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The spacing of births and women's subsequent earnings
– evidence from a natural experiment

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The spacing of births and women's subsequent earnings - evidence from a natural experiment[a]

by

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Abstract

This paper analyzes the consequences of the spacing of births for women's subsequent labor income and wages. Spacing births in longer intervals may allow women to re-enter the labor market between childbearing events, thereby avoiding expanded work interruptions and, in turn, reducing the negative effects of subsequent children. Based on arguably exogenous variation in birth spacing induced by pregnancy loss between the first two live births, the evidence provided in this paper supports this hypothesis and suggest that delaying the second birth by one year, on average, increases the probability of re-entering the labor market between births. Moreover, spacing births are found to increase both labor market participation and labor income over a long time period after second birth. Also long-run wages are positively affected, with a more pronounced effect for highly educated mothers.

Keywords: Child spacing, Female wages, Female lifetime earnings, Natural Experiment
JEL-codes: J31, J13

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Table of contents

1 Introduction

Public policies aimed at facilitating the combination of market work and childbearing have gained increasing salience in the past few decades and today all OECD countries except the United States offer governmentally funded parental leave benefits. The parental leave schemes in the Nordic countries have long been the most developed, both in terms of the duration of statutory job protected leave and in terms of the duration of wage-replaced leave. As benefits are conditioned on employment, the schemes create a strong incentive to participate in the labor market before childbirth, which has likely contributed to the high female labor force participation rates in the Nordic countries (see e.g. Baker & Milligan 2008, Jaumotte 2004, Han et al. 2009, Waldfogel 1998). At the same time, however, the generosity of the parental leave schemes may discourage women's participation on the intensive margin and generate employer expectations that constrain women's labor market opportunities. For example, Albrecht et al. (2003) find evidence of a "glass ceiling effect" in Sweden, revealed as a significant gender gap in pay at the upper tail of the wage distribution.[1] The authors argue that the extensive leave provisions in Sweden create room for statistical discrimination, which could give rise to the observed wage gap pattern. Thus, there is potentially an important distinction between the *provision* of leave and the *duration* of granted leave in terms of the ability of policies to successfully promote women's labor market opportunities.

A large economics literature estimates the effects of childbearing on the subsequent employment and earnings of women. For the U.S., for example, Angrist & Evans (1998), Bronars & Grogger (1994) find negative labor supply responses to having an additional child. For Sweden, Angelov et al. (2013) find that, 15 years after the first child is born, the within-couple income gap increases by 35 percentage points. However, while providing evidence on the effects of additional children, these studies do not address the effects of the duration of leave on subsequent earnings. The latter is instead often addressed by using variation in maternity leave entitlements. For example, Schönberg & Ludsteck (2012) study policy reforms in Germany and find that expansions in leave coverage re-

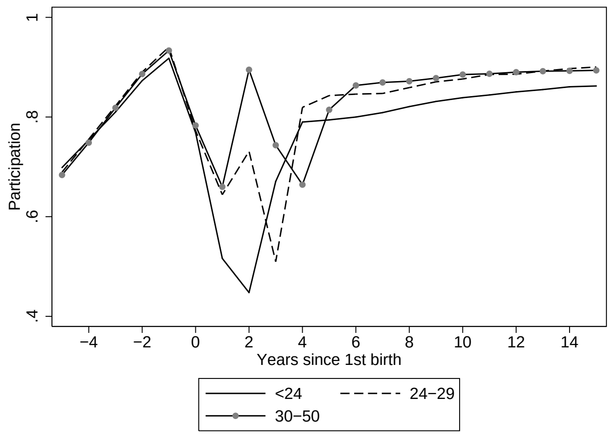
[1]This glass ceiling is particularly striking given the compressed wage structure in Sweden, and is not evident to the same extent in, e.g., the United States.

duces women's employment in the short run, whereas small effects are found in the long run. Lalive & Zweimuller (2009) study two reforms in Austria and find that extended parental leave significantly reduces return to work. Joseph et al. (2013) evaluates the effects of short parental leave on French mothers' employment, and find that short full-time leave has almost no effect on participation or wages. A potential limitation to studies exploiting parental leave reforms or studying the effects of additional children is, however, that the strategies do not allow an examination of whether the rate of transitions in and out of the labor market during childbearing ages has any relevance for subsequent earnings and wage rates; an issue that becomes increasingly important as the more relevant choice of couples in developed countries concern *when* to have children and not how many children to have.

This paper instead proposes a new approach to analyzing career consequences of work interruptions by studying variation in the duration and tempo of work interruptions generated by fertility timing behavior. In particular, the aim of this paper is to estimate the effect of birth spacing on i.) the labor market commitment between two childbearing episodes and ii.) women's long run labor market attachment, income and wage rates, where the latter three variables are likely to be functions of the former. For example, on the extensive margin, spacing births could affect the likelihood of returning to work between births and, on the intensive margin, spacing births may allow a longer spell of market work between births among those women who re-enter the labor market after a period of parental leave. The labor market behavior between childbearing events, in turn, is likely to be of importance for labor market outcomes also in the long run. To illustrate, *Figure 1.1* depicts the labor market attachment by time since first birth for mothers with varying number of months between the first and second child. As seen, women with the shortest birth intervals have the lowest level of labor market commitment in the interval between the first and second child, and also have permanently lower attachment, compared to women with longer birth intervals, even 15 years after first birth.

Fertility timing choices and career decisions are, however, likely to be jointly determined. Moreover, women may have differing preferences regarding market work and family that induce some women to invest more effort at work and space their children

Figure 1.1: Labor market attachment by years since first birth for women with varying child spacing.



with longer intervals. A selection-on-observables estimator will then likely yield an upward biased estimate of the effect of birth spacing on labor market outcomes. To address these potential endogeneity issues - and examine whether the patterns illustrated in *Figure 1.1* reflect a causal relationship - I employ an instrumental variables approach and exploit arguably exogenous variation in birth spacing induced by miscarriages that occur between the first and second live births; random fertility shocks that delay time to birth and thus induce a logner time interval between births.[2]

To this end, I use a combination of individual-level longitudinal Swedish registers, which provide information on fertility and work histories for the entire population of mothers. Individual level data on miscarriages are drawn from hospitalization data, which covers the universe of hospital admission in Sweden. I follow mothers for up to 15 years post second birth, as well as before entering parenthood, which enables me to provide important falsification tests and other tests of the validity of my empirical strategy.

My results suggest that increasing the time interval between the first and second birth largely increases women's subsequent labor income. The effect of a one-year delay of the second birth, on average, is positive and increasing in magnitude over a 15-year horizon

[2] Miscarriages have been used in previous studies to instrument for the timing of first birth (see e.g. Ashcraft et al. 2013, Miller 2011, Bratti & Cavalli 2014, Hotz et al. 1997, 2005).

after second birth. Moreover, spacing births in a longer interval is found to increase the probability of re-entering the labor market between the births of the first and second child, and to increase the long-run labor market attachment of mothers. Small effects are found on the completed number of children, implying that the impact of spacing births on long-run earnings is not entirely driven by fewer children. Spacing births in longer intervals is also found to have positive consequences for women's long-run wage rates; a one-year delay of the second birth is estimated to increase the full-time equivalent monthly wage, an effect that is more pronounced among highly educated mothers.

The analyses provided in this paper contributes to the relatively limited knowledge about how fertility timing affects the magnitude of the career costs of childbearing. The majority of the works focuses on the effects of *first* birth timing, and in particular on effects of teenage childbearing for subsequent outcomes (see e.g. Hotz et al. 1997, 2005, Ashcraft et al. 2013). Although recent studies define birth timing more broadly, the existing evidence on the effect of first birth timing is still scarce, and even less is known about the impact of the timing of subsequent births on women's career outcomes. An exception is provided by Troske & Voicu (2012), who use multinomial probit models to study the effects of the timing and spacing of births on women's labor market involvement and find that both matter for women's labor supply around birth.[3] Thus, the present paper contributes with new evidence on the economic consequences of birth spacing and, to the best of my knowledge, only one previous paper uses miscarriages to instrument for birth spacing; Buckles & Munnich (2012) employ this strategy to study the effect of birth spacing on sibling outcomes.

In addition, my findings provide new evidence on the importance of career interruptions due to childbearing, and the level of labor market commitment, for subsequent labor market outcomes. In part, my analyses can also be viewed as an indirect evaluation of the generosity of parental leave provisions as they, to some extent, allow inferring the effects

[3] Specifically, they find that postponing first births reduce the negative effects of children on labor supply, and that the effect of the second child increases with the spacing of two births. The authors argue that this is because, while the negative effect on participation decreases, the positive effects on the probability of working part-time and the negative effect on the probability of working full-time increases. They conclude that women returning to work after the first birth finance child care time increasingly through reductions in market time.

of lengthy career interruptions on subsequent outcomes.

Moreover, while some policies are specifically targeted at affecting the duration of the time spent at home with young children, other policies may unintentionally affect the same margin, particularly through its impacts on fertility timing behavior. One such policy in Sweden is the so called speed premium; an administrative rule which carries incentives to space children in close intervals. The rule allows parents to retain the same level of (wage-replaced) benefits for a subsequent child as for the previous child, without having to re-establish eligibility by going back to work between the two births, provided that the birth interval is sufficiently short. The eligibility birth spacing interval was initially quite short, but was extended to 24 months in 1980 and further to 30 months in 1986, where it remains today. Indeed, previous studies find tentative evidence suggesting that the introduction of the speed premium rules induced shorter birth intervals for Swedish couples (Pettersson-Lidbom & Skogman Thoursie 2009, Hoem 1993). To the extent that couples' fertility behavior is responsive to economic incentives and family policies, it seems important to understand the consequences of fertility timing decisions for parental labor market outcomes.[4] In light of this, my results suggest that for couples who adjust their fertility behavior in order to gain short-run economic advantages, e.g. due to the speed premium rules in the Swedish parental leave scheme, this may come at a cost to women's long-run labor income and wage growth. Moreover, these findings may have implications for the next generation if the mother's or the household's financial resources are affected in such a way as to have an impact on the resources available for investments in children.

2 Data

The analysis is based on a panel data set created by combining several Swedish administrative registers. Information on the birth year, birth month, and birth order of each of an individuals's children is obtained from the multi-generational register, which links all chil-

[4]For example, Lalive & Zweimuller (2009) exploit reforms in the Austrian parental leave system to analyze the effect of paid and job protected leave and find that different changes in these components affect both employment of mothers, the number of children, and the spacing of births.

dren to their biological parents. Individual level information on annual labor income and background variables are then matched to these data. Moreover, I add information from a linked employer-employee data set containing unique identifiers for the establishment at which the individual is employed each year, the first and last calendar month in each year that the worker received income from the specific employer, and the total income earned from the specific employer each year. These registers cover the entire Swedish population aged 16-64 between 1985 and 2007. From the Wage Structure Statistics I add information on full-time equivalent monthly wages for each person-year-establishment pair. Data on wages are available for the entire public sector and about half of the private sector workers for the time period 1985-2007.[5]

In addition, I match these records with individual level data on miscarriages, which are provided by the National Patient Register (NPR); the inpatient register administered by the National Board of Health. The NPR covers all hospital visits in Sweden during 1987 to 2005 and includes medical information associated with each hospitalization, classified according to the International Classification standard for Diseases (ICD). Using the ICD-codes from the patient register, I can recover all hospital visits associated with miscarriages.[6] In ICD10 the definition of a miscarriage is a pregnancy loss occurring between the 6th and 24th week of gestation (the total length of a pregnancy is 40 weeks).[7] The order of the pregnancy is not recorded in the NPR, and neither is the gestational age at which the miscarriage occurred. I define the instrument to equal unity if an individual experienced a pregnancy loss between the first and second live births, where the timing of both births are drawn from the multi-generation register.

By combining the registers described, I construct a panel data set consisting of individuals with at least two children, who gave birth to their first child between 1985 and 2006, and were aged 21 or older at first birth. Women with twin (or higher order multiple) births and women who experienced a miscarriage before the birth of the first child

[5] All private sector firms with 500 employees or more are included in the wage data, whereas a random sample is drawn on firms with less than 500 employees. The sampling is a stratified random sampling, where the stratification is based on a cross-classification of industry and firm size.

[6] The ICD10 code for miscarriage is O03.

[7] The WHO definition of a miscarriage is a pregnancy loss that occurs before 22 weeks of gestation.

are excluded from the sample, as are women with recurring miscarriages. The population net of these sample restrictions consists of 642 464 individuals. The number of women in the study sample that experienced a miscarriage between the first two live births sum to 16 540 women. *Figure A1* reports the frequency of these miscarriages by year and shows that the number of miscarriages reported in the NPR for the studied sample decreases over time. This is likely due to miscarriages being increasingly treated at outpatient facilities over time; the NPR only records inpatient care and thus women seeking treatment for pregnancy losses at outpatient medical facilities are not included in the data available here. One cause of concern could thus be that only cases with additional complications are treated as inpatient care when outpatient care becomes more common. However, results provided in Karimi (2014) do not support the conjecture that the miscarriages that are treated as inpatient care are increasingly associated with medical complications over time. This, and other threats to internal validity are discussed in more detail in the next chapter.

Summary statistics for the study sample (for details, see *Table A1* in the Appendix) show that 2.6 percent of the sample experienced a miscarriage between the first two live births. Furthermore, the women in the sample were on average aged 27.2 years at first birth, and the average spacing between the first two children - measured as the number of years elapsed between first and second birth - is 3.1 years. There is considerable variation in the time interval between the first two births, where the overwhelming majority of women have their first two children within 50 months from each other (see *Figure A2* in the Appendix).

I follow each individual for at most up to 15 years after second birth; the length of the follow-up period varies with birth cohort due to the time series not being long enough for women who gave birth in later years. The main dependent variable used in the empirical analysis is the annual labor income in 1000s SEK, expressed in 2008 prices (deflated using the Consumer Price Index).[8] To study potential effects of birth spacing on the returns to work, a second dependent variable analyzed is the full-time equivalent monthly wage (in

[8]Note that labor income does not include parental leave benefits or other transfers. In periods of non-work, income is reported as 0 income.

natural logs). Wages are not observed for individuals not working, and due to private firms being randomly sampled to be included in the wage data, there are also missing values on wages for individuals employed in the private sector. Moreover, individuals that are not present at the workplace during the survey month, e.g. due to sickness absence or parental leave, are not included in the wage data even though they are employed. For missing observations on wages - e.g. due to working in the private sector and hence not sampled to be included in the wage data, or due to being absent from work during the survey month - in years where individuals have a positive income I impute wages through linear regression on a set of background characteristics, industry affiliation, labor income, and pre-birth wages.[9]

3 Institutional setting

Along with the other Nordic countries, the Swedish parental leave system is quite generous in international comparison and offers a great deal of flexibility for parents. At the time of the introduction of the system in 1974, Swedish parents were entitled to six months of paid leave at a compensation rate of 90 percent of previous earnings. Following the introduction, entitlement to paid leave was extended sequentially and the system now offers 16 months of paid parental leave for each child, of which 13 months are compensated at a rate of 80 percent of previous earnings up to an inflation adjusted cap. The remaining three months entitles a fixed lower rate of compensation. In order to receive wage-replaced benefits, parents must have been employed for at least 240 days before birth. This work requirement has likely contributed to the high female labor force participation rates observed in the Nordic countries (Jaumotte 2004, Baker & Milligan 2008, Han et al. 2009, Waldfogel 1998). In 1995, one month of paid leave was earmarked to each parent as a means to increase fathers' share of parental leave, and an additional month was reserved for each parent in 2002. Parents can be on full-time leave for the child's first 18 months of life, with job protection. Furthermore, paid leave can be used until the child turns eight years old, and parents have the right to reduce working hours

[9]Sensitivity analyses are carried out without imputing missing values on wages.

with up to 25 percent until the child's eighth birthday.

In addition, the system includes an administrative rule sometimes called the 'speed premium'. Before the introduction of the speed premium, women had incentives to postpone subsequent births until eligibility of wage-replaced benefits had been re-established. During the 1970s, however, it became legal practice for parents to keep the level of income compensation paid after one birth during the leave for a subsequent birth, provided the two births were sufficiently close. This interval was initially quite short, but was extended in 1980 to 24 months and extended again to 30 months in 1986. Thus, there are short-term economic incentives for parents to space their children in short intervals, which could result in substantially prolonged work absences.

The average birth spacing in Sweden has decreased over the past decades. In Appendix *Figure A3*, the average spacing in months between the first two children is graphed for cohorts of mothers who gave birth to their second child in 1970 to 1995. The two horizontal lines represent the introduction of the first and second speed premiums, respectively. There is a sharp decrease in the spacing of births between these two points in time. Moreover, *Figure A4* in the Appendix plots kernel density estimates for the likelihood of having the first two children within 30 months for the cohort of women who gave birth to their second child before the extension of the speed premium in 1986 (second child born 1985) and for the cohort of women who gave birth after the extension (second child born in 1987). As seen from *Figure A4*, there is a clear shift in the distribution of births occurring within a 30 month interval from 1985 to 1987, tentatively suggesting that the rule had an effect on fertility spacing behavior. Previous evaluations of the speed premium suggest that the policy indeed shortened the birth interval for Swedish parents. For example, Pettersson-Lidbom & Skogman Thoursie (2009) exploit the 1980 extension and found that the spacing of children decreased for mothers with strong labor force attachment compared to mothers with less labor market attachment (and therefore less strong incentives to adjust their spacing). Also, Hoem (1993) shows that parents reacted by increasing their fertility particularly strongly before the end of the eligibility interval. The author further argues that Swedish couples are willing to adjust the timing of their childbearing after the first birth to gain short-term economic advantages, but that this may come at a cost to mothers' long-term career advancement. Moreover, Björklund (2006) studies whether the package of family policies introduced in Sweden from the mid 1960s to 1980 affected fertility by comparing the fertility behavior with neighboring countries where family policies were not extended as much as in Sweden. The results found suggest that the extension of family policies raised the level of fertility, shortened the spacing of births and induced fluctuations in the period fertility rates. Thus, these and similar findings suggest that public policies have the potential to adjust individuals' fertility behavior, also in cases where the policies are not aimed at doing so.

4 Empirical strategy

Interest lies in evaluating whether the spacing of births affects the long run labor market outcomes of women. The causal question of interest is summarized by the following equation:

$$y_i = \alpha_0 + \beta S_i + \mathbf{x}_i' \delta_x + \varepsilon_i \tag{1}$$

where y_i is the labor market outcome of interest and $\mathbf{x}_i'$ is a vector personal characteristics. The regressor of interest is S_i, and is defined as the time interval, in years, between first and second birth. Ordinary Least Squares (OLS) estimation will yield biased estimates if child spacing is correlated with the error term. For instance, due to heterogeneous preferences for market work and family, some women might invest more effort at work and space their children with longer intervals, or women with higher earnings potential may choose to postpone further childbearing to reduce the costs of childbearing. If mothers with higher earnings potential space their children with longer intervals, the OLS estimator will over-estimate the effect of spacing on labor market outcomes. The data on which the analysis are based allows an extensive set of control variables, which could possibly account for part of the heterogeneity. The controls included in $\mathbf{x}_i'$ are dummies for educational attainment, a dummy for non-Nordic origin, cohort dummies, dummies for the age at first birth, the number of pre-birth hospitalizations (during a five-year period before second birth) as well as the number of pre-birth hospitalizations by diagnosis category.

However, further childbearing could be delayed if women, for some reason or the other, returns to work after first birth, causing a reversed causality problem. In this case, the inclusion of control variables will not help address the identification problem. In order to address these potential problems of endogeneity, I make use of the arguably exogenous variation in spacing induced by miscarriages between first and second live births. The first-stage regression equation is thus given by:

$$S_i = \gamma_0 + \gamma_1 M_i + \mathbf{x}_i' \gamma_x + \nu_i \tag{2}$$

where $\mathbf{x}_i'$ contains the same control variables as in Equation (1), and M_i is a dummy variable taking the value one if individual i experienced a miscarriage between the first and the second birth. 2SLS estimation then yields the effect of birth spacing for women who spaced their children in longer intervals due to experiencing a pregnancy loss after first birth.

4.1 Internal validity

In order for miscarriage to be a valid instrument for child spacing, a miscarriage must affect the time interval between births, i.e., there must exist a first-stage relationship, and the instrument must not be correlated with the error term in Equation (1). The first assumption can be tested directly, and evidence of an existing first-stage relationship is shown in the subsequent section. The exclusion restriction, however, cannot be tested and must be argued for on a case-by-case basis.

One potential concern regarding the independence assumption is that the health of women who experience pregnancy loss is worse on average compared to women who do not, or that women who miscarry differ in terms of unobservable characteristics from women that do not experience miscarriage. This critique against the miscarriage instrument is lifted in e.g. Wilde et al. (2010). Evidence in the medical literature suggest that most miscarriages are random, but that some may not be: miscarriages have been associated with some extreme behaviors such as heavy of regular alcohol-, tobacco- or drug use during pregnancy (see e.g Garcia-Enguidanos et al. 2002, Maconochie et al. 2007, for reviews). However, miscarriages are commonly occurring fertility shocks, where one in four of all women who become pregnant is estimated to experience pregnancy loss and the overwhelming majority occur before 12 weeks of gestation (Regan & Rai 2000).

To study the extent to which health differs between women who do and do not experience miscarriage in my sample, I make use of the detailed information covered in the National Patient Register, and examine whether there are differences in the average number of hospitalizations (for all medical reasons) during the time period $t-5$ to $t-1$, where $t=0$ is the birth year of the second child. All pregnancy-related hospitalizations are excluded from this analysis (including the miscarriage-related admissions). *Table 4.1* reports correlations between the number of pre-natal hospital visits (and hospital visits due to grouped diagnosis categories, respectively), and the spacing of births (S_i) as well as with miscarriage (M_i). As seen, the spacing of births is positively correlated with the number of pre-natal hospitalizations, as is miscarriage, albeit to a lesser extent. Breaking down the hospital visits by diagnosis category, we see that there are some health issues that are more prevalent among women who experience miscarriage; the number of hospitalizations associated with tumors and neoplasms, respiratory diseases, musculoskeletal, genitourinary system and a few other causes are positively correlated with miscarriage. Thus, in line with the medical literature, there appears to be some health differences between women who miscarry and women who do not. Hence, it is important to control for health and in all estimations I will therefore control for the number of pre second birth hospitalizations as well as the number of hospitalizations due to each diagnosis category listed in *Table 4.1*. The identifying assumption imposed is then that conditional on these health variables (and other personal characteristics) the instrument is as good as randomly assigned.

Hospitalizations represent the most severe health issues, and one worry is consequently that there are differences in the average health that is not captured by hospital visits. If women who miscarry have worse health on average, the 2SLS estimates of the effect of birth spacing would be biased towards zero.[10] In order to further assess the validity of the instrument, *Table 4.2* reports correlations between the independent variable of interest, S_i and the instrument M_i , respectively, and a number of individual characteristics. As seen from column 1 of *Table 4.2*, women who are younger at first birth, with

[10] That is, the effect is biased towards zero if the effect of birth spacing on labor market outcomes is positive.

Table 4.1: Correlations between pre-natal hospitalizations, child spacing and miscarriage

Dependent variable	Spacing	Miscarriage
Number of pre-2nd birth hospitalizations	0.0638***	0.0025***
	(0.0038)	(0.0003)
By diagnosis category		
Infectious	0.0704***	0.0026
	(0.0249)	(0.0021)
Tumors and neoplasms	0.2127***	0.0075***
	(0.0307)	(0.0025)
Diseases of the blood(-forming) organs	0.0859	0.0052
	(0.0658)	(0.0056)
Endocrine	0.3816***	0.0026
	(0.0367)	(0.0027)
Mental behavioral	0.5430***	-0.0017
	(0.0336)	(0.0018)
Nervous system	0.3224***	0.0044
	(0.0447)	(0.0031)
Eye	0.2067***	0.0017
	(0.0727)	(0.0055)
Ear	0.4143***	-0.0002
	(0.0699)	(0.0045)
Circulatory	0.4281***	0.0048
	(0.0462)	(0.0034)
Respiratory	0.2780***	0.0060***
	(0.0235)	(0.0020)
Digestive system	0.2042***	0.0016
	(0.0153)	(0.0012)
Skin	0.1057**	0.0032
	(0.0531)	(0.0041)
Musculoskeletal	0.3178***	0.0055**
	(0.0309)	(0.0023)
Genitourinary system	0.1325***	0.0083***
	(0.0137)	(0.0012)
Congenital malformations	0.1278**	0.0135**
	(0.0636)	(0.0056)
Symptoms not classified elsewhere	0.1447***	0.0065***
	(0.0149)	(0.0013)
Factors associated with health status	-0.2802***	0.0058***
	(0.0084)	(0.0010)
External causes	0.1486***	-0.0004
	(0.0223)	(0.0016)
Alcohol or drug induced hosp.	0.2480	0.0101
	(0.1595)	(0.0113)
Observations	620580	

NOTES.— Each coefficient reported in the table is obtained from a separate regression of the dependent variable on the control variable listed in each row plus a constant term. Standard errors are presented in parentheses. *$p<0.1$, **$p<0.05$ ***$p<0.01$.

lower educational levels and who have a non-Nordic background tend to space their children at shorter intervals. These fairly strong associations seen between child spacing and background factors are, however, also existent between miscarriage and the same background factors, albeit less strong. Women who are born in one of the Nordic countries and who are older at labor market entry tend to experience miscarriage to a somewhat larger extent. It thus seems as women who miscarry are not a random selection of the population. However, there is a large chance that these correlations are driven by age at first birth, since female fecundity is known to decline with age. In *Table 4.3*, therefore, I regress miscarriage onto all of the variables presented in *Table 4.2*, with and without including dummies for the age at first birth and cohort dummies, presented in columns 1 and 2, respectively. As seen from *Table 4.3*, including dummies for cohort and age at first birth reduces the magnitude of the coefficients on the background variables considerably, and the statistical significance disappears from all but two variables: the number of pre-natal hospitalizations is now weakly significant, but smaller. The coefficient on the dummy variable for residing in a large city before parenthood is still statistically significant and estimated to be positively associated with miscarriage by 0.35 percent, which may reflect that women living in larger cities also live closer to a hospital, making them more likely to visit an inpatient establishment when experiencing a miscarriage. In all regressions I will control for the education, birth cohort and age at first birth.

Furthermore, I carry out an additional assessment of the validity of the independence assumption by estimating the reduced form equation on labor income (expressed in 1000s SEK) in years prior to first birth. The results from this falsification test are presented in *Table A2* in the Appendix and show that there are no differences in labor earnings before becoming parents between women who later had a miscarriage and women who did not; the estimated coefficients are small in magnitude and not statistically significant apart from a weakly significant effect five years before parenthood.

Another potential issue that is important to raise is that miscarriages reported in the inpatient care record may be of a more severe nature than miscarriages treated at outpatient establishments. For example, the cases referred to hospitals may be cases with medical complications, or pregnancies who have reached a higher gestational age at miscarriage.

Table 4.2: Correlations between background variables, child spacing and miscarriage

	Spacing	Miscarriage	Observations
Age at first birth	-0.0686***	0.0003***	642464
	(0.0006)	(0.0001)	
Non-Nordic background	0.4423***	-0.0072***	642464
	(0.0092)	(0.0005)	
Compulsory schooling	0.2197***	0.0001	642464
	(0.0115)	(0.0008)	
High school	0.1545***	0.0009**	642464
	(0.0049)	(0.0004)	
College	-0.2114***	-0.0009**	642464
	(0.0048)	(0.0004)	
Age at labor market entry	0.0036***	0.0007***	584128
	(0.0004)	(0.0000)	
Live in large city (pre 1st birth)	0.0368***	0.0035***	574447
	(0.0061)	(0.0005)	

NOTES.— Each coefficient reported in the table is obtained from a separate regression of the dependent variable on the control variable listed in each row plus a constant term. Heteroskedasticity robust errors are presented in parentheses. *p<0.1, **p<0.05 ***p<0.01.

Table 4.3: Partial correlations between background variables and miscarriage

	(1)	(2)
Non-Nordic	-0.0045***	0.0013
	(0.0009)	(0.0009)
High school	-0.0032***	-0.0009
	(0.0011)	(0.0011)
College	-0.0104***	-0.0005
	(0.0011)	(0.0011)
Pre-2nd birth hospitalizations	0.0020***	0.0015***
	(0.0003)	(0.0003)
Live in a large city	0.0036***	0.0035***
	(0.0006)	(0.0006)
Age at labor market entry	0.0012***	-0.0001*
	(0.0001)	(0.0001)
Birth cohort dummies		✓
Dummies for Age at first birth		✓
Observations	538815	538815

NOTES.— Columns (1) and (2) present results from an OLS regression of miscarriage incidence onto all the control variables listed in the table, with and without including dummies for mothers' birth year and age at first birth, respectively. Heteroskedasticity robust standard errors are presented in parentheses. *p<0.1, **p<0.05 ***p<0.01.

This potential problem could be increasing with time as more cases are being treated as outpatient care, such that those cases still reported in the NPR at later dates only include the most severe cases (recall that the number of reported miscarriages in the inpatient records declines with time). The NPR includes detailed information about the severity of reported miscarriages for the years 1997-2005. *Table A3* in the Appendix reports the type of miscarriage, among all miscarriages reported in the inpatient record during 1997 to 2005 and shows that the vast majority of cases regard miscarriages without additional medical complications. *Figure A5* in the Appendix shows the evolution of the type of reported miscarriages over time in the inpatient record, and suggests that, even as cases treated at hospitals become fewer and there is a slight increase in more severe cases, the vast majority of reported cases are still without complications.

Moreover, as the NPR also includes secondary diagnoses for each hospital visit, I can get an additional indication of the severity by examining whether there are any reported co-morbidities with the pregnancy loss for those women in my study sample that experienced miscarriage. The results, shown in *Table A4* in the Appendix, suggest that 96.5 percent of the cases did not have any co-morbidities reported. Furthermore, 3.14 percent were reported to have one co-morbidity, of which the most common diagnose was pregnancy-related or related to diseases of the genitourinary system. Thus, there is no strong evidence that the miscarriages reported in the NPR are overwhelmingly associated with additional complications.[11]

A final concern is that miscarriages might affect women's psychological well-being such that labor market outcomes are directly (adversely) affected, violating the exclusion restriction. In this case, the instrumental variables estimate would again be downward biased.

[11] Even as the number of reported miscarriages become fewer over time, the fraction of miscarriages that are admitted with a co-morbidity is still around 3 percent. These results are available upon request.

5 Results

The empirical analysis includes the estimation of the effect of child spacing on annual labor income and labor market participation after second birth. The baseline model is specified by Equation (1), which is estimated with OLS and 2SLS, where the occurrence of miscarriage between the first two live births is used as an instrument for child spacing. The first dependent variable measures annual labor income in 1000s SEK. Separate yearly regressions are performed for each year after the second birth, starting from year one after second birth, up to at most 15 years after second birth.[12] The second outcome variable is studied to capture labor market participation, and is defined to equal unity if labor income exceeds one basic amount.[13] To analyze wether labor market experience between the first and second child is affected by increasing the time interval between births, I estimate the impact of spacing births on the probability to return to work between the first and second birth, and on the total income earned in the interim between the first two births.

Moreover, birth spacing may affect subsequent fertility. This could imply that a potential effect of birth spacing partly reflects an altered family size. Therefore, I also display results from analyses examining whether completed fertility is a main driving channel of any effects found on income and participation. Lastly, I analyze potential consequences of birth spacing on women's subsequent wage rates.

5.1 The effect of spacing births on labor income

Table 5.4 reports results from an OLS estimation of the first-stage relationship given by (2), adding control variables stepwise. The coefficient on the instrument is positive and reasonable in magnitude. Having a miscarriage before second birth delays second birth such that the spacing between the first two children is increased by 11.4 months on average (0.953 years). Adding dummies for birth year and dummies for age at first birth, educational level and a dummy for non-Nordic origin reduces this estimate somewhat (depicted in column 2); pregnancy loss is now estimated to yield a delay of second birth by around

[12] Due to different lengths of the time series of income for different birth cohorts, I cannot follow all individuals for the entire 15-year horizon, so the sample size will decrease with each yearly regression.

[13] The basic amount is used to calculate various benefits in the social insurance and is updated yearly by adjusting for inflation.

10.8 months. This estimate is, however, robust to including the number of pre-natal hospitalizations (column 3) and to including the number of hospital visits for each diagnosis category listed in *Table 4.1* (column 4). Thus, the first-stage effect is non-negligible and robust to including control variables.

Table 5.4: The effect of miscarriage on child spacing: OLS estimates of the First-stage relationship

Dependent variable	Child spacing			
	(1)	(2)	(3)	(4)
Miscarriage	0.953***	0.901***	0.876***	0.875***
	(0.017)	(0.017)	(0.017)	(0.017)
High school		0.007	-0.055***	-0.047***
		(0.012)	(0.013)	(0.013)
College		-0.047***	-0.110***	-0.100***
		(0.012)	(0.013)	(0.013)
Non-Nordic		0.421***	0.599***	0.597***
		(0.009)	(0.011)	(0.011)
Pre-natal hospitalizations			0.035***	-0.038***
			(0.004)	(0.006)
Additional controls				
Cohort dummies		✓	✓	✓
Dummies for Age at first birth		✓	✓	✓
Pre-natal hospitalizations by diagnosis				✓
Observations	642464	642464	620580	620580

NOTES.— The outcome variable measures the number of years elapsed between the births of the first and second child. The different sample sizes are due to missing values on control variables (hospitalizations). Heteroskedasticity robust standard errors are reported in parentheses. *p<0.1, **p<0.05 ***p<0.01.

Table 5.5 reports the results from the OLS and 2SLS estimation of the effect of child spacing on subsequent labor income. To conserve space, the table only reports estimates for 2, 4, 6, 8 and 10 years after second birth, but the full set of yearly 2SLS estimates of the effect of child spacing on labor income is presented in *Figure A6* in the Appendix. The results presented in *Table 5.5* show that postponing second birth by one year, on average, increases labor earnings both when estimated in OLS and 2SLS. Furthermore, the positive effect is almost monotonously increasing with time since birth. In years 2 and 4 after birth, the OLS estimate is larger in magnitude compared to the 2SLS estimate, however, in the longer run this pattern reverses.

One feature of the IV strategy employed here is that we can investigate who are driving the estimated effect of birth spacing by studying the difference in the cumulative distribution functions of birth spacing between women who did and did not experience a miscarriage; as shown by Angrist & Imbens (1995), this difference is the weighting function of the average causal effect in the case of a treatment with variable treatment intensity, normalized to sum to one.[14] The CDF:s of birth timing are depicted in *Figure 5.2* and show that women who miscarry always have longer spacing intervals, but most of the estimated effect seem driven by women who move to a birth spacing of three years. From the graphical analysis provided in *Figure 1.1*, women with less than two years between first and second births were indicated to have the lowest labor market participation rates after first birth.

Figure A7 in the Appendix depicts the yearly reduced form estimates on income, which are large in magnitude, positive and statistically significant for the entire follow-up period with the same pattern as obtained by 2SLS estimation of the second-stage relationship.

Table 5.5: The effects of child spacing on subsequent labor income

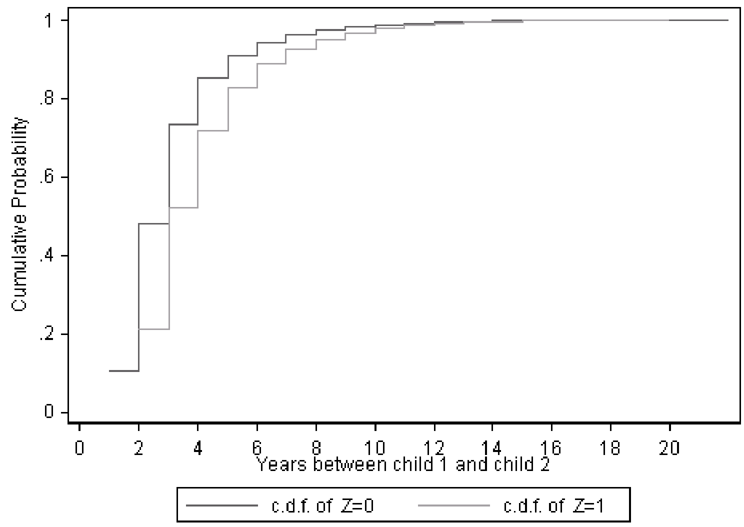
	OLS	2SLS	Observations
Outcome measured at			
Birth year +2	6.475***	2.362**	550240
	(0.079)	(0.928)	
Birth year +4	8.358***	5.192***	485975
	(0.096)	(1.066)	
Birth year +6	9.832***	9.659***	426819
	(0.120)	(1.228)	
Birth year +8	10.060***	10.778***	372989
	(0.139)	(1.366)	
Birth year +10	10.140***	12.283***	318476
	(0.170)	(1.571)	

NOTES.— The outcome variables measures labor earnings in 1000's SEK at 2, 4, 6 and 8 years after second birth, respectively. Labor earnings are deflated with CPI (2008 prices). Included covariates are the number of pre-natal hospitalizations, a dummy for non-Nordic background, dummies for high school education and college education, a full set of dummies for age at first birth and dummies for cohort. Robust standard errors are reported in parentheses. *p<0.1, **p<0.05 ***p<0.01.

The income measure used so far includes women with zero earnings. However, spac-

[14]The treatment here is child spacing, which can take on a range of positive values.

Figure 5.2: Cumulative distribution functions (CDF:s) for birth spacing for women who experienced a pregnancy loss and women who did not, respectively.



ing births may also affect the extensive margin of labor supply. In *Figure 5.3*, coefficients from yearly 2SLS estimates of the effect of birth spacing on subsequent participation are depicted. As seen from *Figure 5.3*, spacing the first two births in a longer interval leads to an increase in the probability to participate in the labor market; aside from an initially negative effect in the years immediately after second birth, a one year delay of second birth causes an increase in the probability to participate by around 2 percentage points, an effect that stays rather constant throughout the follow-up period. The effect of spacing births on labor income is thus found to be positive, sizeable and increasing in magnitude by time since birth. One possible explanation for this finding is that postponing second birth induces mothers to re-enter the labor market between births to a greater extent, as indicated by the graphical evidence presented in *Figure 1.1*, thereby gaining more labor market experience before the birth of the second child. Thus, spacing births in a longer interval could potentially imply a shorter consecutive absence from work, and a stronger labor market attachment as a result.

Table 5.6 reports results from 2SLS estimation of the effect of spacing births on the likelihood of returning to work between the first two births and on the total income earned in the years between first and second birth, respectively. The former variable is defined as

Figure 5.3: 2SLS estimates of the effect of spacing births on the probability to participate in the labor market after second birth and corresponding 95-percent confidence intervals.

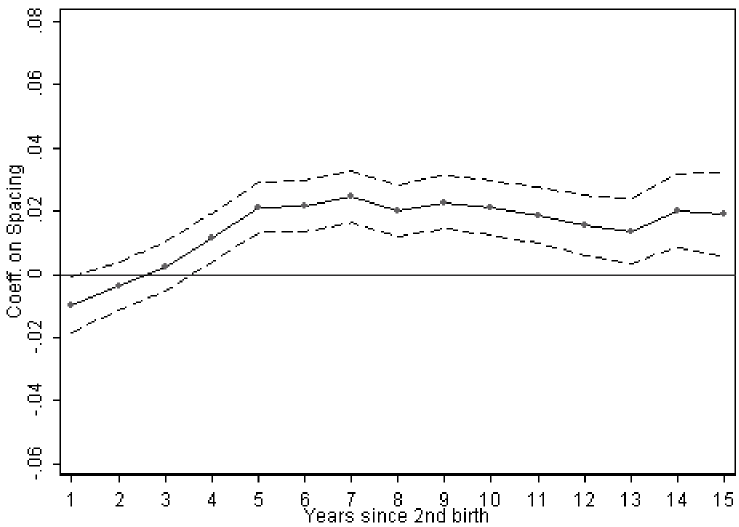


Table 5.6: The effects of child spacing on the probability to return to work between births and on total income earned between births

Dependent variable	Return to work	Labor income
Specification	OLS	2SLS
Years between child 1 and child 2	0.178***	130.722***
	(0.004)	(2.669)
Control variables		
Personal characteristics	✓	✓
Cohort dummies	✓	✓
Dummies for Age at first birth	✓	✓
Pre-natal hospitalizations	✓	✓
Observations	620580	619275

NOTES.— The outcome variables measures the natural log of the sum of labor income from the year of first birth to the year of second birth. Robust standard errors are reported in parentheses. *p<0.1, **p<0.05 ***p<0.01.

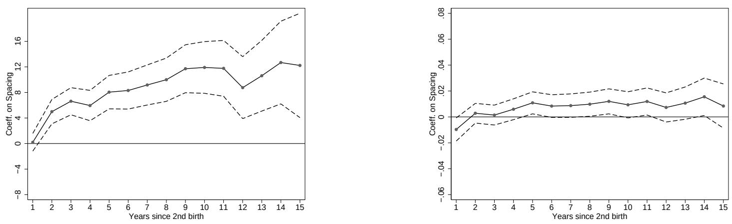
a dummy variable that equals unity if individual *i* has at least one year of work between births that yields an income exceeding two basic amounts. The results suggest that one years additional spacing leads to an increase in the probability to return to work between the first and second child by 18.4 percentage points, and an increase in the total income earned between births by around 130,000 SEK, on average. Since the average earnings of women in the sample was almost 164,000 SEK in the year prior to first birth, the estimate reflects almost one extra year of income in the time period between the first and second births. Hence, for those returning to work, spacing births in a longer interval seem to induce a longer work spell before the second child is born.

5.2 Subsequent fertility

The effect of spacing births on subsequent labor income were found to be relatively sizeable. Potentially, they could be mediated by an effect on completed fertility; if postponing second births leads to a lower completed fertility, part of the positive effect found on income could simply reflect more hours worked due to having fewer children. To analyze how the effect of birth spacing affects earnings without allowing the possibility of this effect being mediated through the number of children, I re-estimate Equation (1) for labor income and participation, respectively, in each year following the second birth, up to 15 years later. This time, however, observations are successfully dropped for individuals from the year of third birth onwards. Thus, individuals in the sample who subsequently have a third child are dropped from the sample in the year that they give birth to their third child and excluded from the estimations thereafter. This analysis yields consistent estimates under the assumption that the "censoring" of observations from third birth onwards is ignorable conditional on covariates. The estimated coefficients on birth spacing from these estimations are presented in *Figure 5.4* and show a strikingly similar pattern as the one observed for the uncensored sample, albeit with wider confidence intervals. Thus, completed fertility does not seem to be the main driving mechanism of the effect of spacing births on subsequent labor market outcomes.

However, as the assumption that the censoring of observations is ignorable conditional on covariates may be fairly strong, one should interpret these results with some caution.

Figure 5.4: Coefficients from yearly 2SLS regressions of the effect of birth spacing on labor income (left) and participation (right), and corresponding 95-percent confidence intervals. The sample is censored from the year that individuals have a third child onwards.



(a) Labor income **(b)** Participation

As an additional sensitivity analysis, *Table 5.7* displays estimates from a 2SLS estimation of the effect of birth spacing on the total number of children born to a woman by 2007 (which is the latest for which I can observe childbearing for the sample). For many women in the sample this represents completed fertility. In column 2, however, I restrict the sample to include only mothers who were 45 years of age or older in 2007, such that this sample includes women who most likely have completed their childbearing by 2007. As seen from *Table 5.7*, spacing births in one year longer intervals, on average, reduces the *number* of children born to a woman by 0.032 and 0.039 in the full and restricted sample, respectively. The average number of children in the full sample is about 2.4, so this effect is relatively modest.

Table 5.7: The effects of child spacing on completed fertility

Dependent variable	Number of children in 2007	
	Full sample	Aged≥ 45 in 2007
Specification	2SLS	2SLS
Child spacing	-0.032***	-0.039***
	(0.005)	(0.007)
Control variables		
Personal characteristics	✓	✓
Cohort dummies	✓	✓
Dummies for Age at first birth	✓	✓
Pre-natal hospitalizations	✓	✓
Observations	620580	147250

NOTES.— The outcome variables measures the total number of children born by the end of 2007 (representing completed fertility). Robust standard errors are reported in parentheses. *p<0.1, **p<0.05 ***p<0.01.

5.3 Consequences for wages

The findings so far suggest that birth spacing affects the probability to return to work between the first and second birth, affects the length of the work spell between the first two births, and has sizeable effects on labor income that lasting even 15 years post second birth. In this section, the aim is to evaluate whether this increased labor market experience between births affects wages of mothers in the medium- and long run.

In *Table 5.8*, results are presented from the analysis of the effect of child spacing on the log of full-time equivalent monthly wages 5, 10 and 15 years after second birth. The results show that postponing second births by one year leads to a 3 percent higher wage in year 15 after second birth. Thus, spacing children in longer intervals has a sizeable effect on women's subsequent wage growth. In addition, as seen in *Table 5.9*, wages are more positively affected for highly educated women (some college or more) compared to lower educated women. This result is in line with previous studies suggesting that highly educated women benefit the most from postponing motherhood (see e.g. Miller 2011). For second births, Troske & Voicu (2012) find that highly educated women have incentives to delay subsequent births as well as first births, since the effects of children are more negative for highly educated women, but grow more slowly with the spacing of births.

Table 5.8: The effects of child spacing on subsequent monthly full-time equivalent wage

	OLS	2SLS	Observations
Outcome variable: log wage			
Birth year +5	0.029***	0.034***	372878
	(0.000)	(0.002)	
Birth year +10	0.025***	0.032***	264388
	(0.000)	(0.003)	
Birth year +15	0.023***	0.028***	132048
	(0.001)	(0.005)	

NOTES.— The outcome variables measures the full-time equivalent monthly wage in 1000s SEK, measured at 5, 10 and 15 years after second birth, respectively. Wages are deflated with CPI (2008 prices). Robust standard errors are reported in parentheses. *p<0.1, **p<0.05 ***p<0.01.

Table 5.9: Heterogeneous effects on wages by educational level

Sample	Low educated		Highly educated	
Specification	OLS	2SLS	OLS	2SLS
Outcome variable: log wage				
Birth year +15	0.021***	0.024***	0.026***	0.032***
	(0.001)	(0.006)	(0.001)	(0.008)
Control variables				
Personal characteristics	✓	✓	✓	✓
Cohort dummies	✓	✓	✓	✓
Dummies for Age at first birth	✓	✓	✓	✓
Pre-natal hospitalizations	✓	✓	✓	✓
Observations	74228	74228	57820	57820

NOTES.— The outcome variables measures the full-time equivalent monthly wage in 1000s SEK, measured at 15 years after second birth. Wages are deflated with CPI (2008 prices). Robust standard errors are reported in parentheses. *p<0.1, **p<0.05 ***p<0.01.

6 Conclusions

This paper adds to the literature on the timing of births by analyzing whether spacing births affects women's long-run labor earnings, labor market participation and wages. To account for the possible endogeneity of fertility timing decisions and labor market outcomes, I exploit arguably exogenous variation in child spacing resulting from miscarriages between the first two live births. These random fertility shocks delay births and thereby extend the spacing between births. The analyses are based on Swedish individual level register data, which allows me to follow income- and wage trajectories of mothers for up to 15 years following the second birth, as well as a number of years before first birth. Moreover, data on miscarriages are provided by hospital registers, which avoids potential bias associated with misreporting abortions as miscarriages.

I find that spacing births substantially increases mothers' income earned from market work, an effect that becomes increasingly larger in magnitude over the 15-year follow-up horizon after second birth. For labor market participation, I find a positive effect of around 2 percentage points; an effect that remains rather constant throughout the follow-up period. While the total number of children born to a woman is somewhat decreased by spacing births, fewer children does not seem to be the main driving mechanism for the large and positive income effects of spacing births. A more likely explanation is that spacing births allows women to re-enter the labor market between births and thereby to avoid a lower subsequent attachment to the labor market. Finally, spacing births are also found to have positive consequences for long-run wages, with this effect being more pronounced for highly educated mothers.

The results provided in this paper may have important policy implications as changes in family policies have previously been shown to have unintended consequences for both the number of children as for the spacing of births. The results also suggest that the generosity of parental leave provisions may have adverse consequences for women's market earnings in the long-run as they indicate that extended work interruptions have adverse consequences for both income and wages that do not dissipate over time. However, in order to draw inference on the optimal child spacing, it is crucial to also take into account potential impacts on child well-being. Spacing of child births has previously been shown to impact sibling outcomes through maternal and infant health, and the results provided in this paper suggest an additional channel through which child spacing might affect the next generation, namely the household's financial resources.

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Appendix

Figure A1: Number of reported miscarriages by year in the National Patient Register. The sample consists of women who gave birth to their first child between 1988 and 2006, aged 21 or older at first birth and who had two or more children.

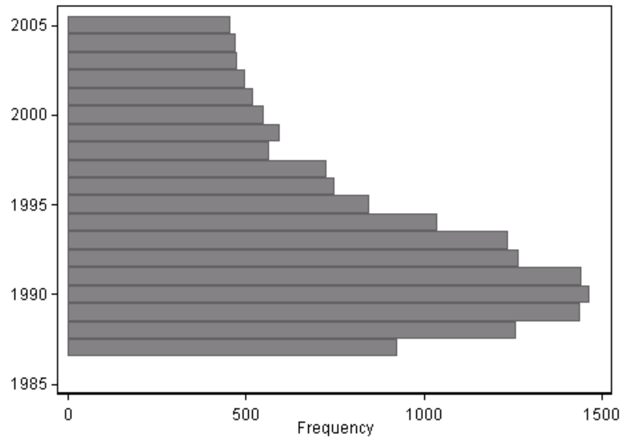


Figure A2: Distribution of child spacing in months. Child spacing is defined as the number of months elapsed between the births of the first and second child.

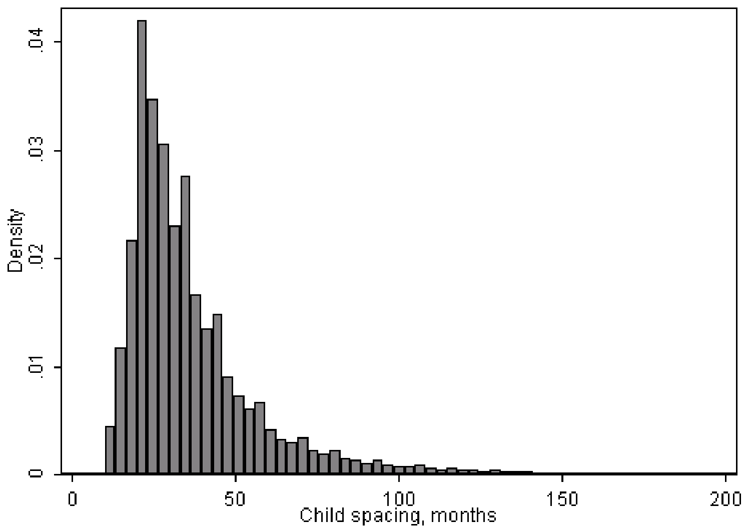


Table A1: Summary statistics

	Mean
Miscarriage	0.0257
	(0.158)
Age at first birth	27.20
	(3.973)
Child spacing	3.115
	(1.943)
Number of children in 2007	2.367
	(0.657)
Non-Nordic background	0.123
	(0.328)
Compulsory schooling	0.0675
	(0.251)
High school	0.480
	(0.500)
College	0.453
	(0.498)
Age at labor market entry	25.27
	(5.990)
Live in large city (pre 1st birth)	0.212
	(0.409)
Pre-birth labor income (SEK)	163 731.9
	(99619.8)
Pre-birth monthly wage (SEK)	18 193.6
	(5208.5)
Observations	642464

NOTES.— The table reports means and standard deviations in parentheses. The sample consists of mothers who have at least two children, gave birth to their first child between 1985 and 2006, and for whom income is observed 15 years after the birth of the second child.

Figure A3: Average number of months between the birth of the first and second child by (second) birth cohort. The two vertical lines represent the introduction of the "speed premium" and the extension of the eligibility interval from 24 to 30 months, respectively.

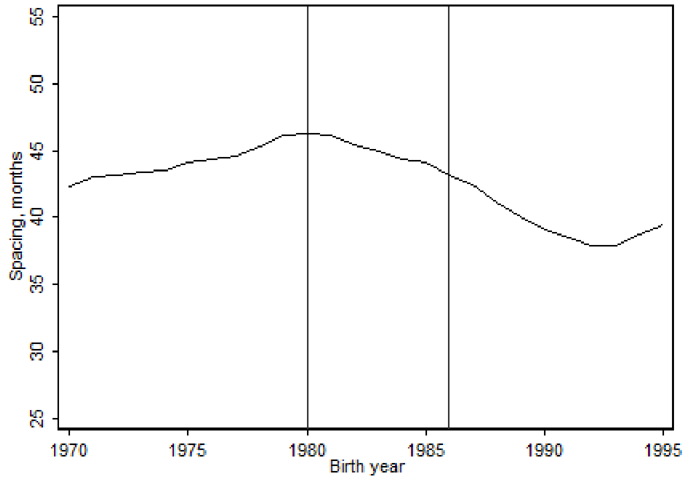


Figure A4: Kernel density estimates: the likelihood of giving birth to the first two children within a 30-month interval, by eligibility status for the speed premium. Eligible: second child born 1987.

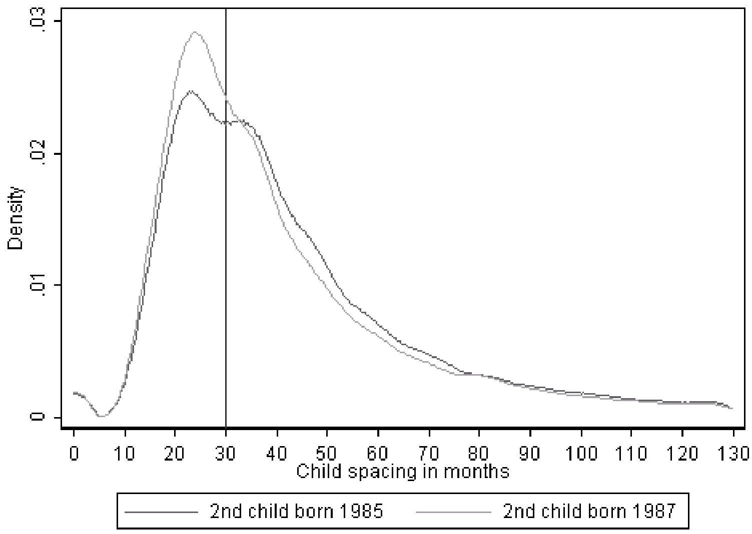


Table A2: Falsification test: Reduced form estimates of the effect of miscarriage on pre (first) birth income

	OLS	Observations
Outcome measured at		
Year of first birth	0.442	610085
	(0.532)	
Year of first birth -1	1.225*	574389
	(0.703)	
Year of first birth -2	0.841	532598
	(0.688)	
Year of first birth -3	-0.345	495379
	(0.720)	
Year of first birth -4	-0.383	458931
	(0.714)	
year of first birth -5	-1.224*	422767
	(0.724)	

NOTES.— Included covariates are the number of pre-natal hospitalizations, a dummy for non-nordic background, dummies for high school and college, a full set of dummies for age at first birth and a full set of dummies for cohort. *p<0.1, **p<0.05 ***p<0.01.

Table A3: Severity of miscarriages, 1997-2005

	Mean
Incomplete with complication	0.108
	(0.311)
Complete with complication	0.0183
	(0.134)
Incomplete without complication	0.676
	(0.468)
Complete without complication	0.197
	(0.398)
Observations	26120

NOTES.— Means and (standard deviations). Source: Karimi (2013).

Figure A5: Proportion of miscarriages with and without complications, 1997-2005. Source: Karimi (2013).

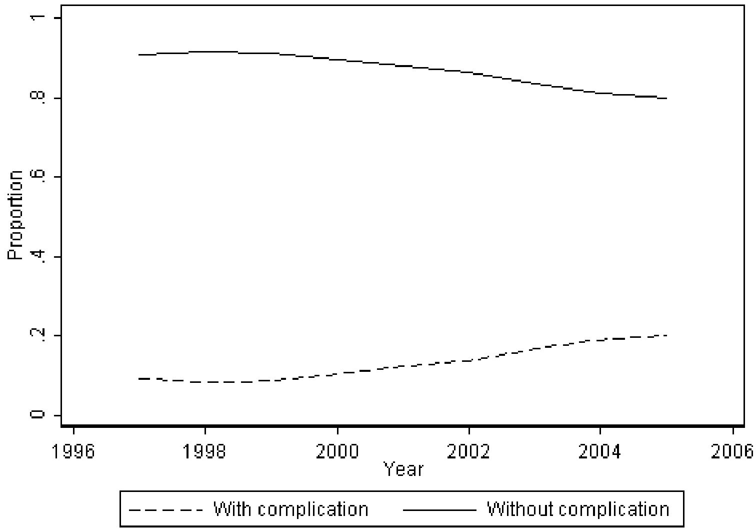


Figure A6: Coefficients from the 2SLS estimation of the effect of child spacing on labor income after second birth, and the 95 percent confidence intervals.

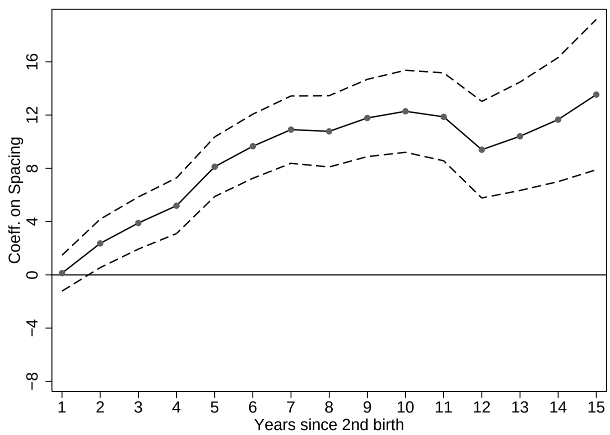
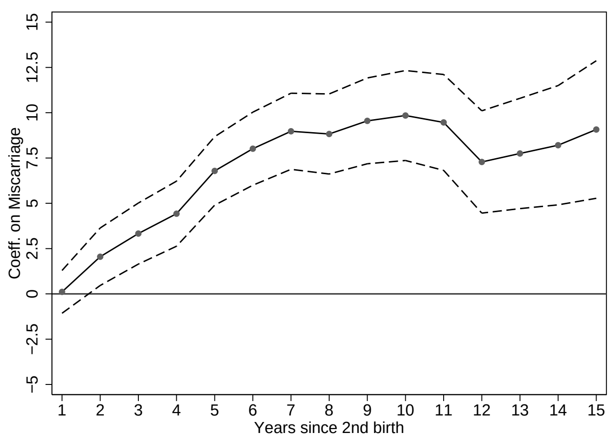


Table A4: Frequency and type of co-morbidities to hospital admissions due to miscarriage

Co-morbidities	Freq.	Percent	Cum.
0	15924	96.51	96.51
1	518	3.14	99.65
2	49	0.30	99.95
3	7	0.04	99.99
4	1	0.01	100.00
Total	16499	100	
Co-morbidity type	**Freq.**	**Percent**	**Cum.**
Infectious	16	3.09	3.09
Tumors and Neoplasms	17	3.28	6.37
Diseases of the blood(-forming) organs	105	20.27	26.64
Endocrine	15	2.90	29.54
Mental behavioral	2	0.39	29.92
Nervous system	3	0.58	30.50
Circulatory	4	0.77	31.27
Respiratory	6	1.16	32.43
Digestive system	2	0.39	32.82
Skin	1	0.19	33.01
Musculoskeletal	10	1.93	34.94
Genitourinary system	73	14.09	49.03
Pregnancy-related	142	27.41	76.45
Congenital malformations	10	1.93	78.38
Symptoms not classified elsewhere	11	2.12	80.50
Factors associated with health status	89	17.18	97.68
External causes	12	2.32	100.00
Total	518	100.00	

NOTES.— The table reports the extent to which the miscarriages reported for the main sample were admitted with one or more co-morbidities, and the diagnosis category of the co-morbidity for those with only one reported co-morbidity.

Figure A7: Reduced form estimates, labor earnings.



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