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The effect of fertility timing on women's earnings at midlife in the UK

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Title: The effect of fertility timing on women's earnings at midlife in the UK

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Abstract: An extensive body of research shows that motherhood has substantial impacts on women's earnings, but there is less evidence on the effect of the timing of motherhood, particularly in the long term and from contexts other than the US. This study analyses data from the 1970 British Cohort Study (BCS70) to examine whether the timing of motherhood affects women's midlife earnings, as well as the role of potential mediators (tertiary education, years in paid work, and number of children). We make use of the occurrence and timing of biological fertility shocks as a source of exogenous variation in the age at first birth. We find evidence for that avoidance of early motherhood may have a positive effect on women's earnings in midlife in the UK. This effect is likely to be mediated by years in paid work and number of children. These findings call for policies that support early mothers' employment careers.

Keywords: BCS70; age at first birth; employment; gender; labour market attachment; earnings

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1. Introduction

While there is an extensive body of research studying the negative effects of motherhood on women's careers (e.g., Cukrowska-Torzewska & Matysiak, 2020; Matysiak & Vignoli, 2008), the effects of motherhood timing have received less attention. The effects of fertility timing on labour market outcomes of women are particularly relevant in light of the current trend towards delayed childbearing (Mills et al., 2011). Over the past decades, there has been a strong trend towards later motherhood timing in European countries (EUROSTAT, 2021). In the UK, the average age of women at the birth of their first child has increased by almost three years since 1995 and reached 29.0 in 2018 (UNECE, 2021). Many studies, primarily from the United States (US) (e.g., Amuedo-Dorantes & Kimmel, 2005; Chandler et al., 1994; Hofferth, 1984; Taniguchi, 1999), have identified an association between later motherhood timing with higher wages and higher labour force participation of mothers. Knowledge about whether this association reflects a causal effect of fertility timing, which has the potential to contribute to understanding the consequences of the current trend towards delayed childbearing, remains more limited. Furthermore, insight into the effect of the age at entry into motherhood on women's labour market outcomes, such as earnings, can be relevant for policy decisions. A positive effect of later fertility timing on women's earnings would effectively imply a penalty for early childbearing, thereby calling for policies that reduce the burden on early mothers, for instance through improving the conditions for mothers in entry-level jobs. Despite accumulating evidence on the topic across countries, a large fraction of previous studies are still based in the US (e.g., Blackburn et al., 1993; Buckles, 2008; Herr, 2016; Miller, 2011; Troske & Voicu, 2013; Wilde et al., 2010), where fertility rates of young women born in the late 1960s and 1970s declined less than in most other high-income countries (Frejka & Sardon, 2006) and age at first birth remains comparatively low (Mogi et al., 2021). It is therefore important to provide further evidence on the relevance of the timing of motherhood from other contexts where the age at first birth has increased more strongly.

Methodologically, it is challenging to identify a causal effect of fertility timing on women's earnings due to processes of self-selection. Women with better career prospects might plan to start childbearing at a later age, while women with poor career prospects might choose early childbearing. Similar differences can exist depending on women's individual value judgment of childbearing. Instrumental variables (IV) regression utilizing biological fertility shocks (Bratti & Cavalli, 2014; Karimi, 2014; Miller, 2011; Rosenbaum, 2021) and family background characteristics (Blackburn et al., 1993; Chandler et al., 1994; Kind & Kleibrink, 2012) as instruments of fertility timing has previously been used to study effects of motherhood timing. However, the lower strength of such instruments has been at time considered a limitation (Bratti, 2015; Wilde et al., 2010). A common alternative approach has been the use of fixed effects models, (Amuedo-Dorantes & Kimmel, 2005; Buckles, 2008; Cantalini et al., 2017; Dumauli, 2019; Putz & Engelhardt, 2014; Taniguchi, 1999), which essentially compare the change in earnings following motherhood between groups of women who had a first birth at different ages, but who therefore may differ also in other respects. This study aims to overcome the methodological challenge of finding exogenous variation in first birth timing by exploring several analytical approaches, both established and innovative. First, the relationship of interest is analysed through a "naïve" ordinary least squares (OLS) model. Second, selection bias is addressed by an IV approach similar to earlier applications especially by Miller (2011) and Bratti & Cavalli (2014), using biological fertility shocks as a source of exogenous variation in the age at entry into motherhood. Third, we examine a more homogenous subsample of women whose first live birth was conceived as a consequence of contraceptive failure to address endogenous age at first birth without the use of an IV. The analysis is based on data from the 1970 British Cohort Study (BCS70). We focus on women's earnings at midlife as a measure of their labour market success, which can also be more broadly viewed as a facet of their socioeconomic status. We also explore to which extent the effect of fertility timing on midlife earnings can be explained by differences in completion of tertiary education, work experience, or total fertility.

This study contributes to the literature in the following ways. First, it does not only use biological fertility shocks as IVs following earlier applications, but also proposes an alternative approach to identifying a causal effect of fertility timing. Our empirical findings suggest that the validity of fertility shocks as IVs for the timing of fertility remains questionable. Triangulating results from three approaches using different identifying assumptions allows us to draw more robust conclusions. Second, this study focuses on women's earnings at midlife, considering outcomes measured at the ages of 46 or 42 (for women whose earnings at age 46 were not reported), as compared to many previous studies on the effect of motherhood timing that measured short- to medium-term outcomes, shortly after the first birth or when the women were still in their 30s (Amuedo-Dorantes & Kimmel, 2005; Bratti & Cavalli, 2014; Miller, 2011; Nisén et al., 2019; Taniguchi, 1999), or estimated average effects based on broad age ranges (Dumauli, 2019; Kind & Kleibrink, 2012; Putz & Engelhardt, 2014; Taniguchi, 1999). Investigating the effects of fertility timing on earnings at midlife is of particular interest because there are indications that fertility timing may have long-lasting effects on women's labour market outcomes, including their earnings (Buckles, 2008; Frühwirth-Schnatter et al., 2016; Herr, 2016; Hofferth, 1984; Karimi, 2014; Picchio et al., 2021). The level of earnings at midlife is important given that at this life stage women need to save for retirement as well as to support children, who may still have not finished their education (Kahn et al., 2014). Third, this study explores potential mediators of the effect of fertility timing on earnings. In particular, we focus on the cumulative number of years in paid work until midlife, number of children, as well as formal education. The first aspect is relevant given that previous research has found that employment trajectories with weak labour market attachment are associated with lower wages and lower subjective wellbeing later in life in women (Comolli et al., 2021; Weisshaar & Cabello-Hutt, 2020). Moreover, only few studies so far studied the mediating effect of total number of children (Amuedo-Dorantes & Kimmel, 2005; Buckles, 2008; Herr, 2016; Karimi, 2014), given common sample restrictions to earlier ages. Lastly, this study contributes to the discrepant evidence on the labour market effects of fertility timing in Europe (Bratti & Cavalli, 2014; Cantalini et al., 2017; Fitzenberger et al., 2013; Frühwirth-Schnatter et al., 2016; Karimi, 2014; Kind & Kleibrink, 2012; Leung et al., 2016; Lundborg et al., 2017; Nisén et al., 2019; Picchio et al., 2021; Putz & Engelhardt, 2014; Rosenbaum, 2021). This study is situated in the country context of the United Kingdom (UK), where public support for working mothers is weak as compared to other European countries (Brooks, 2012; Sigle-Rushton, 2008), leading to the expectation that motherhood timing may be consequential for mothers' earnings more similar to the US, and potentially also in the long term.

2. Fertility timing and women's earnings: a conceptual framework

2.1. Human capital: education and experience

One of the most frequently mentioned mechanisms of the effect of fertility timing on women's earnings is differential human capital. Human capital describes the resources of an individual that can contribute to increases in their future income, such as education or work experience (Becker, 2009). Early childbearing can have a negative impact on young women's possibilities to acquire human capital. Women who have children before finishing their education face various challenges, such as difficulties in combining parenting responsibilities with the time commitments required for their studies, as well as high costs of childcare in contexts such as the UK (Lyonette et al., 2015). These challenges may lead women who become pregnant during their studies to drop out of higher education and have a discouraging effect on mothers who are considering the pursuit of a higher degree. Since education is most commonly pursued in early adulthood, the negative effect of childbearing on educational attainment, and consequently on long-term work trajectory and earnings, is likely to affect mostly women who enter motherhood at a relatively early age, i.e. in their teens and early 20s (Hynes & Clarkberg, 2005; Miller, 2011; Taniguchi, 1999).

Child-related career breaks may importantly interrupt human capital accumulation at work (Mincer & Polachek, 1974) or lead to depreciation of existing knowledge or skills during the break (Mincer & Ofek, 1982). The magnitude of the missed human capital accumulation, as well as that of depreciation, is likely to increase with the length (and intensity) of the career break (Baum, 2002). The more strongly a woman's human capital is subject to depreciation, the more likely is she to experience a drop in her wages after returning to work after childbirth – in the absence of depreciation she may expect to return to their pre-motherhood wage levels (Miller, 2011). Women who are still at an early stage of their career and thus have lower earnings at the birth of their first child might have higher incentives to take longer career breaks due to the lower opportunity costs of staying at home and the low net earnings when the costs of childcare are high. Thus, a positive effect of fertility timing on women's earnings at midlife might be explained by the shorter birth-related career breaks of women who become mothers later. On the other hand, young women are more often at a crucial career stage where human capital accumulates quickly (Leung et al., 2016; Picchio et al., 2021) and where investment in human capital is particularly important for later career development (Herr, 2016; Taniguchi, 1999). In line with this argument, timing of work-interruptions was found to partly explain the gender wage gap in the US (Light & Ureta, 1995). The effects of motherhood timing on later earnings through human capital may accumulate also through the occurrence and timing of subsequent children, which may lead to additional career interruptions (Karimi, 2014; Troske & Voicu, 2013).

2.2. Work adjustment and effort

The theory of compensating wage differentials and work effort theory both provide another possible explanation for the decrease in women's career opportunities after childbirth. The theory of compensating wage differentials states that "unpleasant" job characteristics are compensated in the wage to ensure that the job is attractive to workers (Smith & Seligman, 1910). It is possible that mothers make adjustments in their work life to accommodate for care needs of their children by choosing to work in jobs that have more "pleasant" characteristics. Such jobs can thus be more easily reconciled with family responsibilities, for instance due to more flexible hours, part-time work, fewer over-hours, or requiring no travelling (Cukrowska-Torzewska & Matysiak, 2020). According to the compensating wage differentials theory, these jobs on average pay lower wages because workers can be attracted by the working conditions rather than by a high wage, leaving women who need these job characteristics to combine paid work with caring responsibilities with lower earning opportunities. We may assume that women with more than one child may face a stronger conflict between care and work demands, and may thus be more likely to revert to jobs with flexible working conditions.

Work effort theory also deals with work-family conflicts and suggests that mothers especially with multiple children might invest less effort into their work than childless women or men, since their effort is also required in caring responsibilities (Chandler et al., 1994; Cukrowska-Torzewska & Matysiak, 2020; Kaufman & Uhlenberg, 2000). Similar to the choice of more family-friendly working conditions, the exhibition of lower work efforts is likely to reduce earnings and career opportunities. A recent empirical study provides support for notions of both work effort as well as adjustment: the sizable reduction in earnings of Danish mothers after childbirth is driven by a reduction in work effort both at the extensive margin (i.e., labour force participation rates) and at the intensive margin (hours worked), and Danish mothers are more likely to choose family-friendly working conditions (Kleven et al., 2019). The long-term effect of a reduction in career opportunities may accumulate over the life course and be stronger for women who are at earlier stages of their career at the time of their first birth, which might explain a positive effect of later fertility timing on earnings later in life.

2.3. Discrimination

Finally, a decrease in women's earnings and career opportunities after childbearing that is not explained by women's human capital, work adjustment nor work effort, is often attributed to discrimination. Employers might expect women to invest lower efforts into their work after childbearing and might thus discriminate against mothers with one or multiple children. Correll et al. (2007) found in an experimental study that mothers are systematically assessed as less competent and offered lower starting salaries than childless women, fathers, or childless men. Moreover, Benard & Correll (2010) found that mothers who indisputably demonstrate high competence and commitment still experience discrimination because they are assessed to be colder and less likeable than equally successful childless women or men. Also the length of child-related career breaks could be interpreted by employers to signal work commitment, and therefore affect future earnings (Albrecht et al., 1999). Although Bratti & Cavalli (2014) found no evidence that the delay of the first birth would affect different aspects of employer discrimination (e.g., being offered less interesting tasks, less responsibility, or lower wages), the effects of employer discrimination might accumulate over the life course, which may lead to a positive long-term effect of later fertility timing on women's earnings at midlife.

2.4. The UK context

This study is situated in the context of the UK, a liberal welfare state characterised by the provision of many welfare services by the private market and non-universal state intervention (Brooks, 2012). The low availability of affordable childcare remains one of the most challenging aspects of combining motherhood with paid work in the country (OECD, 2020). Until the late 1990s, the UK government mainly relied on the private market for the provision of childcare, which led to a low availability of affordable childcare places. In 1998, the government started providing free childcare for children aged three to four for 12.5 hours a week (Sigle-Rushton, 2008). Although this policy led to an increase in the availability of childcare, it did not support the full-time employment of mothers due to the low number of hours covered. Family policy in the UK is characterized also by other aspects which reinforce traditional gender roles (Sigle-Rushton, 2008), such as low income compensation (OECD, 2019) and a generous length of maternity leave (OECD, 2021b). In line with the expectations based on these policies, both the motherhood wage penalty and the gender pay gap in the UK are above international averages (Cukrowska-Torzewska & Matysiak, 2020; OECD, 2021b). Given that negative effects of motherhood on women's earnings may accumulate over their life courses (Cantalini et al., 2017; Loughran & Zissimopoulos, 2009), we would expect that also the timing of motherhood may have long-term consequences in the context of the UK. Earlier evidence from the UK showed that teenage motherhood predicts lower chances of being employed and lower earnings at ages 30 and over, but that the relationship with earnings is explained by different chances of being employed at these ages (Ermisch, 2003).

3. Previous empirical evidence

3.1. Studies from the US

A large share of studies focusing on the effects of fertility timing on women's earnings, wages, or other labour market outcomes have analysed data from the US. The interest on the question of whether timing matters dates back to the 1970s (Cutright, 1973). Special attention, particularly in the US context, has been paid on teenage mothers, who often end up with lower-than-average educational and labour market outcomes, which seems to result at least partly from selection rather than causal effects of early births (e.g., Geronimus & Korenman, 1992; Hoffman et al., 1993; Hotz et al., 2005; Ribar, 1999). Blackburn et al. (1993), Chandler et al. (1994) and Taniguchi (1999) were among the first to identify a more general positive effect of delayed childbearing on women's wages in a sample representative of working women in the US. Amuedo-Dorantes & Kimmel (2005) assessed the effect of fertility timing on the motherhood wage gap, i.e., the wage difference between mothers and non-mothers, and found that college-educated women experienced a motherhood premium rather than a penalty, which increases in size with a later age of entry into motherhood. Buckles (2008) found a penalty across skills levels and ages, but also that higher-skilled mothers benefited more from a delay. Miller (2011) investigated the effect of the higher age at entry into motherhood on mothers' wages, wage growth rates and hours worked, notably using IV regression with biological fertility shocks very similar to one of the empirical approaches of the current study. She identified a positive effect of a delayed entry into motherhood on all three outcomes, and estimated an effect of 3.5% per cent on wages at age 34. Using the same US data source, Wilde (2010) adopted a different methodological approach by applying fixed effects models, confirming the beneficial effects of delaying motherhood for US women's wages. Troske & Voicu (2013) performed a simulation study focusing on women's labour market involvement. They found that a later timing of the first birth is associated with higher pre-birth labour market involvement, as well as a higher propensity to work and to work full-time in the year of birth. Herr (2016) found that later timing is beneficial for women's wages, but advocated for using a measure of career timing rather than absolute age at first birth, and showed that the beneficial effect of motherhood delay may be constrained only to (the majority of) women who enter the labour market before the first childbirth.

3.2. Studies from Europe

In the European context, the evidence on the effects of fertility timing on women's earnings and related outcomes is still accumulating, and the hitherto results are less consistent than those from the US. Bratti & Cavalli (2014) examined the effects of delayed childbearing on labour market outcomes among Italian women and found that a delay in the first birth has a positive effect on the mother's labour force participation and the number of hours worked in the two years after birth. In addition, the authors also provided an additional descriptive analysis, which indicated a positive effect of delayed childbearing on women's wages at the age of 40, in line with the findings from the American context. More recently, Picchio et al. (2021) also concluded that the delay of first childbearing strengthens Italian mothers' post-birth labour market attachment and earnings, but that very long delays may result even in larger reductions in employment and decreasing returns to earnings. For Germany, using an IV regression approach, Kind and Kleibrink (2012) estimated a 6.4 per cent increase in wages by an additional year of delay in first childbirth, while Putz and Engelhardt (2014) using a fixed effects approach in turn found larger wage gaps for mothers who had a higher age at first birth in Germany. Fitzenberger et al. (2013) also found that the effect of first-time motherhood on labour market participation may in fact be larger among women who de facto enter motherhood later in life in Germany. Frühwirth-Schnatter et al. (2016) suggested the later timing of motherhood in the long run to be associated both with a higher chance of a high-wage career, but also that of a labour market exit in Austria. In Denmark, Rosenbaum (2021) used an IV (with biological fertility shocks) design combined with siblings comparison and found that early motherhood (<25 years) has a negative effect on Danish women's earnings only until the early 30s, and that this effect is largely explained by the lower labour force participation of early mothers. Lundborg et al. (2017) suggested post-birth earnings losses to be larger among women who enter motherhood later, and Leung et al. (2016) found later timing to be beneficial for Danish women's cumulative lifetime earnings. In their study on Swedish women, Karimi (2014) exceptionally found a negative effect of fertility delay on earnings using various methods (incl. IV with biological fertility shocks). According to Cantalini (2017), earnings of Swedish women do not vary at age 40 depending on the timing of motherhood, despite a delay being beneficial for cumulative lifetime earnings. Nisén et al. (2019) found a positive effect of entering motherhood later on employment and income (until the early 30s) among Finnish women.[1]

3.3. Mediators and length of follow-up

When estimating effects of motherhood timing on earnings, some studies do not control for work-related human capital, given that it represents a mechanism of the estimated effect (Cantalini et al., 2017; Herr, 2016; Leung et al., 2016; Rosenbaum, 2021). In turn, other studies focus on effects net of differences in available measures of work experience (Amuedo-Dorantes & Kimmel, 2005; Dumauli, 2019; Karimi, 2014; Kind & Kleibrink, 2012; Putz & Engelhardt, 2014; Taniguchi, 1999; Wilde et al., 2010). The few studies paying attention to work history as a mediator tend to conclude that measures of education and work experience together (with varying other controls) explain a significant share of the observed differences in wages between women with different fertility timing in the US (Blackburn et al., 1993; Buckles, 2008; Chandler et al., 1994). Further, most previous studies either adjust for educational differences or assess effect heterogeneity by education, but it is not clear what share education explains of the total effects of fertility timing. Available direct evidence would suggest a partial mediating effect (Blackburn et al., 1993; Chandler et al., 1994; Nisén et al., 2019), for instance of about one third of the total effect on wages in the US as reported by Buckles (2008). Moreover, only few studies have controlled for the total number of children (Herr, 2016; Karimi, 2014; Wilde et al., 2010), which is awaited given the common age restrictions in prior samples. A mediating role of completed fertility is plausible given that later timing of motherhood predicts lower chances of subsequent fertility in many countries (including the UK) (Bratti & Tatsiramos, 2012), but previous US-based studies seem to suggest only a small mediating role of it (Amuedo-Dorantes & Kimmel, 2005; Buckles, 2008; Miller, 2011).

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[1] To add, Dumauli (2019) reported no differential motherhood wage penalty between early and late mothers in Japan.

Many of the studies presented above examined the effects of fertility timing on short-term outcomes, focusing on the first years after birth or following women until their early or late thirties. A notable early exception is a study by Hofferth (1984), who analysed the effects of fertility timing on women's economic wellbeing at retirement age in the US, finding that a delay of childbearing beyond the age of 30 had positive effects. Among the more recent studies, there is increasingly coverage of older reproductive ages and outcomes measured at ages beyond the reproductive ages. Among the studies utilizing an IV approach, Bratti and Cavalli (2014) and Miller (2011) included ages up to 37 and 34 respectively, and the former focused on labor market participation within a relatively short time span after the first birth. Blackburn et al. (1993) covered ages up to 38, which, given that the study sample is from the 1980s with a lower mean age at birth than currently, may be capturing long-terms effects present in that period fairly well. A recent study by Rosenbaum (2021) covered effects of early (below age 25) motherhood until age 40 with full-population data. Studies applying fixed effects models to shed light on the role of timing have often captured higher ages better, but are often based on rather small samples with a wide age range (see, for instance, Dumauli, 2019). Mean age was below 40 also in a number of other relevant studies (Amuedo-Dorantes & Kimmel, 2005; Kind & Kleibrink, 2012; Putz & Engelhardt, 2014; Taniguchi, 1999). In turn, in the studies by Buckles (2008), Wilde et al. (2010), Cantalini et al. (2017) and Karimi (2014), ages up to 40 and over were captured well. Among studies applying other approaches to investigate the effects of the timing of motherhood, some have a long follow-up to cover higher ages (Frühwirth-Schnatter et al., 2016; Herr, 2016; Leung et al., 2016; Lundborg et al., 2017; Troske & Voicu, 2013), while others are more limited in this respect (Fitzenberger et al., 2013; Picchio et al., 2021). Moreover, a recent study confirmed the positive association of later family formation with midlife earnings in women across Europe (Muller et al., 2020).

4. Methodology

4.1. Data

The analysis in this study uses data from the 1970 British Cohort Study (BCS70), which is an ongoing data collection following the lives of more than 17,000 people from the UK who were all born in the same week in 1970 (Elliott & Shepherd, 2006). The study population includes all people who were born in that week in Great Britain, and 95-98% of births in that week were captured in the initial data collection (UK Data Archive, 2022). The data collection takes place ca. every four years and covers a wide range of topics, such as family, education, health, employment, and finances. This study makes use of the richness of BCS70 data by incorporating information from throughout the cohort members' life course until 2016, when the cohort members were 46 years old. However, since both the outcomes and the independent variable of interest of this study (described later in this section) are only measured at one point in time, no panel data analysis was possible. The final sample includes 2,167 women for whom necessary information was available. Sample selection criteria are presented in detail in Table S1 in the Supplementary material. We note that the sample was restricted to women who reported the birth of their first child in the 6th sweep of data collection, since this sweep included the detailed history of previous pregnancies. Thus, the analytical sample consists of women who had their first pregnancy at the age of 30 or below.

Our main outcome of interest are earnings. These are measured at age 46 at the individual level as the weekly take-home income. However, since some cohort members did not participate in the 2016 sweep (ca. 26% of the final sample), data on earnings from the last available sweep (i.e., at age 42) are used instead. Earnings were modelled as a continuous variable and transformed to their natural logarithm to normalise the distribution.[2] We explored other operationalizations in a series of robustness checks. We also analyse three potentially relevant mediators of the effect of fertility timing on earnings: tertiary education, cumulative time in paid work, and the total number of children.

[2] To avoid the occurrence of missing values for women without earnings, 1 GBP was added to all the earnings before calculating the logarithm.

Tertiary education was assessed using information on the highest academic qualification recorded at age 34. Women who reported having obtained at least an undergraduate degree, a diploma in higher education (awarded after two years of full-time study at a university), or a teaching qualification were classified as having undertaken tertiary education. The cumulative time in paid work was assessed using data from the Activities dataset of the BCS70 study. This dataset provides detailed information on all activities carried out by cohort members since the age of 16 and was calculated until age 42, as no data was available for age 46 at this study's inception. It was measured in years and includes all types of paid work, whether it is in part-time or full-time work or in employment or self-employment. Periods of maternity leave, education, unemployment, illness, or unpaid care work were counted as time not spent in paid work. The total number of children included all children born by age 46, both in- and outside the household.

4.2. Analytical strategy

We conducted the analysis in four steps. First, the association between fertility timing and earnings as well as the three potential mediators was explored in an OLS regression model. Second, an IV regression analysis was carried out. Third, the OLS regression analysis was repeated in a restricted sample for which the potential for endogeneity was considered to be particularly low. Finally, a mediation analysis was performed to quantify how much of the effect of fertility timing on earnings was explained by the three mediators. Heteroscedasticity-robust standard errors were used in all analyses. Since the BCS70 study includes almost all people who were born in Great Britain in a specific week, neither weighting of observations nor controlling for cohort or period effects was necessary. The analysis was carried out using Stata 17.0 (StataCorp, 2021).

4.2.1. OLS regression

The OLS regression model can be written as:

$$Y_i = \beta_0 + A_i\beta_1 + \mathrm{X_i}\beta_2 + \varepsilon_i \quad (1)$$

Y_i denotes the outcome variable for observation i. A_i represents the age at entry into motherhood and X_i is a vector including several control variables for each observation *i* that are pre-determined before a woman's first birth. We control for the parental socioeconomic background by including a variable for the parental social class at birth of the cohort member and a variable for the cohort member's mother's age at completion of education as a proxy for the mother's educational level. We further included controls for factors related to parental fertility behaviour by including the mother's age at entry into motherhood, the marital status of the parents at birth of the cohort member, and a dummy variable for whether the cohort member was conceived out of wedlock. Moreover, the model includes the region of birth of the cohort member to account for regional differences in the socioeconomic status and fertility behaviour. Finally, to control for systematic differences between earnings at age 46 and at age 42, a dummy variable for the sweep from which earnings data was taken was included. We do not include controls for level of education or the total number of children in the regression, because we consider these as potential mediators that can explain part of the effect of fertility timing on earnings.

4.2.2. Instrumental variable regression

Although equation (1) includes a variety of control variables, cohort members' unobservable preferences with regard to family or career orientation may present an obstacle to our identification strategy. Thus, a two-stage least squares (2SLS) regression analysis was carried out using biological fertility shocks as an instrument to predict a woman's age at her first live birth. Two instruments were used for this analysis, both of which have been previously applied by Miller (2011). The first instrument was a dummy variable describing whether a woman experienced a miscarriage or stillbirth in her first pregnancy. In the BCS70 data, a loss of pregnancy before the 26^{th} week of pregnancy is defined as a miscarriage, whereas a loss of pregnancy after the 26^{th} week is defined as a stillbirth. If the first pregnancy was an abortion, information on the outcome of the first non-aborted pregnancy was used. The second instrument used in the analysis is contraceptive failure, measured as a dummy variable describing whether a woman's first child was conceived despite the use of contraception at the time of conception.

The IV regression analysis followed a two-stage approach, delineated below:

$$A_i = \alpha_0 + F_i\alpha_1 + X_i\alpha_2 + \nu_i \quad (2)$$
$$Y_i = \beta_0 + \widehat{A_i}\beta_1 + X_i\beta_2 + \varepsilon_i \quad (3)$$

where A_i denotes the age at entry into motherhood for women i and F_i is a vector of the two IVs. In the second stage, $\hat{A}_i$ denotes the predicted values for age at first birth from the first stage. Essentially, the IV model identifies the causal effect of fertility timing on the outcome by focusing on variation in the age at entry into motherhood induced by fertility shocks. For example, a miscarriage or stillbirth forces a woman who was about to have a child to delay childbearing until she gets pregnant again at a later point in time. Contraceptive failures are expected to affect fertility timing in the opposite direction, since women who experience a contraceptive failure would usually have their first child at a later point in time when they cease to use contraception.

For valid identification of a causal effect of fertility timing, we have to assume that biological fertility shocks occur as good as random, and that these shocks affect earnings only by changing age at first birth. For pregnancy loss, one concern is that there are behavioural factors that influence both the likelihood of experiencing pregnancy loss as well as socioeconomic status. However, a recent review concluded that lifestyle factors only play a minor role in predicting miscarriages and that most miscarriages can be attributed to structural malformations or genetic aberrations of the foetus, which are likely to be randomly distributed (Larsen et al., 2013). Another concern is the possibility of reverse causality, because the risk of pregnancy loss is higher at higher maternal ages. Yet, this association does not seem to occur before the age of 30 (Andersen et al., 2000; de La Rochebrochard & Thonneau, 2002; Magnus et al., 2019). Similarly, a woman's age might also determine her risk of contraceptive failure. However, the empirical literature on this question found that there are no major age-related differences in the risk below the age of 30 (Kost et al., 2008; Moreau et al., 2007). Finally, women's attitudes toward a potential pregnancy may also influence their risk of contraceptive failure. Ambivalence about pregnancy has been shown to be associated with less consistent use of contraception, which might increase the risk of contraceptive failure (Frost & Darroch, 2008). Moreover, women with a strong preference against motherhood at the time of the contraceptive failure might have been more likely to undergo an abortion than women who were more ambivalent. To avoid self-selection by abortion, women who had an abortion after a contraceptive failure prior to their first live birth were excluded from the analysis.

4.2.3. OLS regression in the restricted sample

The IV approach outlined in the previous section is not free from limitations, particularly with regard to the reliability of the instruments, on which evidence will be presented in section 6.3. The third step of the analysis applies an alternative approach to avoid potential endogeneity by focusing on a more homogeneous subsample in which differences in age at first birth are hypothesised to be randomly distributed: women whose first live birth was conceived as a consequence of contraceptive failure. The use of contraceptive failure as an instrument gave rise to concerns about differences between women who experienced contraceptive failure and women who did not, since contraceptive failure is partially determined by behavioural factors such as the consistency of use and the type of contraceptive used. When analysing only women who experienced contraceptive failure, it can be assumed that the sample is more homogeneous with regard to the behavioural determinants of contraceptive failure, because all women experienced a contraceptive failure at least once. Still, the presence of risk factors for contraceptive failure does not imply that a woman will get pregnant immediately, since the use of any contraceptive reduces the risk of pregnancy substantially (Black et al., 2010). Thus, even if contraceptive failures are not assigned completely at random, the exact timing of a contraceptive failure can be reasonably expected to be randomly distributed. Note that under this assumption, *age at first birth* would be randomly distributed, although the *desired* timing of fertility is not randomly distributed since all women in this subsample gave birth earlier than planned. This selectivity does not threaten the causal interpretation of our estimates in this subsample, which only depends on whether the timing of contraceptive failure can be considered as good as random or not (i.e., the internal validity). Yet, it does limit the external validity of our findings, because the effects of age at first birth on earnings may differ for women who give birth earlier than planned (included in this subsample) and for women who are able to realise their desired fertility timing or give birth later than planned (not included in this analysis). Based on these considerations, the OLS regression analysis was repeated among women whose first child was conceived as a consequence of contraceptive failure. Women who already had an abortion after a contraceptive failure prior to their first live birth were again excluded from the analysis, because for these women the assumption that the timing of the first birth caused by contraceptive failure is random is violated. Moreover, the same control variables were added to the model as in the previous approaches to adjust for any residual confounding.

4.2.4. Mediation analysis

A mediation analysis was performed to explore the role of three potential mediators in the effect of the age at entry into motherhood on earnings: tertiary education, cumulative time in paid work, and the total number of children. For the mediation analysis, we followed an approach suggested by VanderWeele and Vansteelandt (2014). Their approach allows evaluating the joint impact of more than one mediator. First, we estimate a regression model for earnings while controlling for all three mediators. For example, in the OLS model we would estimate the equation:

$$Y_i = \beta_0 + A_i\beta_1 + \mathrm{X_i}\beta_2 + \mathrm{M_{1i}}\gamma_1 + \mathrm{M_{2i}}\gamma_2 + \mathrm{M_{3i}}\gamma_3 + \varepsilon_i \tag{4}$$

where M_{1i} is an indicator for tertiary education of woman *i*, M_{2i} refers to the cumulative time in paid work, and M_{3i} is the total number of children for woman i. In a second step, we then estimate a separate regression model for each mediator *k*:

$$M_{ki} = \delta_{\mathrm{k0}} + A_i\delta_{\mathrm{k1}} + \mathrm{X_i}\delta_{\mathrm{k2}} + \nu_{ki} \tag{5}$$

Using this set of equations, we can derive the direct effect of age at first birth on earnings (which does not operate through the three mediators) as $DE = \beta_1$. The indirect effect explained by the three mediators is given by $IDE = \gamma_1\delta_{11}+\gamma_2\delta_{21} + \gamma_3\delta_{31}$, and the total effect of age at first birth on earnings is given as $TE = DE + IDE$. Standard errors around these estimates are derived using 1,000 bootstrap replications. Quantifying the impact of an individual mediator requires much stronger assumptions, in particular a clear sequencing of the *k* mediators. Total fertility and cumulative time in paid work are very closely related and establishing a clear sequence is not feasible. However, it seems plausible that completion of tertiary education precedes total fertility and cumulative work experience. Therefore, we quantify the individual impact of tertiary education by re-estimating eq. (4) while controlling only for tertiary education.

5. Results

5.1. Sample characteristics

The characteristics of the sample are presented in Table 1. On average, the women included in the analysis earned 253.84 GBP per week at midlife and had worked 17.65 years until age 42. However, it should be noted that both outcome variables have a high standard deviation, i.e., the values of many women were far above or below the mean. The low mean and the high standard deviation of earnings can be explained by the fact that many women (ca. 20.5% of the sample) were not in paid work at midlife and thus earned 0 GBP. The characteristics of these women without earnings are presented in Table S2 in the Supplementary material. These show that women without earnings in midlife came from lower SES backgrounds, had on average less education and had worked fewer years themselves, and much more often belonged to the lowest household income quintile than women who had some earnings.

Regarding the age at entry into motherhood, the cohort members on average had their first child slightly below age 24 (median age: 24), which is more than two years later than their mothers. Mean age at first birth is comparable with 1970s population figures in the UK (i.e. 23.7) and remains close to figures for 1994 (i.e. 26) – or when our cohort would have reached 24 years of age (ONS, 2022). Less than 10% of the cohort members experienced a miscarriage or stillbirth in their first pregnancy, and 15.51% conceived their first child while using contraception. The majority of the cohort members left the education system after achieving their O levels/GCSE, which were typically completed at age 16, the mandatory schooling age at that time. However, ca. one third of the cohort members continued their education after this stage and completed their A-levels or even a tertiary degree. Thus, the cohort members spent more time in education than their mothers, who on average left the education system below the age of 16. Most cohort members' parents were married at the time of their conception and birth and the majority of the parents belonged to the working class when the cohort member was born. Women in the sample had on average 2.36 children by age 46.

The mean age at first birth was higher among women who had miscarried than women who had not (24.75 vs. 23.91 years) and lower among women who experienced a contraceptive failure than among women who did not (22.49 vs. 24.27 years) (Table S3 in the Supplementary material). Further description of the sample is provided in Table S4.

[Table 1 about here]

5.2. OLS regression

Table 2 displays the results of the OLS regressions of earnings and the three potential mediators on the age at the first live birth and the control variables. In line with the findings of previous research, the results show a significant positive association, with a one-year delay of entry into motherhood being associated with a 7.2% increase in earnings at midlife. A significant association was also observed between earnings and the social class of the parents at birth, the mother's age at completion of education, as well as the parents' marital status at birth. We also find significant associations between age at first birth and all three mediators: delaying childbearing by one year is associated with an increase in cumulative time in paid work by more than half a year, an increase by two percentage points in the likelihood to complete tertiary education, and a reduction in the total number of children by 0.06.

[Table 2 about here]

5.3. Instrumental variable regression

Table 3 presents the results of the first stage of the IV regression analysis. On average, pregnancy loss in the first pregnancy was associated with a delay of the entry into motherhood by ca. 8 months, whereas contraceptive failure was associated with an advance in the entry into motherhood by ca. 19 months. Both instruments are individually significantly associated with fertility timing, and the Kleibergen-Paap F-statistic of their joint significance is 34.684.

[Table 3 about here]

The results of the second stage regression are displayed in Table 4. No significant effect could be observed on the earnings at midlife. The effect of age at entry into motherhood on the number of years in paid work was significant at the 10% level. The coefficients for both outcomes are similar to those in the OLS regression, albeit slightly lower. The estimates for tertiary education and the total number of children are much smaller than in the OLS regression, close to zero and not significant. Based on the IV results, it can be concluded that a one-year delay of the first birth due to biological fertility shocks increases the time spent in paid work until age 42 by almost five months.

[Table 4 about here]

5.4. OLS regression in the restricted sample

Table 5 displays the results of the OLS regression analysis in the restricted sample consisting only of women whose first child was conceived as a consequence of contraceptive failure. The coefficients for the age at the first live birth are once again similar to those of our naïve OLS estimation for earnings and all three potential mediators. Among women who entered motherhood after experiencing contraceptive failure, a one-year delay of the birth of the first child was associated with a 7.3% increase in earnings at midlife, an increase in the cumulative time spent in paid work until age 42 by half a year, a 1.4 percentage point increase in the likelihood to complete tertiary education, and a reduction in the total number of children by 0.071. As opposed to the IV results, findings are now statistically significant, at the 10% (earnings, tertiary education) and 0.1% significance-level (number of years in paid work, total number of children) respectively.

[Table 5 about here]

5.5. Mediation analysis

Table 6 shows the results of the mediation analysis, conducted for each of the three previously mentioned models. When considering all three mediators jointly, the analysis suggests that the total effect in all three models is essentially completely mediated by the cumulative time in paid work, tertiary education, and the total number of children. In all three different models, the direct effect is very small and statistically not significant, whereas the indirect effect is similar in size to the total effect. The opposite is true when considering only mediation through tertiary education – the direct effect of age at first birth on earnings is similar in size to the total effect, whereas the indirect effect operating through tertiary education is close to zero and (mostly) insignificant. Conversely, this suggests that the effect of age at first birth on earnings is almost completely mediated by time in paid work and total fertility. Further disentangling the contributions of these two mediators would require strong assumptions about their sequencing and is thus beyond the scope of this study.

[Table 6 about here]

6. Robustness

We conducted a series of sensitivity analyses to assess the robustness of our main findings. First, we re-estimated our regression models using different sample selection criteria. We then considered alternative operationalisations of the main dependent variable, earnings. Finally, we conducted a series of sensitivity analyses to examine the validity of our IVs.

6.1. Sample selection

Our working sample does not impose any restrictions on women's labour market participation. This means that the analyses include women with zero earnings, and more importantly also women that did not have labour market experience before entering motherhood. In particular, we might expect that delaying age at entry into motherhood on earnings should not have a positive effect on earnings for women who did not engage in paid work prior to their first childbirth (see Herr, 2016; Karimi, 2014). We therefore consider whether our results are sensitive to excluding women without work experience prior to their first childbirth. The results (Table S5 in the Supplementary material) show that estimates of the effect of age at first birth on earnings for all three models are similar in magnitude and significance to our main results. Next, we consider whether our effect estimates are affected by the exclusion of women who gave birth below age 20. Table S6 in the Supplementary material suggests that excluding these teenage mothers from the sample does not affect our OLS estimates. However, the IV estimates are now negative and insignificant, whereas the estimates among women who experienced contraceptive failure are considerably smaller and no longer significant. The latter result in particular might be because births due to contraceptive failure are more common below age 20. In our working sample, 27% of births below age 20 occurred due to contraceptive failure, whereas above age 20 only

13% of births occurred due to contraceptive failure. It also suggests that the premium for delaying childbearing may be larger below age 20.

6.2. Operationalisation of earnings

We examined whether our results are sensitive to the inclusion of earnings measured at age 42 for women who did not participate in the data collection at age 46. Using only information on earnings collected at age 46 results in larger and significant estimates in the OLS model and in the restricted sample, whereas the IV regression coefficients remain smaller and not statistically significant (Table S7 in the Supplementary material).

Next, we estimated our models using raw earnings to examine whether the transformation of zero earnings affected our results. Table S8 in the Supplementary material suggests that in the OLS model a delay in age at first birth by one year is associated with an increase in weekly earnings by £5. The effect is significant at the 0.1% level. The estimate for the IV model is negative and very imprecisely estimated, whereas the estimate in the restricted sample is not significant but very similar in size to the estimate from the naïve OLS regression.

We conducted two additional analyses to examine whether the observed relationship between fertility timing and earnings occurs at the extensive margin (having positive, non-zero earnings) or the intensive margin (the level of earnings conditional on having earnings). First, we re-estimated our models using a binary indicator for having any earnings as the dependent variable. The results (Table S9 in the Supplementary material) suggest that a delay in age at first birth by one year increases the probability of having any earnings by between 1.1 and 2.1 percentage points. Estimates in the OLS model and the restricted sample are very similar and statistically significant at the 0.1 and 10% level, respectively, while the larger IV estimates are not significant. Second, we estimate a distribution regression model to examine which part of the earnings distribution is showing the strongest response (see Chernozhukov et al., 2013). The results show that, as one could expect, effects are more significant for the portion of the earnings distribution closer to the average, while they lose significance the further we move away from this average, with top and bottom 10 percentiles showing consistently insignificance association (results available on request). Effects' magnitude reduces slightly when moving towards the extremes of the distribution, but remain overall comparable and always of the same sign.

6.3. Instrument validity

We conducted several additional checks to examine the validity of the two instrumental variables. First, the Sargan-Hansen test fails to reject the null hypothesis of joint instrument validity for all four outcomes considered in Table 4, suggesting that both loss of pregnancy and contraceptive failure are valid instruments for age at first birth. However, recent research suggests that the test can perform poorly and is not very well-suited to establish instrument validity (Kiviet & Kripfganz, 2021). Therefore, we next examined whether control variables included in our models are balanced across values of the instrument. All covariates are predetermined and refer to characteristics of the woman's parents. Following the arguments highlighted in section 4.2.2, we would thus expect that average levels of these covariates are similar for women who experienced loss of pregnancy or contraceptive failure and those who did not. Table S3 in the Supplementary material shows that there are significant differences in parental socioeconomic status between women that experience the loss of a pregnancy and those who do not. In contrast, parental characteristics of women experiencing contraceptive failure are very similar to those who do not. While we find a significant difference in the age of the mother at her first live birth, the magnitude of this difference of about half a year is relatively small. Finally, we implemented a recently proposed test of instrument validity and monotonicity (see Mourifié & Wan, 2017). The test rejects the null hypothesis of joint instrument validity and monotonicity at the 1% level for both instruments, regardless of whether we control for parental characteristics or not.

In summary, the results of these sensitivity analyses suggest that estimates from the naïve OLS regression and the regression in the restricted sample are generally robust to the examined analytical choices and typically very similar to each other. The latter model often lacks significance, which is not surprising given the relatively small sample size. In contrast, the IV estimates tend to be sensitive to different analytical choices. However, our examination of instrument validity also casts doubt on the validity of fertility shocks as instruments for age at entry into motherhood. Moreover, a Durbin-Wu-Hausman test also failed to reject the null hypothesis that, in our sample, age at first birth is exogenous (p=0.835). Therefore, the IV estimates presented in this study should be considered cautiously.

7. Discussion

7.1. Main findings and implications

The results of this study enhance our knowledge on the relationship between fertility timing and earnings at midlife. We draw on three methodological approaches that require different identifying assumptions for a causal interpretation – *(i)* a naïve OLS regression, which requires the assumption that all relevant confounders are controlled for, *(ii)* an IV regression model, which assumes that biological fertility shocks predict age at first birth but are not correlated with earnings through any other mechanism, and *(iii)* a regression model estimated on a sample of women that experienced contraceptive failure, which requires the assumption that the timing of contraceptive failure can be considered to be random. Comparing findings across all three approaches allows us to draw more robust conclusions, because it seems unlikely that any remaining bias would have the same sign and magnitude in all three models. Taken together, our results suggest that a one-year delay in the entry into motherhood at ages below 30 increases women's earnings at midlife in the UK by 5.5% to 7.3%, depending on the model.

The identified effects of fertility timing are largely in line with the expectations based on previous research, although our results are less precisely estimated than, e.g., those identified by Miller (2011). This might indicate that there are differences in the effect of fertility timing between the American and the British context, or that the effect of fertility timing attenuates over the life course and is lower at midlife than at younger ages. However, the lack of statistical significance may also reflect the low statistical power in this study, particularly due to the low sample size in the restricted sample regression. The robustness checks suggest that our IV regression is more sensitive to analytical choices than other models, and that instrument validity remains questionable. Nevertheless, we argue that our findings are indicative of a causal effect of fertility timing on earnings, because we find effects of similar size across all three different models, and our effect sizes are plausible when compared to the effect on wages as estimated by Miller (2011) for the US and Kind and Kleibrink (2012)[3] for Germany, who utilize a similar research design. Our findings differ from Karimi (2014) who uses an IV approach with biological fertility shocks and exceptionally finds a negative effect of fertility delay, but this may be due to the study being based on Swedish college-educated women who had entered the labour market. Rosenbaum's (2021) study on Danish women, which combines IV with siblings fixed effects, in turn suggests that early motherhood timing has a negative effect on earnings only until the early 30s.

We also examine potential mechanisms for the effect of fertility timing on earnings: tertiary education, cumulative time in paid work, and total fertility. First, we found that a delay in the entry of motherhood leads to higher educational attainment of women. This finding echoes previous studies showing that education partially mediates the effect of fertility timing on women's more favourable labour market outcomes, although these studies have focused more strongly on younger ages (Blackburn et al., 1993; Buckles, 2008; Chandler et al., 1994; Nisén et al., 2019). However, the mediation analysis suggests that higher education contributes little to our understanding of the effect of fertility timing on earnings of women in midlife. Rather, the current findings suggest that the cumulative time in paid work

[3] Kind and Kleibrink (2012) estimated the effect net of controls for tenure and further children, and used family background characteristics as instruments.

and the total number of children play a more important role in mediating the effect of fertility timing on earnings at midlife than education, since the two former variables completely explained the total effect of age at first birth on earnings in the analysis. Although the causality of this mediation analysis needs to be considered carefully, these results suggest an important role of human capital, largely in the form of work experience, as well as that of total fertility, as potential mechanisms through which motherhood timing may influence earnings beyond childbearing years. Quantifying the individual contribution of these two mediators would be of great interest, but requires analysis beyond the scope of this paper to disentangle the close relationship between them. However, we note that the estimated effect of motherhood timing on the number of children seemed modest in comparison to that on years in the labour market, potentially suggesting a larger role of the latter as a mediator. Earlier evidence from the UK context indicated that the effect of post-birth employment on continued fertility may be limited (Bijlsma & Wilson, 2020), but fertility overall, including the timing of the first birth, is important for employment careers of women (Aassve et al., 2006).

Currently, the UK is among the countries in Europe with the highest income inequality (OECD, 2021a). Besides motherhood as such (Cukrowska-Torzewska & Matysiak, 2020; OECD, 2021b), this study suggests that the timing of motherhood may also be a source of such economic inequality even beyond the core childbearing ages. This study suggests that motherhood timing may affect current midlife earnings in the UK context, and even the strong effect on the cumulative time in paid work as found here would be likely to translate into differences in cumulative earnings over the life courses of mothers (Weisshaar & Cabello-Hutt, 2020), thereby reinforcing income inequality among mothers and their families. This is notable in the context of the UK, also given that women there enter motherhood at younger ages than women in most other European countries and levels of teenage pregnancies are high (UNECE, 2021). However, these average characteristics in fertility behaviour are strongly driven by women from lower social classes and socioeconomic variation in the timing of motherhood in the UK is strong (Berrington et al., 2015; Ekert-Jaffé et al., 2002; Rendall et al., 2010). While economic inequality may contribute to the pronounced variation in the timing of motherhood, the timing may also be a mechanism which reinforces economic inequality in the UK.

7.2. Methodological considerations

This study is not exempt from limitations. First, the low sample size decreased the statistical power of the analysis and reduced the reliability of the instruments in the IV model. Although both instruments were significantly associated with age at first birth in the first stage of the IV regression, the F-statistic of joint significance of the instruments was below 35. A recent study by Lee et al. (2020) indicates that in order to reach 95% confidence when using the regular cut-off value of 1.96 for the t-value, an F-statistic above 104.7 is necessary, which is above the F-statistic identified in this study. Future research using the same instruments should thus be conducted in larger samples. Second, tests of instrument validity suggest that biological fertility shocks might not be valid instruments for fertility timing, likely due to unobserved differences between women that experience such fertility shocks and those who do not. Also earlier studies have raised concerns about the feasibility of the use of such instruments. Using NLSY data from the US, Wilde (2010) and Herr (2016) questioned the exogeneity of these instruments and concluded that they did not produce robust estimates of the wage effect of motherhood timing. Using Nordic register data, Karimi (2014) concluded that women who miscarried did largely not systematically differ from other women with respect to prior health-related characteristics, while Rosenbaum (2021) proposed that complementing the IV estimation with siblings comparison to control for family heterogeneities produces estimates with higher internal validity. Bratti (2015) concluded, that the strain of literature as a whole suffers from a lack of strong instruments. This implies that future research needs to examine whether instrument validity can be established conditional on women’s observed characteristics and alternative approaches to establish causality should be considered. We argue that the timing of such fertility shocks might plausibly suffer less from endogeneity than the incidence.

Third, the restriction of the sample to women who had their first child by the age of 30 reduces the generalisability of the findings. This limitation is particularly important to bear in mind when using the findings to make statements about the effects of the current trend towards delayed childbearing, which may lead to an average age at first birth above 30 in the UK in the near future. The marginal (monetary) returns to delaying childbearing by one year likely depend on the duration of fertility postponement, and will thus differ for women giving birth before or after age 30. However, evidence on the shape of the "dose-response" relationship between fertility postponement and earnings remains limited. A Danish study provided associational evidence of larger gains to postponement before age 30 (Leung et al., 2016), suggesting that entering motherhood at these ages prevents women from making important early investments in human capital. An Italian study additionally suggested decreasing returns to earnings of very long delays (Picchio et al., 2021). Future research should consider heterogeneity in the effects of delayed childbearing by age.

Fourth, when treatment effects are heterogenous, the IV approach only identifies a *local average treatment effect*, i.e., the effect of age at first birth on earnings for women whose age at first birth is determined by the instrument. Both instruments used in this study (loss of pregnancy, contraceptive failure) lead to an age at first birth that deviates from the desired timing of birth, because affected women give birth earlier (in the case of contraceptive failure) or later (in the case of pregnancy loss) than planned. Thus, the effects estimated in our IV models may not be informative of the effects of age at first birth for women who are able to achieve their desired timing. Future longitudinal studies would also benefit from applying methods that assess time-varying mediation to estimate long-term mechanisms (Bijlsma & Wilson, 2020). This is important for variables like formal education, which can both affect the age at first birth (Berrington et al., 2015; Ní Bhrolcháin & Beaujouan, 2012) as well as be affected by the age at first birth. Moreover, this study focused on one aspect of the socioeconomic status at midlife: earnings. Future research could examine the effects on other aspects of the socioeconomic status at midlife, but for which no data was collected in the BCS70 study, such as wealth or pension savings.

Despite the limitations, this study makes thematic and methodological contributions. One strength of this study is its long period of follow-up. The study provides further evidence that the effects of fertility timing on women's labour market outcomes do not only matter in the short-term, but are likely to also persist until midlife in the context of the UK. This finding is in line with the early findings by Hofferth (1984), who identified a significant positive effect of delayed childbearing on family economic wellbeing at retirement age in an older cohort of women in the US, as well as with a number of later contributions from the US (e.g., Buckles, 2008; Herr, 2016; Troske & Voicu, 2013). Our findings, however, differ from findings from Denmark and Sweden (Cantalini et al., 2017; Karimi, 2014; Rosenbaum, 2021). Taken together, this suggests that the long-term returns to the delay of motherhood in the UK may be more similar to those in the US than those in the Scandinavian countries. However, we note that our findings were not indifferent to the exclusion of women aged below 20 at their first birth, suggesting that timing at these early ages may matter the most. Besides providing relevant substantive insight into the long-term effects of fertility timing, the measurement of the outcomes at midlife also made it possible to avoid bias arising from differences in the timing of the completion of the reproductive career, and thereby allowed the total number of children to act as a mediator for the long-term effect. Another contribution of this study is that, with the restricted sample analysis, a novel approach to studying causality in the relationship between fertility timing and earnings was proposed, which requires weaker assumptions than the models used in previous research.

7.3. ***Conclusion***

In conclusion, the findings of this study indicate that avoidance of early motherhood may benefit women in the UK in the long term, by strengthening their labour market attachment and earnings. While this finding implies positive consequences for the women in the UK who delay childbearing, it may reflect lower opportunities for early mothers and can be a source of socioeconomic inequalities. Thus, the UK government should work towards implementing policies that increase the opportunities for early mothers on the labour market, for instance through improving access to affordable, high-quality childcare and improving the conditions for mothers in entry-level jobs.

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Table 1: Sample characteristics					
Variable	**N**	**Mean**	**SD**	**Min**	**Max**
Earnings at midlife (net GBP/week)	2,156	253.84	263.59	0	4158.46
Number of years spent in paid work until age 42	2,057	18.01	6.74	0	26.83
Tertiary education	1,889	0.25	0.44	0	1
Total number of children	1,781	2.36	0.95	0	8
Age at the first live birth	2,167	23.99	3.63	15	30
Mother's age at completion of education	2,167	15.58	1.59	0	25
Age of CM's mother at the birth of her first child	2,167	21.64	3.66	12	43

Variable	N	Frequency	Percent
First pregnancy was a miscarriage or stillbirth	2,167		
Yes		207	9.55
No		1,960	90.45
First live birth was a contraceptive failure	2,167		
Yes		334	15.41
No		1,833	84.59
Educational attainment	1,889		
None		174	9.21
CSE		354	18.74
GCE O Level/ GCSE		723	38.27
A Level/ SSCE/ A-S level		159	8.42
Lower tertiary degree (e.g., Bachelor, nursing qual.)		417	22.08
Higher tertiary degree (e.g., Master, PhD)		62	3.28
Social class at birth based on parents' occupation	2,167		
V unskilled		127	5.86
IV partly skilled		397	18.32
III manual		1,016	46.89
III non-manual		285	13.15
II managerial and Technical or I professional		342	15.78
CM was conceived outside of wedlock	2,167		
Yes		329	15.18
No		1,838	84.82
Parent's marital status at birth of CM	2,167		
Single, widowed, divorced, or separated		158	7.29
Married		2,009	92.71

Note: A value of 0 for the mother’s age at completion of education implies that the mother has never visited school.

Table 2: OLS regression				
	Main outcome	**Potential mediators**		
	Earnings at midlife (ln)	**Number of years in paid work until age 42**	**Tertiary degree**	**Total number of children**
Age at the first live birth	0.072****	0.514****	0.019****	-0.064***
	(0.015)	*(0.044)*	*(0.003)*	*(0.007)*
Age of CM's mother at the first live birth	0.021	-0.032	0.006**	-0.004
	(0.015)	*(0.044)*	*(0.003)*	*(0.006)*
Social class: joint significance (F-test)	2.59**	3.82***	11.93****	1.33
V unskilled	0	0	0	0
	(ref.)	(ref.)	(ref.)	(ref.)
IV partly skilled	0.258	0. 233	0.077**	0.100
	(0.252)	*(0.735)*	*(0.032)*	*(0.099)*
III manual	0.371	1.643**	0.114****	0.088
	(0.232)	*(0.667)*	*(0.029)*	*(0.089)*
III non-manual	0.600**	1.733**	0.131***	0.185*
	(0.258)	*(0.759)*	*(0.038)*	*(0.106)*
II managerial and Technical or I professional	0.655**	1.592**	0.268****	0.210
	(0.255)	*(0.75)*	*(0.040)*	*(0.11)*
Mother’s age at completion of education	0.085***	-0.046	0.047****	-0.012
	(0.031)	*(0.104)*	*(0.007)*	*(0.017)*
CM was conceived outside of wedlock	0.052	0.372	-0.011	0.047
	(0.16)	*(0.458)*	*(0.027)*	*(0.075)*
Parents at birth married	0.505**	0.903	-0.019	0.041
	(0.237)	*(0.661)*	*(0.038)*	*(0.108)*
Region of birth	Yes	Yes	Yes	Yes
Sweep at which earnings data was reported	Yes	Yes	Yes	Yes
R-squared	0.081	0.101	0.133	0.068
Observations	2,156	2,057	1,889	1,781

Standard errors in parentheses

* p < 0.1, ** *p* < 0.05, *** *p* < 0.01, **** *p* <0.001

Table 3: IV regression first stage	
	Age at the first live birth
Loss of the first pregnancy	0.668*** (0.241)
Contraceptive failure at conception of the first live birth	-1.589**** (0.207)
Kleibergen-Paap F-test of joint significance	34.684
Observations	2,156

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$, **** $p < 0.001$
Note: The table shows the coefficients of the excluded instruments in the first stage, controlling for the same control variables as the OLS model in table 2. Due to differences in the sample and the presence of one additional control variable for earnings, the results of the first stage are not exactly equal for all outcomes. The table shows the results of the first stage from the analysis of earnings.

Table 4: IV regression				
	Main outcome	**Potential mediators**		
	Earnings at midlife (ln)	**Number of years in paid work until age 42**	**Tertiary degree**	**Total number of children**
Age at the first live birth	0.055	0.393*	0.006	-0.011
	(0.081)	*(0.237)*	*(0.016)*	*(0.036)*
Age of CM's mother at the first live birth	0.024	-0.013	0.008**	-0.011
	(0.020)	*(0.058)*	*(0.004)*	*(0.008)*
Social class: joint significance (F-test)	7.05	12.72**	35.55****	2.48
V unskilled	0	0	0	0
	(ref.)	(ref.)	(ref.)	(ref.)
IV partly skilled	0.264	0.229	0.079**	0.089
	(0.252)	*(0.737)*	*(0.031)*	*(0.101)*
III manual	0.393	1.764**	0.128****	0.023
	(0.250)	*(0.708)*	*(0.034)*	*(0.102)*
III non-manual	0.630**	1.904**	0.151***	0.089
	(0.291)	*(0.823)*	*(0.046)*	*(0.124)*
II managerial and Technical or I professional	0.690**	1.794**	0.290****	0.103
	(0.299)	*(0.845)*	*(0.049)*	*(0.136)*
Mother's age at completion of education	0.088***	-0.024	0.050****	-0.020
	(0.034)	*(0.109)*	*(0.008)*	*(0.017)*
CM was conceived outside of wedlock	0.048	0.348	-0.013	0.057
	(0.160)	*(0.461)*	*(0.028)*	*(0.077)*
Parents at birth married	0.514**	0.961	-0.011	0.015
	(0.240)	*(0.667)*	*(0.039)*	*(0.112)*
Region of birth	Yes	Yes	Yes	Yes
Sweep at which earnings data was reported	Yes	NA	NA	NA
Sargan-Hansen's J	0.152	0.218	0.732	1.368
p-value	0.697	0.640	0.392	0.242
R-squared	0.080	0.097	0.123	0.032
Observations	2,156	2,057	1,889	1,781

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$, **** $p < 0.001$

Table 5: OLS regression among women whose first live birth was a contraceptive failure				
	Main outcome	**Potential mediators**		
	Earnings at midlife (ln)	**Number of years in paid work until age 42**	**Tertiary degree**	**Total number of children**
Age at the first live birth	0.073*	0.506****	0.014*	-0.071****
	(0.038)	*(0.114)*	*(0.008)*	*(0.018)*
Age of CM's mother at the first live birth	-0.019	-0.040	0.009	-0.019
	(0.039)	*(0.122)*	*(0.008)*	*(0.014)*
Social class: joint significance (F-test)	1.49	1.32	9.24****	0.50
V unskilled	0	0	0	0
	(ref.)	(ref.)	(ref.)	(ref.)
IV partly skilled	0.897	3.040	0.138**	-0.228
	(0.649)	*(1.895)*	*(0.054)*	*(0.248)*
III manual	1.302**	3.072*	0.208****	-0.132
	(0.617)	*(1.724)*	*(0.047)*	*(0.240)*
III non-manual	1.337*	2.899	0.284***	0.052
	(0.707)	*(2.002)*	*(0.089)*	*(0.313)*
II managerial and Technical or I professional	1.519**	4.453**	0.390****	0.020
	(0.681)	*(1.965)*	*(0.088)*	*(0.334)*
Mother's age at completion of education	0.143	0.522**	0.005	-0.028
	(0.095)	*(0.237)*	*(0.019)*	*(0.045)*
CM was conceived outside of wedlock	0.582	1.431	-0.064	0.001
	(0.384)	*(1.294)*	*(0.068)*	*(0.219)*
Parents at birth married	1.049*	3.457*	-0.017	0.290
	(0.565)	*(1.850)*	*(0.095)*	*(0.280)*
Region of birth	Yes	Yes	Yes	Yes
Sweep at which earnings data was reported	Yes	NA	NA	NA
R-squared	0.147	0.155	0.119	0.097
Observations	334	319	281	267

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$, **** $p < 0.001$

Table 6: Mediation analysis of the effect of fertility timing on earnings				
Mediators: tertiary education, cumulative time in paid work, and total number of children				
Model	**N**	**Total effect**	**Direct effect**	**Indirect effect**
OLS	1,522	0.081**** (0.017)	-.007 (0.015)	0.087**** (0.010)
IV	1,522	0.064 (0.091)	.009 (0.088)	0.055 (0.040)
Restricted sample	221	0.074* (0.045)	-.008 (0.043)	0.082*** (0.027)
Mediator: tertiary education				
Model	**N**	**Total effect**	**Direct effect**	**Indirect effect**
OLS	1,879	0.066**** (0.015)	0.058**** (0.015)	0.008*** (0.003)
IV	1,879	0.059 (0.090)	0.056 (0.091)	0.003 (0.008)
Restricted sample	281	0.063 (0.042)	0.060 (0.042)	0.004 (0.006)

Standard errors based on 1,000 bootstrap replications in parentheses.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$, **** $p < 0.001$