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Deliberate Birth Spacing in Nineteenth Century Northern Sweden

L'espacement volontaire des naissances au 19e siècle dans le Nord de la Suède

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Abstract Fertility in nineteenth century Europe before the fertility transition has been described as high, unregulated, and stable; the extent of fertility control remains a controversial topic. The aim of this study is to determine whether there is evidence of deliberate birth spacing in northern Sweden prior to the onset of the fertility transition. This study analyses micro-level parish records of 9,636 women in nineteenth century northern Sweden—a remote but, at the time, economically dynamic frontier region of Sweden. Event history analysis reveals evidence of birth spacing that suggests some conscious birth control. Piecewise exponential models of the transition from second to third birth reveal circumstances in which parents increased or decreased the time to next birth. The results on the survival of previous children, geographic context, sex of previous children, and variations in grain prices all indicate that parents deliberately manipulated the spacing between births.

Keywords Fertility control · Fertility transition · Europe · Birth control · Historical demography · Birth spacing

Résumé Si la fécondité prétransitionnelle en Europe au 19^{e} siècle a été décrite comme élevée, stable et non régulée, l'existence d'un certain contrôle de la fécondité reste un sujet controversé. L'objectif de cet article est de déterminer l'éventuelle existence d'un espacement volontaire des naissances dans le Nord de la Suède avant le début de la transition de fécondité. Les données proviennent des registres paroissiaux et concernent 9 636 femmes du Nord de la Suède au 19^{e} siècle, dans une région éloignée mais frontalière caractérisée par un grand dynamisme économique à cette époque. L'analyse biographique révèle un espacement des naissances qui suggère un certain contrôle volontaire des naissances. Des modèles exponentiels par morceaux de la transition entre la deuxième et la troisième

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naissance révèlent des situations au cours desquelles les parents allongent ou raccourcissent l'intervalle entre naissances. Les résultats basés sur la survie de l'enfant précédent, le contexte géographique, la composition par sexe de la fratrie déjà constituée et les fluctuations du prix des céréales, indiquent que les parents contrôlaient volontairement l'intervalle intergénésique.

Mots-clés Contrôle de la fécondité · Transition de la fécondité · Europe · Contrôle des naissances · Démographie historique · Espacement des naissances

1 Introduction

The extent to which fertility in nineteenth century Europe was controlled has been an important question for historical demographers. It is clear that knowledge of fertility control was widespread and practiced by large parts of the population during the fertility transition, but the degree of fertility control *before* the transition remains a controversial issue. Most historical demography literature has focused on trying to detect parity-specific stopping behavior, parents ceasing to have more children after having attained a specific parity. The extent of parity independent fertility control or deliberate birth spacing has received less attention.

This study examines what factors were associated with the timing of births among married couples in a region of Northern Europe prior to the onset of the fertility transition. The study analyses micro-level parish data to examine the transition from second to third birth using hazard regression. The aim of the study is to examine if parents in nineteenth century northern Sweden exercised control over fertility by either delaying or advancing the arrival of a subsequent child. Such practices are not necessarily aimed at reducing final parity but at attempts to space births in accordance with favorable life-circumstances. The data come from nineteenth century (1820–1900) northern Sweden, a frontier region characterized by a high, stable fertility during the entire study period. Fertility in the region did not start to decline until the early twentieth century.

In historical demography, fertility limitation has generally been divided into two categories. Parity-specific control refers to an aim for a specific number of children after which subsequent births are avoided. Parity independent control or birth spacing refers to fertility reduction that is not connected to a specific parity. Research in historical demography has mainly focused on the former, both because it is easier to detect, and also because it has remained the prominent method used by parents in developed countries to control their fertility after the fertility transition. The concept of fertility control and its counterpart 'natural fertility' were introduced by Henry (1953 [1972]) as exclusively parity-specific control. These concepts have been very influential and possibly responsible for the lack of attention to birth spacing as a possible strategy in fertility reduction.

The consensus in historical demography has been that parity-specific birth control played only a negligible role in Europe before the fertility transition. The onset of parity-specific control in different parts of Europe was carefully studied

Table 1 Total fertility rates for selected countries and regions of Sweden

Year	Västernorrland county	Västerbotten county	Norrbotten county	Sweden	USA	France	England
1860	4.88	5.37	5.51	4.53	5.21		
1870	4.85	4.96	5.48	4.22	4.55	4.00	5.45
1880	5.37	5.29	5.75	4.51	4.24	3.95	5.3
1890	5.31	5.48	5.81	4.25	3.87	3.58	4.6
1900	4.96	5.48	6.19	4.05	3.56	3.38	4.07
1910	4.22	4.80	5.46	3.76	3.42	2.95	3.51

Sources: Chesnais (1992) for French and English data, Coale and Zelnik (1963) for US data and Statistics Sweden (1999) for the Swedish data

during the 1960s to the 1980s, in particular by the Princeton European Fertility Project (EFP). Only recently have researchers started questioning whether deliberate birth spacing played a more important role in the pre-transitional demographic system than was previously assumed.

This article begins with an overview of Swedish fertility, followed by a summary of the debate regarding the extent of fertility control in nineteenth century Europe. Subsequently, a section follows on previous methods used in historical demography to measure and detect parity dependent and independent fertility control. The data and the methods used in this study are then presented followed by study results and conclusions.

2 Fertility in Nineteenth Century Sweden

At the beginning of the nineteenth century, fertility in Western Europe was lower than in most other parts of the world. This was primarily the result of women and men marrying relatively late combined with a large proportion of the population never marrying at all. Marital fertility was also nearly 25% below that of an expected maximum [1] fertility within marriage (Anderson 1988; Coale 1986).

Sweden had fertility levels lower than most of Europe throughout the nineteenth century (Table 1). Aggregated data for northern Sweden reveals a different pattern with high and even somewhat rising fertility throughout the nineteenth century (in contrast to central and southern Sweden where fertility started to decline during the final decades of the nineteenth century). The area was a frontier region of Sweden and the population increased rapidly due to both high migration and high fertility throughout the century. In many ways, northern Sweden contrasts with the rest of Sweden and Europe, showing similar trends to that of the New World in America at that time. Similarities are found in new settlements, net in-migration, population growth and relatively high fertility.

[1] The reference level often used for a maximum practical fertility in a population is that of the American Hutterites in the 1920s. The Hutterites are an example of a group with completely unregulated marital fertility in a strongly pro-natalist society.

Fertility behavior in nineteenth century Sweden has received surprisingly little attention in demographic research despite the availability of excellent data (both in terms of detail, longitudinal depth, and coverage), and new digitized databases of longitudinal parish records. High quality aggregated statistics give accurate measures of most demographic processes at the national and regional level (Hofsten 1986; Statistics Sweden 1999), and aggregated Swedish data has often been used as evidence of Europe's fertility decline (e.g. EFP, Carlson 1966, Knodel 1977).

Research on eighteenth and early nineteenth century, Swedish fertility has mainly been based on aggregated data (Bengtsson and Ohlsson 1988; Carlsson 1966; Larsson 1984; Lithell 1981; Lockridge 1984; Rogers 1995; Schultz 1985) although a few micro-level studies have examined fertility responses to economic stress measured by grain prices (Bengtsson and Dribe 2005; Bengtsson and Dribe 2006).

Gaunt (1973) found some evidence of fertility control on the island of Gotland in eastern Sweden in the eighteenth century. Carlsson (1966) found patterns in the diffusion of the Swedish fertility transition which he explained by changing economic demand and widespread knowledge of fertility control before the transition.

Bengtsson and Dribe (2006) use micro-level data to examine variation in birth spacing as a response to economic stress in Southern Sweden between 1766 and 1864. They use Cox-regression to examine if short-term economic stress affected the fertility and spacing of births and find evidence for longer birth intervals when grain prices were high. In an earlier study (Bengtsson and Dribe 2005), they use data for the entire nineteenth century where they also found an association between grain prices and fertility.

3 Fertility Control in Nineteenth Century Europe

The concept of natural fertility as defined by Louis Henry in the fifties (Henry 1953 [1972]) and popularized in English a decade later (Henry 1961) has been central to debates surrounding fertility regulation in pre-transitional Europe. Natural fertility was defined as the absence of fertility regulation aimed at reducing final parity. Following Henry, many demographers have traditionally seen variations in birth spacing between population as due to biological (i.e.. related to fecundity) or social (i.e., due to spousal separation or breastfeeding) factors but never in terms of deliberate fertility regulation. This view has influenced historical demography, as demonstrated for example in the summary of the summary volume of the EFP (Coale and Treadway 1986) where the possibility of non-parity-specific fertility regulation in pre-transitional Europe is overlooked.

The conventional view in historical demography has been that fertility control was largely absent in populations prior to the fertility transition. Following Henry's focus on completed parity, fertility regulation has been conceptualized in terms of parity-specific stopping. Research in historical demography between the 1960s and 1980s suggests the absence of parity-specific birth control in Europe until the last decades of the nineteenth century[2] (Coale 1986; Knodel 1977, 1978; Wilson 1984). It is undisputable that a major change in the use of birth control took place in the late nineteenth century in Europe and that parity-specific control was largely absent in pre-transitional Europe. Important participants in the EFP (Coale 1986; Knodel and Van de Walle 1986) suggest that the knowledge of the methods of deliberate birth control was unavailable/not acceptable or at least not used in Europe before the fertility transition.

Theorists have criticized the de-emphasis of birth spacing in historical demography (Anderton and Bean 1985; Van Bavel 2004b). Much of this criticism (Anderton and Bean 1985; Van Bavel 2004a, Van Bavel and Kok 2004, Bengtsson and Dribe 2006, Tsuya et al. 2010) questions if birth spacing did not have a more important role prior to transition. For example, Wrigley (1966) found evidence of family limitation in an English village as early as the seventeenth and eighteenth centuries. There is also convincing evidence from a large database of Mormons from Utah (Anderton and Bean 1985) that birth spacing was practiced to some extent to limit fertility during the second half of the nineteenth century. The Eurasia project's volume on fertility (Tsuya et al. 2010) also found evidence of parents deliberately manipulating their birth spacing in French-speaking Belgium, Italy and Sweden, as well as in East Asia before the fertility transition in response to economic stress. Conscious spacing of births may also have been used in Flemish speaking Belgium and the Netherlands (Van Bavel 2003; Van Bavel 2004a; Van Bavel and Kok 2004) before and during the fertility transition.

Historical demography examining if there existed a Malthusian homeostatic balance in pre-transitional Europe has also examined the degree to which fertility responded to social changes in nineteenth century Europe. The link between economy and population growth is a classical issue in demography and a clear negative fertility response to economic hardship has been found in a large number of studies using aggregated data from various countries (Bengtsson 1986; Bengtsson and Ohlsson 1988; Hammel and Galloway 2000; Lee 1997; Schultz 1985).

The possible deliberate deviations from natural fertility that may exist in this study are most likely due to partial sexual abstinence and withdrawal/coitus interruptus (Santow 1995). While abortion may have been practiced by a small minority of people, it is very unlikely to have occurred within marriage given associated health risks and social stigma. Barrier methods, which later increased in popularity, were also unlikely to be used within marriage. It can therefore be assumed that abstinence and withdrawal would be the primary source of any major pre-transitional spacing of births, though any birth control was most likely practiced at a relatively modest scale. If carried out among the majority of parents, it was probably more evident in terms of a partial adaption of withdrawal or partial abstinence, reducing rather than eliminating the probability of a conception.

The history of contraception and birth control in Sweden in the early twentieth century is fairly well documented. At the turn of the twentieth century, documentation suggests that withdrawal was known among most of the population,

[2] The main exception being France and possibly a few smaller populations like the Jews and the European aristocracy (Livi-Bacci 1986).

but other forms of birth control were largely unknown (Kling 2006). Abortion existed but was very dangerous, illegal, and, in all probability, rare.

4 Methodology in Research on Fertility Control

Given limitations in both data and methods, it has been problematic to uncover evidence of birth spacing in historical demography. Research using longitudinal individual-level data and survival analysis makes it possible to get closer to the actual behavior (and possibly intentions) of parents than what has been possible through the use of traditional methods. This study aims to detect evidence of birth spacing behavior by applying hazard regressions to data on progressions from second to third birth. Unlike approaches with aggregated data, the present micro-level study of a specific progression between parities provides a modeling of the actual probability of having a subsequent birth.

Variations in hazard-regression coefficients provide evidence of birth spacing behavior through variations in covariates for calendar period, socio-economic status, and other available socio-demographic characteristics of parents. By means of interacting multiple variable effects with the main duration variable of time since previous birth, it is also possible to detect any decline in third-birth risks related to tempo changes in birth spacing.

If parents appear to consciously manipulate the timing of their births, it would indicate that the knowledge and acceptability of fertility control existed in Northern Sweden during the nineteenth century. Any variation in the spacing of children prior to the fertility transition caused by short-term economic fluctuations or the survival and sex of previous children would strengthen the argument that deliberate fertility regulation was practiced under certain circumstances. Even minor differences in birth spacing patterns would be relevant for determining whether fertility in pre-transitional Europe was regulated or not.

Most previous fertility research in historical demography has used aggregate data in order to find signs of deviations from natural fertility. With this purpose in mind, methods were developed to find evidence of onset of fertility control. Two important measures that have been used in historical demography are the "I_g" measure developed for the EFP (Coale and Treadway 1986) and the "m & M" measures developed by Coale and Trussell (1974). The methods are based on widely available data on historical age specific fertility. The methods were developed to measure fertility when only limited information is available and to compare populations across time and space.

Both measures have been popular as they require relatively simple and widely available data and also are mathematically fairly straightforward. However, both the I_g and the m & M measure are of little use in detecting birth spacing as a strategy of fertility control. The I_g measure can only detect birth spacing if it reduces completed marital fertility. If birth spacing is practiced at a constant level, it is not possible to isolate deliberate birth spacing from other factors that also affect marital fertility. The m & M measure is constructed to measure parity-specific stopping only and is based on the assumption that deliberate birth spacing is negligible. Small "m" measures deviations in age of mothers relative a standard fertility pattern, representing stopping behavior. Large "M" measures birth intervals, representing variations in the underlying level of fertility. If deliberate birth spacing is present in the population (affecting "M") a number of complications with interpreting the measure occur (Wilson et al. 1988).

Criticisms have been leveled against both of these methods. Guinnane et al. (1994) point out that both methods fail to recognize possible fertility control in subpopulations. Large groups can practice parity-specific control without being detected. The authors also argue that both the I_g and m & M methods are of limited use in dating the initial decline and adaptation of parity-specific fertility regulation because large subpopulations can practice fertility control unnoticed. Therefore, it is hard to use macro level data to draw conclusions about how widespread knowledge and/or acceptance of fertility control were before the fertility transition.

Individual-level methods are different from aggregated approaches for several reasons. Using individual-level methods, it is possible to measure the effect of individual-level characteristics and, when duration data are available, it is possible to model actual behavior. A critical problem in research on fertility control has been the difficulty in measuring actual intentions. Still, modeling childbearing behavior using individual-level characteristics permits researchers to get closer to modeling actual fertility intentions.

The last decade has offered a body of research (Bengtsson and Dribe 2006; Van Bavel 2004a, Tsuya et al. 2010) which examines birth spacing behavior using methods similar to those in this study. Using event history models have much in common with previous attempts to detect birth spacing based on the median duration of closed birth intervals (e.g. Wrigley 1966; Anderton and Bean 1985). As long as the vast majority of mothers progress to a next birth event history models can be seen as a measure of birth intervals.

For several reasons, the progression from second to third birth is an ideal transition for detecting patterns in birth spacing. The main advantage of only using the transition to a third birth instead of pooling a large number of transitions is methodological. No large assumptions need to be made that the baseline (and other) hazards are proportional across parities. Some statistical power is sacrificed by not including a large number of transitions in the same models; however, the focus on a single transition makes interpretations of covariates more straightforward. A focus on the third birth also means that survival of previous children and their sex can be measured in a way that it easy to interpret. By avoiding the heterogeneity caused by using several transitions the effect of covariates become stronger.

After the arrival of a second child, most couples have a stable life situation and their behavior is presumably quite typical for general patterns of marital fertility. Using the transition from second to third birth avoids complications from family-formation factors that may also affect fertility. It is also unlikely that parents would have an interest in increasing the spacing of the first two children, given that it can be assumed that couples marrying in the nineteenth century wanted at least two children. The third birth is a theoretically good candidate for when we can expect parents to demonstrate a hypothetical interest in increased birth spacing. Parents with two children are also in most cases quite young and therefore, the effect of declining fecundity is modest.

The third-birth transition also has the advantage that most couples with children in the study make the transition between two and three children, meaning that a large share of mothers in the data is covered. The share of two-child mothers who have a third child is very high.[3] As the entire period can be considered pre-transitional, it is safe to assume that possible parity-specific stopping after the second child is very uncommon.

In this study, covariate estimates of long or short birth intervals indicate that parents either try to deliberately manipulate their fertility, or alternatively that the covariate influences fertility because it is associated with another proximate determinant of fertility.[4] If no other indirect proximate determinant seems to play a role, we may conclude that parents consciously regulate their fertility. The two other circumstances that might be expected to have an effect on fertility are breastfeeding and, possibly, harsh socioeconomic conditions that might decrease fecundity. If there is a difference in the speed of transition to third birth between two groups differentiated by a relevant characteristic and no proximate environmental determinant is deemed important, this is an indication that some parents have delayed the arrival of their next child.

Grain prices in Sweden did not vary to such degree that one would expect starvation to negatively affect fecundity. In contrast, breastfeeding has a significant impact on fecundity after childbirth. In the case of the death of a child, the immediate cessation of breastfeeding decreases the period of post-partum infecundity and thus noticeably increases the risk for a third birth. It is also possible that there are regional differences in breastfeeding practices, but these are likely to be relatively small. However, when comparing different socioeconomic groups there is more reason for caution. There might be significant differences in breastfeeding practices between socio-economic groups.

Patterns in the timing and prevalence of third births can be shown using Kaplan–Meier survival curves. In this study, changes in relative risks in the models are due to variations in the tempo of the third birth. The proportion of mothers who never have a third child and thus are censored at age 50 is very low; this ratio is nearly independent of region of residence and calendar period.

5 Data, Parishes and Study Population

This study is based on parish records from three regions in different parts of northern Sweden. The records include data on all registered vital events including marriage formation and migration for the complete population of the parishes. This information was created and maintained by the clergy of the Swedish state church. The clergy were also state officials who reported the data to government authorities.

[3] Less than 5% of two-child mothers are censored because of high age.

[4] Bongaarts et al. (1984) provides a complete model of all proximate determinants of fertility.

The parish data were updated throughout the year and can now be used for family reconstitution; the data include information on both migration and family relations. For the majority of the male population there is also recorded information on occupation. The time period for the present study is 1820–1900.[5] The digitized database with parish records in the present study is derived from the Demographic Data Base compiled at Umeå University (Edvinsson 2000).

The data include information on all mothers beginning at transition to second birth. We are able to follow them until the birth of a subsequent child or until they are removed from the population of two-child mothers for another reason. Data stem from three regions, each of which includes 3–4 parishes. The three regions are; the Norrland interior[6] region in the northwest of Sweden, the Skellefteå[7] region and the Sundsvall[8] region, both in the northeast of Sweden. Mothers are followed from the birth of their second child through the successful conception of their third child,[9] death, out-migration, age 50 or the end of the study period. A father was recorded for each birth and the data on partners refer to the father of the second child. Because divorce was almost nonexistent[10] divorce it is not a cause for concern. Paternal death could however bias the results to minor degree. However, the mother's civil status is continually updated. Most children have a reported father: less than 0.5% of mothers have no father reported and in less than 6% the information on the father is missing.

Data on infant mortality in nineteenth century Sweden are of high quality. Issues with possible underreporting of infant mortality might nevertheless result in a few third births not having been recorded. This would lead some women to remain in the study population even after their unrecorded third birth thus resulting in much longer birth intervals. If previous infant mortality was also not reported, it is possible that some women had more than two previous births and thus are miss-specified in their parity, and therefore not part of the data when they should be included. These issues are however most likely unimportant and the quality of infant mortality data in Sweden is believed by European standards to be high (Lynch and Greenhouse 1994).

The parish records are of very high quality and we can therefore assume that we have complete coverage of the population of mothers who have just given birth to their second child. Both in and out-migration was registered even though people who visited the area for a short period of time may not have been recorded. Registration in parishes was done at the local level, so some minor reporting differences by region may exist.

The parishes differ in geographic size and character. Each parish had from a few hundred to almost 20,000 inhabitants. The total number of two-child mothers

[5] Information is available from 1820 in all parishes; the registers are discontinued at different years between 1894 and 1900.

[6] Parishes in the region are Gällivare, Jukkasjärvi, and Karesuando.

[7] Parishes in the region are Skellefteå landsförsamling, Jörn and Norsjö.

[8] Parishes in the region are Indal, Sättna, Sundsvalls stad, and Tuna.

[9] The measure of a successful conception is a recorded birth subtracting 9 months.

[10] Not a single divorce is reported for any of the mothers during the study period.

included in the dataset is slightly below 10,000. The two largest parishes, which represent the majority of the women in the data, are Skellefteå parish and Sundsvall's stad, two towns on the east coast of Northern Sweden. Given that it is not possible to determine the number of children born to women who have migrated into a parish (in particular whether any previous children had died) only parish inhabitants who can be followed from age of 15 are included in the data. Due to the documented high mobility in early adulthood in Sweden (Dribe 2003) some women in the parish will not be included in the data. It can be estimated from aggregated statistics that because of migration after age 15, the data cover slightly less than two thirds of all two-child mothers in the parishes of interest.

Women are right censored when migrating out of the parish, thus mobility does not create bias in the models for the women included in the data. It is possible that selection bias may exist between the more stationary women included in the analysis, and the more mobile women excluded from the study population if there existed an association relationship between migration and birth interval. Data evaluation for the large Skellefteå parish where most of the short-distance migration is likely to have taken place inside the parish (therefore yielding a longer continuous presence in the parish) indicates that model results are not significantly biased by the omission of mobile women.

During the time period under study, the population in northern Sweden increased rapidly (Table 2). This was partly a result of high fertility and partly due to migration from southern Sweden. The parishes under study experienced drastic growth during the nineteenth century as shown in Table 2. The three selected regions represent distinct areas of Sweden (see Umea University 2009; Alm Stenflo 1994 for an account of the regions during the nineteenth century). The geographically large parishes of the northwest region include some of the least habitable areas of Sweden. Those parishes were made up of a relatively large proportion of indigenous Sami and an increasing proportion of agricultural immigrants from southern Sweden. Late in the nineteenth century, the population also included workers in a growing mining industry. The most populous region in the study is the area surrounding Skellefteå and is dominated by the large Skellefteå parish. Throughout the nineteenth century, small independent farmers dominated the region. The area surrounding Sundsvall was dominated by forest and a large timber industry. The region experienced rapid industrialization and population growth during the nineteenth century.

Table 2 Population size in the two main regions

Year	Sundsvall region	Skellefteå region	Sweden
1800	13,272	6,919	2,347,303
1820	15,460	8,462	2,584,690
1840	18,793	10,836	3,138,887
1860	26,794	16,433	3,859,728
1880	46,418	21,925	4,565,668
1900	69,167	29,847	5,136,441

Sources: Alm Stenflo (1994) and Statistics Sweden (1999)

6 Model and Study Variables

The main model of the analysis is the piecewise exponential (or constant) proportional hazards model (Hoem 1993). It models the hazard of experiencing an event in separate intervals each having a constant hazard throughout the interval. The models follow an at-risk population starting from the second birth to the occurrence of an event or until censoring. The advantage of event history analysis like this is that it properly accounts for the amount of time a population was at risk as well as modeling actual individual behavior. An advantage for piecewise constant proportional hazard models over Cox-models is that time to the next birth, the baseline time variable, can be studied directly when it is of interest (i.e., when you examine birth spacing). In this case, the population under study is followed from the occurrence of a second birth through to the conception of the third child (the event), or until censoring due to death, achievement of age 50, out-migration or the discontinuation of the parish records.

The models include a variable for geographical location, year of second birth and age of the mother at second birth. The mother's union status is continually updated; although the vast majority of both second and third births take place inside marriage (Table 3).[11]

Given that survival of previous children[12] is expected to be associated with birth spacing/regulation, continually updated data on the survival of both the first and second child are included in the model. The death of a previous child would most likely increase parents' interest in a new child. The sex of the previous children is included in order to examine whether parents had any gender preference and whether this affected their propensity to have another child. Given that the strongest effects can be expected when both previous children are of the same sex, the variable is a full interaction of the sex of the first and second child.

A variable that indicates the occupation of the father is included as is father's age at the birth of the second child. Occupation was recorded at some point during the father's life, however, this may have occurred after the third birth. If there are contradictions in the data, the record closest to the second birth will be used. The partner for whom data is collected is the father of the second child. This does not perfectly correlate with the father of the third child, but since marriages were stable the correspondence is very high.

Finally, annual grain prices are included as a covariate in the model. Grain represented a very large share of household consumption for the majority of the population, and prices varied considerably between years. Parents are expected to delay their fertility when real wages are low and the price of grain is high. The data consists of local market scales (Jörberg 1972) and was recorded by the state at the county level for administrative reasons and closely reflects the actual prices in the parishes. The price of labor showed less variation between years so the price of grain is a superior indicator of real wages and thus short-term economic stress. The

[11] 93% of both second births and third births are within marriage.

[12] See Zhao (1997) for how patterns in parity progression according to gender and number of children are used as an indicator of birth control in pre-transitional China.

Table 3 Summary statistics of frequencies measured at second birth and time at risk for all variables

	Individuals	Person-months
Mother's age		
16–19	352	7,626
20–24	3,597	85,654
25–29	3,531	106,756
30–34	1,535	61,002
35+	621	33,709
Father's age		
16–24	1,606	35,553
25–29	3,802	94,976
30–34	2,287	72,425
35–39	798	26,686
40+	556	24,955
Father missing		
Period		
1820–1840	1,090	37,950
1841–1855	1,174	40,002
1856–1870	1,765	60,483
1871–1882	2,302	76,905
1883–1890	1,852	49,709
1891+	1,435	29,700
Region		
Skellefteå region	6,182	166,555
Norrland interior region	1,609	42,030
Sundsvall region	1,845	86,164
Civil status (time-varying)		
Unknown	21	1,005
Not married	664	36,690
Married	8,931	243,544
Widow	20	13,499
Partner's work		
Higher and lower civil servant	286	11,212
Self owning farmer	4,443	118,413
Educated worker	138	4,813
Uneducated worker	506	14,555
Other worker	2,960	85,479
Unspecified/unknown	716	20,113
Missing father	587	40,153
Sex of previous children		
Male–male	2,479	77,477
Female–male	2,390	69,833
Male–female	2,406	75,112
Female–female	2,361	72,316

Table 3 continued

	Individuals	Person-months
Survival of 1st child (time-varying)		
Missing data	159	3,498
Alive	7,861	233,189
Dead	1,616	58,051
Survival of 2nd child (time-varying)*		
Missing data	223	4,221
Alive	8,493	261,334
Dead	920	29,183
Barley prices (time-varying)		
Less than −10%	1,768	51,266
−10–0%	3,484	108,407
0–10%	2,624	75,878
10–20%	1,496	40,044
20–30%	220	11,045
More than 30%	44	8,112
Time since birth*		
0–5 months	770	55,707
6–11 months	662	49,026
12–17 months	3,275	37,403
18–23 months	1,816	24,009
24–29 months	950	15,251
30–35 months	458	10,910
36–47 months	465	16,163
48–71 months	348	22,209
72–119 months	309	28,499
120 + months	460	35,555
Final event/censoring		
Third birth	8,256	–
Death	242	–
Alive at end of nineteenth century	252	–
Age 50	417	–
Out-migration from the parish	469	–
Status of the father		
No information in the registers	554	–
Record of a missing father in the registers	33	–
Record of a father in the registers	9,049	–

*Measured at third birth or censoring

grain used in the data is barley, given that barley represents the most important grain in northern Sweden and was grown locally in the parishes. A series of 11-year moving averages is computed for each year. The tails of the moving averages in the

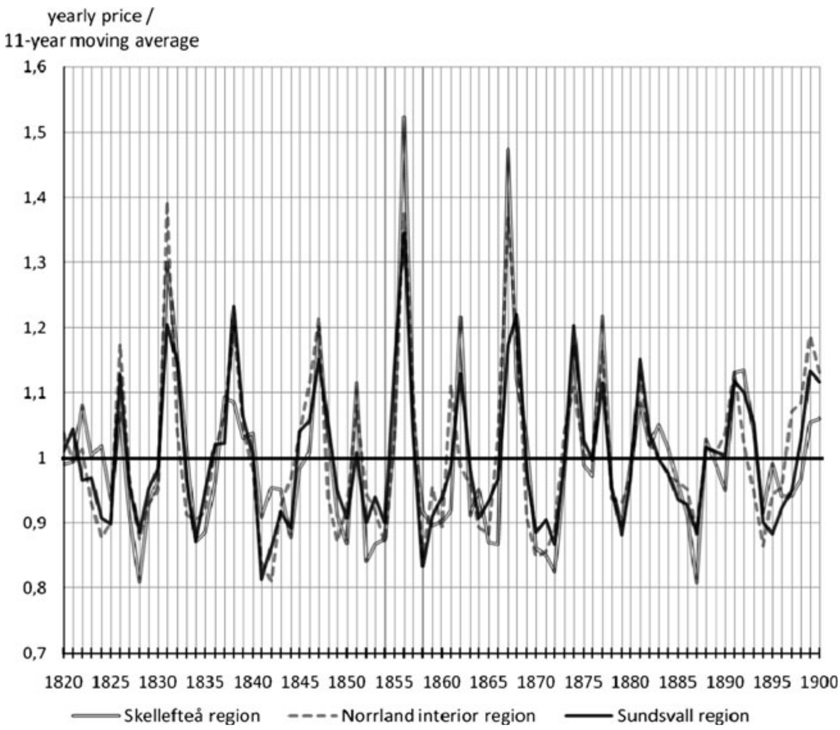

Fig. 1 Yearly variations in bareley prices, devations from 11-year moving average

beginning and end of the study period are adjusted as suggested by Hoem and Linnemann (1988). Short-term price fluctuations are measured as a ratio of moving averages to the actual price in order to measure the impact of short-term economic stress while simultaneously adjusting for economic trends (Fig. 1).

The causal pathways between grain prices, economic stress, and reduced fertility are hard to disentangle. Land owners may have benefited from rising grain prices. The association between economic stress and reduced fertility is also somewhat problematic. It is possible that there are confounding factors (i.e., increased migration and spousal separation) associated with high grain prices that may have negatively affected fertility levels and that a decline in fertility could be explained by factors unrelated to deliberate fertility control. Nevertheless, local grain prices remain a robust measure of economic stress.

7 Results

The first model (Table 4-1) includes the main demographic variables that explain how age, location, and calendar period impact the risk of third birth. Unsurprisingly, the risk of a third birth declines with age—most likely due to the decreasing fecundity of the woman. Even when controlling for mother's age there is also an

Table 4 Piecewise exponential hazards models on the risk of a third birth

	Model 1				Model 2			
	RR	*p*-values	95% C.I.		RR	*p*-values	95% C.I.	
Mother's age								
16–19	1.26	0.00	1.12	1.41	1.20	0.00	1.07	1.36
20–24	1.15	0.00	1.10	1.21	1.16	0.00	1.11	1.22
25–29	1				1			
30–34	0.82	0.00	0.77	0.88	0.82	0.00	0.77	0.88
35+	0.39	0.00	0.34	0.43	0.37	0.00	0.33	0.41
Father's age								
16–24	1.09	0.01	1.02	1.16	1.08	0.01	1.02	1.15
25–29	1				1			
30–34	0.89	0.00	0.84	0.94	0.89	0.00	0.84	0.94
35–39	0.85	0.00	0.78	0.92	0.85	0.00	0.78	0.93
40+	0.71	0.00	0.63	0.79	0.70	0.00	0.63	0.78
Father missing	0.96	0.73	0.76	1.21	0.93	0.54	0.73	1.18
Period								
1820–1840	0.93	0.07	0.86	1.01	0.92	0.05	0.85	1.00
1841–1855	0.98	0.59	0.91	1.06	0.98	0.63	0.91	1.06
1856–1870	1.03	0.42	0.96	1.10	1.03	0.41	0.96	1.10
1871–1882	1				1			
1883–1890	1.13	0.00	1.06	1.21	1.14	0.00	1.06	1.22
1891+	1.02	0.59	0.95	1.10	1.03	0.47	0.95	1.11
Region								
Skellefteå region	1				1			
Norrland interior region	1.12	0.00	1.05	1.20	1.07	0.05	1.00	1.15
Sundsvall region	0.57	0.00	0.54	0.61	0.55	0.00	0.51	0.58
Civil status								
Unknown	0.28	0.00	0.13	0.58	0.27	0.00	0.13	0.56
Not married	0.29	0.00	0.23	0.37	0.28	0.00	0.22	0.35
Married	1				1			
Widow	0.20	0.00	0.15	0.26	0.19	0.00	0.14	0.25
Partner's work								
Higher and lower civil servant	1.13	0.08	0.99	1.29	1.15	0.04	1.00	1.32
Self owning farmer	1				1			
Educated worker	1.09	0.36	0.91	1.31	0.99	0.93	0.82	1.19
Uneducated worker	1.02	0.73	0.92	1.13	0.98	0.76	0.89	1.09
Other worker	0.97	0.21	0.92	1.02	0.98	0.41	0.93	1.03
Unspecified/unknown	0.76	0.00	0.69	0.84	0.75	0.00	0.68	0.83
Sex of previous children								
Male–male					1			
Female–male					1.04	0.22	0.98	1.10

Table 4 continued

	Model 1				Model 2			
	RR	*p*-values	95% C.I.		RR	*p*-values	95% C.I.	
Male–female					0.98	0.48	0.92	1.04
Female–female					1.07	0.03	1.01	1.14
Survival of 1st child								
Missing data					0.95	0.61	0.78	1.16
Alive					1			
Dead					1.09	0.00	1.03	1.15
Survival of 2nd child								
Missing data					1.20	0.06	1.00	1.44
Alive					1			
Dead					2.09	0.00	1.95	2.24
Barley prices								
Less than −10%					1.01	0.68	0.95	1.08
−10–0%					1			
0–10%					0.95	0.09	0.90	1.01
10–20%					0.94	0.10	0.88	1.01
20–30%					0.83	0.01	0.73	0.95
More than 30%					0.67	0.00	0.58	0.78
Time since last birth								
0–5 months	0.15	0.00	0.14	0.17	0.15	0.00	0.14	0.17
6–11 months	0.30	0.00	0.27	0.33	0.30	0.00	0.27	0.33
12–17 months	0.65	0.00	0.61	0.69	0.65	0.00	0.61	0.69
18–23 months	1				1			
24–29 months	0.90	0.01	0.83	0.98	0.89	0.01	0.82	0.97
30–35 months	0.67	0.00	0.60	0.74	0.64	0.00	0.58	0.72
36–47 months	0.47	0.00	0.42	0.53	0.45	0.00	0.40	0.50
48–71 months	0.26	0.00	0.23	0.29	0.24	0.00	0.21	0.27
72–119 months	0.12	0.00	0.10	0.14	0.11	0.00	0.09	0.13
120+ months	0.02	0.00	0.02	0.03	0.02	0.00	0.01	0.03

independent negative effect of increasing male age on fertility. The timing of third conception peaks at around 2 years after the second birth.

The period effect displays a moderate trend toward shorter birth intervals over the course of the nineteenth century. There are no clear signs of a decrease in fertility based on the transition to third birth. The data suggests that the onset of parity-specific stopping behavior, aimed at parity two, occurred after 1900 for the parishes in this study. In aggregated statistics for northern Sweden, an increase in TFR can also be observed in the 1880s and 1890s.

However, the dominant pattern in the study is that of very stable birth spacing behavior throughout the nineteenth century. Neither fecundity, breastfeeding nor marital behavior is likely to have changed much during the years under study.

Perhaps the small increase in risk of a third birth might be due to changes in fecundity or eagerness to have children stemming from a better standard of living. Relative risks by period are consistent with TFR trends for northern Sweden, but contrast with national level trends (where fertility began to decline in the last two decades of the century).

The extended final model (Table 4-2) includes a number of additional variables that may also have an impact on fertility and that are used to find evidence of deliberate birth control. The variables with the largest impact on risk of third birth are those related to the survival of previous children. If the second child has died the risk of having a third conception increases by 109%. The survival of the first child has a less significant impact, most likely due to the fact that mortality occurs very soon after childbirth, and therefore would likely affect only the likelihood of a subsequent birth. The increase in risk is 9%, most likely due largely to replacement effect.

An increase in risk of subsequent birth after the death of a child is partly due to the increasing fecundity that accompanies a halt in breastfeeding. For contemporary developing countries, demographers have estimated that the increased risk due to the halt of breastfeeding is between 40 and 60% (Grummer-Strawn et al. 1998; Lindstrom and Kiros 2007; Park et al. 1998). Using event history models on the transition to third conception in Ethiopia, Lindstrom, and Kiros (2007) finds an increase of 56% following the death of a second child, and no increase in risk following the death of a first child. Lithell (1981) examined how infant mortality affected birth intervals in the Vasa region of Finland and Jämtland in Sweden between 1825 and 1865. Birth intervals were shortened by 6–18 months following the death of an infant, comparable to results of the studies referred to above.

Previous research (Grummer-Strawn et al. 1998; Lindstrom and Kiros 2007; Lithell 1981; Park et al. 1998) suggests that observed effects in the main model cannot be due to uniquely biological increases in fecundity after the death of a child. The results from the main model suggest a contrasting negative correlation between the birth interval of a third child and the death of a first child. Moreover, the magnitude of the effect of the second child loss appears higher than in studies of contemporary high-fertility populations not practicing birth control. It seems probable that parents may intensify their attempts to conceive again following the loss of a child, thus behavioral factors explaining a portion of the observed increase in risk. This behavioral hypothesis would indicate that parents had at least a partial understanding of the mechanisms behind fertility and fertility regulation and were thus able to increase the probability of a new conception within a given time span. Similar results showing a strong association between infant death and subsequent births have been found for many parts of pre-transitional Europe (Dribe and Scalone 2010; Tsuya et al. 2010) before the fertility transition.

The findings are also relevant for the general debate regarding the importance of reduced infant mortality as a precondition for fertility decline. The relationship between infant mortality and subsequent fertility is important in theoretical explanations linking mortality with fertility transitions. If parents respond behaviorally to the death of a young child, this reaction may be a relevant factor in explaining more general changes in aggregate fertility. This topic is however outside the scope of this study.

Sex composition of the two previous children has an effect on the risk of third birth. We find a statistically significant 7% increase in fertility when the first two children are girls compared to when the two children are boys, indicating a preference for at least one son. In a society with a preference for boys one would expect sons to be breastfeed longer than girls thus delaying the next birth. However, parents with two sons or a daughter followed by a son seems to have higher risk of a third birth than parents with a son followed by a daughter; this is contrary to what we would expect if sex-differences in breast feeding had a major impact. The high risk for parents with two daughters can only be explained by that parents deliberately change their behavior based on the sex composition of previous children.

The covariate measuring grain prices suggests that economic stress in the form of elevated grain prices had a significant negative effect on fertility. A year with a price increase of more than 30% in a given year decreased the risk of a third conception by 33%. This represents an attempt to postpone fertility in years marked by low real income. More modest increases in price also decreased the risk of a third birth, but the effect was not linear. The effects of grain prices are generally stronger compared to what has been found in other micro-level studies on economic stress and fertility (Bengtsson and Dribe 2006; Dribe and Scalone 2010; Tsuya et al. 2010) in pre-transitional Europe. Interactions with the occupation of the father (not shown) display no significant differences in fertility for different social groups when grain prices are high.

The variable for father's occupation reveals only small differences in fertility by parents' socioeconomic status. In general risk, differences are not significant and the father's occupation seems to have a weak effect on birth spacing. Further interactions with occupation reveal that no social group shows any sign of shorter third birth intervals toward the end of the study period.

When the father's job is unknown, the risk of third birth is significantly reduced. This could be explained as a rational response to parents' unstable economic situation. However, it is more likely that an unknown paternal occupation indicates that the parents no longer live together, which also would explain the reduced risks.

A notable result is the different patterns of the semi-rural Sundsvall region compared to the two more uniquely rural regions. The parishes in the area in and around Sundsvall have much lower risks of third birth with longer birth spacing intervals. These semi-rural parishes represent a more urbanized area with greater contacts with southern Sweden in general. The economic structure contrasts with the more rural areas dominated by small-scale family agriculture in the two other regions under study. The difference in risks is greater than 40% and is independent of time period. It suggests substantial differences in marital fertility and length of birth intervals throughout the nineteenth century between the two types of areas.

In order to examine whether the patterns of the two regions differ fundamentally separate models are run for the two areas. Results of covariates of interest are presented in Fig. 2. All the variables estimated in Table 4-2 were included.

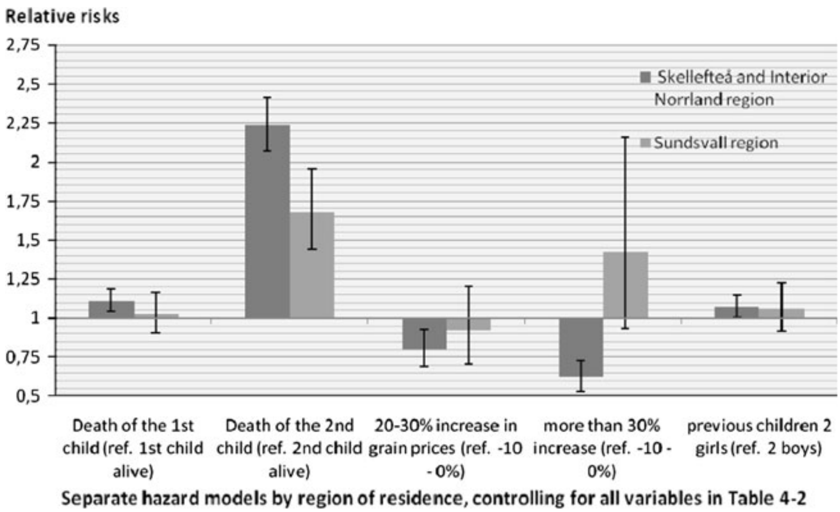

Fig. 2 Indicators of birth spacing by region of residence

Survival of previous children, grain prices and the sex composition of previous children all have an effect in both of the regions. Grain prices have a more complex effect. High grain prices seems to consistently decrease fertility in the rural regions, while showing no effect or even possibly elevating fertility in the more urban Sundsvall region. This is puzzling as one would expect the consumers in the more urban Sundsvall region to be more negatively impacted by high grain prices as compared to the producers in the rural regions. Effects of birth intervals, period and the effect of the mother's age were very similar (not shown) for the two groups of regions.

Table 4-2 indicates that the semi-urban population with a large share of wage earners around Sundsvall had much lower risks of third birth than those of the more rural areas. The higher risk among rural women are likely due to differences in everyday life. One explanation for the low risk of third birth across birth intervals frequency in the Sundsvall region would be a lower fecundity or coital frequency. Lower fecundity may be an unlikely explanation, but a different life situation could explain the longer birth intervals. A possible reason may be periods of spousal separation or crowded living conditions. The final explanation of the lower fertility in the Sundsvall region is that it was due to voluntary abstinence or coitus interruptus and thus a strategy among parents to reduce the frequency of childbirth. The size of the difference, over 40%, suggests the possibility that parents acted intentionally to increase birth intervals in the Sundsvall region. The share of mothers who eventually have a third child is very similar for all regions and do not suggest major differences in stopping behavior.

The question of whether the findings are valid across calendar periods, in particular the period half a century prior to the fertility transition is of theoretical importance. Therefore, separate results for three different periods are presented in Fig. 3. Some effect of the main variables of interest suggests that the indicators of birth spacing are evident across all sub-periods starting from the early nineteenth

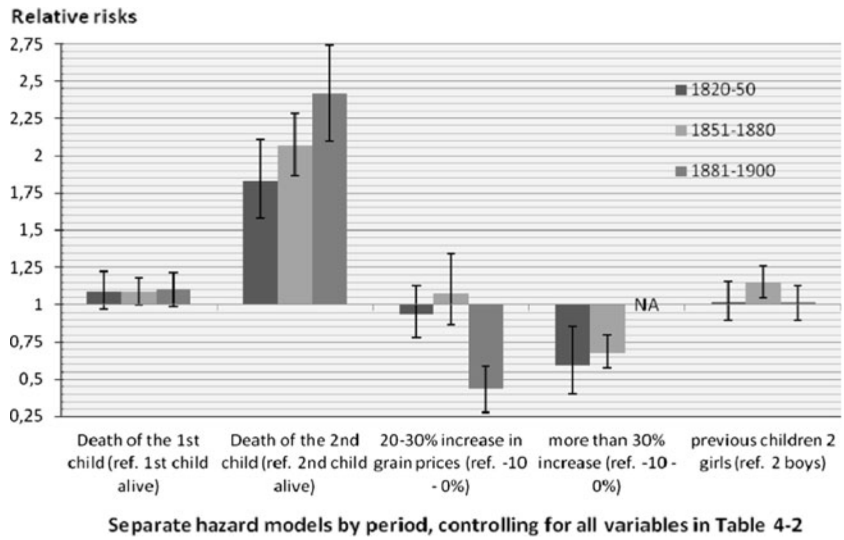

Fig. 3 Indicators of birth spacing by period

century. The effects get stronger in the last decades of the study. In particular grain prices and survival of previous children increases in importance over time.

To conclude, there is evidence of at least minor deliberate birth spacing in all regions over the course of the nineteenth century. The interpretation of a decreased fertility in harsh socio-economic conditions is in keeping with previous research despite the possibility of explanations such as spousal separation in years of economic stress. Fertility increase based on the survival and sex of a previous child, indicates that fertility was below an achievable maximum that parents could reach trough shifts in behavior.

Study findings indicate that fertility was partially controlled by parents. How this fertility regulation was carried out remains difficult to discover, but likely reflects voluntary and conscious decisions of birth control by parents based on current economic conditions and the family situation. Some of the effect could possibly be due to parents with living children voluntarily having lower coital frequency. However, it seems likely that some parents also used methods like coitus interruptus or partial abstinence to try to influence the spacing of births.

8 Conclusions

The aim of this study has been to examine the issue of parents' possible influence over birth spacing in nineteenth century Northern Europe. The approach was to study the effects of different characteristics of parents that could have given them a reason to control their fertility. The findings give some support to the notion that this was indeed the case. All relevant variables indicate that to some extent, parents reacted to changing circumstances by extending or shortening the time to a third birth in the expected direction. Some variable effects failed to reach significance suggesting only moderate differences between groups, but taken together they lend support to the notion that parents both knew how to and actively tried to influence their birth spacing as a response to changing circumstances.

The behavior was probably not practiced by all parents and the limited size of effects suggests that it probably amounted more to relatively small modifications in behavior than drastic interventions with efficient methods to delay the arrival of a subsequent child. The main picture is still that of high fertility with most parents unwilling or unable to reduce their fertility overall, but it seems as if some parents under some circumstances did try to influence the length of their birth intervals. In particular, the increased risk of parents who had lost a previous child is an argument for the notion that parents acted upon a notion of their ideal family situation and thus modified the timing of the arrival of their third child. The impact of a death of a first child clearly indicates an interest in compensatory births. The elevated risk of birth after the death of a second child also most likely partly represents an interest in replacing this child. Parents also postponed births when real wages were low. A gender preference for boys seems to also affect fertility.

The findings partly stand in contrast with earlier research in historical demography that suggests that deliberate behavior to reduce fertility or space children was absent in pre-transitional Europe. Parents in Sweden seem to have been able to successfully influence their fertility in accordance with changing life circumstances of their lives. These findings support recent research (Anderton and Bean 1985; Bengtsson and Dribe 2006; Dribe and Scalone 2010; Hammel and Galloway 2000; Tsuya et al. 2010; Van Bavel 2003, 2004a) that shows that fertility control played a more important role in pre-transitional Europe than what has been assumed in earlier research.

The results indicate that birth spacing was used as a family-building strategy in Northern Sweden throughout the nineteenth century, even when marital fertility remained high. There is no reason to doubt the previous conclusion in historical demography that the fertility transition marked the onset of widespread parity-specific birth control or to deemphasize the pronounced differences in fertility between pre- and post-transitional Europe. However, there are reasons to advocate for a more nuanced view of fertility control in pre-transitional Europe than that of much of previous historical demography. Evidently, many parents used birth spacing as a strategy to influence the tempo of childbearing.

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