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On the timing of motherhood and higher education

John Ardelius (22453) & Samuel Förnes (22475)

Abstract

This thesis examines the economic trade-offs women face between pursuing a professional career and having children. Using the NLSY79 data and fertility shocks, we observe a natural experiment and isolate the effect of having children prior to or after college graduation. Our results confirm previous findings that women who postpone childbearing have higher lifetime earnings. However, for women who have children and obtain higher education within a ten year period no such differences are observed. Rather we find that the absolute temporal proximity between first childbirth and college graduation is a better, and significant, determinant of lifetime earnings. Further, we confirm the existence of a "student effect" found in recent studies. Our results suggest that motherhood penalty may not be explained by negative labor market signaling but rather by lost opportunities of early ability capitalization.

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Discussant:	Cecilia Hedlund, Jorunn Ottesen
Examiner:	Karl Wärneryd

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1 Introduction and purpose

Combining a successful career with childrearing is challenging. Women who usually invest a substantially larger amount of energy and time in child rearing than men, face a particularly tough priority decision if and when to have children and a career respectively. Provided some women want children, a higher education and to pursue a career, how should they reason about the timing strategy of these events? Intuitively, being absent from work due to parental leave could decrease chances of promotion and valuable on-the-job training, while instead having children prior to the first job is associated with other challenges such as reduced time for educational attainment. Having children when entering work life can signal lower willingness to commit to work while not having children could imply longer periods of future parental leave. Planning the timing of when to have children is for that reason an important strategic choice, but what are the consequences of the various options?

Models from current research suggests that the two main effects of childrearing on work success, measured in wage levels and earnings, is lost income in immediate connection with childbirth and a generally lower wage level once back from the absence (Hofferth 1984, Miller 2011). The underlying reason for the latter effect, known as the 'mommy track', is not extensively studied in the literature and we seek to shed some light on it through this thesis.

Following the literature on the subject we find two conflicting assumptions on the impact of motherhood timing; On the one hand stating that being absent from the workforce at a higher age is negative due to a higher loss of income (a higher wage level will lead to a higher economic loss for the same amount of time absent). On the other hand, stating that having children early is bad per se and yields a lower wage level due to signaling effects. We are interested to see which effect is stronger. If the "older age" theory is dominating, the optimum strategy for a woman striving to have both children and a successful career would be to have her children early on, preferably before entering work life and then fully focus on work. A viable option could therefore be to have children during (or even before) her education. Likewise, if instead the signaling theory is dominating it would be rational to postpone childbearing as long as possible in order to attain a high wage level before going on maternity leave. Even though her income loss would exceed that of early mothers she would experience less permanent penalty due to signaling and hence would be better off in the long run.

We investigate these trade-offs by studying a large cohort of American women who have been interviewed periodically about work and family related topics during the past

thirty years. We isolate the event of having children before or after graduating from college and analyze its effect on total accumulated income. We study various aspects of the combination of motherhood timing and graduation on lifetime earnings in relation to the existing literature.

In order to isolate the effect of going into work life with children from underlying variables such as ability or aspiration, we first compare women who expressed a desire to have children before completing their college degree but where a random subset experience an involuntary fertility delay (due to miscarriage, fertility lag or stillbirth) and instead obtain a degree prior to the birth of their first child. We then perform the same experiment on women who express no desire to have children prior to graduation (by actively using contraceptives) and compare the group who experience accidental pregnancies and the following childbirth with the successfully protected group who have their first child after college.

Our results indicate that in order to attain relatively high lifetime earnings women have to extensively postpone childbearing (at least 10+ years after graduation). In addition, we find that with regards to the timing of events, lifetime earnings is generally lower for women who have children in close proximity to (either before or after) graduation. Besides these two findings we do not find any statistically significant differences in lifetime earnings as a function of the timing order of these events.

Whereas the current literature has focused on a linear impact on earnings on fertility delay our research contributes to the current state of knowledge by showing that in the early years there are certain cut-off dates which are important to the future income and the relationship is not always linear. In this case, more specifically, what you choose to do in proximity to your graduation day has a greater impact than having children or not.

2 Research question

As per the above introduction we seek to answer the following question:

What is the economic consequence of the relative timing between motherhood and higher education?

We define the economic consequence as the impact on accumulated lifetime earnings. Furthermore, we break down our research question into the following set of testable hypotheses:

- *H1: Lifetime earnings are higher for women who complete their degree before having children.*

- *H2: Lifetime earnings are correlated with the temporal proximity between having children and the graduation date.*

3 Background

The investigation of consequences of motherhood timing and higher education on career success is closely related to various research areas within social economics. Even though we restrict ourselves to a specific sub group (women with both children and college degree) and only one metric (lifetime earnings) the results need to be understood and put in a broader social and economic context. Both being a mother and having a college degree is, for the individual, associated with direct and alternative costs. To understand the decisions and tradeoffs made we need to map how these costs are perceived by the women. We start out with an overview of the current literature on relevant related topics in order to put our work in a proper context.

Perhaps the most relevant theoretical concept in relation to our work is that of *signaling*. The theory of signaling (Spence 1973), state that an individual may undertake some activities for the sole purpose of showing to others that they can be afforded. Even though the activity does not give a direct benefit, other individuals' interpretation of the signal will generate positive outcome in the future. The literature on signaling is extensive (Spence 1973, Arrow 1973, Weiss 1995) and entered economics in the 70's with seminal work on the role of signaling behavior in the job market. In this framework, the main purpose of a college degree is not as an acknowledgement of the knowledge gained during education (which is hard for the employer to observe) but rather a signal that some amount

of effort has been made in qualifying for the school and completing the degree. This signals that the individual is also likely to put effort into work and is able to complete tasks at hand. A fairly recent survey of the effects on education to earnings (Card 1999), suggest that there is a clear wage premium not explainable using regular OLS on variables such as ability and work experience. This signaling wage premium is measured to be around 10% in studies of identical twins. A recent general overview of the research field of signaling and higher education can be found in Oreopoulos and Petronijevic (2013).

In the context of our work, being a mother (even a woman) and having or not having a college degree could be interpreted by an employer as signals of current and future ability to perform in the work place. Employers, who are unable or unwilling to evaluate details of ability and experience, use signaling instead to gauge ability. If being a mother is interpreted as a signal, there could be a risk of discrimination. This leads to another active research topic namely that of *motherhood wage penalty* (Anderson, Binder & Krause 2003, Correll, Benard & Paik 2007) where existence of and reasons for mothers lower wage levels are examined.

Apart from signaling theory, the other main way to analyze wage differences is that of *human capital accumulation*. According to this theory the wage is proportional to the amount and quality of relevant knowledge and experience that has been accumulated in the past. Several studies have been focusing on explaining the effects of motherhood to career success (generally wage levels) in the context of human capital accumulation and depreciation (Miller 2011, Corcoran, Duncan 1979, Cox 1984, Albrecht et al. 1999). The aim of these studies is to explain the difference in wage mainly between men and women but also among other groups (mothers, non-mothers, ethnical groups etc.). In the early work of Mincer and Polachek (1974), a formal model for human capital accumulation is developed to explain the wage difference between women and men. One of the conclusions of this work is that time away from the labor market will not only imply lost opportunity to gain human capital but since the model assumes that current experience (human capital) is proportional to the experience gained in all previous time steps and also that the rate of increase in capital is proportional to past experience the relative loss will only increase over time. Losing out on early opportunities to gain experience (due to childrearing) would then imply a lifelong degradation to lower wage levels. The model is inline with that of Miller (2011) in that it assumes that wage levels are a direct consequence of time on the job. We could place our work further in a gender context and delve more into the issue of how women and men who have children are treated differently by the labor market. However we refrain from doing so partly because our scope is limited

and if there are any clear effects of combining children and a career it should be most visible among women. We refer the interested reader to Lazear and Rosen (1990) as an introduction to the vast literature on the subject. An in-depth discussion of the differences between signaling and human capital theories of higher education can be found in Bedard (2001).

During the 1980s, when most of the subjects in our data graduated from college, the return to higher education (college wage premium) increased substantially. According to Grogger and Eide (1995) the trend was most visible among men when comparing high school and college graduates but the effect was also visible among women. In the study, this is explained by the increasing complexity of the emerging IT industry and other white-collar jobs. An interesting finding in the study is that women who gained the most from having a college degree were those who enrolled in technical programs such as engineering. For this group of women, this effect was almost completely explained by pre-college mathematical ability. The reason being that women in the 80's started to obtain degrees leading to more qualified technical jobs than previously (such as in education or social care) where wage premiums are particularly high. This fact would further incentivize talented women to pursue a college degree in order to attain a successful career.

Another interesting and related line of research shows that childrearing during studies is very unusual and is postponed until after graduation for various reasons. In close succession to graduation a peak in birth rate was observed in a large study of Norwegian women and Lappegård et al. coined this the "student effect" (Lappegård, Rønsen 2005). The existence of a student effect indicates that women actively plan the timing of motherhood in relation to attainment of higher education and that the graduation date is truly special in relation to childbearing compared to other dates. This implies that the temporal proximity between higher education and childbearing is a relevant factor to examine.

In this work, our ambition is not to examine or explain any of these underlying structural issues but merely to determine if the relative timing between having children and graduating from college can explain differences in lifetime earnings.

Our work is inspired by the work of Miller (2011) who consider a simple human capital model where the timing of motherhood is affecting not only wage loss due to absence from work but also introduces the notion of the "mommy track". Once a mother, the woman will experience a lower wage development than women without children. She shows that motherhood delay leads to a substantial increase in earnings of 9% per year of

delay, an increase in wages of 3%, and an increase in work hours of 6%. The explanation given by Miller is that this is due to career advancement foregone while being away (lost human capital as in the Mincer model) but also a general negative attitude towards mothers (signaling) as lacking motivation and time to focus on a career. Given these findings we asked ourselves if it would not be an optimal strategy for the women to have their children *before* entering into work life. That is during or even before their higher education. With childrearing out of the way they could then focus fully on their careers without experiencing a penalty due to work absence.

There are prior studies focusing on timing effects in relation to obtaining higher education. Monks (1997) study the effects of age at college graduation in the NLSY79 data and finds that hourly wage is negatively affected by postponing graduation. Even after controlling for ability and work experience they find a 4% reduction in hourly wage per year that graduation is postponed (OLS coefficient for age times college binary variable). This analysis is extended by Taniguchi (2005) who show that the effect exists but is smaller for women than men with the possible explanation that women gain less from a college degree in the first place. There is also work that has shown that women who wait longer to have children have higher salary later in life (Hofferth 1984). This is argued to be due to the fact that these women tend to have smaller families rather than being an effect of signaling.

We restrict our study to mothers who, at some point in time, obtain a college degree. The reason as to why we do not consider for instance the effect of having children prior to receiving a high school degree is that having a college degree is to a greater extent a rational choice aimed at increasing future utility. We are interested in exploring the trade-offs (if any) between having a successful career and a successful family life. Considering the existence of the student effect in the Miller framework of early career absence penalties one can ask if deliberately postponing childbearing until after graduation is really a wise strategy?

In the experiment we conduct we make use of fertility shocks. The following sections will review the literature on specific phenomenon pertaining to the fertility shocks we make use of.

Spontaneous abortions

Ex-ante miscarriage, controlling for key events, such as drug use and higher age, miscarriage is usually seen as biologically random (Garcıa-Enguıdanos et al. 2002, Rai, Regan 2006). However, ex-post it might not be able to view a group that experiences

miscarriage as random anymore due to the introduction of social events, such as induced abortion. A woman who is pregnant can choose to abort or proceed. Proceeding with the pregnancy can result in a spontaneous abortion (miscarriage or stillbirth) or live birth. There is a time window, where the individual who considers having an induced abortion might have a spontaneous abortion instead. This means that the group who experiences spontaneous abortion might be biased due to individuals who wanted to have an induced abortion but experienced a spontaneous abortion before the induced abortion.

Studies among teens have found that white women are more likely to choose to abort a pregnancy than black women. In addition, white women were viewed as being more advantaged on average. This introduces a modest bias when using regression models to estimate the effect of a spontaneous abortion. The group who miscarries would be biased with less advantaged individuals. However, it has also been shown that the group who miscarries tend to be more advantaged than the group who completes the pregnancy. This effect, being modest initially diminishes further with the increase in age (Ashcraft, Fernandez-Val & Lang 2013).

Infertility and fertility delay

Infertility and fertility delay is usually considered to be biologically random. Analog with spontaneous abortions, key events such as drug use and higher age can affect infertility. Research has shown that the mother's background characteristics does not explain infertility (Joffe, Barnes 2000, Agüero, Marks 2008).

The duration a couple has to be actively trying but unable to conceive before they can be defined as infertile differs depending on which jurisdiction one belongs to. WHO defines the interval to 12 months. In Sweden you can seek treatment for infertility if at least one year has gone by with unprotected intercourse. If the couple unsuccessfully tries to conceive for a shorter time period they are usually defined as subfertile and if unsuccessful for a longer time period they are defined as infertile. Fertility delay is defined as the time from when the conception should have happened during working circumstances and when it actually did.

The most common causes for infertility for the female are biological dysfunctionalities such as pelvic adhesion and endometriosis. For the male, sperm quality is the most common infertility reason. Many couples are unaware of any problem until they investigate why they are experiencing conception difficulties (Dunphy et al. 1989). Since the unawareness is high and the problems usually don't affect daily life the effect of infertility exhibits low correlation to workplace productivity.

Fertility acceleration and contraceptive failure

A pregnancy can be wanted, wanted but mistimed, unwanted, or the individual could be neutral towards becoming pregnant. Among unmarried women in the USA in year 2006 about 57% of all births were either unwanted or mistimed (Mosher, W. D., Jones, J., & Abma, J. C. 2012), hence being accelerated. Other studies puts this range between 49% - 81% (Miller 2011, Brown, Eisenberg 1995, Finer, Henshaw 2006b).

Among the same group of US women, looking at those who cohabit and experience an accidental pregnancy, the reason for the accidental pregnancy is contraceptive failures in 47% of the cases (Fu et al. 1999). Meaning that they were using contraceptives at the time (at least reported usage) and became pregnant. Other researchers have found that 51% of the unintended conceptions in 1994, and 48% in 2001, occurred during a month when contraceptives were used (Finer, Henshaw 2006a).

One study determined that, among US women, the most common reason for oral contraceptive (OC) failure is cessation of the OC. The women do not want to become pregnant but some experience side effects from the OC and stop taking it. In the transition period between the OC and the replacement contraceptive they unwillingly become pregnant (Rosenberg, Waugh & Long 1995). In a Swedish study, 30,000 women who induced abortion were interviewed looking for answers on the reasons for the abortion. Among these women 64% had used contraception at the time of the conception. Among the women who did not use a contraceptive, the main reason for not doing so was stated to be that they did not think they could become pregnant at the time of the conception. Hence, the majority of the abortions were done by women who prior to the conception actively did not want to become pregnant and took measures against it (Larsson et al. 2002).

4 Data

The Bureau of Labor Statistics at the US Department of Labor has conducted a set of surveys to study the US labor market. One of the largest surveys is the National Longitudinal Survey of Youth 1979 (NLSY79) where 12,686 men and women who were 14-22 years old when they were first surveyed in 1979, are interviewed regularly about a multitude of topics such as income, wealth, education, family status and fertility. The data set is unique in both its size and duration (U.S. Bureau of Labor Statistics 2015).

There are some known biases in the NLS data. Most important is non-participation by some of the selected respondents which will cause a selection bias problem in the data. A second factor is that respondents at times give invalid answers, a problem that is explicitly handled by the interviewers who marks inconsistent or unrealistic answers (such as a decrease in number of childbirths in consecutive interviews) as

"invalid". There is also a noted bias due to interviewers erroneously following the predetermined question order. Many auxiliary variables to mitigate bias has been added to the data over the years. In general, the NLS data is considered to be of good quality and a large number of different studies are based on the data sets (U.S. Bureau of Labor Statistics 2015) and makes them well suited as benchmarks for new theories.

Some technical issues we faced when working with the data was that some of the survey questions changed in formulation over the years and some questions initially asked every year were later only asked bi-annually. Also some time data in some years contain day information and in others only year and month. Further, in some cases the timing of events (like graduation in certain years) is only noted as "since last interview". In these cases we averaged the event date to the day 12 months prior to the current interview date.

After reviewing the notes published by NLS on data validity and companion research, we excluded, to the extent possible, variables that were considered to contain inconsistent data and we used updated and transformed data wherever made available. Furthermore, when the phrasing of the questions changed over the years we made sure to the extent possible that we were able to capture the same intent of the question being asked even if the phrasing of it changed. In some years, this meant that we had to combine a set of variables in order to extract the same intent from the answer.

Summary statistics

Here we present a summary of the most important variables used in our study. Table 1 contains data for the whole female population and Table 2 only the subset we are interested in, namely mothers who at some point in their life have received a college degree.

Variable	Obs	Mean	Std.Dev	Min	Max
Age at first child	4931	23.339	5.477	11.674	50.367
Age at first diploma	5353	18.662	2.315	12.422	54.789
Age at first degree	2279	23.898	6.686	12.756	54.786
Age at first miscarriage	907	25.808	6.306	13.173	40.112
First child born # years after degree	1671	1.968	9.831	-36.107	22.849
First child born # years after diploma	4108	5.261	6.392	-35.444	32.523
If: Has child	6283	0.785	0.411	0	1
If: Has degree	6283	0.363	0.481	0	1
If: Alchohol before pregnancy	4933	0.462	0.499	0	1
If: Smoking before pregnancy	4931	0.422	0.494	0	1
If: Cocaine before pregnancy	6110	0.129	0.336	0	1
If: Marijuana before pregnancy	6149	0.562	0.496	0	1
If: Used contraceptive before degree	6283	0.207	0.405	0	1
If: Used contraceptive when conceived	6283	0.234	0.423	0	1
If: Succesfully using contraceptive	687	0.675	0.469	0	1
Total children	4460	2.074	1.427	0	11
Total lifetime earnings	6052	242 860	258 247	108	2 686 848
log(Total lifetime earnings)	6071	11.591	1.693	1.792	14.804

Table 1 *Summary statistics of relevant variables for the whole set of women in the NLSY79 data set.*

Variable	Obs	Mean	Std.Dev	Min	Max
Age at first child	1671	26.066	5.683	14.340	45.534
Age at first diploma	1613	18.237	1.206	15.178	33.942
Age at first degree	1671	24.097	7.095	12.756	54.786
Age at first miscarriage	309	27.650	5.840	13.926	37.945
First child born # years after degree	1671	1.968	9.831	-36.107	22.849
First child born # years after diploma	1613	7.897	5.947	-13.762	27.690
If: Alchohol before pregnancy	1656	0.530	0.499	0	1
If: Smoking before pregnancy	1654	0.314	0.464	0	1
If: Cocaine before pregnancy	1663	0.124	0.330	0	1
If: Marijuana before pregnancy	1665	0.580	0.494	0	1
If: Used contraceptive before degree	1671	0.420	0.494	0	1
If: Used contraceptive when conceived	1671	0.305	0.461	0	1
If: Succesfully using contraceptive	521	0.639	0.481	0	1
If: Experienced fertility delay	1671	0.022	0.147	0	1
Total children	1384	2.249	1.000	0	8
Total lifetime earnings	1662	352 845	300 862	139	2 686 848
log(Total lifetime earnings)	1663	12.296	1.249	4.078	14.804

Table 2 *Summary statistics of relevant variables for women with both a child and a college degree.*

If: Experienced fertility delay	Freq.
0	465
1	37

Table 3 *Number of women with children and college degree who were pregnant prior to graduation and did (1) or did not (0) experience a miscarriage (fertility delay).*

5 Method

Data collection and data construction

In order to study the effect of sequencing the events of motherhood and graduation we perform an OLS regression of (the logarithm of) lifetime earnings on whether graduation happens before the birth of the first child.

Since many factors could affect the event sequence, conducting a controlled randomized experiment would be the preferable way to answer our research question. However, given the topic of this thesis, conducting necessary fertility experiments would be both impractical and highly unethical. Another valid approach is to find a natural experiment where random events partition participants in treatment and control groups. Our chosen data allows us to observe two such experiments. Using fertility shocks as random events, inspired by Miller's research (Miller 2011) where she used fertility shocks to estimate the effect 'age at first birth' has on income, we can use similar shocks to construct different groups to analyze our research question.

We collected data for the experiment by accessing the NLSY interface being made available by courtesy from the US Bureau of Labor Statistics. Using the service we extracted panel data over a period of 33 years and selected the variables needed for our analysis.

We restricted the data set to form a group of analysis. The shared characteristics between the respondents are that they are; 1) all women and 2) have at some point in their life at least one biological child and have obtained a college degree. This left us with a subpopulation of 1671 individuals.

Lifetime earnings is defined as the accumulated income over the period the data set covers. We assume that missing years are missing at random.

Experiment 1: Fertility shocks causing fertility delay

Within this restricted group we look at individuals who prior to obtaining their degree had their first attempt of conception. A first attempt of conception is defined as, prior to the birth of their first child, either being pregnant or being sexually active and actively stopped using contraceptives. From this subset we observe two groups, one being the control group and the other being the (unfortunate) experiment group. We restrict the control group to have their date of first birth within two, four and all years of their college degree. The reason being that we want to measure the relative impact of delay within a narrow time span. We include the 'all' years comparison for reference. Comparing a person who had a child 20 years before their degree to someone who had their child 2 years after

is of little interest to the majority of women since they do not choose to face these types of trade-offs. We want to measure the effect that would be applicable to most people and the choices they face and so we will focus on the two and four year groups.

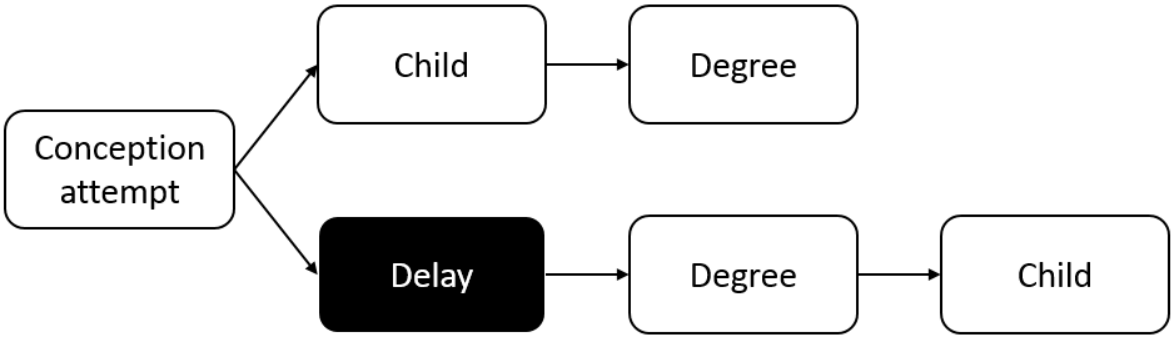


Fig. 1 *Note: Control group having their child after conception. Treatment group affected by a delay before having their first child.*

The experiment group has an involuntary delay forced upon them by random event. The delay consists of women who either experience a miscarriage, fertility lag or a stillbirth. Fertility lag is defined as being unable to conceive for more than a month while actively trying to.

Comparing these groups, the control group has a successful fecundation resulting in a live birth prior to obtaining their degree. The experiment group experience an involuntary lag between the conception attempt and the first live birth. During this delay they go on to obtain their degree.

This allows us to observe a homogenous group of individuals with otherwise identical traits. Among this group a set of individuals experience the random delay which brings the date of the first childbirth beyond the graduation date, and comparing these groups allows us to estimate the effect a sequence inversion of motherhood and education has on lifetime earnings.

Experiment 1: Method of analysis

OLS is an appropriate method to use in these experiments in order to answer our research question. It will not produce biased coefficients due to omitted variables as long as our assumptions hold of randomness in the chosen explanatory variable.

In the specific case of miscarriage, there are certain key actions that could induce a higher rate of miscarriage. These being the usage of various substances and higher age. Regarding age, the literature argues that increased rates of miscarriage are seen starting in the early 30's among women (Nybo Andersen et al. 2000). In our sample, almost all respondents are below that limit and the average age when experiencing miscarriage is in

the 20's. As for substance use we have constructed binary variables for the use of alcohol, smoking, marijuana and cocaine prior to or during first pregnancy. The binary variable for alcohol is positive if the respondent has consumed alcohol within 12 months of conceiving. Smoking is positive if the respondent smoked during the pregnancy. Marijuana and cocaine are positive if the respondent consumed any of them prior to conception. Hence, after controlling for substances the event of miscarriage should be random.

The following regression model will be used for the evaluation of the delayed group:

$$log(LifetimeEarnings)_i = \beta_0 + \beta_1 Delayed_i + \beta_2 Substances_{ij} + \epsilon_i \quad \text{(Eq. 1)}$$

Where *Delayed* is a binary variable measuring if the individual experienced an involuntary fertility delay as previously defined. $Substances_i$ is a vector of control variables which includes indicators for the usage of alcohol, smoking, marijuana and cocaine.

Experiment 2: Fertility shocks causing fertility acceleration

Within the same restricted group we look at individuals who prior to obtaining their degree were sexually active but did not want to conceive. The unwillingness to conceive is measured by them using contraceptives. From this subset we observe two groups, one being the control group and the other being the experiment group. We compare the group who accidentally had a child before their degree (experiment group) to the group who had their child after their degree as intended. We again perform three studies by restricting the experiment group to have their date of first birth within two, four and all years of their college degree. The reason being analog with the previous experiment.

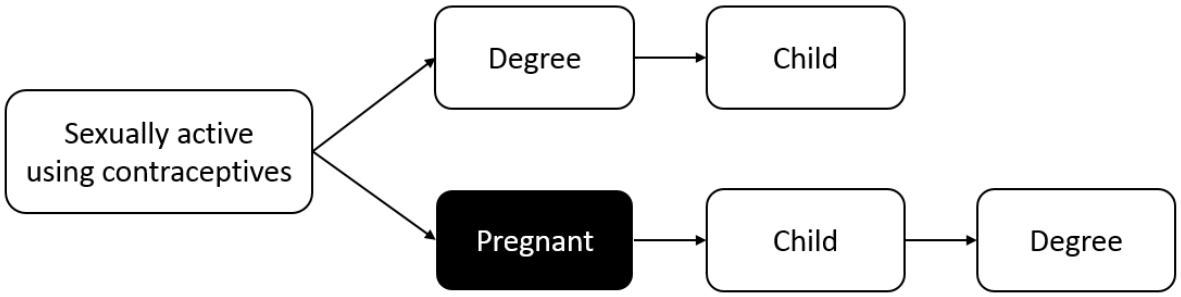


Fig. 2 *Note: Control group having their child after completion of degree. Treatment group affected by a fertility acceleration so that they have their first child earlier than intended.*

The experiment group has an involuntary or accidental acceleration forced upon them. The acceleration consists of women who conceive while not intending to, by means of contraceptive failure. Instead of going on to obtain their degree and then having a child the sequence is involuntarily or accidentally reversed compared to the control group.

This allows us to observe a highly homogenous group of individuals with common traits such as non-intention to conceive. Comparing our two groups allows us to estimate the effect a sequence inversion of motherhood and education has on lifetime earnings.

Experiment 2: Method of analysis

We have chosen to include a control for substance usage. Substance usage could be correlated with inability to properly follow manufacturer's recommended usage procedure for a given contraceptive. There are cases when the contraceptive fails due to manufacturing fault, lack of quality or the contraceptive being fundamentally unreliable (spermicide etc.) which would be random seen from the user's perspective. The failure could also be caused due to misuse by the user, such as being under the influence and temporarily unable to follow proper procedure in the act. The control for substance use remedies the bias from misuse. We discuss other potential biases and their effect on fertility acceleration in the background and discussion sections.

The following regression model will be used for the evaluation of the accelerated group:

$$log(LifetimeEarnings)_i = \beta_0 + \beta_1 Accelerated_i + \beta_2 Substances_{ij} + \epsilon_i \quad \text{(Eq. 2)}$$

Where *Accelerated* is a binary variable measuring if the individual experienced an involuntary or accidental fertility acceleration as previously defined. $Substances_i$ is a vector of control variables which includes binary variables for the usage of alcohol, smoking, marijuana and cocaine in connection with the conception.

6 Empirical results and analysis

As a first step we set out to understand when, in relation to graduation, women have their first child. As a reference we start out by plotting the distribution of age of first time mothers (Fig. 3) and then move to plot the number of years passed after graduation when women have their first child. For this we generate a new variable, *yearsBetweenDegreeAndChild,* which measures the duration between the graduation date and the birth of the woman's first child. The graduation date is set to the date where the completion of a college degree, or higher, is reported for the first time (we do not consider consecutive degrees). The results are shown in (Fig. 4). We see a clear peak of women who have children in years closely succeeding the graduation date (time 0) in accordance with previous studies of a student effect. To further validate this effect we did the same analysis

for high school students. Hence, we generated a new variable *yearsBetweenDiplomaAndChild* which measures the time between high school graduation and the birth of the first child. Results are shown in (Fig. 5). The student effect is even more pronounced in this case. It seems that many women indeed delay childbearing during high school and have children in very close succession to obtaining their diploma. Hence we conclude that we see a clear student effect in our data.

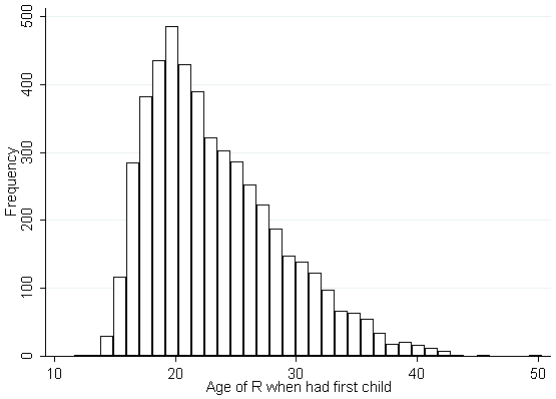


Fig. 3 *Distribution of age at first motherhood for the whole unrestricted sample.*

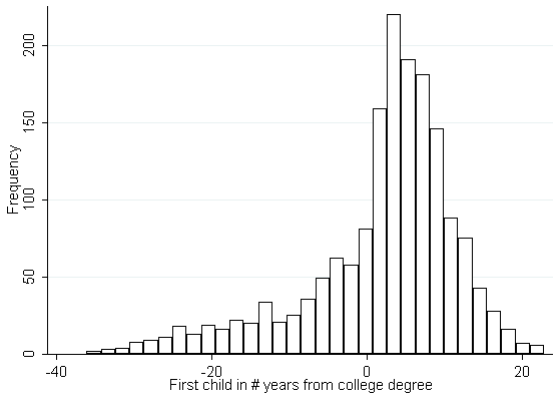


Fig. 4 *Years between college degree and first motherhood. A clear "student effect" is visible as a sharp peak after time 0.*

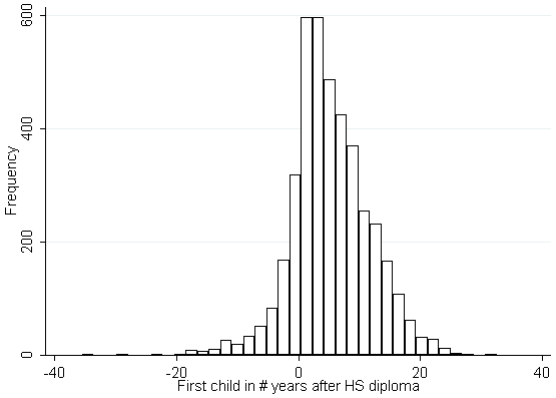


Fig. 5 *Years between high school graduation and first motherhood. A pronounced "student effect" is visible at time 0.*

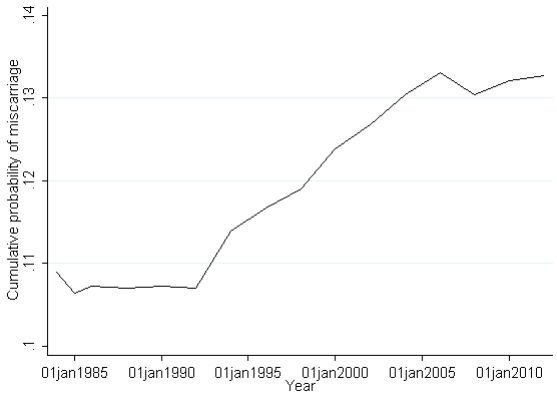


Fig. 6 *Cumulative miscarriage rate over the interview period. The positive slope indicates an increased tendency with age.*

Next, we studied the validity of our independent variables. We need to justify our assumption that miscarriages, for instance, are in fact random and not correlated with other variables that could affect wage (such as age). The NLSY79 data contains reported number of accumulated pregnancies and miscarriages for the period 1984-2012. Using this data we plot the average miscarriage rate as function of time (Fig. 6). We see a clear indication that miscarriage rates increase with age. However, for women of age under

thirty (in year 1990 the oldest women are 33) we see that miscarriage rates are approximately constant at around 11% consistent with previous findings validating our treatment of involuntary delays as random (age independent) events.

To perform our experiments we generated binary variables for the group who delayed childbearing past the date of college graduation for our two experiments respectively. The indicator variable *Delayed* was set to 1 for the individuals who had children after graduation. Further, to investigate how the duration of the delay affects lifetime earnings we evaluated our regression for the group of individuals who have children no longer than T years after graduation, and vary T from 1 to 20 years. For each value of T, we estimate the OLS regressions in equation 1 and 2 above for the respective experiment.

The resulting coefficient and the 95% confidence interval is plotted for different values of T in (Fig. 9). The figure indicates the approximate percentage increase in lifetime earnings experienced by the group of women who postpone childbearing up to T years from graduation compared to the group who have children prior to this event.

For our first experiment, the delayed vs. not delayed group, we see that the difference is not significant at the 5% level for any value of T (0 is within the confidence interval). Only when we compare women who have children at most 2 years prior to graduation with the group who delay childbearing extensively (more than 10 years) do we see a significant difference.

For the other experiment, studying the group of women who actively try not to have children by using contraceptive, and comparing the successful (no child prior to graduation) with the unsuccessful group (child), the picture is somewhat different. Comparing the full set of successful and unsuccessful women the prior group have to postpone motherhood extensively (more than 10 years) to gain significant higher lifetime earnings. However, when we restrict the unsuccessful group to those women who have children no more than 4 years prior to graduation we note that the cut off when the delayed group is significantly better off decreases to about 8 years of delayed childbearing. When the restriction is set to 2 years the cutoff is down to 5 years and is almost significant even at lower cut offs. Overall, the results indicate that there is no significant difference in lifetime earnings between the groups when we only consider women who have children in proximity to their degree. For women who actively try to avoid pregnancy and extensively postpone having children after graduation, there is an increase in lifetime earnings.

We then study the impact of absolute proximity between the first child and graduation. We generate a new variable *Proximity which* measures the absolute temporal

distance between the two events. It is restricted to be within four years in absolute temporal distance. We show restrictions for two years and all years in the appendix. This variable is then used in the following OLS regressions:

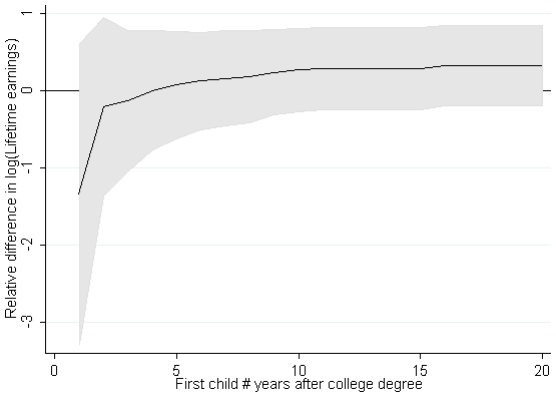
$$log(LifetimeEarnings)_i = \beta_0 + \beta_1 Proximity_i + \beta_2 Delayed_i + \beta_3 \text{Substances}_{ij} + \epsilon_i \quad \text{(Eq. 3)}$$

$$log(LifetimeEarnings)_i = \beta_0 + \beta_1 Proximity_i + \beta_2 Accelerated_i + \beta_3 \text{Substances}_{ij} + \epsilon_i \quad \text{(Eq. 4)}$$

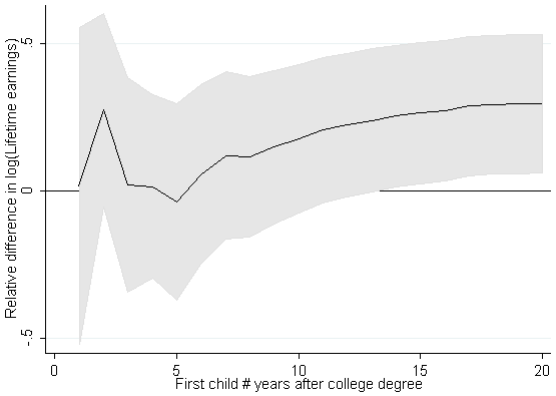
The results are shown in (Table 4a) and (Table 4b). We see that the coefficient for the variable is statistically significant, positive and relatively large. Each year of separation between childbearing and graduation, in either direction, increases lifetime earnings by more than 18% per year for the delayed group and 5% for the accelerated group. We still include the *Delayed and Accelerated* dummy variables in the regressions and find that they are not significant.

Using this result we conclude that we are *not able* to reject our first null hypothesis that there is no difference in income between the groups on a 5% confidence level. However, we are able to reject our second null hypothesis that there is no difference in lifetime earnings as a function of motherhood-graduation proximity. Taken together we answer our research question by the following statement:

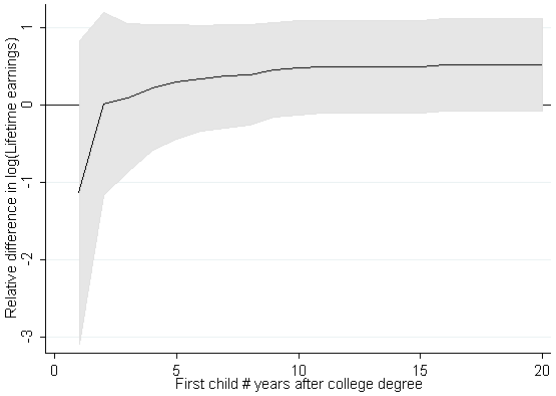
Having children in close proximity to college graduation has a negative impact on lifetime earnings. Whether or not motherhood happens before or after graduation does not seem to have a significant effect.



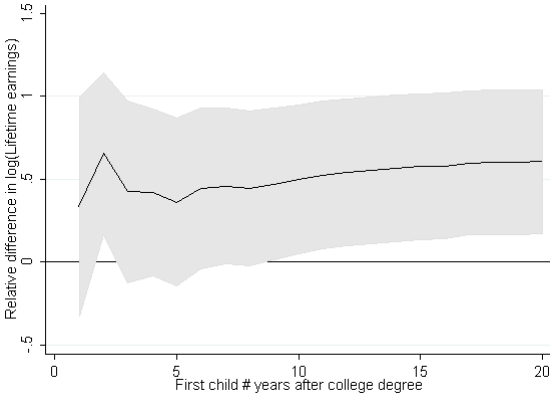
(A) *Delay experiment full set*



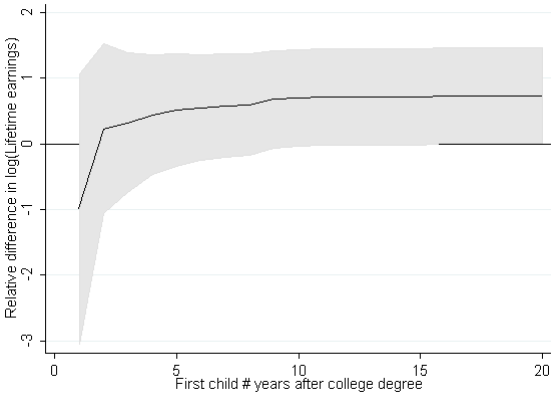
(D) *Acceleration experiment full set*



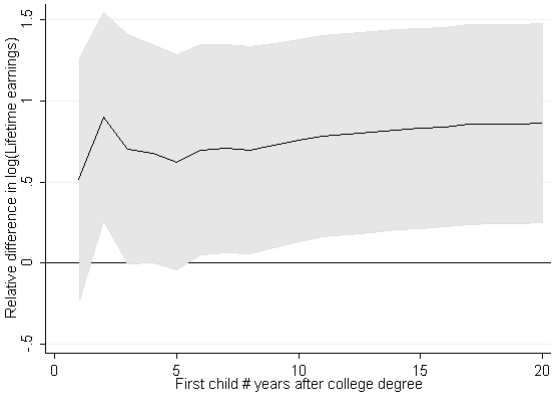
(B) *Delay experiment 4 year cutoff*



(E) *Acceleration experiment 4 year cutoff*



(C) *Delay experiment 2 year cutoff*



(F) *Acceleration experiment 2 year cutoff*

Fig. 9 *Increase in log(Lifetime earnings) for the group who have children T years after graduation compared to the group who have children prior to graduation. Fig A-C compares involuntary delayed mothers with voluntary mothers and Fig. D-F compares voluntary delays due to successful use of contraceptives with unsuccessfully protected mothers. The first row (Fig A and D) compares all women in the experiment whereas fig. B and E restricts the non-delayed group to only those who have children no more than 4 years prior to graduation. In the last row, Fig C and F, the restriction is set to 2 years.*

VARIABLES	log(LifetimeEarnings)
Proximity	0.182***
	(0.0576)
Delayed	0.169
	(0.348)
bin_cocaine	-0.619
	(0.380)
bin_alcohol	0.0254
	(0.261)
bin_marijuana	0.0336
	(0.280)
bin_smoking	-0.392
	(0.276)
Constant	11.82***
	(0.236)
Observations	159
R-squared	0.098

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

VARIABLES	log(LifetimeEarnings)
Proximity	0.0563***
	(0.0122)
Accelerated	-0.357
	(0.235)
bin_cocaine	-0.120
	(0.163)
bin_alcohol	-0.0520
	(0.143)
bin_marijuana	0.455**
	(0.176)
bin_smoking	-0.398**
	(0.184)
Constant	12.05***
	(0.163)
Observations	376
R-squared	0.111

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4a (left), **4b** (right) *Results of the OLS regressions of child-graduation proximity on log(LifetimeEarnings) controlling for delay, acceleration and substance use.*

Lastly, as a visual confirmation of the proximity effect, we plot income data and proximity to both high school diploma (Fig. 10) and college graduation (Fig. 11). We do indeed see a cusp in the data close to the graduation date (time T=0). From the scatter plot we see that among the women who have lowest lifetime earnings, many had children in close proximity to graduating high school.

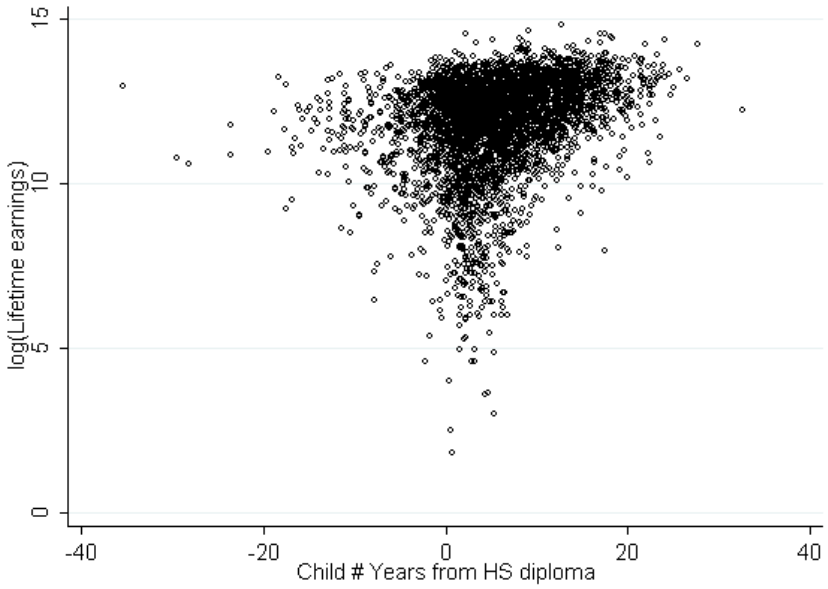


Fig. 10 *log(Lifetime earnings) as function of child-high school graduation proximity.*

Doing the same scatter visualization for the college graduates reveals the same effect. Among the lowest earning women, many have children in close proximity to graduation. This is both prior to and succeeding the graduation date. (Fig. 12) shows the

same plot for the group of women who actively avoid having children before graduation by using contraceptives. Even here we see the cusp close to 0 but less pronounced due to a smaller sample size.

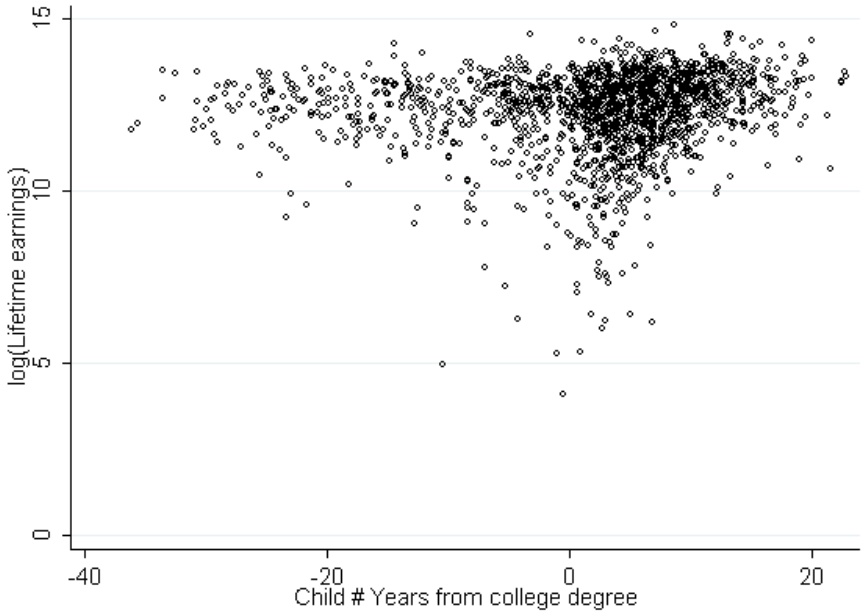


Fig. 11 *log(Lifetime earnings) as function of child-college graduation proximity.*

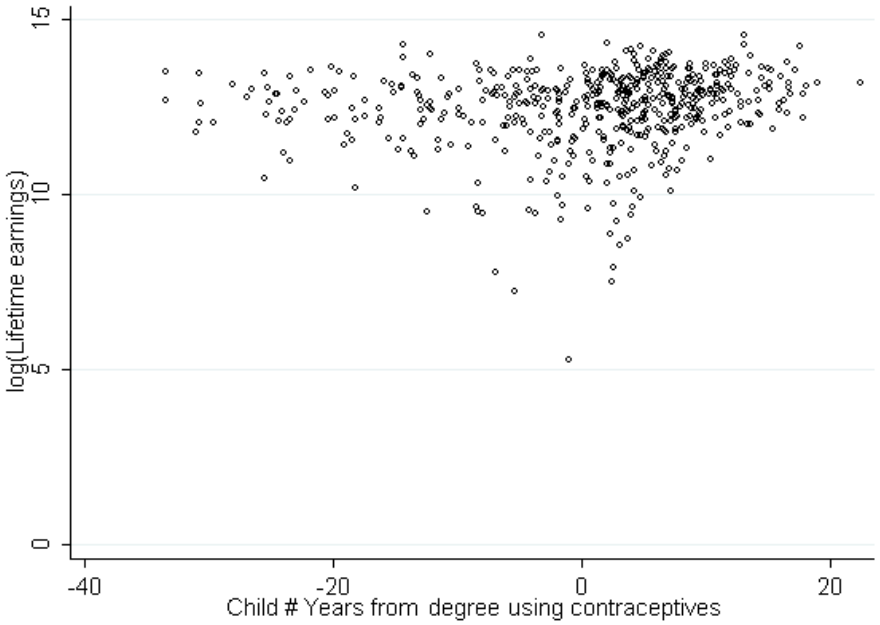


Fig. 12 *log(Lifetime earnings) as function of child-college graduation proximity for the group who actively use contraceptives prior to graduation.*

7 Conclusion

By observing a natural randomized experiment where women who are about to graduate from college are placed in groups where the birth of the first child is before or after graduation respectively, we are *unable* to detect any significant difference in lifetime earnings between the two groups unless childbearing is postponed extensively (more than 10 years after graduation).

We are able to confirm previous findings that delayed motherhood, on average, increases lifetime earnings. However, we found that this effect is mostly explained by the women who delay childbearing extensively above average. This group of women who delay childbearing until 10+ years after graduation have on average higher lifetime earnings.

For women who attain a higher degree and children in relatively close proximity we found *no significant differences* in lifetime earnings. We find that having children in immediate proximity to graduation (within 0-4 years before or after) is negatively correlated with accumulated lifetime earnings.

In conclusion and according to data, for women who receive both children and a college degree during their lifetime either;

1. extensively postponed childbearing (more than 10+ years) is correlated with significantly higher earnings and;

2. childbearing and graduation in close proximity is correlated with lower lifetime earnings.

Apart from these two effects we do not find any significant correlations between timing of motherhood, graduation and lifetime earnings.

8 Concluding remarks

Since we are unable to find any significant difference in lifetime earnings for women who enter post graduate labor market with or without children (excluding extensive postponing women) we could argue that wage differences is caused less by discrimination of mothers (signaling) and is more due to mechanisms related to workplace absence. The fact that having children in close proximity to graduation has a negative effect on lifetime earnings could perhaps be understood, or at least interpreted, in the light of a recent study by Arcidiacono et al. (Arcidiacono, Bayer & Hizmo 2010) who examines how ability is revealed to the labor market for college and high school graduates

respectively. Using the same dataset, NLSY79, they show that return to ability (as measured by the Armed Forces Qualification Test, AFQT), is revealed almost immediately for college graduates whereas the initial return to ability for high school graduates is miniscule. As a possible explanation the authors suggest that college resumes, grades and the particular college attended conveys enough information for the employer to correctly judge the ability of the candidates which is reflected in initial wage levels. Instead, for high school graduates the return to ability is revealed gradually and grows with work experience.

If this interpretation is correct and return to ability is revealed to employers immediately after college graduation one could reason that missing this opportunity of early signaling would cause candidates to ”miss out” on an important initial higher wage which would explain lower lifetime earnings. The college education can in this way be seen as a buildup of ability signaling which is capitalized at graduation but which deprecates rapidly. It would then be beneficial to enter the labor market only if the candidate can secure a job with adequate initial wage. Thus if women are absent during this crucial time due to motherhood, they will be unable to early capitalize on their ability as indicated by their college degree and end up on a lower income curve in accordance with Miller's mommy track (Miller 2011). Being preoccupied with rearing small children prohibits active job-seeking. Hence, it would be better to have children sufficiently prior to or after college graduation.

Potential biases

Among the group of women who experienced miscarriage there might be a sub-selection of women who would have induced an abortion should the miscarriage not have happened. As mentioned in the literature overview, this group is usually seen as more advantaged. Therefore we might have a modest bias favoring the miscarriage group over the group who proceed to have children. This effect, if it even exists among our group, should be modest as the effect is strongest among teens and wears off among adolescents. Regardless, the bias would be favorable towards the delayed group and since we do not find any significant effect between the groups we conclude that this bias does not contribute to change the results in our experiment.

For the women who experienced a fertility lag we identified a few possible biases. Women who successfully delay their conception (for example taking into account the OC half-life) until a desired time period might exhibit other favorable characteristics. This implies that our delayed group would be upwards biased. Analog with the previous section,

since we did not find any significant effect that this group would be better off, we conclude that this bias even if it exists is not strong enough to change the outcome. Another potential bias, this time downwards might be that women who involuntarily experience a delay might over time become depressed as hope dies. This is usually over longer time periods. We would see such an effect in the time graphs for higher years but we do not, it is more or less consistent. This effect would counteract the previously mentioned upwards bias. Our conclusion for both effects are that they most likely are modest and would not significantly change our results.

Thinking about fertility acceleration and potential biases, we reason that women who successfully use contraceptives could be gifted with characteristics that would also be favorable in the job market. If this is the case we would have an upwards bias, meaning that our acceleration variable is hiding other characteristics that would explain the difference in lifetime earnings. Since we did not find any effect, or a very small effect depending on the time period analyzed, we conclude that even though our experiment might have been favorable against the control group we did not find any effect. This would indicate that the effect could be even smaller than shown for all time periods.

External validity

How do our results extend beyond the NLSY79 data set? Even if many conditions for women in general and mothers in particular have changed in the past decades our results should be valid for more recent cohorts as well as societies fairly similar to the US. The fact that we do not see a clear motherhood penalty in our data suggests that there is no clear signaling effect of being a mother per se but rather that absence from work in a critical early period of the career is the reason for the observed wage differences. The attitude towards working mothers have, if anything, been more accepting in recent years compared to the 80's which would then support the external validity of our results. Together with the fact that the student effect is observed both in recent studies of Norwegian women and in our data suggest that there might be some behavioral similarities across the globe.

And finally, we would like to invite you, the reader, to contemplate the following words from Nate Silver:

"The story the data tells us is often the one we'd like to hear, and we usually make sure that it has a happy ending."

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Appendix

VARIABLES	Log(LifetimeEarnings
bin_degree	1.489***
	(0.0591)
Constant	10.66***
	(0.0466)
Observations	6,283
R-squared	0.072

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Reg. 1 Regression showing ceteris paribus effects of college attainment on lifetime earnings. A significant higher level in lifetime earnings for the college graduates.

VARIABLES	log(LifetimeEarnings)
Total # children	-0.204***
	(0.0139)
bin_degree	0.740***
	(0.0333)
Constant	12.29***
	(0.0375)
Observations	4,417
R-squared	0.156

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Reg. 2 Regression showing ceteris paribus effects of number of children and college attainment binary on lifetime earnings.

VARIABLES	log(LifetimeEarnings)
Proximity	0.175***
	(0.0629)
Delayed	0.270
	(0.465)
bin_cocaine	-0.873*
	(0.479)
bin_alcohol	0.111
	(0.402)
bin_marijuana	0.0783
	(0.452)
bin_smoking	-0.582
	(0.418)
Constant	11.78***
	(0.329)
Observations	98
R-squared	0.132

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Reg. 3 OLS regression for child-graduation proximity in the fertility delay experiment controlling for substance. We restrict the population to those having their first child no earlier than two years prior to graduation.

VARIABLES	log(LifetimeEarnings)
Proximity	0.0182***
	(0.00608)
Delayed	0.447*
	(0.266)
bin_cocaine	-0.437**
	(0.199)
bin_alcohol	0.0973
	(0.137)
bin_marijuana	-0.0285
	(0.138)
bin_smoking	-0.225*
	(0.131)
Constant	12.14***
	(0.123)
Observations	495
R-squared	0.038

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Reg. 4 OLS regression for child-graduation proximity in the fertility delay experiment controlling for substance and no restriction on time.

VARIABLES	log(LifetimeEarnings)
Proximity	0.0545***
	(0.0122)
Accelerated	-0.580*
	(0.327)
bin_cocaine	-0.174
	(0.162)
bin_alcohol	0.00210
	(0.146)
bin_marijuana	0.520***
	(0.188)
bin_smoking	-0.448**
	(0.192)
Constant	12.02***
	(0.165)
Observations	353
R-squared	0.125

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Reg. 5 OLS regression for child-graduation proximity in the fertility acceleration experiment controlling for substance. We restrict the population to those having their first child no earlier than two years prior to graduation.

VARIABLES	log(LifetimeEarnings)
Proximity	0.0355***
	(0.00732)
Accelerated	-0.441***
	(0.126)
bin_cocaine	-0.174
	(0.154)
bin_alcohol	0.0826
	(0.115)
bin_marijuana	0.290**
	(0.143)
bin_smoking	-0.337**
	(0.146)
Constant	12.22***
	(0.123)
Observations	513
R-squared	0.074

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Reg. 6 OLS regression for child-graduation proximity in the fertility acceleration experiment controlling for substance and no restriction on time.