University of Oxford

# Outcomes of fertility treatments for children and families
## *Evidence from the UK and the US*

**Anna Barbuscia**

**Nuffield College**

Thesis submitted for the degree of *Doctor of Philosophy* in Sociology

Michaelmas Term
2017

# Declaration of Authorship

I certify that the thesis I have presented for examination for the DPhil degree in Sociology of the University of Oxford is solely my own work other than where I have clearly indicated that it is the work of others (in which case the extent of any work carried out jointly by me and any other person is clearly identified in it).

Anna Barbuscia

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## *Thesis abstract*

A continued postponement of childbearing and the rapid technological development that have occurred in the last decades have led to a considerable increase in the demand and use of fertility treatments and Assisted Reproductive Technologies (ART). Since the first birth *in vitro* in 1978 an estimated 5 million babies have been born through ART worldwide, with the number of couples seeking fertility treatments continuously increasing (Calhaz-Jorge et al., 2016). In light of the great expansion in the use of ART and fertility treatments and of the intense debates about their regulation, funding and use, there is a growing urgency to understand the long-term outcomes of such treatments.

This thesis studies the outcomes of fertility treatments for children and families and specifically children's cognitive development, parenting and couples' stability. While there is evidence of increased health risks for children at birth such as multiple births and low birth weight, the literature has usually shown a good development of children and positive family functioning. However, the existing literature presents several limitations especially on the long-term outcomes. Furthermore, the demographic and socio-economic characteristics of couples accessing the treatments have been neglected. This is a crucial point, as people accessing the treatments tend to be older and from an advantaged socio-economic background, which is likely to affect the observed outcomes.

I rely on representative, longitudinal data from the UK Millennium Cohort Study (MCS) and the US National Survey of Family Growth (NSFG), which allow me to follow a consistent number of children and families to study their outcomes over time. An important focus is on how the observed outcomes might be affected by the selective background of individuals who can afford the expensive treatments in the UK and US.

# Acknowledgments

I have always enjoyed reading others' acknowledgments and thinking of a doctoral thesis as the result of individual effort, as well as collaborative work. Now, I fully realize how lucky I am for all the people who were involved and necessary for me to complete the journey that writing this thesis represented.

First and foremost, I want to thank my supervisor Melinda Mills, who gave me the opportunity to start this DPhil and always inspired, motivated and critically supported me and my work. Thank you, Melinda, also for being an example of what I believe a good researcher and professor is. I am grateful to Melinda for financing two years of my DPhil through her Higher Studies Fund. I would like to thank Andreas Edel, because without him I would have never began this experience in the first place, and for having encouraged and supported me all the way through. I thank Andreas and the Max Plank for the financial support in the first year of my doctoral studies. I would like to thank Arnstein Aassve and Francesco Billari, for introducing me to the field of demography, for the inspiring conversations and useful advice. I would like to thank Letizia Mencarini for her generous support at the very beginning of my research experience, which helped me realize this is what I wanted to do. I thank Anette Fasang, who allowed me to spend a few months working in the stimulating environment that the WZB is. I thank Anette, Maria, Julie, Ridhi, Rosie, Sander and especially Alice for their help and comments on the chapters of this thesis.

I consider myself extremely lucky for the opportunity to experience the vibrating environment of Nuffield College. I thank the several colleagues and professors with whom I had the most interesting conversations about social sciences, but also any other topic one can think of.

I am especially grateful for all the friends that I met during the past years in Oxford as well as at conferences and workshops around the world. Thank you Felix, Patrick, Belinda, Dingeman, Rob, Tina, Bastian, Chiara, Roberta, C., my years at Nuffield and around would have been far from the same without you! Rosie, Valentina, and Benedetta in the last few months, have been amazing flat-mates and all, in their own ways, source of wise and warm support. I would like to thank Clement for the nice

moments together that made me appreciate Oxford more. I want to thank Matilde (and Donald) who, despite leaving too quickly, had nevertheless the time to make my first months in Oxford special. Thanks to Nicola, Betta, and Polpettina, for how they made me feel part of a family during the many hours spent together. A special thanks to Nicola for making sure that I was properly (and deliciously) fed during these years.

I want to thank my German twin Felice for being a careful, good friend and for all the fun and the wise words that he shared with me during the time in Oxford. As you once wrote me, life takes and life gives, but twins are ultimately inseparable. I want to thank Ceci for her kindness and big heart, which have been the perfect support and company in Nuffield and during conference trips. Thank you Nicolo' for the uncountable moments of fun, for the deep conversations, and for being the only person I know with whom I could start- and continue- a friendship the way we did. It is hard to imagine these years without Isabel. Thank you for your friendship, and for sharing the joys and pains of this intense time that was the one in Oxford. I owe a special thanks to Maria and Julie. There are so many things ranging from Sunday pizzas and moving to understanding survival analysis that I could never mention all. I especially thank Maria because these years in Nuffield and Oxford would just not have been the same without her.
This DPhil also gave me the opportunity to get closer to Benni (again) and Gilles, whose generosity, love and cheerful company helped me survive much better some harder times. Thanks Benni for the endless chats that we can have, and thanks Gilles for reading the first chapter of this thesis (and even pretending you enjoy it).

While miles away from there, I could not have made it so easily without the support and constant presence of my friends back at home. Marta, Ele, Giorgia, Emma, Rebecca, knowing that you are there and that at some point, sooner or later, we will (eventually!) manage to have a cena MEGERA makes things better wherever I am. And thinking that Franci, Giulia, Carlo, Mati, Lollo might join for dinner or some chats over aperitivo, things get even better.

Especially, I want to thank my family. I thank my parents for having taught me, and for showing me every day what is important in life, and for always providing me with unconditional love and support in any way. I thank my mum for her ability to not make

me feel lonely. I thank my dad for always being a loving, critical source of interesting conversations about anything from politics to ourselves. Thank you also for having been my first –and most affectionate- reader. I thank my brother Michele, who despite being 5 years younger than me, is an example for me in many ways and someone I can really count on.

Last and surely not least, thanks to Gaizka, who suddenly made the very last part of this journey such a special and *eppy* time, and will hopefully continue doing so in some next ones.

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# Chapter 1

# Assisted Reproductive Technology (ART) and Fertility Treatments. Why should we care?

## 1.1 Introduction

This research is inspired by the spread in the availability and use of treatments of infertility and Assisted Reproductive Technology (ART) which occurred over the last decades especially among industrialized western societies. The development and spread of techniques such as In Vitro Fertilization (IVF) has represented a relevant technological and medical innovation but also a societal trend that is worth investigating for a number of reasons. The term ART refers to different treatments of infertility in which gametes or embryos are handled in vitro (outside of the body) for establishing a pregnancy. In IVF, oocytes are fertilized using sperm in a laboratory and the embryo is surgically implanted into the woman's womb. When only a single sperm cell is injected into the oocyte during IVF, the procedure is referred to as Intracytoplasmatic Sperm Injection (ICSI).

Worldwide infertility rates have been estimated to affect around the 10% of couples in their reproductive age who don't succeed in having a live birth within one year of attempt (Boivin et al., 2007). The availability of a wider range of increasingly effective treatments of infertility therefore represents the opportunity to alleviate the burdens of infertility for millions of people. Since the first birth in vitro in 1978, it is estimated that more than 5 million children were born with the aid of ART, and the numbers continue to increase. In some European countries around 5% of births occur with the aid of ART

(Calhaz-Jorge et al., 2016). It has therefore become crucial for the social sciences to investigate the outcomes of treatments for children, adults and family relationships.

The spread of fertility treatments is also intrinsically linked to contemporary demographic and social trends, such as the childbearing postponement in the developed world in the last decades which means an increasing number of women face the challenges of age-related sub-fertility (Mills et al., 2011; Kocourkova et al., 2014), and the resulting levels of involuntary childlessness (Lockwood, 2011; Leridon, 2004; Sobotka et al., 2008). The development of ART techniques has revolutionized the extent to which infertility can be overcome, providing a new perspective for individuals and couples who suffer from infertility or face sub-fertility problems because of delayed entry into parenthood. At the same time, it has deeply unsettled established ideas of what is "natural" (Franklin, 2013) and opened the door to new, before unthinkable ways of forming a family that overcame the "heterosexual couple in reproductive age" (Fasouliotis and Schenker 1999; Golombock et al., 2001) model- with all the social, ethical and religious issues connected to this. As many countries are experiencing extremely low fertility levels, some have also proposed that ART could represent a valid policy instrument to enhance fertility (Sobotka et al., 2008; Lockwood, 2011). Furthermore, infertility and its treatment has always fascinated social scientists as well as policy makers because of the intimate connection between reproduction and power (Culley et al., 2011).

Advances in assisted reproduction have therefore raised many ethical and practical questions ranging from the right to human reproduction to the models of family to promote (Adamson, 2005; Benagiano and Filippi, 2009), from its availability and legal regulation to health consequences for mothers and their children. In the words of the

biochemist Joseph Goldstein whilst presenting the Lasker Award to Dr. Edwards in 2001:

> *Advances in human reproductive technology arouse people's deepest concerns and often go through a cycle, first of outrage and charges of playing God, then of acceptance. IVF proved no exception "We know that IVF was a great leap because Edwards and Steptoe were immediately attacked by and unlikely trinity- the press, the pope and prominent Nobel laureates"* (New York Times, 2010 in when Edwards was awarded the Nobel prize)

Louise Brown (the first baby born in vitro) herself wrote in the book about her birth- and life:

> *My birth had prompted debates about all sort of things. Some people were arguing about whether it was against God and religion to bring a baby into the world this way [..]; some people were excited about the scientific and medical breakthrough; some believed it was the start of cloning or designer babies.* (Louise Brown, 2015, pp 32)

Still in November (2015), Pope Francis said *the process promoted children as a "right rather than a gift to welcome" and was "playing with life"* (bbc.co.uk 2015)

The complex relationship between fertility treatments and ethical, religious and political issues related to the theme of human reproduction has resulted in countries developing a variety of regulatory systems to the access and the funding of the treatments (Busardo, 2014; Präg and Mills, 2014). This in turn impacts the accessibility and thus the levels of usage across countries (with big variation even among developed societies) and considerably affects the selection of individuals who are able to undertake the treatments. Despite a great variation in price and affordability of fertility treatments across countries, these are generally very expensive even after potential public funding intervention (Brigham, 2013; Chambers et al., 2014). Therefore, they

are only accessible to the more socio-economically advantaged portions of the population, which some authors have called a crucial problem of "stratified reproduction" (Culley et al., 2011). Additional criteria for eligibility in terms of family structure may lead to a further selection of couples into treatments.

The gradient in the access to fertility treatments is relevant in terms of equality of access to health services and of the rights to reproduction, but also when it comes to assessing the outcomes of treatments. In fact, more advantaged demographic and socio-economic conditions might counterbalance potential negative health or psychological effects linked to the treatments, with a similar mechanism to the one observed in the literature about the effects of maternal age (Liu et al., 2011; Myrskyla et al., 2013, Goisis and Sigle-Rushton, 2014) and the "diverging destinies" (McLanhan, 2004).

Together with the spread in the use of fertility treatments, severe concerns about the outcomes for individuals, children and family functioning have come along in the public arena and among policy makers. These concern potential negative health effects of the treatments (van Balen, 1998; Colpin, 2002; Waagenar et al., 2008), but also fears about the consequences of growing up in "new family forms" (Golombock et al., 1995), or the irreversible effects of infertility on parents for couples' relationship and their relationship with the kid (Bernstein, 1990; Gibson et al., 2000; Hammarberg et al., 2008). Again in the words of Louise Brown:

> *Many people believed that I couldn't possibly be normal and as the doctors had checked out that I was physically the same as everyone else they decided there must be something else wrong with me. Some decided that I would develop abnormally and die young or have some awful illness. Others decided I must possess some super-powers or on the other hand have some behavioral problem. (Louise Brown, 2015, p. 46)*

A consistent evidence has shown that the use of fertility treatments can bring higher risks of adverse health outcomes at birth (van Balen, 1998; Wilson et al., 2011; Hansen et al., 2013; Hart and Norman, 2013a). However, there seems to be overall agreement on a good development of children and well-functioning of families in the longer term (Gombolock et al., 1995; Carson et al., 2011; Hart and Norman, 2013).

The existing literature nevertheless presents several limitations. First, most studies have considered only one outcome at a specific point in time, often looking at short time-periods after the treatments. Second, they usually rely on very small sample sizes. Third, the potential role of the demographic and socioeconomic background of couples accessing the treatments is often neglected. This is indeed a central focus of this thesis, where I investigate the effects of ART and fertility treatments on children, parents and family functioning with an emphasis on how the selection of individuals into treatments might play a crucial role for the examined outcomes. I therefore combine the study of the outcomes of ART and fertility treatments with a growing strand of literature about intergenerational transmission of socio-economic status and inequality in opportunities.

The aim of this first chapter is to provide the rationale for my thesis and the general background information that is necessary to better frame and understand the empirical chapters that follow. Why should we be interested in the outcomes of fertility treatments? Why should the social sciences be concerned with it in particular? What is the specific contribution of this research to the knowledge we have on it? The remainder of the Chapter proceeds as follows. First, I outline the main research questions of this thesis and how it aims at contributing to the existing literature. Second, I explain why the spread of ART and fertility treatments should be of interest for the social sciences, and describe demographic and societal changes and trends that constitute its setting. I provide some basic information about ART and fertility treatments, its regulation and

uptake across countries and the main issues related to it. I especially focus on the UK and the US -which, as we will see, constitute the geographical setting of the empirical research. Third, I review the existing literature on the outcomes of the treatments, which is the main focus of this thesis. I then explore the selection of women and individuals into fertility treatments in the UK and US relying on the same data that will be used in the following chapters. With logistic and multinomial logistic regressions, I examine what are the individual predictors of the probability to use different kinds of fertility treatments. I conclude the chapter by outlining how the rest of this thesis is structured.

## 1.2 Research questions

The scarce evidence about the outcomes of fertility treatments and the mechanisms affecting them, especially in the long run, represents an important limitation to our understanding about the potential consequences of the diffusion of fertility treatments. As the number of children born with the aid of ART and other treatments is increasing and the first generations start reaching the adult age, a better knowledge of whether and how the use of fertility treatments might have consequences on children and families becomes necessary.

What I ask in this research is whether ART children develop differently compared to naturally conceived children? Do individuals and couples who conceived with the aid of fertility treatments differ in their parenting practices compared to natural parents? Are couples that undertake a fertility treatment more likely to divorce than other couples? What is the role of the selective demographic and socio-economic background for the observed outcomes?

The first question I aim to answer is whether children born with the aid of ART differ in their cognitive development compared to their naturally-born peers. Cognitive

skills are important determinants for several outcomes in childhood and later in life, from education and income, to health and psychological wellbeing (Feinstein, 2003; Heckman, 2007). A consistent literature has shown that children's cognitive development begins in the very first years of life and depends strongly on the environment, including parental background and inputs (Heckman, 2006; Cunha et al., 2010). Furthermore, poor health outcomes at birth such as low birth weight and preterm delivery might be related to worse cognitive development (Boardman et al., 2002). It is therefore especially important to assess whether a potential health risk at birth after the use of treatments might be linked to lower cognitive development later in life, and whether parental characteristics might have a compensatory effect.

The second research question is whether there is an association between the use of fertility treatments and parenting, and to what extent it might affect children's cognitive ability after adjusting for parental background. Parenting style represents an important channel through which parents affect their children's development (Ermisch, 2008) and depend strongly on demographic and socio-economic characteristics (Lareau, 2002; Brooks-Gunn and Markman, 2005; Altintas, 2016). I focus on measures of parental involvement and time-investment. Despite the relevance for children's development, such dimensions of parenting have been neglected by the literature on the outcomes of fertility treatments, which has usually focused on parent-children relationships. The use of fertility treatments might affect parental investment in children because of the long process undertaken to conceive a very much desired child (Bernstein, 1990; Gibson et al., 2000; Hammarberg et al., 2008), with potential important consequences for the child's development (Colpin, 2002).

The last research question concerns family functioning after the use of fertility treatments, from the perspective of the parents. I ask whether the use of fertility

treatments is associated with marital stability, and how this depends on its success (i.e. whether it results in a live birth or not). Divorce is an increasingly common life event with important consequences for adults and children (Amato, 2000). The experience of fertility treatments might affect marital stability in different ways (Ulrich et al., 2004; Verhaak et al., 2007) and the existing literature has not reached conclusive results. Furthermore, most studies have focused on measures of quality of relationship, and very few looked at couples' disruption.

The approach I follow will add to the literature in a number of ways. Considering several outcomes is crucial to get a more complete picture and the different dimensions are likely to be linked to one another. The use of longitudinal data on country-representative samples allows me to follow a consistent number of children/families in the long term and represents an important contribution to the existing studies. A longitudinal approach is especially important since outcomes of the treatments might differ depending on how long after the treatment/at what age of the child they are measured. The specific focus on the role of selective characteristics of individuals leads to a deeper understanding of the mechanisms that might operate in the development of children and families born with the aid of fertility treatments.

## 1.3 Emergence of ART and related demographic trends

The last four decades have witnessed the fast development and the diffusion in the use of treatments of infertility and especially Assisted Reproductive Technology (ART). The first baby to be born *in vitro* was Louise Brown, in 1978 in the UK. In Vitro Fertilization (IVF) is considered a main technological innovation of the last century and in 2010, Robert G. Edwards was awarded the Nobel Prize in Physiology or

Medicine for its development. Since then, it is estimated that more than 5 million children have been born with the aid of ART.

IVF still represents, together with Intracytoplasmatic Sperm Injection (ICSI), the main form of ART. ICSI was developed to deal with male infertility problems, such as low sperm counts or poor sperm quality, but has become a standard form of fertilization in ART in recent years. Both IVF and ICSI might use one or both donor gametes. Other techniques include frozen embryo transfers, where embryos are used that have previously been cryopreserved for storage gametes donation, pre-implantation genetic diagnosis, where embryos are examined for specific genetic and structural alterations. ART represents only a relative part of the broader spectrum of fertility treatments available. Other non-ART treatments include Intrauterine Insemination (IUI), where the sperm is injected directly into the woman's body, or the use of ovarian-stimulating drugs not followed by any further treatment. These relatively "low-tech treatments" are used for some category of infertility especially as first-stage treatments for younger women and as the only accessible form of treatment for those who cannot afford the expensive option of IVF (Culley et al., 2011). A complete ART treatment follows a hierarchical progression, but not all couples proceed through all steps (Bitler and Schmidt, 2012). It usually starts with a diagnostic workup to one or both members of the couple. The first treatment level consists in ovarian stimulation with clomiphene citrates; the second level is ovarian stimulation with exogenous gonadotrophins, followed or not by intrauterine insemination; the last step is IVF or ICSI.[1] Of couples who begin the treatment, more than 80% of those who proceed through all the steps are

[1] As mentioned, the use of fertility drugs by themselves as well of IUI and other non-ART treatments are included in the definition of fertility treatments in Chapter 3 and 4.

likely to conceive. Even for couples who are successful at the first cycle, the process can take 2-3 years (Bitler and Schmidt, 2012).

The development of a wide range of increasingly effective treatments of infertility has changed completely the extent to which infertility or subfertility problems can be overcome, with immediate benefits for the consistent proportion of population affected by such problems. The worldwide population of infertile people is very difficult to estimate because of the heterogeneity in the criteria used to define infertility, critical differences between estimates of infertility based on large-scale population versus epidemiological studies of infertility and whether infertility is defined as being located in women, couples, people, individuals (Inhorn and Patrizio, 2015). However, it was estimated that around 10% of women in their reproductive age who don't succeed to become pregnant within one year of non-protected sexual activity (Boivin et al., 2007). Although infertility rates do not appear to have increased significantly over the past two decades, this means that nowadays millions of people around the globe suffer from infertility (Inhorn and Patrizio, 2015). The inability to conceive has been documented as an experience that has a profound influence on the wellbeing of women and men (among others, see Inhorn, 1994; Franklin, 1997).

Infertility represents a major health and social problem around the world, and stigma about childless women are still very strong especially in some Asian and sub-Saharan countries (Inhorn and Patrizio, 2015). Studies have shown that in 2002 more than 186 million women in developing countries were infertile because of primary or secondary infertility- which is more than one-quarter of ever-married women of reproductive age in these countries (Inhorn and Patrizio, 2015). Despite the recent spread of ART around the world, however, many countries still lack the necessary structures to provide any treatments; different reasons include the high costs of the treatment but also pressures

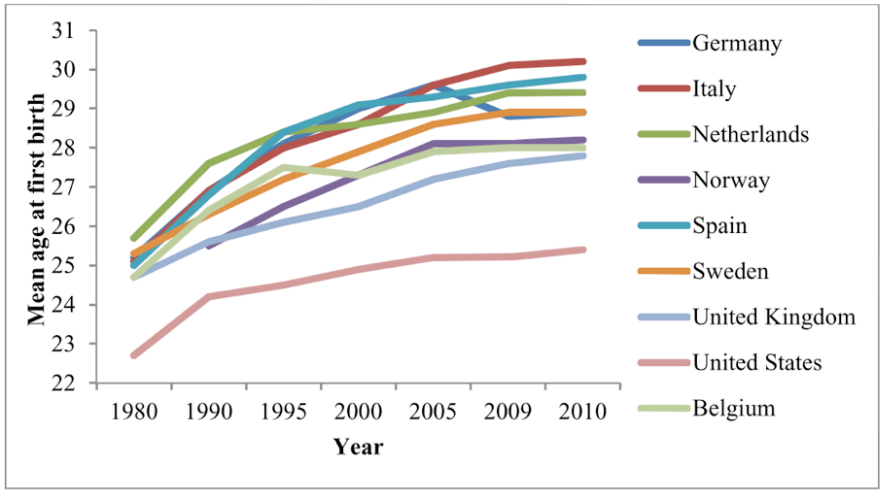
to not provide treatments for infertility as part of policies to reduce natality in high fertility countries.

### 1.3.1 Fertility postponement

Among the main factors underlying the great diffusion of fertility treatments, one is undoubtedly the postponement of fertility occurred in the developed world in the last four decades. Over the last century, a radical transformation of fertility patterns has occurred throughout Europe and most of the developed world (Mills et al., 2011), with the result that never before in history have European women borne their first children so late, on average, as at the beginning of the 21st century (Billari et al., 2007). The mean age of mothers at first childbirth has increased by around 1 year each decade across European countries since the 1970s (Mills et al., 2011). The mean age at childbearing (at all parities) is now exceeding 30 years in most OECD countries, with the exception of the Czech Republic, Estonia, Hungary, Poland, The Slovak Republic and the United States. Highest ages were observed in Ireland at 31.6 and Spain and Switzerland at 31.8 (OECD, 2016).

The fraction of late fertility (defined as occurring to women older than 40 years) has also increased considerably among developed countries (Billari et al., 2007). There is important variation among European countries, with highest levels observed in Spain and Italy (3.9%), due to low fertility rates at young ages rather than to higher fertility rates at older ages (Billari et al., 2006; 2007). Entry into parenthood has also been increasingly delayed in other developed countries including the US, where age-specific fertility rates at ages older than 40 years more than doubled since 1980.

**Figure 1.1: Mean age at first birth in selected developed countries, women (1980-2010)**




source: Goisis (2013)
note: Data for Germany refer to West Germany before 1989, and to mean age of first birth in marriage before 2008

### Reasons for the postponement of childbearing

Studies of the demographic trends over the past decades have argued that individuals began forming smaller families later in life in response to changes in the surrounding socio-economic context (Mills et al., 2011). These changes include the diffusion of the contraceptive pill, the expansion of tertiary education, new employment opportunities, diverse partnership patterns and changes in values and social norms across the population (Frejka and Sardon, 2006; Ni Bhrolchain and Beaujouan, 2012). The availability of effective contraception (Goldin and Katz, 2002) and new educational, employment and career opportunities for women provided them the opportunity for broader emancipation and the possibility to depart from the exclusive mother role they previously occupied (Van de Kaa, 1987; Mills et al., 2011). The result has been a massive delay in childbearing in Europe (Kohler et al., 2002; Sobotka, 2004), and in the US and other countries among certain groups (highly educated) of women (Rindfuss et al., 1996; Martin, 2000). Some studies have shown that women's career planning is indeed a strong component behind postponement of childbearing (Balbo et al., 2010)

and scholars have argued that having children later in life might be a rational strategy from an economic and career perspective (Schmidt et al, 2012). Changes in partnership patterns and notably the rise in unstable forms of union such as unmarried cohabitation, retreat from marriage and increase in divorce are also often responsible for postponement in childbearing and potentially childlessness (Testa, 2007).

In addition to competing with education and employment aspirations, parenthood has increasingly become an issue of personal preferences, involving possibilities as voluntary childlessness and postponement until a moment in life when raising children is more consistent with women's chosen career path or other life goals (Blossfeld and Huinink, 1991; Mills et al., 2011). A change in norms and attitudes is at the core of the so-called Second Demographic Transition (SDT) theoretical framework. Proponents of the SDT identify a change in norms and values as a main driving component in recent demographic changes and specifically the low fertility rates and raise in divorce since the 1960s. According to the SDT, individuals' values have shifted in the last decades to a greater focus on self-realization, of which childbearing and a family may or may not be a part (Lesthaege and Van de Kaa, 1986).

Despite childbearing at older ages is not a new phenomenon, and the overall age-specific fertility at older age is now similar to the ones observed at the beginning of the 20$^{th}$ century (among others, see Billari et al., 2007; Goisis and Sigle-Rusheton, 2014), the profile of women giving birth at later ages has changed consistently. While in the past, childbearing at advanced age was primarily due to high-parity birth occurring to fecund couples, contemporary patterns of childbearing postponement are mainly driven by a rising fraction of women who attempt to become mothers at late ages.

**Biological limits in fertility and awareness**

From a biological perspective, the postponement transition has resulted in an increased proportion of couples starting to have children in a period when women's fecundity is already in decline (te Velde and Pearson, 2002). Declining fecundity with maternal age is mainly linked to ageing at the level of the ovaries and to the increasing risk of fetal loss. Leridon (2008) estimated that the prevalence of infertility increases from 1% at the age of 25 to 5% at the age of 35, 17% at the age 40 and up to 55% at age 45. The risk of a fetal death also strictly depends on the age of the woman and it reaches 37% at 45-49 years (Leridon and Slama, 2008). In a simulation of the effect of childbearing postponement, Leridon shows that when the mean age at first pregnancy attempt increases from 25.1 to 27.6 years (in line with trends observed in some European countries such as Italy and the Netherlands in the last couple of decades) fertility is reduced by 5.2% and a further 3 years reduces fertility by 11.9%. A postponement of childbearing by 30 months is also linked to a 46% increase in infertile couples after 5 years and a 30% increase in couples that are involuntarily childless. As a consequence, the amount of couples eligible for ART would increase by almost 32%.

Studies have also demonstrated that men and women are often unaware of the age-related decline in fertility. Tough et al. (2007) reported that just over 50% of respondents were aware that women over the age of 35 had more difficulties conceiving a child. Mills et al. (2011) showed that individuals often overestimate the age at which a woman is able to have more children. On average Europeans reported that a woman is too old to conceive after the age of 40 in 20 out of the 23 countries considered in the study.

### 1.3.2 Childlessness

The postponement of childbearing occurred in the last decades is linked to the increasing rates in childlessness observed across Europe and other industrialized countries. This is an extremely ideologically charged trend among the main shifts in demographic behaviors observed (Kreyenfeld and Konietzka, 2017). Increasing childlessness rates have been characterized by some as a consequence of a more and more individualistic society and linked to population ageing. Others have called for a "childfree style", considering the decision to remain childless as an expression of a self-determined life and possibly part of a "feminist" lifestyle (Gillspie, 2003; Tanturri and Mencarini, 2008). Some have argued that childfree might be the status that is most compatible with contemporary society (Walters, 2012).

In contrast with such views is the consistently low share of women and men declaring the intention to remain childless. For instance, in the UK only one third of women and men who were childless at the age of 40 declared it was an intentional choice (Berrington, 2017). It is argued that childlessness can be best understood as an unintended series of fertility postponements (Rindfuss et al., 1996; Morgan 1991). Rather than being consistently planned, childlessness *is often driven by a mix of adverse circumstances and adjustments to unforeseen events, such as infertility, poor health, not having the right partner, partnership dissolution* (Sobotka, 2004). Men and women therefore may adopt a strategy of perpetually postponing childbearing until it is too late. These were named "perpetual postponers", women spending more time in education or pursuing career opportunities may repeatedly decide to postpone childbearing and thus drift into childlessness (Berrington and Pattaro, 2014; Berrington, 2017).

Despite reflecting different opportunities and a change in norms and aspirations, the postponement of childbearing has therefore resulted in increasing levels of what has been termed "involuntary childlessness" (Sobotka and Testa, 2008; Mills et al., 2011).

In such picture, the greater availability of increasingly effective treatments for infertility has represented both a solution to infertility problems for growing number of people and represented hope for many women willing to pursue other life objectives before entering parenthood.

## 1.4 ART and Fertility Treatments usage and determinants

### 1.4.1 ART usage in Europe and the World

Since the first birth in vitro in 1978, the demand and use of fertility treatments and ART have constantly increased, and so the number of children and families born with the aid of such techniques. The annual increase in the use of ART in the first decade of 2000 has been approximately 5-10% in developed countries (Chambers et al., 2009) and the phenomenon is quickly expanding to Asian industrialized countries as well as some North African ones. Availability of ART services varies tremendously around the globe: European countries perform approximately 55% of all the ART cycles in the world, North America 20%, Asia 10%, Middle East 6%, Australia/New Zealand 6% and Latin America 3%. Access to ART ranges from a high of 3263 cycles performed per million inhabitants in Israel to two cycles per million inhabitants in Guatemala, and none available in many countries, especially those in Sub-Saharan Africa and other developing countries (Adamson, 2009).

Since 1998, the International Federation of Fertility Societies (IFFS) has undertaken an international surveillance project in an attempt to assess the number of clinics in each country, the services offered, and the legal and regulatory environment. The reports show that over the past decade, there has been a significant increase in the number of IVF clinics, and hence the number of ART cycles performed worldwide. By the year 2010, more than half of the world's nations have developed IVF services.

Between 4000 and 4500 IVF clinics were estimated to exist (Jones et al., 2010), with over 500 in India and around 600 in Japan. Other nations with large number of IVF clinics outside Europe and North America included Korea, China, Israel, Lebanon, Jordan, Tunisia (Adamson, 2009). Latin American nations had a lower number of clinics, nonetheless nine Latin American countries were among the 48 nations offering the most IVF cycles per capita. The success of Asia, the Middle East and Latin America stands in contrast to the relative absence of Sub-Saharan African nations where less than one-third hosted an IVF clinic as of 2010.

Precise information about the usage of non-ART fertility treatments is harder to collect, especially outside European countries and the US. While ART cycles have been performed in clinics, which are often required to report to national or international registers, it is harder to control other treatments performed. These might be performed outside of clinics or not be registered.

**ART usage in Europe**

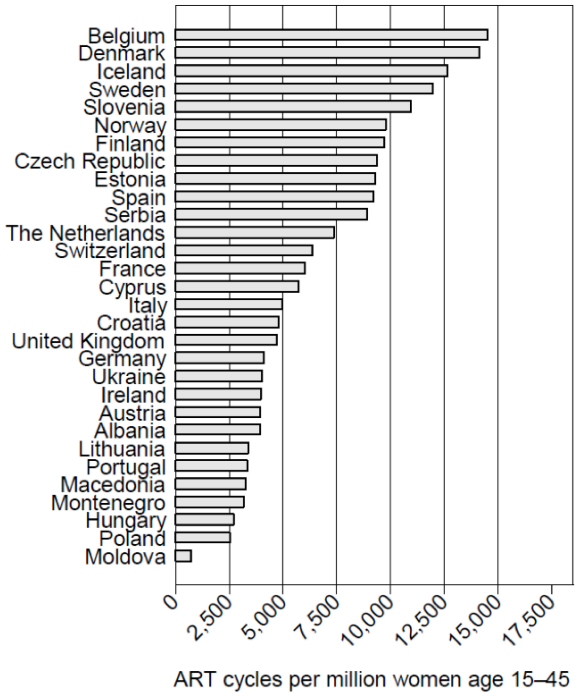
With around 55% of all treatments performed in 2005 (last year for which global information is available), globally, Europe has the largest number of ART treatments. Since 1997, ART data in Europe have been collected and reported by the European Society for Human Reproduction and Embryology (ESHRE). ESHRE reports over time have shown that the overall number of ART cycles has continued to increase year by year, despite some fluctuations in the number of countries reporting data. The most recent available report refers to treatments initiated in 2012 in 34 countries. In total, 640,155 cycles were reported in 2012, a 4.9% increase since 2011. Among these, 31% were IVF and 69% were ICSI. Between 1997 and 2007, an increase in the proportion of ICSI to IVF cycles was observed, while since 2008 a plateau seems to have been established. 26 countries reported IUI cycles, with a total of 175,028 cycles. Main

contributors were France, Italy, Spain, Poland, and Belgium. 43,974 cycles of donor-IUI were performed in 20 countries, and the main contributors were Denmark, Belgium and Spain (Calhaz-Jorge et al., 2016).

In terms of ART availability, in the 18 countries where all clinics reported to their ART register, a total of 369,081 ART cycles were performed in a population of around 295 million inhabitants, corresponding to 1,252 cycles per million inhabitants. Huge differences in access (cycles/million females of reproductive age) exist among countries, with the highest figures from Denmark (2726), and the lowest from Moldova (166). ESHRE estimated that around 3000 couples per million inhabitants may be eligible for ART and half of them request it. Therefore IVF/ICSI services for 1500 couples per million inhabitants would be required to fulfil the ART needs of a population. Out of the 18 countries where the evaluation was possible, 3 countries reported accessibility above this threshold- Denmark (2112), Slovenia (1876) and Belgium (1592). Nine countries reported less than 1000 (Austria, Croatia, Finland, France, Hungary, Italy, Moldova, Portugal and the UK). The percentage of new-borns conceived through ART varied from 0.2% in Lithuania to 6.1% in Denmark with a total of 5 countries exceeding 4% of ART contribution to national natality.

Figure 2 reports the number of treatments by the main group of potential ART patients in a country, namely women between the ages of 15 and 45 years. Denmark, Belgium, Iceland, Sweden and Slovenia are the countries with the largest number of ART cycles initiated. Czech Republic, Estonia and Serbia are also in the upper half of the distribution, and the authors of the studies considered it striking that the top group is not completely dominated by affluent western European countries

**Figure 1.2: ART cycles per million women age 15-45 per country, 2010**




source: Präg and Mills (2015)

## 1.4.2 Determinants of fertility treatment usage

The great variation in availability and usage of ART and other fertility treatments across countries reflects important differences in terms of regulations, funding, but also ethical and religious norms about reproduction and political views.

"*As a health-care good among others in the benefits basket, IVF occupies a unique place subject to a range of characterizations- from discretionary good to fundamental human right- that affect how it is regulated. Beyond the clinical and economic considerations that generally affect access and coverage decisions are complex social, historical and political dimensions that are sometimes cloaked in scientific and ethical rationales"* (Brigham et al., 2013 p. 667).

A number of studies have analyzed the factors influencing access to ART. These include religious, cultural and political characteristics (Präg and Mills, 2017; Adamson, 2009); economic and relative cost of treatment (Brigham et al., 2013); nature of the healthcare system and government regulation (Adamson 2009); social and cultural

norms surrounding childbearing (Billari et al, 2006; Präg and Mills, 2017). The clinical context also distinguishes IVF from other treatments, as fertility problems are often diagnosed in the context of a couple, and the medical intervention may involve a patient who herself has no identified pathology (for instance in the case of infertility linked to male factors, or homosexual couples). Age may simultaneously be a clinical factor underlying subfertility and a criterion that excludes treatment. In the case of donor gametes or embryo, the interest and protection of different parties are at issue (Brigham et al., 2013). Against this complex backdrop countries have enacted laws regulating access to, and public coverage of, IVF. Regulatory responses to IVF have evolved in very different ways across Europe, leading to a variety of environment in terms of access and therefore use of ART.

**Fertility treatments regulations and funding**

Europe is the only continent where the legal regulation of ART is widespread, while other countries where ART is used largely rely on voluntary guidelines. Regulatory systems may differ in terms of restriction on access to IVF treatments, general eligibility and public financing and studies have shown the difference in these criteria affects the levels of usage across European countries (Brigham et al 2013; Busardo, 2014). Eligibility criteria includes age limits, social criteria (mainly civil status and/or sexual orientation) and requirements of medical diagnoses. Both medical requirements and age limits may be more narrowly defined for publicly-financed IVF, to limit expenditure of public health-care resources to those with demonstrated medical need and statistical better chance of success. In most European countries, a medical indication must form the basis for a demand for IVF (Brigham et al., 2013). Austria, Germany and Italy are particularly restrictive, limiting treatment to diagnosed infertility, while France, the Netherlands, Portugal and Sweden also permit the use of

IVF to avoid the transmission of serious diseases. Belgium, Denmark, Finland, Greece, Spain and the UK have a more liberal approach to access to IVF and do not require a medical diagnosis of infertility to access the treatments. Ten out of the 22 countries examined by Präg and Mills (2015)- Netherlands, Sweden, Denmark, Finland, Belgium, Bulgaria, Spain, Greece, the UK and the US – do not require treatment seekers to be heterosexual couples. Regulatory pattern on age limits were less clear.

**Figure 1.3: Couple and sexuality requirements for ART in Europe, India, Japan and the US, 2013**

| | Marriage required | Stable relationship permitted | Singles permitted | Lesbians permitted |
|---|---|---|---|---|
| Austria | Yes | Yes | No | No |
| Belgium | Yes | Yes | Yes | Yes |
| Bulgaria | Yes | Yes | Yes | Yes |
| Croatia | Yes | Yes | No | No |
| Czech Republic | Yes | Yes | No | No |
| Denmark | Yes | Yes | Yes | Yes |
| Finland | No | Yes | Yes | Yes |
| France | No | Yes | No | No |
| Greece | No | Yes | Yes | No |
| Hungary | Yes | Yes | Yes | No |
| Ireland | No | Yes | No | No |
| Italy | Yes | Yes | No | No |
| Latvia | Yes | Yes | Yes | Yes |
| Russia | Yes | Yes | Yes | No |
| Slovenia | No | Yes | No | No |
| Spain | Yes | Yes | Yes | Yes |
| Sweden | Yes | Yes | No | No |
| Switzerland | No | Yes | No | No |
| Turkey | Yes | No | No | No |
| United Kingdom | No | Yes | Yes | Yes |
| India | Yes | Yes | Yes | No |
| Japan | Yes | No | No | No |
| United States | No | Yes | Yes | Yes |

source: Ory et al. (2014)

In terms of public funding of the treatments, virtually all European countries offer some assistance to the financing of ART treatments. Only Belarus, Ireland and Switzerland do not provide any coverage (Präg and Mills, 2017). Six countries- Denmark, France, Hungary, Russia, Slovenia and Spain- offer complete coverage through national health plans. In the countries where partial coverage is provided, the extent of coverage varies considerably. For example, two-thirds of the costs are covered by the national health system in Austria, while 40% of the costs are covered in Finland.

In the UK, the access to IVF is determined by primary care trusts, which has resulted in a "postcode lottery" for services, with differing conditions for access to publicly financed treatment and no IVF offered in some areas. Variation in coverage in other countries might depend upon waiting lists (Finland), or region (Italy and Spain), while cost sharing for drugs exist in Denmark, Finland and Portugal (Brigham et al., 2013).

Regulations about the public funding of IVF are generally more restrictive than the general eligibility criteria. All but two countries (Denmark and Finland) condition coverage upon the existence of a medical requirement and four of the six countries with no age limit for general IVF access establish limits only for the publicly financed treatments. In the US, since only 25% of health care plans cover infertility treatments, legislation was introduced to mandate coverage of infertility treatment by private insurers. Since the first mandate in 1977 in West Virginia, 14 other states introduced infertility-insurance mandate so far. The kind of mandate varies across states, and most do not cover IVF (Bitler and Schmidt, 2012). Furthermore, mandates only concern individuals who have a private health insurance.

Studies of the impact of regulatory patterns on ART use showed a clear positive association between the rate of utilization and the general eligibility for IVF while no link was found between utilization and restrictions to publicly financed IVF (Brigham et al 2013), and between utilization and a measure of the comprehensive availability of ART (including the range of treatments that are available) (Präg and Mills, 2017). The authors speculated that the rights for access to many ART procedures may be irrelevant in the bigger picture, since ART is extremely expensive and prohibitive for most patients.

Indeed, other studies identified the affordability and costs of treatments as important determinants of the levels of usage in a determined country. A country's affluence

(measured with GDP) is associated with the prevalence of ART treatments: the wealthier the country, the greater the number of ART treatments (Adamson, 2009; Prag and Mills, 2017), however GDP explains only a limited portion of the variance of ART usage between countries. Chambers et al. (2009) suggested that what is more relevant is the affordability of treatments (net cost of a cycle as a share of average disposable income in the country). A greater affordability of ART due to insurance mandates or public subsidies was associated with greater utilization even after accounting for GDP per capita, number of physicians, number of clinics (Chambers et al, 2009). Therefore, great differences in the utilization of ART are observed even in developed countries, since the cost of ART relative to income can vary relative to the income of the country per capita.

The cost of a standard IVF cycle in 2006 ranged from 12,513 USD in the US to 3,956 USD in Japan, and affordability, as percentage of GNI per capita, from 18% in the US to 10% in Japan (Chambers et al., 2009). Countries with the highest cost per live birth were the US and UK, the ones with the lowest, Scandinavia and Japan. After government subsidy, the cost of an IVF cycle ranges from 50% of annual disposable income in the US to 20% in Scandinavia and 6% in Australia. This is reflected by Australia and Scandinavia having levels of utilization that approximate demand, whereas North America only meets 24% of estimated demand. Scholars have suggested that only countries with funding arrangements that minimize out-of-pocket expenses meet expected demand (Adamson 2009).

**Norms and beliefs**

Other studies have focused on the role of norms and beliefs in explaining cross-country differences in the levels of ART usage. Billari (2011) observed a large positive association between higher social ages deadlines for childbearing and availability of

ART in European countries. Kocourkova and colleagues (2014) showed that ART use and total fertility rate in a country are correlated, which they interpret as a sign of increasing demand for children. Präg and Mills (2017) found a positive relationship between ART usage and childbearing postponement, measured as the size of the biggest group of potential ART users-highly educated, mid-aged women.

Präg and Mills (2017) also showed that normative cultural values measuring the acceptability of ART were the strongest predictor of ART usage, with a one point increase of average approval in a country associated with 276 additional ART treatments per million women of reproductive age. According to their results, 62% of the variance in ART usage could be explained by normative values. However, the positive relationship between ART approval and the number of ART treatment was stronger at higher levels of GDP, suggesting that a certain level of country wealth i.e. demand and available infrastructure -is necessary.

Religious differences also affect access to care mainly because of divergent opinions on the moral status of the embryo (Adamson, 2009; Präg and Mills, 2017). The moral and legal status of the embryo are interlinked and are often key to the acceptability of many procedures made available by IVF technology. The share of Muslim population in a country was shown to be negatively related to IVF usage, while the share of Protestants was positively related. Surprising, the share of Catholics was not significantly related to IVF usage (Präg and Mills, 2017).

## 1.5 ART and fertility treatments: a potential policy instrument?

As many European countries have been characterized by "lowest low" fertility (Kohler et al., 2002), some scholars have argued that ART might represent not just a means to alleviate the suffering of individuals who are involuntarily childless, but also

a potential policy lever for raising fertility rates in Europe (Kocourkova et al., 2014; Präg and Mills, 2017). Others have expressed skepticism about suggestions that ART should be integrated into pro-natality policies- as promoting the illusion that fecundity is possible at higher reproductive ages could prove problematic (Sobotka et al., 2008; Lockwood, 2011; Präg and Mills, 2014).

The proportion of ART births on total fertility has been increasing with the spread of ART and today IVF births account for around 1-6% in most European countries, and 1.2% in the US (Calhaz-Jorge et al., 2016; CDC, 2015). ART has therefore a minor but rapidly increasing influence on childbearing trends in advanced societies and it is likely to become more important for future fertility trends in many low-fertility countries. To what extent could it become a policy instrument to face low fertility? Sobotka et al. (2008) projection based on Denmark suggests that the proportion of children born as a result of ART increased from 2.1% among women born in 1965 to 4-5% among women born in 1978 (therefore an estimated net effect of 3-4%). In addition, a further rise in ART births may take place if the success rates of ART improve in the future, especially at late childbearing ages.

Kocourkova at al. (2014) results indicate that the growing utilization of ART has become relevant when assessing recent fertility trends. Despite the limits in the increase of ART use, its impact on the fertility level could be significant especially in countries with TFR below 1.5, although most studies overestimated the effectiveness of ART or neglected biological and behavioral factors when assessing its true effect. The authors suggest that it should nevertheless not constitute a policy with demographic objective (Kocourkvoa et al., 2014). While the free provision of treatments to infertile couples would lead to a slight increase in fertility, such policies might bring several undesirable effects such as supporting premature provision of ART to couples who would

eventually conceive without and increase the rate of multiple pregnancies (Sobotka et al., 2008)

Using a Monte Carlo simulation, Leridon and Slama (2008) assessed to what extent the use of ART could make up for the loss in fertility due to the postponement of childbearing. Their results showed that, for women who postpone their first attempt to achieve pregnancy from age 30 to 35, the use of IVF by all eligible couples would make up for half of the births "lost" due to age-related declines in conception rates. The use of ART by 50% of the eligible couples (which would represent an extremely high usage of ART) would make up for about one fifth of all the births lost in an additional postponement of 30 months for pregnancy attempts in the French population. A wide use of ART would therefore makeup for only a small part of the reduction in fertility linked to postponement. The rise in perpetual postponers has led to greater reliance on assisted conception, but even with IVF, success rates in terms of live births for this group are poor and the personal and financial cost is high.

Recently, technological improvements, such as Oocyte cryopreservation, have transformed the outcome of modern assisted reproductive treatments and might offer a realistic technological fix for the age-decline in fertility. Embryo Cryopreservation is the ability to freeze in time the quality and enhance the chance of implantation of an embryo and a healthy delivery at the age the woman was when the embryo was created. Such technique, also referred to as "the social freezing of eggs", has the potential to reinforce the argument that ART could help some countries raise their fertility levels (Lockwood, 2011).

Overall, studies seem to predict that if ART continues at around current levels, the extent to which these treatments can compensate for the postponement of fertility would be negligible on a demographic perspective. Nevertheless, it can make an important

contribution at the individual level by helping couples fulfil their desire to have a child. This is particularly relevant as involuntary childlessness is still a social taboo which can have important psychological and mental implications for individuals (Hyatt, 2012). However, authors are reluctant in arguing that it is an upcoming policy to reconcile career and family aspirations, such as measures that encourage flexible working schedules. It was suggested that couples should be encouraged to consider parenthood sooner rather than later and society should work towards a social framework that is financially and structurally supportive of young families (Präg and Mills, 2014; Mills et al, 2014). Women should not consider oocyte cryopreservation as an alternative to conventional reproduction, but rather as an ultimate back-up. ART tend to have low success at older ages, so it cannot be expected to reverse the biological clock. (Lockwood, 2011).

A considerable change in birth timing is a key demographic aspect related to ART and results do suggest that the increasing prevalence of women aged 35 and over among all women who asked for IVF has been part of the effect of childbearing postponement. However, the demographic relevancy of ART use is more common in a population with less advanced postponement rates (Kocourkova et al., 2014). For instance, women using ART in Denmark are younger than in other countries, and better access to ART might thus also mean that couples are able to undertake the treatment earlier (Sobotka et al., 2008).

## 1.6 Setting of the thesis: the UK and the US

The UK and the US represent an interesting setting for this research for a number of reasons including recent demographic and fertility patterns, levels and regulations of the use of treatments and data availability.

### i. Fertility patterns

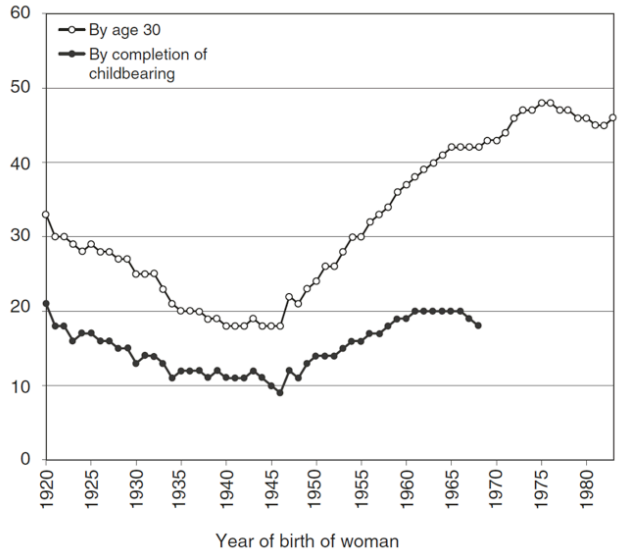
Both countries have been characterized by a pronounced polarization in childbearing behavior, with relatively high fertility rates both at younger and at older ages and important differences depending on ethnic and socio-economic factors (Sobotka, 2004). Heterogeneity in fertility behavior in the US is linked for example, to ethnic minorities having children at younger ages compared to White women (McLanahan, 2004).

In the UK, relatively high fertility levels have coexisted together with high rates of childlessness in the last decades. While lower educated people and some immigrant groups are characterized by early childbearing and relatively high fertility rates, higher educated women tend to have low fertility, postpone childbearing and high rates of childlessness (Berrington, 2017; Sigle-Rushton, 2008). In this context, the association between the rise in childlessness and the increased mean age at entry into parenthood is of particular relevance, especially among the more highly educated women. As an increasing number of couples delay childbearing, the issue of declining reproductive capacity with age becomes increasingly important. This is indeed the population subgroups that is most interested by the spread and availability of ART and fertility treatments.

Levels of childlessness were very low among women born in the 1940s, started rising among cohorts born in the 1950s and stabilized among women born in the 1960s. Current levels of childlessness are not unprecedented, as historically in Britain, around one fifth of the population were childless and never married. This was part of the West European marriage pattern identified by Hajnal (1965). However, what differentiates patterns of contemporary cohorts is that today high levels of childlessness at age 30 are associated with the postponement of entry into parenthood (Berrington 2017). Contrary to other countries, a positive educational gradient in childlessness is observable in the

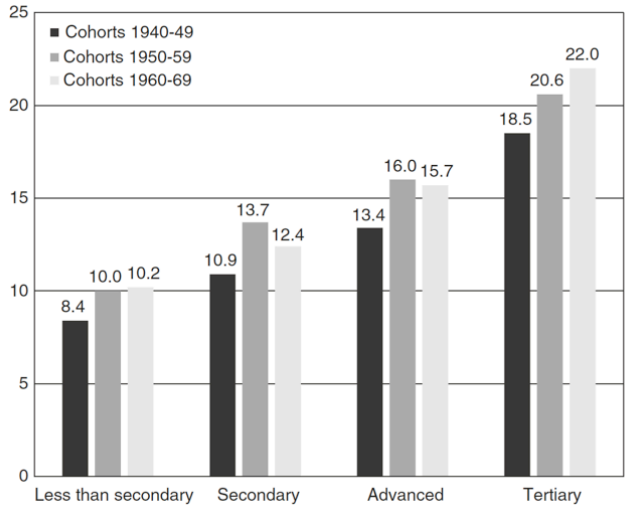
UK in all cohorts starting with women born in the 1940s and has not faded (but even slightly increased) over time. Today, the proportion of childless women with tertiary education is the double of women with no or less than secondary education (Berrington, 2017). While some have argued that more educated women choose to remain childless to pursue education and career, very few British men and women intend to remain childless (around 3 in ten childless individuals at 42, Berrington 2017), suggesting that the pathways of the "perpetual postponers" might explain much of the trend.

**Figure 1.4: Share of women who were childless at their 30th birthday and upon completion of childbearing, by year of birth of woman. England and Wales, in per cent**




source: Berrington (2017)

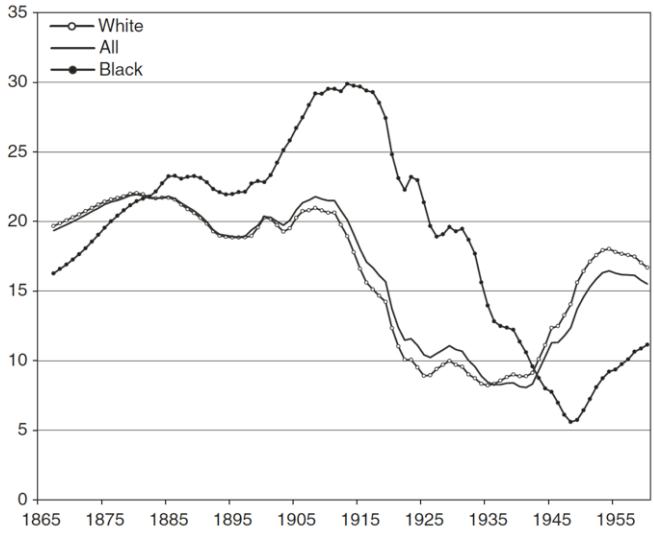
**Figure 1.5: Childlessness by birth cohort and highest level of education. British women aged 40-49 born 1940-1969, in per cent**




source: Berrington (2015)

The rate of childlessness has seen a consistent increase in the last decades in the US as well. The percentage of women who do not have any children at the end of their reproductive years doubled between the mid-70s and 2000s, from about 10% to 20%, and has been decreasing since then (around 15% in the 2000-2012) (Frejka, 2017). Similar to what is observed in other countries, rates of childlessness were already relatively high among all cohorts born between the late 1860s and the early 1910s, at around 20% of white women. A rapid decline in the share of childless women started with the 1913 birth cohort and lasted until the early 1940s birth cohorts. A pronounced increase ensued, from 10% among the 1943 cohort to 18% among the 1953 cohort. There exists a strong ethnic and socio-economic gradient in childlessness (Frejka, 2017). Evidence from several rounds of the National Survey of Family Growth show that childless women and particularly the voluntary childless ones tend to be White, employed full-time, have a higher education, less likely to be married and less religious and tend to differ from women who have children and temporary childless in terms of attitude regarding gender egalitarianism, work, and family (Abma and Martinez, 2006).

**Figure 1.6: Share of childless women at age 50, all White and Black women, birth cohorts 1867-1960, United States**




Source: Frejka, 2015

### ii. ART and fertility treatments usage

Both countries are characterized by a consistent and growing use of treatments, although levels are still lower than in other countries such as the Scandinavian ones. In 2013, an estimated 1.5% of all infants were born through ART in the US and 2.1% in the UK.

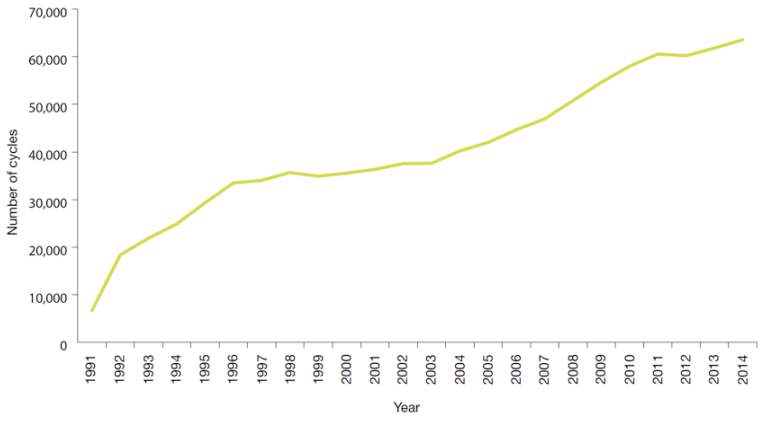
The UK has been widely recognized to have the most comprehensive and well-thought-out regulatory framework with the Human Fertilization and Embryology Authority (HFEA), an independent regulator of fertility treatment in the UK which came into force in 1991. Clinics are required by law to provide information to the HFEA about all licensed fertility treatments they carry out. The HFEA Register therefore contains information about fertility patients, the treatments they receive and its outcomes.

In 2014, 82 clinics performed ART treatments, with most clinics located in London and the South East. The number of women treated in each region ranged from 1,522 in

Northern Ireland, to 15,885 in London. 52,288 women had a total of 67,708 cycles of IVF or ICSI and 2,511 women had a total of 4,675 cycles of IUI. The majority (two thirds) were aged 37 years and under, and the type of IVF cycle (fresh or frozen embryos, donor or patient's eggs) varied according to the woman's age. Most women used their own eggs, however the proportion of women using donor eggs increased with age and now around 60% of cycles in women 45 and over use donor eggs before transfer.

The long-term trend in the age of women seeking fertility treatment reflected the general trend in the UK and elsewhere for women to have children later in life. Since 1991 the average age of women being treated increased by about one and a half years for IVF (from 33.6 to 34.9) and by over 3 years for IUI (from 31.9 to 34.7). A total of 1285 cycles of IVF were performed in women who registered with a female partner in 2014 (20% more than in 2013- similar year on year increase has been seen for the last 20 years). The number of IVF cycles performed each year in the UK has increased almost every year since 1991. Between 1991 and 2013, 240,724 babies have been born after IVF treatment. The proportion of babies born after IVF steadily increased: 0.3% in 1991; 1.4% in 2002; 2.1% in 2013.

**Figure 1.7: Number of IVF cycles performed each year, UK from 1991 to 2014**



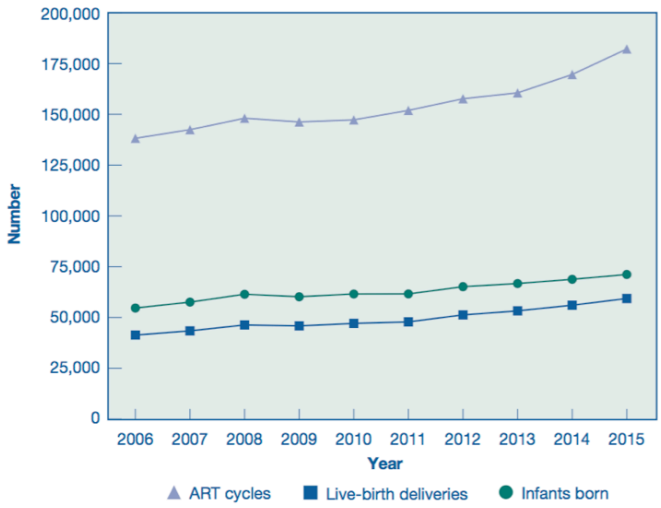

source: HFEA, 2015

The US also shows relatively high levels of utilization of ART and other fertility treatments. The last Centers for Disease Control and Prevention's (CDC) report collected data from the 464 clinics operating in 2015 in the US that provided and verified data on the outcomes of all ART cycles started in their clinics. A total of 186,157 cycles was started in 2015 and resulted in 60,778 live births and 72,913 infants.

The largest group of women using ART services were women younger than 35 years, who represented approximately 38% of all ART cycles performed. 21% of cycles were performed among women aged 35-37%, 19% among women aged 38-40, 10% among women aged 41-42 and about 10% among women older than 41. The average age of women using ART in 2005 was 36. The percentage of ART cycles in which a woman used her own eggs declined with age, with the vast majority (97%) of women younger than 35 years who used their own eggs, while 34% of women aged 43-44 and 71% of women older than 44 used donor eggs.

The number of ART cycles performed in the US has increased 32% from 138,198 cycles in 2006 to 182,154 in 2015, with the number of infants who were conceived using ART increasing from 54,656 in 2006 to 71,169 in 2015. Estimates based on data from the National Survey of Family, Growth (NSFG), show that the percentage of women aged 15-44 who had ever used infertility services increased from 9% in 1982 to 15% in 1995, declined to 12% in 2002 and remained at that level until 2010 (Chandra et al. 2014). The CDC estimates that 1.5% of all infants were born through ART.

**Figure 1.8: Number of ART cycles performed, live-birth deliveries and infants born using ART, US 2006-2015**




Source: CDC 2015 Report

### iii. ART regulations and funding

Eligibility criteria are relatively liberal in the UK and the US. In both countries, access is provided both to single women and to lesbian couples, and no medical condition is required. A wide variety of treatments is available, including surrogacy which is prohibited in most European countries (Präg and Mills, 2015). There is significant regulation and oversight in the US regarding ART, but multiple overseeing authorities and organizations has resulted in inconsistencies, duplication, potentially inappropriate regulations (Adamson, 2005). The American Society of Reproductive Medicine (ASRM) issues guidelines for clinics, but these are not binding. This results in the lack of strict criteria for eligibility to access fertility treatments.

However, in both countries the treatments are extremely expensive and only partly covered by national public health systems. The UK is characterized by a mix between private and public, with 41.3% of IVF treatment cycles funded by the NHS in 2014. As mentioned above, funding of ART works on a regional basis, with the result that most

individuals and couples rely on private clinics. In the US, there is limited insurance coverage for infertility services. A legislation was introduced to mandate coverage of infertility treatments by private insurers. Since the first mandate in 1977 in West Virginia, 14 other states introduced infertility-insurance mandate so far. The kind of mandate varies across states, and only few cover IVF- so far, only 5 states have comprehensive mandates (Bitler and Schmidt 2012; Chambers et al., 2014). Furthermore, mandates only concern individuals who have private health insurance.

As a result, both in the UK and in the US, the prices of fertility treatments are extremely high. In the UK, the average cost of a single ART cycle is approximately 5,000 pounds and 600 for a cycle of IUI. In the US, a mean IVF per-cycle costs ranging from $8,000 to $15,000. This means that most couples seek medical help at private clinics and pay treatments entirely out of their own pockets (HFEA, 2014; NCD, 2015) and many individuals and couples are not able to afford the costs of the treatments.

#### iv. Data availability

Finally, both countries offer high quality data that enables this research to be conducted. The availability of longitudinal surveys including information about the use of treatments, allows to follow a representative number of families and children in the long run after the use of treatment/birth. Both surveys provide rich information about socio-economic background and family relationships, which is crucial for the focus of this research. In addition, the UK MCS also provides information about parent-children relationships, which I use in Chapter 3.

## 1.7 Outcomes of Fertility Treatments

### 1.7.1 Existing literature

Debates on the legitimation, regulation and funding of treatments have come along with concerns about the possible detrimental consequences for children and family functioning. These concerns are linked to fears about the negative health effects (Van Balen, 1998; Colpin, 2002; Fauser et al., 2011), the development of children in what has been defined as "new family forms" (Golombok, 2015) and to the possible negative consequences on parents' well-being and relationships (Cook et al., 1989; Colpin, 1999; Kjaer et al., 2014).

There is strong evidence in the literature that the use of fertility treatments can bring higher risks of adverse outcomes at birth such as low birth weight, preterm delivery and multiple births (van Balen, 1998; Wilson et al., 2011; Hansen et al., 2013; Hart and Norman, 2013a). This is linked both to parental characteristics related to infertility and to the treatment itself, especially the number of embryos that are transferred after fertilization. This has been reduced by regulations in most countries to reduce the risks of multiple births, which however still represent a consistent proportion of ART births (Calhaz-Jorge et al., 2016).

However, few studies have examined outcomes beyond the first years of life to look at the later development of the children (Golombok, 1995; Mains et al., 2011; Hart and Norman 2013a; 2013b). The existing evidence shows overall a good performance during childhood and adolescence both in terms of health and behavioural (Ponjaert-Kristoffersen et al., 2004; Balayla et al., 2017) and intellectual abilities (Spangmose et al., 2017). Some studies even

observed that ART children performed better during childhood in terms of cognitive skills and educational scores, but this was mainly due to parents' demographic and socio-economic characteristics (Carson et al., 2011; Mains et al., 2001).

These results suggest that different factors play a role in their development. The experience of infertility and going through the treatment may be linked to the way parents perceive their children and therefore parenting style and investment in their development (Bernstein 1990; Gibson et al., 2000; Hammarberg et al., 2008; Golombok, 2015). Parenting style and activities have been the focus of a consistent economic, sociological and demographic literature in the last few decades. Since the 90s, the active involvement of parents in their children's cognitive and non-cognitive development has been considered as a main determinant of children's performances at later ages (Gauthier, 2004; Brooks-Gunn and Markman, 2005; Ermisch, 2008; Altintas, 2016). The studies about fertility treatments and parenting provide mixed results, with some scholars finding higher levels of anxiety and sense of inadequateness among mothers who used fertility treatment (Colpin, 2002; Hammarberg, 2008), while others observing no difference or an even better functioning of family created with the aid of fertility treatments (Golombok, 2001; 2015). Dimensions such as the parental involvement and time investment, however, have been neglected by the literature despite their relevance for children's development and the potential association with the use of fertility treatments.

Another way in which fertility treatments may impact family outcomes is the potential consequence on a couples' relationship and stability. Divorce is an increasing common life course event (Andersson and Philipov 2002; Harkonen and Dronkers, 2006) and it is consequential for both adults and children (Amato, 2000). While some scholars have worried that the stressful experience of infertility and the treatment may negatively affect the well-being of individuals and couples (Verhaak et al., 2007; Baldur-Felskov, 2013, Kjaer et al., 2014), others have argued that living together through such experience has the potential to strengthen relationship of the couple and

thus lead to higher stability (Ulrich et al., 2004; Schmidt et al., 2005), with most empirical evidence showing indeed good quality of relationships and stability among couples undertaking fertility treatments (Ulrich et al., 2004; Peterson et al., 2011; Borneskog et al., 2012).

Overall, the evidence about the consequences of fertility treatments on children's and adults' wellbeing in the long-term seems to indicate that a strong desire for parenthood might be important for fostering positive family relationships and that conception after treatments does not appear to have an adverse effect on the socio-emotional development of the child (see the work of Golombock and colleagues[2] ; Fasouliotis and Schenker 1999). However, it also suggests that the observed outcomes may vary depending on the considered sample, control group and point in time considered. Most studies are based on very small samples and acknowledge only one point in time, usually soon after the treatment (Hart and Norman, 2013; Golombok, 2015). While a few studies do suggest that the socio-economic background of individuals who can access the treatments may partially explain the observed outcomes (Mains, 2010; Carson, 2011), the role of the selective characteristics of couples undertaking the treatments has not been adequately considered in most studies and represents a crucial issue (Golombok, 2015).

### 1.7.2 Selection into treatments

Couples who undertake ART are highly selective when it comes to parenthood both in terms of resources and willingness to have children. Literature has shown that they are on average older, more highly educated and with a higher income compared to other

[2] Studies on family functioning carried on by Golombok and colleagues will be mentioned in more details in the following chapters and especially in chapter 3

parents (Carson et al., 2009; Bitler and Schmidt, 2012; Chambers et al., 2014, Chandra et al., 2014). On the one hand, this is due to the relatively old age at which individuals start seeking fertility treatments and therefore bear pregnancies. On the other hand, as discussed in the previous sections, the high costs of the treatments make them accessible only to a selective population (Chambers et al, 2014), and barriers to the access lead to the exclusion of part of the population (Präg and Mills, 2015). An older age and high socio-economic background are usually linked with greater resources, a high investment in children and a view of parenting focused on the development of a strong parent-child relationship (Lareau, 2002; MacLahnan, 2004; Brooks-Gunn and Markman, 2015). As shown with the effects of older parental age, such factors can override the possible negative consequences of poorer health outcome at birth and lead to a better cognitive and non-cognitive child development (Liu et al., 2011; Goisis, 2013; Myrskyla et al., 2013).

The selective characteristics of individuals and couples who access the treatments are likely to play a crucial role for children's and family outcomes, especially in the UK and the US where prices of fertility treatments are extremely high and not, or only partly, publicly covered. This will be a central point throughout this thesis, where I bring together the study of the outcomes of ART and fertility treatments with an intergenerational transmission perspective focused on the different opportunities experienced by couples and children with different demographic and socio-economic backgrounds.

In this section, I explore the selection of individuals into treatments in the UK and the US, using the same samples of the empirical analyses in chapter two, three and four. The aim is to test whether individuals (here women) accessing treatments represent indeed a selective population, which will constitute a main starting point in the later

chapters. What are the characteristics of mothers who use fertility treatments? How do they change depending on the kind of treatment considered?

There is sound evidence of ethnic and socio-economic gradients in the access to fertility treatments in the US. Studies have shown that individuals who seek medical help to treat infertility and access the treatments tend to be White, older, more highly educated and with higher income compared to the rest of the population (Smith et al., 2011; Chambers et al., 2014; Chandra et al., 2014), even in states with laws requiring insurance companies to provide infertility coverage (Smith et al., 2011). In fact, more socio-economically advantaged individuals and couples are also more affected by the law mandates because they are more likely to have a private insurance which is subject to the mandate (Bitler and Schmidt, 2012). Despite the higher incidence of infertility among many minority groups and strong cultural meanings attached to having children, the needs of minority women have received little attention academically and in public policy (Culley et al., 2011). The evidence collected by Culley suggests that in the US there are multiple obstacles hindering minority ethnic couples from seeking medical health care for infertility, reflecting a wider process of "stratified reproduction".

The evidence about selection into fertility treatments in the UK is rather scarce. Evidence shows that fertility problems overall do not vary by socioeconomic status at a population level (Dalwhani et al., 2013). However, women from higher socioeconomic groups are more likely than women from lower socioeconomic groups to seek medical help (Gunnell and Ewings, 1994). Carson et al (2011) showed that mothers who conceived with the aid of ART or ovulation-inducing drugs have higher socioeconomic profiles compared to women who experience an unplanned pregnancy. Qualitative studies of cross-border fertility care found that individuals travelling out of

the UK to receive treatments often reported the cost of UK treatments (as well as the low success rate) as reasons to travel (Culley et al., 2011).

In light of the reviewed literature and of the high costs of the treatments in the two countries, I expect individuals who access fertility treatments to represent a selective population among the British and American population. To test this hypothesis, I apply logistic and multinomial logistic models on data coming from the UK Millennium Cohort Study (MCS, that I use in Chapter two and three to study children outcomes and parenting style), and the US National Survey of Family Growth (NSFG, that I use in Chapter four to study couples' stability) to study the individual determinants of the probability to use fertility treatments. In the logistic models, all treatments are considered together to study the probability of using any kind of treatment. In the multinomial logistic models, I divide the treatments into two categories to assess whether the determinants differ depending on the kind of treatment considered. As the different treatments vary consistently in terms of prices, length and intensity, we could expect the characteristics of individuals accessing them to differ as well. It is important to underline that my aim is not to compare the selection in the two countries. As the following sections will show, the samples, available predictors and kinds of fertility treatments included are significantly different, as will be explained in the following sections.

## Use of Fertility Treatments in the UK Millennium Cohort Study

The MCS is a longitudinal survey that follows around 18,000 children born in the UK in 2000-2002 and their family. The sample is clustered geographically and stratified to over-represent areas with higher proportions of ethnic minorities in England, high child poverty and the three smaller countries- Wales, Scotland and Northern Ireland. Baseline interviews were conducted when the children were approximately 9 months

old and follow-up interviews when the children were aged 3, 5, 7, 11 and 14 years. Unfortunately, data from the last wave were released too late to be used for the empirical analyses in this thesis. 487 of the mothers who answered the baseline interview declared they conceived with the aid of some fertility treatments. Of these, 206 used ART (IVF or ICSI), 25 used IUI and 247 used ovarian stimulating drugs (OI) not followed by any further treatment. The MCS includes detailed information about the demographic profile, health, socio-economic characteristics of the respondents and their family as well as the children's development including several measures of cognitive and non-cognitive skills.

Table 1.1 shows descriptive statistics of the sample, divided by the kind of treatment used. I only include respondents who conceived while being either in a cohabiting or married relationship, the same selected sample I will use in Chapter 2 and chapter 3 to avoid comparisons with children born to single mothers (who represent a particularly disadvantaged sub-sample in the UK). To examine the characteristics of respondents who undertook different fertility treatments, I consider the use of IUI in the same category of IVF and ICSI, because of the very small number of women who used IUI.

Table 1.2 shows the results of logistic and multinomial models to study the determinants of the probability to start any fertility treatment (model 1) or a specific kind of treatment (model 2). The coefficients are displayed as odds ratios and the reference category is women who conceived without the aid of any fertility treatment. The predictor variables include demographic information: ethnic background, age, age of the partner and parity; marital status (reference category is cohabiting); socio-economic characteristics[3]: income (divided in UK quintiles), educational level,

[3] The same models were performed with alternate measures of socio-economic background: including income and education, including SES and education. Results were virtually identical, therefore all measures are included in the final model

employment status, occupational class (*high SES* for professional or managerial occupations, *middle SES* for intermediate occupations and *low SES* for lower occupations), and whether English is the only language spoken at home.

Both the descriptive statistics and the results from the logistic model indicate that the women who used fertility treatments differ from the rest of the population on several characteristics. As shown in Table 1.1, they are prevalently white, on average older (both the respondents and their partners), more likely to be married, with higher income and educational level. They are also more likely to be in a managerial or professional occupation, especially women who undertook either ART or IUI (47% compared to 40% among women who took OI and the 30% among women who did not undergo any treatment). On the other side, while women who undertook some treatment have on average higher education and income compared to women who did not take any treatment, there is only a small difference depending on the kind of treatment.

Turning to the results of the multivariate analysis (Table 1.2), significant predictors of the use of treatments are the age both of the respondents and the partner, being married and childless, for the use of OI and especially for ART/IUI. A high income is significantly linked to the use of a treatment in general, and for OI, but is not significant for the use of ART/IUI. A higher educational level is negatively linked to the use of the treatments, however the coefficients are not significant.

These results are in line with what found in the literature and confirm the expectation of a selective background of women accessing fertility treatments in the UK. While there are some differences between women undertaking IVF or IUI and those who use OI without any further treatments, the predictors have very similar effects, except for a stronger association of income with the use of OI and a stronger association of age and marital status with the use of IVF/IUI. This is surprising in light of the extremely high

costs of ART, but might suggest that only couples with higher income start seeking medical help to get pregnant in the first place.

**Table 1.1: Characteristics of the sample divided by kind of fertility treatment used**

| | *No treatment* % | *OI* % | *IVF/ICSI/IU* % |
|---|---|---|---|
| *Ethnic Background* | | | |
| White | 83.5 | 94.7 | 90.9 |
| Black | 2.2 | 0.9 | 1.2 |
| Pakistani, Indian or Bangladeshi | 7.8 | 2.8 | 4.3 |
| Other ethnic background | 6.5 | 1.6 | 3.6 |
| Age at birth (mean/sd) | 29.1 (5.53) | 31.03 (4.49) | 33.6 (4.59) |
| Partner age at birth (mean/sd) | 30.9 (8.49) | 33.1 (7.52) | 35.8 (6.05) |
| Childless | 39.1 | 60.1 | 73.1 |
| Married | 70.4 | 84.2 | 93.1 |
| *Household Income* | | | |
| UK 1st quintile | 18.5 | 32.8 | 32.2 |
| UK 2nd quintile | 20.6 | 22.8 | 24.5 |
| UK 3rd quintile | 21.8 | 21.9 | 24.4 |
| UK 4th quintile | 23.2 | 17.2 | 15.1 |
| UK 5th quintile | 15.2 | 4.0 | 3.6 |
| *Education* | | | |
| Degree | 28.0 | 35.7 | 33.1 |
| A levels | 43.4 | 41.4 | 52.2 |
| Lower education | 29.2 | 22.9 | 14.7 |
| Employed | 47.4 | 52.8 | 55.5 |
| *Occupational status* | | | |
| High SES | 29.9 | 40.0 | 46.9 |
| Middle SES | 27.1 | 32.8 | 30.2 |
| Low SES | 33.2 | 22.8 | 20.4 |
| English only | 84.0 | 88.5 | 92.2 |
| Observations | 14,559 | 210 | 245 |

**Table 1.2: Determinants of using fertility treatments, odds ratios from logistic and multinomial logistic models**

| | (1) Logistic | (2) Multinomial logit | |
|---|---|---|---|
| VARIABLES | *Fertility treatment* | *OI* | *IVF/ICSI/IUI* |
| *Ethnic background (ref: White)* | | | |
| Black | 0.563 | 0.317 | 0.858 |
| | (0.242) | (0.204) | (0.518) |
| Pakistani, Indian or Bangladeshi | 0.824 | 0.251*** | 2.371 |
| | (0.267) | (0.136) | (1.178) |
| Other ethnic background | 0.491*** | 0.143*** | 0.818 |
| | (0.135) | (0.0770) | (0.314) |
| Age at birth | 1.117*** | 1.090*** | 1.161*** |
| | (0.0133) | (0.0176) | (0.0207) |
| Partner age at birth | 1.032*** | 1.013 | 1.051*** |
| | (0.00909) | (0.0118) | (0.0141) |
| Married | 2.731*** | 2.480*** | 4.145*** |
| | (0.406) | (0.480) | (1.104) |
| Childless | 4.943*** | 3.835*** | 7.750*** |
| | (0.533) | (0.557) | (1.326) |
| *Household income (ref: UK 5th quintile)* | | | |
| UK 1st quintile | 2.068*** | 2.300** | 1.705 |
| | (0.547) | (0.836) | (0.624) |
| UK 2nd quintile | 1.848** | 2.217** | 1.222 |
| | (0.485) | (0.792) | (0.495) |
| UK 3rd quintile | 2.107*** | 1.990* | 2.318** |
| | (0.541) | (0.799) | (0.734) |
| UK 4th quintile | 1.885** | 2.153** | 1.663 |
| | (0.481) | (0.742) | (0.653) |
| *Education (ref: less than A levels)* | | | |
| Degree | 0.773 | 0.703* | 0.832 |
| | (0.121) | (0.143) | (0.213) |
| A levels | 1.064 | 0.802 | 1.543* |
| | (0.149) | (0.146) | (0.353) |
| employed | 0.823* | 0.697*** | 1.019 |
| | (0.0842) | (0.0967) | (0.161) |
| *Occupational status (ref: low SES)* | | | |
| Managerial/professional | 1.04 | 1.091 | 1.209 |
| | (0.1542) | (0.244) | (0.252) |
| Intermediate | 1.10 | 1.327 | 1.116 |
| | (0.1530) | (0.265) | (0.224) |
| English only | 1.062 | 0.674 | 1.987* |
| | (0.227) | (0.177) | (0.746) |
| Observations | 15,183 | 15,183 | 15,183 |

Note: *p<0.05 **p<0.01 ***p<0.001
SE in parentheses

## Use of Fertility Treatments in the National Survey of Family Growth

The US NSFG is conducted by the CDC National Center for Health Statistics (NCHS). The surveys interviewed a nationally representative sample of women aged 15-44 in the United States. Cycles 1-5 of the NSFG were conducted as periodical cycles in 1973, 1976, 1982, 1988 and 1995. I use data from cycle 6-8, that provide information about the use of fertility treatments. Cycle 6 was carried out in 2002, Cycle 7 consisted of continuous interviews carried out between 2006 and 2010, and Cycle 8 between 2011 and 2013.

My sample includes women entering their first marriage, therefore from the initial sample of 25,523 women, it consists of 11,347 women. Of those, 1,236 declared they have sought medical help to get pregnant. Different treatments might have followed: 75 women underwent either IVF or ICSI, 135 IUI, 403 used Ovarian stimulating drugs not followed by any further treatments. 616 women declared they used other kinds of fertility treatments. This last group of women was excluded from the sample as the broad category might include very different levels of treatments ranging from the only evaluation of infertility or sub-fertility to extremely invasive treatments such as surgery to the corrected obstructed tubes.

Table 1.3 shows the characteristics of the sample divided by the kind of treatment used. IUI and IVF/ICSI are included in the same category because of the small sub-sample sizes. Table 4 shows the results of logistic and multinomial logistics to study the determinants of the probability to start a treatment in general (all treatments considered in one same category, model 1) or a specific kind of treatment (divided between OI and ART/IUI, model 2). Coefficients are displayed as odds ratios and the reference category is women who did not start any treatment. Predictor variables include ethnic background; age at marriage of both partners; educational level (divided

in *degree*, *high secondary education* or *lower education*); educational level of the respondent's mother (divided in *some college education*, *high school* or *less than high school*); whether the partners cohabited before marriage, and whether they had a premarital birth.

Similar to the UK, respondents who used fertility treatments seem to be a selective population compared to the rest of the sample, characterized by older age at marriage and higher educational level. They also have lower probability of having cohabited before marriage and of having experienced a premarital birth (Table 1.3). When such factors are included in the multivariate analysis, the most relevant predictors of the use of fertility treatments seem to be age at marriage and a high educational level (having a degree or equivalent is associated with more than 4 times the odds of using IVF/IUI and more than twice the odds of using OI, $p<.001$). Having a mother who has at least a high school educational level is also positively associated with the odds of using a treatment, although the coefficient for a higher educational level is not significant. Having experienced a premarital birth is negatively and strongly associated with the odds of using treatments. Unfortunately, the NSFG does not provide information about the couples' income.

Similar to what observed for the UK, these results confirm that women accessing fertility treatments in the US represent a selective sub-sample of White, older and highly educated women. The educational gradient in the use of the treatments is especially strong and reflects what was already found in the literature. The predictors for the use of the different kinds of treatments are very similar, except for a stronger association of age at marriage and higher educational level with the use of ART compared to OI.

**Table 1.3: Characteristics of the sample divided by kind of fertility treatments used**

| VARIABLES | *No treatment* % | *IVF/ICSI/IUI* % | *OI* % |
|---|---|---|---|
| *Ethnic background* | | | |
| White | 73.0 | 83.8 | 85.1 |
| Black | 15.7 | 6.1 | 8.1 |
| Other ethnic background | 11.1 | 10.0 | 06.6 |
| Age at marriage | 23.3 | 25.6 | 23.8 |
| Partner age at marriage | 26.4 | 28.6 | 27.3 |
| *Education* | | | |
| Degree | 35.5 | 70.9 | 49.8 |
| High secondary education | 48.5 | 26.2 | 44.4 |
| Lower education | 16.0 | 2.8 | 5.7 |
| *Mother's education* | | | |
| More than high school | 36.4 | 46.2 | 39.2 |
| High school | 32.7 | 39.0 | 39.7 |
| Lower education | 29.9 | 13.3 | 20.6 |
| Premarital cohabitation | 54.6 | 47.1 | 49.1 |
| Premarital birth | 27.0 | 2.8 | 5.2 |
| Observations | 11,347 | 210 | 403 |

**Table 1.4: determinants of the use of fertility treatments, odds ratios from logistic and multinomial logistic models**

| | (1) logistic | (2) multinomial logistic | |
|---|---|---|---|
| | *Fertility treatment* | *IVF/IUI* | *OI* |
| *Ethnic background (ref: White)* | | | |
| Black | 0.576*** | 0.505** | 0.612** |
| | (0.0933) | (0.149) | (0.117) |
| Other | 0.669** | 0.850 | 0.575*** |
| | (0.106) | (0.205) | (0.119) |
| *Educational level (ref: high school or less)* | | | |
| College | 1.910*** | 1.957 | 1.940*** |
| | (0.393) | (0.861) | (0.448) |
| Degree | 2.728*** | 4.346*** | 2.255*** |
| | (0.574) | (1.901) | (0.542) |
| *Mother's education (ref: less than high school)* | | | |
| middle education | 1.404*** | 1.661** | 1.311* |
| | (0.172) | (0.369) | (0.189) |
| high education | 1.096 | 1.293 | 1.020 |
| | (0.136) | (0.287) | (0.151) |
| Age at marriage | 1.041*** | 1.083*** | 1.018 |
| | (0.0128) | (0.0217) | (0.0155) |
| Partner age at marriage | 1.020** | 1.017 | 1.022** |
| | (0.00868) | (0.0146) | (0.0104) |
| Premarital cohabitation | 0.887 | 0.788 | 0.944 |
| | (0.0784) | (0.116) | (0.101) |
| Premarital birth | 0.157*** | 0.118*** | 0.175*** |
| | (0.0322) | (0.0503) | (0.0410) |
| *Year of interview (ref: 2012)* | | | |
| 2004 | 1.142 | 1.275 | 1.083 |
| | (0.109) | (0.207) | (0.125) |
| 2006-2010 | 1.030 | 1.117 | 0.993 |
| | (0.126) | (0.231) | (0.147) |
| Observations | 11,347 | 11,347 | 11,347 |

Note: *p<0.05 **p<0.01 ***p<0.001
SE in parentheses

## 1.8 This thesis

In this chapter I intended to show that the use of ART and fertility treatments should be of interest for social scientists and explained why further investigation into the outcomes is needed. While there is some evidence about the birth-health outcomes of ART, studies of the subsequent development of the children and family relationships are scarcer and often provided mixed results. The effect of unsuccessful treatments for the family functioning has also been neglected by the research so far. The existing findings suggest that different mechanisms with possibly opposite consequences may be operating. The aim of this thesis is to fill the gap in the existing knowledge about the consequences of fertility treatments by considering a number of long-term outcomes for children and parents. I am especially interested in testing whether the advantageous socio-economic characteristics of couples using treatments might compensate or more than compensate the health or emotional risks linked to the use of fertility treatments, and lead to positive outcomes. Using representative samples of the UK and the US, in the previous section I showed that couples who undergo fertility treatments represent a selective sample, on average older, with higher education and income compared to the rest of the population. The effects that such characteristics might have on the development of children and family functioning following treatments need to be taken into account and will be a crucial point in the following chapters of this thesis.

In addition to this introductory chapter and the conclusion, this thesis consists of three substantive chapters that are of publishable quality. In Chapter two I use data from the UK MCS (wave 1-5) to study the cognitive development of children born after ART up to the age of 11. Cognitive ability is an important predictor of a number of outcomes in late childhood and adulthood and was shown to depend heavily on early environment

including parental background and parenting practices. The MCS includes cognitive assessments at each wave up to the age of 11, therefore it is possible to study the children's development in time. To this purpose, I apply growth curve models.

Chapter three builds directly on and expands the findings of chapter two, although as mentioned previously, now non-ART treatments are included too. Using the same data from the UK MCS wave 1-5, I study whether parents who conceived with the aid of some fertility treatments differ from natural parents in their parenting style and practices. I consider two measures at different points in time: a measure of parenting beliefs when the child is about 9 months old, and whether the mother reads every day to the child at the age of 3 and 5 years. Then I explore to what extent these measures of parenting are linked to the child's cognitive ability at the age of 11.

Chapter four is radically different from the two previous ones both in terms of setting, data, sample and outcomes considered. Using the US NSFG (2004-2013), I apply discrete-time event history analysis to study how the risk of divorce is affected by the use of fertility treatments in a sample of women at their first marriage. I focus on the role of demographic and socio-economic confounders, and how the outcome might depend on whether the treatment is successful or not.

It is important to highlight that, while the initial focus of the thesis was on ART only (IVF and ICSI), I then extended my interest to other kinds of fertility treatments. This is reflected by the different categories of treatments considered throughout the chapters. The initial focus on ART was due to a number of reasons. First of all, the introduction of ART represented an important innovation and became the only possible solution to extreme kinds of fertility problems or when other treatments have failed. Secondly, ART treatments are especially invasive for a woman's body and couples' life and therefore carry the risk of consequences for the wellbeing of children, individuals and

families. Third, the development of ART opened the door to the creation of family structures that would otherwise not have been possible and generated related debates about the family models to support. Last, these are the most expensive treatments and therefore the access is likely to be more selective compared to other treatments.

Chapter 2 is based on the hypothesis of a trade-off between potential health risks related to ART and the favorable socio-economic conditions of the parents. The possible health-related consequences are especially important in the case of ART, hence the focus on IVF and ICSI. After the results from chapter two gave me a first hint about the actual outcomes and the mechanisms likely to affect them, I realized that the use of other treatments might lead to similar mechanisms and would be worth including in the research. Already suggested in some studies and confirmed by my first results, the selection into treatments, both in terms of socio-economic conditions and the willingness to have a child emerged as the most relevant factor. Although less than ART, other fertility treatments are very expensive, and likely to be used by couples with strong willingness to become parents. I therefore decided to include other fertility treatments in Chapter three and four.

The inclusion of non-ART treatments adds to the existing studies, which have mainly focused on ART. Considering non-ART fertility treatments has advantages (for instance bigger sub-samples of treated individuals) but poses some challenges too. Collecting information about the use of non-ART fertility treatments across countries is less easy than it is for ART treatments, for which many countries have specific registers and information are available from the clinics that offer the treatments. This is the reason why the first sections of the thesis and especially the ones where I presented data on the use of fertility treatments rather focused on ART. Furthermore, including different kinds of treatments into the same category is likely to limit the

understanding about the specific mechanisms in act which might be different depending, for instance, on the length and intensity of the treatments, or whether donor gametes where used.

This research focuses on heterosexual couples, cohabiting (in Chapter 2 and 3) or married (in Chapter 2, 3 and 4). Despite the availability of treatments to single mothers and homosexual couples in the UK and the US, fertility treatments are still used predominately by heterosexual, married couples. Furthermore, I wanted to keep the samples as homogenous as possible, and decided to avoid comparing ART children with children born from single mothers (Chapter 2 and 3). The choice to exclude cohabiting couples from the analysis in Chapter 4 is also due to the lack of precise information about the formation and dissolution of non-marital unions in the NSFG.

# Chapter 2

# Assisted Reproductive Technology and children's cognitive development [4]

*Abstract*: The number of children born via Assisted Reproductive Technology (ART) has significantly increased over time, yet we know relatively little about the longer-term outcomes for these children.

The bulk of evidence shows that ART is linked to higher risks of adverse health outcomes at birth, and there is mixed evidence as to whether ART children perform better over time, with some studies showing higher cognitive development compared to naturally conceived children. We test whether these mixed findings are related to selective characteristics of ART parents. ART mothers are a selective group and on average older, better educated, and more likely to be employed and married. Using data from the first 5 waves of the UK Millennium Cohort Study (N=15,218), this paper compares the verbal cognitive development (as measured by the British Ability Scale) of children born via ART with naturally conceived children up to the age of 11 in 2000-1. Findings from growth curve models show that ART children perform higher than average, but that this effect disappears when controlling for parental background. Further, we show that differences in cognitive abilities between the two groups of children decrease with age and diminish completely by the age of 11.

[4] This study is co-authored by Melinda Mills. A modified version of this chapter has been published in Barbuscia, A and Mills, M. (2017). "Cognitive development in children up to age 11 years born after ART- a longitudinal cohort study" *Human Reproduction,* 32(7): 1482-1488

## 2.1 Introduction

Since the first 'test-tube baby' was born in 1978, more than 5 million children have been conceived worldwide with the aid of Assisted Reproductive Technologies (ART), with the number of couples seeking ART constantly increasing (Calhaz-Jorge et al., 2016). The term ART encompasses infertility treatments in which both the sperm and oocytes (eggs) are handled outside of the woman's body to establish a pregnancy. The two most common variants of treatment are In Vitro Fertilisation (IVF) and Introcytoplasmatic Sperm Injection (ICSI).

As many ART children are now approaching adulthood and in light of heated debates about ART regulation (Präg and Mills, 2015), there is a growing urgency to understand whether ART children differ from their naturally conceived peers. The wellbeing of children and families born with the aid of ART has primarily focussed on negative outcomes on children's health (Van Balen, 1998; Hart and Norman, 2013a: Hansen et al., 2013) or how arduous infertility experiences and treatments might influence parent's relationship with their child (Bernstein, 1990). Infertility and conception via ART have been associated with elevated anxiety, delayed mother-infant attachment, diminished maternal confidence, overprotecting parenting and idealised expectations (Bernstein, 1990; Gibson et al., 2000; Hammarberg et al., 2008). Others have underlined the risks of growing up in what has been defined as new family forms (Golombok, 2015), particularly in the case of gamete donations, where the child might not be genetically related to one or both parents (Golombok et al., 1995).

Existing evidence examining ART offspring has shown higher risks of adverse birth outcomes, such as low birth weight, preterm delivery and birth defects (Hansen et al., 2013; Hart and Norman, 2013a). Higher risks of poor health at birth are partly related to the higher incidence of multiple births, a historical consequence of ART (Fauser et

al., 2014; Pison et al., 2016). Despite a consistent decrease in the last decades, the twinning rate is still dramatically higher for ART births compared to natural conceptions (NC) (Prag and Mills, 2015; Calhaz-Jorge et al., 2016). A series of systematic reviews have concluded, however, that there are no developmental differences between ART and NC offspring once perinatal problems such as preterm birth, low birthweight and birth defects are taken into account (Wilson et al., 2011; Pandey et al., 2012; Hansen et al., 2013).

Others have likewise found no differences in the behavioural and intellectual development (Ponjaert-Kristoffersen et al., 2004; Leunens et al., 2008; Balayla et al., 2017), mental health (Punamaki et al., 2016), or in academic performances of adolescents (Spangmose et al., 2017). A few studies have even found higher socio-emotional and cognitive development at the age of 3 and 5 (Carson et al., 2009; 2011; Mains et al., 2011).

Research to date has generally examined development at different age groups in isolation, rarely scrutinizing how differences in cognitive development in ART versus NC children develop over time. Cognitive ability during childhood has been shown to be a pivotal determinant of several adolescent and adult outcomes such as educational attainment, earnings, but also crime, participation in risky behaviour, depression and teenage parenthood (Feinstein, 2003; Heckman, 2007). These studies have underlined the importance of looking at progression across different stages of childhood rather than one point in time (Heckman, 2006; Ermisch, 2008; Cunha et al., 2010). Some studies have suggested that infertility and conception via ART may have stronger detrimental impacts in early childhood, due to elevated anxiety, delayed mother-infant attachment, diminished maternal confidence and overprotecting parenting (Bernstein, 1990; Gibson et al., 2000; Hammerberg et al., 2008). Others have argued that perinatal problems may

have longer-term negative effects on children's development at older ages, from health conditions to educational attainment and income (Black et al., 2004; Myrskyla et al., 2012).

Recent studies have argued that findings may be confounded by the characteristics of ART parents (Golombok, 2015; Spangmose et al., 2017), yet few have attempted to empirically investigate this selectivity. There is consensus that the early formation of children's cognitive ability is positively related to older, highly educated and high socio-economic status parents (Feinstein, 2003; Liu et al., 2011; Goisis, 2013; Myrskyla et al., 2013). Since ART treatments are often costly, access is frequently related to individuals who are able to bear these treatment costs (Chambers et al., 2013: 2014; Präg and Mills, 2017).

In this paper, growth curve models are applied on data from the UK Millennium Cohort Study (MCS) to examine the verbal cognitive development up to the age of 11 of a cohort of children born in 2000-2001 in the UK. A key aim is to compare the cognitive ability of children conceived with the aid of IVF or ICSI to naturally conceived children and unpack the factors affect this development. The longitudinal structure of the data allows us to observe how different factors affect the cognitive ability of children across different ages. A longitudinal approach is particularly important since different mechanisms determine whether eventual variation in cognitive ability will widen, narrow or remain constant over time.

We hypothesize that ART children differ consistently from NC children both in terms of birth outcomes and parental demographic and socio-economic background. We expect ART parents to be a selective population in terms of age and socio-economic characteristics and that this will be linked with higher cognitive development of ART

compared to NC children, despite birth outcomes that might per-se be related to worse development.

## 2.2 Health and cognitive outcomes of ART offspring

### 2.2.1 Health

Concerns about the health conditions of ART children have focussed on parent's health, age and the treatment itself (e.g. Hansen et al., 2013). This in turn led to a variety of studies examining the medical outcomes of children born with the aid of ART (see Hart and Norman, 2013a for a review). Others have stressed effects related to the experience of infertility and stressful ART treatments on parents' wellbeing and the development of their relationship with the child (Bernstein, 1990; Van Balen, 1998; Colpin, 2002), and found negative influences on the psychological development of children (Sutcliffe and Ludwig, 2007; Svahn et al., 2015)

There is consistent evidence that ART is linked to adverse health outcomes at birth. ART offspring have a higher risk to be born prematurely, lower birth weight (LBW) and more birth defects (Van Balen, 1998; Romundstad et al., 2008; Wilson et al., 2011; Hansen et al., 2013; Prag and Mills, 2015). This is partly due to the historically high proportion of multiple births among ART births, considered as a main risk of ART (Fauser et al., 2011 et al., 2013; Wilson et al. 2011; Golombock, 2015; Pison et al., 2016). Others explored potential explanations for adverse outcomes at birth after ART. Ovarian stimulation, usually the first step of infertility treatment, has been linked to lower birth weight regardless of ART (Kandapalli and Perales-Puchalt 2013). An analysis of singletons from mothers who conceived both with and without ART showed that the incidence of low birth weight was connected to the underlying infertility rather than the treatment itself (Romundstad et al., 2008). Such results suggest the existence

of higher risks of poor health outcomes at birth after ART in general. In light of the reviewed literature, our first hypothesis about the outcomes of ART birth is that a higher risk of poor health outcomes at birth, such as multiple birth, pre-term birth and low birthweight will be observed among ART children, outcomes that per-se likely may be linked to lower cognitive skills.

*H1.a: a higher risk of adverse outcomes at birth will be observed among ART births compared to NC children, such as multiple births, low birthweight and pre-term delivery.*

Evidence about the development of ART children after the perinatal period is less consistent. Most existing research showed no significant differences in physical growth and development between ART children versus NC children (Van Balen, 1998; Wilson et al., 2011; Pandey et al., 2012; Hansen et al., 2013). Some found a slight increase in the risk of cerebral palsy in children born from IVF, but the effect disappeared after adjusting for low birth-weight and pre-term birth (Hart and Norman, 2009a). Although there is some evidence that ART mothers might be more anxious about the health of their children and show lower levels of self-confidence in parenting ability (Bernstein, 1990; Gibson et al, 2000; Hammarberg et al., 2008), this does not seem to be detrimental to the psychological development of the child. Multiple investigations have shown that ART children have high psychological wellbeing (Ilioi and Golombock, 2014; Wagenaar et al., 2008a), and no differences in the incidence of developmental disorders (Wagenaar et al., 2008; Hart and Norman 2013a), nor in behaviour and socio-emotional functioning compared to control groups (Hart and Norman, 2013b).

### 2.2.2 Cognitive development

Studies about the cognitive ability and educational attainment of ART children have found no differences in the cognitive and language development of 2-years-old (Balayla

et al., 2017) and in the intellectual development of 5-yeard-old (Ponjaert-Kristoffersen et al., 2005), verbal and IQ cognitive ability in 8-10 years-old (Leunens et al., 2008) or in academic performance of adolescents (Spangmose et al., 2017). Some even found that children born after IVF or ICSI have a better cognitive development compared to NC children (Mains et al, 2010; Carson et al., 2011). A study among the 20 first Australian IVF infants showed that they developed faster than other children (Lancaster, 1987). The authors suggest, however, that the effect should not be attributed to the treatment itself, but rather to the specific characteristics of the initial parents who were eligible for such techniques at the time (i.e., highly educated and well-motivated parents). Similarly, Mains and colleagues (2010) found that IVF offspring scored higher on standardised tests than a group of matched peers in Iowa. They also showed that among other factors, maternal age, parental education, child's BMI and parents' divorce affected the score.

A recent study by Carson and colleagues (2011) examined the effect of pregnancy planning, fertility and ART on cognitive outcomes on children respectively at age 3 and 5. Their findings show that children conceived through ART perform better in cognitive tests related to verbal skills than planned children (children born as the result of what was defined an intended pregnancy by their parents), while ART children have lower scores in non-verbal tests and spatial ability tests. The authors suggest that this might be due to the generally advantageous socio-economic position of couples undertaking ART, which might have the greatest effect on language skills. The authors do not, however, explore the impact of parental background and investment, and only consider cognitive scores at two different points in time, at age 3 and 5. Therefore the ability of children beyond age 5 is not examined, which is crucial, since the impact of adverse birth outcomes may linger only in early ages.

## 2.3 Parental background and children development

Cognitive abilities are developed in the first years of life and depend heavily on parental background and investments (Heckman, 2006; Cunha and Heckman, 2007; Cunha et al., 2010). Parental socio-economic characteristics were shown to lead to an early divergence in the amount of children's cognitive skills and explain a large portion of the socio-economic differences in educational outcomes in adulthood (Feinstein, 2003; Ermisch, 2008; Cunha et al., 2010).

The impact of parental age on children's outcomes has been widely explored in light of the continuous trend of fertility postponement in recent decades (Mills et al., 2011). There is general consensus of the negative impact of advanced parental age on the health outcomes of new-born children, but conversely also the positive effects of higher educational level and social status usually linked to older ages (Myrskyla et al., 2013; Goisis, 2013; Liu et al., 2011; Grundy and Foverskov, 2016). Both very young and advanced maternal age were shown to have negative effects on health at birth: higher risk of miscarriages, stillbirth and infant mortality have been observed among both teenage and older mothers (Myrskyla et al., 2012), with similar findings recently shown for schizophrenia. The link between parental age and intelligence is less clear, but several studies showed that parental age is often connected to better cognitive development and IQ scores (Liu et al., 2011). This is usually explained by the relationship with socioeconomic status, which has an influence on the child's environment (readiness for parenthood, energy, networks, preferences) and higher investment in children (Bradley and Corwyn, 2002). Goisis (2013) demonstrates that higher social status associated with fertility postponement compensates for increased risks of health complications that accompany later childbearing. In what she defines as

the 'diverging destinies' framework, MacLanahan (2004) likewise argues that the trends associated with the second demographic transition have led to greater disparities in children's resources, with higher educated parents gaining parental resources by delaying childbearing.

Parenting style is another important channel through which parental background impacts the child development (Gauthier et al., 2004; Brooks-Gunn and Markman, 2005; Ermisch, 2008). A consistent amount of sociological, demographic and economic studies has shown that parents differ consistently in their approach to parenting depending on age, educational level and socio-economic status (Lareau, 2002; Brooks-Gunn and Markman, 2005) and this has an important effect on children's health and cognitive and non-cognitive development (Ermisch, 2008; Cunha et al., 2010).

There is consensus that the formation of children's cognitive ability is positively related to older, highly educated and high SES parents (Goisis, 2013; Myrskyla et al., 2013). This leads us to formulate the following hypotheses about the impact of parental background on ART offspring. First of all, we hypothesize that couples who undertook ART in our sample will differ from those who conceived naturally on several grounds. This is due to the known older profile of ART couples and to the high costs of the treatment (Chambers et al., 2014; Chambers et al., 2013). In line with most literature, we focus in particular on maternal characteristics as factors affecting the children's cognitive skills.

*H1.b: Compared to mothers who conceive their child naturally, ART mothers represent a selective group, characterized by older age, high educational level and higher probability of being in employment.*

In line with literature that argues that older and high SES mothers override possible negative effects of poorer health, we hypothesize that on average, ART children will have higher cognitive ability at the age of 3.

*H2.a: ART birth will be associated with higher cognitive sub-test scores at the age of 3 compared to NC children*.

However, we expect the association between ART and cognitive ability to be mediated by maternal age and SES, which override possible negative effects of outcomes at birth.

*H2.b: If differences in demographic and socioeconomic characteristics between ART and NC mothers exist, the selective profile of ART mothers will be associated with a better cognitive performance of ART children at the age of 3, despite the possible negative effects of birth outcomes.*

As the educational and socio-economic gradient in children's cognitive skills was shown as persistent and evening widening with age, if the better cognitive performance at early ages is linked to the maternal socio-economic characteristics, we anticipate the disparity to remain constant or even to widen over time. This leads to our last hypothesis:

*H3: If there is a cognitive advantage experienced by ART children at early ages due to specific maternal characteristics (H2a and b), this will lead to maintained differences or even a divergence in higher cognitive ability into higher age groups.*

## 2.4 Data

The Millennium Cohort Study (MCS) is a nationally representative prospective cohort study of 18,552 families across the UK. A random two-stage sample of all infants born in 2000-2001 and resident in the UK at 9 months was drawn from the Department of

Social Security Child Benefit Registers. Ethnically diverse and disadvantaged areas were oversampled to ensure adequate representation. Baseline interviews captured socio-demographic and health information, including questions about pregnancy and fertility treatment. Follow-up surveys were conducted in 2003, 2005, 2007 and 2012. The surveys cover different topics such as health, development, behaviour, wellbeing, parenting in a detailed way, and information about their siblings and parents is also collected. In our sample we only consider children born from either married or cohabiting parents, to avoid comparisons with lone mothers. We consider children who have information available for at least one of the waves after the first one, which leads to a final sample of 15,218 children (14,816 families). Information about cognitive scores is available for 11,799 children at wave 2, for 12,125 children at wave 3, for 10,959 children at wave 4 and for 10,643. Analyses were also performed including only children where information is available for all waves (N=8,298). The results of the different specifications are virtually identical with the exceptions of a loss of statistical significance.

## 2.5 Measurements

### 2.5.1 Cognitive abilities

Children's cognitive development is assessed with three sub scales of the British Ability Scales, second edition (BAS II). The standardised tests undertaken by the cohort members to assess their cognitive skills and educational attainment is a particularly valuable element of the Millennium Cohort Study (Connelly, 2013). The BAS II is a battery of twelve core sub-tests of cognitive ability and educational achievement, suitable for children aged from two years and six months to seventeen years and eleven months. It has demonstrated sound validity and test-retest reliability (Elliott et al.,

1997). In the current study, standardised scores of the BAS II sub-tests measuring verbal ability are considered. At age 3 and 5 (wave 2 and 3), MCS members completed the *naming vocabulary* component. At age 7 (wave 4), verbal cognitive abilities are assessed through the *word reading* test and at age 11 (wave 5) through a v*erbal similarity* test. The BAS II sub-tests were designed to be age-specific measures of verbal ability and are comparable over time (Connelly, 2013).

To remedy the problem of comparability of test scores across different sets of items, raw scores were converted into standardised T-scores. These were also adjusted to take into account the different ages of the MCS cohort members, a particularly important feature since MCS cohort members are born throughout the year and might differ in their ability score for this reason (Connelly, 2013). Standardised scores indicate how a child's cognitive abilities have developed relative to his/her peers (Carson et al., 2001). These are provided in the MCS as T-scores with mean 50 and SD 10. The exception is the *word reading* test at wave 4, for which standardised, but not T-scores are provided. These are computed in an identical manner, but do not have the same mean and SD. To construct the BAS verbal scores and allow us to examine variation over time, we re-standardise the scored based on the mean value and SD in our final sample. The re-standardized scores have all mean = 0 and SD=1.

### 2.5.2 Explanatory variables

The main explanatory variable in our study is whether the child was conceived with the aid of ART. This includes the main kinds of fertility treatments: In Vitro Fertilisation (IVF) and Intracytoplasmatic Sperm injection (ICSI). In the baseline interview, 186 mothers declared to have conceived after ART (125 IVF and 61 ICSI). Taking into account multiple births, the number of children conceived with the aid of ART is 214.

ART offspring are captured with a binary variable (*ART*) taking the value of 1 if the child was conceived with the aid of one of the two techniques, and 0 otherwise.

Three sets of confounders are included: child's characteristics at birth, parental age and health characteristics and parental socioeconomic background. Basic demographic characteristics of the child include gender, age and whether she/he was part of a multiple birth (dummy variable *multiple*). A first set of explanatory variables concerns the outcomes at birth: whether the child had a low birth weight (*LBW* taking the value of 1 if the child's weight is lower than 2.5 Kg), and parity (*first born*). A variable assessing whether the mother experienced any problems during pregnancy was also included. All information about pregnancy outcomes were reported by the mother in the first wave. The second set includes the age of the mother at childbirth and parental socioeconomic characteristics, including mother's educational level (*high education* if the mother has a degree or higher educational level) and employment status (*employed*) and a measure of the socio-economic status of the head of the household (*high SES,* based on the NS SEC classification). Controls for partnership status (*married*), the number of siblings, whether the mother breastfed the child, whether the pregnancy was planned (*planned*) and two measures of economic condition were also included: whether the household's income is among the UK first quintile, and a measure of deprivation (*OECD 60%* if the household income is lower than the OECD 60% median). All individual controls are time-invariant factors and the information is provided by parents' in the first wave.

## 2.6 Statistical Methods

Two-tailed t-tests test whether significant differences exist between ART and NC children and their families. In the same way, average BAS cognitive scores of ART and

NC children are compared as measured in the different waves. The standardised cognitive sub-test scores provided by the MCS are centred around a mean of 50 and standard deviation of 10, with the exception of wave 4 discussed previously

Latent growth curve models are used to examine the individual cognitive trajectories of children, which allow us to study the effect of ART, parental characteristics and health outcomes at birth both on the baseline level of cognitive ability (age 3) and on its growth rate. These models are special case of random-coefficient models where the coefficient of time is allowed to randomly vary between subjects and is optimal to examine inter-individual differences in intra-individual change with longitudinal data (Rabe, 2007). Observation can be unbalanced, in other words, we are able to include children for whom the observation is missing at one time point. Specifications of the same models run on the sample including only balanced data are available in the Appendix (Table A4), however results are virtually identical. Clustered robust standard errors were included in all the models to account for the high prevalence of multiple births among ART births.

A comparison of model fits between different specifications of the growth curve models (Akaike IC-AIC- and Bayesian IC -BIC- criteria, Table A1, Appendix) determines that a quadratic random effect model is the most appropriate time metric. Once the optimal baseline growth curve model has been established, we introduce predictors. The different sets of confounders are included in the model one at a time, and the effect both on the initial cognitive level and on the growth rate (slope) are studied. Here the initial cognitive level refers to the first observation, when the children are 3 years old. Our main interest lies in the coefficients of ART, showing the effect of ART birth both on the baseline (cognitive ability at age 3) and on the growth slope.

A general specification of our model is thus:

(1) $\mathrm{COG}_{ij} = \alpha + \beta 1 * ART_i + \beta 2 * ART_i * T_j + \gamma 1 * T_j + \gamma 2 * T_j^2 + \delta 1 * X_i + \delta 2 * X_i * T_j + \mu_{ij} + \mu 2_{ij} * T_j + \varepsilon_i$

where $\beta 1$ is the effect of ART on the initial cognitive abilities (at age 3), $\beta 2$ is the effect of ART on the growth rate of cognitive skills, $\gamma 1$ and $\gamma 2$ are the linear and quadratic fixed effects of time and $\delta 1$ and $\delta 2$ are the random intercept and slope. X is a vector including individual controls. Different sets of control variables include first basic demographic controls, then characteristics at birth and finally parental background characteristics. All predictors included in the models are time-invariant and the characteristics were measured at the first wave. The coefficients predict the random component of the growth trajectories to determine which variables are associated with individual showing higher or lower intercepts or steeper versus flatter slopes. All models include robust clustered standard errors to account for the high number of multiple births among ART births.

## 2.7 Results

### 2.7.1 Health outcomes at birth and Parental background

Descriptive statistics (Table 2.1) illustrate consistent differences between ART and NC children and most notably higher prevalence of multiple births among ART births (more than one third of ART births, compared to the 2% of NC births), which was a central consequence of ART in 2000-1. ART children also have a higher probability of LBW with ART mothers more likely to report problems during pregnancy.

The demographic and socio-economic background of parents who conceived via ART differ markedly from parents who conceived naturally. ART mothers and fathers are on average 4 and 5 years older, respectively. ART parents have a higher income and higher probability of belonging to a high socio-economic class on average. ART

mothers are more likely to have a high educational level and to be employed. All differences are consistent and statistically significant.

These descriptive results show that ART children differ from their naturally conceived peers in terms of outcomes at birth and parental demographic and socio-economic background, therefore giving empirical support to hypotheses H1.a and H1.b. The selective profile of ART mothers and fathers being older, highly educated and higher socioeconomic status, suggests it is worthwhile to study the development of ART children considering the particular family conditions that they are likely to experience.

### 2.7.2 Cognitive development age 3 to 11

The difference in cognitive scores at different time points (Table 2.2) suggests that, without controlling for any other characteristics, children born with the aid of ART tend to perform better in the cognitive tests than NC children. The difference is consistent and statistically significant at waves 2 and 3 (around 3 points, which is 1/3 of a SD), but starts decreasing at wave 4, and is not significant at wave 5. This effect is illustrated in Figure 1, which displays the average cognitive development from age 3 to age 11 of ART versus NC children. A convergent pattern emerges, with children born with the aid of ART showing significantly higher cognitive levels up to age 5, but then converging to very similar level as NC children when they are 11 years old.

Table 2.3 shows the results of the growth curve models where the dependent variable is the standardised cognitive score of the children and the sets of control variables are included consecutively. Robust clustered standard errors account for the high number of twins and triplets among ART births. The coefficients of the variables represent their impact on the initial cognitive level at age 3 and the coefficients of the interactions

between regressors and time represent their impact on the growth rate. In line with what previously observed, being born with the aid of ART is significantly associated with higher cognitive skills at age 3 in the uncontrolled model (coeff. 0.466, $p<0.001$, Model 5), which would provide support to H2.a. The effect of ART on the cognitive baseline decreases in size but persists when controls for multiple birth, low birth weight and parity are included (Model 6). Both the magnitude and the significance of the effect decrease consistently in Model 7, when controls for parental background are added, suggesting that most of the 'ART effect' is driven by parental characteristics.

Conversely, the effect of ART on the growth rate is slightly negative and not significant. This is in line with the convergence in ability already observed in the first part of our analysis but contrary to our expectations (*H3*) and to what predicted by former findings of persistent or diverging differences in children's cognitive performance by parental background. Both results point to other factors connected to a better cognitive development of ART children that might be specific to the first years of life.

### 2.7.3 Confounding effect of parental characteristics

The specific characteristics associated with ART parents show a strong and positive association with the child's cognitive skills at age 3. High education and employment status of the mother have the strongest association with children's cognitive ability together with a high socio-economic status of the head of the household. The age of the mother is also positively related to children's cognitive scores, but the effect is considerably smaller. This result provides empirical evidence of previous speculations that there is a positive effect of older, highly educated and high SES mothers on the children's cognitive ability and confirms that the effect is already strong in the first

years of life. It also supports our hypothesis that the overall better cognitive performance of ART children is mediated by their parents' selective background, which override possible negative effects associated to outcomes at birth (H2.b).

The coefficients of the other control variables add further insights into the impact of different factors on the children's verbal cognitive development in time. Controlling for other outcomes at birth and/or for parental characteristics, being born as a result of a multiple pregnancy does not have any negative impact on cognitive skills. Being the first born has a strong and positive impact on the initial level of cognitive skills, but the coefficient of the interaction with time is slightly negative, suggesting that the differences decrease with the age of the children. LBW has the expected negative effect on the baseline cognitive level, but the effect is slightly positive on the growth rate, suggesting again a declining effect.

## 2.8 Conclusions and discussion

Research has provided very mixed and often contradictory findings regarding whether children conceived with the aid of ART (IVF or ICSI) have lower, similar or better cognitive outcomes in comparison to their naturally conceived (NC) counterparts. We used a large sample representative of the UK population that included children born with and without the aid of ART to examine their cognitive development across 5 measurement periods from age 3 to 11. Our results found a positive association between conception with the aid of ART and children's verbal cognitive abilities as measured by the BAS scale. The effect was strong when cognitive abilities were first measured at the age of 3 and 5, but consistently decreased over time and virtually disappeared by age 11. The comparability of the measures of verbal cognitive ability over time rules

out the possibility that the "decline" in cognitive ability of ART compared to NC children might be due to the different domains assessed by the subtests.

These results demonstrate the importance of examining longitudinal data and the trajectory of children's cognitive development across various ages as opposed to taking one 'snap-shot' in time, which has been the prominent approach to date. Results suggest that the concerns about a possible negative effect of ART on children's cognitive development are not straightforward and need to be examined in an entire trajectory. Results likewise demonstrate that ART conceived children may even have better cognitive outcomes at very early ages, but also that parental background and thus the environment and resources that children are exposed to, particularly in the early years of life are pivotal for development. The positive 'ART effect' appears to be mainly attributed to the selective characteristics of ART parents, who are on average older, better educated and have higher socio-economic status. This would support the importance of environmental conditions especially for the development of children's early cognitive skills, with differences in cognitive abilities linked to parental characteristics already emerging before the age of 3.

The importance of parents' socio-economic background on the children's development highlights the difference in opportunity experienced by children in the UK. ART children represent a specific subsample and although they are exposed to higher risk of adverse health outcomes at birth, and more likely to be multiple births (Hansen, 2013; Hart and Norman, 2013a; Pison et al., 2016), which has been linked to poorer cognitive development both in previous studies and in our analyses, the positive effect of parental background effectively 'overrides' these negative effects, leading to an overall to a better performance. Our findings echo studies that have found similar positive effects of older maternal age on offspring's outcomes (McLanahan, 2004;

Goises and Sigle-Rushton, 2014). The better cognitive performance of ART children until age of 5 is in line with previous literature (Carson et al., 2009; 2011). The convergence in the cognitive ability of ART and NC children after the age of 5 and variation in this trajectory, however, is new and takes us beyond previous findings. Until now, previous research demonstrated that differences in cognitive ability emerging at early ages linked to parental characteristics largely remains stable or even diverge over time (Ermisch and Francesconi, 2011, Feinstein, 2015).

The current study likewise suggests that there might be some key mechanisms affecting the cognitive development of ART children that are specifically related to their first years of life. One interpretation is that parents may develop specific ways of parenting and relationships with these children as they perceive their ART children to be more fragile because of the poorer health outcomes and the long and complex process that lead to their birth (Bernstein, 1990; Gibson, 2000; Carson et al., 2001). Such perceptions could lead to particularly attentive ways of parenting when the child is very young, which might change as the child grows up healthy and for example, starts going to school. Once the child is not perceived as particularly fragile, parents might develop alternative ways of parenting that are simply in line with their socio-economic background, linking to a smaller difference in the performance of the two groups of children. The strong need and considerable psychological and financial efforts to have an ART child undoubtedly also contribute to the differences and higher attention in parenting.

## 2.9 Strengths and limitations

The study also suffers from some important limitations. First, the sample size of the cohort of ART children is not ideal and consistently smaller than the one of NC children. Furthermore, it does not allow us to distinguish between the different kinds of ART, which has been highlighted in previous studies (Knoester et al., 2008; Goldbeck et al. 2009; Bonduelle et al. 2003; Ponjaert-Kristoffersen et al., 2005). Another limitation is that we did not directly explore the role of parenting in the link between parental background and ART and children's development, which would need a dedicated separate study to be fully addressed.

Nevertheless, the results of this study provide an important contribution to the existing knowledge about the outcomes of ART and add a unique contribution to the literature exploring the impact of ART and early life conditions on the cognitive development of children. Information about cognitive skills at different points in time and the rich information about parental background permitted us to explore the effect of different factors on the development of ART children over time as opposed to single snap-shots in time. The dynamic approach is particularly important as the effects of birth after ART are likely to differ depending on the age of the child. The inclusion of twins and triplets in our analyses adds to the previous literature, which usually excluded multiple births or examined them separately from singletons. Considering the high prevalence of multiple births across ART births, excluding twins and triplets can lead to partial results and a consistent loss of information.

The stronger performance of ART children despite the higher prevalence of adverse early health outcomes would support the idea that children growing up in certain SES conditions and with parents that are committed and have the resources to have children overrides possible adverse health outcomes at birth.

**Table 2.1: Parental Characteristics and Outcomes at Birth, Naturally Conceived (NC) and ART births**

| | *NC* | | *ART* | |
|---|---|---|---|---|
| *Parental Characteristics (Family level)* | Mean | SE | Mean | SE |
| Mother's age | 29.12 | 0.045 | 33.86 *** | 0.346 |
| Father's age | 30.92 | 0.069 | 36.07 *** | 0.496 |
| Married parents (%) | 70.59 | 0.003 | 92.21 *** | 0.020 |
| Income (first UK quintile, %) | 18.87 | 0.003 | 37.12 *** | 0.037 |
| Income (below OECD 60%) | 27.08 | 0.003 | 10.17 *** | 0.023 |
| High SES (managerial or professional occupation of the head of household, %) | 30.12 | 0.003 | 47.30 *** | 0.038 |
| Mother with degree or equivalent education (%) | 38.09 | 0.003 | 44.91 * | 0.038 |
| Mother employed (%) | 47.63 | 0.004 | 58.68 ** | 0.038 |
| Mother housewife (%) | 49.34 | 0.004 | 34.73 *** | 0.036 |
| Ever breastfed (%) | 70.86 | 0.003 | 83.83*** | 0.028 |
| English first language at home (%) | 84.05 | 0.003 | 91.10 * | 0.022 |
| Problems during pregnancy (%) | 37.77 | 0.003 | 46.10 * | 0.038 |
| *Birth outcomes* | | | | |
| First born (%) | 39.47 | 0.004 | 75.44 *** | 0.334 |
| Twin (%) | 1.20 | 0.000 | 22.15 *** | 0.0322 |
| Triplet (%) | 0.01 | 0.000 | 1.32*** | 0.013 |
| Number of siblings | 0.97 | 0.008 | 0.30 *** | 0.046 |
| N | 14816 | | 167 | |
| Low Birth Weight (< 2.5 Kg, %) | 5.25 | 0.001 | 19.81 *** | 0.027 |
| N | 15004 | | 214 | |

Notes: The stars indicate whether the difference is significant according to a two-tailed T-test. Source: MCS, wave 1, authors' own calculations

**Table 2.2: Standardised ability scores of BAS tests measuring verbal ability at each wave, for naturally conceived and ART-children**

| **BAS Verbal Cognitive test score** | ***NC*** | ***N*** | ***ART*** | ***N*** | ***Difference*** |
|---|---|---|---|---|---|
| BAS Naming Vocabulary (S2) | 50.03 | 11640 | 52.88 | 168 | -2.85*** |
| BAS Naming Vocabulary (S3) | 54.51 | 11955 | 57.90 | 180 | -3.38*** |
| BAS Word Reading (S4) | 112.52 | 10802 | 116.26 | 157 | -3.83** |
| BAS Verbal Similarity | 59.14 | 10496 | 60.08 | 150 | -0.94 |

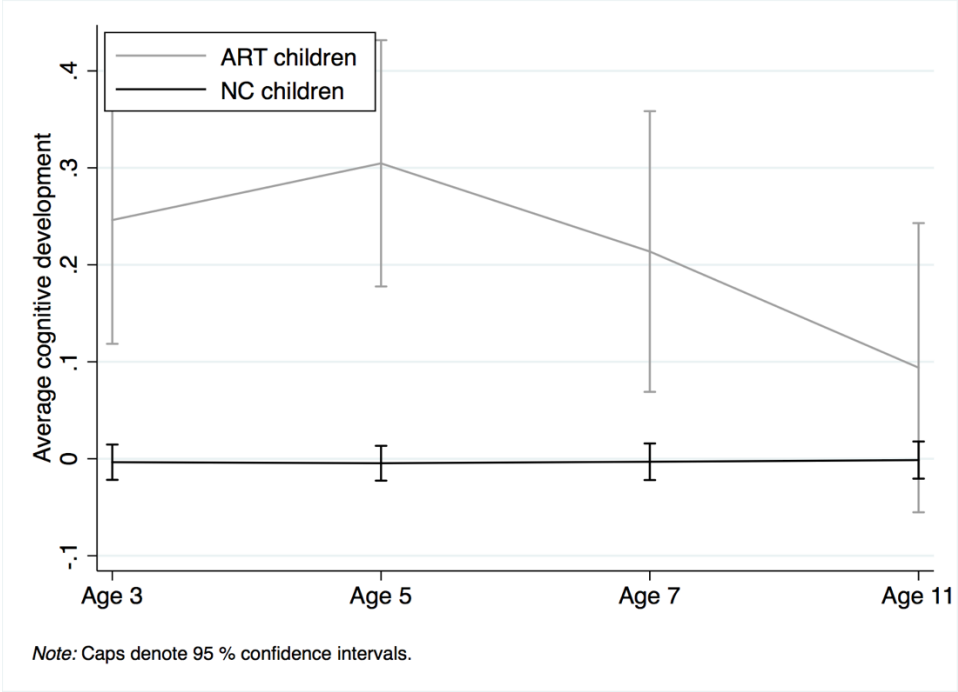
Notes: The stars indicate whether the difference is significant according to a two-tailed T-test.
Source: MCS, wave 2-5, authors' own calculations

**Table 2.3: Results of growth curve models on BAS Verbal cognitive test standardised scores, waves 2-5 (Age 3- 11)**

| | *Model (5)* | *Model (6)* | *Model (7)* |
|---|---|---|---|
| ART | 0.466*** (0.12) | 0.343** (0.12) | 0.088 (0.12) |
| ART*time | -0.0537 (0.030) | -0.0372 (0.031) | -0.0257 (0.031) |
| *Birth outcomes* | | | |
| Multiple birth | -0.210 * (0.11) | -0.0743 (0.11) | -0.139(0.11) |
| Multiple birth*time | 0.030 (0.027) | 0.0104 (0.028) | 0.0214 (0.027) |
| First born | | 0.397 *** (0.030) | 0.120** (0.045) |
| First born*time | | -0.0422*** (0.007) | -0.0264* (0.012) |
| LBW | | -0.479*** (0.074) | -0.323*** (0.072) |
| LBW*time | | 0.0701*** (0.018) | 0.0505*** (0.019) |
| *Parental characteristics* | | | |
| Mother's age | | | 0.0259*** (0.003) |
| Mother's age*time | | | -0.002 ** (0.032) |
| Mother's high education | | | 0.262 *** (0.041) |
| Mother's high educ*time | | | 0.002 (0.001) |
| Employed mother | | | 0.291*** (0.030) |
| Employed mother*time | | | -0.043*** (0.008) |
| High SES | | | 0.165*** (0.036) |
| High SES*time | | | -0.0106 ** (0.0095) |
| N | 45,372 | 45,372 | 45,372 |

Notes: * p < 0.05 **p < 0.01 ***p<0.001, robust clustered SE in parentheses
All models include controls for age and gender of the child. Model (6) includes controls for general problems experienced during pregnancy and whether the pregnancy was planned. Model (7) includes controls about the partnership status of parents, household income, whether the mother breast-fed the child, number of siblings.

**Figure 2.1: Average cognitive development of children age 3-11**




*Note:* Caps denote 95 % confidence intervals.

# Appendix

**Table 2.4: Model fits comparison:**

| *Model* | *Observations* | *LL* | *AIC* | *BIC* |
|---|---|---|---|---|
| *(1) Empty* | 44182 | -173077.6 | 346161.2 | 346187.2 |
| *(2) Linear* | 44182 | -171908.6 | 343827.2 | 343870.7 |
| *(3) Quadratic fixed, linear random time effects* | 44182 | -171699.8 | 343411.7 | 343463.9 |
| *(5) Quadratic fixed, quadratic random time effects* | 44182 | -171699.8 | 343405.7 | 343431.8 |

Notes: model (1) is the random intercept-only model. Model (2) includes a linear random slope for the time; Model (3) includes a fixed quadratic effect for time; Model (4) includes a random quadratic effect for time.
AIC and BIC are measure "deviance" statistics: smaller values are to be preferred.
AIC = -2LL + 2(n parameters)
BIC = -2LL + log(N)(n parameters)

**Table 2.5: Intra-class correlation coefficient**

| *COG* | *ICC* | *[95% Conf. Interval]* | |
|---|---|---|---|
| *Individual* | .2717323 | .2595759 | .2840454 |
| *Average* | .5987941 | .5837338 | .6134438 |

Random effects: id  Number of targets = 7475

Fixed effects: time  Number of raters = 4

F test that ICC=0.00: F(7474.0, 22422.0) = 2.49  Prob > F = 0.000

Note: ICCs estimate correlations between individual measurements and between average measurements made on the same target.

**Table 2.6: Growth curve models on BAS verbal ability scores, wave 2-5**

| | ***Model (1)*** | ***Model (2)*** | ***Model (3)*** | ***Model (4)*** | ***Model (5)*** | ***Model (6)*** | ***Model (7)*** |
|---|---|---|---|---|---|---|---|
| *var(cons)* | 38.5972 | 40.3748 | 41.0148 | 41.0148 | 40.86232 | 38.67529 | 27.03729 |
| *var(time)* | | 2.57E-13 | 2.81E-13 | 1.07E-17 | 9.29E-17 | 7.88E-16 | 5.91E-12 |
| *var(time2)* | | | | 1.64E-20 | 1.45E-19 | 9.83E-21 | 5.83E-14 |
| *var(residuals)* | 119.0699 | 110.881 | 109.301 | 109.3013 | 108.9374 | 109.1357 | 108.0581 |

Model (1): Empty model

Model (2): Linear random intercept model

Model (3): Quadratic fixed linear random intercept model

Model (4): Quadratic random intercept model

Model (5): ART and basic demographic predictors model

Model (6): ART, demographic and outcomes at birth predictors

Model (7): ART, demographic, outcomes at birth and parental background predictors

**Table 2.7: Results of growth curve models on BAS Verbal cognitive test standardised scores, waves 2-5 (Age 3- 11), balanced sample**

| | ***Model (5)*** | ***Model (6)*** | ***Model (7)*** |
|---|---|---|---|
| *ART* | 0.386** (0.13) | 0.193* (0.12) | 0.058 (0.13) |
| *ART*time* | -0.0600 (0.031) | -0.0447 (0.30) | -0.0328 (0.031) |
| *Birth outcomes* | | | |
| *Multiple birth* | -0.258 (0.13) | -0.116 (0.13) | -0.183 (0.13) |
| *Multiple birth*time* | 0.059 (0.0310 | 0.0331 (0.031) | 0.044 (0.031) |
| *First born* | | 0.418*** (0.035) | 0.0141* (0.054) |
| *First born*time* | | -0.0446*** (0.008) | -0.0276* (0.014) |
| *LBW* | | -0.527*** (0.088) | -0.396*** (0.082) |
| *LBW*time* | | 0.0921*** (0.021) | 0.0715*** (0.021) |
| *Parental characteristics* | | | |
| *Mother's age* | | | 0.024*** (0.0039) |
| *Mother's age*time* | | | -0.002*** (0.001) |
| *Mother's high education* | | | 0.166*** (0.039) |
| *Mother's high educ*time* | | | 0.013 (0.010) |
| *Employed mother* | | | 0.185*** (0.035) |
| *Employed mother*time* | | | -0.046*** (0.009) |
| *High SES* | | | 0.135*** (0.041) |
| *High SES*time* | | | -0.005 (0.010) |
| *N* | 33192 | 33192 | 33192 |

Notes: * p < 0.05 **p < 0.01 ***p<0.001, SE in parentheses
All models include controls for age and gender of the child. Model (6) includes controls for general problems experienced during pregnancy and whether the pregnancy was planned. Model (7) includes controls about the partnership status of parents, household income, whether the mother breast-fed the child, number of siblings.

# Chapter 3

# Parenting after Fertility Treatments and Children's Cognitive Development

*Abstract*: Parenting style and practices represent an important channel through which parental background affects children's outcomes. There are different reasons why the use of fertility treatments may be associated with parenting, including the experience of the treatment itself and the selective characteristics of individuals who access the treatments. Using longitudinal data from the UK Millennium Cohort Study (MCS), this study examines whether parents who conceived after treatments differ from the other parents on two dimensions of parenting up to when the children are 5 years old. It also explores whether parenting affects children's cognitive skills at the age 11. Results show that mothers who used fertility treatments tend to be more involved with the child and are more likely to read every day to the child. Such differences are related to their background characteristics rather than to fertility treatment experience, and they positively affect the children's cognitive skills.

## 3.1 Introduction

The diffusion in the use of fertility treatments that occurred in the last decades has come along with concerns about possible detrimental effects on child health and development, parents' wellbeing, and parent-children relationships. Yet, research has usually found higher risks of adverse health outcomes at birth (van Balen, 1998; Wagenaar et al., 2008;) but, overall, a good development of children and families born with the aid of fertility treatments (Golombok et al, 1995; Hart and Norman, 2013), and in some cases even a better development of children born with the aid of Assisted Reproductive Technologies (ART) (Carson et al., 2011, Barbuscia and Mills, 2017). The positive result was mainly attributable to the selective demographic and socio-economic characteristics of individuals and couples who can access the (expensive) treatments and who tend to be older and have higher socio-economic status than the average population (Chambers et al, 2014).

As children's cognitive skills are developed in the first years of life and depend heavily on the environment including parental background and stimuli (Carneiro and Heckman, 2003; Cunha et al., 2006; Heckman and Masterov, 2004), a crucial question is whether specific ways of parenting following fertility treatments might play a role in the good cognitive development observed. Scholars have suggested that the experience of the treatment might affect the way parents develop the relationship with their offspring (Bernstein 1990, Gibson et al., 2000; Hammarberg et al., 2008). In addition, the characteristics of parents who use fertility treatments may be linked to the emotional involvement and time investment (i.e. the amount and kind of activities carried on with the children), a main determinant of children's cognitive and non-cognitive development and important component in the intergenerational transmission

of socio-economic status (Ermisch and Francesconi, 2000; Carneiro and Heckman, 2003; Cunha et al., 2006). A longstanding tradition of sociological work links parents' involvement with their children to higher level of education and income (Blau and Duncan, 1967; Muller, 1993), and identifies older parental age as a resource that facilitates investments in children (McLanahan, 2004).

In this study, I ask whether there is indeed an association between the use of fertility treatments and parental involvement and time investment, and to what extent it might affect children's cognitive ability after controlling for parental background. Most existing studies that looked at the effects of fertility treatments on parent-children relationships relied on very small samples and considered one single point in time, usually in the perinatal years (Colpin, 2002; Golombok, 2015). Moreover, the role of the specific demographic and socio-economic characteristics of parents, despite the important role that parental background has on the observed outcomes, was often not adequately considered (Colpin, 2002; Golombok et al., 1995; 2001). Furthermore, the majority of studies focused on emotional dimensions of the parent-children relationship and to the best of my knowledge, no study has investigated parent's investment and active involvement in their children's development. These might be dimensions especially relevant to study for children born after fertility treatment because of the amount of emotional, financial and time resources that parents have invested in the birth.

I study whether parents who conceived after fertility treatments differ from natural parents in their involvement with the child using two measures of parenting style: an index of what I call "parenting beliefs", measured when the child is 9 months old, and how often the mother reads to the child at the age of 3 and 5 years. Although these are of course not comprehensive of the many dimensions involved in parenting, I

consider them as measures of parental involvement and time investment. A key question is whether potential differences in parenting might depend on the specific background of couples accessing the treatments rather than the experience of the treatment. Moreover, I investigate how these measures of parenting at early age affect the children's cognitive development at later ages. While giving an important contribution to the existing knowledge about the outcomes of fertility treatments, this work tries to improve the understanding that we have about the general processes underlying the process of parental investment. This is an important field of study as it can help determine how family structure benefits or hinders children's life chances.

## *3.2* Infertility, fertility treatment and parenting

The experience of infertility is very stressful and going through the process of fertility treatment can be very long. Therefore, scholars have been investigating the possible consequences of fertility treatment on the wellbeing of individuals and couples (Baldur-Felskov et al., 2013; Kjaer et al., 2014) and on the way parents develop the relationship with their children (Gibson et al., 2000; Hammarberg et al., 2008). Bernstein (1990) proposes several potential ways in which infertility could affect the transition to parenthood and parenting. These include the potential of a carryover of negative feelings (increased anxiety levels during pregnancy and just after-birth, sense of loss, a decreased self-esteem and sense of competence), delayed bonding with the child, a lack of role models. The experience might also negatively affect the couple' relationship (Bernstein, 1990; Kjaer et al., 2014) and therefore the development of parent-child relationships. Others have underlined the high expectations couples might have of themselves in the parent role (Hammarberg et al., 2008), or the possibility of

self-exclusion from social networks, which negatively impact the development of parent-children relationship (Belsky, 1984).

Empirical studies, however, in general show no significant difference in the way parents who conceived with the aid of fertility treatment adjust to parenthood and develop their relationship with the children compared to the rest of parents (Hammarberg et al., 2008). In a review of the literature, Colpin (2002) reports evidence that IVF mothers tend to report less self-esteem and parenting competence; no difference on the level of protectiveness was observed, but IVF mothers perceived their children as more vulnerable and "special". No differences were found on many other dimensions, including attachment to the child and attitudes to child-rearing. Colpin and Soenen (2002) also observed that parenting and children's psychosocial development do not differ significantly between IVF and natural families.

A few studies compared the parent-child relationship and the child's development in families created with the aid of fertility treatments and natural families after the perinatal years, with mixed findings (Golombok et al., 1995; Owen et al., 2009; Golombok et al., 2015;). Some revealed positive effects of IVF parenting like higher emotional involvement with children and less parenting stress, while others have found that IVF parents are overprotective. One explanation that has been provided for the positive findings is that the stress that accompanies infertility might be compensated for by the birth of a child (Gibson et al., 2000). Children born after IVF are an extreme example of planned and desired children, and this might be linked to higher levels of satisfaction coming from parenthood and thus to better relationship with the child (Colpin, 2002). In another study Golombok and colleagues (2001) looked at parent-children relationships during adolescence without finding significant differences.

Considering the theoretical and empirical studies reviewed, I hypothesize that parents who used a fertility treatment will show higher levels of involvement (H1).

I expect such difference to be directly connected to the experience of the treatment and therefore to the birth of a very desired child, and not to parental demographic and socioeconomic characteristics (H1.a).

## *3.3* Parenting style and socio-economic background

The association between parenting and demographic and socio-economic background has been extensively studied in sociological, economic and psychological research. A complete review of such literature goes beyond the scope of this article. However, since parents who conceived with the aid of fertility treatments are likely to represent a selective population in terms of demographic and socio-economic characteristics, it is important to highlight how such characteristics might be associated with specific ways of parenting or parenting activities.

Parents were shown to differ consistently in their approach to parenting depending on age, educational level and socio-economic status (among others, Brooks-Gunn and Markman, 2005; Lareau, 2002) and this has an important effect on their children's health and cognitive and non-cognitive development (Ermisch and Francesconi, 2000; Ermisch, 2008; Heckman et al., 2010). A consistent literature has shown that cognitive and non-cognitive abilities are developed in the first years of life of the child and depend heavily on parental background (Carneiro and Heckman, 2003; Cunha et al., 2006; Heckman and Masterov, 2004). The different parenting styles and practices linked to parental background are an important mechanism in how parental education and socio-economic status affect the children development (Lareau, 2002;

Gauthier et al., 2004; Brooks-Gunn and Markman, 2005; Ermisch, 2008; Cheadle and Amato, 2011).

Starting from the 90s, the idea of 'good parenting' emerged and greater attention has been given to the way parents actively engage in their children development (Gauthier, 2004; Brooks-Gunn and Markman, 2005; Altintas, 2015). The idea that parents should not only provide for the material needs of the children but actively engage in their cognitive and non-cognitive development has led to a social pressure on what is "good parenting" (Gauthier, 2004). It has also increased the focus on the time parents spend with their children and the activities they engage as relevant in the study of how educational and economic status is transmitted from a generation to the next one (Ermisch, 2008). In 2002, Lareau introduced the idea of 'concerted cultivation' referring to an approach that considers it crucial for the children to be involved in several organised activities expected to arm them with important life skills, a stress on the use of language and development of reasoning and talking as a preferred form of discipline. This approach would be specific to middle- and upper class, in contrast to working- and lower-class parents who are more inclined towards 'natural growth' (Lareau, 2002). Following Lareau's seminal work, several studies have proposed a quantitative assessment of concerted cultivation. Bodowsky and Farkas (2008) observed that concerted cultivation has an important role in explaining the better educational performances of children from higher socio-economic background. Interestingly, they also concluded that this is a direct expression of the socio-economic status of the parents rather than a rational strategy to promote the development of the child. Cheadle and Amato (2011) observed that parental education has the strongest net association with concerted cultivation. Older mothers are also more likely to engage in concerted

cultivation, while the biggest the family size, the lower probability of experiencing concerted cultivation.

Other scholars have focused on the importance of parental time as main source of parental investment in children and having a strong impact on their development (Gauthier et al., 2004; Kalil et al., 2012; Fiorini and Keane, 2014; Altintas, 2015). Fiorini and Keane's (2014) results show that time spent in educational activities, especially with parents, is the most productive input for cognitive skills. Older parental age and higher education are linked to more time spent with children (Gauthier et al., 2004). Altintas (2015) used time use data to show that the educational gap in how high- and low-educated parents spend time in developmental child-care activities with their children has been widening. Ermisch (2008) found that differences by parents' income group in cognitive and behavioural development emerge by the child's third birthday and that an important part of these differences can be accounted for by what parents do in terms of educational activities and parenting style. His results show that reading more often to the child or taking the child to the library improve cognitive and behavioral development up to the age of 3.

In light of the literature on parental background and parenting style and practices, I hypothesize that parents who used fertility treatments will show higher levels of time investment in the child's development (H2.a). However, I expect such difference to be linked to the demographic (age) and socio-economic background of the couples accessing fertility treatments rather than to the experience of the treatment itself (H2.b).

Considering the findings about the importance of parenting for children's development, I also hypothesize that parenting style and practices at early ages will have a significant positive association with the children's cognitive skills measured at older ages (H3).

## *3.4* Data and measurements

### Sample

The Millennium Cohort Study (MCS) is a nationally representative prospective cohort study of 18,552 families across the UK. A random two-stage sample of all infants born in 2000-2001 and resident in the UK at 9 months was drawn from the Department of Social Security Child Benefit Registers. Ethnically diverse and disadvantaged areas were oversampled to ensure adequate representation. Baseline interviews captured socio-demographic and health information, including questions about pregnancy and fertility treatment. Follow-up surveys were conducted in 2003, 2005, 2007 and 2012. The surveys covered different topics such as health, development, behaviour, wellbeing, parenting, and collected information about their siblings and parents. This represents an advantage when compared to registered data, which do not include such kind of information about the environment where the child lives. My sample included children born from either married or cohabiting parents.[5] I only considered the ones who had available information for at least one of the waves after the first one, which led to a final sample of 15,218 observations. Of these, 487 children were born with the aid of some kind of fertility treatment. These included In Vitro Fertilization (IVF) and Intracytoplasmatic Sperm Injection (ICSI), the most common kinds of ART, Intra-Uterine Insemination (IUI), and the use of ovarian stimulating drugs not followed by any ART treatment (OI).

### Measurements

[5] Because of the selective sample considered in this study, i.e. children born to cohabiting or married parents and who have available information at later sweeps, I did not include the survey weights in the analyses.

**Parenting style**

My main dependent variables were two measures of parenting style and activities at different ages of the child. They were both derived from the main respondent surveys and refer to mothers. The choice to focus on mothers exclusively is due to the greater richness of information available and the high number of missing values in answers about parenting style provided by fathers. Although it is undoubtedly a limitation to include measures referring to mothers only (Gibson-Davis, 2008), there seems to be overall agreement in the literature that mother's parenting behavior have a stronger impact on the children's development, because mothers tend to spend more time interacting and engaging with children in the early years being usually the primary caregivers (Martin et al 2010; Sayer et al., 2004).

The first measure was derived from a series of question asked to the respondents at the first interview, when the child was 9 months old. Mothers were asked about the importance of cuddling, talking, stimulation and regular bedtimes for the child's development, and whether a child should be picked up immediately whenever crying. Answers were on a 1-4 scale, from "strongly agree" to "strongly disagree"[6]. I used factor analysis to identify an index of *parenting beliefs* and considered it a measure of maternal involvement at very young age of the child (higher values of the factor meaning higher levels of involvement). The 5 questions were originally developed by the European Longitudinal Study of Pregnancy and Childhood to measure what parents think about child rearing practices, whether the baby should grow up in a structured or in a more laissez-faire environment. They help to understand the likelihood that parents will provide sensitive care to their babies[7].

[6] The distribution of the answers to each item and factor loadings are shown in the Appendix

[7] Other measures of parenting were considered in additional analyses. A measure of maternal attachment was built from a series of question asked at the first wave, however this is rather similar to

The second measure was derived from a series of questions about the time spent by mothers in different activities with the child, that were asked in the MCS starting from the second wave (when the child is around 3 years old). The general structure of the question was "How often do you … with the child?" with possible answers going from "every day" to "not at all". I considered how often the mother reads to the child as a dummy variable taking the value 1 when the mother answered "every day" and 0 otherwise. Such operationalization followed the one suggested by Ermisch (2008) and was due to the skewed distribution of the answers on the first two options. Reading to the child was also shown to be a reliable measure of the extent the parents engage with their children in educational activities, and important for the children's cognitive development (Sylva et al., 2004; Ermisch, 2008). An additional appealing feature of the measure was that the question on how often parents read to their child was available in several sweeps of the MCS and therefore at different ages of the child. I considered it as a measure of maternal time investment in the child at the age of 3 and 5.[8] Reading to the child after the age of 5 was not considered because of the possible association with lower cognitive skills of the child/ more need for help in reading at an age when many children are able to read on their own.[9]

other measures already used in literature and refer to the emotional dimension of parent-child relationship. Further, it showed very small variation across individuals. A measure of parenting was also built from a series of questions asked at the 2nd wave (age 5) concerning the presence of strict rules in the family. The results were very similar to the ones obtained considering parenting beliefs, but less statistically significant. I decided to opt for parenting beliefs instead of parenting style as it is measured at a younger age of the child. Results of the analyses of the determinants of these alternate measures are available in the Appendix.

[8] I tried different measures of maternal time investments that included other parenting activities at age 3 and 5 years, using factor analysis. The results were very similar to the ones for reading to the child, but with less statistical power. Factor loadings and results of the main analyses considering such other measure are available upon request.

[9] Analyses were also performed considering reading every day at the age of 7, but the measure was not included in the final analyses for the possible association with lower cognitive skills of the child

Information about parenting beliefs was available for 14,247 observations; for reading to the child at age 3, for 12,393 observations; for reading to the child at age 5, for 12,189 observations.

**Cognitive skills**

The other dependent variable in the study were children's cognitive ability at the last observation available (age 11). Children's cognitive skills were assessed in the MCS with three sub scales of the British Ability Scales, second edition (BAS II). The standardized tests undertaken by cohort members is a particularly valuable element of the MCS (Connelly, 2013). The BAS II is a battery of twelve core subtests of cognitive ability and educational achievement, suitable for children aged from two years and six months to seventeen years and eleven months. It has demonstrated sound validity and test-retest reliability (Elliot et al., 1997). At age 3 and 5, MCS members completed the *naming vocabulary* component. At age 7, verbal cognitive abilities were assessed through the *word reading* test and at age 11 through the *verbal similarity* test. Here, I considered standardized measure of the test-score at the age of 11 years, the last sweep available.[10] Information about cognitive skills was available for 8,871 observations.

**Fertility treatments**

Main independent variable was whether the child was conceived with the aid of a fertility treatment, as declared by the mother in the first wave. All the different kinds of fertility treatments mentioned in the MCS were included in the treatment category. These included the two main kinds of Assisted Reproduction Technology, i.e. In Vitro Fertilization (IVF, 137 women) and Intracytoplasmatic Sperm Injection (ICSI, 72 women), Intrauterine Insemination (IUI, 25 women) and Ovarian Stimulating drugs

[10] The same analyses were run on the child's cognitive ability at the age of 7, with very similar results.

(OI, 247 women). All kinds of fertility treatments were considered together in the analyses, as looking at them separately would lead to small sample sizes.[11]

**Control variables**

I controlled for a number of confounders that are likely related both to parenting style and the use of fertility treatments. These were child and maternal demographic characteristics, family structure and parental socio-economic factors. Child's and mother's characteristics included child's ethnicity (*white*, *black* or *other*), gender, multiple birth and low birth weight *(LBW*), mother's age. Measures of family structure were marital status of the parents, whether the child was first born and the number of siblings. To measure parental socioeconomic background, both the educational level of the mother (whether she had a degree or higher educational level, A levels, or lower) and the household income (*UK income quintiles*) were considered[12]. I also included a control for whether the child was born from an intended pregnancy (*planned*). All individual controls were time-invariant characteristics and the information was provided by respondents at the first sweep of the MCS.

## 3.5 Statistical methods

Two-tailed t-tests compared the demographic and socioeconomic characteristics of couples who conceived with and without the aid of fertility treatments, the birth outcomes and the average values of the measures of parenting style considered.

[11] Sensitivity analyses considered separately the different kinds of fertility treatment used. The results (available upon request) were very similar but with less statistical power because of the smaller sample size.

[12] Other specifications of the models included socio-economic status of the head of the household (based on the NS SEC classification), but were not included in the final analysis because of the high correlation with the measures of income.

To test hypotheses H1 and H2, I run respectively linear regression and logistic regression models to study the determinants of parenting beliefs and of the probability that a mother reads every day to the child. In both sets of regression, the confounders were added to the model in a stepwise way. The first models included only basic demographic characteristics and whether the mother undertook any fertility treatment, to see whether there was an overall association with parenting style. I then added controls for family structure, age and socio-economic characteristics of the parents to understand whether possible differences in parenting style were linked to the treatment itself (H1a.) or to confounding parental background (H2a). Because of the high prevalence of twins and triplets as consequence of fertility treatments, all models included robust clustered standard errors.

To test H3, I examined the children's cognitive ability at the age of 11 and to what extent it was associated with the use of fertility treatments and with the measures of parenting style and activities. Linear regression models were fit on the sub-test score for verbal cognitive ability. Main explanatory variables were the use of fertility treatments, the measures of parenting style and parental socio-economic background. Again, the sets of confounding factors were included one at a time. All models controlled for child's gender, ethnicity and birth outcomes.

## 3.6 Results

### Fertility treatments and parenting style

Descriptive characteristics of the sample confirmed the prediction that couples who conceived with the aid of fertility treatments differed consistently from the rest of the sample (Table 3.1). Parents who accessed the treatments were significantly older (around 3 years both for mothers and fathers), more likely to be married, to be in the

first quintile of the UK income distribution and to have higher socio-economic status (managerial or higher professional occupation of the head of household). The mothers were also more likely to have at least a tertiary educational level, to be employed and to have breast-fed the child. These findings were in line with the literature, and consistent with the high costs of fertility treatments in the UK, which makes them accessible only to a selective population. The proportion of children born from multiple births and the prevalence of low-birth-weight were significantly different between the two sub-samples, and confirmed previous findings about the high incidence of multiple births following fertility treatments, which often result in pre-term births and low-birth-weight. The uncontrolled measures of parenting style were also significantly different. The index of parenting beliefs when the child was 9 months showed higher values in the treatment subgroup, suggesting higher maternal involvement in the first months of life of the child. Mothers who undertook fertility treatments were also more likely to read every day to their children at the age of 3, 5 and 7, although the difference at the last observation was smaller and only slightly significant. Children born after fertility treatment had on average higher cognitive skills compared to the rest of the sample, in line with what found in previous studies about ART children using the same data (Carson et al., 2011; Barbuscia and Mills, 2017). However, these findings did not control for any other characteristics of the parents or the children.

Table 3.2 shows the results of the linear regression models to study the determinants of parenting beliefs. The use of fertility treatment was associated with higher values of the factor both in the first uncontrolled model (Model 1) and after adjustment for parity and number of siblings (Model 2), indicating higher maternal involvement when the child was 9 months old. However, the association became insignificant after controlling for parental background. Mother's age, educational level and household income were

all significantly associated with higher values of parenting beliefs, suggesting higher levels of involvement among older and higher SES parents. While the general hypothesis of higher involvement among parents who used fertility treatment was confirmed (H1), no support was provided to the hypothesis of a "fertility treatment effect" net of parental background (H1.a), which seemed to be the main driver of the observed difference.

The models on the determinant of the probability of reading every day to the child showed similar results (Table 3.3). Mothers who conceived after fertility treatment had a higher probability of reading every day to the child in the uncontrolled model (Models 1). The association was reduced, but remained significant on adjustment for family structure and birth outcomes at the age of 3, and became statistically insignificant at age of 5. There was no remaining significant association at both ages after controlling for parental background. These results seem to support hypothesis H2.a of a higher time investment of mothers who conceived with the aid of fertility treatment and that this is linked to their demographic and socio-economic characteristics (H2.b). The effects of the confounders were similar to the ones for parenting beliefs, with older and higher SES mothers more likely to read every day to their child. Household income in particular showed the strongest association. Being first born and the number of siblings were also significantly (respectively positive and negative) associated with the probability that the mother reads every day, suggesting that this might be affected by time-related constraints like having other children to take care of. Results were similar at the age of 3 and 5 years, but at later age the relationship with parental background was weaker[13].

[13] The analysis of the determinants of reading every day to the child at the age of 7 provided very similar results.

**Parenting style and cognitive ability**

Table 3.4 shows the results of linear regression models to study the association of children's cognitive ability at 11 years old with fertility treatments, parenting style and parental demographic and socio-economic characteristics. The positive association between fertility treatment and cognitive score in Model 1 and Model 2 reflected what already found about an average better cognitive performance of ART children and suggested that this is true when considering treatments other than ART, too.

When the measures of parenting style and activities were added in the model, the coefficient of fertility treatment became very close to zero and statistically insignificant. Both the measure of maternal involvement when the child was 9 months old and the variable indicating that the mothers read to the child every day at age 3 and 5 were significantly and positively linked to the child's cognitive performance[14]. The positive association persisted after controlling for parental demographic and socio-economic background, although the coefficients decreased consistently. These results provide support to our hypothesis that there is a positive association between maternal involvement and time investment and the children's cognitive ability (H3). Parental background and especially a high educational level of the mother and household income were still the strongest predictors of the child's cognitive skills.

## 3.7 Conclusion and Discussion

[14] When reading to the child at the age of 7 was included in the model, all results remained unvaried but the coefficient of the measure itself was negative.

The importance of parenting style and activities for children's development is well established and in the last decades, research has shown that an active involvement of parents since very early ages is linked to higher cognitive abilities during childhood (Lareau, 2002; Ermisch 2008; Fiorini and Keane, 2014). There are several reasons why undertaking a fertility treatment may affect the way individuals interact with and invest in their offspring, which makes it not only relevant but also particularly interesting to investigate. The literature on parenting after fertility treatments, however, is scarce and provided mixed findings.

I examined two measures of parenting style (parenting beliefs and whether the mother reads every to the child) at different ages of the child and studied their association with the use of fertility treatments, parental background and children's cognitive ability. I found that mothers who conceived with the aid of fertility treatments showed higher levels of maternal involvement when the child was 9 months old and were more likely to read every day to the child at the age of 3 and 5 years compared to mothers who conceived naturally. However, my results indicate that these differences were linked to the specific demographic and socio-economic background of couples who accessed fertility treatments rather than to the use of the treatments. These findings corroborate the ones from previous studies suggesting that parenting style and practices are a direct expression of socio-economic background (Bodowsky and Farkas; 2008). Parents who used fertility treatments were on average older, with higher education and income, all characteristics that were associated with a high involvement and investment in the child's development. Family structure also emerged as an important factor for parenting practices linked to the time spent with children. Children born after fertility treatments were more likely to be first born and have a smaller number of siblings, which was linked to higher maternal time investment.

I also found that children born after fertility treatment had higher average verbal cognitive skills at the age of 11 years compared to naturally conceived children. Among the explanatory factors, higher level of maternal involvement and time investment, especially at younger ages of the child, partly explained the good performance, even after controlling for parental background. Socio-economic characteristics of the parents, nevertheless, were the strongest predictors of children's cognitive abilities.

This study confirms that children and families born with the aid of fertility treatment are a selective population in terms of the demographic and socio-economic characteristics of parents and children's outcomes at birth. Despite the concerns about possible negative health consequences of the treatments, the children seem overall to benefit from the parental resources and parenting practices related to such advantageous socio-economic conditions, and show a cognitive development that is higher than average.

The study suffers some important limitations. The chosen measures of parenting style are of course not comprehensive of the many dimensions of parenting that may be crucial for children's development. As discussed earlier, they only refer to mothers and might therefore be only partially informative about the stimuli received overall by the children. Furthermore, an important question that remains partly unanswered is what these measures do actually measure. My results show that they are strongly associated with the observable socio-economic characteristics of parents, but part of the association with children cognitive skills remains after adjustment for parental background. However, is it real inputs or do they mainly reflect unobserved traits of the parents? The question has been asked previously in the literature (Ermisch, 2008), and remains relevant for interpreting the results of this study, as the measures of

parenting style considered here might well being another expression of parental background, rather than indicate actual differences in how the children are raised.

The relatively small number of children who were born with the aid of fertility treatments compared to naturally born children represents another limitation of the study, and makes it impossible to perform the analyses dividing by the kind of treatment. Nevertheless, these findings provide an important contribution to the literature exploring the consequence of the use of fertility treatment, an increasingly relevant phenomenon especially in Western societies. Further, they add to our understanding of the mechanisms underlying intergenerational transmission of socio-economic status and highlight once more the different environment and opportunities faced by children from different background in the UK.

**Table 3.1: Descriptive statistics of the sample, divided by whether the respondent used fertility treatments**

| | Natural Conception | | Fertility treatment | |
|---|---|---|---|---|
| *Birth outcomes* | Mean | SE | Mean | SE |
| Twin (%) | 1.11 | 0.000 | 12.50*** | 0.001 |
| Triplet (%) | 0.003 | 0.001 | 1.17 *** | 0.005 |
| First born (%) | 39.07 | 0.004 | 67.45*** | 0.022 |
| Number of siblings | 0.98 | 0.008 | 0.39 *** | 0.030 |
| Low birth weight (%) * | 5.21 | 0.001 | 10.40*** | 0.014 |
| *Parental background* | | | | |
| Mother's age | 29.10 | 0.045 | 32.32*** | 0.22 |
| Father's age | 30.87 | 0.070 | 34.62*** | 0.33 |
| Married parents (%) | 70.34 | 0.037 | 87.73*** | 0.015 |
| Mother's education: degree (%) | 27.91 | 0.004 | 36.08*** | 0.024 |
| Mother's education: A levels (%) | 43.45 | 0.004 | 46.61 | 0.022 |
| HH Income: UK 1st quintile (%) | 18.61 | 0.003 | 34.90*** | 0.023 |
| UK 2nd quintile (%) | 20.65 | 0.003 | 24.76* | 0.020 |
| UK 3rd quintile (%) | 21.86 | 0.003 | 21.46 | 0.019 |
| UK 4th quintile (%) | 23.20 | 0.003 | 14.62*** | 0.017 |
| UK 5th quintile (%) | 15.32 | 0.002 | 4.10 *** | 0.009 |
| High SES (managerial or professional occupation of head of HH, %) | 29.92 | 0.003 | 43.63*** | 0.024 |
| Employed mother (%) | 47.51 | 0.004 | 56.13*** | 0.024 |
| *Parenting style and activities* | | | | |
| Parenting beliefs | 0.025 | 0.007 | 0.183*** | 0.032 |
| Read every day to the child (age 3, %) | 59.40 | 0.004 | 71.75*** | 0.023 |
| Read every day to the child (age 5, %) | 51.11 | 0.004 | 60.23 ** | 0.026 |
| Read every day to the child (age 7, %) | 41.64 | 0.004 | 47.63* | 0.028 |
| *Child's Cognitive ability* | | | | |
| Naming Vocabulary* (age 3) | 49.99 | 11.45 | 52.29*** | 10.89 |
| Naming Vocabulary* (age 5) | 54.46 | 11.20 | 57.40*** | 10.42 |
| Word reading* (age 7) | 112.36 | 17.25 | 115.86 | 16.25 |
| Verbal similarity* (age 11) | 59.09 | 9.91 | 115.86*** | 16.25 |
| *N* | 14,559 | | 424 | |

Notes: the sample is family-specific, i.e. only one twin or triplet for each multiple birth was considered to avoid the repetition of family characteristics (*except for LBW and children's cognitive skills)
Stars indicate that the difference is significant according to T-test: *p<0.05 **p<0.01 ***p<00.1

**Table 3.2: Determinants of parenting beliefs at age 9 months, estimates from linear regression models, clustered SE**

| | Model 1 | Model 2 | Model 3 |
|---|---|---|---|
| Fertility treatment | 0.142*** | 0.125*** | 0.055 |
| | (0.036) | (0.037) | (0.037) |
| Female | -0.009 | -0.011 | -0.013 |
| | (0.014) | (0.014) | (0.014) |
| *Ethnic background (ref. white)* | | | |
| Black | -0.088* | -0.052 | -0.055 |
| | (0.047) | (0.047) | (0.048) |
| Pakistani | -0.375*** | -0.341*** | -0.200*** |
| | (0.034) | (0.035) | (0.036) |
| Other | -0.118*** | -0.114*** | -0.104*** |
| | (0.031) | (0.031) | (0.031) |
| First born | | 0.0192 | 0.025 |
| | | (0.022) | (0.022) |
| Num. siblings | | -0.031*** | -0.028** |
| | | (0.011) | (0.011) |
| LBW | | -0.055* | -0.034 |
| | | (0.036) | (0.035) |
| Multiple pregnancy | | -0.004 | -0.016 |
| | | (0.056) | (0.055) |
| Planned pregnancy | | | 0.011 |
| | | | (0.016) |
| Mother's age at birth | | | 0.013*** |
| | | | (0.001) |
| *Mother's education* | | | |
| Degree or higher | | | 0.302*** |
| | | | (0.023) |
| A levels | | | 0.191*** |
| | | | (0.020) |
| *HH income (ref. 5th UK quintile*) | | | |
| 1st quintile | | | 0.161*** |
| | | | (0.032) |
| 2nd quintile | | | 0.134*** |
| | | | (0.031) |
| 3rd quintile | | | 0.110*** |
| | | | (0.029) |
| 4th quintile | | | 0.099*** |
| | | | (0.028) |
| Mother employed | | | -0.004 |
| | | | (0.015) |
| Observations | 14,247 | 14,247 | 14,247 |
| R-squared | 0.013 | 0.018 | 0.044 |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Low Birth Weight refers to children<2.5 Kg

**Table 3.3: Determinants of reading every day to the child at age 3 and 5, estimates from logistic regressions, clustered SE**

| | Age 3 | | | Age 5 | | |
|---|---|---|---|---|---|---|
| | Model 1 | Model 2 | Model 3 | Model 1 | Model 2 | Model 3 |
| Fertility treatment | 0.400*** | 0.208* | -0.0325 | 0.262** | 0.074 | -0.0934 |
| | (0.125) | (0.126) | (0.129) | (0.117) | (0.119) | (0.121) |
| Female | 0.142*** | 0.156*** | 0.158*** | 0.0692* | 0.0738** | 0.0674* |
| | (0.0375) | (0.0383) | (0.0393) | (0.0365) | (0.0371) | (0.0375) |
| *Ethnic background (ref. White)* | | | | | | |
| Black | -1.282*** | -1.154*** | -1.312*** | -0.414*** | -0.345** | -0.427*** |
| | (0.144) | (0.147) | (0.160) | (0.133) | (0.137) | (0.139) |
| Pakistani | -1.318*** | -1.156*** | -0.768*** | -0.744*** | -0.629*** | -0.452*** |
| | (0.0762) | (0.0807) | (0.0859) | (0.0760) | (0.0797) | (0.0846) |
| Other | -0.630*** | -0.639*** | -0.659*** | -0.235*** | -0.244*** | -0.281*** |
| | (0.0769) | (0.0791) | (0.0831) | (0.0774) | (0.0792) | (0.0808) |
| Multiple birth | 0.0294 | 0.132 | 0.136 | -0.0393 | 0.0236 | -0.0170 |
| | (0.163) | (0.171) | (0.173) | (0.156) | (0.162) | (0.168) |
| Firstborn | | 0.258*** | 0.347*** | | 0.445*** | 0.499*** |
| | | (0.0611) | (0.0628) | | (0.0581) | (0.0593) |
| Num. siblings | | -0.231*** | -0.213*** | | -0.120*** | -0.153*** |
| | | (0.0300) | (0.0321) | | (0.0280) | (0.0301) |
| LBW | | -0.172* | -0.112 | | -0.0675 | -0.0427 |
| | | (0.0892) | (0.0918) | | (0.0867) | (0.0883) |
| Planned pregnancy | | | 0.0888** | | | 0.029 |
| | | | (0.0432) | | | (0.0417) |
| Mother's age at birth | | | 0.0317*** | | | 0.0313*** |
| | | | (0.00440) | | | (0.00428) |
| *Mother's education* | | | | | | |
| Degree or higher | | | 0.976*** | | | 0.438*** |
| | | | (0.0500) | | | (0.0463) |
| A levels | | | 0.462*** | | | 0.186*** |
| | | | (0.050) | | | (0.050) |
| *HH Income (ref. 5th UK quintile)* | | | | | | |
| 1st quintile | | | 0.600*** | | | 0.266*** |
| | | | (0.0852) | | | (0.0832) |
| 2nd quintile | | | 0.430*** | | | 0.102 |
| | | | (0.0785) | | | (0.0772) |
| 3rd quintile | | | 0.314*** | | | 0.0294 |
| | | | (0.0729) | | | (0.0728) |
| 4th quintile | | | 0.068 | | | 0.0290 |
| | | | (0.0677) | | | (0.0677) |
| Mother employed | | | -0.202*** | | | -0.126*** |
| | | | (0.0447) | | | (0.0431) |
| N | 12,189 | 12,189 | 12,189 | 12,189 | 12,189 | 12,189 |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Low Birth Weight refers to children<2.5 Kg

**Table 3.4: Determinants of children's cognitive skills at age 11 (BAS verbal similarity test), estimates from linear regression models, robust clustered SE**

| VARIABLES | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 |
|---|---|---|---|---|---|
| Fertility treatment | 0.142** | 0.0437* | 0.0301 | 0.0281 | -0.0199 |
| | (0.0577) | (0.0578) | (0.0578) | (0.0567) | (0.0549) |
| Female | -0.0681*** | -0.0653*** | -0.0629*** | -0.0721*** | -0.0677*** |
| | (0.0206) | (0.0204) | (0.0204) | (0.0202) | (0.0198) |
| *Ethnic background (ref. White*) | | | | | |
| Black | 0.129* | 0.181** | 0.190** | 0.253*** | 0.198*** |
| | (0.0761) | (0.0756) | (0.0761) | (0.0757) | (0.0735) |
| Pakistani | -0.613*** | -0.548*** | -0.514*** | -0.448*** | -0.300*** |
| | (0.0522) | (0.0519) | (0.0518) | (0.0520) | (0.0551) |
| Other | 0.130*** | 0.133*** | 0.142*** | 0.166*** | 0.144*** |
| | (0.0485) | (0.0476) | (0.0476) | (0.0475) | (0.0472) |
| Multiple birth | 0.0283 | 0.0254 | 0.0277 | 0.0259 | 0.0425 |
| | (0.0838) | (0.0819) | (0.0817) | (0.0792) | (0.0777) |
| LBW | -0.172*** | -0.176*** | -0.170*** | -0.164*** | -0.150*** |
| | (0.0539) | (0.0532) | (0.0528) | (0.0526) | (0.0517) |
| First born | | 0.0305 | 0.0286 | 0.00305 | 0.0134 |
| | | (0.0319) | (0.0317) | (0.0316) | (0.0316) |
| Num. siblings | | -0.100*** | -0.0965*** | -0.0850*** | -0.0742*** |
| | | (0.0165) | (0.0164) | (0.0165) | (0.0171) |
| Parenting Beliefs | | | 0.108*** | 0.0899*** | 0.0567*** |
| | | | (0.0135) | (0.0134) | (0.0132) |
| Read every day (age 3) | | | | 0.210*** | 0.127*** |
| | | | | (0.0229) | (0.0228) |
| Read every day (age 5) | | | | 0.0729*** | 0.0420** |
| | | | | (0.0214) | (0.0211) |
| Planned pregnancy | | | | | -0.00677 |
| | | | | | (0.0232) |
| Mother's age at birth | | | | | 0.0112*** |
| | | | | | (0.00236) |
| *Mother's education* | | | | | |
| Degree or higher | | | | | 0.360*** |
| | | | | | (0.0229) |
| A levels | | | | | 0.187*** |
| | | | | | (0.029) |
| *HH Income (ref. UK 5$^{th}$ quintile*) | | | | | |
| 1$^{st}$ quintile | | | | | 0.371*** |
| | | | | | (0.0470) |
| 2$^{nd}$ quintile | | | | | 0.252*** |
| | | | | | (0.0451) |
| 3$^{rd}$ quintile | | | | | 0.213*** |
| | | | | | (0.0434) |
| 4$^{th}$ quintile | | | | | 0.099*** |
| | | | | | (0.0425) |
| Mother employed | | | | | -0.0521** |
| | | | | | (0.0216) |
| Observations | 8,871 | 8,871 | 8,871 | 8,871 | 8,871 |
| R-squared | 0.025 | 0.043 | 0.051 | 0.064 | 0.107 |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
The sample is restricted to children for who have available information at all waves

# Appendix

**Table 3.5: Individual predictors of undertaking fertility treatments, estimates from logistic regression, odds ratios**

| VARIABLES | Fertility treatment |
|---|---|
| Mother's age | 1.116*** |
| | (0.0132) |
| Father's age | 1.031*** |
| | (0.00901) |
| Married parents | 2.725*** |
| | (0.403) |
| *HH Income* | |
| UK 1st quintile | 2.119*** |
| | (0.554) |
| UK 2nd quintile | 1.898** |
| | (0.492) |
| UK 3rd quintile | 2.135*** |
| | (0.541) |
| UK 4th quintile | 1.890** |
| | (0.479) |
| *Mother's education* | |
| Degree or higher | 0.773* |
| | (0.120) |
| A levels | 1.078 |
| | (0.151) |
| Mother employed | 0.826* |
| | (0.0843) |
| English only language spoken | 1.385** |
| | (0.229) |
| Childless | 4.900*** |
| | (0.527) |
| Observations | 15,183 |

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

**Figure 3.1: Distribution of answers on parenting beliefs items**

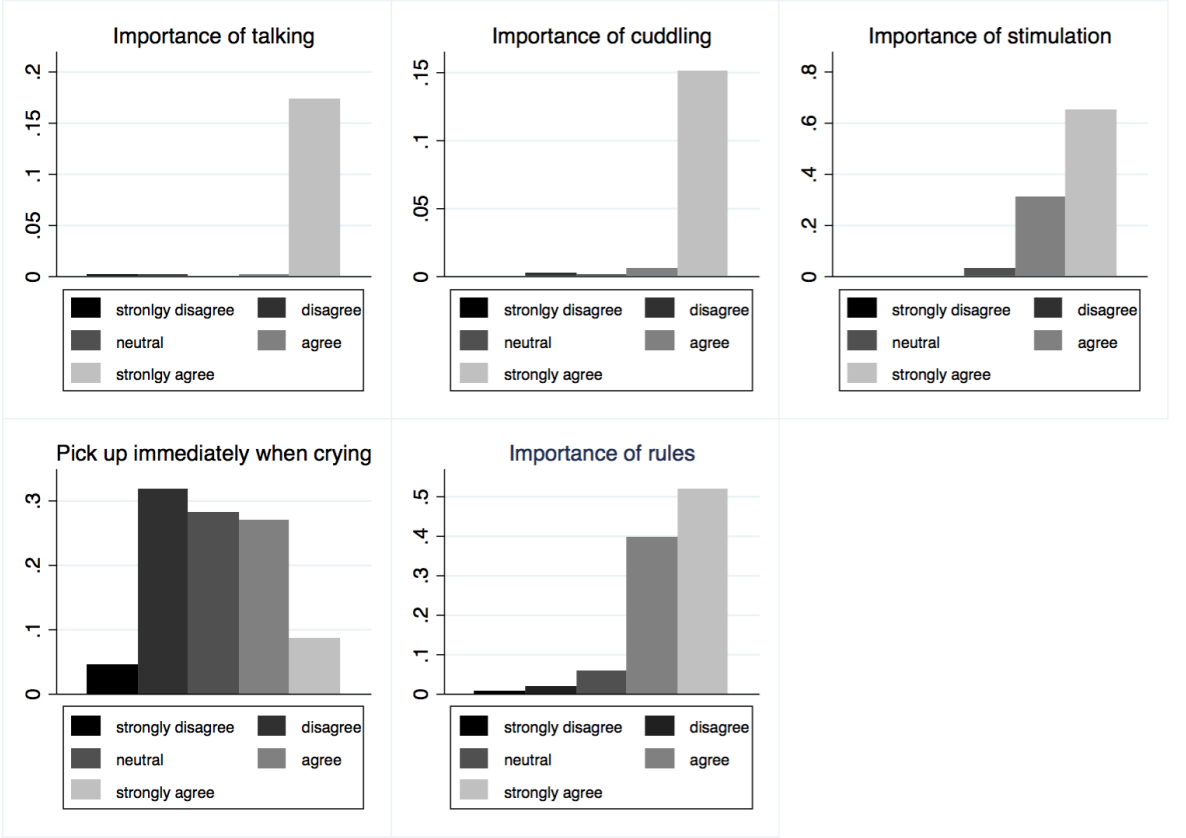



**Table 3.6: Parental beliefs- factor loadings**

| ***VARIABLES*** | ***Parenting Beliefs*** |
|---|---|
| *Importance of talking* | 0.403 |
| *Importance of cuddling* | 0.284 |
| *Importance of stimulation* | 0.275 |
| *Pick up immediately when crying* | 0.033 |
| *Importance of rules* | 0.118 |

**Table 3.7: Determinants of maternal attachment, estimates from linear regression models**

| | Model(1) | Model(2) | Model(3) |
|---|---|---|---|
| Fertility treatment | -0.0552 | -0.0152 | 0.00464 |
| | (0.0377) | (0.0380) | (0.0381) |
| Female | 0.0638*** | 0.0634*** | 0.0647*** |
| | (0.0127) | (0.0126) | (0.0125) |
| *Ethnic background (ref: white)* | | | |
| Black | 0.219*** | 0.213*** | 0.208*** |
| | (0.0445) | (0.0453) | (0.0465) |
| Pakistani | -0.0973** | -0.122*** | -0.195*** |
| | (0.0402) | (0.0405) | (0.0410) |
| Other | -0.0134 | -0.0134 | -0.0213 |
| | (0.0317) | (0.0316) | (0.0315) |
| First born | | 0.135*** | 0.138*** |
| | | (0.0199) | (0.0199) |
| Num. siblings | | 0.0746*** | 0.0740*** |
| | | (0.0101) | (0.0107) |
| LBW | | 0.0354 | 0.0303 |
| | | (0.0323) | (0.0319) |
| Multiple birth | | -0.202*** | -0.203*** |
| | | (0.0558) | (0.0550) |
| Planned | | | 0.0521*** |
| | | | (0.0143) |
| Mother age at birth | | | -0.00391*** |
| | | | (0.00147) |
| *Mother's education (ref: high school)* | | | |
| Degree | | | -0.150*** |
| | | | (0.0204) |
| A levels | | | -0.0213 |
| | | | (0.0174) |
| *Household income (ref: UK 5th quintile)* | | | |
| UK 1st quintile | | | -0.0339 |
| | | | (0.0288) |
| UK 2nd quintile | | | 0.0291 |
| | | | (0.0271) |
| UK 3rd quintile | | | 0.0489* |
| | | | (0.0259) |
| UK 4th quintile | | | 0.0613** |
| | | | (0.0253) |
| Mother employed | | | -0.00376 |
| | | | (0.0140) |
| Observations | 12,775 | 12,746 | 12,734 |

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

**Figure 3.8: Determinants of parenting style, estimates from linear regression models**

| | Model (1) | Model (2) | Model (3) |
|---|---|---|---|
| Fertility treat | 0.0579* | -0.0151 | -0.00615 |
| | (0.0355) | (0.0369) | (0.0363) |
| Female | 0.0145 | 0.0139 | 0.0131 |
| | (0.0118) | (0.0117) | (0.0116) |
| *Ethnic background (ref: White)* | | | |
| Black | -0.333*** | -0.302*** | -0.282*** |
| | (0.0467) | (0.0469) | (0.0481) |
| Pakistani | -0.220*** | -0.178*** | -0.0886*** |
| | (0.0256) | (0.0264) | (0.0282) |
| Other | -0.169*** | -0.155*** | -0.132*** |
| | (0.0261) | (0.0259) | (0.0258) |
| First born | | -0.112*** | -0.119*** |
| | | (0.0186) | (0.0184) |
| Number of siblings | | -0.0751*** | -0.0386*** |
| | | (0.00973) | (0.0101) |
| LBW | | -0.0243 | 0.00263 |
| | | (0.0300) | (0.0296) |
| Multiple birth | | 0.145*** | 0.161*** |
| | | (0.0523) | (0.0516) |
| Planned pregnancy | | | 0.0761*** |
| | | | (0.0131) |
| Mum age birth | | | -0.00760*** |
| | | | (0.00133) |
| *Mother's education (ref: high school)* | | | |
| Degree | | | 0.225*** |
| | | | (0.0190) |
| A levels | | | 0.130*** |
| | | | (0.0167) |
| *Household income (ref: 5th quintile)* | | | |
| UK 1st quintile | | | 0.196*** |
| | | | (0.0266) |
| UK 2nd quintile | | | 0.147*** |
| | | | (0.0253) |
| UK 3rd quintile | | | 0.0964*** |
| | | | (0.0240) |
| UK 4th quintile | | | 0.0102 |
| | | | (0.0229) |
| Mother mployed | | | -0.0480*** |
| | | | (0.0127) |
| Observations | 12,281 | 12,243 | 12,225 |

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

# Chapter 4

# Fertility treatments and divorce[15]

## Evidence from the National Survey of Family Growth (2002-2013)

*Abstract:* The experience of infertility and subsequent treatment is a very stressful one and may lead to lower couple satisfaction and instability, or conversely bring the partners closer together and increase marital stability. High levels of couple satisfaction have been observed among couples during or just after the treatment. However, very little evidence exists on the probability of divorce following a treatment, especially in the longer term. Further, virtually no studies have considered both successful and unsuccessful treatments, which is a crucial distinction since the experience of childbearing is itself a main determinant of marital stability.

This study investigates the association between the use of fertility treatments and divorce in a sample of American women in their first marriage (N=11,498). Discrete-time event history analysis on data from the National Survey of Family Growth (NSFG) 2002-2013 shows that women who used fertility treatments have overall a lower probability of experiencing divorce. This is especially true when the treatment is successful. However, also women who do not conceive after the treatment have a lower probability of divorce compared to childless women who never started a fertility treatment.

[15] This study is co-authored by Maria Sironi, UCL and Nuffield College.
Earlier versions of the study were presented at the Population days in Florence, February 2017, at the PAA in Chicago, April 2017 and at the LSQ seminar at ENSAE (CREST), November 2017. I would like to thank Alice Goisis, Ridhi Kashyap and Sander Wagner for their comments.

## 4.1 Introduction

The prevalence of impaired fertility is difficult to assess. The current worldwide level of infertility is estimated at 9% of females in the reproductive age group who are in a marital or consensual union, and not conceiving within one year while not using contraception (Boivin et al., 2007). This means that a consistent number of women and couples seek and undertake treatments of infertility, and the numbers are expected to increase in the future in light of social and demographic trends, such as childbearing postponement and the technological development of treatments (Mills and Präg, 2015; Calhaz-Jorge et al., 2016). Fertility problems impose profound physical, psychological, and social strains on both partners in a couple, and this can negatively affect the quality of the relationship (Cook et al., 1989; Colpin, 1999; Kjaer et al., 2014). However, most empirical evidence about couples' relationship during and after fertility treatment found high levels of marital satisfaction (Ulrich et al., 2004; Peterson et al., 2011; Borneskog et al., 2012), and scholars have argued that the stressful experience might bring the two partners closer and strengthen the relationship (Ulrich et al., 2004; Schmidt et al., 2005).

The questions of whether and how the use of fertility treatments might be associated with marital (in)stability are important for several reasons. First, the increasing number of families that are formed with the aid of these treatments makes it necessary to expand the existing knowledge about the associated consequences. Furthermore, different factors interact in the association between treatments and risk of divorce, making it difficult to make a priori predictions. As in most countries, fertility treatments remain very expensive and not or only partly financed by public health care system (Prag and Mills, 2017), important socio-economic gradients exist in accessing them in terms of age, education, income, and employment (Klemetti et al., 2004, Chambers et al., 2014;

Adashi et al., 2016; Barbuscia and Mills, 2017). These factors, in turn, are all associated with marital stability (Amato, 2010; Lyngstad and Jalovaara, 2010; de Graaf and Kalmijn, 2006). Therefore, it is crucial to consider how the demographic and socio-economic profile of women and couples accessing the treatments might be associated to the risk of divorce.

While the risk of divorce might overall be lower among those seeking fertility treatments on account of their higher socio-economic status, the success of fertility treatments among those who access is also likely to be linked with divorce risks. Existing literature shows that experiencing a birth per-se is usually found to decrease the probability of divorce (Morgan and Rindfuss, 1985; Waite and Lillard, 1991; Lyngstad and Jalovaara, 2010), even though with important variations depending on age, parity (Heaton, 1991; Boheim and Ermisch, 2001; de Graaf and Kalmijn, 2006; Amato, 2010), and on whether the birth was intended or unintended (Guzzo and Hayford, 2012). The special case of children born after fertility treatment, who are really desired (Gibson et al., 2000; Colpin 2002) and implicate high parental investments (Golombok, 2015), may lead to even higher couples' satisfaction and marital stability. However, undertaking a stressful treatment that does not result in a live birth may be particularly detrimental for individual wellbeing and potentially for the stability of the couple (Verhaak et al., 2007; Baldur-Felskov, 2013, Kjaer et al., 2014).

While some evidence exists about dimensions, such as feelings toward the partner and quality of relationships during or after treatments (Ulrich et al., 2004; Schmidt et al., 2005; Peterson et al., 2011; Borneskog et al., 2012), only very few studies have looked at the probability of divorce or couple dissolution, especially considering a longer time-span after the treatments. The existing literature, mainly from Scandinavian

countries, focuses on dissolution after unsuccessful treatments (Kjaer et al., 2014), showing a higher probability of dissolution among couples who experienced unsuccessful treatments compared to successful ones up to 12 years after the evaluation of infertility.

The availability of longitudinal, retrospective information coming from the US National Survey of Family Growth (NSFG) allows us to follow a large sample of women since the beginning of their first marriage. We use discrete-time survival analysis to study the probability that they experience a divorce, and its association with fertility treatments and childbirth (controlling for demographic and socio-economic characteristics). We consider different kinds of fertility treatments. These include In Vitro Fertilization (IVF) and Intracytoplasmatic Sperm Injection (ICSI) - the two most common Assisted Reproductive Techniques - Intrauterine Insemination (IUI), and ovarian stimulating drugs not followed by any further treatment.[16] Studying the consequences of fertility treatments in the long-run is an important contribution to the existing literature, which has usually looked at the outcomes during or shortly after the use of the treatment. Furthermore, to the best of our knowledge, this is the first study to compare both successful and unsuccessful treatments and couples not undertaking any treatment, while taking into account important individual sociodemographic characteristics. It is also the first one to look at consequences of the use of fertility treatments on couples in the US context.

Results show that undertaking a fertility treatment is associated with lower risks of divorce even after controlling for the fact that those accessing fertility treatments are positively selected on socio-economic characteristics. The association is particularly

[16] Assisted Reproductive Technology is defined as all treatments or procedures that include the *in vitro* handling of both human oocytes and sperm or embryos for the purpose of establishing a pregnancy.

strong when the treatment results in a live birth. However, experiencing an unsuccessful treatment is also linked to lower risks of divorce compared to remaining childless without starting any treatment. To interpret the results, it is important to highlight that the lack of any information about the quality of relationship or the desire to have children before starting (or not) the treatments does not allow us to make any causal claim on the observed associations.

## 4.2 Background and hypotheses

### 4.2.1 Fertility treatments and couples' relationship

Several studies of couples undertaking fertility treatments have shown that the experience of infertility and going through the treatment can simultaneously be seen as a challenge and a source of benefits for couples' relationship and stability. Scholars have argued that it may have detrimental effects on one or both partners' wellbeing and, therefore, on couples' relationship (Cook et al., 1989; Colpin, 1999; Kjaer et al., 2014). Studies found that diagnosed infertility is connected with high levels of relationship instability and low sexual satisfaction in both men and women (Verhaak et al., 2007). A study on women 10 years after In Vitro Fertilization (IVF) showed that, while 17% declared to have permanent problems resulting from infertility, 66% said infertility had made them depressed at times, and 70% said that the period of infertility had influenced the relationship with their partner for many years. Respondents often mentioned how the communication with their partner for years had been dominated by having children, getting pregnant, and related topics (Sundby et al., 2007).

However, most empirical evidence has found a good relationship quality and high marital satisfaction among couples during and after fertility treatments. A study on 2,250 women and men reported marital benefits from fertility treatments, with 26% of

women and 21% of men reporting that the treatment had strengthened the marriage and brought the partners closer together (Schmidt et al., 2005). Respondents described how the infertility experience forced the partners to talk about existential aspects of life and to manage stressful situations (Schmidt et al., 2005), and in general had strengthened their marriages and improved their mutual connection (Peterson et al., 2011). A study analyzing homosexual and heterosexual couples undertaking IVF in Sweden reported that, overall, couples had good levels of satisfaction regarding their relationship (Borneskog et al., 2012). Ulrich and colleagues (2004) also found high partnership satisfaction among couples that started IVF. A prospective longitudinal study on couples with singleton pregnancies showed that the marital relationship one year after successful ART was not negatively affected, and some respondents reported that the shared stress of infertility even stabilized the relationship (Repokati et al., 2007). Holter and colleagues (2006) assessed 117 couples before, during and one month after treatment, and found no overall significant change on views of marital relationships. Instead, most spouses tried to be close and support each other during and immediately after the treatment. The majority of respondents also said the treatment had positively affected their relationship with the spouse, both in the pregnant and non-pregnant group.

In light of the existing evidence about fertility treatment and marital satisfaction, we hypothesize that the experience of infertility and undertaking the treatment is linked with higher marital stability and, therefore, lower risks of divorce (H1).

### 4.2.2 Fertility treatment and individuals' background

The demographic and socio-economic background of individuals and couples who undertake fertility treatments has been investigated in the literature. The high costs of

the treatments, and the relatively late age at which many women and couples start seeking medical help to have children, mean that those who access the treatments are a selected group, not representative of the average population (Chambers et al., 2014, Klemetti, 2004). Important differences exist in the utilization and selection of treatments across countries, especially in relation to regulations and public funding (Brigham et al., 2013; Mills and Präg, 2014) and the cultural acceptance of the treatments (Präg and Mills, 2017).

In the US, where fertility treatments are in most states not or only partly covered by the public health care system (Adashi et al., 2016), the costs of treatment range from around 500 USD for intrauterine insemination to 26,000-28,000 USD for IVF with donor eggs (a cycle of regular IVF costs on average between 10,000 and 12,000 USD). It is also very difficult (and expensive) to obtain private health insurance that covers not only infertility testing, but also subsequent treatments when not required by the state law (source: advancedfertility.com). Therefore, important gradients exist in the use of ART and other kinds of treatment. Previous findings have shown that individuals and couples who can access and afford the treatments tend to be on average older, highly educated, and with higher income, compared to parents who conceive without any medical help (Chandra et al., 2014; Chambers et al., 2014; Adashi et al., 2016). It is necessary to consider these characteristics when studying the link between the use of fertility treatments and couples' stability, as demographic and socio-economic factors are shown to be important for marital stability (Amato, 2000; Harkonen and Dronkers, 2006). Therefore, it is possible that observed differences in divorce rates and timing might be related to the selective characteristics of treated individuals rather than to the use of the treatment itself.

A rich literature has explored the determinants of divorce. Although a complete review of such studies goes beyond the scope of this work, it is crucial for our aim to emphasize some main findings on this regard, especially given that they might be relevant for the specific population that we are considering. Well-established risk factors for divorce are marrying as a teenager, being poor, experiencing unemployment, achieving low education, experiencing premarital cohabitation and premarital birth, inter-racial marriage, and growing up in families without the continued presence of two parents (Amato, 2010). Age at marriage has been shown to be an important risk factor of divorce, with higher age at marriage associated with lower probability of couple dissolution (Lyngstad and Jalovaara, 2010; Amato, 2010). The link between educational level of one or both partners and marital stability has been extensively explored by the literature and presents mixed results, with trends depending on the country and changing over time (Harkonen and Dronkers, 2006). American, Nordic and British studies usually found a negative effect of women's educational level on divorce rates (Berrington and Diamond, 1999; Teachman, 2002; Jalovaara, 2003; Lyngstad, 2004), while studies on Germany, Italy, Spain showed positive effects (Blossfeld et al., 1994; Kalmjin et al., 2004; de Graaf and Kalmijn, 2006; Harkonen, 2014). In the US, a negative correlation between women's education and divorce has been observed, with higher educational level linked to lower probability of divorce (Harkonen and Dronkers, 2006; Martin, 2006) for both Whites and Blacks (Orbuch et al., 2002).

Wives' employment, income, and economic resources have a less clear relationship with marital stability (Boheim and Ermisch, 2001; Harknet and Kuperberg, 2011). While according to both the sociological and the family economics literature, wives' independence should be linked to higher marital instability, empirical studies have shown that women employment and wages are not significantly associated with higher

risks of divorce (Sayer and Bianchi, 2000) and that wives' full- time employment might even be associated with greater marital stability (Schoen et al., 2006). Using the 1995 NSFG, Brambett and Mosher (2002) found that the odds of divorce were highest when women were not employed, second highest when women were employed full-time, and lowest when they were employed part-time.

Premarital cohabitation has been found to be consistently associated to a higher probability of divorce, likely due to a selection effect of couples that cohabit before marriage (Lillard et al., 1995; Lyngstad and Jalovaara, 2010; Teachman, 2011). Different probabilities of divorce were also observed among ethnic groups, with higher divorce rates in the Black population compared to White and Hispanic populations in the US (Bramlett and Mosher, 2002; Raley and Bumbpass, 2003).

In light of what we expect to be the selective characteristics of women undertaking fertility treatment, such as older age, higher education and socio-economic status, we expect that such characteristics might themselves be associated with lower divorce risks. Therefore, our second hypothesis is that women who undertook fertility treatments are a selective population, whose characteristics are correlated to lower risk of divorce (H2).

### 4.2.3 Fertility Treatments and childbearing

Among the factors and life events that might affect marital stability, childbearing is particularly relevant for the aim of this study. The desire to have a child is often one of the main reasons for establishing a union in the first place (Berrington, 1999), and the effects of having one or more children on couples' stability have been extensively studied in the literature. Earlier contributions usually found that having a child decreases substantially the probability of union dissolution, at least when the

number of children is small (Morgan and Rindfuss, 1985; Waite and Lillard, 1991; Andersson, 1997; Lyngstad and Jalovaara, 2010). Different results were found across countries, but the literature seems to agree in general on the stabilizing effect of first child and young kids (Heaton, 1991; Andersson, 1997), while this is much weaker for subsequent births and when the children are older (Andersson, 1997; de Graaf and Kalmijn, 2006). On the contrary, childless unions were shown to be relatively unstable, and studies found that a larger fraction dissolved compared to couples with children (Andersson and Philipov, 2002).

Theoretical links between childbearing and divorce are based on the idea that children are an example of union-specific capital. Benefits gained from having children are, therefore, bigger when the parents are living together than when they are not living together (Becker et al., 1977). It is not established whether the effect of childbearing on couples is a causal one or linked to the selection of couples into childbearing (de Graaf and Kalmijn, 2006); it is most likely a combination of the two effects. An important contribution in this respect was given by the work of Lillard and Waite (1993), who disentangled the selection and causal effects of childbearing by joint-modeling the determinants of child-birth and marital dissolution. Also, unintended pregnancies tend to increase the probability of couple dissolution (Guzzo and Hayford, 2012).

In light of the important role of childbirth for marital stability, we expect the effects of a treatment to depend on whether it is successful (i.e. followed by a live birth) or not (Klemetti et al., 2009; Kjaer et al., 2014). In case of successful treatments, we might expect a positive effect of the treatment linked to the experience of childbearing. However, births occurring after the use of fertility treatments represent a special case of particularly desired children (Colpin, 2002; Golombok, 1995; 2015), which may be linked to even higher satisfaction about parenting (Gibson, 2000; Golombok et al.,

2004). In a utility maximization perspective, fertility treatments represent a high investment into having a child together, and this may raise the opportunity-cost of divorcing.

Therefore, we hypothesize that women who experienced a successful treatment have a lower risk of divorce compared to childless ones (both those who started a treatment but did not achieve childbearing, and those who never started a treatment), but also compared to women who naturally conceived a child (H3.a).

On the contrary, literature has shown that unsuccessful treatments may be highly detrimental for marital stability (Verhaak et al., 2007; Klemetti et al., 2009; Baldur-Felskov, 2013, Kjaer et al., 2014). Evidence from Denmark showed that women with fertility problems who did not succeed in having a child had a higher likelihood of divorce up to 12 years after the medical assessment than women who did have a child (Baldur-Felskov, B., 2013, Kjaer et al., 2014). Other studies found that unsuccessful IVF treatment was a predictor for decreased satisfaction with the marital and sexual relationship (Verhaak et al., 2007).

Hence, our last hypothesis is that women who experienced an unsuccessful treatment have a higher risk of divorce compared to women who had a live birth, and also compared to women who did not experience a childbirth and never started a treatment during the marriage (H3.b).

## 4.3 Data and measurements

The National Survey of Family Growth (NSFG) gathers information on family life, marriage and divorce, pregnancy, infertility, use of contraception, and general and reproductive health of a nationally representative sample of women aged 15-44 in the United States. Cycles 1-5 of the NSFG were conducted as periodical cycles in 1973,

1976, 1982, 1988 and 1995. The Survey is conducted by the Centers for Disease Control and Prevention's (CDC) National Center for Health Statistics (NCHS). We used data from Cycles 6-8, which provide information about the use of fertility treatments. Cycle 6 was carried out in 2002, Cycle 7 was carried out between 2006 and 2010 and consists of continuous interviews, and Cycle 8 was conducted between 2011 and 2013. As we only considered women entering their first marriage, our final sample consisted of 11,498 women (from the initial sample of 25,523), and 613 of those women were treated for infertility problems and started a treatment with the partner of interest. We excluded women in cohabiting relationships because of the lack of information in the NSFG about the precise dates of union start and dissolution. It is important to bear in mind that this means our sample was a selected part of the original sample, as important ethnic and socio-economic gradients in entry into marriage exist in the US (among others, see Cherlin, 2004). We chose to consider only first marriages, thus excluding women who undertook treatments in subsequent marriages, to have a sample that is as homogeneous as possible. Indeed, entering a second (or higher order) marriage might be associated with observable and unobservable characteristics that are, in turn, related to different risk of divorce.

Women were observed from the date of their first marriage until the date of divorce or of interview. This means the average observation time was 93.2 months (SD = 76.2). The information about the date of marriage and divorce was provided by the NSFG in century months, as were the dates of other life-events included in the dataset. Information about the use of fertility treatment was based on the question whether the respondent had ever received any medical help to get pregnant. The following treatments were included: IVF and ICSI, IUI, ovarian stimulating drugs, and other less common treatments of infertility, such as uterine fibroid surgery or treatment for

endometriosis. We considered as treated those women who undertook IVF, ICSI, IUI, or stimulating drugs[17] not followed by any further treatment. In the final analyses, we did not distinguish between the different treatments, as separate analyses would lead to small sample sizes[18]. The variable indicating that the respondent undertook a treatment is time-varying. It takes value one in the time-period when she had a first medical visit to get pregnant while in her first marriage, and maintains value one in the following time-periods when she is observed. As for the outcomes of the treatment, we considered a treatment successful when a live birth was experienced after the beginning of the treatment and while the woman was still in the union.[19] The measure indicating that the respondent had a successful treatment takes value one when a child was born after the first medical visit while in her first marriage, and maintains value one afterwards.

In terms of confounders, we included a number of controls for socio-economic and demographic characteristics that are associated both with the risk of divorce, and with the access/use of fertility treatments: respondent's ethnicity (*Black*, *White*, and *other* ethnic background), age at marriage, educational level (*high education* if the respondent had a degree or equivalent, *middle education* if the respondent had high secondary education), mother's educational level (*mother's high education* if she attended some

[17] Out of 1,236 women who had a first visit to receive medical help to get pregnant, 75 women underwent IVF or ICSI, 135 Artificial Insemination, 403 used Ovarian stimulating drugs without undergoing any other treatment. The 614 women who used other kinds of fertility treatment (such as surgery to blocked tubes or only receiving medical advice) were excluded from ours sample in the final analyses. However, we included them in the treated sub-sample in sensitivity analyses. The results were very similar, but less statistically significant.

[18] In sensitivity analyses we ran the same models on the sample divided by the kind of treatment, however, results (available upon request) showed no significant differences depending on the kind of treatment.

[19] We tried different specifications of the analyses where treatments were considered as successful only when a live birth occurred within a specified time-period. Results, available upon request, are virtually identical. However, we considered the choice of the time limit to be extremely arbitrary. Furthermore, the great majority of births occurred relatively shortly after the beginning of treatments. Figure 4.3 in the Appendix shows the average length of treatments.

college or equivalent, *middle education* if she finished high school, *low education* if less than high school), whether the respondent had any live births before the first marriage (*premarital birth*) and whether she cohabited with the partner before the marriage (*premarital cohabitation*). We also included wave dummies to control for the possible time-change in patterns of divorce and of fertility treatments' diffusion. To disentangle the general effect of childbearing from the treatment one, we included a control for whether the respondent experienced a natural birth with the partner of interest (*natural birth*).

## 4.4 Analytical strategy

First, we show descriptive statistics of the sample, divided by whether the respondent received any medical help to get pregnant while in her first marriage. We used two-tailed t-tests to study if the differences between the two sub-samples were statistically significant[20].

To test our hypotheses about the association between the use of fertility treatments, background factors, childbearing and divorce we implemented discrete-time event history analysis, which allowed us to model the risk of dissolution and the effects of the covariates as time-varying[21]. Event-history analysis regresses the conditional probability of experiencing an event (divorce) at time t – provided that it has not happened before – on selected covariates. Data transformed to discrete-time format are analyzed with logistic regression models using STATA. The unit of time on which our

[20] A logistic regression model was also performed to study the predictors of undertaking a fertility treatment. Results are shown in Table 4.3 in the Appendix.
[21] We tried different specifications of parametric models. LL test suggested Gompertz model might be the most suitable to our data. Results (available upon request) go in the same direction, but show stronger effects.

analysis was performed was months; however, we created longer time intervals for the final months in the considered time-period, to avoid periods with no events.

The confounders were included in the analysis in a stepwise way. Model 1 shows the bivariate association between the use of fertility treatment and risk of divorce (*H1*). To test our second hypothesis about selection (*H2)*, model 2 included whether the respondent used any fertility treatment and demographic and socio-economic confounders. In model 3, we added the interactions between fertility treatment and childbirth, to explore the associations between both successful and unsuccessful treatments and the risk of divorce (*H3.a* and *H3.b*). By adding the interaction term, we were also able to compare these groups both with women who had a natural child and with women who did not have any child with the partner of interest.

## 4.5 Results

Table 1 shows the characteristics of the sample, divided by whether or not the respondent received medical help to get pregnant while being with the partner of interest. The two sub-samples differed significantly suggesting that women who accessed fertility treatment were indeed highly selected in terms of demographic and socio-economic characteristics. The great majority of women who undertook fertility treatments were White, 7.5% proportion of Blacks compared to the 15.7% among women who did not undertake any treatment. The average age at marriage was higher for both respondents and their husbands who used treatments, although the difference was small (approximately 1 year). Women who undertook some treatment were also more likely to have a higher educational level, and a mother with a higher educational level too, while they were less likely to have experienced a pre-marital childbirth and pre-marital cohabitation. In terms of marriage outcomes, the overall proportion of

respondents who experienced a divorce was significantly lower among women who had a fertility treatment (16% compared to 44% in the rest of the population), and the average duration of marriage was longer[22] (more than 122 compared to around 84 months). Slightly less than half of the treatments (46.9%) resulted in a live birth in our sample. This is lower than the average success rates of fertility treatments reported by the literature, and might be due to the inclusion of non-ART treatments in our sub-sample[23].

The consistently lower proportion of divorce and higher duration of marriage among women who undertook a treatment would suggest higher marital stability compared to women who did not undertake any treatment. However, these findings did not take into account any confounder and lack an understanding of whether they would differ when other factors are included. Results of discrete-time event history models to study the relationship between the odds of experiencing divorce, fertility treatments and covariates are shown in Table 2. Coefficients are displayed in the form of odds ratios. In model 1, the variable *treated* shows the association between having had a fertility treatment and the risk of experiencing a divorce. In the uncontrolled model, starting a fertility treatment was associated with around 50% lower odds of divorce (Model 1, OR=0.49, $p<0.001$). After adjustment for demographic and socio-economic characteristics (Model 2), the association between fertility treatment and odds of divorce was reduced (OR=0.6, $p<0.001$), however, it remained negative and significant. This was in line with our first hypothesis (H1) of higher marital stability among couples that undertook fertility treatments compared to couples that did not. It also suggested

[22] The distribution of the average duration of marriage on the sample divided by whether the respondent used any treatment is shown in the Appendix (Figure 4.2).

[23] Table 4.4 in the Appendix shows descriptive characteristics of the sample further divided by whether the treatment was successful or not, and among non-treated women by whether they had a natural birth or not while in the marriage.

that the lower odds of divorce observed among couples that undertook a treatment was not entirely mediated by their demographic and socio-economic characteristics. The effects of individual controls went in the expected direction, with lower odds of divorce associated with high education of the respondent (OR= 0.85, $p<0.001$) and age at marriage (OR=0.93, $p<0.001$), and higher odds associated with black ethnicity (OR=1.43, $p<0.001$), premarital cohabitation (OR=1.52, $p<0.001$), and childbirth (OR=1.52, $p<0.001$). Maternal high education was associated with higher probability of divorce (OR=1.12, $p<0.001$). A possible interpretation is that having a highly educated mother might mean the woman grew up in a less traditional environment, likely linked to a higher acceptance of divorce. The results from Model 2 partially support our hypothesis about the effects of selective demographic characteristics and socio-economic background (H2). While older age at marriage and more advantaged socio-economic characteristics were associated with a lower probability of divorce as we expected, the association between the use of fertility treatment and marital stability was not fully explained by such characteristics.

The association between the use of fertility treatments and odds of divorce varied consistently depending on whether the treatment was successful or not. If the treatment was followed by a live birth, the odds of divorce were almost 60% lower compared to women who didn't have children or start any treatment during the marriage (the reference category) (OR=0.42, $p<0.001$, Model 3). An unsuccessful treatment, however, was associated with higher odds of divorce compared to successful treatment, but still significantly lower compared to the reference group (around 40%, OR=0.6, $p<0.001$) and to couples who naturally conceived at least a child (OR=0.8, $p<0.001$), although the difference was not statistically significant. Having a child, whether

naturally or following a treatment, was in general associated with a decreased risk of divorce compared to remaining childless.

These results support our hypothesis that the experience of a treatment followed by a live birth is associated with higher marital stability compared both to an unsuccessful treatments and remaining childless (H3.a). The hypothesis about the effects of an unsuccessful treatment (H3.b) was only partly supported: while it was linked to higher odds of divorce compared to the experience of a successful treatment, starting a treatment that did not result in a live pregnancy was still associated with lower odds of divorce compared both to not having a child and to having a natural birth within the marriage[24].

Figure 4.1 shows the predicted probability of divorce over time experienced by the four groups of women, after controlling for demographic and socio-economic characteristics. The estimates are taken from model 3 in table 4.2. For computational power issues, we merged time periods in groups of 5. For a clearer visualization, Figure 4.2 shows the predicted probability of divorce over time, where the estimates are taken from a model that is identical to Model 3 in Table 4.2, but where time was used as a continuous variable. Results of this model can be found in the Appendix (Table 4.5).

## 4.6 Conclusion and Discussion

Despite the fast increase in the use of fertility treatments occurred in the last decades, there is still a lack of knowledge about the outcomes in terms of couples' wellbeing and stability. This is important to assess, as the stressful experience of infertility and the

[24] Figure 4.3 shows that successful treatments tended to be longer than successful one, which might indicate a stronger perseverance of couples who had a successful treatment. To address the potential selection of couples who had successful treatments, we ran the same models on women who were treated and included length of the treatment as a confounder, with virtually identical results.

treatments might be linked to couple instability and divorce (Cook et al., 1989; Colpin, 1999; Kjaer et al., 2014), which is a detrimental event for the wellbeing of both adults and children (Amato, 2000). On the other side, it has the potential to bring couples closer (Ulrich et al., 2004; Schmidt et al., 2005) and is usually linked to a strong desire for children, which might be related to marital stability (Andersson, 1997; Lyngstad and Jalovaara, 2010). The literature has provided mixed findings, but most existing studies have focused on a short time-span around the treatment, and did not consider the interplay of multiple factors, such as whether the treatment was successful or not and individual background. These are crucial points: first of all, the treatments might have different effects depending on when the outcome is observed. Second, individuals and couples undertaking the treatments differ from other couples in terms of important demographic and socio-economic characteristics that might in turn be related to marital stability. Third, in the case of successful treatments, the effect is intrinsically linked to the experience of childbirth, which is an important determinant for couple stability. On the other side, an unsuccessful treatment might be linked to even higher levels of stress and dissatisfaction and therefore lower marital stability.

Thanks to the availability of longitudinal data on a representative sample, we were able to study the association between fertility treatments and the risk of marital dissolution over time (up to around 20 years after the marriage), and how this depended on the success of the treatment and on other individual characteristics. Using discrete-time event history analysis, we found that undertaking a fertility treatment was associated with a longer duration of marriage and a lower risk of experiencing divorce in a sample of American women in their first marriage. The association was particularly strong when the treatment was successful, namely when it resulted in a live birth, but even an unsuccessful treatment was associated with lower risks of divorce compared to

women who did not have any child or undertake a treatment during the marriage. Our results seem to confirm previous evidence about a relative stability of couples who undertake fertility treatments, and represents an important contribution to the literature as no previous studies had examined couples' stability following fertility treatments in the long-run or considered both successful and unsuccessful treatments. Furthermore, to our knowledge no such study had been carried on before in the US context.

The sub-sample of women undertaking fertility treatments differed consistently from the rest of the sample and was characterized by an older age, a higher educational level, and a lower probability of having experienced premarital cohabitation or birth. This was in line with previous findings, and likely reflects the high costs of treatments in the US. As expected, these selective characteristics were also associated with higher marital stability. However, they did not account entirely for the difference in the duration of marriage and probability of divorce observed between women undertaking treatments and not. We were also able to test that this relative stability was not due to the experience of childbearing, as experiencing an unsuccessful treatment was linked to higher marital stability as well. The last result was unexpected, since theoretical considerations and previous empirical findings suggested detrimental effects of treatments not resulting in a live birth for couples' relationships.

These findings might support the idea that going through fertility treatment has the potential to strengthen couples' relationship, and suggest that the effect partly remains even when the treatment is not followed by a live birth. However, we were not able in this work to argue any causal effect of the treatments on the probability of divorce. It is likely that couples that choose to start a fertility treatment are highly selected, not only in terms of demographic and socio-economic characteristics, but also in the quality of relationship and couple stability linked to the desire to have a child. This might drive

part of the results. With no available information on dimensions, such as satisfaction about the relationship with the partner or fertility intentions, we were not able to address this question, but acknowledge that it might be an important component.

Among couples that did undertake a treatment, it is also important to consider that the ones who experienced a successful treatment might be an even more selective population compared to those who experienced an unsuccessful treatment, both in terms of socio-economic characteristics and perseverance in the treatment. Although our findings were robust to adjust for observable characteristics, other unobservable factors might partly drive the results. In the same way, couples that chose to not have children might also represent a selected part of the population and in our sample a big proportion of them had cohabited and had a premarital birth.

Another limitation of the study is the lack of precise information about the order of fertility treatments undertaken, their duration, and whether childbirth is a direct consequence of the treatments, as we only know when women start seeking medical help to get pregnant and the date of childbirth. The choice to consider only marital relationships in our study makes the results specific to married couples, who are in the US context a selected subsample and, therefore, not representative of the average population. However, it also makes our results stronger, as the reference population is relatively homogeneous. Furthermore, despite the relatively liberal eligibility criteria for the access to treatments, married couples still represent the big majority of people who use the treatments.

**Table 4.1: Descriptive statistics of the sample, by use of fertility treatments**

| | Non-treated | | Fertility treatment | |
|---|---|---|---|---|
| | Mean | SE | Mean | SE |
| Ethnicity: White (%) | 73.1 | 0.004 | 84.6*** | 0.011 |
| Ethnicity: Black (%) | 15.8 | 0.003 | 7.5 *** | 0.008 |
| Ethnicity: other (%) | 11.1 | 0.003 | 7.8** | 0.008 |
| Age at marriage | 23.2 | 0.045 | 24.5*** | 0.127 |
| Partner's age at marriage | 26.4 | 0.062 | 27.8*** | 0.172 |
| Premarital cohabitation (%) | 54.6 | 0.004 | 48.4** | 0.020 |
| Premarital birth (%) | 27.0 | 0.004 | 4.4*** | 0.008 |
| High education (%) | 35.4 | 0.004 | 57.1*** | 0.020 |
| Middle education (%) | 48.5 | 0.004 | 38.1*** | 0.019 |
| Low education (%) | 16.1 | 0.003 | 5.5*** | 0.006 |
| Mother's high education (%) | 36.5 | 0.004 | 41.6** | 0.019 |
| Mother's middle education (%) | 32.7 | 0.004 | 39.4*** | 0.019 |
| Mother's low education (%) | 29.9 | 0.004 | 18.2*** | 0.010 |
| Childbirth (%) | 61.6 | 0.004 | 66.2* | 0.019 |
| Divorce (%) | 40.1 | 0.004 | 16.3*** | 0.015 |
| Duration of marriage (months) | 84.6 | 0.669 | 122.7*** | 2.64 |
| Treatment success (%) | | | 46.9 | |
| Duration of marriage before treatment (months) | | | 42.7 | |
| Duration of treatment (months) | | | 26.4 | |
| N | 10,885 | | 613 | |

Note: high education of the respondent refers to having a degree or equivalent, middle education to high secondary educational level, low education to less than high school diploma. High education of the mother refers to some college or higher, middle education to high school degree, low education to less than high school degree. Stars indicate whether the difference is significant according to two-way t-test. *p<0.05 **p<0.01 ***p<0.001

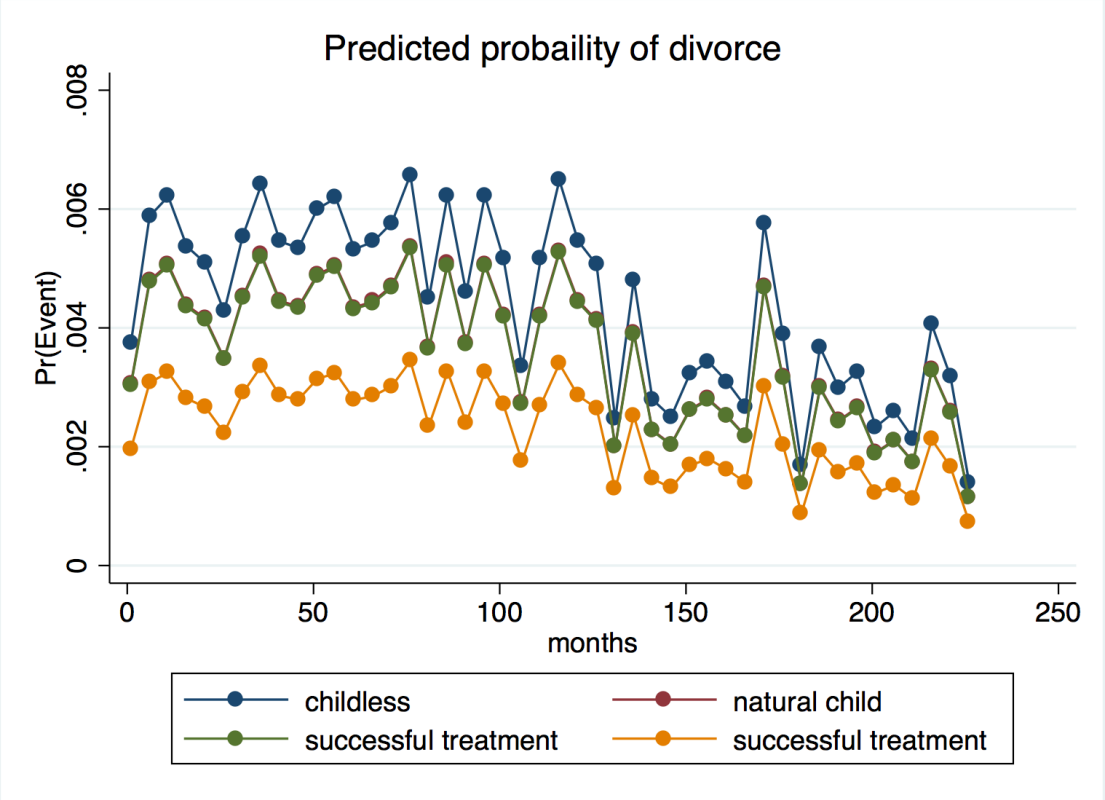
**Table 4.2: Odds of experiencing divorce and use of fertility treatments. Estimates from discrete-time event history analysis**

| | Model(1) OR/se | Model(2) OR/se | Model(3) OR/se |
|---|---|---|---|
| Fertility treatment | 0.494*** | 0.608*** | |
| | (0.050) | (0.062) | |
| *Treated # child (ref: no children, no treatment)* | | | |
| Successful treatment | | | 0.422*** |
| | | | (0.063) |
| Unsuccessful treatment | | | 0.634*** |
| | | | (0.090) |
| Natural birth | | | 0.788*** |
| | | | (0.029) |
| *Ethnicity (Ref: White)* | | | |
| Black | | 1.413*** | 1.421*** |
| | | (0.057) | (0.057) |
| Other | | 0.790*** | 0.797*** |
| | | (0.044) | (0.044) |
| *Education (Ref: low)* | | | |
| High education | | 0.867*** | 0.852*** |
| | | (0.046) | (0.045) |
| Middle education | | 1.173*** | 1.169*** |
| | | (0.051) | (0.051) |
| Age at marriage | | 0.926*** | 0.924*** |
| | | (0.004) | (0.004) |
| Premarital birth | | 1.498*** | 1.416*** |
| | | (0.056) | (0.055) |
| Premarital cohabitation | | 1.226*** | 1.229*** |
| | | (0.041) | (0.041) |
| *Mother's education (Ref: low)* | | | |
| High education | | 1.248*** | 1.238*** |
| | | (0.051) | (0.050) |
| Middle education | | 1.146*** | 1.134*** |
| | | (0.045) | (0.044) |
| *Year (Ref: 2002)* | | | |
| 2006-2010 | 0.979 | 1.005 | 1.008 |
| | (0.033) | (0.035) | (0.035) |
| 2013 | 1.097** | 1.112** | 1.111** |
| | (0.045) | (0.047) | (0.047) |
| Observations | 987,857 | 987,857 | 987,857 |

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

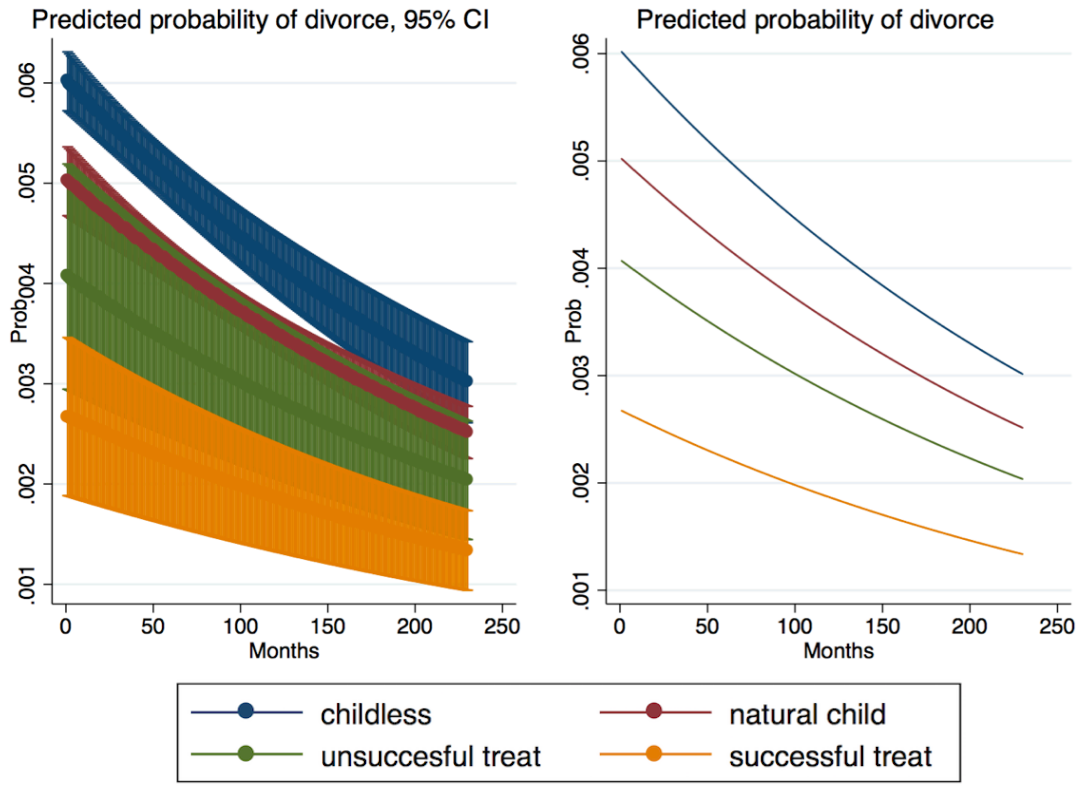
Notes: Discrete-time models provide estimates for each time-interval, however such estimates are not shown in the table. Reference categories for respondent's and mother's education variables are respondent' and mother's low educational level (less than high school).

**Figure 4.1: Predicted probability of divorce among women experiencing successful treatment, unsuccessful treatment, natural conception, no childbirth or treatment. Estimates from discrete-time event history analysis**




Note: the predicted probabilities come from model Model 3 in Table 4.2. For reasons of computational power, the time-periods were merged in groups of 5. The model controls for demographic and socio-economic characteristics of the respondents.

**Figure 4.2: Predicted probability of divorce among women experiencing successful treatment, unsuccessful treatment, natural conception, no childbirth or treatment. Estimates from continuous-time event history analysis**




Note: the predicted probabilities come from a model that is identical to Model 3 in Table 2 but where time was included as a continuous variable. The model controls for demographic and socio-economic characteristics of the respondents.

# Appendix

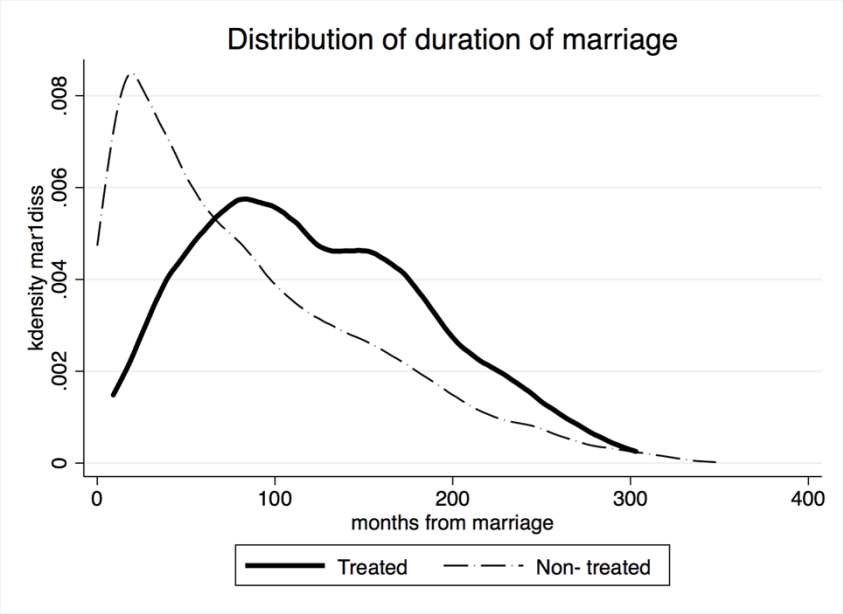



**Figure 4.2: average duration of marriage, by fertility treatment**

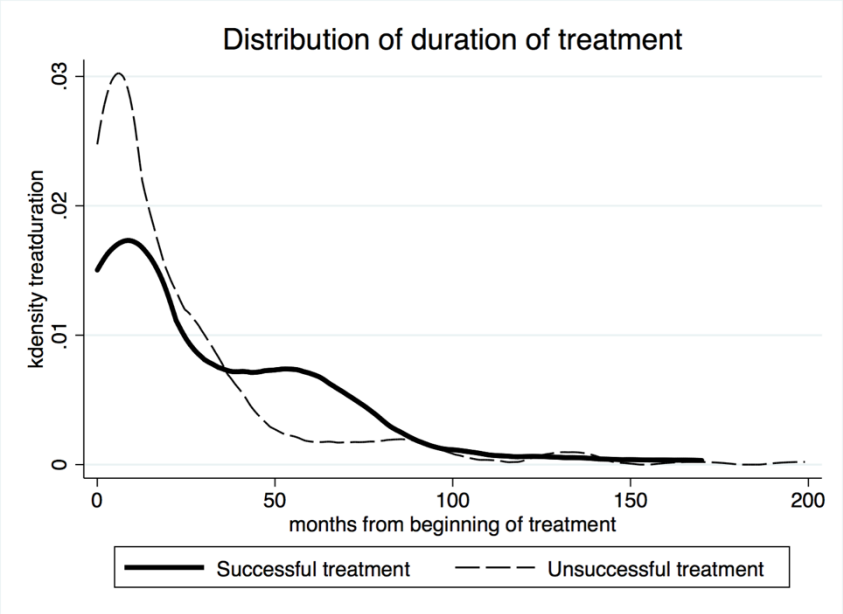



**Figure 4.3: Average duration of treatments**

**Table 4.3: Individual determinants of probability to undertake fertility treatments, estimates from logistic regression model**

| | OR/se |
|---|---|
| *Ethnic background (ref: White)* | |
| Black | 0.57*** |
| | (0.093) |
| Other | 0.67** |
| | (0.106) |
| *Education (ref: low)* | |
| Middle education | 1.91*** |
| | (0.393) |
| High education | 2.73*** |
| | (0.574) |
| *Mother's education (ref: low)* | |
| Middle education | 1.40*** |
| | (0.172) |
| High education | 1.09 |
| | (0.136) |
| Premarital cohabitation | 0.88 |
| | (0.078) |
| Age at marriage | 1.04*** |
| | (0.013) |
| Partner's age at marriage | 1.02** |
| | (0.008) |
| Premarital birth | 0.16*** |
| | (0.032) |
| *Year of interview (ref: 2004)* | |
| 2006-2010 | 1.14 |
| | (0.109) |
| 2013 | 1.03 |
| | (0.126) |
| Observations | 11,347 |

se in parentheses
*** p<0.01, ** p<0.05, * p<0.1

**Table 4.4: Descriptive characteristics of the sample divided by whether the respondent experienced no birth, a natural birth, an unsuccessful or a successful treatment**

| | **Non-treated** | | **Fertility treatment** | |
|---|---|---|---|---|
| | *No child* | *child* | *unsuccessful* | *successful* |
| Ethnicity: White (%) | 71.9 | 73.7* | 81.8 | 87.8* |
| Ethnicity: Black (%) | 18.7 | 13.9** | 10.1 | 4.5** |
| Ethnicity: other (%) | 9.2 | 12.3*** | 0.08 | 0.07 |
| Age at marriage | 24.3 | 22.5*** | 24.6 | 24.2 |
| Partner's age at marriage | 27.7 | 25.6*** | 28.2 | 27.3 |
| Premarital cohabitation(%) | 60.3 | 51.03*** | 49.8 | 46.8 |
| Premarital birth (%) | 38.2 | 20.1*** | 8.3 | 0.0* |
| High education (%) | 35.5 | 35.2 | 53.2 | 61.4* |
| Middle education (%) | 50.1 | 47.5* | 40.9 | 35.1 |
| Low education (%) | 14.3 | 17.2 | 5.8 | 3.4 |
| Mother's high education (%) | 39.8 | 34.4*** | 40.3 | 43.0 |
| Mother's middle education (%) | 33.9 | 32.0 | 38.1 | 40.9 |
| Mother's low education (%) | 25.2 | 32.9 | 20.9 | 14.9 |
| Divorce (%) | 52.0 | 32.6*** | 22.1 | 9.7*** |
| Duration of marriage (months) | 42.7 | 110.7*** | 110.7 | 136.1*** |
| Duration of marriage before treatment (months) | | | 50.3 | 34.1*** |
| Duration of treatment (months) | | | 22.3 | 30.9** |
| N | 4,182 | 6,703 | 325 | 288 |

Note: Stars indicate whether differences between non-treated couples who experience a birth after the marriage and who don't and between couples who experienced a successful and unsuccessful treatmenr are significant according to two-tailed t-tests.

**Table 4.5: Odds of experiencing divorce and use of fertility treatments, estimates from continuous-time event history analysis**

| | OR/se |
|---|---|
| Successful treatment | 0.44*** |
| | (0.066) |
| Unsuccessful treatment | 0.67*** |
| | (0.095) |
| Natural child | 0.83*** |
| | (0.030) |
| *Ethnic background (ref: White)* | |
| Black | 1.42*** |
| | (0.057) |
| Other | 0.80*** |
| | (0.044) |
| *Education (ref: low)* | |
| High education | 0.86*** |
| | (0.046) |
| Middle education | 1.17*** |
| | (0.051) |
| Age at marriage | 0.92*** |
| | (0.004) |
| Premarital birth | 1.43*** |
| | (0.05) |
| Premarital cohabitation | 1.23*** |
| | (0.041) |
| *Mother's education (ref: low)* | |
| Mother's middle education | 1.13*** |
| | (0.044) |
| Mother's high education | 1.24*** |
| | (0.050) |
| *Year of interview (ref: 2004)* | |
| 2006-2010 | 1.01 |
| | (0.035) |
| 2013 | 1.11** |
| | (0.047) |
| time | 0.99*** |
| | (0.000) |
| Constant | 0.023*** |
| | (0.002) |
| Observations | 989,474 |

se in parentheses
*** p<0.01, ** p<0.05, * p<0.1

# Chapter 5

# Conclusion

This research has been inspired by the increasing number of individuals and couples seeking treatments of infertility in the last few decades, especially among industrialized western societies. The technological development of more effective fertility treatments such as Assisted Reproductive Technologies has radically changed the extent to which fertility problems can be overcome, as well as processes of family formation. This means that, nowadays, a consistent number of children is born with the aid of fertility treatments and the numbers are expected to increase in the future (Calhaz-Jorge et al., 2016). If the overall demographic impact of ART and treatments it still debated, the importance of the availability of these techniques at the individual level and especially for part of the population (older, highly educated men and women in particular) is undoubtable (Sobotka, 2008; Kocourkova, 2014). In addition, it has generated important debates about the legitimization, regulation and funding of fertility treatments (Präg and Mills, 2015). Such discussions are often centered around the promotion of the well-being of families, and of children in particular, but the empirical evidence about the outcomes is still limited, especially in the long-run. A better knowledge of the consequence of treatments for the wellbeing of children and families, who in many countries represent nowadays a significant part of the population, could drive appropriate policy choices.

Existing studies have usually considered one outcome at a single point in time, are often based on very small samples size, and the literature lacks a broader understanding

of the consequences of the treatments for families as a whole. Although the results have been mixed and at times counterintuitive, there has been little attempt to examine the different mechanisms that might be operating and drive these results.

With this research, I contributed to the existing knowledge by examining the long-term outcomes of fertility treatments for both children and parents. Looking at different outcomes is crucial to reach a better understanding of the consequences of treatments. By highlighting the role played by the advantageous characteristics of couples who are able to access the treatments, I contributed to the understanding of the different factors and mechanisms operating. While some studies did show that individuals using treatment tend to be a selected population (Chandra et al., 2014; Chambers et al., 2014; Adashi et al., 2016), their demographic and socio-economic characteristics have usually been neglected by the literature exploring the outcomes of treatments. I hypothesized that the profile of individuals using the treatments might compensate for the health risks and the potential negative consequences of the stressful experience, with a similar mechanism to what has been observed for the effects of advanced maternal age (Goisis and Sigle-Rushton, 2014). Combining these two separate perspectives is one main contribution of this research.

## 6.1 Summary of the findings

Overall, the results of this thesis indicate positive outcomes of the use of fertility treatments, both in terms of children's development and couple stability. They also suggest that this is at least partly due to the older age and advantageous socio-economic characteristics of couples who access the treatments. Chapter 1 empirically showed that women who used different kinds of treatments in the UK and the US, which were the

geographical focus of this thesis, represented indeed a selective population. In both countries, they were predominantly White and on average older, with higher education compared to the rest of the sample. In the UK, where this information was available, they also had higher income and occupational status.

Chapter 2 and 3 focused on child development and the factors affecting it. I examined cognitive ability, which is an important determinant for several later life outcomes, and is developed starting from the very first years of life (Feinstein, 2003: Heckman, 2006). The results of Chapter 2 showed a good cognitive performance of children born with the aid of ART up to the age of 11. ART children had higher verbal cognitive skills than average up to the age of 7, despite higher risks of adverse outcomes at birth such as low birth weight and pre-term delivery. The better performance, however, was explained by parental characteristics and especially maternal age and education, and no significant association was found between the use of ART and cognitive skills after adjustment for parental background. This result suggested that the hypothesis of a (more than) compensatory effect of advantaged parental characteristics was in fact correct. Furthermore, the convergence in the children's cognitive performance by the age of 11 suggested that some mechanisms specific to the use of ART might be operating in the very first years of life of the children.

Chapter 3 built-up on the findings of chapter 2 and studied parenting style after the use of fertility treatments, and its impact on the cognitive development of children. Parenting style depends strongly on parental background and is an important factor for children's development (Brooks-Gunn and Markman, 2015; Ermisch, 2008). In addition, there are several reasons why it is likely to be affected by the experience of the treatments (Bernstein, 1990; Gibson, 2000). I analyzed two measures of parenting style at different ages of the children to assess whether significant differences existed

between mothers who conceived with the aid of some treatment compared to mothers who conceived naturally. The results showed that mothers who used fertility treatments tended to have a higher involvement with the child at the age of 9 months (through a measure of what I called *parenting beliefs*) and were more likely to read every day to the child at the age of 3, 5 and 7 years. All these measures (except for reading at the age of 7) were in turn associated with better cognitive skills of the child at age 11 after adjustment for parental background, suggesting that parenting style and activities were indeed a channel through which parental socio-economic background is transmitted. However, the difference in parenting between women who conceived after treatments and naturally was entirely accounted for by their background characteristics. This corroborated the findings of chapter 3, providing further support to the hypothesis of a crucial role of parental background for the development of children born after fertility treatments.

Chapter 4 looked at the outcomes of fertility treatments from the perspective of the parents and specifically examined marital stability. This is an important dimension of family functioning, as divorce and couple dissolution have been shown to affect parents' and children's wellbeing (Amato, 2010). The results showed high marital stability after the use of treatments, with lower risks of divorce observed among women who sought medical help to get pregnant compared to the rest of respondents for up to around 20 years. The advantageous socio-economic profile of these women was itself linked to higher marital stability, however background characteristics did not capture all the association linked to the use of fertility treatments. Women who undertook fertility treatments thus seemed to experience relatively high marital stability not only because of their advantaged socio-economic characteristics. The findings also showed that the relative marital stability was not only due to the experience of childbearing;

while a successful treatment was especially linked to decreased risks of divorce, even an unsuccessful treatment was associated to lower risks of divorce compared to not having any child during the marriage.

## 6.2 Discussion

A good development of children and high marital stability after the use of fertility treatments are important results in light of the debates and concerns that have surrounded the spread of ART and other treatments of infertility. Since techniques such as IVF have changed the way families can be created, the use of treatments has generated fears related to medical outcomes, children's development and families' wellbeing. Potential negative consequences of the treatments have been proposed as the argument to promote different regulatory or funding systems, but debates have been intrinsically linked to ethical and also political views and not supported by strong empirical evidence.

This research showed that the selective background of the couples who accessed the treatments was an important determinant of children's outcomes and parental involvement. This is in line with a broad literature on intergenerational transmission of status and highlights once again the importance of the different conditions and opportunities experienced by children coming from different backgrounds. It is an important finding as it indicates that it is crucial for studies looking at the consequences of fertility treatments to take into account important demographic and socio-economic confounders. Not considering such characteristics is likely to lead to biased results and an incorrect understanding of the outcomes of treatments. The results of the analysis of parenting style reinforced the importance of integrating this socio-economic perspective into the study of treatments' outcomes. While confirming that parenting

style is important for children's development and an important channel for intergenerational transmission, this study did not find a specific way of parenting after the use of treatments, if not related to parental background.

In conclusion, while the results of this research do not suggest that the use of treatments might bring positive consequences for children, they seem to indicate that treatments overall do not bring negative consequences, either. For ART children, as for naturally conceived ones, a good development was linked to the favorable conditions of growing up with older and more socio-economic advantaged parents. Since only children born from either cohabiting or married parents were included in this study, the results might underestimate the effects that we would find by comparing ART children with children born from single mothers as well, who in the UK represent a disadvantaged population (among others, see Goisis, 2013). It is also important to consider that the treatments in this study occurred in the year 2000-2001. The improvement in the techniques and the introduction of regulations such the ones about single-embryo transfer are usually linked to a lower incidence of adverse health risks at birth for treatments that occurs nowadays (Calhaz-Jorge et al., 2016).

Demographic and socioeconomic individual characteristics did not account entirely for the relatively high marital stability observed among couples who undertook a treatment. This suggests that something more specifically related to the use of the treatments might lead to higher stability compared to couples who do not start any treatment. Our findings were in line with previous studies showing that the experience of the treatments had a strengthening effect on some couples, who reported improved communication with and feeling closer to the partner (Ulrich et al., 2004; Schmidt et al., 2005). However, other characteristics are likely to distinguish couples who started a treatment in the first place and for which we could not control for. For instance, the

decision to undertake a long and stressful process such as fertility treatments is probably associated with a good couple relationship. Furthermore, it reflects the strong desire to have a child, which is itself an important determinant for marital stability (Berrington and Diamond, 1999; Amato, 2000). If we were not able to identify a strengthening effect of the treatments, because of the lack of information about quality of relationship or desire of childbearing, we can speculate that higher levels of marital stability among couples who start the treatments in the first place might at least partly drive the results.

It is important to keep in mind that comparing couples who undertook treatments with couples at the first marriage who chose not to have children, we were comparing extremely different groups. Although we controlled for observed confounders, there are likely to be important unobservable confounders. At the same time, differences other than the birth of a child might exist between couples who experienced a successful versus an unsuccessful treatment. The literature has shown that individual characteristics are predictors of the success of a treatment among people that access it (Smith et al., 2011). In our sample, women who had a successful treatment were on average more highly educated that those who had an unsuccessful treatment, and they were treated for longer, which might be a signal of strong desire to have a child and perseverance.

## 6.3 Strengths and limitations

This research has contributed to the existing literature in a number of ways. Looking at both children's and couples' outcomes allowed me to get a broader picture about the wellbeing and functioning of families after the use of fertility treatments. The use of longitudinal data on country-representative samples represented a main contribution to the existing studies, which have often relied on small samples sizes and lacked a longitudinal design (Hart and Norman, 2013). This is crucial, as the effects of

treatments might change depending on when the outcome is observed. Several scholars, for instance, have worried that consequences for children might emerge after childhood at the time when they become more independent, or when the parents disclose the way they were conceived (Golombok, 1994 ; Colpin, 2002).

The inclusion of non-ART fertility treatments was another relevant feature of this study. ART represent only a relative portion of the treatments of infertility that are used all around the world, but most studies on the outcomes of treatments have focused only on ART. The findings about similar mechanisms of selection and outcomes when considering treatments that are very different in term of accessibility, length, intensity and price might also suggest that the crucial discriminant is indeed to start seeking help to achieve a pregnancy and undertake the first steps of the treatments. This would suggest that, rather than focusing only on specific features of the treatments process, it is important to consider the process of selection into starting a treatment of infertility.

This research nevertheless suffers from some important limitations. Some of these limitations were discussed in more details in each of the chapters, but others, more general, need to be mentioned to interpret the results. Highlighting the limitations of this research is also important to identify potential areas for future one (discussed in the next section).

First of all, despite being an improvement compared to many earlier studies, both in the UK MCS and in the US NSFG, the sample sizes of women receiving treatments were relatively small, especially compared to the reference groups they were compared to. It was hence not possible to further identify important factors for the mechanisms linking the use of fertility treatments to the studied outcomes (for instance, stratifying the sample by maternal age or kind of treatments). Furthermore, the studies focused on

women (mother)'s characteristics only and lack a perspective on the role partners (and fathers)' characteristics.

The focus on one dimension of children's development (cognitive skills) represented another important limitation of this research. Despite the importance of cognitive skills for later development, it is necessary to look at other outcomes as well. Children could, for instance, experience a good cognitive development, and at the same time have worse behavioral or health outcomes. While there is a consistent literature on health outcomes at birth following fertility treatments, knowledge about the later health outcomes is still scarce. In this research, we were able to control for health outcomes at birth such as multiple births, and LBW, but later health outcomes as well as the development of non-cognitive skills were neglected.

The measures of parenting style analyzed were also indicative of only some dimensions of the many that constitute parenting, and looking at other components might have led to different results.

As already discussed in the chapter 4, a main limitation in the study of marital stability after the use of treatments was the lack of any information about the quality of relationship and desire for a child. Couples are likely to be relatively stable when (and if) they decide to start a treatment for infertility. However, in our study we were not able to account for any source of selection into treatment other than socio-economic characteristics. This represented an important limitation for understanding whether a potential causal link between the use of the treatments and marital stability might exist.

## 6.4 Future research

The results of this study have also highlighted the need to carry on further research on the outcomes of the use of fertility treatments. It seems especially important to reach

a comprehensive understanding of different dimensions of children's development and family relationships, in the long-run and based on representative samples. An important extension of this research would be the analysis of non-cognitive (behavioral) children's development over time. Non-cognitive skills are extremely important for later outcomes in life as well (Heckman et al., 2006; Cunha and Heckman, 2007; Cunha et al., 2010), and need to be considered in order to assess properly children's development. In addition, scholars have argued that the use of treatments and subsequent problematic parent-children relationships might lead to worse child development in terms psycho-social abilities (Wagenaar, 2008; Hart and Norman, 2013). The MCS provides rich information about the behavioral development of cohort members, through the Strengths and Difficulties Scales reported by parents starting from the second wave (and children themselves at the last wave), which would allow the study of children's behavioral development over time.

As a number of individuals born with the aid of fertility treatments are now reaching the adult age, it also becomes crucial to assess their health and wellbeing after childhood. Some scholars have suggested that health or socio-psychological problems may arise after childhood and especially when entering adolescence (Colpin, 2002). Others have worried that the use of treatments might be linked in turn to reproductive problems (Hart and Norman, 2013). The results of chapter 2, showing a convergent patter in the development of cognitive skills between ART and naturally conceived children by the age of 11 suggest that it might be important to look at the children's development over time.

Regulatory and funding frameworks differ consistently between countries and might change the extent to which individuals and couples are selected into treatments (Klemetti, 2004; Brigham et al., 2013). Therefore, another important extension of this

research would be to analyze the outcomes of fertility treatments in different contexts, to study whether similar mechanisms to the ones observed might be in act, and to what extent. An interesting setting for further research would be, for instance, Scandinavian countries. Because of the different regulations concerning the access to and funding of ART, the population accessing treatments is likely to differ from the UK and the US, which might impact the mechanisms of selection that played an important role in the outcomes studied in this thesis.

Another important area of development for the study of the outcomes of fertility treatments would be that of considering family structures that differ from the heterosexual, married or cohabiting couples. While, for the time being, these have constituted in fact the biggest part of population using fertility treatments, the number of single mothers and homosexual couples demanding and accessing the treatments is increasing over time (Calhaz-Jorge et al., 2016). While important debates have been centered on whether children can develop well in families that lack the traditional structure of a mother and a father, the evidence is still very scarce. With the availability of more data, the wellbeing of children and parents in these "new family forms" created with the aid of fertility treatments become a crucial target for research.

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