly reduce the number of observations in each group. The second measure of family SES, which is used as a robustness check, is the family income quintile. The operationalization employed distinguishes between those in the top 20% versus the bottom 20% of the income distribution. All the information about the variables is shown in **Table B.2**.

3.3.3 Analytical strategy

The analytical strategy of this paper aims to estimate the effect of developmental declines on mothers' cognitive stimulation. To do so, it uses two different approaches. In the first part of the analysis, I present the results from a two-way fixed effects (TWFE) estimator. In the second stage, I use the fixed effects counterfactual estimator (FEct) by Liu et al. (2022) to account for the potential biases derived from the dynamic character of the treatment (i.e., experiencing developmental declines).

Regarding the first stage, the TWFE estimate reports within-child estimates (instead of between-children) of the effect of developmental declines on mothers' stimulation, and accounts for unobserved time-invariant heterogeneity so that it minimises potential omitted variable biases. For example, some variables such as personality traits or parent-child relationships may impact the declines in skills (predictor) and maternal cognitive stimulation (outcome). In a scenario in which these unobserved factors were not considered, the results would be upwardly biased if, for instance, a bad parent-child relationship negatively impacts the child's developmental process and the cognitive stimulation implemented by the mothers.

The implementation of the TWFE model is possible thanks to the longitudinal repeated data of individuals over time and it exploits the within-individual differences as the main source of variation. It is superior to one-way fixed effects models insofar as it controls for both individual-specific and time-specific confounders, which increases the precision of the estimates. Moreover, it is relevant to notice that this model provides the average treatment effect on the treated, so that the results should be interpreted only in relationship to those who experience declines in their developmental process. The TWFE model is specified in *Equation (2)* below:

$$CS_{i,t} = \beta_1 D_{i,t} + \beta_2 C_{i,t} + \alpha_i + \tau_t + \varepsilon_{i,t} \tag{2}$$

where $CS_{i,t}$ is the cognitive stimulation for individual i at time t; β_1 is the coefficient for the treatment, experiencing a developmental decline $D_{i,t}$; β_2 is the coefficient for the time-varying control variables (since TWFE cannot estimate the effect of time-invariant controls); α_i is the individual fixed effects for individual i; τ_t is the time fixed effect for time t; and $\varepsilon_{i,t}$ is the error term for individual i at time t. Standard errors are clustered at the family level. For the stratification analyses that aim to examine whether the hypothesized effect is in place for both low- and high-SES families, the same model specified in *Equation (2)* is run on the stratified samples for each group.

A problem with the TWFE estimator is that, according to Goodman-Bacon (2021), in order to derive causal interpretation from the TWFE estimates, it is required that three assumptions hold: (i) parallel trends, (ii) no anticipation, and (iii) treatment effects that are constant over time. Although there are econometric tools to test and account for the two first assumptions (Abadie, 2005), the last assumption that speaks to the dynamic nature of treatment effects has been only recently problematized. As a response, a series of dynamic difference-in-difference estimators have been developed (Callaway & Sant Anna, 2021).

The dynamic nature of a treatment effect can be produced (i) by a staggered rollout, namely individuals are exposed to the treatment at differential times (instead of the classical policy example that affects all individuals at the same time), or (ii) by the withdrawal from the treatment, which means that the individuals change their status between treated and untreated on several occasions so that the treatment is not permanent.

In the first scenario, when different individuals are exposed to the treatment at different time points, the problem with TWFE estimators is that the estimates will be contaminated by information from lags and leads of the treatment from other periods (Sun & Abraham, 2021). This is because the

TWFE estimator uses the already treated units as controls, which becomes problematic in a dynamic setting in which different observations get the treatment at different points[15]. In the second scenario, when the exposure to the treatment is intermittent, the difficulty comes from the fact that the TWFE does not account for carryover effects, which means that it ignores that the probability of being exposed to the treatment in the present period could be affected by previous exposure (Sun & Abraham, 2021).

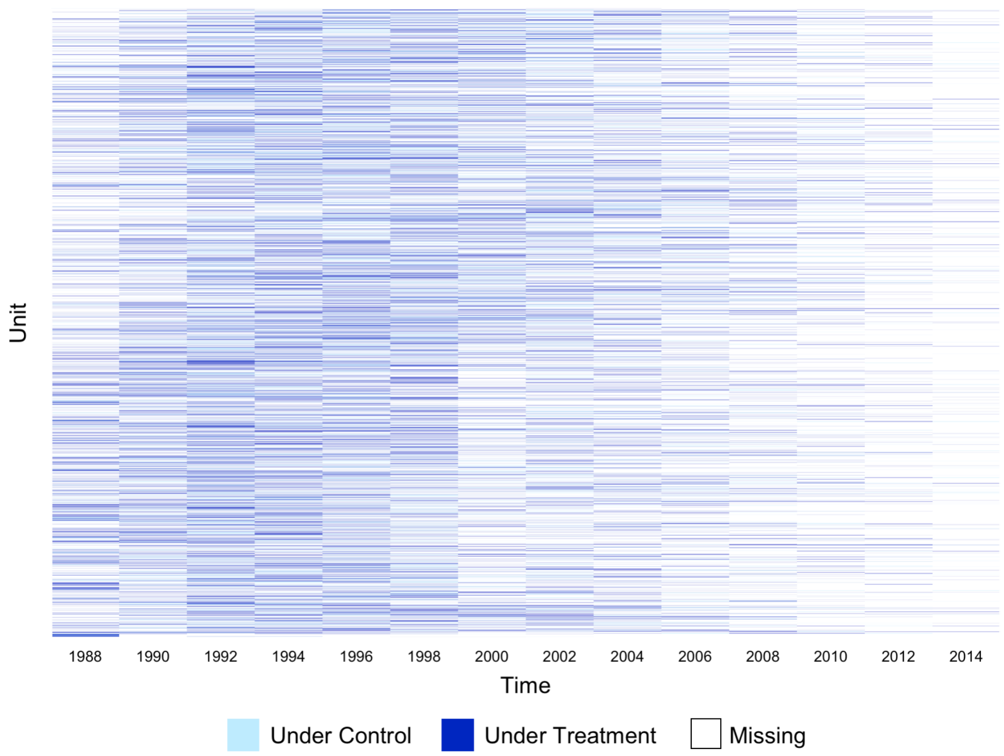
To account for these two problems, Liu et al. (2022) propose a group of fixed effects counterfactual estimators (FEct), which are based on taking the observations under treatment as missing and using those under the control condition to get counterfactuals of treated observations. The resulting estimators, "by not using the treated observations at the modelling stage and by imposing uniform weights on individualistic treatment effects on treated observations, [...] it correct biases induced by treatment effect heterogeneity" (p. 2). The authors show that in the context of dynamic (staggered and intermittent) treatment effects, the FEct estimators perform better than the traditional TWFE.

In this paper, the treatment of interest has a staggered nature, since each of the children in the sample may show a developmental decline at different points during their childhood (i.e., it is not uniform across the sample). Moreover, the same child that experiences a developmental decline may

[15]As explained by de Chaisemartin and D'Haultfoeuille (2019), "negative weights arise because *Beta* is a weighted sum of several difference-in-differences (DID), which compare the evolution of the outcome between consecutive time periods across pairs of groups. However, the control group in some of those comparisons may be treated in both periods. Then, its treatment effect at the second period gets differenced out by the DID, hence the negative weights" (p. 2).

change the pattern afterwards (i.e., show a developmental increase or keep a constant trajectory). This means that individuals switch between treated and untreated across the period studied. The specific treatment pattern of the sample can be visualized in **Figure 3.1**, which shows a line for each individual. In dark blue, there are those periods in which the individual is under treatment, in light blue those in which the individual is used as a control, and in white the non-observed or missing periods. Therefore, to account for these complex dynamic patterns of treatment, I will make use of the FEct estimators in the last stage of the analyses.

Figure 3.1: Treatment status of individuals in the sample over time *(for reading declines)*



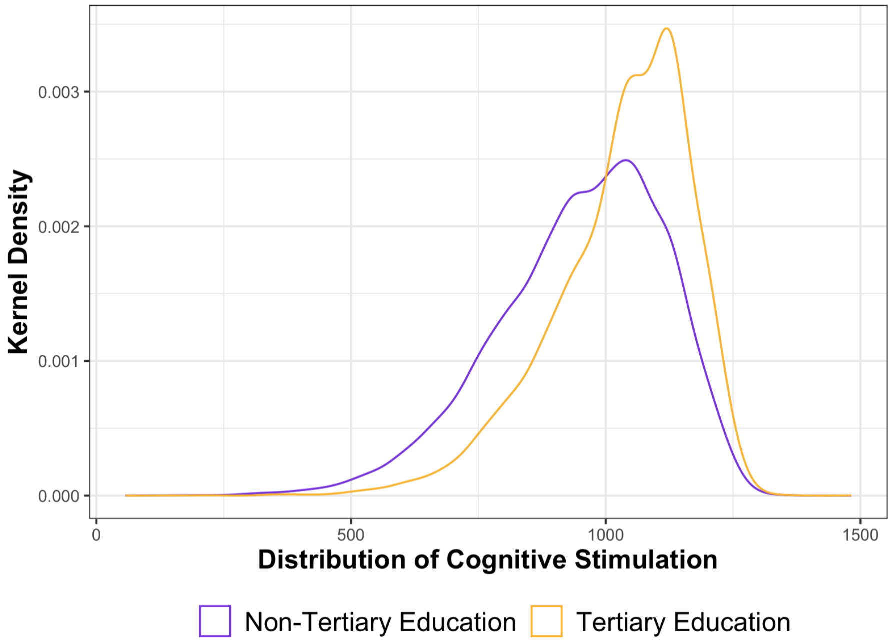
The analyses of this paper are performed using R Studio. For the TWFE estimation, I use the package *fixest*, and for the FEct estimation the package *fect*, which was developed by Liu et al. (2022). Finally, the two assumptions regarding parallel trends and no anticipation that are necessary to sustain the two estimation strategies used in this paper are tested in the robustness section together with other relevant tests.

3.4 Results

3.4.1 Descriptives

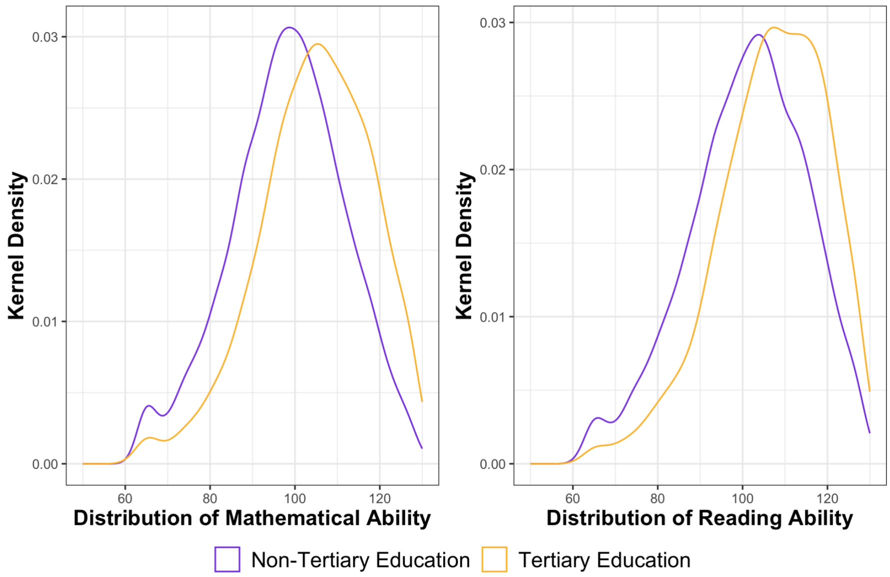
Figure 3.2 shows the distribution of the main outcome variable, the mothers' cognitive stimulation index. On a range from 0 to 1500, the mothers in this sample present an average cognitive stimulation of 971. There are notable differences in the cognitive stimulation of mothers with tertiary and non-tertiary education. The first group, those with tertiary education, present an average of 1039.38 points on the cognitive stimulation scale, whereas the low-educated mothers have an average of 950.26 points. The difference between the two groups is significant (Welch t-test comparison, p-value=0.000).

Figure 3.2: Distribution of mothers' cognitive stimulation by maternal education



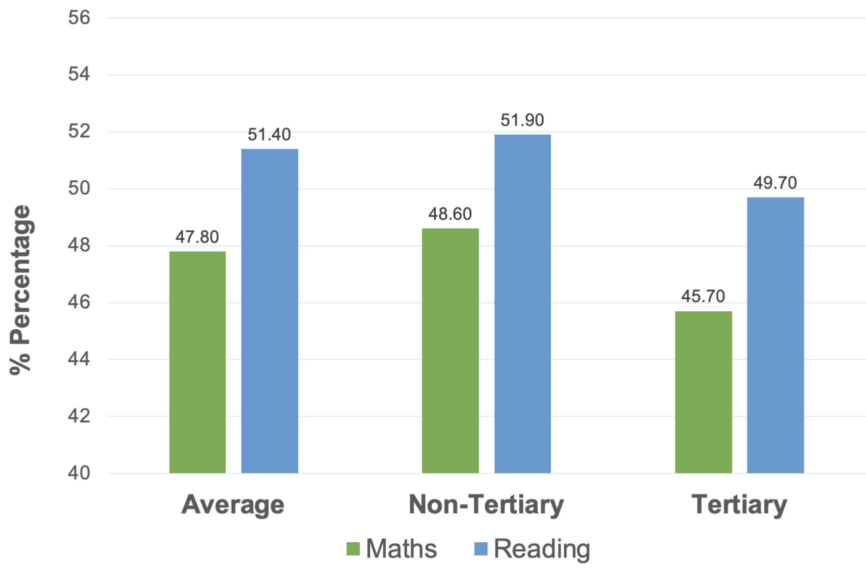
It is also relevant to explore the distribution of children's mathematical and reading skills (**Figure 3.3**). On a range from 0 to 135, the children in this sample show an average of 100.6 and 104.1 in their mathematical and reading skills respectively. As expected, children from more privileged backgrounds seem to perform better in the two dimensions, showing significant differences between groups (p-value=0.000 in the Welch t-test comparisons for both dimensions).

Figure 3.3: Distribution of children's mathematical and reading skills



However, the main predictor of this study is not the absolute level of ability of the children shown in **Figure 3.3**, but experiencing a decline from *t-1* to *t* in mathematics or reading skills. 47.8% of the sample (children-year units) experience some decrease in mathematical skills across time, and 51.4% show decreases in their reading skills. As shown in **Figure 3.4**, among those with low-educated mothers, 48.6% experience these decreases in mathematical skills and 51.9% in reading skills. These numbers are lower for those with highly educated mothers: 45.7% and 49.7% show decreases in their mathematical and reading skills respectively.

Figure 3.4: Percentage of declines in mathematical and reading skills by family SES



3.4.2 Main models

The main results from this paper are shown in **Table 3.1** below. The first two columns present the results for the OLS models with controls[16], the third and fourth show the two-way fixed effects models, and the last two columns are the fixed effects counterfactual results.

According to models (1) and (2), when a child experiences a decline in their mathematical or reading skills from time t-1 to time t, the level of cognitive stimulation of the mother will be reduced by 4.37 and 4.55 points respectively. When I include individual and time-fixed effects, the impact of mathematical declines on mothers' stimulation drops slightly (4.13 points),

[16] OLS models are presented to provide a baseline upon which to interpret the more complex TWFE and FEct models.

although still shows a significant effect. In the case of reading skills, the negative effect of developmental declines on maternal cognitive stimulation disappears. This suggests that the OLS models are overestimating the negative impact of children's reading declines.

Table 3.1: OLS, TWFE, and FEct Regressions

	Dependent Variables: Cognitive Stimulation					
	OLS (1)	OLS (2)	TWFE (3)	TWFE (4)	FEct (5)	FEct (6)
Decline in Maths Skills	-4.374^{*} (1.872)		-4.127^{**} (1.515)		-6.179^{***} (1.503))	
Decline in Reading Skills		-4.552^{*} (1.870)		1.606 (1.553)		0.9444 (1.721)
R^2	0.191	0.190				
Observations	23,293	23,293	23,293	23,293	23,293	23,293

Note: Models (1) and (2) are OLS regressions with controls for gender, race, year, and mothers' education.
Models (3) and (4) are Two-Way Fixed Effects Regressions with controls for changes in mothers' education.
Models (5) and (6) are Fixed Effects Counterfactual estimations.
Standard errors for models (5) and (6) are obtained through non-parametric bootstrap procedures (1000 bootstrap runs).
Standard errors are clustered at the mother level and presented in parentheses in the table.
$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Models (5) and (6) show the effect of declines in children's development on mothers' cognitive stimulation once the dynamic character of the treatment is taken into consideration. These models deal with the fact that (i) not all individuals in the sample experience the developmental declines at the same time, and (ii) the developmental pattern of a large part of the sample implies intermittent declines over time (i.e., switch on and off from the treatment status).

The findings from the fixed effects counterfactual models show that decreases in children's mathematical skills have a negative and significant effect of almost 6 points on mothers' cognitive stimulation. In the case of reading skills, however, mothers do not seem to respond to these developmental declines. Therefore, these results are consistent with the TWFE models but suggest that by not accounting for the dynamic character of the treatment, the conventional TWFE might be underestimating the average treatment effect of the treated. As explained by Liu et al. (2022) this could be due to the fact that the probability of getting the treatment is conditioned by the treatment in the previous period, which is something that the TWFE cannot control for, and that generates the negative weights problem and the downward bias that de Chaisemartin and D'Haultfoeuille (2019) discuss in depth.

It is also relevant to notice that, despite being statistically significant in all the models, the effect of declines in mathematical skills on mothers' cognitive stimulation has a limited effect size (around one-tenth of a standard deviation).

3.4.3 SES heterogeneity

Table 3.2 presents the results for the TWFE and FEct models stratified by the socioeconomic background of the family. In both model specifications, and for the mathematical skills dimension, mothers with low levels of education reduce their levels of cognitive stimulation when their children show developmental declines. However, tertiary educated mothers do not modify their cognitive stimulation when their children experience setbacks in their mathematical development. Moreover, according to the TWFE model, highly educated mothers increase their cognitive stimulation when their children experience reading declines.

Table 3.2: Cognitive stimulation by mothers' education.

	Dependent Variables: Cognitive Stimulation			
Panel A: **TWFE**	Non-Tertiary Education	Tertiary Education	Non-Tertiary Education	Tertiary Education
	(1)	(2)	(3)	(4)
Decline in Maths Skills	-5.400^{*}	-3.239		
	(2.303)	(1.978)		
Decline in Reading Skills			-0.616	4.012^{*}
			(2.395)	(1.990)
Observations	16,830	6,506	16,830	6,506
Panel B: **FEct**	Non-Tertiary Education	Tertiary Education	Non-Tertiary Education	Tertiary Education
	(5)	(6)	(7)	(8)
Decline in Maths Skills	-7.318^{***}	-5.215		
	(2.333)	(2.078)		
Decline in Reading Skills			-0.443	2.292
			(2.607)	(2.205)
Observations	16,830	6,506	16,830	6,506

Note: Two-Way Fixed Effects and FEct regressions run in stratified samples (*high/low SES*). Standard errors are clustered at the mother level and presented in parentheses in the table. Standard errors for models (5), (6), (7) and (8) are obtained through non-parametric bootstrap procedures (1000 bootstrap runs). . $^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table 3.3 replicates these analyses using a different operationalization of family SES, which is family income (top vs. bottom 20% of the distribution). These results show a similar scenario: those mothers who are in the lowest quintile of the income distribution reduce their cognitive stimulation when their children show decreases in their mathematical development. This is true both for the TWFE and FEct models. Moreover, those in the top quintile of the income distribution increase their cognitive stimulation as a response to decreases in their children's skills.

Table 3.3: Cognitive stimulation by family income.

	Dependent Variables: Cognitive Stimulation			
Panel A: **TWFE**	Top 20% income	Bottom 20% income	Top 20% income	Bottom 20% income
	(1)	(2)	(3)	(4)
Decline in Maths Skills	−4.576 (3.258)	−3.667* (1.767)		
Decline in Reading Skills			7.735* (3.244)	0.9476 (1.821)
Observations	4,201	4,201	4,201	4,201
Panel B: **FEct**	Top 20% income	Bottom 20% income	Top 20% income	Bottom 20% income
	(1)	(2)	(3)	(4)
Decline in Maths Skills	−4.271 (3.594)	−5.664** (1.84)		
Decline in Reading Skills			7.695* (3.505)	0.3979 (1.848)
Observations	4,201	4,201	4,201	4,201

Note: Two-Way Fixed Effects and FEct regressions run in stratified samples (Top/Bottom quintiles). Standard errors are clustered at the mother level and presented in parentheses in the table. Standard errors for FEct models are obtained through non-parametric bootstrap procedures (1000 bootstrap runs). $^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

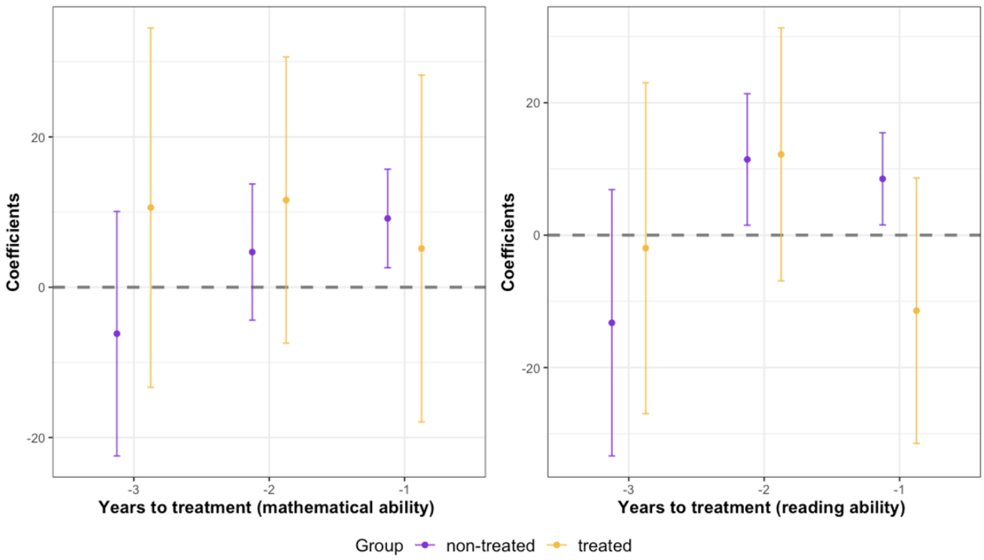
3.4.4 Robustness tests

3.4.4.1 Testing the assumptions

There are two fundamental assumptions that must be fulfilled for the TWFE and FEct models to be reliable. The first one is parallel trends, which implies that, if the treatment (in this case, cognitive declines) had not taken place yet, the difference in the outcomes between the treated and untreated groups should not exist. Although this assumption cannot be fully tested because there is not an observable counterfactual, I provide some evidence for this assumption through a test of prior trends and four further tests (Huntington-Klein, 2021).

Figure 3.5 (and **Table B.3** in the Appendix) show the prior trends for the treated and non-treated groups in the pre-treatment period. The differences in the coefficients between the treated and untreated groups are not significant, as shown by the overlapping error bars between groups in the figure. This gives support for the parallel trends' assumption.

Figure 3.5: Pre-treatment trends



In the first model of **Table B.4**, I show that when, instead of using the real treatment observed in the data (i.e., developmental declines), I use a randomly assigned treatment (i.e., a placebo set at different points in the pre-treatment period), there is not a significant effect of the treatment on maternal stimulation. This suggests that the parallel trends assumption is not violated in the model by the existence of some non-observable dynamic.

For the remaining tests, I follow Liu et al. (2022) and implement three tests for (no) pretends that account for the dynamic (staggered and intermittent) character of the treatment. The first of these three tests is an F-test for pretreatment differential trends. Models (2) and (5) in **Table B.4** present the p-value for mathematics and reading respectively. According to the authors, a larger F-test p-value implies better pre-trend fitting, since it suggests that pre-treatment differential trends have not been found. This is the case for both outcomes, mathematics and reading, although more reassuring in the case of mathematics, with a p-value of 0.42.

The other two tests implemented following Liu et al. (2022) are considered equivalence tests. These tests are characterized because the starting point is that the data is not consistent with the assumption (in this case, the lack of pre-treatment trends). The results from the TOST tests are presented in models (3) and (6) and examine whether, at a 95% confidence, the average treatment effect in the pretreatment period exceeds what is called the equivalence range. Following the authors, the smaller the TOST p-value the better the pre-trend fitting. A modification of this is the LOO (Leave-One-Out) test, which instead of using the estimated average treatment effects for the periods before the treatment, hides consecutively one pretreatment period. In both cases, the results shown in Models (3), (4), (6) and (7) of **Table B.4** show that the data employed in this paper pass the test of no pretend that is needed for the TWFE and FEct models to hold.

The second assumption needed is the absence of anticipation effects. If anticipation effects were in place, mothers would be foreseeing the developmental declines of their children before these take place. Consequently, I would observe a displaced effect just immediately before the actual treatment occurs. To test for this possibility, I conduct another type of placebo test shifting the treatment point to one and two years before the event took place. Results are reported in **Table B.5** and show that there is no causal effect of the treatment before the actual developmental decline happens. In other words, mothers do not vary their cognitive stimulation levels in the periods before their children show a developmental decline as a way of preparing for it.

3.4.4.2 Reverse causality

An important limitation of the current models is that they do not very successfully address reverse causality. The TWFE and the FEct models in this paper aim to measure whether there is an effect of the fluctuations in children's development on later parental cognitive stimulation. The time dimension ensures that the changes in child development occur earlier in time than the parental cognitive stimulation. However, this does not discard the possibility of previous parental stimulation affecting children's abilities, or even both being the product of a time-invariant factor such as the parent-child relationship. A way of accounting for this possibility is by implementing a dynamic panel data model.

These models let the dependent variable be affected by its previous values so that the model acquires a dynamic component and accounts for temporal order (assuming that parental stimulation at time *t* will be related to parental stimulation at time *t-1*, *t-2*...). The inclusion of lagged values of parental stimulation implies that the effect of the main independent variable on the outcome is compared among individuals with the same level of initial parental stimulation (at time *t-1*). This accounts for potential unobserved factors that could be affecting the outcome and be correlated with the predictor. It has been shown in the literature that these models produce more consistent estimates than fixed and random effects in the presence of potential reverse causality (T. W. Anderson & Hsiao, 1982; Bond, 2002; Del Bono et al., 2012; Rosenzweig & Wolpin, 1988).

Something to consider is that, by including a lagged version of the dependent variable, a problem of endogeneity emerges, which can be solved through the inclusion of instrumental variables described by Arellano and Bond (1991). Therefore, in practice, these models have to be implemented through a System Generalized Methods of Moments (GMM) estimator (Arellano & Bond, 1991; Roodman, 2009), which is especially advisable for panels with few periods and many individuals, such as in this case.

The results from these models are presented in **Table B.6** and show that mothers respond to declines in their children's mathematical sills by decreasing their cognitive stimulation, which is consistent with the main results from this paper. The fact that this is true despite accounting for the lagged version of the cognitive stimulation variable is reassuring in terms of the potential reverse causality problems. It is also relevant that previous in time cognitive stimulation has a positive and significant effect on later parental stimulation, which points out to the cumulative character of parenting (Cano, 2022).

3.4.4.3 Skewed distribution of the outcome

Another robustness test is implemented to account for the left-skewed distribution of the main outcome variable (see **Figure 3.2**). With this aim, I rerun the main analyses using a log transformation of the cognitive stimulation variable. These results are available in **Table B.7** and show a similar pattern to the main results reported in **Table 3.1**, although the size of the estimates of course differs given the re-escalation of the variable.

3.4.4.4 Accounting for age effects

A possibility is that mothers respond heterogeneously to their children's developmental declines when they have different ages. For instance, it could be that mothers are much more sensitive to these developmental declines when children are younger. To account for this potential age heterogeneity, I replicate the main TWFE models in **Table B.8** introducing an interaction term between the main predictors (decreases in mathematical and literacy abilities) and the age category of the children. The age variable has four categories according to the quartile of the child's age, from 5 to 9 years old (i), from 9 to 11 (ii), from 11 to 13 (iii), and from 13 to 15 (iv).

Interestingly, as compared to those children who are between 5 and 9 years old, older children receive a higher cognitive stimulation from their mothers'. However, as shown by the interaction coefficients, the differences in the effect of declines in skills among age groups are not statistically significant.

3.4.4.5 Accounting for time varying factors

The current model specifications account for all the individual time-invariant characteristics that could affect both the level of child development and maternal cognitive stimulation. However, there might be time-varying factors that affect the ability of the mothers to implement cognitively stimulating parenting and the level of child development. That could be the case of parental separation, the number of children in the family and changes in the region where the family lives. **Table B.9** shows the results from the main analytical models accounting for these time-varying confounders. These findings show that the main effect of a decline skills is not altered by the introduction of these controls: a decline in mathematical skills still shows a negative and statistically significant effect on mothers' cognitive stimulation, and a decline in reading skills does not produce any consistent significant impact.

3.4.4.6 Regression to the mean

A possibility is that the results from the main analyses are capturing those children who experienced a positive period of above-average performance in the past, and then just returned to their average performance (i.e., a regression towards the mean). To account explicitly for this possibility, I rerun the main model of this paper introducing controls for previous variations in abilities at time *t-1* and *t-2*. Thus, the estimates obtained would only capture the effect net of the variations in the children's ability in previous periods.

These results, presented in **Table B.10**, show that the effect of a decline in skills on mothers' cognitive stimulation is still negative and significant despite including the lag of skills variations at time *t-1*, which goes against the idea of regression towards the mean being in place. In the case of skills variations at *t-2*, the main estimate of interest is still negative but not significant anymore. This could be driven by the fact that the sample with the inclusion of the two lags imposes large restrictions on the data and the available observations do not offer enough power to detect statistical significance. In any case, it is reassuring that the direction and magnitude of the estimate go in line with the previous results. Also consistent with the rest of the findings, the models for the variations in reading skills are not substantively or statistically significant.

3.4.4.7 Interaction with the total level of ability

A remaining question is how these relative changes in ability relate to the absolute level ability of the children. To fill this gap, I introduce in the main models an interaction term between children's baseline abilities (operationalised as the specific quartile in which the child locates compared to the distribution of absolute ability in the whole sample) and the declines in ability from *t-1* to *t*.

Table B.11 shows that, in the case of mathematical abilities, there are no significant differences in the effect of developmental declines on mothers' stimulation regarding the position of the children in the distribution of absolute ability. As expected, there is a positive and significant main effect of having a higher total ability (quartiles 3 and 4) on the level of maternal cognitive stimulation. In the case of reading abilities, these results show that the negative effect of cognitive declines on mothers' stimulation is specifically concentrated among those at the lowest part of the ability distribution.

3.4.4.8 Different intensity of the treatment

The current analyses operate under the assumption that every decline in abilities produces a uniform effect, as they do not differentiate how the specific magnitude of these declines influences the outcomes. To address this limitation, the subsequent analyses, presented in **Table B.12**, involve a reevaluation of the main models by categorising participants into four distinct groups based on the intensity of the decline. For mathematical abilities, the decline spans from 1 to 70 points, while for reading abilities, it extends from 1 to 116 points.

The results indicate that, in comparison to those with minor declines in abilities, children experiencing the most substantial declines in mathematical abilities (fourth quartile) also exhibit a more pronounced negative effect on their mothers' cognitive stimulation. These variations regarding treatment intensity are not present for the reading abilities models

3.5 Discussion and conclusions

This study examines how children's developmental declines impact the level of cognitive stimulation implemented by the mothers and whether there are heterogeneous socioeconomic effects in this relationship. Building on the compensatory advantages literature and the *developmentally effective parenting* concept, I suggest that parents will respond to declines in their children's skills by increasing their cognitive stimulation, especially in the case of high-SES parents. The intuition behind these hypotheses is that the moments when the child's development is more stagnant are precisely when a parental boost is needed the most, and parents from more privileged backgrounds are especially aware of this. I explore these two questions using longitudinal NLS79-CYA data from the US and a series of two-way fixed effect and fixed effects counterfactual models.

Results show a compelling and partially unexpected scenario. Net of all the other factors included in the models, mothers reduce their cognitive stimulation when their children have experienced decreases in their mathematical skills. This result is consistent with the literature on the bidirectional influence between parents and children and suggests that parents do modify their behaviour based on their children's developmental fluctuations (Bell & Chapman, 1986). Although this finding is constant across specifications (OLS, TWFE, and FEct), it is important to notice that these effects have a small size (around one-tenth of a SD). Moreover, the mothers in the sample do not modify their behaviours as a response to declines in children's reading skills.

Although the different stages of the analysis show consistent results, there are some nuances that should be mentioned. First, by focusing for between families' variation, the OLS models seem to overestimate the effect of developmental declines on mothers' cognitive stimulation. Second, when compared to FEct, the TWFE estimation fails to account for the dynamic character of the treatment, which generates the problem of negative weights that de Chaisemartin and D'Haultfoeuille (2019) discuss, and that would explain why these estimates would be underestimating the effect of developmental declines.

When I zoom in on the different socioeconomic levels, I find that this effect is not homogeneous across social groups. Mothers with lower levels of education or those at the bottom of the income distribution reduce their cognitive stimulation as a response to decreases in mathematical skills. This evidence supports the idea from the compensatory advantage literature that low-SES mothers are more likely to reinforce existing disadvantages (Restrepo, 2016). Although high-SES mothers do not show such a consistent response to children's developmental declines across models, they seem to increase their cognitive stimulation when their children show reading declines, which could be considered partial evidence of compensatory behaviour.

This research makes several noteworthy contributions to the field. Firstly, it delves into the dynamic nature of child development and parental responses and argues that parents do not only modify their behaviours based on the total level of skills of their children, as previous studies have noted, but also based on the fluctuations experienced in the developmental process. Secondly, it expands the previous literature on compensatory and reinforcing parental effects by investigating whether mothers from diverse socio-economic backgrounds respond differently to their children's developmental setbacks. Lastly, this paper discusses the use of fixed effects counterfactual estimations, which have been mostly overlooked in the previous sociological research, and that overcome some of the limitations of the two-way fixed effects models to analyze dynamic social processes.

However, this paper has several limitations too. First, this study is only capturing two dimensions of children's development, mathematical and reading skills, but parents might respond differently to other dimensions. Second, the main outcome of this study, maternal cognitive stimulation as measured by the HOME index, includes some items that might capture the child's specific tastes more than the parents' behaviours. This is the case of those items measured when the child is 10 to 14 years old, such as reading books or attending musical lessons. It is reassuring, however, that these items are not as directly connected to the mathematical dimension as they are to the reading dimension. Third, given the survey data nature of this study, it is not possible to disentangle how exactly parents observe the changes in their children's development or how aware they are of their expected developmental levels. This is relevant because if some parents are more likely to detect these changes, they will also be more likely to respond the these.

This study has important implications for the understanding of societal inequality. If, as these results show, parents reinforce existing disadvantages by decreasing their cognitive stimulation, the long-term human capital of these children will likely be affected by these parental behaviours. This is especially daunting in the case of more disadvantaged families, since the decreases in cognitive stimulation may broaden the developmental gap that already exists between children in low- and high-SES contexts and reinforce pre-existing inequalities.

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Chapter 4

Skills Beget Skills:

Addressing the Role of Mothers' Occupation-Specific Skills on Children's Developmental Process.

Abstract

This paper examines how mothers' occupation-specific skills affect the process of children's skills formation. Whereas the impact of parental education on children's development has been widely studied in the literature, this has not been the case for parental occupation. I exploit variations in mothers' occupation-specific skills that occur when mothers change their jobs. I combine longitudinal family data from the NLSY79-CYA with the O*NET dataset, and implement a series of two-way fixed effects models combined with inverse probability weighting techniques, as well as asymmetric fixed effects models. Results show that when mothers transition to a job in which more mathematical skills are required, their children's mathematical skills get boosted. The findings are similar for the literacy skills dimension although are less robust to the implementation of more demanding model specifications. Further results show that (i) the more time the mother spends in the job the larger is the effect of these skills on children's development, (ii) the effect is dimension-specific, i.e., changes in mothers occupation-specific mathematical skills affects children's mathematics but not literacy skills (and the other way around), (iii) this effect is mainly driven by skills upgrading but not skills downgrading, and (iv) children with high-SES mothers benefit more from skills increases than those with low-SES ones. Overall, this study suggests that the transmission of occupation-specific skills might be a channel through which social reproduction operates.

4.1 Introduction

This paper examines the impact that mothers' occupation-specific skills have on children's skills formation. A wide literature on human capital formation has focused on the effect of parental education on child development (Anger & Heineck, 2010; Breinholt & Holm, 2020; Guryan et al., 2008; Rowe et al., 2016). However, the role of parental occupation in fostering children's skills has been mostly overlooked. Mothers' occupations are relevant for children's development for two reasons. First, mothers are still the main caring agents and are responsible for a large part of children's developmental outcomes (Huston & Rosenkrantz Aronson, 2005). Second, given the expansion of women's labour market participation in the last decades, mothers' jobs play a crucial role in mothers' lives, and consequently, home dynamics (Ruhm, 2004).

Occupation-specific skills are the skills that the workers learn effectively on the job and have been noted to affect labour market trajectories and outcomes (Kwon & Meyersson Milgrom, 2014; Lagoa & Suleman, 2016), as well as political preferences and attitudes formation (Emmenegger, 2009; Polavieja, 2012). Therefore, following Jonsson et al. (2009) and Barg and Klein (2023), and considering that occupation-specific skills are a crucial component of individuals' skills sets, I suggest that they might also wield significant influence in the intergenerational transmission of skills, and contribute to the process of social reproduction.

I combine data from the US National Longitudinal Survey and the Children's Supplement with the O*NET dataset. The first datasets follow mothers and their children across several decades and provide valuable information on the occupational history of the mothers (with biennial observations) as well as assessments of the child's skills across different dimensions. The second dataset, O*NET, provides information about the specific skill levels needed to carry each job. I measure mothers' occupation-specific skills with two indexes capturing (i) mathematical skills and (ii) literacy skills. Children's skills are measured through the age-specific Peabody Individual Achievement tests, implemented by external assessors, in the same two dimensions, mathematical and literacy. The children in the sample are between 5 and 15 years old.

The analytical strategy of this paper exploits mothers' occupational changes during their labour market trajectories that bring fluctuations in the level of required occupation-specific skills. This way, I estimate the effect of variations in mothers' occupation-specific skills at time *t-1* on children's skills at time *t*. I employ a series of two-way fixed effects models in combination with inverse probability weighting, as well as asymmetric fixed effects models.

The main finding of this paper is that an increase in maternal occupation-specific mathematical skills at time *t-1* has a positive effect on her child's mathematical skills at time *t*. The effect size is approximately one-ninth of a standard deviation. This result is robust to the inclusion of inverse probability weighting techniques. In the case of literacy skills, however, the results show a less consistent pattern, with positive and significant effects in some of the models that disappear after accounting for potential selection.

Moreover, the findings also shed light on the potential mechanism behind this effect. First, the effect of mothers' skills changes gets larger when the mother stays in the job for a longer period. Second, the transmission of skills is produced in a dimension-specific way, which means that changes in mothers' mathematical skills do not impact children's literacy skills but only the mathematical ones (and the other way around). Finally, and thanks to the implementation of the asymmetric two-way fixed effects models, I disentangle the direction of the main causal effect. I find that children's skills vary as a response to mothers' skills upgrading, whereas mothers' skills downgrading does not show any effect on children's skills.

Additionally, I account for several alternative pathways through which mothers' job changes could impact children's skills formation. In the case of mathematical ability, the effect of occupation-specific skills remains constant despite considering several child-, family-, and job-specific factors. However, for the literacy skills example, the main effect disappears when accounting for the working hours of the mother and other occupation-related factors. Finally, after rerunning the models in stratified samples for high- and low-SES children, the results show that children from high-SES families benefit more from the skills changes than those from low-SES backgrounds.

This paper makes four key contributions to the literature. First, it represents, to the best of my knowledge, the first empirical test on whether changes in maternal occupation-specific skills impact the process of skills formation of their offspring. Two previous papers have studied this issue theoretically (Jonsson et al., 2009) and in a descriptive setting (Barg & Klein, 2023). Second, this study advances the existing research by disentangling the asymmetric causal effect and distinguishing between skills upgrading and downgrading, as well as by indirectly examining the potential mechanism behind this effect. Third, it investigates the stratified nature of intergenerational transmission of occupation-specific skills, which has significant implications for understanding the process of social reproduction. Finally, this paper explores the US case, which has been previously overlooked despite the rich available data.

4.2 Theoretical frame

4.2.1 Intergenerational transmission of skills

Several mechanisms have been noted as potential channels through which inequality persists across generations, such as the transmission of education, cultural inputs, wealth, genes, or even health (Bowles & Gintis, 2002). Among all of them, the transmission of skills has been considered especially relevant to understand how parents pass their socioeconomic status to their children (Blanden et al., 2007). Skills are generally highly rewarded in the educational system and the labour market (Gronqvist et al., 2010), and therefore, if parents with certain skills manage to pass them on to their offspring, these children will experience an advantage compared to those children who do not receive certain inputs from their parents (Anger, 2012).

Most of the literature on the intergenerational transmission of skills has found evidence of skills persistence across generations (Anger & Heineck, 2010; Attanasio et al., 2020; Bowles et al., 2009; Campos-Vazquez, 2018; Gronqvist et al., 2010; Hsin & Xie, 2017; Lundborg et al., 2014). However, there are some variations based on the type of skills and the measure employed, as well as the stage of the child's lifecycle and the country studied.

Regarding the type of skills, there are two main groups of studies. The first and most developed branch of literature examines the intergenerational transmission of cognitive abilities (Agee & Crocker, 2002; Hanushek et al., 2021). Among these, some studies use a very specific measure of cognitive abilities, namely IQ (Bjorklund et al., 2009; Black et al., 2009), whereas others use test scores (Blanden et al., 2007; Duncan et al., 2009) or total measures of educational attainment (Lundborg et al., 2014; Sacerdote, 2002). In all instances, there is consensus in the literature about the positive and persistent effect that parental cognitive skills have on children's cognitive skills.

The second type of skills examined, mainly from the psychological and developmental literature, has been non-cognitive ones. In general, the correlations between parents and children's non-cognitive skills are lower than the ones found for cognitive abilities (Attanasio et al., 2020; Mayer et al., 2004). Hsin and Xie (2017) suggest that the effect of parental socio-behavioural skills on their children is one-third of the cognitive skills effect. However, as Gronqvist et al. (2010) notice, measurement error is more present when measuring non-cognitive skills, and this can be biasing the results obtained in the previous studies.

The magnitude of these effects varies by country: whereas in Germany, an increase of one point in the cognitive ability scale of the mother implies 0.5 points increase in the children's abilities; in Scandinavian contexts (Sweden and Norway) the average increase is of around one-third of a point (Bjorklund et al., 2009; Black et al., 2009). Hanushek et al. (2021) use Dutch data to identify the causal connection between the cognitive skills of parents and their children. They use a within-family between-subjects estimation strategy and find that an increase in one standard deviation in the parents' abilities increases in 0.1 standard deviation in children's skills. In the US, Duncan et al. (2009) show that without further controls, mothers' math tests score has an average positive impact of 0.23 points on daughters' mathematical ability and 0.15 on sons' scores.

The process of intergenerational transmission of skills has been also noted to vary according to the stage of the life-course. The most accepted position suggests that parental influence on children's skills is the largest during early childhood (Bijou, 1976; Datar et al., 2010; Durham et al., 2007; Farkas & Beron, 2004; Rowe & Goldin-Meadow, 2009). However, some pieces of evidence suggest that the older the children are, the stronger the intensity of transmission of skills is (Anger, 2012), putting special emphasis on the teenage period (Campos-Vazquez, 2018; Lundborg et al., 2014).

4.2.2 A multidimensional approach to skills

The traditional literature on skills has relied on the assumption that skills are either innate, and therefore they can be captured through an IQ measure (Black et al., 2009), or acquired during the educational trajectories, and thus the total level of education is a good proxy for the level of skills (Chevalier, 2004; Lundborg et al., 2014).

A caveat of these approaches is that they fail to integrate the role that occupations play in fostering certain skills. This is particularly relevant in the context of the third industrial revolution, which has brought with it a very high level of labour-market specialization (Autor & Dorn, 2013). In this line, Liu and Grusky (2013) suggest that the unidimensional approach to skills (well reflected in the division between skilled and unskilled workers) is insufficient to understand how skills operate in the new scenario of skills-biased technical change. Consequently, an emerging literature has started to investigate the role that occupation-specific skills play. These are specific types of skills that are effectively learned in the job (Polavieja, 2012), and have been noted to affect the labour market trajectories and outcomes (Kwon & Meyersson Milgrom, 2014; Lagoa & Suleman, 2016), as well as political preferences and attitudes formation (Emmenegger, 2009; Ortega & Polavieja, 2012).

4.2.3 Intergenerational transmission of occupation-specific skills

If occupations are a pivotal part of individuals' skill sets, it would not be surprising that they also play an important part in the process of intergenerational transmission of skills that is responsible for social reproduction. This is especially relevant given the expansion of women's participation in the labour force during the last decades and the fact that mothers keep being the primary care source for children. In the US, for instance, the percentage of mothers with children younger than 6 years old who were in the labour market increased from 47% to 65% between the 80s and 90s (Ruhm, 2004).

Two conditions need to hold for this transmission of occupation-specific skills between parents and offspring to take place. First, there must be an association between what mothers do as part of their jobs (usually known as job tasks) and the skills they develop. As explained by Pankhurst (2010), on-the-job learning comes from the repetition of tasks, the self-reflection on mistakes, and the formal and informal evaluations of performance that take place at the workplace. On average, there is a linear relationship between the complexity of the job and the cognitive stimulation that is derived from performing that job (Pouliakas & Russo, 2015). Therefore, previous literature has concluded that there is a direct association between skills utilisation in the job and skills development (Russo, 2016).

The second condition is that parents' occupation-specific skills must have spillovers into their child rearing practices or home environment, which eventually will impact children's lives (Augustine, 2014; Verropoulou & Joshi, 2009). A good example of this type of effect has been shown by Mues et al. (2021) when examining how the mathematical component of the job of the parents influence the home numeracy environment, which has a direct impact on children's mathematical skills. Mues et al. (2021) sustain that home environment comprises both formal activities such as doing homework together or having specialised books at home, but also other informal ones such as day-to-day application of mathematical knowledge or topic-relevant conversations held in the family (LeFevre et al., 2009). Similarly, in the case of literacy skills, parental jobs' skills can instil certain formal (i.e., reading books) and informal (i.e., introducing new words to the everyday conversations) activities to the home environment (Martini & Senechal, 2012), which will impact children's literacy skills (Carroll et al., 2019; Griffin & Morrison, 1997).

On top of the influence on the home environment, the literature has noted that parental jobs also impact the parental values and behaviours that are relevant to parenting. For instance, Parcel and Menaghan (1994) show that mothers who work in complex occupations build home environments that are more cognitively stimulating, and Downey and Moen (1987) sustain that parental attention to children, as well as levels of stimulation, will be affected by parental job arrangements. Yetis-Bayraktar et al. (2013) find that mothers' higher occupational complexity during the first three years of the life of the children has a positive long-lasting effect on children's mathematical and literacy abilities. The underlying mechanism for Herman and Perry-Jenkins (2020) is that, when parents experience more autonomy and challenges in their work, they acquire cognitive resources that then they apply to their interactions with their children.

Consistently with these two arguments, Jonsson et al. (2009) suggest that one of the channels through which occupations or micro-classes are socially reproduced is through the transmission of occupation-specific skills. Barg and Klein (2023) go a step further and test the associations between maternal occupation specific-skills and children's cognitive development in the UK. The authors use data from the Millennium Cohort Study and the British Skills Survey and find that mothers' literacy skills are positively associated with children's literacy ability (net of parental human, financial and social capital). Moreover, the children of mothers whose jobs require physical skills show lower literacy abilities. They, however, do not find associations between mothers' and children's non-literacy abilities. Some tangential works have explored how the skills associated with self-employment jobs are more commonly transmitted across generations (Colombier & Masclet, 2006) or how skills related to care-related occupations are more commonly passed from parents to children (Charles et al., 2015). Based on this literature, I suggest that (**hypothesis 1**) *increases in mothers' occupation-specific skills will positively impact children's skills*.

The mechanism behind this hypothesis is that parents learn certain skills as part of their jobs, and these directly impact the children's skills formation (i.e., they get transmitted to the children). However, it could also be the case that getting a job is the reflection of a previous latent increase in skills that has been happening for some time, and therefore, the job changes are merely a proxy to capture the skills level of the mother. Therefore, this study's main limitation lies in the inability to definitively rule out the possibility that skills may naturally improve over time, with job changes potentially reflecting pre-existing abilities rather than direct causal effects. To indirectly account for this possibility (since a direct examination of this limitation is not possible with the current data), I examine the underlying mechanism in three different ways.

First, I account for the time the mother has been in the job since changing occupations. Given that the process of learning is a cumulative and progressive one, mothers who spend more time in a job will get better at these skills, and therefore, their children will get larger returns from these new jobs than those mothers who quit a job earlier. Following this, if the mechanism suggested is true, I would expect (**hypothesis 2**) *the effect of mothers' occupation-specific skills on children's skills to be larger the more time the mother has been on the job*.

Second, I expect the intergenerational transmission of skills to be subject-specific. This is, I expect (**hypothesis 3a**) *increases in mothers' mathematical occupation-specific skills to impact children's mathematical skills*, and (**hypothesis 3b**) *increases in mothers' literacy occupation-specific skills to impact children's literacy skills*. Otherwise, it could simply be the case that children generally benefit from any skill change of their mothers, which is not necessarily the same as claiming that these skills are transmitted from parents to children.

Finally, because of the cumulative character of skills, it is unlikely that mothers experience a substantial loss of the skills that they have acquired even if they change their job to one in which they do not use those skills regularly. Therefore, I expect skill increases and decreases to have different effects on the children's skills. I frame this as the asymmetric effect of occupation-specific skills and suggest that (**hypothesis 4**) *children's skills will be positively influenced by mothers' occupation-specific skills increases, whereas they will not be affected by mothers' occupation-specific skills decreases.*

4.2.4 Alternative pathways

When looking at the transmission of occupation-specific skills it is important to notice that there are several competing pathways through which parents' occupations can impact children's skills formation that do not necessarily imply the transmission of occupation-specific skills.

For instance, that is the case of the timing of maternal employment. Some studies suggest that child development is particularly vulnerable to maternal labour market participation during the first six months of life (Huerta et al., 2011), whereas others suggest that the first 18 months are the crucial period (Gregg et al., 2005), or even the first 3 to 4 years (Ruhm, 2004). Brooks-Gunn et al. (2010) examine the comprehensive childhood period and find that the short-term negative effect of maternal employment is neutralised in the medium term by a positive impact.

Another factor explored in the previous literature has been the number of working hours of the mother. The most common finding in this sense is that mothers find a way of compensating their children for the time they spend working, especially by reducing their housework, sleeping, and leisure time (Bianchi et al., 2006), by engaging in more positive interaction with their children (Bass et al., 2009) or by increasing their quality time with their children (Hsin & Felfe, 2014).

Finally, a competing channel that has been noted to connect parents' occupations with children's skills is job conditions. Children of mothers who experience psychological stress and physical hazards have been noted to show more developmental problems (Hsin & Felfe, 2014). Similarly, children of parents with non-standard work schedules show lower well-being and development levels (Li et al., 2014).

Despite the relevance of these and other child-, family-, and job-related factors to understand how parental occupation impacts children's lives, I suggest that mothers' occupation-specific skills represent a substantively different phenomenon, and therefore, I expect *the effect of mothers' occupation-specific skills on children's skills to exist independently of these changes associated to transition into a new job* (**hypothesis 5**).

4.2.5 Heterogeneous transmission by SES

Previous literature has suggested that parents from different socioeconomic backgrounds present information asymmetries as well as different abilities and resources that condition the effectiveness of their skills transmission to their children (Heckman & Kautz, 2012; Rowe, 2008). Based on this, it might be the case that *high-SES mothers are more able to transmit their occupation-specific skills, and therefore, their children would benefit more from the increases in their mothers' occupation-specific skills than children with low-SES mothers* (**hypothesis 6a**).

A competing possibility, however, is that since children and mothers in low-SES contexts present a lower baseline level of skills, a marginal improvement in the mothers' occupation-specific skills has a greater impact on them than on those children with high-SES mothers, who start with a higher level of skills, and thus, might experience a ceiling effect. If this is the case, *I would expect low-SES children to benefit more from the increases in their mothers' occupation-specific skills than high-SES children* (**hypothesis 6b**).

4.3 Data and methods

4.3.1 Data

This paper combines two datasets. First, the National Longitudinal Survey and Children's Supplement data (NLSY79-CYA), which is a nationally representative US cohort-based data set that follows the children of those women who were part of the original NLSY79 survey (US women born between 1957-1964). The children born to these women from 1970 onward have been interviewed biennially from 1986 to 2018. The interviews with the children consisted of a set of assessments to evaluate the physical, cognitive, and socio-emotional development of the child.

The sample for this paper is restricted to children over 5 years old, given that the relevant cognitive assessments are only implemented and measured after this age. I also exclude the years in which the mothers were unemployed (so that transitions from unemployment to employment are not included in the analysis) since it will be difficult to assess their initial level of skills when they are not associated with a particular job, as well as those who never change jobs, since there is no variation to be exploited in those cases and the analytical strategy of this paper relies on it. The final analytical sample comprises approximately 17,000 units of observation (the final number varies depending on the model specification), for a total of 7,559 individuals and an average of 2.26 observations per individual over time. The minimum number of observations per individual is 2. These children are born from 4,941 mothers of the NLS79 original sample. There are no relevant patterns of attrition in the sample that are connected to either mothers' or children's skills or to the family socioeconomic background.

Several aspects make this database suitable for this study. First, the long period available allows me to follow the mother and children's trajectories over decades. Second, the high frequency of the data makes it possible to capture changes in mothers' occupations with high precision. Third, given that the measures of children's skills are the product of interviewers' assessments, this circumvents the problem of mothers misreporting their children's abilities.

The second database employed is the O*NET dataset, which provides detailed information about the work characteristics and skills requirements of jobs in the US. This database is produced by the Department of Labor and has been widely used in the literature on labour economics (Peri & Sparber, 2009; Tippins & Hilton, 2010). It provides information on almost 1000 different occupations. The process of collecting the information is two-fold: first, a sample of businesses is selected from each type of occupation; and second, a sample of employees from each business is chosen to complete a survey. Businesses are selected with a proportional probability to the number of workers in the company to account for the distribution of the workforce (Burrus et al., 2013). These employees are asked to complete several surveys on the title, definition, job zone of the occupation, the tasks that are part of the job, the knowledge required, the specific work activities, and the work context. In the final stage, a group of occupational analysts, following a standardised process, rate the information on each of the above dimensions and assign a final number on the level of skills associated with each occupation[17].

I merge the NLSY79-CYA with the O*NET dataset through the six-digit occupational level of the mother (Standard Occupational Classification). Since some occupations have likely changed the level of skills required for that job over time, I use three different O*NET taxonomies: 2000, 2010, and 2019. This way, for each of the occupations held by the mother throughout her labour market trajectory, I have detailed information on

[17] All the information about the rating criteria and the whole process of data collection can be found in Fleisher and Tsacoumis (2018) report titled "O*NET Analyst Occupational Skills Ratings: Procedures Update."

the skills required according to the closest-in-time O*NET taxonomy.

4.3.2 Variables

The dependent variable of this study is children's skills, operationalized through the child's mathematical and literacy skills at time t. Both measures are part of the Peabody Individual Achievement Test (PIAT), which is a standardized measure of child development and achievement. This index is age-specific (i.e., measures the ability of the children for a given age) and relative (i.e., the children in the representative NLS sample are ranked based on their abilities compared to the other children in the sample). Therefore, if a child scores 100 points at age 5 but 50 points at 7, it does not mean that the child's skills have decreased over time (i.e., it does not mean that the child reads worse at age 7 than she used to read at age 5). However, what it means is that the child who at age 5 was in the top percentile of the ability distribution for that age, is now in the medium part of the ability distribution when she turns 7 years old. The variables have been standardized with a mean of 0 and a standard deviation of 1.

The independent variable is the mother's occupation-specific skills at time t-1. I use two different operationalizations: mathematical and literacy skills. The O*NET dataset provides information about the degree to which a specific skill is needed to perform an occupation. The question in the O*NET original survey is worded in the following terms: "What level of [SKILL] is needed to perform your current job?". The respondent can choose from 1 to 7, but the O*NET data construction team assigns a zero score when respondents have reported in the previous question (Importance Scale) that the skill in question is not important at all for their jobs. Therefore, the final measure ranges from 0 to 7, with higher values measuring higher levels of skills. To increase the consistency in the ratings, the respondents are given three specific examples or benchmarks of what could be considered each level of skill in different jobs (Handel, 2016).

The mathematical skills variable is constructed as a mean composite of several skills that belong to the scientific and mathematical areas of knowledge: science, mathematics, programming, system and operations analysis, system evaluations, and technology design. A description of each of these dimensions is given in **Table C.1** in the Appendix. The high internal consistency of this index is shown by the 0.9 Cronbach alpha. Some examples of occupations that require a very high level of these skills are web developers, all types of engineers, physicists, statisticians, and finance-related jobs.

The literacy skills variable is a mean composite of reading comprehension, speaking, writing, and active listening. The Cronbach alpha of this composite is 0.98. Occupations such as counsellors, social workers, judges, magistrates, writers, or English teachers, are associated with high levels of literacy skills. A change in an occupation usually implies a change in both dimensions, literacy, and mathematics, although not necessarily to the same extent. The correlation between the increases in mathematical and literacy skills is of 0.61, and of 0.5 in the case of skills decreases.

4.3.3 Analytical strategy

The analytical strategy of this paper combines several steps aimed at (i) identifying the changes in occupations experienced by the mothers, which will be considered a proxy in the saliency of skills at time *t-1*, and (ii) estimating their effect on the variation in children's skills at time t.

In the first stage of the analysis, I run a series of baseline OLS models for the two outcomes of interest (mathematical and literacy skills) including the usual sociodemographic controls. In the second stage, I introduce the main models of this analysis, the two-way fixed effects (TWFE) models that account for time-invariant unobservable confounders of the individual, which reduces the potential omitted variable biases in the obtained estimates. Since TWFE models control for both individual-specific and time-specific characteristics, this model specification is more appropriate for this study than exclusively individual or time-fixed effects. The TWFE model is specified in *Equation (1)* below:

$$S_{i,t} = \beta_o + \beta_1 MS_{i,t-1} + \beta_2 C_{i,t} + \alpha_i + \tau_t + \varepsilon_{i,t} \tag{1}$$

where $S_{i,t}$ is the children's specific skills at time t; β_1 is the coefficient for the variable maternal occupation-specific skills at time *t-1* ($MS_{i,t-1}$); β_2 is the coefficient for the control variables; α_i is the fixed effects for individual i; τ_t is the time fixed effect for time t; and $\varepsilon_{i,t}$ is the error term for individual i at time t. Standard errors are clustered at the family level.

The second stage of the analytical strategy aims to account for the selection into changing occupations by using inverse probability weighting (IPW). If the mothers who already have more skills (for instance, higher educational levels) are more prone to select themselves into changing occupations, there would be a positive selection (selection on unobservables) and the estimates would be upwardly biased. I implement IPW following the steps of Breinholt and Holm (2020): (i) I predict through a logit model the probability of mothers' changing occupations, (ii) I construct the inverse probability weights from those predictions so that the mothers who are less likely to change jobs have higher weights, (iii) I rerun the fixed effects model accounting for these weights.

I use two types of predictors to construct the weights. First, cross-sectional predictors that do not vary together with the jobs held by the mother, such as the mother's level of education, race, job sector, long-term health problems, family size, the marital status of the mother, the gender of the child, the age of the mother at the moment of birth of the child and the anxious-personality scale. Second, I use job-related time-varying predictors such as household income, job quality, working hours of the mother and her partner, residential changes, reasons to leave the previous job, and flexible work arrangements. This second group of predictors accounts for the possibility of the weights varying within the same individual across time. I perform the IPW-TWFE with the R package *WeightIt*.

In the third stage, I implement three different specifications of the model that allow me to indirectly examine the mechanism underlying the effect previously described. First, I introduce an interaction term between the changes in mothers' occupation-specific skills and the years that have passed in the new job, as shown in *Equation (2)* below:

$$S_{i,t} = \beta_o + \beta_1 MS_{i,t-1} * \text{ Years in the job } + \beta_2 C_{i,t} + \alpha_i + \tau_t + \varepsilon_{i,t} \tag{2}$$

Second, I introduce the alternative dimension of skills (i.e., literacy or mathematical) within the control variables ($C_{i,t}$ component in *Equation 1*) to test whether the transmission of skills is dimension specific.

Third, I implement a series of asymmetric two-way fixed effects models (ASYM-TWFE). The reason for this is that the default TWFE model assumes that the estimated causal effect is reversible, i.e., that the positive effect of an increase in the predictor variable will be of the same magnitude as the negative effect of a decrease. However, as Lieberson (1985) sustained, social processes are rarely reversible. In this specific case, given the cumulative character of skills (Cunha & Heckman, 2007; DiPrete & Eirich, 2006), I theoretically assume that once mothers have reached a certain level of skills it is unlikely that they lose those skills. That is why, I expect the average effect of changes in occupation-specific skills on children's development to be driven by increases in skills instead of decreases. To examine this, I implement the following model, which is an adaptation of the work by Allison (2019) on asymmetric fixed effects:

$$S_{i,t} = \beta_o + \beta_1 MS^{+}{}_{i,t-1} + \beta_2 MS^{-}{}_{i,t-1} + \beta_3 C_{i,t} + \alpha_i + \tau_t + \varepsilon_{i,t} \tag{3}$$

where the effect of changes in maternal occupation-specific skills is disaggregated into two estimates: β_1 will account for the increases in skills and β_2 for the decreases in skills. To estimate this equation I use York and Light (2017) method to (i) compute first differences and (ii) decompose the varying predictors in positive and negative components. This way, thanks to the first differences calculations and the use of a generalized least squares (GLS) estimator, the model will produce unbiased and efficient estimates for the positive and negative components of the predictor. The estimation is done with the R package *panelr*.

In the fifth stage of the analysis, further tests are implemented to account for the possibility that a job change affects children's skills through other channels different from occupation-specific skills (i.e., competing pathways). That is the case of (i) child-related variables: gender, age, health limitations, learning disability and childcare use; (ii) job-related variables: household income, working hours, working hours of the partner, supervisory responsibilities, job quality and firm size; and (iii) family-related variables: whether the mother has been enrolled in continuing education, changes in the mother's marital status and the family size, whether there is a newborn at home, and whether the family has moved regions in the last period.

In the sixth step I re-run the model in *Equation (1)* in a stratified sample by SES, to investigate the possibility that the effect of occupation-specific skills on children's development varies by the socioeconomic background of the parents.

Finally, I address some reverse causality concerns in the robustness checks section.

4.4 Results

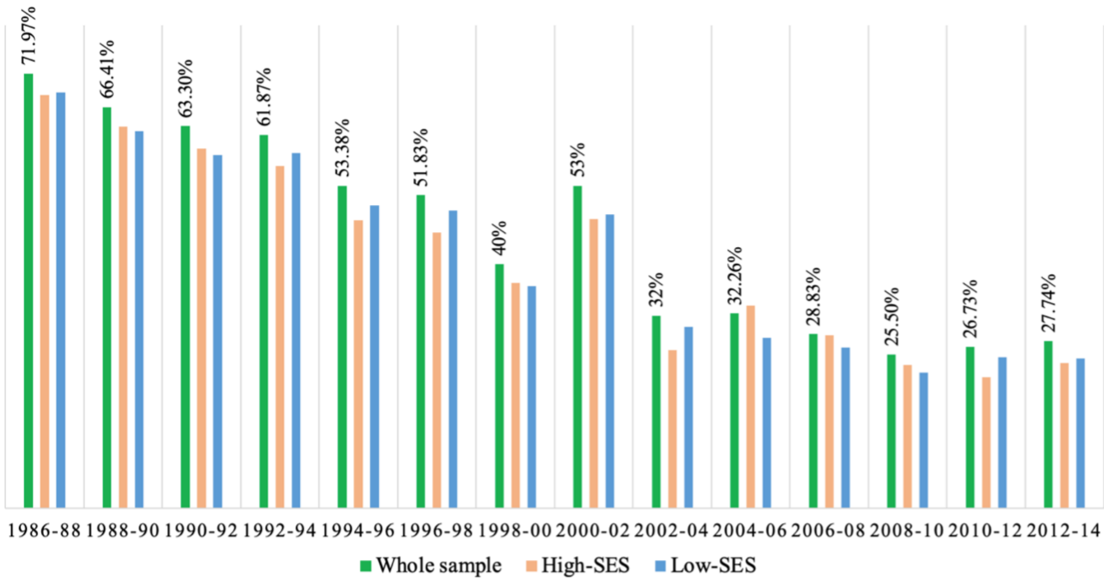
4.4.1 Descriptives

How common is it for mothers to change their occupations? Given that this is the source of variation that this study relies on, it is important to make sure that a sufficient proportion of mothers in the sample change their jobs with some regularity. **Figure 4.1** shows the percentage of women who change their occupation between each of the time points measured in the NLS data. This percentage varies over time, and in all cases is higher than 25%. These numbers go in line with the reports from the U.S. Bureau of Labor Statistics, according to which, individuals born between 1957 and 1964 (i.e., the same cohorts explored observed in this study) have had an average of 12.4 jobs during their active working life. Of these, 5.6 jobs were held between ages 18 to 24 and 4.5 jobs between ages 25 to 32 (and decreased progressively until 2.1 jobs between ages 45 and 54). According to the same report, this is explained by the short duration of some of these jobs (i.e., among those aged 18 to 24, 74.6% had a job that lasted less than 2 years)[18]. There are no statistically significant differences between low-

[18] For a summary of the report, see Bureau of Labor Statistics, U.S. Department of Labor, The Economics Daily, Baby boomers born from 1957 to 1964 held an average of 12.4 jobs from ages 18 to 54 at `https://www.bls.gov/opub/ted/2021/baby-boomers-born-from-1957-to-1964-held-an-average-of-12-4-jobs-from-ages-18-to-54.htm` (visited December 30, 2022). The original report is available at `https://www.bls.gov/news.release/archives/nlsoy_08312021.htm#`.

and high-SES mothers in the regularity of changing jobs during the time of the survey, although low-SES ones are, on average, slightly more likely to change their jobs.

Figure 4.1: Percentage of women changing their occupation by SES



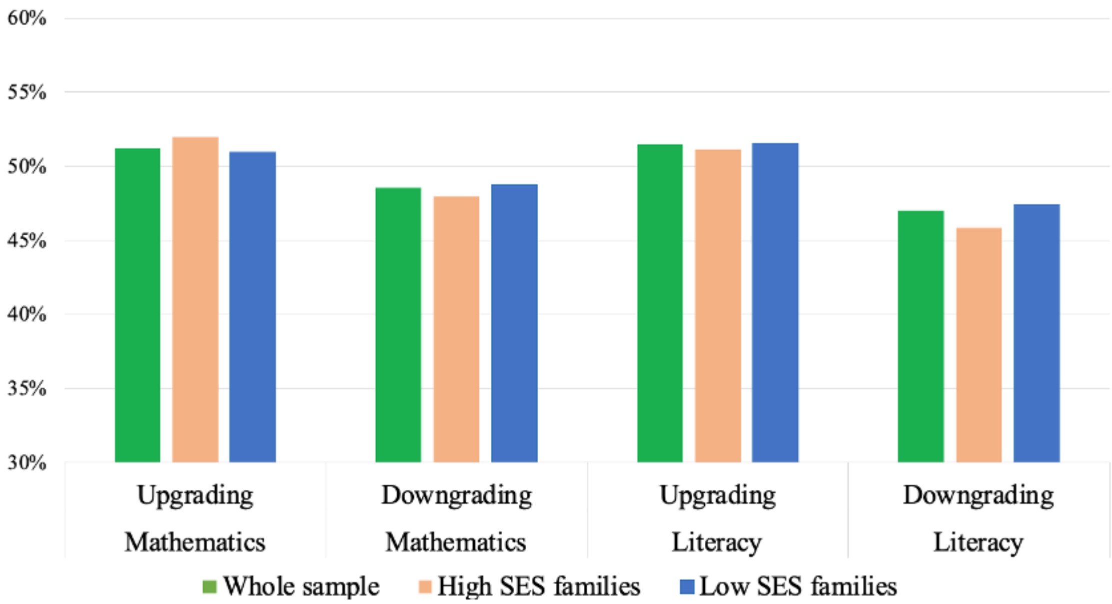
Own elaboration from the analytical sample.

It is relevant to note that the percentage of these changes varies considerably over time, with more women changing their jobs during the first decades of this study. This might be driven by two reasons: a life-course explanation, and a survey-design artifact. First, since the NLSY79 data is a cohort-type survey, the women observed are in the first steps of their professional carers during the first years of the survey, which explains the larger number of jobs held during that period. Second, in the first waves of the survey carried out in the 80s and 90s, and given the less-advanced technological resources, the NLS interviewers asked the participants for details about their jobs and afterward coded them manually. However, during the late 90s, a new system was implemented, and the interviewers started to carry electronic devices with pre-recorded information. This increased the precision of the coding and ensured certain continuity when the person in question was still doing the same job. This also means that the estimates obtained from the second half of the sample (i.e., from 2000 onwards) can be interpreted as conservative coefficients, as compared to the more optimistic ones in the 80s/90s given the (potentially) over-represented changes in maternal jobs[19].

After aggregating all the waves' information, 46,9% of the total number of person-year observations shows a change between the current and the previous occupation. As shown in **Figure 4.2**, among those whose occupation changes from *t-1* to *t*, 52,6% increase their skills (upgrading), and 47,4% show declines in their skills (downgrading). In the case of literacy skills, 54,1% of the changes in occupation reflect an upgrade in skills, and 45,8% a downgrade. Highly educated mothers are slightly less likely to show downgrading skills patterns, although the differences between the two socioeconomic groups are not significant.

[19]Note that the results presented in this study are robust to restricting the waves included to those from 1996 onwards (once the % of mothers changing occupations drops to 50%). These time restricted results are available from the author upon request.

Figure 4.2: Percentage of skills upgrading and downgrading among the mothers who change occupations



Own elaboration from the analytical sample.

The high percentage of skills downgrading, which seems counterintuitive with a standard career trajectory, can be explain by the two factors. First, since the sample is formed by young women in reproductive age, it is likely that a large part of these downgrading responds to mothers trying to accommodate their families' needs by finding less-demanding jobs, as previous literature has shown (Tomlinson et al., 2009). A second explanatory factor would be related to the type of measurement I am using. It might be the case that some mothers simply stop using certain skills because they transition to a more management-based position in which those skills are not central part of the role. In these cases, even if the use of skills will be downgraded, the new job will be superior in the job hierarchy. This should not affect my results, since as far as this paper is concerned, what matters for the intergenerational transmission of skills is how central certain skills are for a mother's life, which is what the measure employed here captures, and not that much about other aspects of the job transition. In any case, I control for income and other changes associated to the job to account for these possibilities.

It is also informative to show the correlations that exist between mothers' and children's skills. The correlation between mothers' occupation-specific mathematical skills and children's mathematical skills is 0.19, and the correlation between mothers' occupation-specific literacy skills and children's literacy skills is 0.21. These numbers are consistent with the correlations shown by Barg and Klein (2023) in the UK, which range between 0.10 and 0.24. They also go in line with the correlations found in the United States for crystallized intergenerational intelligence (between 0.15 and 0.24), and they are much larger than the ones detected for personality traits (between 0.07 and 0.10) (Anger, 2012). All in all, this suggests that the occupation-specific skills of the mother could be relevant to understand children's skills development.

Finally, to facilitate the understanding of the results presented in the next section, I provide here some examples of the most common job transitions that entail an increase in mathematical and literacy skills in the data. Most of the transitions can be understood as a natural career development for a young person's labour market trajectory (such as the ones of the mothers' followed by the NLSY survey) and occur within the same occupational sector.

In the case of mathematics, the most common transitions are: from sales representatives (2.25 points on the 0 to 7 scale of skills level) to sales manager (3.25 points); from pre-school education administrator (2.88 points) to secondary education administrators (3.25 points), from data entry keyer (2 points) to database administrator (3.5 points), from helper electrician (1.38 points) to electrical and electronic technician (3.5 points), from office machine operator (2 points) to system operators (3 points), from transportation inspectors (2.38 points) to transportation managers (3.17), from insurance claims clerks (2.38 points) to insurance sales agents (3 points), or from retail salesperson (2) to supervisor of retail sales workers (3 points).

In the case of literacy skills, the most common transitions in the data are: from marketing strategist (3.75 points on the 0 to 7 scale of skills level) to marketing specialist (4.62), from library assistants (3 points) to library technicians (3.88 points), from telemarketers (3.25 points) to sales agents (4 points), from medical equipment preparers (2 points) to medical secretaries and administrative assistants (3 points), or from postal service mail sorters (1.88 points) to postal service clerks (3.12 points). It is important to notice that, although there are some paradigmatic examples of more common transitions in the data, there is no clear and common pattern for mathematics and literacy skills changes that could be shown here.

All the descriptive statistics of the variables included in this paper can be found in **Table C.2** in Appendix C.

4.4.2 Main models

Table 4.1 shows the results from the OLS baseline models. In a cross-sectional analysis, an increase of one point in mothers' mathematical skills at time *t-1* is associated with an increase of 0.122 points in the child's mathematical skills at time *t*. This estimate is slightly bigger (0.149 points) for the literacy skills model (2). The magnitude of these effects is around one-ninth of a standard deviation.

Moreover, the children of highly educated mothers show, on average, around 0.2 points higher mathematical and literacy skills than those children of non-tertiary educated mothers. As expected according to the existing literature, there are also gender and race differences in children's skills. Girls outperform boys in literacy skills (0.17 points higher on average). The racial gradient in skills suggests that white children show the highest levels of mathematical and literacy skills, followed by Hispanic children (the reference category) and black children. Moreover, older mothers have children with higher mathematical and literacy skills, and children in larger families show lower levels of skills.

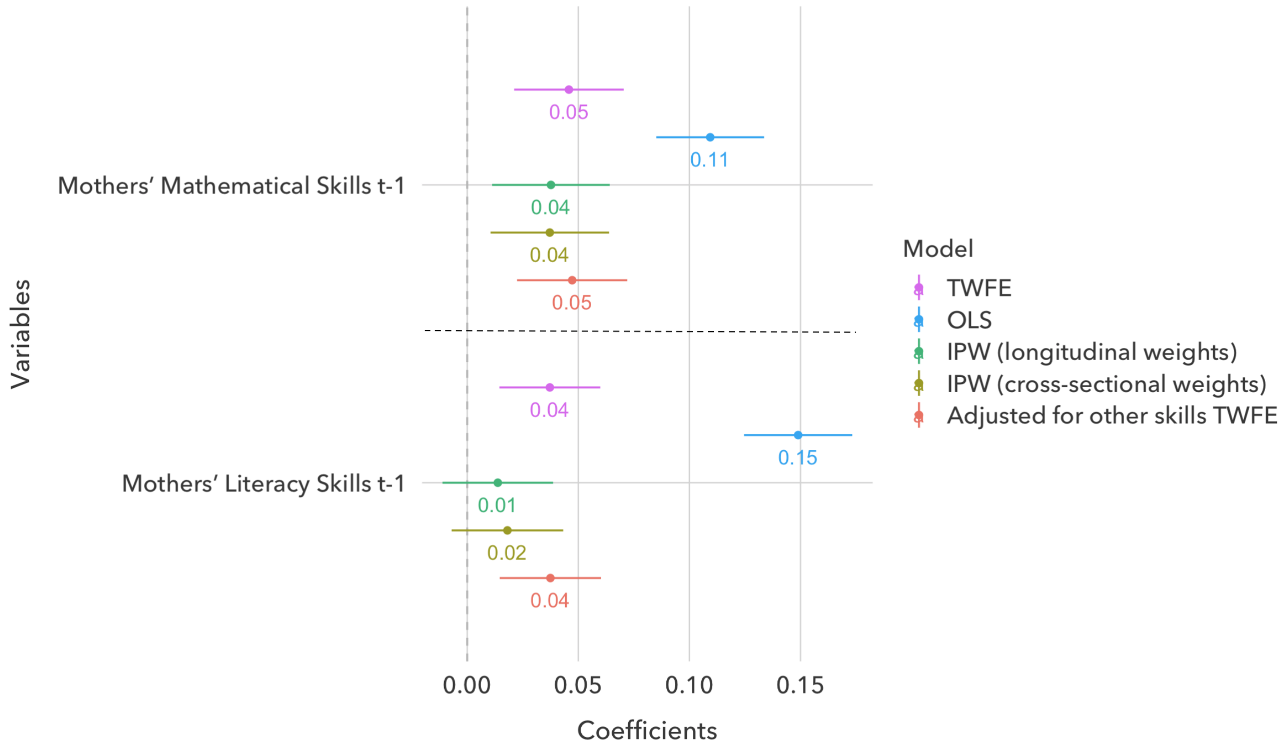
Table 4.1: Baseline OLS models

	Dependent Variables: Children's Skills	
	Maths Skills	Literacy Skills
	(1)	(2)
Mothers' Mathematical	0.122^{***}	
Skills at t-1	(0.013)	
Mothers' Literacy		0.149^{***}
Skills at t-1		(0.012)
High educated mother	0.197^{***}	0.209^{***}
(ref. cat. low-educated)	(0.017)	(0.017)
Male child	-0.004	-0.172^{***}
	(0.013)	(0.014)
Race: black	-0.098^{***}	-0.087^{***}
(ref. category Hispanic)	(0.019)	(0.020)
Race: white	0.398^{***}	0.238^{***}
(ref. category Hispanic)	(0.018)	(0.019)
Age of mother	0.019^{***}	0.017^{***}
at birth	(0.002)	(0.002)
Family size	-0.031^{***}	-0.057^{***}
	(0.005)	(0.005)
Residence with	0.014	0.016
the mother	(0.047)	(0.049)
Dummy controls sector	Yes	Yes
Constant	-0.7901^{***}	-0.735^{***}
	(0.822)	(0.075)
Observations	16,959	16,877

Note: Standard Errors are in parentheses and clustered at the mother level. $^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Figure 4.3 (and **Table C.3** in the Appendix C) shows the main results from the TWFE and the IPW-TWFE models. In the basic TWFE specification, an increase of one point in the mothers' mathematical skills at time *t-1* implies an increase of around 0.05 points in the children's mathematical skills at time t, and in the case of literacy skills of approximately 0.04 points. These estimates are around 5% of a standard deviation.

Figure 4.3: Estimates from main TWFE and OLS models



Corresponds to Table 4.1 (OLS models) and Table C.3 (the rest of the models). Confidence intervals 95%.

The IPW-TWFE models aim to account for the potential selection into changing occupations for certain mothers. In the case of mathematical skills, despite using cross-sectional or longitudinal weights for the inverse weighting, I find that an increase in mothers' occupation-specific skills brings with it a rise in their children's skills. The magnitude of this effect is only slightly smaller than the TWFE results without the inverse probability weighting and it is still significant. In the case of literacy skills, however, once I account for the probability of changing occupations (both with cross-sectional and longitudinal predictors), the estimates are no longer significant. This suggests that the literacy skills effects detected in the previous models might have been driven by selection.

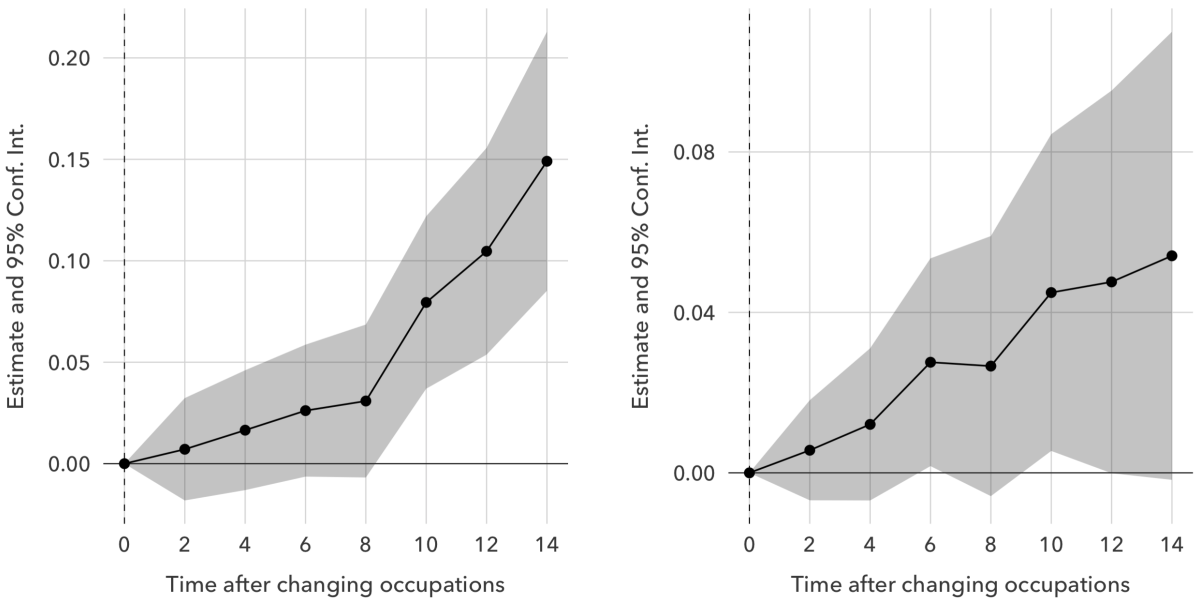
4.4.3 Accounting for the alternative dimension

Models (3) and (4) in **Table C.3** and the last two models in **Figure 4.3** aim to examine whether the intergenerational transmission of skills is subject-specific. To address this, in the model with mathematical skills as the main outcome of interest, I also include variations in literacy skills (and the other way around for the literacy skills outcome). What the results show in this sense is that increases in children's mathematical skills are fostered by mothers' mathematical skills and not by variations in the mothers' literacy skills. Similar results are found for the literacy skills dimensions when introducing changes in mathematical skills as one of the predictors.

4.4.4 Introducing the time dimension

Figure 4.4 shows that, as compared to those who have just transitioned into a new job, the children of mothers who have been in the new job for many more years benefit especially from the occupation-specific skills of the mothers. In the case of literacy skills, children seem to obtain especially high returns when their mothers have been six years in the job, although this effect is quite unstable, as shown in previous models for the literacy skills outcome. For mathematical skills, this difference becomes evident after 8 years on the job. This suggests that the more time mothers spend on the job, the more skills they acquire, and therefore, the more their children benefit from their occupation-specific skills.

Figure 4.4: Estimates from main TWFE models with time dimension (left mathematics, right literacy)



Corresponds to Table C.4. Reference category 0 years in the job. Confidence intervals 95%.

4.4.5 Asymmetric models

The current TWFE models assume that the effect of changes in mothers' skills on children is symmetric. However, as explained in the analytical strategy section, it is a possibility that increases and decreases in the mothers' skills have different effects on children's skills, which is something that the TWFE specification could not detect.

Table 4.2 below shows the results of the ASYM-TWFE models that disaggregate the main effect of mothers' skills changes into upgrading and downgrading. In both dimensions, mathematical and literacy, when mothers show improvements in their occupation-specific skills, children increase their skills by 0.05 and 0.03 points respectively. These estimates are consistent with the results obtained in the TWFE models. Unsurprisingly, a decline in mothers' occupation-specific skills does not foster any variation in children's skills.

Table 4.2: Asymmetric TWFE

	Dependent Variables: Children's Skills			
	Mathematical Skills		Literacy Skills	
	Upgrading (1)	Downgrading (2)	Upgrading (3)	Downgrading (4)
Mothers' Mathematical Skills at t-1	0.05^{**} (0.02)	-0.01 (0.02)		
Mothers' Literacy Skills at t-1			0.03^{*} (0.015)	-0.00 (0.02)
Observations	8,920	8,039	9,130	7,747

Note: Standard Errors are in parentheses and clustered at the mother level. Note that the N of these models is significantly lower than in the previous ones because they exploit exclusively the variation produced by increases or decreases in each of the skills dimensions, whereas the previous models were accounting for both types of variations. All the models include controls for the job sector. $^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

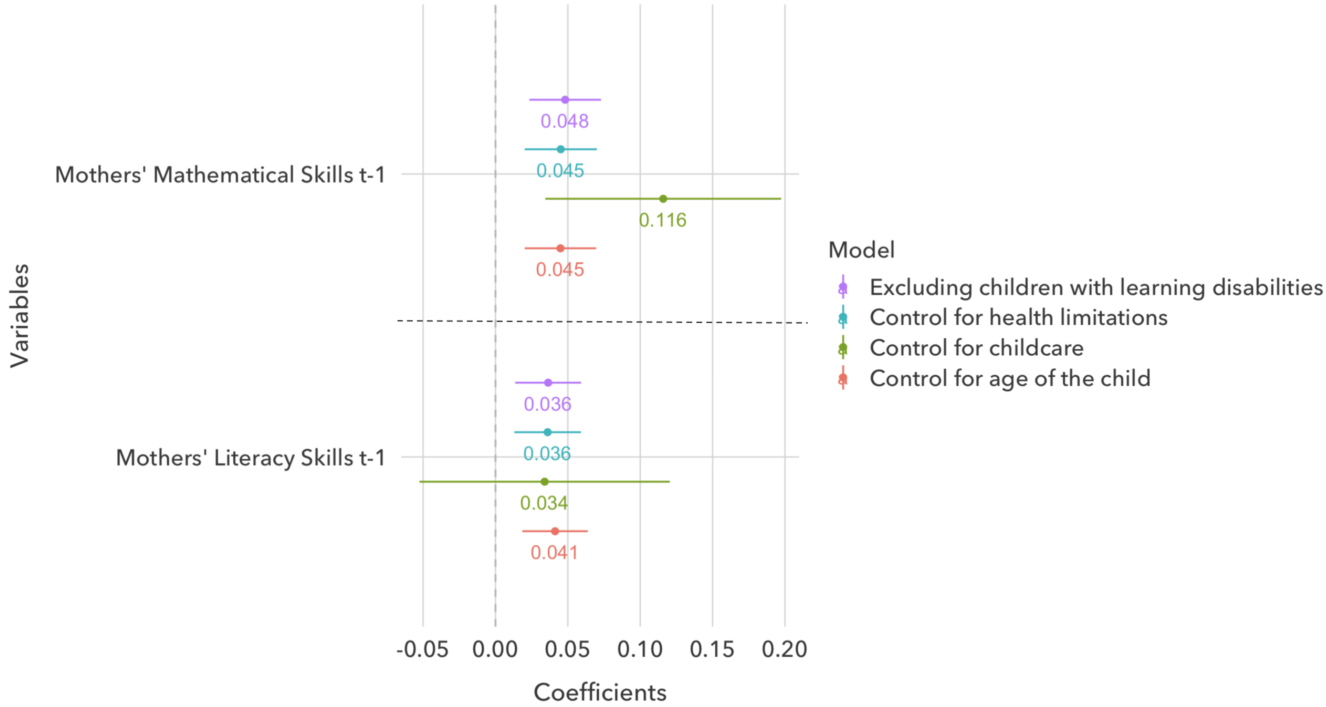
4.4.6 Alternative pathways

As explained in the theoretical section, there is a potential issue of omitted variable bias, that comes from the fact that when mothers change their jobs, several other factors can change at the same time that could be responsible for the increase in children's skills. To account for this possibility, I construct several models that include controls for time-varying (i) children characteristics, (ii) family-related characteristics, and (iii) job characteristics. All these factors might change together with the job or trigger a job change themselves.

Figure 4.5 shows the main estimates from the TWFE models once several characteristics of the children are accounted for. Both the mathematics and literacy skills results remain constant despite controlling for the age of the child and the health limitations experienced. When I include a control for childcare, two different patterns emerge. On the one hand, the literacy skills coefficient loses significance, which can be justified by the fact that childcare absorbs part of this positive effect, as shown by the positively significant coefficient of the child being in childcare for literacy skills (**Table C.5**). On the other hand, the baseline effect of the mathematical skills variable stays constant and even increases the size when we account for childcare. This increase is likely driven by a negative correlation between the mothers' mathematical skills and the use of childcare. Moreover, in a further model specification, I exclude those children who have shown any type of learning disability in the past, so that the possibility of parents changing jobs as a response to these disabilities is ruled out. The results remain constant despite imposing this restriction.

Another important characteristic of the children that are not included in this figure is children's gender. This is because it is a time-invariant characteristic in the sample, and therefore, the TWFE model cannot estimate its effect. To overcome this, I rerun separate models for boys and girls. The results in **Table C.7** (Appendix C) show that whereas both gender groups benefit from their mothers' acquiring new literacy occupation-specific skills, girls are especially likely to respond positively to increases in maternal mathematical skills. This suggests that given the usual lower baseline level of mathematical skills of the girls as compared to the boys, there is more room for benefiting from their mothers' extra skills.

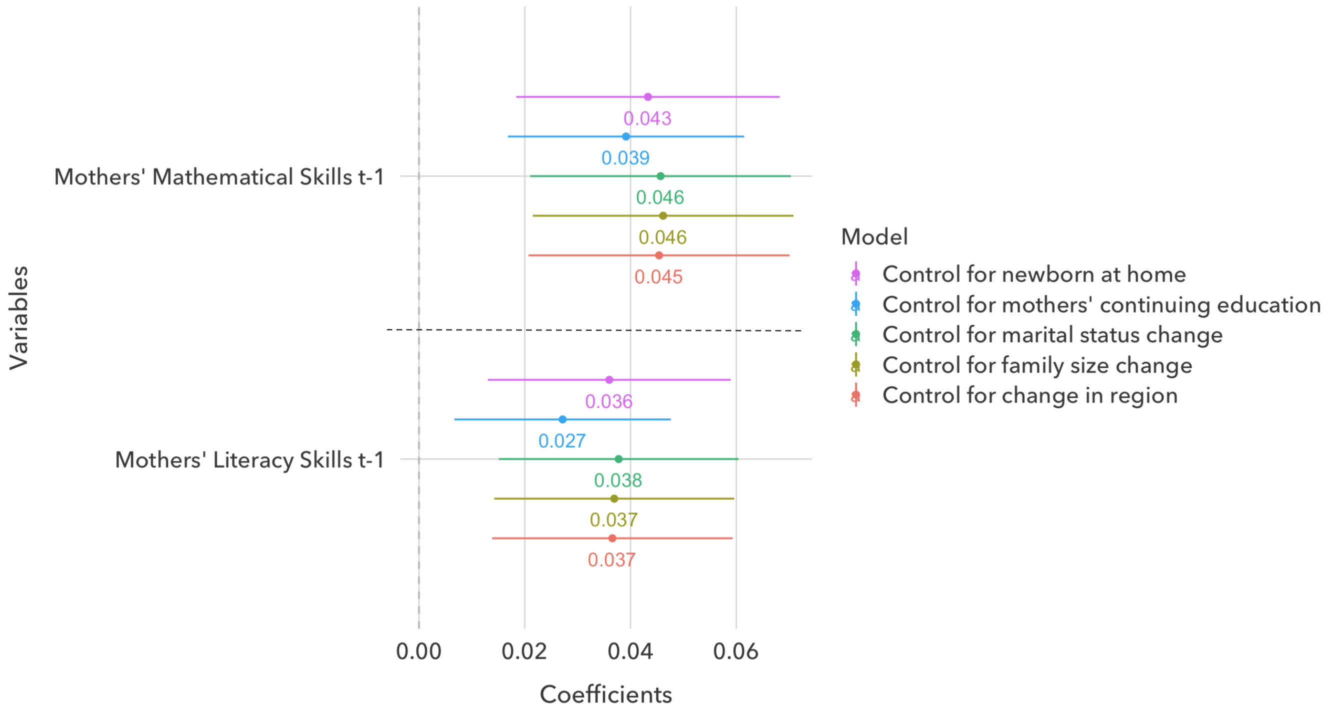
Figure 4.5: Estimates from the TWFE with child characteristics controls



Corresponds to Table C.5 in the Appendix. Confidence intervals 95%.

Figure 4.6 displays the results once several family-related changes are taken into consideration. That is the case of changes in the location or region of the family, changes in family size and marital status, having a newborn at home, or mothers enrolling in continuing education. None of these factors seems to absorb the effect of mother occupation-specific skills on children's skills. This is especially important in the case of mothers' continuing education because it would be an alternative pathway through which mothers might acquire skills that positively impact their children.

Figure 4.6: Estimates from the TWFE with family characteristics controls.

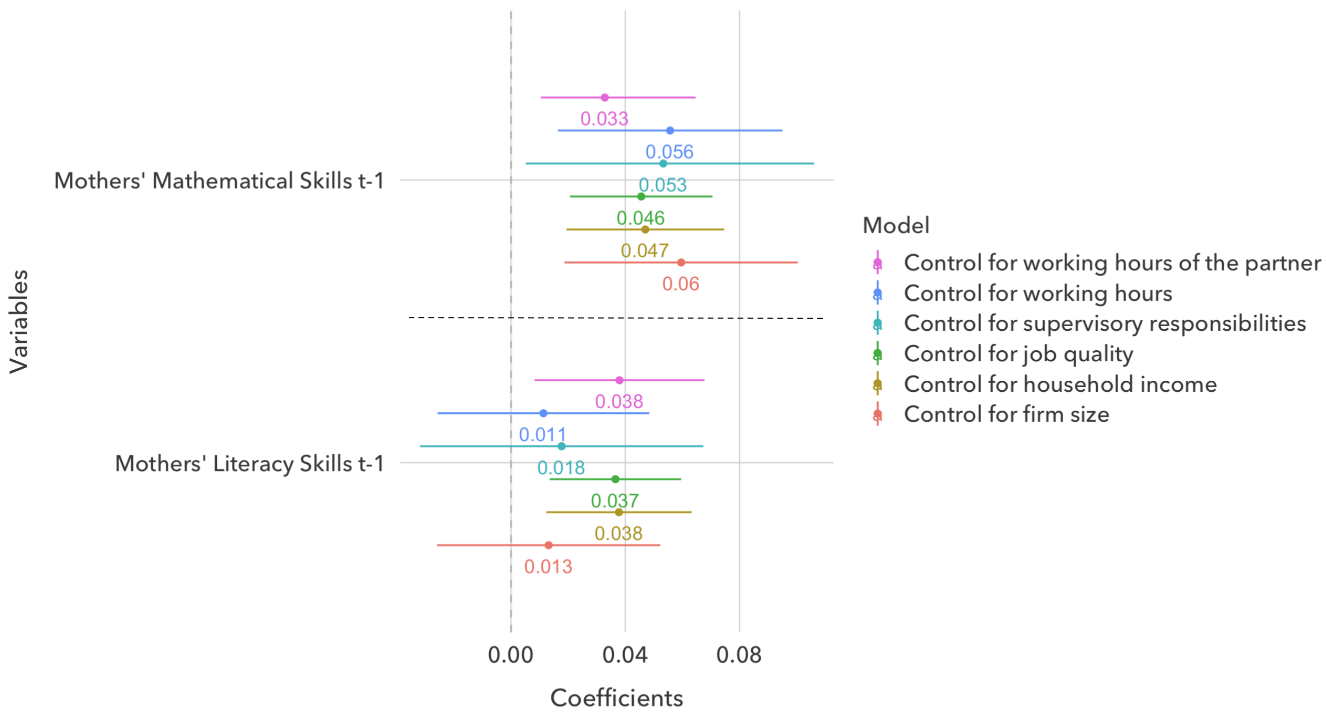


Corresponds to Table C.8 in the Appendix. Confidence intervals 95%.

Finally, **Figure 4.7** shows the results once job-changing characteristics are considered. For instance, if the new occupation of the mother, on top of requiring higher skills, also presents a better job quality, this factor can be partially responsible for the positive effect on children's development. In the case of mathematical skills, the main estimates remain positive and significant despite controlling for a variety of factors such as changes in firm size, job quality, supervisory responsibilities, working hours of the mother and the partner and household income. Of particular interest is the fact that despite accounting for the changes in total household income and working hours of the partner/father, the main effect of mothers' occupation-specific skills remains constant.

However, in the case of literacy skills, the results are more unstable. When the controls for firm size, supervisory responsibility, and working hours are introduced the main estimates stop being statistically significant. This is consistent with the results from the IPW-TWFE that suggested that the results of the literacy skills dimension were driven by selection.

Figure 4.7: Estimates from the TWFE with job characteristics controls.



Corresponds to Table C.9 in the Appendix. Confidence intervals 95%.

4.4.7 Stratified models

An unresolved question so far is whether children from high- and low-SES families equally benefit from changes in their mothers' skills. **Table 4.3** shows the results from the TWFE models run in stratified samples for those with and without tertiary education separately. The results show that, for mathematical skills, children with tertiary-educated mothers benefit significantly from occupation-specific skills increases. However, this effect is not significant for low-educated mothers. This suggests that there is an educational gradient in the relevance of occupation-specific skills and that children in highly educated families get the highest returns from their mothers' skills changes. These results, in line with the previous model specifications, are not significant for the literacy skills model.

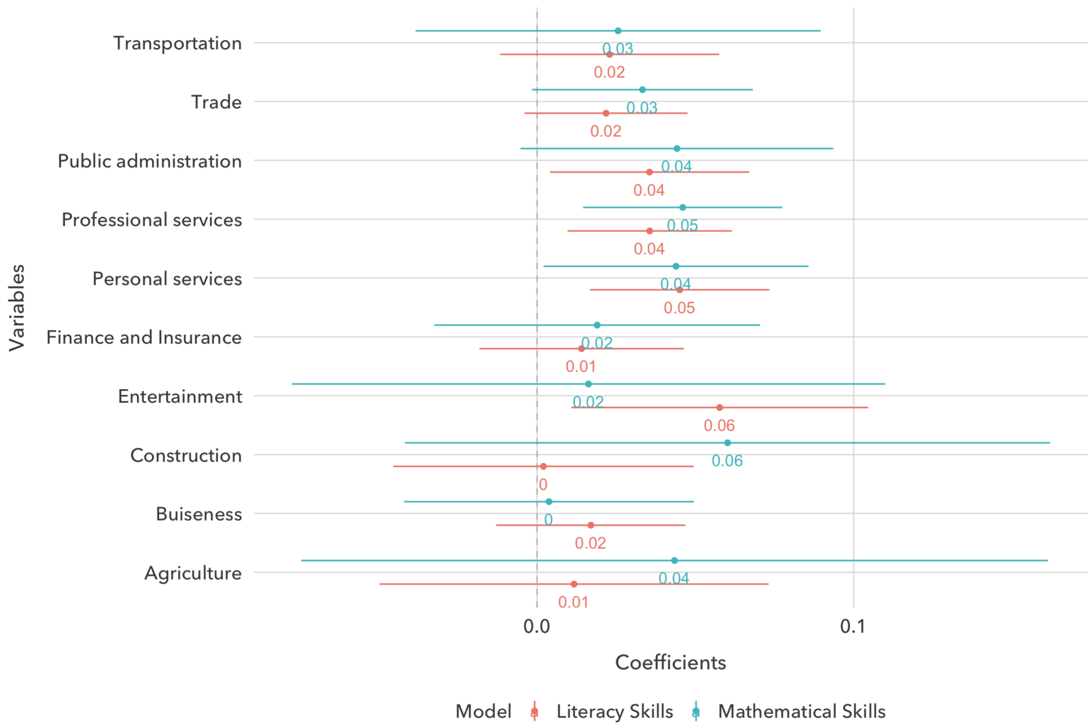
Table 4.3: Stratified TWFE models

	Dependent Variables: Children's Skills			
	Non-tertiary educated		Tertiary educated	
	Child Maths Skills	Child Literacy Skills	Child Maths Skills	Child Literacy Skills
	(1)	(2)	(3)	(4)
Mothers' Mathematical Skills at t-1	0.021 (0.014)		0.057^{*} (0.023)	
Mothers' Literacy Skills at t-1		0.023 (0.013)		0.021 (0.024)
Observations	12,827	12,827	4,154	4,154

Note: TWFE models. Standard Errors are in parentheses and clustered at the mother level. $^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

On top of education, given the nature of occupation-specific skills it is worth it to examine whether the effect of these changes in maternal skills on children's development varies in terms of the occupational sector. **Figure 4.8** shows that there are three main sectors in which maternal skills seem to matter more: public administration, professional services, and personal services. In the three cases, these are sectors usually associated with service-class occupations.

Figure 4.8: Estimates from the TWFE by job sector.



Corresponds to Table C.6 in the Appendix. Confidence intervals 95%.

4.4.8 Sensitivity checks

The causal identification of the effect of mothers' occupation-specific skills on children's skills will be challenged if mothers changed their jobs as a response to certain children's characteristics, which would originate an issue of reverse causality. There are four ways in which the current analytical strategy partially addresses this concern.

First, I exploit the time dimension of this effect by measuring the impact of changes in mothers' skills at time *t-1* on children's skills at time *t*. This means that there is a period of two years between mothers' occupational changes and children's skills variations.

Second, the asymmetric model helps with the potential issue of reverse causality too. In the case of skills downgrading, it would be intuitive to consider that reverse causality plays a role because mothers can decide to downgrade their skills and transition to a less demanding job as an adaptation to children's lower developmental rhythms. However, the fact that the findings are driven mostly by skills upgrading suggests that this is not what is driving the results.

Third, several of the factors included in the alternative pathways section account for the possibility of parents changing their work arrangements as a response to variations in children's development. For instance, I exclude those children with learning disabilities and control for health limitations of the children to account for the possibility of parents modifying their occupation as a response to children's problems.

Fourth, and connected to the rationale of the previous point, I include controls for changes in parental working arrangements. An example of the potential risks that this strategy aims to tackle is: what if mothers transition from a full to a part-time employment arrangement to be able to spend more time with their children because they are noticing some developmental problems which are not appropriately captured by the health and learning disability variables? Reassuringly, I find that despite taking into consideration potential changes that occurred in the working hours of the mother or the partner of the mother, there is still (in the case of mathematical ability) an effect of changes in mothers' occupation-specific skills on the children's skills.

In this section, I implement four further robustness tests to discard the possibility of (i) children's skills, (ii) health limitations, (iii) learning disabilities or (iv) behavioural problems at time *t-1* determining mothers' skills change at time *t*.

These results are displayed in **Table C.10**. I find that there is either a substantively or statistically significant impact of changes in children's mathematical and literacy skills at time *t-1* on mothers' skills at time *t*. Similar results are found for the health limitations and learning disabilities variables, as well as the behavioural problems variable. This all suggests that mothers do not modify their skills as a response to previous variations in children's characteristics, which would compromise the causal identification of this study.

4.5 Discussion and conclusions

This paper examines whether mothers' occupation-specific skills impact children's skills development. Given the central role that occupations have on individuals' skills sets formation, it seems consistent to suggest that they may play an important part in the process of intergenerational transmission of skills that is responsible for social reproduction. I merge longitudinal household data from NLSY-CYA with O*NET data that measures the type of specific skills that are required for each job. The analytical strategy of this paper exploits changes in occupation-specific skills driven by job changes experienced by mothers. With this aim, I implement a series of two-way fixed effects models that I combine with inverse probability weighting, as well as asymmetric fixed effects models.

The main result of this paper is that when a mother transitions to an occupation in which higher levels of mathematical skills are required at time *t-1*, her child will develop more mathematical skills at time *t*. Although small, the size of these detected effects is not negligible. If a mother increases the occupation-specific skills in one unit (on a scale from 0 to 7), the child is expected to increase her mathematical skills by around 5% standard deviation, which is larger than the effect of most of the time-varying socio-demographic, family, and job predictors included in these models.

Whereas in the case of mathematical skills, these results are constant across several specifications and very robust, this is not the case for literacy skills once inverse probability weighting techniques are implemented. The in-consistency of the literacy skills result might be explained in different ways. First, there might be an underlying process of selection in the transition into occupations that require more literacy skills. This would be the case if, for instance, there are some changes associated to the mothers' lives that foster both their job change and their children's developmental changes. However, to some extent, this option is contemplated when alternative pathways, such as changes in residence or mother's enrolment in continuing education, are accounted for in the models. Moreover, this would not explain why the effect disappears in the case of literacy but not mathematical skills. Another option would be that there is selection both for mathematical and literacy skills, but since the effect size of the literacy models is smaller in general than the mathematical one, the inverse probability weighting techniques only make the literacy effect disappear but not the mathematics one.

Apart from these potential selection processes, the lack of a significant effect in some of the literacy skills models could also be explained by the distinct level of difficulty of mathematical and literacy skills. Whereas high levels of mathematical skills are usually harder to sustain over time unless they are often used (i.e., by-hand complex divisions), the upgrades in literacy skills might be less often fostered by occupational changes but more associated with the baseline educational level. And therefore, less likely to be affected by changes in jobs such as the ones considered in this paper.

Crucially, three pieces of results give indirect support to the suggested mechanism in this paper, which is that mothers learn certain skills as part of their jobs, and they transmit these to their children. First, I find that the more time mothers spend on the job, the larger the benefit for their children's skills. This means that the more familiar a mother gets with her job and tasks, the easier will be for the children to acquire these skills (*hypothesis 2*).

Second, the results also suggest that the transmission of occupation-specific skills is particular to each of the dimensions of skills examined (*hypothesis 3*). This is, changes in mothers' literacy skills do not impact children's mathematical skills, which is consistent with the statement made by Autor and Dorn (2013) about different skill dimensions not being perfect substitutes for each other.

Third, the asymmetric fixed-effects models implemented allow me to differentiate between skills upgrading and downgrading. The findings show that the effect of maternal skills changes on children's skills is driven by skills upgrading but not downgradings (*hypothesis 4*). This is consistent with my theoretical expectations that assumed that even if mothers transition to a job in which a lower level of skills is required it would be unlikely that they lose previously acquired skills.

In the case of mathematical ability, these results are robust to the introduction of several factors that could work as alternative pathways through which mothers' jobs impact children's skills formation (*hypothesis 5*). However, the effect of mothers' literacy occupation-specific skills disappears when the number of working hours, the size of the firm, or the assumption of supervisory responsibilities are considered, which reinforces the selection argument stated above.

Lastly, I account for the possibility of children from different socioeconomic backgrounds obtaining different returns from their mothers' changes in occupation-specific skills. In this sense, the results suggest that children with highly educated mothers benefit more from the marginal increases in mathematical occupation-specific skills. This goes against the idea of a ceiling effect existing for high-SES families (*hypothesis 6b*) and is in line with the previous theories suggesting that the information and ability asymmetries make more privileged parents more able to channel their skills towards their children (*hypothesis 6a*).

These findings contribute to various strands of existing literature. Primarily, they align with research on the intergenerational transmission of skills which shows a positive impact of parental cognitive and non-cognitive skills on children's abilities (Anger & Heineck, 2010; Attanasio et al., 2020). The current study extends this understanding by highlighting the influence of mothers' occupation-specific skills on children's skills. Importantly, it underscores the need to explore additional dimensions of skills beyond the conventional cognitive and non-cognitive categories, emphasising the relevance of skills associated with parental occupations. This observation resonates with the work of Autor and Dorn (2013) that describes a societal shift toward a highly specialised labour market, suggesting that parents now acquire more profound and specific skills from their occupations.

Furthermore, these results align with and advance the micro-class literature, supporting the notion that parental occupations serve as a channel for the transmission of social reproduction (Jonsson et al., 2009). Additionally, they corroborate the findings of Barg and Klein (2023), who identify a positive association between mothers' skills and children's abilities. Notably, while Barg and Klein (2023) observe this effect in the literacy dimension, the present study establishes more robust results in the mathematical domain. This discrepancy may be attributed to contextual differences, as Barg and Klein (2023) focus on the UK and employ self-reported skills, whereas this study utilises externally assessed skills in the US context.

This paper makes four main contributions to the literature. First, this is, to the best of my knowledge, the first empirical test of whether changes in maternal occupational skills impact the process of skills formation of the offspring. This idea has been only studied from a theoretical perspective (Jonsson et al., 2009) or in an associational way (Barg & Klein, 2023). Second, this study goes a step further and disentangles the asymmetric causal effect of occupation-specific skills on children's skills, differentiating between skills upgrading and downgrading, and offers a closer look to the mechanism behind this effect by exploring the multidimensional and cumulative character of this skills transmission. Third, it also examines the stratified nature of the intergenerational transmission of occupation-specific skills, which has important implications for understanding the process of social reproduction. Finally, this paper explores the US case, which had been previously overlooked despite the rich available data which provide external assessments of the level of occupation-specific skills and children's development and therefore improves the previous literature using self-reported levels of skills.

The primary limitation of this study stems from the inherent challenge of not being able to conclusively dismiss the possibility that skills may naturally evolve over time, with job changes potentially reflecting pre-existing abilities. In such cases, the improvement of skills may not be directly tied to acquiring a new job, making it challenging to assert a causal relationship between the job change itself and skill enhancement. To address this concern, efforts have been made to shed light on this aspect by (i) accounting for the duration of time a mother spends in the new job, (ii) examining the specificity of skill transmission in different dimensions, and (iii) differentiating between skill increases and decreases.

However, it is important to acknowledge that these measures may not entirely eliminate the likelihood of an underlying process of skills improvement occurring in the background. Nevertheless, crucially for the interpretation of the implications of these results, if such a process exists, the results could be downwardly biased, leading to potentially underestimated coefficients. This is because the current models assume that individuals who remain in their current jobs lack the skill levels of those who undergo a job switch. In reality, there might be individuals in the non-switching group who possess high-level skills suitable for a job upgrade. Consequently, there is a potential bias arising from the inadvertent inclusion of individuals with comparable skills in the control group, mirroring those who changed occupations.

Another limitation of this paper is that only two dimensions of skills are included given data restrictions. This means that other types of occupation-specific skills of the mother which are important for children's development, such as social or motor skills, are omitted in this paper. A third limitation is that the potential mechanisms linking mothers' and children's skills are only indirectly examined, but not directly tested. Particularly, the changes in parental strategies or home environments that are fostered by occupational changes and eventually impact children's development should be examined in future research. Also motivated by data limitations, this paper only considers mothers' skills but not fathers. I have tried to account for the fathers or the partner of the mother by including information about their working hours or the variations in total household income, but there are not enough available observations on fathers' job transitions in the dataset employed. Further research would benefit from having a more comprehensive approach to the family unit in this sense. Moreover, an important avenue for future research would be to explore which type of selection processes could be responsible for the different impact that mathematical and literacy skills seem to have, which is something that this paper has not been able to deepen in given space limitations.

A final nuance to make is that occupations are not necessarily a perfect proxy for occupation-specific skills: even if O*NET accounts for the specific job tasks that are part of the job and derives the skills indexes from this and other job indicators, it does not allow me to differentiate conceptually between the job tasks and the job skills, which brings some conceptual undefinition to the paper.

Overall, these results suggest that the intergenerational transmission of skills does not only operate at the educational level as previous literature has suggested (Attanasio et al., 2020; Bowles et al., 2009; Lundborg et al., 2014; Sacerdote, 2002) but also through the transmission of skills that are associated to the specific job of the mothers. These results open new doors for policy programs trying to tackle social reproduction during the childhood period to examine mothers' skills from a more holistic perspective that includes other dimensions of the mothers' and children's lives.

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Chapter 5

Conclusions

5.1 Summary of the empirical findings

The overall research question driving this dissertation is *which are the mechanisms through which the process of intergenerational transmission of (dis)advantages occurs*? While prior research has uncovered a substantive portion of the complex combination of channels responsible for the intergenerational transmission of advantages and disadvantages, this thesis introduces three innovative mechanisms that have yet to be explored in the literature.

Chapter 2 of this dissertation underscores that parents tend to reinforce their children's early health problems. Within a family context, the unwell twin receives more negative emotional responses from their parents and faces stricter disciplinary measures compared to the healthier sibling. These parental responses exert a negative influence on the educational achievements of the unhealthy children in the long term. Interestingly, whether parents belong to low- or high-SES groups seems to make little difference in the adoption of these reinforcing parental behaviours. This remains consistent regardless of how I define socioeconomic background, whether through education, occupation, or income.

Therefore, while valuable in understanding how parents respond to their children's health disadvantages, the results from **Chapter 2** cannot confirm that this is a relevant mechanism for the intergenerational transmission of (dis)advantages. It is worth noting, however, that I cannot rule out the possibility of these same reinforcing parental responses being more detrimental for low-SES than high-SES children (i.e., differences in returns).

This might be the case if, for instance, high-SES children receive alternative forms of compensation from institutions like schools or extended family networks to which low-SES children do not have access to. However, such conclusions cannot be drawn from the results of this chapter alone.

Chapter 3 reveals that mothers tend to decrease their engagement in cognitive stimulation activities when their children's show declines in their mathematical abilities during the childhood period. This means that mothers do not only respond to the absolute level of ability of the children, but also to the relative fluctuations that children show over time. This finding is particularly prominent among mothers without tertiary education or who fall within the lower income bracket.

From these findings, we can conclude that parental responses and adjustments to children's relative ability are channels through which intergenerational reproduction operates. These results align with the compensatory advantage framework since they show that low-SES mothers are especially likely to reinforce the cognitive declines experienced by their children as compared to high-SES mothers (Breinholt & Conley, 2023; Halla & Zweimuller, 2014; Hsin, 2012).

Finally, the results from **Chapter 4** show that an increase in mothers' occupation-specific mathematical skills has a positive impact on their children's skills. This effect persists even after accounting for selection biases through inverse probability weighting techniques and considering potential confounding factors. Importantly, high-SES children derive greater benefits from these improvements in maternal occupational skills compared to their low-SES counterparts.

These results, by showing that an increase in parental skills has a direct influence on the acquisition of children's skills, align with the mechanisms centred around parental adjustments over time and cumulative skills. Furthermore, the results from **Chapter 4** underscore the multidimensional nature of skills, in accordance with the dynamic complementarities literature. This is evident as parental occupational-related skills exhibit different returns conditional on the educational levels of the mothers.

Overall, the results from this thesis suggest that, of the three mechanisms examined, two are relevant for the intergenerational transmission of disadvantages. This is the case of the stratified parental responses to children's cognitive declines studied in **Chapter 3** and the intergenerational transmission of occupation-specific skills analysed in **Chapter 4**. These findings underscore the importance of accounting for the bidirectional influence within the parent-child dyad and the cumulative character of skills when examining the intergenerational transmission of inequality (**Chapter 3**), as well as the relevance of adopting a comprehensive and multidimensional approach to skills that incorporates parental occupation as a source of human capital formation (**Chapter 4**).

5.2 Systematisation of the literature

In this section, my aim is to organise the existing literature by establishing a dialogue between the current studies and the findings of this dissertation. As mentioned previously, the central focus of this thesis revolves around three mechanisms that underlie the intergenerational transmission of inequalities.

In **Table 5.1**, I provide a summary of empirical studies that meet two criteria: (i) they address specific mechanisms of intergenerational transmission, investigating how particular advantages and disadvantages are passed down through generations, and (ii) they exhibit a dynamic understanding of the social reproduction process, i.e., they assume that over-time or within-family reciprocal influences will shape the intergenerational transmission of (dis)advantages.

Subsequently, in the following discussion, I examine which aspects are consistent across studies and offer some interpretations. I also theorise on how future research might expand upon this body of literature.

Table 5.1: Overview of the dynamic mechanisms of intergenerational transmission of (dis)advantages.

Threotical approach	**Study**	**Dynamic component**	**Parental resource (*how*)**	**Triggering characteristic (*why*)**	**Children's outcome**	**Age (*when*)**	**Country (*where*)**	**Method**	**Results**
Compensatory advantage framework	Hsin (2012)	Bidirectional influence	Time	Birthweight	-	0-12 yrs	US	Siblings FE	Reinforcement low-SES
	Halla and Zweimuller (2014)	Bidirectional influence	Labour market supply and family size	Early health shock	Educational track choice and labour market outcomes	Prenatal	Austria	Diff-in-diff	Compensation high-SES
	Graetz and Torche (2016)	Bidirectional influence	Quality of the interactions	Developmental milestones and birth weight	-	10 months to 4 yrs	US	Twin FE	Reinforcement high-SES for developmental milestones. No stratification birth weight.
	Restrepo (2016)	Bidirectional influence	Emotional support and cognitive stimulation	Low birth weight	-	0-14 yrs	US	Siblings FE	Reinforcement low-SES, compensation high-SES
	Graetz and Bernardi (2017)	Bidirectional influence	Involvement	Month of birth	-	0-11 yrs	UK	Linear prob models and exogenous variations	Reinforcement low-SES and compensation high-SES
	Breinholt and Conley (2023)	Bidirectional influence	Cognitive stimulation	Education attainment polygenic score	-	0-5yrs	US	Linear prob models with parents' and children's polyg. scores	Reinforcement low-SES

Table 5.1: Overview of the dynamic mechanisms of intergenerational transmission (cont.)

Developmental psychology literature	Lugo-Gil and Tamis-LeMonda (2008)	Transactional parenting	Parenting quality	Early cognitive performance	Later cognitive performance	1-3 yrs	US	Structural eq. modelling	Reciprocal influences children's performance, parenting and family SES.
	Kalil et al. (2012)	Sensitivity in parenting	Time spent in each parenting activity	Age of the child	-	0-13 yrs	US	Tobit models	High-SES mothers tailor their parenting to the specific tasks and capacities of the developemental period.
Dynamic complementarities framework	Rosenzweig and Wolpin (1988)	Dynamic complementarities	Allocation of resources within the family and fertility decisions	Health of the child	-	0-6 yrs	Colombia	Instrumental approach using lagged inputs on siblings and parental characteristics	Parents adapt their behaviour to unanticipated health outcomes.
	Aizer and Cunha (2012)	Dynamic complementarities	Quality of parental interactions	Early human capital	Late human capital	0-7 yrs	US	Dynamic production function and family FE	Reinforcement: parents invest more in the highly endowed child.
	Garcia and Gallegos (2017)	Dynamic complementarities	Parental time and material investment	Initial human capital	Cognitive abilities	0-3 yrs	US	Randomized control trial and dynamic production function	More disadvantaged children benefit the most from parental investments.
	Duque et al. (2019)	Dynamic complementarities	Investments through conditional cash transfers	Early exposure to weather shocks	Long-term educational outcomes	Prenatal to age 3	Colombia	Difference-in-differences	Very early parental investments compensate for the shock.

Table 5.1: Overview of the dynamic mechanisms of intergenerational transmission (cont.)

Dynamic models of cultural reproduction	Jaeger and Breen (2016)	Parental adjustments over time and accumulation of skills	Parents' cultural capital investments	Children's cultural capital	Educational performance	10-14 yrs	US	Dynamic Panel Data Model	Parents adjust their investments based on the returns to past investments.
	Blaabaek (2021)	Parental adjustments over time and accumulation of skills	Parents' cultural inputs and cognitive ability	Early children's reading and cognitive ability	Late children's reading	10-14 yrs	US	Dynamic Panel Data Model	Children's reading is the product of present and past parental investments.

Note: this is not a meta-analysis including all the literature covering the process of social reproduction, but a systematisation of the empirical findings that fulfil the two conditions stated above: (i) they examine specific mechanisms of transmission, and (ii) they have a dynamic component.
In the studies accounting for the bidirectional influences and the literature on developmental psychology, I have only included the works that account for heterogeneous SES effects.
The reason for this is that these studies are specifically centred on understanding the dynamics of social reproduction.
This also means that some relevant works that could be understood within these branches of literature that do not account for SES differences are excluded from this table.
That is the case of Datar et al. (2010), Almond and Mazumder (2013), Ayalew (2005) and Bharadwaj et al. (2017).

Despite there is a considerable level of heterogeneity in how parents transmit their advantages and disadvantages to their children, a close analysis of the literature reviewed above, in conjunction with the findings of this dissertation, yields two primary conclusions, which I will elaborate upon below.

5.2.1 A tale about reinforcement, but under which circumstances?

The most consistent piece of evidence across this literature is that the average parental response to children's disadvantages is a reinforcing one (Aizer & Cunha, 2012; Lugo-Gil & Tamis-LeMonda, 2008), which is also what the results from **Chapter 2** show. However, more important for social reproduction than this average response is to look closely at the two different patterns that low- and high-SES parents display.

While low-SES parents generally reinforce their children's disadvantages through their behaviour (Breinholt & Conley, 2023; Graetz & Bernardi, 2017; Hsin, 2012; Restrepo, 2016, and **Chapter 3** of this thesis), high-SES parents often exhibit compensatory behaviours with their children (Graetz & Bernardi, 2017; Halla & Zweimuller, 2014; Restrepo, 2016). Taken together, these two pieces of evidence indicate that the bidirectional influence wherein parents (heterogeneously) adapt their responses to children's disadvantages can be an important mechanism for the intergenerational transmission of disadvantages.

Within this group of mechanisms, however, there are notable nuances concerning the *how* (types of resources that parents use to reinforce or compensate), *when* (timing), *why* (triggering characteristics of the children), and *where* (institutional context) of parental responses.

5.2.1.1 *How? Types of parental resources*

When it comes to the type of resources, the sociological literature examining parental responses has not focused on parental monetary investments as much as the work coming from economics. However, many of the studies reviewed above have explored the quantity and quality of parental interactions and the cognitive stimulation of the parents.

In this sense, it seems that parents tend to reinforce their children's disadvantages by reducing the quality of their interactions, while they are more inclined to compensate by increasing the quantity of time they invest. This phenomenon can be explained because parents may find it simpler to alter the quality of their parenting rather than the quantity when implementing a reinforcing response, as it is less explicit for both them and their children. For example, it is more evidently wrong from the parents' lenses to stop spending time with their children in the evenings, than keeping the same amount of time but multitasking meanwhile.

Regarding parental cognitive stimulation, the most consistent pattern suggests that it is low-SES parents who more commonly reduce it as a response to children's disadvantages. This aligns with the findings presented in **Chapter 3** of this thesis. The greater fluctuation in cognitive stimulation observed among low-SES parents, compared to their high-SES counterparts, can be attributed to the increased effort required by parents with lower levels of education to meet their children's cognitive needs. In other words, it is reasonable to expect that low-SES parents might reach their own cognitive stimulation limits sooner than their high-SES counterparts.

5.2.1.2 *When? The age of the child*

Answering the *when* question is less straightforward based on the literature presented above and on the results from this dissertation. In general, the time span considered varies a lot across studies, although it mostly goes from the perinatal time to the middle childhood period (around 12 years old). Although several studies coincide in emphasizing the early years (0 to 6) as the most impressionable period for children's future outcomes (Cunha & Heckman, 2008), most of the studies reviewed in **Table 5.1** as well as the three chapters of this dissertation find also relevant effects of parental behaviours on children in later ages.

Therefore, further research could dig deeper into the role that the age of the children plays in the three mechanisms examined in this dissertation. For instance, it would be substantively interesting to test the mechanisms examined in **Chapters 3** and **4**, which originally covered ages 5 to 15, on the very early ages of the children. My intuition is that if these mechanisms matter in the medium to late childhood period, they would be even more relevant during the early and most malleable years, according to most of the literature on human capital formation.

5.2.1.3 *Why? The triggering characteristics*

The third important nuance has to do with the specific triggering element that activates parental responses. First, there is no consensus in the literature about the role of birth weight, as some studies find reinforcing and compensatory effects (Hsin, 2012; Restrepo, 2016), while others yield null results. Within the latter group, several papers have employed alternative measures of endowments to understand what triggers parental responses.

For example, Breinholt and Conley (2023) have used polygenic scores, Graetz and Torche (2016) have examined developmental milestones, and **Chapter 2** of this dissertation has focused on early health problems.

Beyond birth weight, several studies focus on children's cognitive abilities. What has been less common in this literature, however, is an examination of how parents respond to children's non-cognitive skills. Future research could significantly benefit from incorporating this non-cognitive skills dimension and exploring the interactions that occur when different levels of cognitive and non-cognitive skills come into play.

5.2.1.4 *Where? The institutional context*

Finally, the fourth important detail to consider when thinking about compensatory and reinforcing mechanisms according to this systematisation is the institutional context. Most of the channels noted in **Table 5.1** as well as the mechanisms tested in this dissertation are geographically located in the US and the UK. This not only implies that these mechanisms have primarily been tested in affluent Western settings but also within a specific subtype of liberal welfare state, characterised by particular educational systems and labour market structures.

Although this dissertation lacks an explicit exploration of how the three examined mechanisms interact within specific institutional contexts, a plausible scenario is that in societies characterised by more egalitarian welfare states, such as the Nordic countries (i.e., Sweden, Finland, or Norway), the influence of parental characteristics on children's development may be diminished (Fochesato & Bowles, 2015). Consequently, the mechanisms proposed in this thesis may play a less prominent role in such settings.

For instance, regarding **Chapter 4** and the role of parental occupational-specific skills, one could argue that in contexts characterized by a labour-market-oriented educational system, children from low-SES backgrounds have an increased likelihood of acquiring these skills through formal education. This, in turn, could potentially diminish the role of parental skills in shaping children's human capital. Turning to the mechanism explored in **Chapter 3**, which examines how low-SES parents respond to their children's cognitive declines by reducing their cognitive stimulation, it is plausible that in settings with well-trained educators and a robust educational infrastructure, these cognitive setbacks could be promptly identified and addressed through additional or specialized training.

Therefore, a holistic and context-dependent approach will be crucial in future research for understanding the intricate interplay between families and other societal institutions in shaping the intergenerational transmission of advantages and disadvantages.

5.2.2 A tale about dynamic processes

The second important conclusion from this systematization of empirical findings is that accounting for the dynamic aspect of the intergenerational transmission of inequalities is crucial. As shown in **Table 5.1**, the dynamic understanding of the process of social reproduction should be seen as an umbrella under which different perspectives can be framed. The common factor is that they do not approach the intergenerational transmission of disadvantages from a static perspective, which would be the case if, for instance, we compared parental characteristics and children's outcomes within the same time frame, or if we assumed that parental investments in their children are invariable despite children's characteristics or previous parental investments.

The literature on the intergenerational transmission of disadvantages can be organized by identifying three primary sources of dynamism.

5.2.2.1 *Bidirectional influence*

This literature has been led by the compensatory advantage framework (which I have explained in detail in the previous section), and its predecessor the intra-household allocation of resources literature. These studies consistently demonstrate that children are not only influenced by their parents' actions, but parents' behaviours are also shaped by their children, which is the essence of bidirectional influence. Moreover, these responses vary between high- and low-SES families. This bidirectional influence is a prevalent finding in the studies listed in **Table 5.1**, as well as in **Chapters 2** and **3** of this thesis.

5.2.2.2 *Time and accumulation*

The second source of dynamism has to do with time and accumulation mechanisms. In this sense, the developmental psychology literature has expanded the idea of bidirectional parenting to include a time dimension. From this research, we can learn that it is important to understand parents' and children's reciprocal influence as a continuous process happening in everyday life (Lugo-Gil & Tamis-LeMonda, 2008). This literature has also opened the door to examining how parents tailor their actions to the specific developmental stage of their children. This focus on time has allowed Kalil et al. (2012) to build a model by which parents account for the specific developmental rhythms of their children and tailor their behaviours and investments to these. This is also what **Chapter 3** of this dissertation shows: parents are sensitive to the specific developmental progression of their children and adjust their parenting according.

This relevance of the timing dimension is also incorporated in the dynamic models of cultural reproduction and the dynamic complementarities literature that suggest that skills accumulate over time and parents adjust their investments to this (and based on their previous investments). This dissertation confirms the relevance of this accumulation process in two ways. First, **Chapter 3** shows that parents respond to relative variations in skills (instead of absolute values), and that parents base their investments on their previous level of investments (i.e., cumulative parenting). Second, **Chapter 4** shows the relevance of parents' skills upgrading (instead of downgrading) which is driven by this cumulative aspect of skills, as well as the importance of accounting for how many years the mother has been exposed to certain skills herself to understand their impact on children's development.

5.2.2.3 *Multidimensionality and complementarity of skills*

Finally, the third and last source of dynamism in this literature comes from the multidimensionality and complementarity between different types of skills and parental investments. Led by Cunha and Heckman (2008), the literature on dynamic complementarities has broadly shown that there is not necessarily a correspondence between the human capital pillar that parents invest in and the final skill affected, because all of them are part of a complex interlocking system.

This multidimensionality is also present in the results of this thesis in two ways. In **Chapter 2**, I show that parental responses to health problems negatively impact children's long-term educational outcomes, which we could consider a spillover effect across different human capital dimensions. Finally, in **Chapter 4**, I account for a novel type of parents' skills, occupation-specific ones, which introduces a new dimension to the intergenerational transmission of skills. Moreover, this chapter shows that children with low-educated mothers benefit less from increases in occupation-specific skills than those with high-educated ones, which speaks to the dynamic complementarities between the skills acquired in the formal educational systems and further types of skills.

5.3 Contributions

This dissertation aimed to deepen our understanding of the social reproduction process by investigating three innovative mechanisms responsible for the intergenerational transmission of (dis)advantages in the UK and the US. While each of these chapters explores distinct pathways, they all share a common theoretical and methodological framework. Consequently, their contributions can be assessed on both a general and chapter-specific level.

From a theoretical standpoint, this dissertation makes a significant contribution to the body of literature that investigates the micro-mechanisms responsible for the phenomenon of social reproduction by suggesting three new channels through which advantages and disadvantages are transmitted from parents to children. In particular, it adds to the dynamic approaches to the intergenerational transmission of inequalities, such as those found in the compensatory advantage or the dynamic complementarities literature, which account for within-family and time-specific dynamics in the study of social reproduction.

Each of the three chapters makes specific substantive contributions. **Chapter 2**, to the best of my knowledge, is the first to consider the possibility of differential responses from high- and low-SES parents to their children's health problems. This is particularly significant in the context of compensatory advantages, as children's health plays a pivotal role in human capital formation, and the effects of early health issues can have lasting repercussions into adulthood. **Chapter 3** expands on the literature regarding compensatory advantages by addressing a previously unanswered question: how do high- and low-SES mothers respond to fluctuations in their children's developmental processes? Lastly, **Chapter 4** advances the literature on intergenerational transmission and early human capital formation by analysing how mothers' occupation-specific skills impact their children's skill acquisition. To my knowledge, this is the first empirical exploration of the effect of parental occupation-specific skills on children.

In terms of methodology, all three chapters employ causal approaches and rely on high-quality household panel datasets. Additionally, they share the common objective of addressing prevalent biases in the social reproduction literature, including issues like omitted variable bias, reverse causality, and selection.

Chapter 2 enhances the use of twin models by incorporating a longitudinal design, bolstering the robustness of the identification strategy. In **Chapter 3**, fixed-effects counterfactual models are introduced to enhance the precision of conventional two-way fixed-effects models in the identification of dynamic social processes. This innovation carries broader implications for the literature on the intergenerational transmission of (dis)advantages, particularly considering the dynamic nature inherent to child development and other intertwined social processes. **Chapter 4** offers several methodological contributions, including the introduction of asymmetric fixed effects models to isolate the effects of skills upgrades and downgrades, which can be valuable for future research in skills transmission. Additionally, it extends the use of inverse probability weighting to account for selection bias by computing longitudinally based weights. Lastly, it combines the NLS panel with rich O*NET data, offering a novel approach that improves the previous literature using self-reported levels of skills.

5.4 Limitations

Several limitations of this thesis warrant further discussion.

First, this dissertation delves into three potential mechanisms responsible for the intergenerational transmission of advantages, but it does not provide an exhaustive exploration of all the possible channels at play in the process of social reproduction. Moreover, I study each of these channels in an isolated manner, which means that I cannot offer any hint on how relevant each of these is when compared to the others, or what happens when several of these mechanisms collide.

Second, as stated in the systematisation of empirical findings section, the primary focus of this thesis is on the UK and the US, both of which represent affluent Anglo-Saxon countries with similar welfare state configurations. As a result, the generalizability of these findings to different socio-political contexts should be approached with caution. Additionally, each paper exclusively concentrates on one country, which limits the ability to conduct cross-country comparative analyses to assess the influence of institutional settings.

Third, the null results found in **Chapter 2** with respect to stratified parental responses imply that this thesis offers mixed support for the compensatory advantage mechanism, despite this being the main theoretical framework underlying this dissertation. This may partly stem from the specific selection of the dependent variables. For example, in **Chapter 2**, the focus is on parental emotional responses and discipline behaviours, while other aspects of parental responses, such as cognitive stimulation, time spent with children, or financial investments, might exhibit different patterns. Further research should aim to disentangle this complex combination in a more systematic way.

Fourth, despite the efforts to address the common biases in the social reproduction literature, observational data has been used in all three chapters. This opens the possibility of unobserved factors influencing the scenarios under investigation. Experimental designs could offer greater control over parent-child relationships but were not feasible in these studies, and would require further consideration of the ethical implications.

Finally, each chapter has its unique Achilles heel. In **Chapter 2**, the within-family design is susceptible to spillover effects between twins, potentially complicating the accuracy of the results. However, any such spillovers would likely result in underestimating the observed effects, which should offer some reassurance about their substantive significance. In **Chapter 3**, a limitation arises from the black box surrounding how parents detect changes in children's development, which the available data cannot address but could be explored in future research with different surveys or experimental approaches. In **Chapter 4**, the exclusive focus on mothers leaves out an examination of fathers' roles within the family unit, resulting in an incomplete portrayal of intra-familial dynamics. Moreover, this chapter only manages to indirectly test the potential mechanism involved.

5.5 Avenues for future research

On top of expanding the literature on the directions suggested in the systematisation section, such as delving into the age and contextual effects more clearly, and accounting for the multidimensionality and cumulative character of skills more carefully, there are three promising avenues for future research can build upon the foundations laid by this thesis.

First, there is a pressing need to continue investigating potential micro-level channels through which the intergenerational reproduction process operates. While existing research has been crucial in establishing the link between social origins and destinations, future studies should delve deeper into the micro-foundations driving this social process. As I have argued throughout this dissertation, a focus on mechanisms is beneficial both for the empirical study of the process of social reproduction and for understanding the normative and policy implications (Jencks & Tach, 2005; Swift, 2009).

Second, building on the channels introduced in this thesis, researchers can further explore the intricacies and broader implications of these three mechanisms. **Chapter 3**, for instance, opens the door to investigating how fluctuations in children's cognitive abilities interact with different elements of the educational system such as tracking, as well as their long-term impact on children's socioeconomic outcomes. **Chapter 4** lays the foundation stone to examine the influence of parents' occupation-specific skills on children. Future research should consider a wider array of skill dimensions beyond literacy and mathematics, as well as evaluate the effects of these skills' transmission on children's educational performance throughout their lives and aim to test directly the mechanism involved in how mothers transmit these skills to their children.

Third, future research could benefit from adopting some of the empirical strategies proposed in this thesis. Life course analysis, for instance, can incorporate fixed-effects counterfactual models to enhance the study of dynamic social processes. Causally oriented research on social stratification can leverage asymmetric models to disentangle the effects of positive and negative changes in predictors, thereby enhancing the precision of estimates.

5.6 Normative and policy implications

Despite the predictions of modernization theory, which anticipated that educational systems would play a pivotal role in explaining persistent inequalities, research has shown that the developmental disparities between children from more and less advantaged backgrounds are already apparent before they reach school age (Heckman & Carneiro, 2003). This suggests that family-related factors also play a critical role in influencing children's educational achievements and socioeconomic prospects (Bowles et al., 2009; Duncan et al., 2009). As Torche (2016) states, "there are powerful determinants of intergenerational reproduction that bypass the educational system" (p. 252).

Consistent with this, the results from this dissertation show that some important channels for understanding the intergenerational transmission of (dis)advantages operate within the family unit. Consequently, public interventions aimed at addressing this source of inequality must focus on the family and its internal dynamics. However, a practical challenge lies in reconciling these policies with a more normative view of the family as a strictly private domain.

On the one hand, a common philosophical and political approach to the family as a source of inequality suggests, in words of Swift (2009), that "whereas it is possible to legislate on issues of schooling, wealth transfers, and so on, one cannot do the same with respect to private interaction within the family. What goes on there is properly immune from political action" (p. 259). On the other hand, an alternative viewpoint in the literature contends that it is precisely due to the family's central role in perpetuating inequality that it must be subject to careful scrutiny. In this sense, the literature has suggested two types of solutions to deal with the inequalities reproduced by the family.

The most radical position follows Rawls (1999), which claims that "equality of opportunity can be only imperfectly carried out, at least as long as some form of the family exists" (p. 64), and based on this, suggests abolishing the family as an institution. A more realistic perspective has proposed to think about the different mechanisms responsible for social reproduction and determine the normative implications of each of them for the equality of opportunity (Swift, 2009).

Within this second approach, Swift (2009) claims that the pivotal criterion for determining the moral acceptability of parental behaviour lies in scrutinising whether such conduct is embedded within the realm of intimate family interactions. According to the author, if these actions fall within this sphere, they should be deemed permissible, irrespective of the potential repercussions for inequality.

In a later work, Brighouse and Swift (2009) give the following example: engaging in activities such as reading bedtime stories to children and involving them in associations that foster participation in meaningful community experiences shared by both parents and children holds value for the children and their intimate family interactions. In contrast, the enrolment of children in costly private schools to maximise their future opportunities may not be necessary for parents and children to fully appreciate the unique benefits that family relationships offer.

From these lenses, the mechanisms examined in **Chapters 3** and **4**, which speak to how high-SES parents put more emphasis on their children's skills development, would be morally questionable. The reason is that they are not naïve interactions taking place in the intimate sphere of the family, but more explicitly, efforts of the parents to boost certain abilities in their children. **Chapter 2**, however, shows a scenario in which parental emotional and discipline responses are modified based on children's health problems. These types of parental behaviours could be part of the natural functioning of family life, and therefore, would be acceptable from Swift's lenses.

Another important differentiation to understand the normative implications of the mechanisms examined by this dissertation comes from the specific concept of equality of opportunity chosen. From a radical perspective, as far as an element beyond the individual control influences life chances, this would be considered an unfair source of inequality (Roemer, 1998, 2002). The findings in **Chapter 3** suggest that fluctuations in children's cognitive abilities, which are beyond the individual's control, impact the level of stimulation they receive from their parents. Similarly, **Chapters 2** and **4** reveal scenarios in which health shocks, parental responses, and parental occupation-specific skills all contribute to unequal outcomes. Thus, this interpretation of the results justifies policy interventions aimed at addressing these sources of inequality.

However, determining whether these findings also constitute unfair inequality from a liberal standpoint is more intricate. According to this perspective, differences in outcomes resulting from disparities in innate abilities or effort levels are not morally condemnable (Rawls, 1971). The findings derived from **Chapter 3** can be framed as differences in outcomes arising from disparities in abilities, and, therefore, from the liberal standpoint, would not inherently signify an unjust scenario.

When it comes to translating the findings of this thesis into policy measures, the primary consideration revolves around the fact that policies designed should target parents as the primary actors, rather than concentrating on children, since their behaviours are the focus of this dissertation.

Starting with **Chapter 2**, the most direct type of intervention would involve addressing the negative or reinforcing parental practices. Yet, parents are often unaware of the consequences of certain behaviours, which are socially learned and perpetuated. This could distress some families, especially the most vulnerable ones. A potential solution then would be to shift the focus from condemning the practices of disadvantaged families to uncovering strategies commonly employed by high-SES families, therefore making them accessible to low-SES groups (Ballarino & Bernardi, 2016).

This could involve sharing information typically available only to more privileged social groups with the entire population. For instance, Bergman (2021) demonstrates that providing parents with information about their children's performance enhances children's educational achievement. Thus, based on the results of **Chapter 3**, it would be beneficial to provide guidance to low-educated mothers on how to detect and address cognitive declines in their children. Similarly, following **Chapter 4**, offering extra-skills training for low-SES children, akin to what high-SES children receive through their parents' occupations, could be valuable.

To sum up, the normative approach to the results from this thesis suggests that (i) the mechanisms of intergenerational reproduction uncovered represent sources of unfair inequality, particularly in **Chapters 3** and **4**; (ii) in those cases, public policies should be justified by this unfairness to intervene in the private domain of the family and focus on parents as the primary actors; and (iii) interventions should avoid accusatory discourse toward disadvantaged families and instead aim to reveal the strategies that enable more privileged families to perpetuate their advantages.

An example of an intervention aligned with these considerations is the field experiment by Mayer et al. (2015), which incentivized low-SES parents to engage in light-touch interventions with high returns for their children. This approach addresses biases that hinder low-educated parents from implementing practices beneficial for their children's development, such as a lack of awareness of the long-run impact of their actions. Solutions include providing information on relevant actions and offering reminders and incentives for parents to stay motivated in supporting their children. This behavioural approach to parental interventions yields positive short- and long-term effects on children's development and can be applied to a broad range of contexts where the process of intergenerational transmission of (dis)advantages occurs.

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A| - Appendix for Chapter 2

Table A.1: Descriptive statistics

Variable	Mean/ Proportion	*SD*	Min	Max	Measured at Age	Reported by Parents (*P*) or Twins (*T*)
Twin Medical Risk Scale	0	1	-3	6	1	P
Emotional Age 3	0	1	-6	6	3	P
Emotional Age 4	0	1	-6	6	4	P
Emotional Age 7	0	1	-6	6	7	P
Discipline Age 3	0	1	-6	6	3	P
Discipline Age 4	0	1	-6	6	4	P
Discipline Age 7	0	1	-6	6	7	P
Educational Performance - GCSE	8.89	1.2	4	11	16	T
Subjective-Health	2.53	1.01	1	5	21	T
Parental Education	Tertiary-Educated 27%	-	0	1	1	P
Twin's Gender	Male 49, 9%	-	0	1	1	P
Birth order	50%	-	1	2	1	P
Age of the mother at birth	30.73	4.84	16	45	-	P
Number of siblings	0.04	0.22	0	6	7	P
Birth Weight (g)	2476.1	559	1937	4560	1	P
Cognitive Ability at Age 3	0	1	-3	3	3	P
Zygosity	Mopozyg 33%	-	0	1	1	*P*
Maternal Occupation	Service Class 50.1%	-	0	1	1	P
Gender of the Parent-Respondent	Father 1.57%	-	0	1	1	P
Household Income	7.89	2.94	1	11	1	P

Table A.2: Parental responses and cognitive ability control.

	Dependent Variables					
	Negative Emotional Responses			**Negative Discipline Behaviours**		
	Age 3	Age 4	Age 7	Age 3	Age 4	Age 7
	(1)	(2)	(3)	(4)	(5)	(6)
Twin Medical Risk Scale	0.051^{*} (0.022)	0.054^{**} (0.018)	0.054^{*} (0.021)	-0.016 (0.020)	0.032^{*} (0.015)	0.022* (0.01)
Cognitive Ability	-0.082^{***} (0.018)	-0.032^{*} (0.015)	-0.086^{***} (0.014)	-0.021 (0.012)	-0.070^{***} (0.018)	-0.041^{*} (0.018)
Male	0.144^{***} (0.023)	0.264^{***} (0.020)	0.132^{***} (0.018)	0.236^{***} (0.016)	0.109^{***} (0.022)	0.293^{***} (0.023)
Observations	9,457	15,196	11,781	9,457	15,196	11,781

Note: standard errors are in parentheses. $^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table A.3: Parental responses to birth weight.

	Dependent Variables					
	Negative Emotional Responses			**Negative Discipline Behaviours**		
	Age 3	Age 4	Age 7	Age 3	Age 4	Age 7
	(1)	(2)	(3)	(4)	(5)	(6)
Birth weight	-0.0001^{*} (0.00003)	-0.00002 (0.00002)	-0.00001 (0.00002)	-0.0001^{**} (0.00002)	-0.00001 (0.00003)	-0.00001 (0.00003)
Male	0.158^{***} (0.020)	0.160^{***} (0.018)	0.155^{***} (0.019)	0.259^{***} (0.018)	0.244^{***} (0.016)	0.315^{***} (0.020)
Observations	11,640	15,463	15,026	11,640	15,463	15,026

Note: standard errors are in parentheses. $^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table A.4: Parental responses and each of the factors of the twin medical risk composite.

	Dependent Variables					
	Negative Emotional Responses			**Negative Discipline Behaviours**		
	Age 3 (1)	Age 4 (2)	Age 7 (3)	Age 3 (4)	Age 4 (5)	Age 7 (6)
Days in Hospital	0.002 (0.004)	0.006 (0.003)	0.010^{*} (0.004)	0.002 (0.003)	0.004 (0.003)	0.005 (0.004)
Observations	11,488	11,496	15,278	15,297	14,874	14,814
Problems at birth	0.043 (0.029)	0.057^{*} (0.025)	0.065^{*} (0.027)	-0.039 (0.025)	0.005 (0.022)	0.021 (0.027)
Observations	11,734	11,741	15,651	15,677	15,270	15,209
Special care needed	0.002 (0.003)	0.010^{**} (0.003)	0.010^{**} (0.003)	0.001 (0.003)	0.005 (0.003)	0.003 (0.003)
Observations	4,471	4,470	5,904	5,907	5,799	5,775

Note: standard errors are in parentheses. All the models include controls for gender.
$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table A.5: Parental responses and gender of the child interaction.

	Dependent Variables					
	Negative Emotional Responses			**Negative Discipline Behaviours**		
	Age 3 (1)	Age 4 (2)	Age 7 (3)	Age 3 (4)	Age 4 (5)	Age 7 (6)
Medical risk (ref. cat.: female)	0.051^{*} (0.023)	0.072^{***} (0.020)	0.056^{**} (0.021)	-0.025 (0.020)	0.036^{*} (0.017)	0.048^{*} (0.022)
Male	0.160^{***} (0.020)	0.154^{***} (0.018)	0.149^{***} (0.019)	0.251^{***} (0.018)	0.240^{***} (0.015)	0.310^{***} (0.020)
Medical risk x male	-0.010 (0.021)	-0.021 (0.017)	-0.002 (0.019)	0.027 (0.018)	-0.004 (0.015)	-0.012 (0.019)
Observations	11,525	15,295	14,745	11,525	15,295	14,745

Note: standard errors are in parentheses.
$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table A.6: Parental responses and parental gender control.

	Dependent Variables					
	Negative Emotional Responses			**Negative Discipline Behaviours**		
	Age 3	Age 4	Age 7	Age 3	Age 4	Age 7
	(1)	(2)	(3)	(4)	(5)	(6)
Medical Risk	0.046*	0.062***	0.055**	-0.010	0.062***	0.042*
(ref. cat: mother)	(0.020)	(0.018)	(0.019)	(0.018)	(0.018)	(0.019)
Medical scale x	0.014	-0.102	0.041	-0.053	-0.102	-0.023
father	(0.186)	(0.214)	(0.203)	(0.163)	(0.214)	(0.204)
Observations	11,525	15,295	14,745	11,525	15,295	14,745

Note: standard errors are in parentheses.
$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table A.7: Parental responses and zygosity interaction

	Dependent Variables					
	Negative Emotional Responses			**Negative Discipline Behaviours**		
	Age 3	Age 4	Age 7	Age 3	Age 4	Age 7
	(1)	(2)	(3)	(4)	(5)	(6)
Medical Risk	0.025	0.061***	0.041*	-0.030	0.028	0.013
(ref. cat.: dizyg)	(0.024)	(0.021)	(0.023)	(0.021)	(0.019)	(0.024)
Medical scale x	0.040	-0.022	0.023	0.018	-0.019	0.042
monozyg	(0.044)	(0.039)	(0.041)	(0.039)	(0.034)	(0.042)
Observations	11,525	15,295	14,745	11,525	15,295	14,745

Note: standard errors are in parentheses.
$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table A.8: Parental responses by extended parental education

	Dependent Variables					
	Negative Emotional Responses			**Negative Discipline Behaviours**		
	Age 3	Age 4	Age 7	Age 3	Age 4	Age 7
	(1)	(2)	(3)	(4)	(5)	(6)
Medical Risk	-0.054	-0.094	-0.081	0.021	0.022	-0.105
(ref. cat.: No-Ed)	(0.102)	(0.109)	(0.107)	(0.087)	(0.096)	(0.108)
Medical Risk	0.070	0.153	0.169	-0.057	-0.007	0.188
x Sec. Educ.	(0.108)	(0.113)	(0.112)	(0.093)	(0.100)	(0.113)
Medical Risk	0.116	0.202	0.143	-0.003	-0.014	0.190
x Vocational	(0.116)	(0.120)	(0.120)	(0.100)	(0.106)	(0.121)
Medical Risk	0.024	0.108	0.101	-0.102	-0.052	0.138
x A-levels	(0.118)	(0.120)	(0.119)	(0.102)	(0.106)	(0.120)
Medical Risk	0.206	0.190	0.173	0.0001	0.106	0.116
x Undergraduate	(0.114)	(0.117)	(0.116)	(0.098)	(0.104)	(0.117)
Medical Risk x	0.133	0.198	0.044	-0.015	0.012	0.058
x Postgraduate	(0.118)	(0.119)	(0.120)	(0.101)	(0.105)	(0.121)
Observations	11,525	15,295	14,745	11,525	15,295	14,745

Note: standard errors are in parentheses. The extended parental education variable follows the same logic of construction as the dichotomous version used in the main analysis, i.e., a dominance model, but without clustering the categories into only two groups.
$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table A.9: Parental responses by maternal occupation

	Dependent Variables					
	Negative Emotional Responses			**Negative Discipline Behaviours**		
	Age 3	Age 4	Age 7	Age 3	Age 4	Age 7
	(1)	(2)	(3)	(4)	(5)	(6)
Medical Risk (ref. working class)	0.013 (0.026)	0.0003 (0.05)	0.002 (0.05)	−0.63 (0.042)	−0.020 (0.04)	0.004 (0.051)
Medical scale x service class	0.107 (0.066)	0.103 (0.071)	0.041 (0.071)	0.101** (0.06)	0.028 (0.057)	−0.051 (0.073)
Observations	4,364	4,142	4,294	4,364	4,142	4,294

Note: standard errors are in parentheses.
Following the reduced Goldthorpe scheme, the "service class" includes those individuals in professional and managerial groups , and the "working class" those skilled and unskilled manual workers.
$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table A.10: Parental responses by household income

	Dependent Variables					
	Negative Emotional Responses			**Negative Discipline Behaviours**		
	Age 3	Age 4	Age 7	Age 3	Age 4	Age 7
	(1)	(2)	(3)	(4)	(5)	(6)
Twin Medical Risk x household income	0.006* (0.004)	0.0003 (0.003)	0.005 (0.004)	0.001 (0.003)	0.001 (0.004)	-0.003 (0.004)
Observations	4,364	4,142	4,294	4,364	4,142	4,294

Note: standard errors are in parentheses. The variable Household Income Level presents 11 categories, although I am treating it as continuous one in the analyses for simplification. Range from 5,000 to 100,000.
$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table A.11: Parental responses. OLS models with interaction.

	Dependent Variables					
	Negative Emotional Responses			**Negative Discipline Behaviours**		
	Age 3	Age 4	Age 7	Age 3	Age 4	Age 7
	(1)	(2)	(3)	(4)	(5)	(6)
Medical Risk	0.034**	0.044***	0.034***	-0.001	0.016	0.032***
	(0.012)	(0.009)	(0.009)	(0.012)	(0.01)	(0.01)
Tertiary Educ	0.059**	0.057**	0.094***	−0.269***	−0.242***	−0.090***
	(0.022)	(0.019)	(0.019)	(0.022)	(0.019)	(0.019)
Medical Risk	0.016	-0.025	-0.016	0.002	-0.0002	0.001
x Tertiary Educ	(0.022)	(0.018)	(0.019)	(0.022)	(0.018)	(0.019)
Constant	−0.169*	−0.123*	-0.090	0.555***	0.243***	0.129*
	(0.070)	(0.061)	(0.062)	(0.069)	(0.061)	(0.061)
Observations	11,525	15,295	14,745	11,525	15,295	14,745
R^2	0.006	0.008	0.007	0.032	0.026	0.024

Note: standard errors are in parentheses. Controls include gender, age of the mother and number of siblings.
$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table A.12: Subscales of the parental discipline index.

	Dependent Variables					
	Smack and shout	Explain and being firm (reversed)	Make jokes and ask others to take responsibility			
	(1)	(2)	(3)			
PANEL A: main analyses						
Twin Medical Risk (outcome at age 3)	−0.014 (0.017)	0.001 (0.014)	−0.008 (0.013)			
Twin Medical Risk (outcome at age 4)	0.023 (0.015)	−0.019 (0.013)	0.005 (0.011)			
Twin Medical Risk (outcome at age 7)	0.028 (0.015)	0.028 (0.015)	0.005 (0.011)			
Observations	11,525	15,295	14,745			
PANEL B: by SES groups						
	High SES			**Low SES**		
	Smack and shout	Explain and being firm (reversed)	Make jokes and ask others to take responsibility	Smack and shout	Explain and being firm (reversed)	Make jokes and ask others to take responsibility
Twin Medical Risk (outcome at age 3)	0.026 (0.032)	−0.005 (0.025)	−0.005 (0.025)	−0.034 (0.022)	−0.012 (0.016)	−0.012 (0.016)
Twin Medical Risk (outcome at age 4)	0.054 (0.028)	−0.040 (0.022)	0.029 (0.022)	0.006 (0.019)	−0.004 (0.017)	−0.006 (0.015)
Twin Medical Risk (outcome at age 7)	−0.005 (0.028)	−0.005 (0.028)	0.029 (0.022)	0.034 (0.019)	0.034 (0.019)	−0.006 (0.015)
Observations	3,043	3,053	3,053	7,146	7,141	7,141

Note: standard errors are in parentheses. Control for gender included.
$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table A.13: Analyses for long-term compensation.

	Dependent Variables	
	Long-term educational performance	**Long-term subjective health**
	(1)	(2)
Twin Medical Risk Scale (ref. cat: non-tertiary)	-0.114^{***} (0.029)	0.016 (0.048)
Twin Medical Risk Scale x tertiary educated	-0.034 (0.048)	0.017 (0.074)
Observations	11,696	8,306

Note: standard errors are in parentheses. $^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table A.14: Mediation analyses: long-term educational performance.

	Mediator Variables					
	Negative Emotional Responses			**Negative Discipline Behaviours**		
	Age 3 (1)	Age 4 (2)	Age 7 (3)	Age 3 (4)	Age 4 (5)	Age 7 (6)
Direct effect	-0.111^{***} (0.029)	-0.118^{***} (0.026)	-0.131^{***} (0.026)	-0.119^{***} (0.03)	-0.119^{***} (0.026)	-0.135^{***} (0.025)
Indirect effect	-0.006 (0.003)	-0.003 (0.003)	-0.006^{*} (0.003)	0.004 (0.003)	-0.001 (0.003)	-0.004 (0.002)
Total effect	-0.117^{***} (0.029)	-0.122^{***} (0.026)	-0.138^{***} (0.026)	-0.116^{***} (0.03)	-0.12^{***} (0.026)	-0.139^{***} (0.026)
Observations	6,905	6,905	6,905	6,905	6,905	6,905

Note: standard errors are in parentheses. Outcome: long-term subjective health. Mediator: parental emotional and discipline responses. Independent variable: twin medical risk scale.
$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table A.15: Mediation analyses: long-term subjective health.

	Mediator Variables					
	Negative Emotional Responses			**Negative Discipline Behaviours**		
	Age 3	Age 4	Age 7	Age 3	Age 4	Age 7
	(1)	(2)	(3)	(4)	(5)	(6)
Direct effect	0.048	0.017	0.003	0.049	0.016	0.005
	(0.04)	(0.033)	(0.033)	(0.04)	(0.033)	(0.033)
Indirect effect	0.001	−0.002	0.002	0.0002	0.0002	−0.0001
	(0.002)	(0.002)	(0.002)	(0.000)	(0.000)	(0.001)
Total effect	0.005	0.016	0.005	0.049	0.016	0.005
	(0.041)	(0.033)	(0.03)	(0.03)	(0.026)	(0.033)
Observations	4,992	4,992	4,992	4,992	4,992	4,992

Note: standard errors are in parentheses. Outcome: long-term educational performance. Mediator: parental emotional and discipline responses. Independent variable: twin medical risk scale.
$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table A.16: Different operationalizations of long-term subjective health.

	Dependent Variables:			
	Health compared to last year	Get sick easier than others	Healthy as anybody	Expect worse health
	(1)	(2)	(3)	(4)
Neg. Emotional Responses Age 3	0.034	0.033	−0.072*	0.004
	(0.029)	(0.036)	(0.033)	(0.031)
Twin Medical Risk Scale	−0.075	0.113*	−0.001	0.056
	(0.043)	(0.055)	(0.050)	(0.047)
Neg. Emotional Responses Age 4	0.011	0.029	−0.044	−0.005
	(0.023)	(0.031)	(0.027)	(0.025)
Twin Medical Risk Scale	−0.039	0.091	0.008	0.039
	(0.036)	(0.047)	(0.042)	(0.039)
Neg. Emotional Responses Age 7	−0.015	0.055	−0.061*	0.009
	(0.022)	(0.029)	(0.026)	(0.024)
Twin Medical Risk Scale	−0.027	0.098*	−0.012	0.028
	(0.036)	(0.047)	(0.042)	(0.038)
Neg. Discipline Age 3	0.028	0.013	−0.020	0.006
	(0.031)	(0.039)	(0.036)	(0.034)
Twin Medical Risk Scale	−0.070	0.121*	−0.012	0.061
	(0.043)	(0.055)	(0.050)	(0.047)
Neg. Discipline Age 4	−0.030	−0.009	−0.031	−0.010
	(0.027)	(0.036)	(0.031)	(0.029)
Twin Medical Risk Scale	−0.034	0.104*	−0.0002	0.038
	(0.036)	(0.048)	(0.042)	(0.039)
Neg. Discipline Age 7	−0.011	0.041	−0.051*	−0.003
	(0.022)	(0.029)	(0.026)	(0.024)
Twin Medical Risk Scale	−0.028	0.098*	−0.016	0.027
	(0.036)	(0.047)	(0.042)	(0.038)
Observations	4,996	4,996	4,996	4,996

Note: standard errors are in parentheses. Individual models including each of the parental responses and the twin medical risk scale are run to avoid collinearity, given the high correlations between the parental responses at different ages. Variables: (i) health compared to last year (1=worse, 5= much better), (ii) get sick easier than others (1= strongly disagree, 5= strongly agree), (iii) healthy as anybody (1= strongly disagree, 5= strongly agree), (iv) expect worse health (1= strongly disagree, 5= strongly agree). $^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Appendix A- Potential biases

There are several biases and sources of measurement error that could be playing a role in these models. Some of them are common to all the within-family estimators, whereas others are specifically related to the nature of the independent or dependent variables used in this paper.

The first one is the reporting bias, which would imply that some parents are more likely to report health problems given certain observed or unobserved characteristics (Yi et al., 2015). Within-twins estimators solve this problem since I am looking at reports made by the same parent for each of their children. It is still a possibility that reporting biases differ by SES, which would be influential for the third part of the results presented in this study. However, an exploration of the mean values of health risks for each group (high- and low-SES) shows that there are no significant differences in the reported health status of the children.

A specific type of this reporting bias can be considered the social desirability bias, or the tendency to answer surveys with what is expected to be a socially correct answer. Since parents do not want their children to be ill, they could tend to misreport health problems. To deal with this, the twin medical risk composite includes objective measures of health such as days stayed in the hospital or time spent in special care. This would also partially account for the possibility of parents reporting more health problems only when the child is very ill, but not when the child is only mildly sick (i.e., reporting bias by responses).

The second type of bias to consider is the attenuation bias, generated by a measurement error problem in the independent variables and that would bias the estimates towards zero. This is especially relevant in this study for two reasons. First, as Griliches (1979) shows, the within-twin estimator can exacerbate the problem of measurement error. Second, as shown by Strauss and Thomas (1998), self-reported health is particularly prone to incorporate measurement error. However, there are several advantages of the data and methods used in this paper that minimize this problem.

First, it is important to notice that I am not using self-reported health measures, but parental-reported ones. These are collected by the interviewers who ask the parents about the health status of their children through very concrete questions (i.e., "*how many days has the twin been in special care in the last yea*r"?) to which parents have to offer accurate answers (i.e., the exact number of days).

On top of this, another potential source of measurement error is the one arriving from different respondents having different thresholds to consider a health condition a problem. But, as Yi et al. (2015) state, this is overcome by the twin design again, since parents would implement the same threshold with the two children. Besides, there is a danger of measurement errors coming from recalling bias (i.e., parents whose child is currently ill might be more likely to report that the child has been ill in the past). However, following Yi et al. (2015) on this point too, given the young age of the twins (maximum 18 months) it is unlikely that recall bias could play a role in the results.

As mentioned in the main text, regarding the presence of measurement error in the second part of the analysis, when parental responses are used as independent variables, the risk is that parents find it difficult to notice differences in treatment between their children, especially when they are monozygotic twins (Abufhele et al., 2017). However, the way these questions are formulated in the TEDS survey, emphasising the difference in treatment between the twins, ensures a certain level of accuracy. Thus, I argue that the risk of the results presented here being attenuated by the presence of measurement error is unlikely. In addition, and as shown in the results section, the estimates are not biased toward zero.

A different potential bias to consider is selection bias. In sibling models, there is always the chance that parents make fertility decisions based on previous children's endowments, which would generate some selection problems. However, since twins share their birth date, this should not be a matter here (Ermisch & Francesconi, 2013; Graetz, 2015). Moreover, according to Savelyev et al. (2020) "as long as the omitted variable that affects sample selection is family-specific, the twin first differences model controls for it" (p. 16).

Finally, the longitudinal design employed in this paper accounts for potential reverse causality problems. This is, if health aspects and parental responses were measured at the same time, it would be hard to argue that health problems are not affected by previous parental actions. However, given that health is measured in the very first stages of life here, and that parental responses are captured between two and five years afterwards, this should circumvent the reverse causality issues.

B| - Appendix for Chapter 3

Table B.1: Cognitive Stimulation Items

ITEM	Age Assessed			
	0-2 yrs	3-5 yrs	6-9 yrs	10-14 yrs
1. Child gets out of the house 4 times a week or more	S	-	-	-
2. Child has 3 children's books (10 for ages 3 – 9yrs; 20 for ages 10 – 14yrs)	S	S	S	S
3. Mother reads to child 3 times a week or more	S	S	S	-
4. Child is taken to the grocery store (once/week or 2 – 3 times a month)	S	S	-	-
5. Child has one or more cuddly, soft, or role-playing toys	S	-	-	-
6. Child has one or more push or pull toys	S	-	-	-
7. Mother believes parents should usually or always spend time teaching kids	S	-	-	-
8. Mom provided appropriate toys/activities to the child	O	-	-	-
9. Play environment is safe (home or building for ages 36mos+)	O	O	O	O
10. Family subscribes to at least one magazine	-	S	-	-
11. Child has use of a record/CD player and at least 5 records/CDs/tapes	-	S	-	-
12. Child helped to learn numbers at home	-	S	-	-
13. Child helped to learn the alphabet at home	-	S	-	-
14. Child helped to learn colors at home	-	S	-	-
15. Child helped to learn shapes and sizes at home	-	S	-	-
16. Child was taken to the museum in the past year	-	S	S	S
17. Musical instrument in-home child can use	-	-	S	S
18. Family gets a daily newspaper	-	-	S	S
19. Child reads several times a week for enjoyment	-	-	S	S
20. Family encourages the child to start and do hobbies	-	-	S	S
21. Child receives lessons or belongs to sports/music/art/dance/drama org	-	-	S	S
22. Child was taken to a musical or drama performance in the past year	-	-	S	S
23. When watching TV, the parent discusses the program with the child	-	-	S	S
24. Home is not dark	-	-	S	S
24. Home is reasonably clean	-	O	O	O
26. Home is minimally cluttered	-	O	O	O

Note: S represents Mother Self-Report and O Interviewer Observations.
Own elaboration based on Appendix A1, A-2a, 2b, 2c, and 2d HOME SF Scales Section of the National Longitudinal Surveys home page:
`https://www.nlsinfo.org/content/cohorts/nlsy79-children/other-documentation/codebook-supplement/appendix-home-sf-scales`.
The corresponding variables are distributed between the Children's Supplement, Mother's Supplement, and the Assessments.

Table B.2: Descriptive statistics

	Mean	Std. Dev	Range
Cognitive Stimulation	975.13	60.72	0 to 1500
Declines in Math. Skills	47.8%	-	0/1
Declines in Reading Skills	51.4%	-	0/1
Mothers' Education	27% tertiary educated	-	0/1
Family income	Top 20% vs. bottom 20%	-	0/1
Year	2000	8.64	1988 to 2014
Age of the child	9.17	3.45	5 to 15
Gender of the child	51% female	-	0/1
Race	53% White, 19.3% Hispanic, 27.7% Black	-	0/1/2
Log (Cognitive Stimulation)	8.86	0.188	4 to 7.30
Parental separation	23% separated	-	0/1
Region	North (15%), Central (25%), South (39%), West (20%)	-	0/1/2/3
Number of children	2.43	1.48	1 to 14

Table B.3: Pre-trends test

	Dependent Variable: Cognitive Stimulation	
	Mathematical Skills	**Reading Skills**
	(1)	(2)
3 years to treatment x non-treated	-6.181 (8.300)	-13.88 (10.34)
3 years to treatment x treated	10.60 (12.20)	-5.066 (12.79)
2 years to treatment x non-treated	4.681 (4.622)	11.22* (5.097)
2 years to treatment x treated	11.60 (9.712)	11.33 (9.786)
1 year to treatment x non-treated	9.150** (3.343)	8.416* (3.559)
1 year to treatment x treated	5.148 (11.78)	-11.36 (10.26)
Observations	12,611	12,611

Note: These estimates correspond to a model that predicts the cognitive stimulation of the mothers from the interaction between the years to treatment and a treated vs. non-treated dummy. The reference category is 0 years to treatment and treated. The models follow the main TWFE models and include a control for mothers' education. Standard errors are in parentheses. $^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table B.4: Tests for (no) pre-trend

	Dependent Variable: Cognitive Stimulation						
	Both skills	Mathematics			Reading		
	Placebo	F-test for pre-treatment differential treatment	TOST equivalence test	Leave-One-Out (LOO) pre-treatment test	F-test for pre-treatment differential treatment	TOST equivalence test	Leave-One-Out (LOO) pre-treatment test
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Random Treatment	0.8307 (1.712)						
F-test p-value		0.42			0.092		
TOST equivalence p-value			0.000			0.001	
LOO equivalence p-value				0.000			0.002
Observations	23,293	23,293	23,293	23,293	23,293	23,293	23,293

Note: Standard errors in parentheses were obtained
through a non-parametric bootstrap procedure (1000).
Following Liu et al. (2022) a larger F-test p-value suggests a better pre-trend fitting,
and a smaller TOST and LOO p-value suggests a better pre-trend fitting.
$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table B.5: Test for anticipation effects

	Dependent Variable: Cognitive Stimulation			
	(1)	(2)	(3)	(4)
Placebo Treatment (maths) at t-1	1.477 (1.619)			
Placebo Treatment (reading) at t-1		1.756 (1.515)		
Placebo Treatment (maths) at t-2			0.161 (2.307)	
Placebo Treatment (reading) at t-2				2.326 (2.199)
Observations	23,293	23,293	15,469	15,469

Note: Standard errors in parentheses obtained through non-parametric bootstrap procedure (1000). $^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table B.6: Dynamic panel data models

	Dependent Variables: cognitive stimulation	
	Mathematics	Reading
	(1)	(2)
Decline in Maths Skills	-6.165^{*} (2.001)	
Decline in Reading Skills		-0.835 (1.95)
Lagged Cognitive Stimulation	0.989^{***} (0.01)	0.982^{***} (0.01)
Observations	21,419	21,419

Note: These models use the two-step system generalized method of moments estimator with controls for year dummies (computed through *xtabond2* package in Stata). The first lag of the cognitive stimulation variable is used as an instrument. Standard errors are clustered at the mother level and presented in parentheses in the table. These dynamic panel data models presented show p-values above 0.250 in the Hansen (j) tests, suggesting that the employed instruments are exogenous and valid (Blaabaek, 2021; Piper, 2014). The Arellano-Bond tests for autocorrelation in second differences show no autocorrelation among instruments. Finally, the explanatory power of the instruments is tested through the Olea and Pflueger (2013) test for weak instruments (*weakiv* in Stata). The instruments used are relevant to explain the outcome variable in these analyses. $^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table B.7: OLS, TWFE, FEct regressions with log-transformed outcome variable

	Dependent Variables: log-transformed cognitive stimulation					
	OLS	OLS	TWFE	TWFE	FEct	FEct
	(1)	(2)	(3)	(4)	(5)	(6)
Decline in Maths Skills	-0.0085^{***} (0.0023)		-0.0044^{**} (0.0017)		-0.0067^{***} (0.0017)	
Decline in Reading Skills		-0.012^{***} (0.0023)		0.0013 (0.0018)		0.00053 (0.0019)
R^2	0.00057	0.00115				
Observations	23,293	23,293	23,293	23,293	23,293	23,293

Note: Standard errors for models (5) and (6) are obtained through non-parametric bootstrap procedures (1000 bootstrap runs). Standard errors are presented in parentheses in the table and clustered at the mothers' level. * p<0.05, ** p<0.01, *** p<0.001. $^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table B.8: Heterogeneous age effects

	Dependent Variables: cognitive stimulation	
	Mathematics	Reading
	(1)	(2)
Decline in Skills (ref. cat. 5 to 8 yrs)	−5.085 (6.312)	2.627 (6.474)
Age 8 to 11 yrs	3.458 (4.794)	6.914 (5.585)
Age 12 to 15 yrs	−4.861 (6.373)	−6.608 (7.079)
Decline in Skills x Age 8 to 11	4.606 (6.644)	−1.496 (6.879)
Decline in Skills x Age 12 to 15	−3.159 (6.788)	0.4553 (6.911)
Observations	23,293	23,293

Note: TWFE models. The age categories are 5 to 7 (ref. category), 8 to 11 and 12 to 15 years old. Standard errors are presented in parentheses in the table. $^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table B.9: Time-varying controls

	Dependent Variable: cognitive stimulation					
	Maths	Reading	Maths	Reading	Maths	Reading
	(1)	(2)	(3)	(4)	(5)	(6)
Decline in Maths Skills	-4.184^{**}		-4.034^{**}		-4.156^{**}	
	(1.514)		(1.520)		(1.516)	
Decline in Reading Skills		1.527		1.484		1.574
		(1.553)		(1.557)		(1.554)
Parental Separation Stimulation	-24.21^{***}	-24.77^{***}				
	(4.259)	(4.243)				
Region Central (ref. cat. North)			10.96	9.653		
			(15.41)	(15.57)		
Region South (ref. cat. North)			12.49	11.09		
			(14.04)	(14.24)		
Region West (ref. cat. North)			9.475	8.141		
			(15.48)	(15.67)		
Number of children					1.866	2.029
					(1.421)	(1.417)
Observations	23,293	23,293	23,293	23,293	23,293	23,293

Note: TWFE models. All models include a control for mothers' education.
Standard errors are presented in parentheses in the table. $^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table B.10: Exploring the regression towards the mean.

	Dependent Variable: cognitive stimulation			
	Maths	Reading	Maths	Reading
	(1)	(2)	(3)	(4)
Decline in Skills	-4.788^{*} (2.106)	-2.152 (3.102)	0.617 (2.081)	2.571 (3.096)
Lag (1) of skills	0.248^{*} (0.122)	-0.254 (0.172)		
Lag (2) of skills			0.151 (0.119)	-0.306 (0.185)
Observations	14,690	8,513	14,690	8,513

Note: TWFE models. Standard errors are presented in parentheses in the table. $^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table B.11: Interaction between declines in skills and the total level of ability.

	Dependent Variables: cognitive stimulation	
	Mathematics (1)	Reading (2)
Decline in Skills (ref. category first quartile of total ability)	-2.973 (4.169)	-8.150^{*} (3.904)
Second quartile of total ability (ref. category first quartile of total ability)	4.215 (4.860)	6.914 (5.585)
Third quartile of total ability (ref. category first quartile of total ability)	10.75^{*} (5.086)	-14.26^{*} (5.095)
Fourth quartile of total ability (ref. category first quartile of total ability)	13.70^{*} (5.393)	-4.024 (5.423)
Decline in skills x second quartile of total ability	3.023 (5.404)	17.80^{***} (5.302)
Decline in skills x third quartile of total ability	1.988 (5.382)	14.11^{**} (5.027)
Decline in skills x fourth quartile of total ability	4.471 (5.023)	7.585 (5.088)
Observations	23,293	23,293

Note: TWFE models. Standard errors are presented in parentheses in the table. $^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table B.12: Different intensities of the treatment.

	Dependent Variables: cognitive stimulation	
	Mathematics	Reading
	(1)	(2)
Decline in skills second quartile (ref. category first quartile)	-6.484 (4.114)	3.569 (3.755)
Decline in skills third quartile (ref. category first quartile)	-5.561 (4.434)	1.785 (3.962)
Decline in skills fourth quartile (ref. category first quartile)	-11.72^{*} (4.677)	-4.071 (4.148)
Observations	23,293	23,293

Note: TWFE models. Standard errors are presented in parentheses in the table. The main predictor is the quartile of the treatment intensity. $^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

C | - Appendix for Chapter 4

Table C.1: Description of the O*NET skills

Variable	Skill	Description by O*NET
Mathematical skills	Science	Using scientific rules and methods to solve problems.
	Mathematics	Using mathematics to solve problems.
	Programming	Writing computer programs for various purposes.
	Systems analysis	Determining how a system should work and how changes in conditions, operations, and the environment will affect outcomes.
	Systems evaluation	Identifying measures or indicators of system performance and the actions needed to improve or correct performance, relative to the goals of the system.
	Operations analysis	Analyzing needs and product requirements to create a design.
	Technology design	Generating or adapting equipment and technology to serve user needs.
Literacy skills	Literacy comprehension	Understanding written sentences and paragraphs in work-related documents.
	Speaking	Talking to others to convey information effectively.
	Writing	Communicating effectively in writing as appropriate for the needs of the audience.
	Active listening	Giving full attention to what other people are saying, taking time to understand the points being made, asking questions as appropriate, and not interrupting at inappropriate times.

Table C.2: Descriptive statistics.

Variable	Mean	Std. Dev	Range
Mothers' occupation-specific mathematical skills	1.42	0.59	0 to 7
Mothers' occupation-specific literacy skills	3.29	0.63	0 to 7
Children's mathematical skills	0	1	-2.5 to 2.5
Children's literacy skills	0	1	-6 to 2
Job Sector	-	-	10 to 999
Age of the mother at birth	25.78	6.12	16 to 50
Residence	72% with the mother	-	0/1
Race	50% white, 30% Hispanic, 20% black	-	1/2/3
Gender of the child	51% boys	-	0/1
Age of the child (in months)	99	49	60 te 180
Health limitation	6% with a health problem	-	0/1
Learning delay	0.9%	-	0/1
Behavioural problems	52% have ever had some sort of behavioural problem	-	0/1
Mothers' education	29% tertiary educated	-	0/1
Annual household income	50,805	67,555	0 to 974,100
Mothers' continuing education	4.7% in continuing education	-	0/1
Marital status	13% never married, 60.3% married, 7.2% separated, 17.1% divorced, 1.4% widowed	-	0/1/2/3/6
Family size	3.671	1.61	1 to 16
Newborn at home	19.85%	-	0/1
Region	Northeast (14.83%), Central (25%), South (40.61%), West (19.45%)	-	1/2/3/4
Working hours	36.5	11.74	0 to 160
Working hours of the partner	44.12	11.85	0 to 160
Supervisory Responsibilities	36% increased responsibilities, 3% decreased, 61% stayed the same	-	1/2/3
Job quality	4.42% reported very bad quality	-	0/1
Firm size	1132 workers	8555	1 to 99,995

Table C.3: TWFE models

	Dependent Variables: Children's Skills							
	TWFE		TWFE adjusted		IPW cross-sectional		IPW longitudinal	
	Child Maths Skills	Child Literacy Skills	Child Maths Skills	Child Literacy Skills	Child Maths Skills	Child Literacy Skills	Child Maths Skills	Child Literacy Skills
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Mothers' Mathematical Skills at t-1	0.046^{***} (0.013)		0.048^{***} (0.013)	0.003 (0.013)	0.037^{***} (0.014)		0.037^{***} (0.013)	
Mothers' Literacy Skills at t-1		0.037^{**} (0.012)	0.016 (0.015)	0.037^{**} (0.012)		0.018 (0.013)		0.014 (0.013)
Observations	16,959	16,877	16,959	16,877	16,959	16,877	16,959	16,877

Note: Standard errors are in parentheses and clustered at the mother level.
All the models include controls for the job sector.
$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table C.4: Effect of mothers' job changes by years after changing occupation.

	Dependent Variables: Children's Skills	
	Maths Skills	Literacy Skills
	(1)	(2)
Mothers' Skills x 2 years after	0.012 (0.016)	0.007 (0.01)
Mothers' Skills x 4 years after	0.013 (0.015)	0.015 (0.01)
Mothers' Skills x 6 years after	0.028 (0.017)	0.024* (0.012)
Mothers' Skills x 8 years after	0.015 (0.017)	0.035* (0.014)
Mothers' Skills x 10 years after	0.051** (0.019)	0.042* (0.017)
Mothers' Skills x 12 years after	0.109*** (0.022)	0.053** (0.02)
Mothers' Skills x 14 years after	0.147*** (0.028)	0.066** (0.023)
Observations	16,959	16,877

Note: TWFE models. Interaction between years after arriving to the job (ref.category=0 years in the job). Standard errors are in parentheses and clustered at the mother level. $^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table C.5: TWFE with children-related controls.

	Dependent Variables: Children's Skills							
	Age of the child		Health limitation		Excluding disable		Childcare	
	Child Maths Skills	Child Literacy Skills	Child Maths Skills	Child Literacy Skills	Child Maths Skills	Child Literacy Skills	Child Maths Skills	Child Literacy Skills
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Mothers' Mathematical Skills at t-1	0.045*** (0.013)		0.045*** (0.013)		0.048*** (0.013)		0.116*** (0.041)	
Mothers' Literacy Skills at t-1		0.041*** (0.012)		0.036*** (0.012)		0.036*** (0.012)		0.034 (0.044)
Age of the child	0.000 (0.00)	−0.001*** (0.00)						
Health limitations			0.004 (0.031)	−0.052 (0.030)				
Childcare							−0.103** (0.039)	0.154*** (0.038)
Observations	17,285	17,285	16,917	16,917	17,170	17,170	4,904	4,904

Note: Standard errors are in parentheses and clustered at the mother level.
All the models include controls for the job sector.
$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table C.6: Stratified TWFE by job sector

	Dependent Variables: Children's Skills	
	Predictor	
	Mothers' Maths Skills t-1	Mother's Literacy Skills t-1
	(1)	(2)
Agriculture	0.043	0.0117
	(0.068)	(0.0353)
Construction	0.060	0.0020
	(0.049)	(0.0218)
Transportation	0.025	0.0229
	(0.026)	(0.0180)
Trade	0.033	0.0218
	(0.018)	(0.0136)
Finance and insurance	0.019	0.0140
	(0.026)	(0.0173)
Business	0.004	0.0170
	(0.025)	(0.0157)
Personal services	0.044*	0.0450**
	(0.022)	(0.0148)
Entertainment	0.016	0.0577*
	(0.054)	(0.0239)
Professional services	0.046**	0.0356**
	(0.016)	(0.0136)
Public administration	0.044*	0.0355*
	(0.022)	(0.0168)
Observations	16,959	16,877

Note: TWFE models. Standard errors are in parentheses and clustered at the mother level. All the models include controls for the job sector. $^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table C.7: TWFE models stratified by gender

	Dependent Variables: Children's Skills			
	Girls sample		Boys sample	
	Child Maths Skills	Child Literacy Skills	Child Maths Skills	Child Literacy Skills
	(1)	(2)	(3)	(4)
Mothers' Mathematical Skills at t-1	0.067^{***} (0.018)		0.023 (0.018)	
Mothers' Literacy Skills at t-1		0.031^{*} (0.016)		0.044^{**} (0.017)
Observations	8,756	8,756	8,575	8,575

Note: Standard errors are in parentheses and clustered at the mother level.
All the models include controls for the job sector.
$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table C.8: TWFE models with family-changes controls

	Dependent Variables: Children's Skills									
	Extra training		Marital status		Moving regions		Newborn at home		Family size	
	Child Maths Skills	Child Literacy Skills	Child Maths Skills	Child Literacy Skills	Child Maths Skills	Child Literacy Skills	Child Maths Skills	Child Literacy Skills	Child Maths Skills	Child Literacy Skills
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Mothers' Maths Skills at t-1	0.039*** (0.011)		0.046*** (0.013)		0.045*** (0.013)		0.043*** (0.012)		0.046*** (0.012)	
Mothers' Literacy Skills at t-1		0.027** (0.010)		0.038** (0.011)		0.037** (0.012)		0.036** (0.012)		0.037** (0.012)
Married			0.008 (0.051)	−0.215*** (0.048)						
Separated			−0.014 (0.057)	−0.26*** (0.053)						
Divorced			0.02 (0.056)	−0.252*** (0.053)						
Widowed			0.028 (0.131)	−0.530*** (0.125)						
Moving regions					0.018 (0.029)	0.025 (0.027)				
Newborn at home							−0.023 (0.018)	0.041* (0.017)		
Family size									0.012 (0.007)	−0.007 (0.007)
Observations	17,064	16,982	17,064	16,982	17,064	16,982	17,064	16,982	17,064	16,982

Note: Reference in the marital status variable: never married.
Standard errors are in parentheses and clustered at the mother level.
Models constructed based on the baseline model (*Equation 1*) plus controls.
All the models include controls for the job sector.
$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table C.9: TWFE models with job-related controls

	Dependent Variables: Children's Skills											
	Income		Working hours		Supervisory		Job quality		Firm size		W. hrs. partner	
	Child Maths Skills	Child Literacy Skills	Child Maths Skills	Child Literacy Skills	Child Maths Skills	Child Literacy Skills	Child Maths Skills	Child Literacy Skills	Child Maths Skills	Child Literacy Skills	Child Maths Skills	Child Literacy Skills
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Mothers' Maths Skills at t-1	0.044** (0.014)		0.056** (0.02)		0.053* (0.027)		0.046*** (0.013)		0.06** (0.021)		0.033* (0.016)	
Mothers' Literacy Skills at t-1		0.04** (0.013)		0.011 (0.019)		0.018 (0.025)		0.037** (0.012)		0.013 (0.02)		0.038* (0.015)
Household Income	0.00 (0.00)	−0.000* (0.000)										
Working Hours	−0.001 (0.001)	0.000 (0.000)										
Supervisory respons.					−0.042*** (0.013)	−0.017 (0.011)						
Job Quality							0.026 (0.035)	−0.033 (0.033)				
Firm size									−0.0 (0.0)	−0.0 (0.0)		
Working hours partner											0.000 (0.001)	−0.000 (0.001)
Observations	14,549	14,549	9,476	9,476	6,435	6,435	16,992	16,911	8,901	8,901	11,387	11,387

Note: Standard errors are in parentheses and clustered at the mother level.
All the models are constructed based on the baseline model (*Equation 1*) plus controls.
All the models include controls for the job sector.
$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table C.10: Reverse causality checks

	Dependent Variables: mother's occupation-specific skills at time t							
	Maths	Literacy	Maths	Literacy	Maths	Literacy	Maths	Literacy
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Children Maths Skills at t-1	−0.002 (0.005)							
Children Literacy Skills at t-1		−0.007 (0.005)						
Behavioural problems			0.001 (0.008)	−0.000 (0.008)				
Health limitations					−0.011 (0.008)	−0.005 (0.008)		
Learning disabilities							−0.089 (0.046)	−0.081 (0.045)
Observations	16,877	16,877	26,071	26,071	15,900	15,900	2,635	2,635

Note: TWFE models. Standard errors are in parentheses and clustered at the mother level.
All the models include controls for the job sector
$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$