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Detecting Deliberate Fertility Control during the Pre-Transitional Period in a Sample of German Villages

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Abstract

This paper deals with the possible existence of deliberate fertility control before the fertility transition. The timing of the fertility response to economic stress, as measured by fluctuations in grain prices, is used as a measure of deliberate, but non-parity specific, control. Birth histories from six German villages (1766-1863), including information on occupation of the husband, are used together with community-wide grain price series in a micro-level event-history analysis. The results show a negative fertility response to grain prices both in the year immediately following the price change, and with a one-year lag. The response is also highly different between socioeconomic groups, with the most pronounced effects among the unskilled laborers. Moreover, the response in this group is very rapid, already present after 3-6 months after the price change. Because all involuntary fertility responses to economic hardship (e.g. malnutrition, spousal separation, and spontaneous abortion) come with a considerable time lag, the existence of such a rapid response among the lower social groups clearly supports the idea of individual agency (deliberate control) as the most important explanation.

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Introduction

It is a widely held view that the great fertility decline during the first demographic transition was caused by, or at least intimately connected to, the advent and diffusion of deliberate parity dependent fertility control (see, e.g., Coale and Watkins 1986; Cleland and Wilson 1987; Knodel 1977, 1987, 1988). This led to a limitation of family size and to declining marital fertility, and also implies that before the decline family size was not limited in a deliberate way (Knodel 1978, 1987, 1988; Wilson 1984). Prolonged breastfeeding, low coital frequency, and other factors having a fertility depressing effect, are usually assumed not to have been used deliberately to limit family size (see, e.g., Knodel 1987, 1988). French demographer Louis Henry coined the term natural fertility to describe this absence of parity-specific fertility control that characterized pre-transitional society (Henry 1961). Often, however, the meaning of natural fertility seems to have been extended to mean not only the absence of parity-specific control, but the absence of fertility control more generally, as shown by the overwhelming focus on parity-specific control in most of the literature. Even though it is sometimes acknowledged that non-parity specific control might have been practiced, it is usually judged not to have been of greater importance before or early in the fertility decline (Knodel 1987).

Following these interpretations families in pre-transitional societies took no deliberate actions regarding childbearing within marriage whatsoever. In the famous words of Ansley Coale fertility before the transitions was not "within the calculus of conscious choice" (Coale 1973:65). The fertility transition, accordingly, was the result of the innovation that families began to control their fertility in a parity-dependent way, while socioeconomic change played a secondary role, at best (see Coale and Watkins 1986 for a summary account). Pre-transitional differences in fertility levels would then mainly have been related to collective norms rather than to individual agency. However, according to some anthropologists these collective norms could be critically reinterpreted according to the individual needs. For example, abstinence, abortion and abandonment were methods used in the past by families to control the configuration of the offspring to face changing situations and without necessarily having any targeted family size (Skinner 1997).

In addition a number of studies over the last decades argued both for the importance of socioeconomic factors in the fertility decline (e.g. Brown and Guinnane 2002, 2003; Dribe 2009; Galloway, Hammel and Lee 1994; Schultz 1985) and for the role of non-parity specific control (spacing) in the early phases of the fertility transition in the United

States and Britain (Anderton and Bean 1985; Bean, Mineau and Anderton 1990; Crafts 1989; David and Sanderson 1986; Haines 1989; Morgan 1991; Szreter 1996).

According to this revisionist view families might have deliberately controlled fertility also in societies where parity-specific stopping was largely absent. The problem is that it is very difficult to measure the practice of deliberate, but non-parity specific, control in a preindustrial context using only demographic and other information for various historical registers, which might also explain the preoccupation of parity-specific control in much of the literature (Knodel 1987). Several early studies used rudimentary methods, such as differences in marital fertility between subgroups, to establish the practice of deliberate control. One example is the often noted negative effect of marriage duration on age-specific fertility, which has been viewed as sign of deliberate family limitation (e.g. Wrigley 1966; Gaunt 1973). However, the fact that women marrying earlier had lower fertility at higher ages might be explained by a number of non-deliberate factors such as frequency of intercourse, bridal pregnancies, onset of permanent sterility, and age differences between spouses (Knodel 1978; see also Van Bavel 2003). Similarly, reduction in the mean age at last birth has been interpreted as a sign of parity-specific control (Knodel 1987), but it has been shown that spacing also affects this measure (Anderton 1989; Okun 1995).

Some studies have looked at the timing of births in relation to the number of surviving children or previous experience of infant deaths as an indication of deliberate fertility control (David and Mroz 1989a, 1989b; Van Bavel 2004a). Other studies have used micro level data to directly model the likelihood of not having another child as a function of parity and age (Van Bavel 2004b) to detect stopping behavior, or used the absence of a parity effect on the duration of closed birth intervals as an indicator of spacing (see, e.g., van Bavel 2004a).

In a recent study of a sample of parishes in southern Sweden, Bengtsson and Dribe (2006) used a different approach, where the timing of the fertility response to economic stress was used as a measure of deliberate, non-parity specific, control in a rural pre-transitional society with natural fertility. The simple idea is that a fertility response very soon after an economic change (price change in this case) is unlikely to be caused by anything else than deliberate postponement of childbirth. Non-deliberate fertility responses through malnutrition, spousal separation, induced or spontaneous abortions all imply a prolonged time lag between the changing economic circumstances and the fertility outcome, as will be explained in more detail in the following section. Hence, the clear response in fertility just a couple of months after the price change in the Swedish study was interpreted as an indication than families took active action to avoid having children in difficult times, and deliberately postponed childbirth in years when they foresaw bad economic times following bad harvests.

The aim of this paper is to use the same approach on a different geographic context to see if the results from southern Sweden have more general applicability. We study the timing of the fertility response to grain price fluctuations in different communities in Germany between 1766 and 1863 controlling for socioeconomic status and some demographic variables. The sample of parishes covers three different areas of Germany, in the north, the middle and the south. We use demographic and occupation data from village genealogies (see Knodel 1988) and local level price data taken from towns in the three areas (Jacks 2005).

In the following section we discuss the analytical framework followed by a description of the area under study and the data and methods used. Then we present the empirical results followed by a concluding discussion.

Analytical framework

Clear responses of fertility, mortality, and nuptiality to short-term changes in food prices or real wages have been found in aggregate studies of several preindustrial countries, including Germany, indicating the high degree of vulnerability in those societies (see, e.g., Bengtsson and Ohlsson 1985; Galloway 1988; Hammel and Galloway 2000; Lee 1981; Weir 1984). The fertility response was much stronger and more consistent than that of mortality (Galloway 1988) and was not dependent upon fluctuations in marriage (Bengtsson 1993; Lee 1975). Micro-level studies of different contexts have also shown the same marital fertility response to economic stress, and also that the response usually differed considerably across socioeconomic groups (Bengtsson and Dribe 2006, 2010). In this section we present an analytical framework for detecting deliberate fertility control in times of economic stress, based on the study of Bengtsson and Dribe (2006).

Marital fertility can be affected by economic stress caused by changes in food prices in several ways. First, economic stress may influence exposure by inducing people to migrate temporarily in search of work, provided that alternative labor markets were within reach, leading to the separation of spouses if women stayed behind while men went looking for work. The groups that potentially might have temporarily left are different types of workers who were not hired on annual contracts. However, in a grain-producing economy, such as the areas under study, we expect most farm laborers to have remained until after the harvest, because work was usually available until all the crops had been harvested even in bad economic years. The time to leave to find work would be shortly after the harvest, which would depress fertility at least nine months later and for as long as the absence lasted plus nine months gestation time. Another three months later, which we assume is the average waiting time to conception, a “normal” level of fertility would be attained. To the extent that these groups foresaw bad times and went searching for jobs elsewhere before the harvest, the effect of spousal separation could indeed come sooner. In fact temporary migration could be considered an integral part of preindustrial German life. For poor laborers without enough work and for peasant with too little land to support family, the most frequent response was seasonal migration (Hochstadt, 1983). Prior to 1700, thousands of poor peasants migrated every summer from the northwest of Germany to Holland to help with the hay harvest (Hochstadt, 1983 and 1981). The so-called *Hollandsgehen* was a mass seasonal flux which certainly involved at least one of the north-western villages included in our analysis (Knodel, 1988: 519).

Second, families may deliberately postpone childbirth in times of economic hardship by practicing abstinence, by using contraception, or through induced abortion. Induced abortion will indeed give a faster fertility response to short-term economic stress than will abstinence or use of contraception, perhaps as short as six months, because abortion generally takes place in the first trimester (see, e.g., Hammel and Galloway 2000). Some scholars have argued that, although illegal, inducing abortions very early in gestation by taking different drugs or herbs to regain menstruation was quite common in Europe before 1900 (McLaren 1990; Shorter 1982: chap. 8) and was even considered to be similar to contraception (McLaren 1990:160–161). In their study of the eighteenth- and nineteenth-century Balkans, Hammel and Galloway (2000) argued that the deliberate fertility response to price fluctuations that they observed mainly came through induced abortion. Van de Walle (1997), on the other hand, argued that women used various herbs and plants mainly to stimulate the natural menstruation cycle rather than to induce abortion. Nevertheless, it is difficult to rule out the possibility that induced abortion early in gestation was used as one method of controlling fertility among married women in the areas under study. According to a survey of rural Protestant clergy in Germany during the mid-1890s, abortion was not widespread and was mainly practiced by unmarried women (Knodel 1988: 315). German legislation also explicitly punished abortion at least from 1851, when Penal Code for Prussia was codified (David, Fleischhacker and Hohn 1988: 82). For previous periods there is some evidence of abortions from transcriptions of trials and other court archives. Even though it is difficult to establish the frequency of this phenomenon, the sources offer a clear idea about the population concerned. In fact, abortion trials involved maidens, servants, prostitutes, and nuns but very rarely married women (Van de Walle 1999: 124-125).

Because the main concern of this study is the distinction between deliberate and involuntary fertility responses to short-term economic stress, and not the actual methods that were practiced in the deliberate timing of childbirth, whether families controlled fertility through *coitus interruptus*, abstinence, or induced abortion early in gestation is not significant for our purposes; these contraceptive actions should all be viewed as methods to deliberately affect the timing of childbirth. It is quite clear that people in the past were aware of different traditional contraceptive methods (e.g. McLaren 1990; Santow 1995)[1] and were able to form a rough idea about food price developments and local harvest outcomes at least during the spring—long before fall, when the harvest was stored in the barns and the new price on grain was known (see the discussion in Bengtsson and Dribe 2006). Thus, a deliberate fertility response could become evident very quickly after the price change and last until conditions improved, plus some nine months or slightly longer due to the waiting time to conception. Even in cases when it was impossible to foresee economic problems, the effect of contraception would still be experienced well within a year after the new food prices were known.

Third, fertility may have been affected involuntarily by lower fecundability and temporary sterility, and possibly by a higher degree of spontaneous abortions, following malnutrition or increased exposure to disease. There seems to be general agreement that fertility can be affected by periods of severe but temporary malnutrition (i.e., subfecundity due to starvation, stress, and/or heavy work load), although there is disagreement concerning the effects on fertility of chronic but less severe malnutrition (Bongaarts 1980; Frisch 1978; Menken, Trussell, and Watkins 1981). Because we are dealing solely with short-term effects in this study, we can safely conclude that temporary and severe malnutrition may lead to the cessation of ovulation, loss of libido, and reduced sperm production, all of which lower fecundity and thereby fertility. Such an effect of malnutrition will influence fertility with at least a nine-month lag. Malnutrition may also affect fertility through spontaneous abortions. Because the risk of fetal loss is highest during the first trimester of pregnancy (Wood 1994: table 6.7), such malnutrition effects on fertility through spontaneous abortions should come with at least a six-month lag. Because malnutrition in a rural society usually is the most severe during the spring, when food becomes scarce, we would expect the effects to appear

[1] However, based on literary evidence, Van de Walle (2000) and Van de Walle and Musham (1995) argued that these methods were practiced mainly outside marriage in the preindustrial period.

between 12 and 15 months after the food prices went up, depending on whether the reduced fertility is due to spontaneous abortions or infecundity. Thus, regardless of the mechanisms, malnutrition will affect fertility with a considerable delay compared with a deliberate response.

Finally, short-term economic stress might influence fertility indirectly through changes in breast-feeding, that is, lactational infecundability. Assuming that people were aware of this effect of breast-feeding, it might have been a deliberate way to avoid pregnancy.[2] Women may also have been forced to breast-feed longer in difficult times as a result of lack of food. On the other hand, one could also argue that they had to breast-feed for shorter periods because of the need to work harder during harsh years. Thus, there are several possible links between short-term economic stress and breast-feeding. Bad economic years may prolong or shorten breast-feeding, and breast-feeding could also be used deliberately to control fertility, which makes it difficult to have any a priori expectations of how economic stress influences fertility through breast-feeding. Either way, we expect any effects to have appeared at least a year after the prices went up.

One problem with using aggregated data to analyze the impact of economic fluctuations on fertility, which has been the main approach used in the literature, is the difficulty to distinguish between the different potential mechanisms previously mentioned. Another, related problem is that it is impossible to disaggregate the results by socioeconomic status. This is very important because farmers can be expected to have responded quite differently from farm laborers to changes in market prices of grain; farmers were producers and benefited from high prices, while laborers suffered due to their dependence on the market for buying food (see Abel 1980: 9-11; Dribe 2000: chap. 7). Farmers and the higher occupations should have been far less vulnerable to price changes than laborers because they had better opportunities to store wealth (grain, livestock, and valuable items) and because they had more chances to borrow money as well as the opportunity to adjust production costs.

In this study, we use micro-level individual data to overcome these problems, enabling us to study the fertility response to short-term economic stress in much more detail than is possible using aggregated data. We are able to distinguish the fertility response between different socioeconomic groups (based on occupation of the father); to control for important social, economic, and demographic factors; and to study the timing of the response

[2] Even though there are evidence that the fertility-depressing effect of breast-feeding was known to people in the past, the most common view seems to be that regional differences in breast-feeding practices were more related to customs and culture than to reproductive agency on the part of the families (see, e.g., Knodel 1987, 1988).

in great detail. Clearly, the timing of the response is crucial to understanding the mechanisms. Lowered fertility very soon after the economic downturn—say, within six to nine months—is evidence of deliberate control as a result of families foreseeing bad times. If, on the other hand, the response is lagged for more than nine months, several factors, both intentional and unintentional, could be at work.

Study area

The villages under study represent a considerable range of demographic conditions and they are quite different from a geographical point of view, covering the north (Middels), the center (Braunsen and Massenhausen) and the south (Kappel, Rust and Öschelbronn) of Germany (see map). Kappel and Rust are situated in the southern region of Baden, close to the Rhine. In both these villages, the economy was based on fishing and agriculture, with the latter dominating. Since the greater part of the land was concentrated in the hands of a small group of wealthy farmers, the sharp social differences became more and more evident. It is important to underline that, before the embankment works, especially for Kappel, the harvests were frequently ruined by flooding, provoking hunger and subsistence crisis. Öschelbronn, Middels and the two villages of Braunsen and Massenhausen in Waldeck, were also dominated by agriculture, and here migration fluxes were due the growing pressure on the scarce sources and the few economic opportunities (Knodel 1988).

Map here

The demography of these villages has been analyzed in great detail by John Knodel in a long-term research project summarized in his 1988 book *Demographic Behavior in the Past*. He also studied the transformation from natural fertility to family limitation (parity-specific control) using traditional demographic techniques in a series of studies (e.g. Knodel 1977, 1978, 1987). According to these analyses, even though the total marital fertility rate over age 20 was above 8.5 (see table 1 below) during the whole period in question, there was nonetheless considerable variation in marital fertility between the different villages. On the one hand, during the eighteenth and the nineteenth centuries, the marital fertility indexes of the Bavarian villages (not included in the present analysis) showed the highest levels (the Coale I_g' index was 0.9 in the period 1800-1924), whereas Middels in East Friesland had the lowest ones (about 0.6 still in 1800-1924). The other villages had marital fertility in-between these levels. These differences are probably connected to differences in infant feeding practices, as breastfeeding was almost absent in the two Bavarian villages while it was practiced in Middles (Knodel 1988).

Table 1 here

In addition, focusing on the fertility levels in the pre-transitional period, Knodel found evidence that family limitation (parity-specific control) was largely absent in these populations until the second half of the nineteenth century. Prior to 1850, marital fertility schedules conformed to the expected age pattern of natural fertility as demonstrated for example by Coale-Trussel *m* values around 0.2 or less as shown in table 1 (Coale and Trussel 1974, 1978 for the underlying methodology). Even if the steady rise of the *M* index reveals an increasing marital fertility in younger ages, the age at which women bore their last child was late and apparently not influenced by previous experience with infant and child mortality. Consequently it is possible to date the onset of the German fertility decline to the last fifteen years of the nineteenth century. From this point of view it is also possible to consider the pattern of the age at last birth before the onset of the fertility decline. According to Knodel's estimations, the average age at last childbirth remained generally around 40, without significant differences between the villages. Before the onset of the fertility decline, it was at the same level as in other natural fertility populations of Europe (Knodel 1988).

In general, deliberate stopping appears to have been the major behavioral mode through which marital fertility came under volitional control and it is the major feature of reproductive change during the initial phase of the fertility transition. Thus, the initial stage of the fertility transition was primarily the result of the introduction of family limitation through stopping behavior (Knodel 1987).

Finally, it is interesting to note that Knodel did not find any pronounced differences by occupation in pre-transitional marital fertility (Knodel 1978). In fact socioeconomic differences within villages appear to have been less evident than differences found in the average fertility levels between villages. Only after the beginning of the fertility transition, did occupational differences become more visible (Knodel 1988).

Data

This study is based on a sample of 6 of the 14 villages used by Knodel.[3] It is only for these six villages (Brausen, Kappel, Massenhausen, Middells, Öschelbronn and Rust) that the data include all individuals in the villages. Only pre-selected couples were coded for the other eight villages.

The data collected by Knodel is based on a collection of village genealogies or *Ortssippenbuch*, literally named “book of local kinsmen”. Even if most of the selected couples in the sample were locally married, unlike the typical genealogies in other countries, which generally were not representative of the entire population, this source includes all the vital events of all the families that were registered in the village parish registers. The organization of the data is based on family histories for each nuclear family unit and it accords with the same logical scheme as the traditional family reconstitution. However, there are some characteristics in the original dataset which are important to underline. Firstly, the original data includes all couples for which the date of marriage was known, and individual codes allow the linkage of the information of the couples to all children ever born. Dates of birth and death are given for the husband and the wife, although in many cases this information is missing for one or both spouses. As in other family reconstitution studies missing death dates makes it impossible to determine the time under risk of giving birth. Knodel defined a set of restrictions in order to select a reduced sample of individuals with complete information (Knodel, 1988: 464).

In this study, the information in the original dataset has been reshaped in a longitudinal form suited for event history analysis. As will be explained in the methods section below, we include only closed birth intervals in order to avoid analyzing only women for whom we observe the full reproductive history (i.e. where the death is observed), because this would have reduced the sample size considerably, and would also have entailed potential selection bias from only looking at the stayer population (see, e.g., the discussion in Ruggles 1992, 1999; Wrigley 1994; Kasakoff and Adams 1995). Twins are treated as a singular childbirth. In total the reproductive life histories of 3,401 married women have been reconstituted taking into account more than 13,000 births in the period 1766–1863. The distributions of women and births in the six villages during the period in question are shown at table 2.

Table 2 here

[3] On the website of the Population Studies Center of the University of Michigan it is possible to download all the original data and documentation: http://www.psc.isr.umich.edu/dis/data/

The occupation of the husband at marriage is reported in detail in the original data. Knodel used two different classifications of the occupational structure. The first included artisans and skilled professionals, farmers, landless laborers and persons with occupations not easy to fit into the previous categories, while the second occupational classification encompassed twelve more detailed subgroups. Rather than using either of these classifications we coded all occupations into HISCO (Historical International Standard Classification of Occupation), and classified them into HISCLASS.[4] HISCO has become the standard coding scheme for historical occupations and is used as a basis of different class schemes (see see e.g. Van Leeuwen and Maas 2005; Van de Putte 2006). In the analysis we use a 7-category classification based on HISCLASS: 1. Higher manager and professionals, 2. Lower managers, lower professionals, clerical and sales, 3. Skilled workers, 4. Farmers, 5. Lower skilled workers, 6. Unskilled workers, and 7. No occupation. The two highest groups can be expected to have had access to resources implying that they were not severely affected by fluctuations in grain prices. The lowest group of unskilled workers we expect to have been most affected by grain prices as they were neither primary producers of grain, nor had assets or other resources enough to live from savings in times of scarcity and high prices. The situation for skilled workers, and lower skilled workers, is more uncertain. Among the skilled workers there were probably a substantial number of people with considerable assets, who might have had fair opportunities to hedge against risks of high grain prices. On the other hand they might have been affected by declining demand for their products, as consumers had to spend higher proportion of their income on food, which makes it difficult to judge their vulnerability to food price variations a priori. At least in times of more normal variations in prices farmers might actually have benefited from high prices, provided that the local harvest was not worse than average (see the discussion in Dribe 2000: chapter 7).

Table 3 shows the distribution of the women in the sample by their husband´s socioeconomic status. Whereas farmers, skilled and unskilled workers are numerous in all villages, specific differences within the frequencies reflect the peculiarities caused by local production structures. Finally, it should be noted that the “no occupation” category includes

[4] See van Leeuwen, Maas and Miles 2002; Van Leeuven and Mass 2005. At the website of the History Of Work Information System, it is possible to find documentation, bibliography and information on the historical international classification of occupations (HISCO) and the on the social class scheme HISCLASS: http://historyofwork.iisg.nl/index.php. The classification into HISCLASS was made using the recode job: hisco_hisclass12a_@.inc, May 2004, see http://historyofwork.iisg.nl/list_pub.php?categories=hisclass

not only the non-professional status in HISCO but also the cases in which the professions were unknown in the original data.

Table 3 here

We use fluctuations in grain prices to measure short-term economic stress. We chose the prices of rye – an important basic bread grain in the period under study – rather than a composite index.[5] It is quite clear however that the short-term price fluctuations were rather similar between the grains, and thus to take a different approach would not have changed the picture in any noticeable way. We used prices from three different places to represent the different areas of Germany included in the study (see the Map). For the northern village we used prices from the town of Emden. There are some gaps in the series, so data from nearby Lüneburg and Stade were used to supplement the series (in a total of 10 years). For the villages in the middle we used prices from Göttingen, which were available for the whole period, and for the southern parishes we used prices from Heilbron. However, they are only available until 1832, and after this date we had to use Göttingen prices also for the southern villages. The prices were linked together to three different indexes, as shown in Figure 1.

Figure 1 here

In order to measure short-term fluctuations we calculated the deviation from a medium term trend, using the Hodrick-Prescott filter with a smoothing parameter of 6.25 (Hodrick and Prescott 1997). Thus in contrast to using first differences to remove the trend we are not primarily measuring change from one year to the next, but deviations from what could be considered as normal years. With first differences a change from very low to normal would yield the same value as from normal to very high, while in our case a high positive value always indicate high prices, while negative values indicate prices lower than normal. The price residuals shown in Figure 2 are the ones used in the estimations.

Figure 2 here.

[5] Prices were collected by David Jacks and all data is available online at: http://www.sfu.ca/~djacks/data/prices/prices.html. See also Jacks 2004, 2005.

Even if the original data spans from the eighteenth to the nineteenth century, this analysis covers the shorter interval between 1766 and 1863 for mainly two reasons. From a practical point of view, the available price series used as community variables do not cover the first six decades of the eighteenth century and the last three ones of the nineteenth. On the other side, the main purpose of this research is to verify the existence of a deliberate fertility control during the natural fertility era, which stopped in this are approximately after 1875.

Methods

Following the approach of Bengtsson and Dribe (2006) we model the duration to next birth as a function of price deviations using a hazard model controlling for demographic and socioeconomic variables. We estimate the overall fertility response to price fluctuations, the interaction between socioeconomic position and prices, and the distributed fertility response to a price change by three-month periods. In this way we get a good picture both of the overall response, which can be compared to previous aggregated studies, and of the more detailed response both in terms of socioeconomic status and the timing of the response in relation to the price change. As has been pointed out already, knowledge about the timing of the response is crucial to understand the underlying mechanisms.

All women are followed from marriage, which implies that no observations are left truncated. We limit the analysis to higher order births, because first births are connected as much with the marriage decision itself as with decisions on fertility and thus require different models and a separate analysis. The quite high proportions of prenuptial pregnancies (see Knodel 1988: 228) testify to this intimate connection between marriage and first birth. As was previously mentioned we also limit the analysis to closed birth intervals, which implies that we condition upon a future birth taking place when selecting women into the sample. In a way this can be thought of as a direct way to measure spacing because, by definition, all intervals in the sample end with a birth (see Van Bavel 2004b). However, estimations on all birth intervals using the “reconstitutable minority”, i.e. the only the women whom we know lived their entire reproductive period in the village, yielded practically identical results, indicating that our results are robust to the choice of empirical strategy.

Because we are analyzing all birth intervals except the first, women included in the sample often experienced several births, and there might be differences in the risk of childbirth between different women due to different woman-specific factors (biological or behavioral) that are not controlled for in the model. To control for this unobserved heterogeneity we estimate a Cox proportional hazards model with shared frailty at the individual level (see Therneau and Grambsch 2000:232–233):

$$ln\ h_{ij}(a, t)=ln\ h_0(a)+\beta X_{ij}+\gamma Z(t)+\omega_j$$

where: $h_{ij}(a, t)$ is the hazard of giving birth to a child for a woman (j) of observed parity i at duration (time since last birth) a at calendar time t; $h_0(a)$ is the baseline hazard, i.e. the hazard function for an individual having the value 0 on all covariates, β is the vector of parameters for the individual covariates (X_{ij}) in the model, γ is the parameter for the prices ($Z(t)$, where t is calendar time), and ω_j is a the random effects (frailties) at the individual level (all births to the same woman), assumed to be normally distributed (Gaussian).[6]

The crucial variables in the analysis are rye prices and socioeconomic status. As already discussed we use prices by harvest year (October to September) and include both current prices and prices lagged by one year. Socioeconomic status is time-invariant and refers to the occupation of the husband at marriage. This is clearly a disadvantage with the data, and also makes it different from the study by Bengtsson and Dribe (2006) where socioeconomic status was time-varying, and also included information on land holding in addition to occupation.

In addition to these main variables we also include a set of control variables, which are not in the main focus of analysis but they all capture important aspects of the reproductive process: age of woman, village of residence, place of marriage (in the village or outside), birth place of the spouses, and age difference between spouses. Finally we control for the life status of the previous child and also distinguish when child deaths took place (before or after age two). Because breast-feeding normally was practiced in the first two years any difference in the effect of child death within two years and after two years would indicate the importance of termination of breastfeeding for the chance of having another birth (Knodel 1988: 396).

Results

Table 4 displays estimates for three different models: a basic model including only age of woman, village and grain price; a full model with all covariates; and the full model with

[6] The estimations were made using the 'eha' package in R (R Development Core Team 2004), developed by Göran Broström at the Department of Statistics, Umeå University, specifically designed to estimate this kind of combined time-series and individual survival model. Previous analyses have shown that estimations assuming Gamma distributed frailty produce the same results (see Bengtsson and Dribe 2006).

interactions between socioeconomic status and price. Before turning to the price effects something should be said about the control variables. The age effects might appear a bit unexpected, but this is totally explained by the exclusion of the open birth intervals in the analysis. Because only closed intervals are analyzed, women will be censored after their last observed birth, which explains the low proportion of women over 40 in the sample. This also explains why the risk of child birth increases at higher ages, because older women who give birth are a selected group with higher than average fecundity or with different behavior in terms of breast feeding, etc.

Table 4 here

There are also quite marked differences between the villages in the average durations of birth intervals, and even though the coefficients differ somewhat between the basic and the full model the inter-village differences cannot be explained by the other covariates in the model, such as socioeconomic status, age homogamy, migration or breast-feeding (effect of child death within 2 years). The same differences were also noted by Knodel in his analysis using the fertility index Ig (Knodel 1988:250-251). The village in the northern province of East Friesland (Middels) had lowest fertility, the villages in the south-west province of Baden (Kappel, Öschelbronn and Rust) had the highest and the villages in the mid-Germany province of Waldeck (Braunsen and Massenhausen) had a level in between.

In-migrating couples have higher birth risks than couples where at least one spouse was born in the village. Husband-older marriages are related to lower birth risks than marriages where the woman is older. The effects of child death are as expected and point to an important effect of breast-feeding on fertility in the areas, because the chance of having another birth is greatly elevated if a child died within two years (i.e. when breast-feeding can be expected to have been practiced, and thus was terminated because of the death of the child) compared to when more than two years passed since the death of the child. Finally, there are notable differences in fertility risks between socioeconomic groups. The higher status occupations have higher birth risks (shorter birth intervals) than farmers and skilled workers, while lower skilled or unskilled workers have lower fertility. Thus, at least among fully established families (i.e. who experienced at least one birth) lower socioeconomic status is associated with lower fertility. The frailty variance is statistically significant in all models, indicating that there are some unobserved differences between women, which could be related to coital frequency, breast-feeding or underlying levels of fecundability not captured by age, age differences between spouses, etc.

Turning to the fertility response to grain prices, the basic model shows statistically significant negative effects of both current prices and prices lagged one year. It should be remembered that prices refer to harvest years, and not calendar years, which means that current prices run from October 1 to September 30. As an example, for women exposed during the spring of say 1800 we use prices from the fall of 1799 to indicate current prices and prices from the fall of 1798 to indicate lagged prices. The statistically significant fertility response to current prices thus implies that prices had a very rapid effect on fertility, bearing in mind that we study births and not conceptions. A comparison of the price effects of the basic model and the full model shows only minor differences indicating that the price response is dependent on level effects of the other covariates.

What is perhaps even more interesting is to look at the interaction model which estimates the differences in price effects on fertility between different socioeconomic groups. Only one of the interaction effects is statistically significant, namely the one for unskilled workers. This group experienced a more negative price effect than the other groups. However, the signs and magnitudes of the other effects indicate that the overall pattern is as expected, at least for current prices. Higher socioeconomic groups have no or, even opposite, effects of prices compared to unskilled worker and people with no occupation. Thus, in the short term (current prices) it was mainly the unskilled workers and those without occupations who suffered from high prices, as shown by their lower fertility, while in the longer term (lagged prices) all groups seem to have been affected in a more similar way.

In order to provide a more detailed picture of the timing of the fertility response to prices, we estimated an interaction model where quarter of a year was interacted with prices. The interaction effects show the extent to which there were differences in the price response between different quarters of the year. Because prices refer to harvest years we can calculate the quarter-specific response to the price changes in the fall, and thereby see how the timing of the response evolves over the two years following the price change. Table 5 shows the estimates and figure 3 displays the net effects (exp[base effect of price+interaction effect price*quarter]). The base effect of current prices is only statistically significant for the unskilled workers and no occupation, while the lagged prices are statistically significant in all groups ($p=0.06$ among the skilled and lower skilled is on the border). Once again this shows that the price response was more similar between the socioeconomic groups in the longer term than in the short term.

Table 5 and Figure 3 here

Only two of the interaction effects are statistically significant, and neither of these in the groups with the most significant price response: the unskilled and no occupation. This could be interpreted as an indication that the fertility response to prices indeed was very rapid in this group, because otherwise there would have been clear interaction effects pointing to a response only in the final quarters of the harvest year. Indeed, looking at the net effects in figure 3 reveals that already in January to March – about 3-4 months after the price change – fertility was significantly depressed, and it took about a year before it started to increase again. This is clear evidence of reproductive agency in lower status families in these areas of pre-transitional Germany. Figure 3 also shows the delayed response in the other two groups, leaving quite similar patterns after about a year after the price change.

To examine the degree of linearity in the fertility response, we look at the fertility response to categorized prices. Prices were categorized into five groups "very low", "low", "normal", "high" and "very high". Each category has been created in order to get a roughly even distribution between the categories. The model was estimated only for the unskilled/no occupation group. The response to prices higher than normal is more or less linear, with a greater effect for very high prices than for high prices. This is fully consistent with the interpretation that the response is deliberate, while an involuntary response related to nutrition could be expected to be clearly non-linear.

It is interesting to note that there is also a negative non-linear fertility effect of very low prices. Times of very low grain prices should clearly be favorable times for groups dependent on the market for their food, which makes a negative fertility response quite unexpected. At the same time, however, very low prices would have adverse effects for farmers, artisans and other employers of unskilled labor, and it could be that the negative effect observed is related to a lower demand for labor, and generally unfavorable times in the local community when prices were very low.

Table 6 here

In order to determine if the timing of the response differ between high and low prices two separate interaction models were estimated (for the unskilled and those with no occupation). The first model considers only the effects of prices lower than the trend (negative residuals, with positive residuals set to 0), and the second model, conversely, estimates the effects of prices higher than normal (positive residuals with negative residuals set to 0). The net effects from the two interaction models are shown in Figure 4. As before, it shows the price response distributed over eight quarters from the price change in October. It is quite clear that the patterns are highly similar, except perhaps for the first quarter. Thus, both in cases of high and low prices, the rapid response (already in the first or second quarter after the price change) point to the conclusion that lower status families could foresee bad times and took active action to deal with economic stress by deliberately adjusting the timing of childbirth.

Figure 4 here

Conclusion

In this paper we have looked at the fertility response to economic stress as a way to detect deliberate control in a pre-transitional fertility regime. The six German villages under study had natural fertility, and thus there were no indications of family limitation (parity-specific control) in the period under consideration (1766-1863). By adopting a micro-longitudinal approach, our analysis has confirmed that deliberate non-parity specific control might have been practiced in times of economic stress also before the fertility decline.

Firstly, a significant fertility response to grain price changes was found both in the year immediately following the price change, and with a one year lag. Secondly, the results support expectations of a differential socioeconomic fertility response to economic fluctuations. As shown by the interaction model, only unskilled workers experienced a significant price response in the first year after the price change, whereas the fertility of other socioeconomic groups was also reduced in the second year.

In addition, a differential timing of the response was found among the various social classes. As expected, the fertility of lower status families was depressed already three to six months after the price change. Because non-deliberate effects on fertility through malnutrition, spousal separation, shorter breastfeeding or spontaneous abortions would come with a considerably longer delay (a year or more) the very rapid response must be interpreted as a clear indication that families foresaw bad economic conditions and deliberately postponed childbirth. In contrast, the upper social groups like farmers and skilled workers had a much slower response, which points to the conclusion that they were less severely affected, and could use assets or stored grain to deal with economic stress. However, the clear response in the second year after the price change also in these groups clearly shows that they could not fully isolate themselves from the adverse impact of economic fluctuations.

As expected, the analysis of potential threshold effects demonstrated that the response to high grain prices was rather linear. However, there was also a non-linear negative fertility effect of very low grain prices among the unskilled/no occupation groups, indicating a possible adverse effect on fertility of low demand for labor and unemployment. The timing of the response to high and low prices was highly similar, both indicating that the response was deliberate. Taken together the analysis gives strong support to the idea that individual agency in the reproductive process was a salient feature of preindustrial Europe, even though it was not aimed at family limitation but at adjusting the timing of childbirth in line with the economic conditions.

Table 1 – Age specific marital fertility, total marital fertility over age 20, the Coale-Trussel indices of natural fertility level (M) and marital fertility control (m) in a combined sample of German village, 1750-1899

Year of Marriage	20-24	25-29	30-34	35-39	40-44	45-49	TMFR20+	M	m
1750-74	439	425	374	303	173	26	8.70	0.95	-0.03
1775-99	455	426	376	301	155	25	8.69	0.99	0.05
1800-24	463	412	362	285	151	18	8.46	0.99	0.08
1825-49	503	430	379	286	141	15	8.77	1.07	0.18
1850-74	533	450	362	288	128	15	8.88	1.14	0.27
1875-99	547	462	353	247	104	6	8.60	1.2	0.46

Source: Knodel, 1988: table 10.2.

Table 2 - Distribution of married women and births 1766-1863 in the six German villages

	Braunsen	Kappel	Middels	Massenhausen	Oschelbronn	Rust	Total
Women	209	669	576	325	512	1,110	3,401
%	6.1	19.7	16.9	9.6	15.1	32.6	100.0
Births	755	2,837	1,970	1,183	2,283	4,298	13,326
%	5.7	21.3	14.8	8.9	17.1	32.3	100.0

Note: Only women selected in the analysis and births of the second and higher order

Table 3 - Percent distribution of married women 1766-1863 by husband's occupation in the six German villages

	Higher managers-professionals	Lower managers-prof, clerical and sales	Skilled workers	Farmers	Lower skilled	Unskilled	No occupation	Total
Braunsen	4.8	2.9	24.9	21.5	10.0	24.4	11.5	100.0
Kappel	1.0	3.4	21.5	29.3	9.1	29.4	6.1	100.0
Middels	2.4	2.3	6.4	48.8	5.0	28.8	6.3	100.0
Massenhausen	4.6	1.8	12.3	22.8	6.8	14.2	37.5	100.0
Oschelbronn	3.5	2.0	35.5	33.6	10.7	4.1	10.5	100.0
Rust	1.3	7.7	27.7	19.5	8.3	22.6	13.0	100.0

Table 4 - Cox proportional hazard estimates of fertility in the six German villages, 1766-1863, for all married women, second and higher-order births

Variable	Mean	Basic Model Rel.Risk	Basic Model *p*	Full Model Rel.Risk	Full Model *p*	Model with Interactions Rel.Risk	Model with Interactions *p*
Age of Women							
15-24	0.11	1.202	0.000	1.230	0.000	1.231	0.000
25-29 (Ref.)	0.25	1.000	-	1.000	-	1.000	-
30-34	0.27	0.850	0.000	0.816	0.000	0.815	0.000
35-39	0.21	0.671	0.000	0.634	0.000	0.632	0.000
40-44	0.08	0.593	0.000	0.536	0.000	0.536	0.000
45-49	0.01	0.765	0.005	0.664	0.000	0.662	0.000
Unknown	0.07	0.722	0.000	1.193	0.037	1.195	0.036
Villages							
Braunsen (Ref.)	0.06	1.000	-	1.000	-	1.000	-
Kappel	0.21	1.089	0.220	1.168	0.028	1.168	0.028
Middels	0.18	0.697	0.000	0.746	0.000	0.746	0.000
Massenhausen	0.09	0.950	0.510	1.028	0.730	1.028	0.720
Oschelbronn	0.15	1.535	0.000	1.350	0.000	1.351	0.000
Rust	0.31	1.157	0.029	1.209	0.006	1.210	0.006
Place of Marriage							
Parish of residence (Ref.)	0.94			1.000	-	1.000	-
Other parish	0.06			0.986	0.840	0.987	0.850
Place of Birth of Spouses							
Both in parish of residence (Ref.)	0.73			1.000	-	1.000	-
One in parish of residence	0.23			0.994	0.870	0.994	0.880
None in parish of residence	0.04			1.314	0.001	1.314	0.001
Age Difference Between Spouses							
Wife is older (Ref.)	0.19			1.000	-	1.000	-
Husband is older by < 6 years	0.40			0.912	0.024	0.912	0.024
Husband is older by > 6 years	0.28			0.905	0.023	0.906	0.024
Unknown	0.13			0.520	0.000	0.520	0.000
Life Status of Previous Child							
Alive (Ref.)	0.86			1.000	-	1.000	-
Dead for < 2 years since previous birth	0.10			4.457	0.000	4.460	0.000
Dead for > 2 years since previous birth	0.04			1.180	0.000	1.182	0.000
Socioeconomic Status							
Farmers (Ref.)	0.31			1.000	-	1.000	-
Higher Managers, Professional and Sales	0.02			1.372	0.002	1.376	0.002
Lower Managers, Professional and Sales	0.04			1.132	0.130	1.132	0.130
Skilled Workers	0.23			1.054	0.210	1.055	0.200
Lower Skilled Workers	0.09			0.909	0.095	0.909	0.096
Unskilled Workers	0.22			0.912	0.027	0.911	0.026
No occupations	0.10			0.719	0.000	0.719	0.000
Rye Price							
Rye Price (t)		0.848	0.000	0.865	0.001	0.933	0.340
Rye Price (t-1)		0.829	0.000	0.795	0.000	0.785	0.001
Interactions Socioeconomic Status*Rye Price (t)							
Higher Managers, Professional and Sales						1.612	0.120
Lower Managers, Professional and Sales						1.019	0.940
Skilled Workers						0.950	0.640
Lower Skilled Workers						0.945	0.720
Unskilled Workers						0.754	0.019
No occupations						0.885	0.450
Interactions Socioeconomic Status*Rye Price (t-1)							
Higher Managers, Professional and Sales						1.079	0.800
Lower Managers, Professional and Sales						0.806	0.370
Skilled Workers						1.104	0.380
Lower Skilled Workers						1.071	0.660
Unskilled Workers						0.949	0.660
No occupations						1.005	0.980
Frailty Variance		0.402	0.000	0.369	0.000	0.370	0.000
Likelihood ratio test		6252		8268		8286	
Overall p value			0.000		0.000		0.000
Number of births		13.326		13.326		13.326	

Table 5 - Cox proportional hazard estimates of fertility with quaters*price interactions in the six German villages, 1766-1863, for all married women, second and higher-order births

	Unskilled and No occupation			Farmers			Skilled and Lower Skilled Workers		
Variable	Mean	Rel.Risk	*p*	Mean	Rel.Risk	*p*	Mean	Rel.Risk	*p*
Age of Women									
15-24	0.11	1.186	0.013	0.13	1.439	0.000	0.10	1.079	0.260
25-29 (Ref.)	0.25	0.000	-	0.25	1.000	-	0.25	1.000	-
30-34	0.27	0.827	0.000	0.26	0.781	0.000	0.28	0.828	0.000
35-39	0.21	0.656	0.000	0.21	0.611	0.000	0.23	0.622	0.000
40-44	0.08	0.634	0.000	0.08	0.491	0.000	0.09	0.498	0.000
45-49	0.01	0.544	0.001	0.01	0.622	0.003	0.01	0.676	0.021
Unknown	0.07	1.935	0.000	0.07	0.692	0.110	0.05	0.809	0.170
Villages									
Braunsen (Ref.)	0.06	0.000	-	0.05	1.000	-	0.07	1.000	-
Kappel	0.22	1.148	0.270	0.21	1.154	0.290	0.21	1.356	0.009
Middels	0.19	0.695	0.005	0.29	0.750	0.032	0.05	0.944	0.690
Massenhausen	0.15	0.924	0.530	0.07	1.097	0.550	0.06	0.916	0.540
Oschelbronn	0.05	1.627	0.001	0.17	1.287	0.062	0.23	1.416	0.002
Rust	0.34	1.041	0.740	0.20	1.336	0.033	0.38	1.323	0.012
Place of Marriage									
Parish of residence (Ref.)	0.95	0.000	-	0.95	1.000	-	0.95	1.000	-
Other parish	0.05	0.861	0.270	0.05	0.876	0.310	0.05	1.159	0.240
Place of Birth of Spouses									
Both in parish of residence (Ref.)	0.79	0.000	-	0.77	1.000	-	0.67	1.000	-
One in parish of residence	0.18	1.023	0.760	0.21	0.996	0.950	0.29	0.894	0.061
None in parish of residence	0.03	1.007	0.960	0.03	1.496	0.023	0.04	1.411	0.014
Age Difference Between Spouses									
Wife is older (Ref.)	0.17	0.000	-	0.18	1.000	-	0.22	1.000	-
Husband is older by < 6 years	0.37	0.913	0.230	0.40	0.803	0.003	0.45	0.957	0.500
Husband is older by > 6 years	0.27	0.976	0.760	0.34	0.821	0.010	0.24	0.848	0.024
Unknown	0.19	0.340	0.000	0.08	0.719	0.130	0.09	0.755	0.023
Life Status of Previous Child									
Alive (Ref.)	0.85	0.000	-	0.88	1.000	-	0.86	1.000	-
Dead for < 2 years since previous birth	0.09	4.875	0.000	0.10	5.334	0.000	0.11	3.971	0.000
Dead for > 2 years since previous birth	0.05	1.162	0.021	0.03	1.326	0.000	0.03	1.176	0.016
Quarters									
January-March	0.25	0.000	-	0.25	1.000	-	0.25	1.000	-
April-June	0.25	0.863	0.002	0.25	0.825	0.000	0.25	0.943	0.180
July-September	0.25	0.963	0.400	0.25	0.892	0.009	0.25	1.090	0.044
October-December	0.25	1.036	0.430	0.25	0.985	0.730	0.25	1.083	0.062
Rye Price (Ref.)									
Rye Price (t)		0.692	0.018	0.00	0.973	0.840	0.00	1.167	0.260
Rye Price (t-1)		0.674	0.010	0.00	0.703	0.015	0.00	0.764	0.061
Interactions Quarter*Rye Price (t)									
April-June		1.033	0.890		0.846	0.420		0.796	0.260
July-September		0.921	0.710		1.080	0.700		0.577	0.006
October-December		1.303	0.210		0.923	0.680		0.712	0.080
Interactions Quarter*Rye Price (t-1)									
April-June		1.182	0.440		1.335	0.170		1.423	0.079
July-September		1.271	0.260		1.134	0.540		1.287	0.200
October-December		1.035	0.870		1.032	0.880		0.902	0.610
Frailty Variance		0.361	0.000		0.353	0.000		0.319	
Likelihood ratio test		2,517			2,737			2,402	
Overall p value			0.000			0.000			0.000
Number of births		3,961			4,161			4,390	

Table 6 - Fertility response to categorized rye prices among the "Unskilled and No occupation" group in the six German villages, 1766-1863, for all married women, second and higher-order births

Variable	Mean	Rel.Risk	p
Rye Price			
Very low	0.22	0.853	0.004
Low	0.20	0.923	0.145
Normal (Ref.)	0.18	1.000	-
High	0.18	0.843	0.002
Very high	0.22	0.726	0.000
Frailty Variance		0.357	0.000
Likelihood ratio test		2,497	
Overall p value			0.000
Number of births		3,961	

Note: the model also includes age of mother, villages, place of marriage, place of birth of spouses, age difference between spouses, life status of previous child

Map – Geographical references of the demographic data and the price series

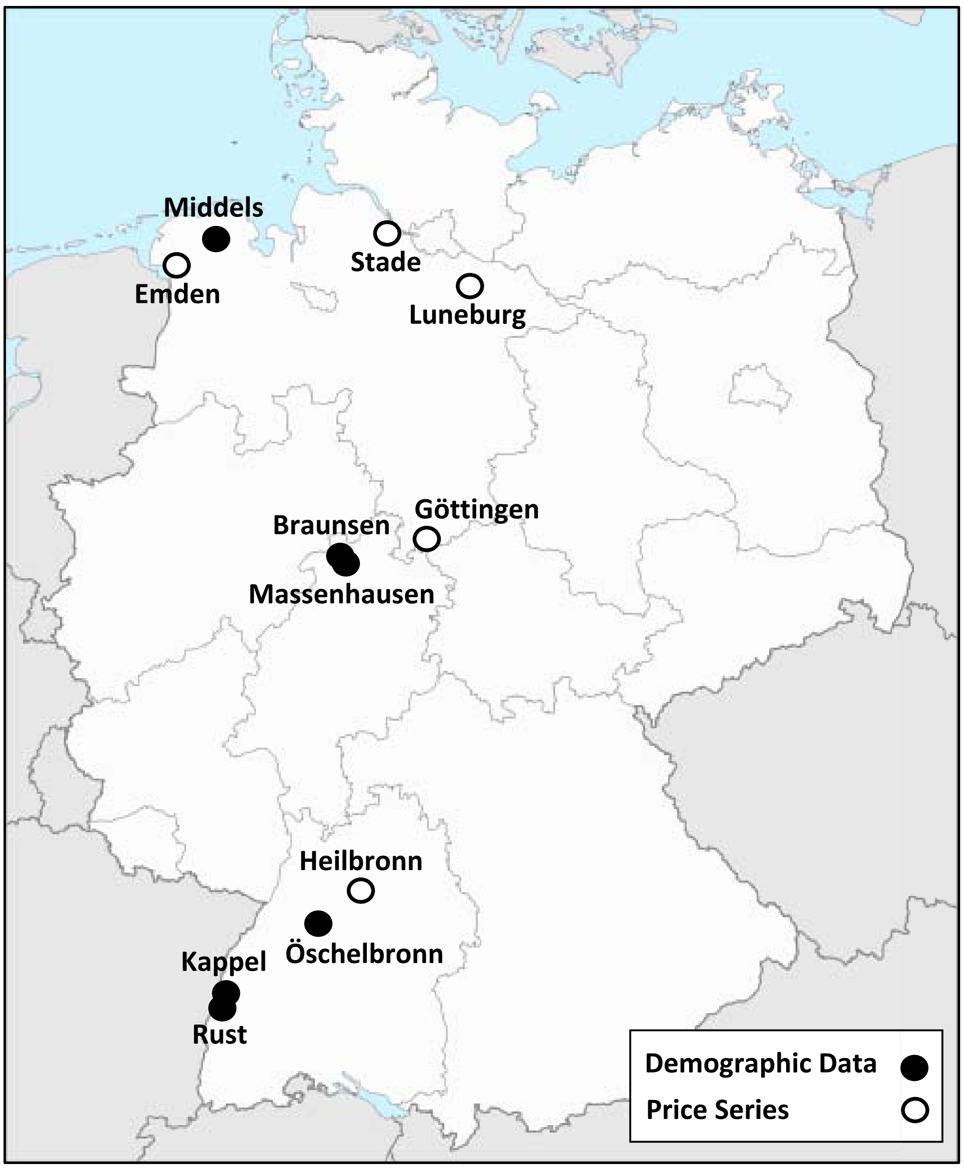
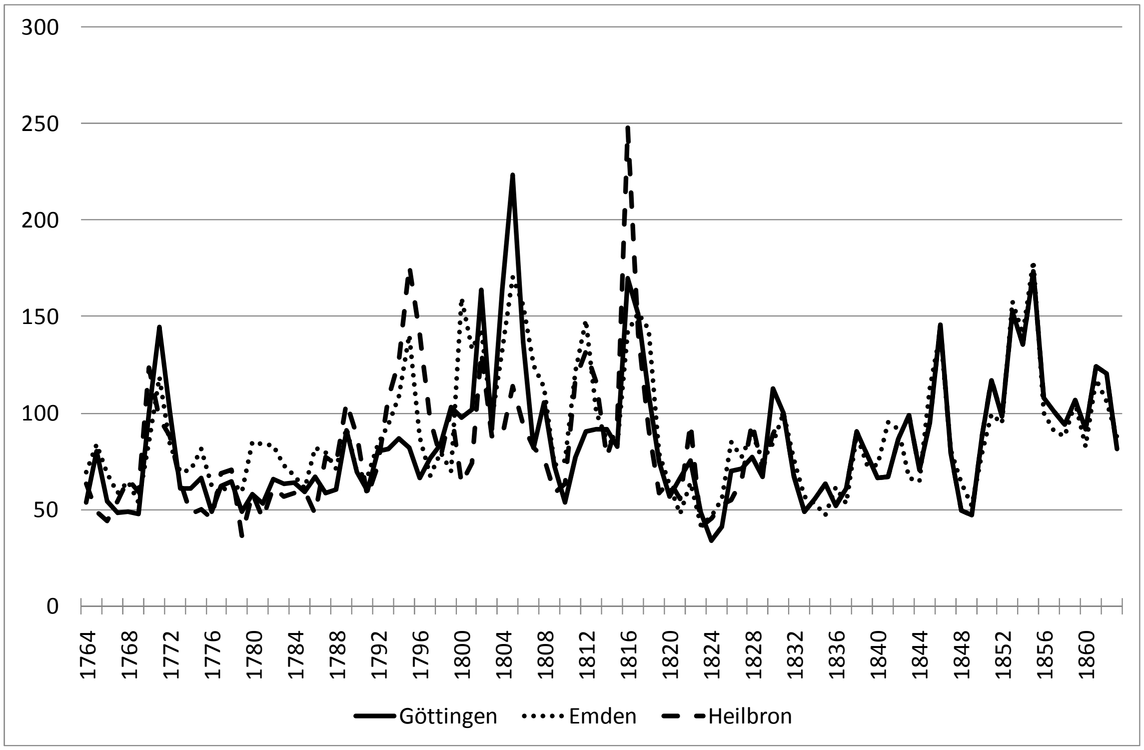
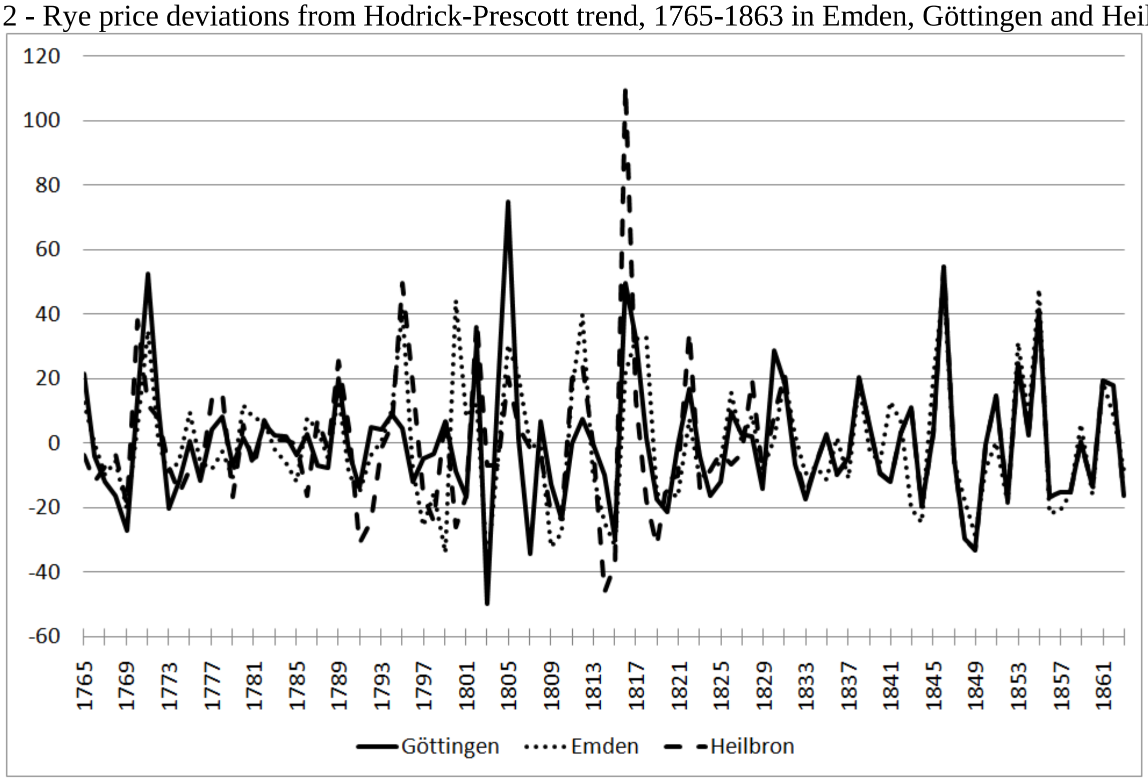


Figure 1 - Rye price index 1764-1863 in Emden, Göttingen and Heilbron (1831=100)



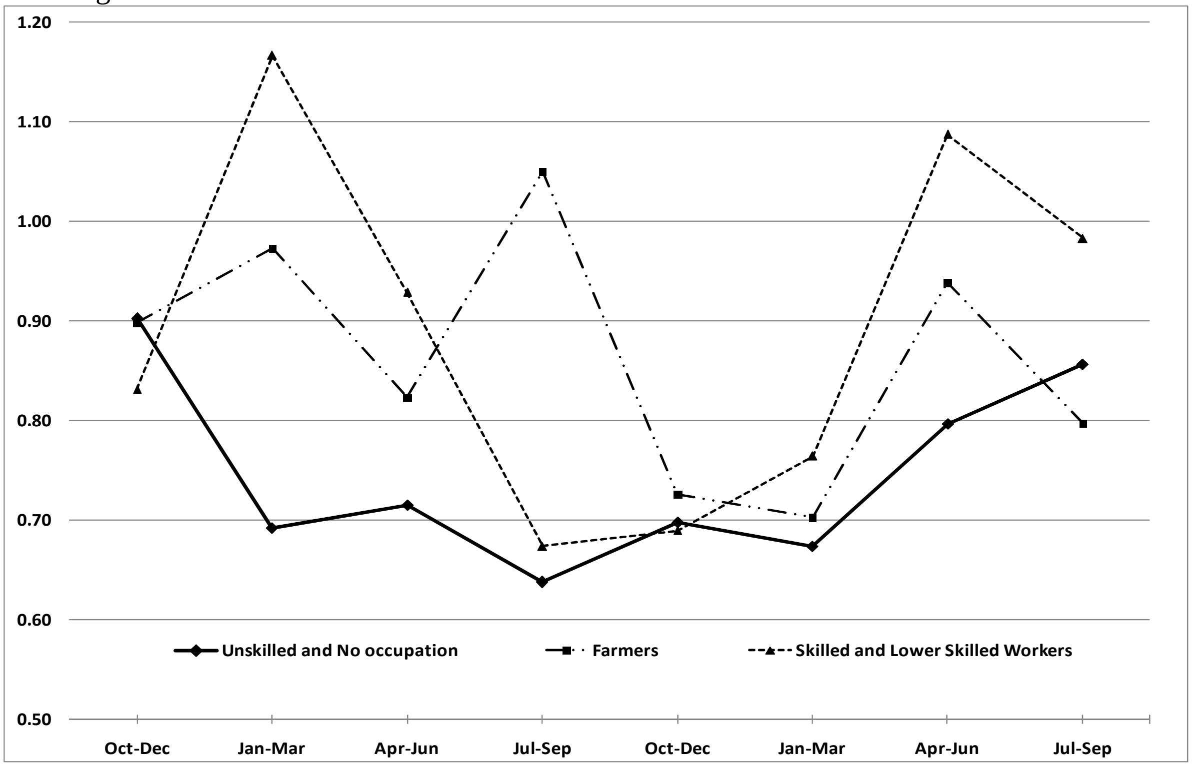
Source: Jacks 2004, 2005.
Note: For construction of the series see text.

Figure 2 - Rye price deviations from Hodrick-Prescott trend, 1765-1863 in Emden, Göttingen and Heilbron



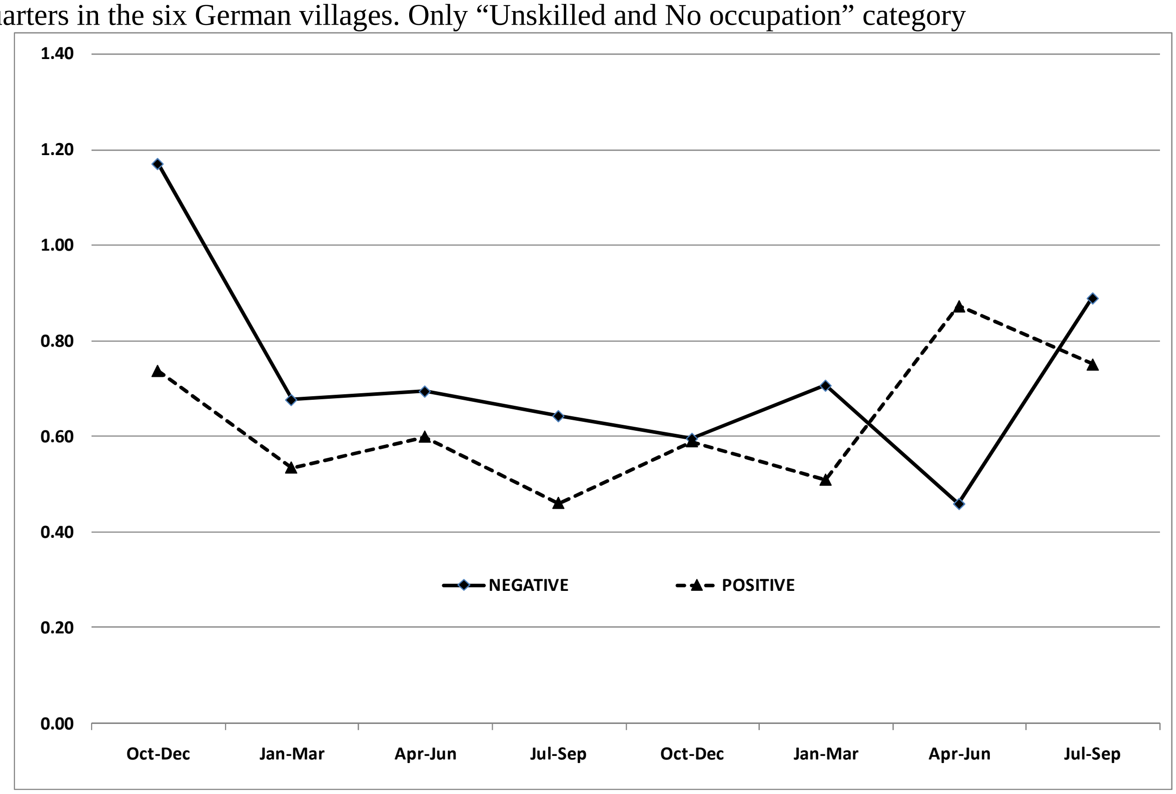
Source and note: see figure 1. Hodrick-Prescott trend was calculated using a smoothing parameter of 6.25, as is recommended for annual data.

Figure 3 – Fertility response to a 100 unit change in rye prices over the next two years by quarters in the six German villages



Note: Based on the estimations of the model in table 5

Figure 4 – Fertility response to a 100 unit negative and positive change in rye prices over the next two years by quarters in the six German villages. Only "Unskilled and No occupation" category



Note: Based on the estimations of the same model in table 5

References

Abel, W., 1980. *Agricultural Fluctuations in Europe from the Thirteenth to the Twentieth Centuries*. London: Methuen & Co.

Anderton, D. L. ,1989. 'Comment on Knodel's "Starting stopping, and spacing during the early stages of the fertility transition"', *Demography* 26: 467–470.

Anderton, D. L. and Bean, L. L., 1985. 'Birth spacing and fertility limitation: A behavioral analysis of a nineteenth century frontier population', *Demography* 22: 169–83.

Bean, L. L., Mineau, G. P., and Anderton, D. L., 1990. *Fertility Change on the American Frontier. Adaptation and Innovation*. Berkeley, CA: The University of California Press.

Bengtsson, T., 1993. 'A re-interpretation of population trends and cycles in England, France and Sweden, 1751–1860', *Histoire & Mesure* 8: 93–115.

Bengtsson, T. and Dribe, M., 2006. 'Deliberate control in a natural fertility population: Southern Sweden, 1766–1864', *Demography* 43: 727–746.

Bengtsson, T. and Dribe, M., 2010. 'Economic Stress and Reproductive Responses', in N. O. Tsuya, et al. (eds.) *Prudence and Pressure. Reproduction and Human Agency in Europe and Asia, 1700-1900*. Cambridge, MA: MIT Press.

Bengtsson, T. and Ohlsson, R., 1985. 'The standard of living and mortality response in different ages', *European Journal of Population* 1:309–26.

Bongaarts, J., 1980. 'Does malnutrition affect fecundity? A summary of evidence', *Science* 208(4444):564–69.

Brown, J. C. and Guinnane, T. W., 2002. 'Fertility transition in a rural, Catholic population: Bavaria, 1880–1910', *Population Studies* 56: 35–50.

Brown, J. C. and Guinnane, T. W., 2007. 'Regions and time in the European fertility transition: Problems in the Princeton project's statistical methodology', *Economic History Review* 60: 574–95.

Cleland, J. and Wilson, C., 1987. 'Demand theories of the fertility transition: An iconoclastic view', *Population Studies* 41: 5–30.

Coale, A. J., 1973. 'The demographic transition reconsidered', in *International Population Conference, Liège*, 1973, Vol. 1. Liège: International Union for the Scientific Study of Population, 53–72.

Coale, A. J., and Trussell, J. T., 1974. 'Model fertility schedules: Variations in the age schedule of childbearing in human populations', *Population Index* 40:185–258.

Coale, A. J., and Trussell, J. T., 1978. 'Technical note: Finding the two parameters that

specify a model schedule of marital fertility.” *Population Index* 44:203–13.
Coale, A. J. and Watkins, S. C. (eds.), 1986. *The Decline of Fertility in Europe*. Princeton: Princeton University Press.
Crafts, N. F. R., 1989. ‘Duration of marriage, fertility and women’s employment opportunities in England and Wales in 1911’, *Population Studies* 43: 325–35.
David, P. A. and Mroz, T. A., 1989a. ‘Evidence of fertility regulation among rural French villagers, 1749–1789. A sequential econometric model of birth-spacing behavior (part 1)’, *European Journal of Population* 5: 1–26.
David, P. A. and Mroz, T. A., 1989b. ‘Evidence of fertility regulation among rural French villagers, 1749–1789. A sequential econometric model of birth-spacing behavior (part 2)’, *European Journal of Population* 5: 173–206.
David, P. A. and Sanderson, W. C., 1986. ‘Rudimentary contraceptive methods and the American transition to marital fertility control, 1855–1915’, in S. L. Engerman and R. E Gallman (eds.) *Long-Term Factors in American Economic Growth*. Chicago: The University of Chicago Press, 307–90.
David, H. P., Fleishhacker, J., and Hohn, C., 1988. ‘Abortion and Eugenics in Nazi Germany’, *Population and Development Review*, 14: 81–112.
Dribe, M. 2000. Leaving Home in a Peasant Society. Economic Fluctuations, Household Dynamics and Youth Migration in Southern Sweden, 1829–1867. Södertälje: Almqvist & Wiksell International.
Dribe, M., 2009. ‘Demand and supply factors in the fertility transition: A county level analysis of age-specific marital fertility in Sweden 1880–1930’, *European Review of Economic History* 13, forthcoming.
Frisch, R. E., 1978. ‘Population, food intake, and fertility’, *Science* 199(4324): 22–30.
Galloway, P. R., 1988. ‘Basic patterns in annual variations in fertility, nuptiality, mortality, and prices in pre-industrial Europe’, *Population Studies* 42: 275–303.
Galloway, P. R., Hammel, E. A. and Lee, R. D., 1994. ‘Fertility decline in Prussia, 1875–1910: A pooled cross-section time series analysis’, *Population Studies* 48: 135–58.
Gaunt, D., 1973. ‘Family planning and the pre-industrial society: Some Swedish evidence’, K. Ågren, D. Gaunt, I. Eriksson, J. Rogers, A. Norberg, and S. Åkerman (eds.) *Aristocrats, Farmers, Proletarians. Essays in Swedish Demographic History*. Uppsala: Esselte, 28–59.
Haines, M. R., 1989. ‘American fertility in transition: New estimates of birth rates in the United States, 1900–1910’, *Demography* 26: 137–48.

Hammel, E. A. and Galloway, P. R., 2000. 'Structural and behavioral changes in the short-term preventive check in the northwest Balkans in the 18th and 19th centuries', *European Journal of Population* 16: 67–108.

Henry, L., 1961. 'Some data on natural fertility', *Eugenics Quarterly* 8: 81–91.

Hochstadt, S., 1981. 'Migration and industrialization in Germany, 1815-1977', *Social Science History*, 4: 445-468.

Hochstadt, S., 1983. 'Migration in preindustrial Germany', *Central Europen History*, 3: 195-224.

Hodrick, R., and Prescott, E., 1997. 'Post-war U.S. business cycles: An empirical investigation', *Journal of Money, Credit and Banking,* 29: 1-16.

Jacks, D. S., 2004. 'Market integration in the North and Baltic seas, 1500-1800', *Journal of European Economic History* 33: 285-329.

Jacks, D. S., 2005. 'Intra- and international commodity market integration in the Atlantic economy, 1800-1913', *Explorations in Economic History* 42: 381-413.

Kasakoff, A. B., and Adams, J. W., 1995. 'The effect of migration on ages at vital events: A critique of family reconstitution in historical demography', *European Journal of Population* 11: 199–242.

Knodel, J., 1977. 'Family limitation and the fertility transition: Evidence from the age patterns of fertility in Europe and Asia', *Population Studies* 31: 219–249.

Knodel, J., 1978. 'Natural fertility in pre-industrial Germany', *Population Studies* 32: 481–510.

Knodel, J. 1987. 'Starting, stopping, and spacing during the early stages of the fertility transition: The experience of German village populations in the 18^{th} and 19^{th} centuries', *Demography* 24: 143-162.

Knodel, J. E., 1988. *Demographic Behavior in the Past. A Study of Fourteen German Village Populations in the Eighteenth and Nineteenth Centuries*. Cambridge: Cambridge University Press.

Lee, R. D., 1975. 'Natural fertility, population cycles and the spectral analysis of birth and marriages', *Journal of the American Statistical Association* 70: 295–304.

Lee, R. D., 1981. 'Short-term variation: Vital rates, prices and weather', in E. A. Wrigley and R. S. Schofield, *The Population History of England, 1541–1871. A Reconstruction*. London: Edward Arnold, 356–401.

Lee, R. D., 1990. 'The demographic response to economic crises in historical and contemporary populations', *Population Bulletin of the United Nations* 20: 1–15.

McLaren, A., 1990. *A History of Contraception: From Antiquity to the Present*. Oxford: Basil Blackwell.

Menken, J., Trussell, J. T. and Watkins, S. C., 1981. ‘The nutrition fertility link: An evaluation of the evidence’, *Journal of Interdisciplinary History* 11: 425–41.

Morgan, S. P., 1991. ‘Late nineteenth- and early twentieth-century childlessness’, *American Journal of Sociology* 97:779–807.

Okun, B. S., 1995. ‘Distinguishing stopping behavior from spacing behavior with indirect methods’, *Historical Methods* 28: 85-96.

Ruggles, S., 1992. ‘Migration, marriage and mortality: Correcting sources of bias in English family reconstitutions’, *Population Studies* 46: 507–22.

Ruggles, S., 1999. ‘The limitations of English family reconstitution: English population history from family reconstitution 1580-1837’, *Continuity and Change* 14: 105–30.

Santow, G., 1995. ‘*Coitus interruptus* and the control of natural fertility’, *Population Studies* 49: 19–43.

Schultz, T. P., 1985. ‘Changing world prices, women’s wages, and the fertility transition: Sweden, 1860–1910’, *Journal of Political Economy* 93: 1126–54.

Shorter, E., 1982. *A History of Women’s Bodies*. New York: Basic Books.

Skinner G.W., 1997, ‘Family systems and demographic processes’, in D.I. Kertzer, T.E. Fricke, *Anthropological Demography: Toward a New Synthesis*. Chicago: University of Chicago Press, 53-59.

Szreter, S., 1996. *Fertility, Class and Gender in Britain 1860–1940*. Cambridge: Cambridge University Press.

Therneau, T. M. and Grambsch, P. M., 2000. *Modeling Survival Data. Extending the Cox Model*. New York: Springer.

Van Bavel, J., 2003. ‘Does and effect of marriage duration on pre-transition fertility signal parity-dependent control? An empirical test in nineteenth-century Leuven, Belgium’, *Population Studies* 57: 55–62.

Van Bavel, J., 2004a. ‘Deliberate birth spacing before the fertility transition in Europe: Evidence from nineteenth-century Belgium’, *Population Studies* 58: 95–107.

Van Bavel, J., 2004b. ‘Diffusion effects in the European fertility transition: Historical evidence from within a Belgian town (1846–1910’, *European Journal of Population* 20: 63–85.

Van de Putte, B., 2006. ‘Social power and class formation in the nineteenth century. How to measure class from occupation?’, Paper for the European Social Science History Conference,

Amsterdam, March 2006.
Van de Walle, E., 1997. ‘Flowers and fruits: Two thousand years of menstrual regulation’, *Journal of Interdisciplinary History* 28: 183–203.
Van de Walle, E., 1999. ‘Towards a demographic history of abortion’, *Population: An English Selection* 11: 115–131.
Van de Walle, E., 2000. ’”Marvelous secrets”: Birth control in European short fiction, 1150–1650’, *Population Studies* 54: 321–30.
Van de Walle, E. and Muhsam, H. V., 1995. ‘Fatal secrets and the French fertility transition’, *Population and Development Review* 21: 261–79.
Van Leeuwen, Marco H. D., Maas, Ineke, 2005. ‘Endogamy and social class in history: An overview’, *International Review of Social History* 50:S1-S23.
Van Leeuwen, M. H. D., Maas, I., and Miles, A., 2002. *HISCO. Historical International Standard Classification of Occupations.* Leuven: Leuven University Press.
Weir, D. R., 1984. ‘Life under pressure: France and England, 1670–1870’, *Journal of Economic History* 44: 27–47.
Wilson, C., 1984. ’Natural fertility in pre-industrial England, 1600-1799’, *Population Studies* 38: 225–240.
Wood, J. W., 1994. *Dynamics of Human Reproduction. Biology, Biometry, Demography*. New York: Aldine de Gruyter.
Wrigley, E. A., 1966. ‘Family limitation in pre-industrial England’, *Economic History Review* 19: 82–109.
Wrigley, E. A., 1994. ‘The effect of migration on the estimation of marriage age in family reconstitution studies’, *Population Studies* 48: 81–97.