

*Original Research Article***Strong Association Between Birth Month and Reproductive Performance of Vietnamese Women**SUSANNE HUBER<sup>1\*</sup> AND MARTIN FIEDER<sup>2</sup><sup>1</sup>Research Institute of Wildlife Ecology, University of Veterinary Medicine Vienna, 1160 Vienna, Austria<sup>2</sup>Department of Anthropology, University of Vienna, 1090 Vienna, Austria

**ABSTRACT** Epidemiological studies on premodern and modern Western societies indicate that birth season may influence female reproduction. Nothing is known, however, about this effect in developing economies. Many of the latter are characterised by tropical climates with a rainy season associated with lower food availability and a greater prevalence of infectious diseases. We therefore predict that an association between birth month and reproductive output, if it exists, should be related to the rainy season. To test this prediction, we analysed census data of Vietnam obtained from IPUMS-International (Vietnam 1999 Population and Housing Census). Based on 493,853 women born between 1950 and 1977 and thus aged 22 to 49 years, we found that the time series of mean offspring count per month of birth has a highly significant period of 12 months (power = 46.871,  $P < 0.00001$ ). Our results further indicate that the 12-month periodic signal has a maximum in July and a minimum in January. Accordingly, the peak corresponds to birth during the rainy season, the low if the third pregnancy month concurs with the rainy season. The month of birth is therefore clearly associated with the later reproductive performance of Vietnamese women, strongly supporting the assumption that environmental and maternal conditions during early development exert long-term effects on reproductive functioning. Provided the rainy season adversely affects developmental processes due to inadequate food and/or high infection risk, the association reported here points to a critical period of reproductive development during early pregnancy. *Am. J. Hum. Biol.* 21:25–35, 2009. © 2008 Wiley-Liss, Inc.

It is increasingly acknowledged that the environmental and maternal conditions during pregnancy and around birth may affect early development, with potential long-lasting effects on later life events. Epidemiological studies on pre-modern and modern Western societies indicate that the birth season may affect a variety of parameters such as reproduction (Huber and Fieder, 2007; Huber et al. 2004a,b, 2008; Lummaa and Tremblay, 2003; Smits et al., 1997), growth (Weber et al., 1998), longevity (Doblhammer and Vaupel, 2001; Lerchl, 2004), performance at university and at intelligence tests (Fieder et al., 2006; McGrath et al., 2006), and susceptibility to disease (Castrogiovanni et al., 1998; Mainio et al., 2006; Procopio et al., 2006; Torrey et al., 1997). Studies on the effects of birth season on later life events in developing economies, however, are scarce and nothing is known about the effects of birth season on later reproductive performance.

Many developing are characterized by a tropical type of climate, in contrast to the temperate climates typically prevailing in the aforementioned study populations. In countries with a tropical monsoon climate such as Gambia, Tanzania, and Vietnam, birth during the rainy season is associated with lower birth weight (Dinh et al., 1996; Kinabo, 1993; Lawrence et al., 1987; Moore et al., 2001; Prentice et al., 1981), higher infant mortality (Simondon et al., 2004), and higher mortality among young adults (Moore et al., 1997; 2001). In these countries, the rainy season is associated with the depletion of the previous year's harvest and, thus, lower availability and higher costs of food (Becker et al., 1986). It is also correlated with an intensive agricultural work load (Kinabo, 1993; Lawrence et al., 1987; Panter-Brick, 1993; Sear et al., 2004) and the prevalence of infectious diseases, particularly malaria (Bates et al., 1991; Kinabo, 1993; Sear et al., 2003; Sear et al., 2004). Accordingly, we predict that an

association between birth month and later reproductive performance, if it indeed exists, should be related to the rainy season. Such an association would point to periods of early reproductive development that are particularly susceptible to adverse environmental and maternal influences. As Vietnam has such a climate, we investigated the relationship between the month of birth and later reproductive output in a large sample of Vietnamese women to test this prediction.

**METHODS**

Vietnam is located between 9 and 23 degrees north. It has a tropical monsoon climate with a single rainy season during the south monsoon (May to September). Temperatures are high year round for southern and central Vietnam, whereas northern Vietnam has a cooler season from November to April. Vietnam is one of the poorest Asian countries, with a gross domestic product in 1999 of 410 US\$ per individual.

To analyze the relation between the month of birth and offspring count in Vietnamese women, we used the data from the Vietnamese "1999 Population and Housing Census", obtained from IPUMS-International (Minnesota

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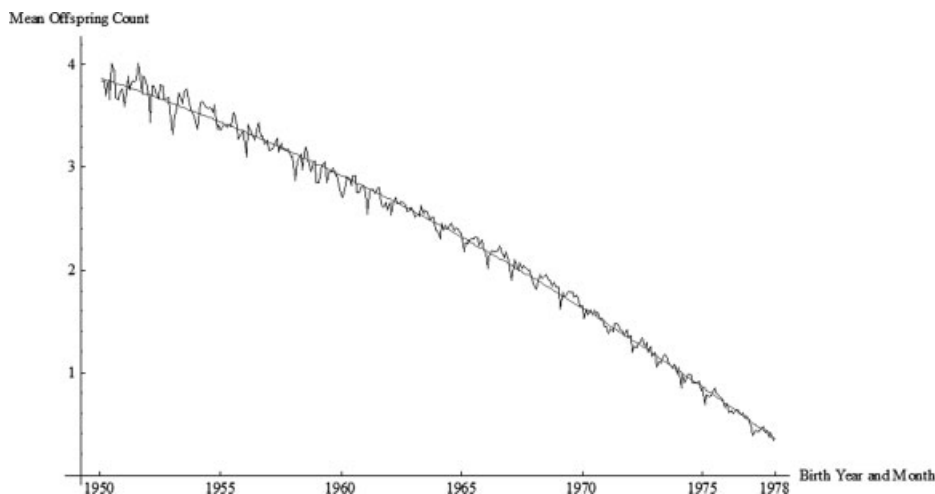


Fig. 1. Mean offspring count and quadratic regression of mean offspring count per month of birth (red line) of Vietnamese women born between January 1950 and December 1977.

Population Center. Integrated Public Use Microdata Series - International: Version 3.0. Minneapolis: University of Minnesota, 2007, Vietnam General Statistics Office, <http://international.ipums.org>). This is a collection of publicly available individual-level census data, where names and other identifying information have been removed (Minnesota Population Center, 2006). In this census, a 3% sample was used to obtain information on births and deaths. This sample is representative for the entire Vietnamese population: it represents a stratified systematic sample of enumeration areas; all dwellings/households within an enumeration area are included in the sample. The date of the census was 1 April 1999, and it was completed within 10 days. This census contains data on birth month, the number of biological children born up to March 1999, and the highest level of education attained. We conducted all analyses on a monthly basis using April 1999 as a reference point. We analyzed women in their reproductive ages to examine whether a putative birth date effect varied during the reproductive career of a woman. We included women born between 1950 and 1977 and thus aged older than 21 years (to avoid small sample sizes per month of birth in younger women) and younger than 50 years of age (offspring count was not sampled for women aged 50 years and older). This yielded a total of 493,853 individuals. We included childless individuals in the analysis, and additionally examined whether the probability to remain childless was also associated with the month of birth by calculating the percentage of childless individuals per month of birth for all women born between January 1950 and December 1977.

We calculated the mean number of biological children of all women born per month of birth from January 1950 to December 1977, thereby obtaining a time series totalling 336 months. To remove the trend caused by the age effect on the number of biological children (Fig. 1), we performed a quadratic regression of mean offspring count per month of birth and used the residuals of this quadratic regression for all further analyses. We calculated this 336 month time series for (i) all individuals in our sample. To control for climatic differences associated with latitude, we additionally calculated this time series separately for inhabitants of (ii) northern Vietnam (i.e., regions northwest, northeast, Red River

Delta), (iii) central Vietnam (i.e., regions north central coast, south central coast, central highlands), and (iv) southern Vietnam (i.e., regions south east, Mekong River Delta). To control for a potentially confounding effect of education, we further calculated the time series separately for (v) uneducated women (i.e., women without schooling), (vi) women with primary education (i.e., women with up to 6 years primary education), and (vii) women with at least secondary education (i.e., women with lower secondary up to university education). Finally, to control for a potentially confounding effect of occupation (used as an indicator of socio-economic status because income data are not available in this census), we calculated the time series separately for (viii) women occupied in elementary occupations (i.e., ISCO code 9 according to the "International Standard Classification of Occupations" encoded in IPUMS Vietnam 1999 <https://international.ipums.org/international-action/variableDescription.do?mnemonic=OCCISCO>), (ix) women occupied in lower non-elementary occupations (i.e., ISCO code 5-8: service workers and shop and market sales; skilled agricultural and fishery workers; crafts and related trades workers; plant and machine operators and assemblers) and (x) women occupied in higher nonelementary occupations (i.e., ISCO 1-4: legislators, senior officials and managers; professionals; technicians and associated professionals; clerks). Sample sizes differ owing to missing data regarding education and occupation.

We tested the residuals of all time series for significant periods using a Lomb-Scargle periodogram (Press et al., 1992), which is a derivation of the classical periodogram based on the method of least squares; it allows missing data and unequally spaced time series. We calculated the Lomb-Scargle periodogram both using a moving average of three to remove possible serial correlations (Ruf 1999), and without using such a moving average. In addition, for the analysis of all individuals, we calculated the periodic signal using the main Fourier component that was found to be significant by the Lomb-Scargle periodogram. That periodic signal was then plotted both over one year and for the entire time series, the latter together with the residuals of the quadratic regression.

The total fertility rate strongly decreased over the studied years from 7.25 in year 1970 (when the oldest women in our sample were ~20 years old) to 2.50 in year 2000 (source:

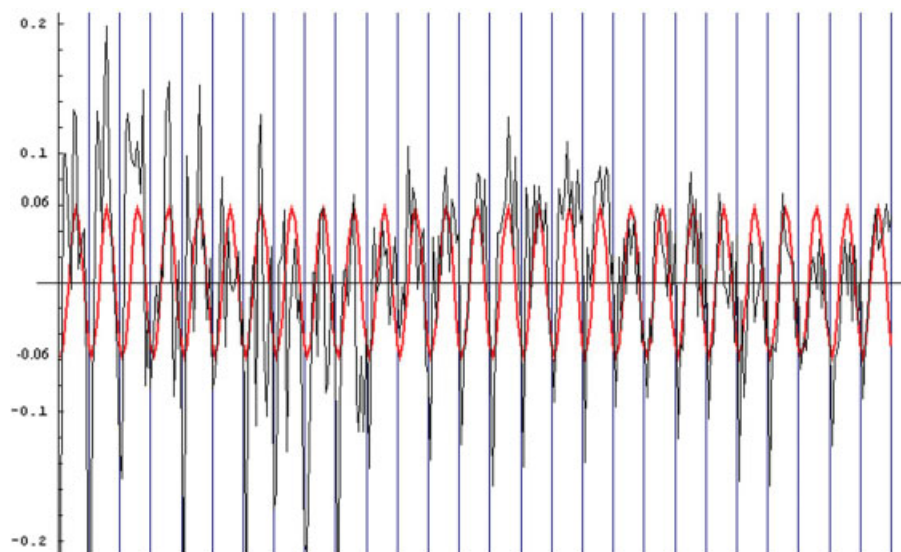


Fig. 2. Residuals of the quadratic regression (black line) and main periodic signal of the residuals of mean offspring count per month of birth (red line) of Vietnamese women born between January 1950 and December 1977. Blue vertical grid lines indicate 12-month intervals.

UN Common Database). We therefore analyzed the association between birth month and average offspring count also in those women who had already finished reproduction. This involved including only women born between 1950 and 1953 and thus aged 47 to 49 years, who did not give birth during the previous 3 years (i.e. after 1996). A Kruskal Wallis H-test was performed on these data.

In the appendices, we present descriptive statistics: average offspring count per month of birth for all time series calculated (Tables A1–A10) as well as the percentage of childless individuals per month of birth (Table A11).

## RESULTS

Including all individuals, the time series of mean offspring count per month of birth of Vietnamese women born between January 1950 and December 1977 has a strong cyclic component (Fig. 1). The cyclic component still remains after removal of the trend caused by the effect of age on reproductive output (via a quadratic regression of mean offspring count per month of birth; Fig. 2). Applying the Lomb-Scargle periodogram to the residuals of this quadratic regression, we find two highly significant periods at 4 and 12 months (Fig. 3), with a power of 46.871 ( $P < 0.00001$ ) at the period of 12 months, suggesting a clear 12-month birth season variation of offspring count in Vietnamese women. The period at 4 months can be attributed to serial correlations in the time series, as only the 12-month peak remains significant if the residuals of the time series are smoothed using a 3-month average prior to performing the Lomb-Scargle Periodogram. The 12-month periodic signal of all residuals of this quadratic regression plotted over one year has a maximum in July and a minimum in January (see also Table A1 for descriptive statistics). Thus the peak is if birth concurs with the rainy season, the low if the third pregnancy month concurs with the rainy season (Fig. 4).

Analyzing post-reproductive women (i.e., women aged 47–49 years who had not given birth during the previous 3 years) yielded a similar association between birth month

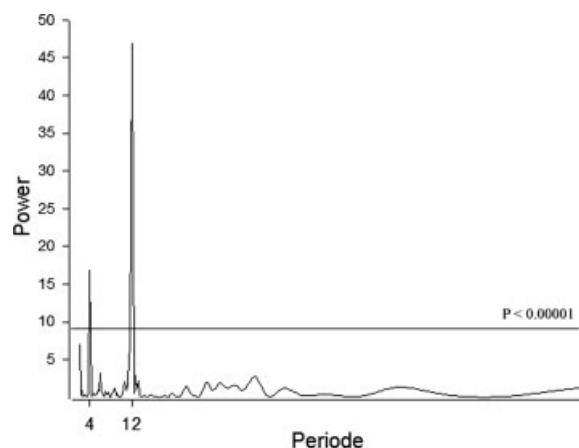


Fig. 3. Lomb-Scargle periodogram of the residuals of the quadratic regression of mean offspring count per month of birth of Vietnamese women born between January 1950 and December 1977. “Spikes” show significant periodicities at 4 and 12 months ( $P < 0.00001$ ).

and reproductive output: on average, women born in June had the most, those born in December the least offspring (Fig. 5; Kruskal Wallis H-Test:  $df = 11$ ,  $n = 28,930$ ,  $\chi^2 = 106.22$ ,  $P < 0.001$ ).

The climatic variation between northern and southern Vietnam does not substantially affect the association between birth month and offspring count: the Lomb-Scargle periodogram performed on the residuals of individuals either born in northern ( $n = 196,752$ ) or southern Vietnam ( $n = 181,835$ ) shows a significant peak at 12 months, that for individuals born in central Vietnam ( $n = 115,266$ ) a major peak at 12 months and minor peak at 4 months (we also attribute this minor peak to a serial correlation in the time series because it vanished in the smoothed time series). Again, women born in June (southern Vietnam) or July (northern and central Vietnam) have a maximum and those

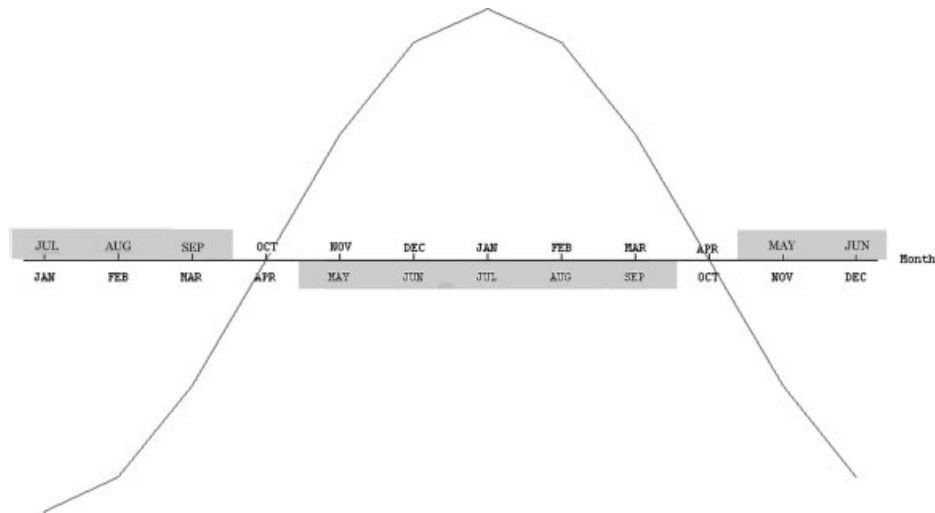


Fig. 4. Main periodic function over one year of the residuals of the quadratic regression of mean offspring count per month of birth of Vietnamese women born between January 1950 and December 1977. Labels below the x-axis indicate months of birth, labels above the x-axis indicate the corresponding third months of pregnancy. Months in bars represent the annual rainy season.

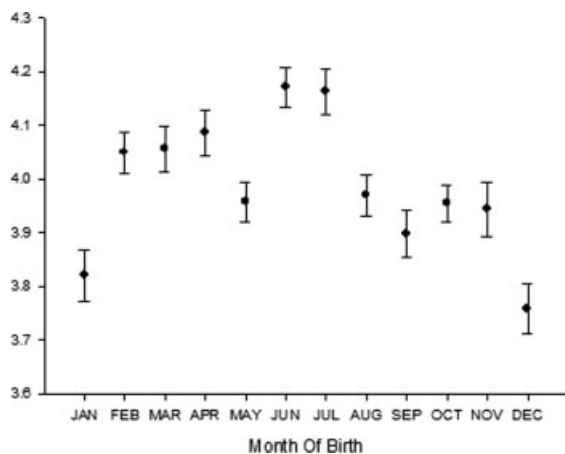


Fig. 5. Offspring count (mean  $\pm$  SE) per month of birth for post-reproductive Vietnamese women (i.e., women aged 47 and 49 years who had not given birth during the previous 3 years).

born in December a minimum average offspring count (Tables A2–A4). In addition, the Vietnam War from 1964 to 1975 did not exert any obvious effect on either average offspring count per year or on the association between birth month and mean offspring count (see Table A1).

Inaccurate reporting of birth months, which may reflect illiteracy, is an unlikely cause of the association between birth month and offspring count among Vietnamese women: among uneducated women ( $n = 29,795$ ), the Lomb-Scargle periodogram only shows a significant 12-month peak if the time series is smoothed ( $P = 0.0037$ ); in addition, maximum average offspring count is found in women born in July, but minimum count in those born in May (Table A5). We attribute the lack of a corresponding birth month effect mainly to low sample size (only  $\sim 90$  individuals per birth month). In women with primary education ( $n = 289,957$ ), on the other hand, the 12-month period is again highly significant ( $P < 0.00001$ ): women born in July again have maximum and

those born in December minimum counts (Table A6). In women with at least secondary education ( $n = 169,807$ ), the birth month effect on reproductive output is less clear: the Lomb-Scargle periodogram shows only nonsignificant peaks at 4 and 12 months, and minimum counts are found in women born in December, maximum values in those born in February (Table A7). Similarly, women with higher nonelementary occupations ( $n = 53,060$ ) show only a nonsignificant birth month effect: the periodogram has two nonsignificant peaks at 4 and 12 months, with maximum values for women born in February, minimum values for those born in November (Table A10). In women occupied in elementary ( $n = 227,669$ ) and lower nonelementary occupations ( $n = 109,065$ ), on the other hand, the 12-month period in the Lomb-Scargle periodogram is again highly significant ( $P < 0.00001$ ; a minor peak at 4 months vanished in the smoothed time series). Moreover, minimum average offspring count is found in women born in December, the maximum in those born in July (elementary occupations) or February (lower nonelementary occupation) (Tables A8 and A9).

In women born after 1965, the probability to remain childless also corresponded with the month of birth, i.e. highest percentage of childless individuals in months with least average offspring and vice versa. In women born between 1950 and 1965, however, this association showed no clear pattern (see Table A11). This indicates that women born in months represented by high average offspring count start giving birth at a younger age than those born in months with lower count. Apart from that, the month of birth did not appear to affect the probability of remaining childless.

## DISCUSSION

We find that the month of birth is strongly associated with reproductive performance of Vietnamese women born from 1950–1977. Although the amplitude decreases with decreasing age (see Fig. 1), the phases remain surprisingly stable within the investigated age range from 22 to 49 years, as evidenced by the highly significant 12-month period obtained in the Lomb-Scargle periodogram.

This association remained essentially unchanged when possible confounders such as reproductive age, the climatic variation between northern and southern Vietnam, or the Vietnam War were taken into account.

Education and occupation, on the other hand, did affect the association between birth month and offspring count: an association was present only in women with primary education or those occupied in elementary and lower nonelementary occupations. In uneducated and highly educated women, as well as those occupied in higher nonelementary occupations, the association was less clear. The weaker birth month effect in women with at least secondary education or with higher nonelementary occupations may reflect lower exposure to adverse environmental conditions as such exposure is presumably less pronounced in women of higher socio-economic status (i.e. higher education and high-level occupations). Likewise, in New Zealand, the significant association between birth month and offspring count in women from low-income families vanished in those of higher income categories (Huber et al. 2008). The lack of significance in the higher nonelementary category, however, may also reflect low sample size, as is the case with uneducated women.

Effects of the season of birth on the reproductive performance of women have been reported in premodern (Lummaa and Tremblay, 2003; Smits et al., 1997) as well as modern Western societies (Huber et al., 2004a,b, 2008). To our knowledge, such potential correlations have not been investigated in developing economies yet, although effects of birth season on parameters such as immune competence and survivability have been demonstrated (2001; Kynast-Wolf, 2006; Moore et al., 1997). Moore et al. (2001), for instance, showed a strong association between birth during or shortly after the annual rainy season and mortality risk from infectious diseases among young adults in rural Gambia. The authors suggest that factors like inadequate food and seasonal infections during the pre- and early postnatal period may have long-term consequences for the immune system. Accordingly, the effects found in these countries probably involve the seasonality of nutrition, energy budget, and infections caused by the alternation between the rainy and dry seasons: the former is typically associated with a depletion of food stocks together with a high energy expenditure for an intensive agricultural workload (Kinabo, 1993; Lawrence et al., 1987; Panter-Brick, 1993; Sear et al., 2004). This is compounded by an increased risk of malaria infection and diarrheal disease (Bates et al., 1991; Dicko et al., 2003; Kinabo, 1993).

Malaria impacts reproductive function via a negative effect on the blood supply to pregnant women and their fetuses (Kinabo, 1993), increased abortion and stillbirth rates in women, as well as reduced sperm counts in men (Sear et al., 2003). Inadequate food intake, which delays menarche, prolongs lactational amenorrhea and suppresses ovulation frequency, are also factors (Bronson, 1995; Ellison et al. 1993; Panter-Brick et al. 1993). Moreover, maternal undernutrition during pregnancy can reduce ovulation rates in adult female offspring, pointing to the potential of carry-over effects of malnutrition in utero on later reproductive function (Ibanez et al., 2002). Jasienska et al. (2005) also reported a positive association between the ponderal index of women at birth and estradiol levels measured during adulthood. The authors (Jasienska et al. 2006) further showed that differences in nutritional status at birth are associated with the sensitivity to adult ovarian function.

Parameters frequently hypothesized as causative agents of the birth season effects on reproductive performance in Western populations with temperate climates, such as photoperiod or temperature, are less likely involved in a tropical country like Vietnam owing to their flat seasonal fluctuation. An effect of temperature, however, cannot be excluded because monthly averages of daily minimum temperatures and conception rates are significantly negatively correlated in Saigon (Roenneberg and Aschoff, 1990).

The main periodic signal of the birth month effect in the present study follows a sinusoidal curve with a maximum in July and a minimum in January (higher average reproductive output after birth during the rainy season, lower values if the third month of pregnancy concurred with the rainy season). If the rainy season adversely affects early developmental processes due to inadequate nutrition and/or an increased infection risk, then the found pattern indicates a critical period of reproductive development during early pregnancy, particularly during the third month of pregnancy. This would be supported by certain characteristics of ovarian development in the human fetus. A critical period is during early pregnancy because the maximum number of germ cells and peak levels of fetal gonadotropins are already present at mid gestation and decline thereafter (Ammini et al., 1994; McGee and Hsueh, 2000; Smitz and Cortvindt, 2002).

In conclusion, our finding strongly supports the assumption that environmental and maternal conditions during early development are decisive for later reproductive functioning. Determining the periods of early reproductive development that are particularly sensitive to environmental and maternal effects could ultimately help to understand early causes of reproductive disorders.

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## APPENDICES

APPENDIX A1. Mean offspring count per birth month, mean offspring count per birth year, and difference between maximum and minimum mean offspring count per birth month of all women in our sample (n = 493,853) born between January 1950 and December 1977 (light grey boxes represent months with minimum, dark grey boxes months with maximum mean offspring count per year)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean	Max-Min
1950	3.5839	3.8450	3.7020	3.8571	3.6629	4.0146	3.9406	3.6798	3.6601	3.7278	3.7697	3.6000	3.7536	0.43
1951	3.7300	3.8882	3.7592	3.8441	3.8314	3.8502	4.0111	3.8807	3.7188	3.8876	3.8447	3.6609	3.8256	0.35
1952	3.4320	3.7945	3.7904	3.7208	3.6710	3.8019	3.7896	3.6645	3.6736	3.6812	3.5524	3.3236	3.6580	0.48
1953	3.4437	3.5864	3.7348	3.6984	3.6265	3.7285	3.7707	3.6585	3.5724	3.5354	3.4863	3.4060	3.6040	0.36
1954	3.3748	3.6313	3.6422	3.6065	3.5888	3.5777	3.5890	3.5412	3.6133	3.3770	3.4267	3.3591	3.5273	0.28
1955	3.3950	3.4223	3.3866	3.4201	3.4045	3.5214	3.5399	3.4057	3.2800	3.3193	3.3687	3.2229	3.3905	0.32
1956	3.1064	3.4251	3.3529	3.3406	3.2647	3.3583	3.4386	3.3031	3.3046	3.2319	3.2703	3.1605	3.2964	0.33
1957	3.1635	3.1836	3.2297	3.2906	3.1509	3.2347	3.1841	3.1679	3.1643	3.1814	3.1010	3.1187	3.1809	0.19
1958	2.8719	3.0576	3.0965	3.1238	2.9849	3.1860	3.2073	3.0342	2.9564	3.0420	3.0695	2.8574	3.0406	0.35
1959	2.8618	3.0276	3.0267	3.0526	2.8563	2.9534	2.9614	2.9923	2.9220	2.9322	2.8299	2.7210	2.9281	0.33
1960	2.7032	2.8164	2.9015	2.8924	2.8177	2.9184	2.9138	2.7616	2.7593	2.8051	2.8235	2.7567	2.8225	0.22
1961	2.5533	2.7516	2.7876	2.7802	2.7419	2.7954	2.8080	2.6419	2.6048	2.6541	2.5851	2.6569	2.6967	0.25
1962	2.5372	2.6604	2.7037	2.6437	2.6420	2.6779	2.6416	2.6366	2.5685	2.5868	2.6156	2.5558	2.6225	0.17
1963	2.5179	2.5463	2.5181	2.6342	2.5538	2.5823	2.5594	2.4828	2.5094	2.5081	2.3946	2.3746	2.5151	0.26
1964	2.2987	2.4601	2.3828	2.4400	2.3997	2.4461	2.4612	2.3707	2.4147	2.3967	2.3601	2.3580	2.3991	0.16
1965	2.1828	2.2598	2.2503	2.2866	2.3063	2.2977	2.3272	2.3134	2.2360	2.2900	2.1953	2.1702	2.2596	0.16
1966	2.0195	2.1260	2.1932	2.1821	2.1815	2.1862	2.2377	2.1718	2.1140	2.1738	2.0881	2.0186	2.1410	0.22
1967	1.8996	2.1046	2.0719	1.9890	2.0721	2.0159	2.0479	2.0126	1.9902	2.0011	1.8902	1.8682	1.9969	0.24
1968	1.8120	1.8913	1.9535	1.9186	1.9288	1.9548	1.8899	1.9006	1.8452	1.8864	1.8332	1.8297	1.8870	0.14
1969	1.6244	1.7782	1.7365	1.7630	1.7937	1.7816	1.7816	1.7316	1.7563	1.7381	1.6446	1.6512	1.7317	0.17
1970	1.5227	1.6259	1.5586	1.6165	1.5614	1.6064	1.5666	1.5830	1.5117	1.5313	1.4493	1.4465	1.5483	0.18
1971	1.3813	1.4303	1.3996	1.4753	1.4810	1.4597	1.4204	1.4004	1.3601	1.4140	1.3352	1.3695	1.4106	0.15
1972	1.1982	1.2597	1.2409	1.2736	1.3044	1.3408	1.2571	1.2938	1.1903	1.2573	1.1588	1.1918	1.2472	0.18
1973	1.0592	1.1007	1.0909	1.1158	1.1810	1.1443	1.0836	1.0680	1.0401	1.0778	0.9874	1.0563	1.0838	0.19
1974	0.8527	0.9787	0.8906	0.9397	0.9835	0.9688	0.8957	0.8998	0.9018	0.9170	0.8251	0.8553	0.9091	0.16
1975	0.6880	0.7832	0.7644	0.7775	0.8073	0.8455	0.7950	0.7718	0.7527	0.7377	0.6649	0.6929	0.7567	0.18
1976	0.6133	0.6237	0.5998	0.6199	0.6330	0.6298	0.5915	0.6157	0.5487	0.5767	0.5129	0.4838	0.5874	0.15
1977	0.3857	0.4392	0.4289	0.4261	0.4554	0.4735	0.4170	0.4427	0.3677	0.4118	0.3365	0.3652	0.4125	0.14
Mean	2.2433	2.3749	2.3641	2.3832	2.3531	2.4054	2.3974	2.3367	2.2978	2.3171	2.2650	2.2190	2.3297	0.24

APPENDIX A2. Mean offspring count and difference between maximum and minimum mean offspring count per month of birth of all women born in northern Vietnam (n = 196,752) between January 1950 and December 1977 (light grey boxes represent months with minimum, dark grey boxes months with maximum mean offspring count per year)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Max-Min
1950	3.3488	3.2977	3.2098	3.3764	3.4128	3.4990	3.3151	3.2665	3.3392	3.2176	3.5200	3.1629	0.36
1951	3.4336	3.2949	3.4423	3.2917	3.4715	3.5420	3.5078	3.4336	3.5720	3.4229	3.3688	3.3385	0.28
1952	3.2070	3.4760	3.3130	3.2280	3.3197	3.4244	3.5027	3.3988	3.2806	3.3531	3.1889	3.0059	0.50
1953	3.2000	3.1127	3.1765	3.3815	3.2522	3.3129	3.3295	3.2912	3.3429	3.2684	3.1772	3.0171	0.36
1954	3.0533	3.1706	3.2264	3.1718	3.1448	3.3233	3.2597	3.2168	3.2823	3.1182	3.2803	3.0367	0.29
1955	3.0709	3.0420	2.9541	3.0386	3.0987	3.1276	3.1578	3.1000	2.9239	3.0912	3.0502	2.9096	0.25
1956	2.9322	3.1159	2.9713	3.0380	3.0187	2.9865	3.1083	3.1035	3.0587	3.0077	3.1408	3.0360	0.21
1957	2.9697	2.9156	2.9222	2.9653	2.8732	2.9946	2.8326	2.8976	2.8927	2.8099	2.8209	2.8349	0.18
1958	2.7289	2.7014	2.8651	2.8551	2.8188	2.8974	2.8887	2.7828	2.8448	2.6995	2.9788	2.6705	0.31
1959	2.6168	2.7225	2.7655	2.7237	2.6819	2.6654	2.8399	2.7594	2.7669	2.6601	2.8221	2.6779	0.22
1960	2.5308	2.5854	2.6747	2.6970	2.5630	2.6368	2.7071	2.6207	2.5831	2.6207	2.6506	2.5946	0.18
1961	2.4159	2.6282	2.6053	2.5839	2.5994	2.5644	2.6916	2.5554	2.5609	2.5584	2.5160	2.6532	0.28
1962	2.4685	2.4851	2.5377	2.4977	2.4385	2.5182	2.6652	2.5544	2.4648	2.4227	2.4948	2.4283	0.24
1963	2.4109	2.4323	2.3878	2.5790	2.4642	2.4903	2.4486	2.4047	2.5075	2.3721	2.3481	2.3224	0.26
1964	2.2331	2.3807	2.3434	2.3787	2.3333	2.3865	2.4558	2.4291	2.3752	2.3509	2.2936	2.3733	0.22
1965	2.2314	2.2154	2.2513	2.2419	2.1940	2.2382	2.3966	2.3234	2.2295	2.3090	2.1652	2.1796	0.23
1966	2.0239	2.1495	2.2802	2.1312	2.2003	2.1194	2.2276	2.2040	2.1437	2.1077	2.1579	2.0919	0.26
1967	2.0594	2.1350	2.1054	2.0563	2.1302	2.0064	2.1033	2.0251	2.1212	2.0433	1.9737	1.9621	0.17
1968	1.8617	2.0207	2.0229	1.9926	1.9185	1.9410	1.9477	1.9484	1.9020	1.8646	1.8544	1.8750	0.17
1969	1.7725	1.8952	1.8135	1.8330	1.8387	1.8395	1.8758	1.7649	1.7997	1.8181	1.7561	1.7309	0.16
1970	1.6547	1.6308	1.6971	1.7061	1.6699	1.7125	1.6616	1.6413	1.6365	1.6104	1.5495	1.5112	0.20
1971	1.4955	1.5539	1.4617	1.6063	1.5765	1.5336	1.5399	1.4648	1.4748	1.4994	1.4784	1.4304	0.18
1972	1.3543	1.3713	1.3421	1.4373	1.3901	1.4516	1.3746	1.4059	1.3924	1.3741	1.2578	1.2761	0.19
1973	1.1788	1.2596	1.2081	1.3192	1.2620	1.3007	1.2334	1.1877	1.1972	1.1753	1.0896	1.1005	0.23
1974	0.9829	1.1311	0.9902	1.0922	1.1103	1.1022	1.0071	1.0532	1.0276	1.0044	0.9049	0.9762	0.23
1975	0.8374	0.9122	0.8800	0.8932	0.9319	1.0122	0.8490	0.8726	0.8742	0.8228	0.7816	0.8306	0.15
1976	0.7053	0.6901	0.7013	0.7105	0.7033	0.7305	0.6877	0.7139	0.6776	0.6549	0.5537	0.5895	0.18
1977	0.4513	0.5176	0.5317	0.4709	0.5413	0.5688	0.4809	0.5539	0.4819	0.5125	0.3828	0.4253	0.19
Mean	2.1868	2.2444	2.2386	2.2606	2.2485	2.2804	2.2891	2.2491	2.2412	2.2061	2.1984	2.1443	0.24

APPENDIX A3. Mean offspring count and difference between maximum and minimum mean offspring count per month of birth of all women born in central Vietnam (n = 115,266) between January 1950 and December 1977 (light grey boxes represent months with minimum, dark grey boxes months with maximum mean offspring count per year)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Max-Min
1950	3.7861	4.1538	3.8727	4.1293	3.6943	4.2979	4.2397	3.8813	3.9441	4.0716	3.8053	3.8535	0.60
1951	4.1176	4.1656	4.0500	3.9304	4.0642	3.7688	4.4118	4.3732	3.8364	4.1039	4.0595	4.0082	0.64
1952	3.5974	4.1729	4.1105	4.0372	3.8427	4.1856	4.0882	4.0354	3.8125	3.8432	3.9206	3.6548	0.59
1953	3.4141	3.6938	4.2736	3.8957	3.6228	4.1197	4.0400	4.1005	3.8976	3.6770	3.8810	3.6519	0.86
1954	3.4020	3.9820	3.8978	3.9391	4.0168	3.9252	3.6981	3.9964	3.9227	3.6068	3.7718	3.6333	0.61
1955	3.6395	3.9416	3.7789	3.6875	3.7714	3.9389	3.8956	3.8750	3.6716	3.4290	3.9013	3.6863	0.51
1956	3.4974	3.6952	3.6709	3.7567	3.5488	3.7410	3.7993	3.5616	3.7900	3.5530	3.3743	3.2791	0.52
1957	3.4809	3.5017	3.5348	3.7177	3.5888	3.4946	3.6440	3.6730	3.5468	3.5832	3.3379	3.4748	0.38
1958	3.1667	3.4857	3.3710	3.5419	3.2420	3.5691	3.7461	3.4062	3.1646	3.3745	3.3227	3.2022	0.58
1959	3.1581	3.4108	3.3669	3.5017	3.1355	3.4331	3.4223	3.3689	3.2371	3.2773	3.0663	2.8582	0.64
1960	2.9965	3.1098	3.2479	3.2788	3.0653	3.2841	3.3722	3.0306	2.9746	2.9984	3.3460	3.0403	0.40
1961	2.9029	3.1805	3.0199	3.0302	3.0515	3.1063	3.1694	2.8901	2.9535	2.9119	2.9385	2.9124	0.29
1962	3.0390	3.1203	3.0151	2.9916	3.0852	2.9486	2.9527	2.9857	2.9007	2.8905	3.0734	2.8713	0.25
1963	2.8359	2.8682	2.8662	3.0025	2.9095	2.9913	2.8997	2.7546	2.8462	2.8925	2.7668	2.7252	0.28
1964	2.4912	2.7733	2.7757	2.7981	2.7179	2.8402	2.7726	2.6010	2.6667	2.5866	2.7464	2.4737	0.37
1965	2.3166	2.5260	2.4169	2.5780	2.6089	2.6955	2.6822	2.6095	2.6818	2.5337	2.5983	2.5321	0.38
1966	2.3840	2.3889	2.4601	2.4380	2.4286	2.5052	2.7307	2.5580	2.4400	2.4603	2.4641	2.2599	0.47
1967	2.1542	2.3094	2.3467	2.1744	2.3016	2.3106	2.3120	2.3120	2.1473	2.2587	2.1120	2.0201	0.33
1968	2.0000	2.1029	2.1449	2.1079	2.1348	2.2274	2.1717	2.1410	2.0884	2.0613	2.1727	2.0387	0.23
1969	1.7300	1.9391	1.9036	2.0123	2.0628	1.9561	1.9880	1.9930	1.9848	1.9088	1.8000	1.7093	0.35
1970	1.6130	1.9089	1.6842	1.8377	1.6626	1.7954	1.7948	1.7418	1.6590	1.7069	1.6643	1.5735	0.34
1971	1.4671	1.5110	1.5852	1.5526	1.5625	1.5779	1.5752	1.5792	1.4647	1.5226	1.4621	1.5940	0.13
1972	1.1930	1.3320	1.3641	1.3913	1.4183	1.4389	1.4323	1.3540	1.2244	1.3528	1.3452	1.2441	0.25
1973	1.1245	1.1501	1.1333	1.2345	1.2638	1.2412	1.1863	1.1612	1.0173	1.1250	0.9530	1.1746	0.31
1974	0.9013	0.9373	0.9288	0.9882	1.0486	1.0208	0.8969	0.8485	0.9820	0.9421	0.9129	0.8436	0.21
1975	0.6433	0.7778	0.8421	0.7789	0.8307	0.8852	0.8222	0.7294	0.7545	0.7645	0.6456	0.6376	0.25
1976	0.6013	0.6425	0.5521	0.6267	0.6164	0.6316	0.5850	0.6109	0.4910	0.5817	0.5061	0.4778	0.16
1977	0.3746	0.4050	0.3995	0.4239	0.4460	0.4444	0.3996	0.3532	0.3083	0.3666	0.2605	0.3058	0.19
Mean	2.4296	2.6138	2.5933	2.6208	2.5622	2.6562	2.6689	2.5902	2.5146	2.5137	2.5074	2.4192	0.40

APPENDIX A4. Mean offspring count and difference between maximum and minimum mean offspring count per month of birth of all women born in southern Vietnam (n = 181,835) between January 1950 and December 1977 (light grey boxes represent months with minimum, dark grey boxes months with maximum mean offspring count per year)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Max-Min
1950	3.7679	4.3943	4.1368	4.1713	4.0341	4.4321	4.3446	4.1755	3.9046	4.1751	4.0191	4.1244	0.66
1951	3.8257	4.3149	3.8730	4.1895	4.1152	4.1404	4.2431	4.1372	3.8161	4.2589	4.1657	3.7624	0.55
1952	3.6054	3.9206	4.0803	3.9928	4.0824	3.9827	3.8789	3.8214	4.0382	4.0095	3.6943	3.5301	0.55
1953	3.6761	3.9890	3.9402	3.8599	4.0981	3.9365	4.0170	3.8449	3.6113	3.7321	3.5919	3.7455	0.51
1954	3.7490	3.8511	3.8668	3.8232	3.8300	3.6534	3.8631	3.7110	3.7758	3.5109	3.3562	3.5368	0.51
1955	3.6096	3.5375	3.5399	3.6456	3.5386	3.7150	3.7133	3.5663	3.4429	3.5038	3.3519	3.3140	0.40
1956	3.0712	3.6166	3.5340	3.3602	3.3874	3.5482	3.5532	3.4081	3.3026	3.2704	3.3322	3.2327	0.55
1957	3.2055	3.3072	3.3722	3.3641	3.2982	3.3563	3.3487	3.2796	3.2649	3.3387	3.2574	3.1869	0.19
1958	2.8993	3.2511	3.1741	3.1585	3.0613	3.2828	3.2585	3.1588	2.9870	3.2128	3.0220	2.8661	0.42
1959	3.0137	3.1960	3.0945	3.1142	2.9004	3.0166	2.8055	3.0979	2.9223	3.0445	2.6930	2.6860	0.51
1960	2.7541	2.9429	2.9477	2.8716	3.0043	3.0851	2.9020	2.8243	2.8583	2.8948	2.7244	2.7525	0.36
1961	2.5135	2.6473	2.8538	2.8168	2.7573	2.8546	2.7495	2.6102	2.4568	2.5918	2.4826	2.5016	0.40
1962	2.3442	2.5499	2.6936	2.5968	2.6202	2.7066	2.4541	2.5398	2.4965	2.5994	2.5053	2.5179	0.36
1963	2.4086	2.4498	2.4200	2.4692	2.4155	2.4252	2.4744	2.4191	2.2967	2.3694	2.2126	2.2071	0.27
1964	2.2178	2.3395	2.1840	2.2648	2.2646	2.2507	2.2734	2.1531	2.2998	2.3073	2.1831	2.2537	0.19
1965	2.0533	2.1424	2.1611	2.1574	2.2270	2.1096	2.0693	2.1079	2.0019	2.1008	2.0072	1.9375	0.29
1966	1.7674	1.9468	1.9754	2.0782	2.0212	2.0325	2.0148	1.9371	1.9123	2.0341	1.8020	1.7937	0.31
1967	1.6266	1.9290	1.9118	1.8428	1.8562	1.8711	1.8354	1.8174	1.7688	1.7757	1.6732	1.6808	0.30
1968	1.6322	1.6561	1.7948	1.7525	1.7922	1.7964	1.6771	1.6797	1.6627	1.7644	1.6095	1.6589	0.19
1969	1.3965	1.5513	1.5580	1.5678	1.5674	1.6175	1.6029	1.5308	1.5687	1.5349	1.4488	1.5188	0.22
1970	1.3111	1.4446	1.3706	1.4260	1.3953	1.4189	1.3491	1.4218	1.3135	1.3269	1.2448	1.2984	0.20
1971	1.1856	1.2373	1.2392	1.3165	1.2968	1.3107	1.1933	1.1747	1.2214	1.0964	1.1678	1.1678	0.22
1972	1.0473	1.1034	1.0786	1.1475	1.1475	1.1827	1.0531	1.1386	0.9944	1.0719	0.9476	1.0618	0.24
1973	0.8807	0.9188	0.9498	0.8848	1.0384	0.9294	0.8721	0.8549	0.8610	0.9233	0.8935	0.9060	0.18
1974	0.6692	0.8311	0.7676	0.7556	0.7588	0.7995	0.7682	0.7228	0.7017	0.7929	0.6749	0.7143	0.16
1975	0.5615	0.6486	0.6121	0.6892	0.6545	0.7270	0.7203	0.6708	0.6157	0.6362	0.5270	0.5694	0.20
1976	0.5192	0.5389	0.5385	0.5387	0.5606	0.5247	0.4957	0.4864	0.4462	0.4932	0.4738	0.3660	0.19
1977	0.3261	0.3854	0.3608	0.3922	0.3753	0.4016	0.3633	0.3699	0.3011	0.3430	0.3327	0.3395	0.10
Mean	2.2014	2.3801	2.3582	2.3635	2.3607	2.3967	2.3533	2.3099	2.2427	2.3156	2.1901	2.1868	0.33

APPENDIX A5. Mean offspring count and difference between maximum and minimum mean offspring count per month of birth of all uneducated women in our sample (n = 29,795) born between January 1950 and December 1977 (light grey boxes represent months with minimum, dark grey boxes months with maximum mean offspring count per year)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Max-Min
1950	4.8070	4.8333	4.8400	5.1042	4.1613	4.7869	5.3818	4.7083	5.1014	4.9703	4.4222	5.8000	1.64
1951	4.9750	4.8500	4.9508	4.5915	4.7500	5.1053	4.7949	5.0822	4.9362	4.8169	5.0000	5.1282	0.54
1952	4.8000	4.7349	5.0238	4.3820	4.7444	5.0847	5.6173	4.5634	4.7049	4.9457	5.0000	4.7885	1.24
1953	4.3714	4.8158	5.0959	4.8690	4.2468	4.7738	5.1942	4.7612	5.0189	4.1111	5.6829	5.1282	1.07
1954	5.0612	4.7451	5.0638	4.6289	4.6867	4.6103	4.8974	5.1111	4.8904	4.6465	4.8857	5.1333	0.52
1955	4.9767	4.3976	4.5349	4.8205	4.5275	4.7049	5.0090	4.6986	4.6719	4.4557	4.5532	4.5849	0.61
1956	4.2727	4.5862	4.6923	4.6771	4.4688	4.6842	4.9808	4.9167	4.7167	4.2750	4.8824	4.5517	0.71
1957	4.4103	4.1370	4.2593	4.7103	4.5862	4.3643	4.8989	4.5333	5.0465	4.0263	4.5926	5.1556	1.13
1958	4.0976	4.6029	4.5176	4.2283	4.6703	4.7594	5.1176	4.6750	4.9474	4.5306	4.4615	4.3125	1.02
1959	3.9048	4.0278	4.5484	4.3980	4.0337	3.9524	4.2778	4.9293	4.4938	3.8704	4.7805	3.8511	1.08
1960	4.2667	3.6598	4.1405	4.3667	4.0385	4.1301	4.3500	3.6986	3.8806	4.2545	4.0566	4.3333	0.71
1961	3.3830	4.3562	4.0723	4.6714	3.5190	4.0759	4.4118	3.7612	3.8305	4.0000	4.3947	4.2564	1.29
1962	3.4800	3.4742	3.9381	3.9479	4.0000	3.8235	4.3299	3.8085	3.6944	3.9205	4.7209	4.6579	1.25
1963	3.9130	3.2125	3.6593	4.0440	3.3939	3.5818	3.6222	3.6364	4.0641	3.4314	3.5385	3.9444	0.85
1964	3.1163	3.2689	3.5368	3.5508	3.2424	3.4336	3.4651	3.6190	3.5529	3.7292	3.5745	3.6538	0.61
1965	2.9412	3.2500	3.3647	3.3625	3.0366	3.1441	3.3546	3.6518	3.5467	3.4946	3.3889	3.0811	0.71
1966	3.1136	3.0435	3.4211	3.3297	3.1339	3.3304	3.2364	3.4255	3.3067	3.1100	3.4694	3.1020	0.43
1967	3.3636	3.3205	3.3491	2.5743	3.4425	3.2178	2.8085	2.8404	2.9565	3.2674	3.1538	2.9038	0.87
1968	2.7797	2.7732	2.7672	2.6923	3.0169	2.8406	2.7669	2.7805	2.7097	2.8462	2.3582	2.5000	0.66
1969	2.7302	2.7619	2.4579	2.5049	2.6761	2.6441	2.5195	2.5093	2.3451	2.5339	2.2037	2.6774	0.56
1970	2.6667	2.3762	2.3083	2.6694	2.1194	2.2267	2.3015	2.5372	2.5043	2.0642	2.2576	2.6176	0.61
1971	2.0500	2.3444	2.0404	2.2747	2.0413	2.3415	2.1158	1.9143	2.0263	2.1702	2.5098	2.1020	0.48
1972	1.7971	1.9839	1.6984	1.8984	2.1308	1.9521	1.8761	2.2578	1.8261	2.0000	2.0484	2.2250	0.56
1973	1.6230	1.6486	1.8103	1.8182	1.8571	1.8303	1.8298	1.6824	1.9429	1.5932	1.6984	1.7976	0.35
1974	1.4681	1.6190	1.5049	1.5929	1.6429	1.4895	1.5088	1.6796	1.7111	1.6186	1.3061	1.4048	0.40
1975	1.2958	1.3113	1.2435	1.3566	1.3784	1.3669	1.3333	1.3481	1.3451	1.2583	1.3377	1.5735	0.33
1976	1.1250	1.1729	1.1563	1.1842	1.2689	1.0270	1.1545	1.2000	1.1446	1.2847	1.2568	0.8548	0.43
1977	1.1600	1.0100	1.0085	0.8300	0.9185	1.0719	0.9741	0.8333	0.9904	0.9706	0.8358	0.6500	0.51
Mean	3.2839	3.2971	3.3930	3.3957	3.2762	3.3698	3.5046	3.3987	3.4252	3.2927	3.4418	3.4561	0.76

APPENDIX A6. Mean offspring count and difference between maximum and minimum mean offspring count per month of birth of all women with primary education in our sample (n = 289,957) born between January 1950 and December 1977 (light grey boxes represent months with minimum, dark grey boxes months with maximum mean offspring count per year)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Max-Min
1950	3.7395	4.0160	3.7779	4.0150	3.8820	4.1900	4.0954	3.9288	3.8665	3.9690	3.9678	3.8341	0.45
1951	3.9673	4.1193	3.9720	4.1004	4.0586	3.9896	4.2434	4.0776	4.1905	4.1919	4.1037	4.0619	0.28
1952	3.6698	3.9728	4.0103	4.0181	3.8629	3.9823	3.9110	3.8682	3.9704	3.8622	3.7520	3.5441	0.47
1953	3.7500	3.7457	4.0049	3.9515	3.8948	3.9447	3.9531	3.8821	3.8277	3.8069	3.7582	3.7375	0.27
1954	3.6266	3.8376	3.8772	3.8296	3.7758	3.8032	3.7290	3.7785	3.8131	3.5702	3.7136	3.6988	0.30
1955	3.6048	3.6292	3.6034	3.5733	3.6577	3.7107	3.7434	3.5759	3.4023	3.5837	3.6198	3.4991	0.34
1956	3.3624	3.6503	3.6027	3.5282	3.5027	3.5732	3.6273	3.6015	3.5892	3.4741	3.5256	3.4039	0.28
1957	3.5065	3.4187	3.5333	3.4460	3.3088	3.4018	3.4393	3.3433	3.3833	3.4461	3.3837	3.4252	0.22
1958	3.2025	3.2376	3.3115	3.3908	3.2009	3.3397	3.3396	3.2954	3.1883	3.2908	3.3732	3.0984	0.29
1959	3.2142	3.3142	3.2115	3.2928	3.1035	3.2227	3.1915	3.2209	3.1685	3.1779	3.1531	3.1059	0.21
1960	2.8905	3.0051	3.1143	3.0646	3.0403	3.1241	3.1019	2.9704	3.0077	3.0147	3.1562	3.0376	0.27
1961	2.8794	2.9545	2.9582	2.9628	2.9577	3.0126	2.9711	2.8982	2.8069	2.8857	2.8638	2.9464	0.21
1962	2.8310	2.8911	2.9471	2.8070	2.8127	2.8620	2.7980	2.8483	2.8453	2.8164	2.8292	2.8024	0.15
1963	2.7853	2.7314	2.6858	2.8203	2.7218	2.7523	2.7369	2.6897	2.7039	2.7492	2.7007	2.6667	0.15
1964	2.5472	2.6698	2.5789	2.6467	2.5891	2.6221	2.6390	2.5564	2.6188	2.6049	2.6402	2.6200	0.12
1965	2.3954	2.4568	2.4342	2.4985	2.5412	2.4944	2.4287	2.4299	2.4556	2.5128	2.3893	2.4332	0.15
1966	2.2076	2.2653	2.3301	2.3426	2.3303	2.3594	2.3819	2.3940	2.3663	2.2610	2.2487	2.2752	0.19
1967	2.1752	2.2167	2.1730	2.1541	2.2028	2.1533	2.2472	2.2043	2.2291	2.2018	2.0863	2.0459	0.18
1968	2.0394	2.0779	2.0737	2.0797	2.1092	2.1483	2.0056	2.1056	2.0269	2.0759	1.9856	2.0878	0.16
1969	1.8583	1.9416	1.9246	1.9357	1.9562	1.9276	1.9270	1.8480	1.9624	1.8870	1.9208	1.8271	0.14
1970	1.7357	1.7837	1.7131	1.7692	1.7437	1.7382	1.7274	1.7337	1.6892	1.7208	1.6525	1.6132	0.17
1971	1.5669	1.5910	1.6133	1.6512	1.6802	1.5828	1.6128	1.5940	1.5789	1.6097	1.5387	1.5989	0.14
1972	1.4195	1.4544	1.3633	1.4629	1.4310	1.4785	1.4048	1.4459	1.3800	1.4446	1.3387	1.3543	0.14
1973	1.2228	1.2512	1.2189	1.2276	1.3136	1.2702	1.2303	1.2368	1.1359	1.2561	1.1955	1.2270	0.18
1974	1.0019	1.1184	1.0343	1.0981	1.1225	1.1356	1.0087	1.0161	1.0594	1.0715	1.0018	1.0296	0.13
1975	0.8547	0.9240	0.8984	0.8907	0.9354	0.9455	0.9112	0.8815	0.8720	0.8712	0.8182	0.8193	0.13
1976	0.7627	0.7512	0.7381	0.7449	0.7436	0.7641	0.6837	0.7421	0.6760	0.7040	0.6261	0.6398	0.14
1977	0.4853	0.5414	0.4949	0.5215	0.5308	0.5536	0.5039	0.5348	0.4623	0.4932	0.4713	0.4837	0.09
Mean	2.4751	2.5560	2.5428	2.5651	2.5361	2.5744	2.5569	2.5251	2.5061	2.5235	2.4934	2.4613	0.21

APPENDIX A7. Mean offspring count and difference between maximum and minimum mean offspring count per month of birth of all women with at least secondary education in our sample (n = 169,807) born between January 1950 and December 1977 (light grey boxes represent months with minimum, dark grey boxes months with maximum mean offspring count per year)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Max-Min
1950	2.9238	2.9767	2.9840	2.6809	2.8205	3.0630	2.6919	2.7617	2.7650	2.7831	2.9690	2.6309	0.43
1951	2.8645	2.8421	2.4058	2.7047	2.7882	2.8391	2.8618	2.7821	2.3515	2.9023	2.9250	2.6185	0.57
1952	2.5484	2.8607	2.6066	2.5696	2.7878	2.7184	2.6585	2.8103	2.6338	2.8319	2.6471	2.5617	0.31
1953	2.6348	2.6745	2.6360	2.4387	2.6367	2.6111	2.5856	2.7285	2.5266	2.5986	2.4124	2.4143	0.32
1954	2.5022	2.6285	2.4610	2.6246	2.7120	2.4243	2.6431	2.5549	2.6739	2.5833	2.4972	2.5183	0.29
1955	2.6359	2.5791	2.4260	2.5563	2.3953	2.4732	2.4686	2.6028	2.6210	2.4534	2.5436	2.4234	0.24
1956	2.3794	2.4930	2.4053	2.4790	2.3554	2.4751	2.5126	2.2883	2.4057	2.3956	2.5174	2.4415	0.23
1957	2.2741	2.4006	2.3149	2.4780	2.4803	2.4038	2.2075	2.4697	2.3316	2.4569	2.2862	2.4268	0.27
1958	2.1361	2.3523	2.2816	2.3210	2.2278	2.4476	2.3819	2.3770	2.2069	2.3349	2.3206	2.3318	0.31
1959	2.2301	2.2575	2.2474	2.2530	2.1933	2.1296	2.1511	2.2044	2.2613	2.2961	2.1657	2.1171	0.18
1960	2.2055	2.3035	2.1988	2.1876	2.1282	2.2707	2.1648	2.2759	2.1578	2.2286	2.1414	2.1641	0.18
1961	2.0423	2.0458	2.1307	2.1111	2.1285	2.1736	2.1352	2.0682	2.1389	2.0949	2.0636	2.0205	0.15
1962	2.0025	2.1405	2.0162	2.0429	2.1121	2.0927	1.9619	2.1197	1.9548	2.0511	2.0563	2.0458	0.19
1963	2.0187	2.0875	2.0420	2.0000	2.1116	2.0446	1.9405	2.0123	1.9981	2.0013	1.8721	1.8674	0.24
1964	1.8934	1.9508	1.8285	1.9072	1.9337	1.8651	1.8723	1.9120	1.8949	1.9050	1.8708	1.8563	0.12
1965	1.8231	1.8038	1.7761	1.7983	1.8345	1.7551	1.8507	1.8475	1.7149	1.8229	1.7864	1.7675	0.14
1966	1.6987	1.6970	1.7194	1.6891	1.7252	1.7383	1.6990	1.8502	1.6947	1.7725	1.6955	1.6160	0.19
1967	1.4645	1.6978	1.5914	1.5871	1.5806	1.5451	1.6119	1.5722	1.4784	1.5714	1.4955	1.5474	0.23
1968	1.4697	1.4427	1.5725	1.5039	1.4743	1.4508	1.4694	1.4806	1.4430	1.4703	1.5622	1.4456	0.13
1969	1.2868	1.3852	1.3043	1.3554	1.3797	1.4061	1.3832	1.4319	1.4106	1.4214	1.3007	1.3812	0.15
1970	1.2043	1.2977	1.1907	1.2172	1.2177	1.2679	1.2410	1.2490	1.1589	1.2591	1.1421	1.1681	0.16
1971	1.1326	1.1245	1.0693	1.1616	1.1301	1.1425	1.0943	1.1130	1.0624	1.1220	1.0506	1.0874	0.11
1972	0.9346	0.9430	1.0158	0.9481	1.0085	1.0343	0.9860	0.9586	0.8877	0.9780	0.9025	0.9394	0.15
1973	0.8362	0.8214	0.8271	0.8449	0.8752	0.8195	0.7985	0.8005	0.8123	0.8373	0.7267	0.8194	0.15
1974	0.6647	0.7103	0.6321	0.6855	0.6991	0.6331	0.6365	0.6750	0.6086	0.6593	0.6163	0.6485	0.10
1975	0.4488	0.5229	0.5201	0.5190	0.5659	0.5658	0.5176	0.5175	0.4885	0.5215	0.4184	0.4795	0.15
1976	0.4167	0.3671	0.3417	0.3589	0.4071	0.3752	0.3692	0.3825	0.3358	0.3396	0.3327	0.3110	0.11
1977	0.2381	0.2544	0.2405	0.2519	0.2938	0.2702	0.2565	0.2836	0.1779	0.2496	0.1757	0.2380	0.12
Mean	1.7468	1.8093	1.7423	1.7598	1.7858	1.7870	1.7554	1.7807	1.7213	1.7836	1.7319	1.7103	0.21

APPENDIX A8. Mean offspring count and difference between maximum and minimum mean offspring count per month of birth of all women occupied in elementary occupations (see methods) in our sample (n = 227,669) born between January 1950 and December 1977 (light grey boxes represent months with minimum, dark grey boxes months with maximum mean offspring count per year)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Max-Min
1950	4.1290	4.2573	3.9517	4.3424	4.0915	4.2929	4.4502	3.8859	4.2230	4.2451	4.1215	4.3154	0.56
1951	4.3029	4.4365	4.2407	4.2230	4.2938	4.1448	4.4424	4.2644	4.2183	4.3711	4.1829	4.0485	0.39
1952	4.0573	4.1796	4.3876	4.0475	4.0798	4.3402	4.2070	4.1702	4.1714	4.1485	4.0964	3.7248	0.66
1953	3.9120	3.9525	4.1566	4.1459	4.0253	4.0541	4.1707	4.0846	4.0957	4.0133	4.1194	3.9380	0.26
1954	3.8026	3.9522	4.0619	3.9212	3.9719	3.9549	3.9607	3.8985	4.0327	3.6998	3.9659	3.8133	0.36
1955	3.9530	3.8223	3.7908	3.8381	3.8138	3.9188	4.0083	3.7678	3.7294	3.7592	3.8597	3.6832	0.33
1956	3.6154	3.8998	3.9524	3.7618	3.7300	3.7820	3.8493	3.8195	3.7313	3.5840	3.9088	3.7111	0.37
1957	3.7040	3.5732	3.6844	3.6575	3.6082	3.5829	3.6764	3.5922	3.6104	3.5876	3.6527	3.6856	0.13
1958	3.4181	3.4413	3.5164	3.6390	3.4771	3.6670	3.5977	3.4201	3.4522	3.4659	3.5516	3.4381	0.25
1959	3.3579	3.4124	3.5423	3.4405	3.2935	3.3603	3.3675	3.5000	3.4846	3.3374	3.4026	3.2525	0.29
1960	3.2047	3.2039	3.3199	3.2874	3.1766	3.3220	3.3151	3.1249	3.1629	3.1737	3.3288	3.2022	0.20
1961	2.9660	3.1301	3.1469	3.2608	3.0548	3.1547	3.2434	3.0825	2.9979	3.0874	3.1728	3.1480	0.29
1962	3.0747	2.9977	3.1066	3.0219	3.0334	3.0109	3.0210	3.0385	2.9074	2.9608	3.0826	2.9107	0.20
1963	2.9396	2.8323	2.9087	3.0066	2.8768	2.9745	2.9343	2.8390	2.9352	2.8079	2.8249	2.7691	0.24
1964	2.6674	2.7863	2.7789	2.8433	2.7629	2.8121	2.8153	2.7393	2.7689	2.7850	2.7629	2.7697	0.18
1965	2.5869	2.6192	2.5959	2.6523	2.6460	2.6179	2.6461	2.7008	2.6140	2.6450	2.5336	2.6353	0.17
1966	2.4282	2.4685	2.5304	2.5194	2.4672	2.5223	2.5586	2.5336	2.3976	2.4708	2.4989	2.4080	0.16
1967	2.3794	2.4467	2.3743	2.3507	2.4390	2.3182	2.3803	2.3275	2.3222	2.3223	2.2614	2.2397	0.21
1968	2.2243	2.2480	2.2510	2.2470	2.1926	2.2794	2.2081	2.2207	2.1605	2.1725	2.2034	2.1863	0.12
1969	2.0000	2.1148	2.0637	2.0836	2.1359	2.0482	2.1395	2.0237	2.1214	2.0611	2.0073	2.0109	0.14
1970	1.9189	1.8861	1.9214	1.9385	1.8150	1.8499	1.8946	1.9089	1.8832	1.8088	1.7240	1.8472	0.21
1971	1.6929	1.7705	1.7298	1.7668	1.7883	1.7365	1.7365	1.7083	1.6753	1.7473	1.7458	1.7495	0.11
1972	1.5821	1.5848	1.4994	1.5957	1.6118	1.6296	1.5368	1.5819	1.5356	1.6024	1.5426	1.5603	0.13
1973	1.3862	1.3893	1.3720	1.4082	1.4803	1.4271	1.3502	1.3661	1.3761	1.3946	1.3299	1.4334	0.15
1974	1.1476	1.2483	1.1576	1.2537	1.2898	1.2219	1.1459	1.1516	1.1953	1.1440	1.1723	1.1687	0.15
1975	1.0067	1.0172	1.0542	0.9954	1.0852	1.0743	1.0410	0.9947	1.0363	1.0127	0.9530	1.0056	0.13
1976	0.8648	0.8442	0.8609	0.8331	0.8664	0.8558	0.8464	0.8542	0.7794	0.8324	0.7449	0.7360	0.13
1977	0.6162	0.6386	0.6155	0.5808	0.6375	0.6459	0.6293	0.6009	0.5823	0.6015	0.5680	0.5602	0.09
Mean	2.6764	2.7198	2.7347	2.7379	2.7052	2.7357	2.7562	2.6857	2.6857	2.6729	2.6900	2.6411	0.24

APPENDIX A9. Mean offspring count and difference between maximum and minimum mean offspring count per month of birth of all women occupied in lower nonelementary occupations (see methods) in our sample (n = 109,065) born between January 1950 and December 1977 (light grey boxes represent months with minimum, dark grey boxes months with maximum mean offspring count per year)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Max-Min
1950	3.2381	3.5969	3.6000	3.3602	3.5822	3.8804	3.5988	3.6796	3.2583	3.6853	3.4519	3.4240	0.64
1951	3.2400	3.4414	3.5923	3.4275	3.6410	3.6143	3.5950	3.6733	3.5664	3.6292	3.5616	3.3905	0.43
1952	3.0880	3.3649	3.1480	3.5300	3.2441	3.3439	3.4464	3.3222	3.1316	3.3633	3.2743	3.1127	0.44
1953	3.1250	3.1684	3.2944	3.2339	3.3421	3.3333	3.4278	3.2888	3.1625	3.3425	3.1062	3.1971	0.32
1954	3.1447	3.4087	3.1778	3.2654	3.0800	3.1894	3.1423	3.3436	3.2849	3.0836	3.2168	3.2222	0.33
1955	2.9634	3.0524	2.9713	3.0630	2.9880	2.9563	3.0818	3.0830	2.7143	3.0055	2.9653	2.9212	0.37
1956	2.7241	2.9144	2.9132	2.8996	2.9604	2.9640	3.2381	2.9188	2.8317	2.9621	2.9257	2.7526	0.51
1957	2.7219	2.7404	2.8826	2.9709	2.7556	2.8590	2.7471	2.8429	2.7519	2.8029	2.8290	2.7893	0.25
1958	2.6739	2.6599	2.6987	2.6361	2.5682	2.8789	2.8834	2.8145	2.5798	2.7172	2.6583	2.5345	0.35
1959	2.6040	2.8000	2.5793	2.7266	2.4868	2.5374	2.6307	2.5385	2.6636	2.5880	2.3366	2.3614	0.46
1960	2.3566	2.6383	2.5714	2.4691	2.4830	2.4377	2.5813	2.5012	2.4365	2.4892	2.3837	2.4549	0.28
1961	2.2544	2.3954	2.4139	2.2955	2.4740	2.4751	2.4330	2.3440	2.2839	2.2742	2.3019	2.1480	0.33
1962	2.1234	2.4550	2.3758	2.2693	2.3159	2.3168	2.1729	2.2159	2.2972	2.2094	2.3306	2.2799	0.33
1963	2.2476	2.3230	2.0836	2.1715	2.1794	2.1632	2.2048	2.1073	2.0678	2.2766	2.0617	1.9316	0.39
1964	1.9569	2.0272	2.0422	2.0367	2.0291	2.0388	2.0911	1.9726	2.0390	2.0021	2.0813	2.0246	0.13
1965	1.8361	1.9164	1.8765	1.9619	1.9267	1.9423	1.9503	1.8150	1.9199	1.9512	1.8283	1.7014	0.26
1966	1.7052	1.6605	1.7352	1.8173	1.8971	1.8446	1.8050	1.7554	1.6957	1.9521	1.6245	1.7343	0.33
1967	1.6027	1.7289	1.6587	1.5392	1.5733	1.5847	1.6168	1.6246	1.5920	1.7042	1.4891	1.5435	0.24
1968	1.4397	1.4595	1.6436	1.5431	1.6422	1.6151	1.5522	1.5143	1.4706	1.5192	1.3591	1.4781	0.28
1969	1.2745	1.3234	1.2971	1.4118	1.4344	1.4472	1.3264	1.3919	1.3351	1.3845	1.2715	1.2838	0.18
1970	1.2006	1.2962	1.1050	1.2245	1.3021	1.2872	1.1648	1.1306	1.0875	1.1882	1.1027	1.0748	0.23
1971	1.0861	1.0685	1.0634	1.1237	1.0811	1.1495	1.0026	1.0554	0.9249	1.1055	0.9432	0.9797	0.22
1972	0.8113	0.8940	0.9236	0.9066	0.9256	0.9310	0.9276	0.9243	0.7847	0.8932	0.7536	0.8292	0.18
1973	0.7845	0.8177	0.7683	0.7429	0.8364	0.7426	0.7587	0.7318	0.6467	0.7261	0.6751	0.6735	0.19
1974	0.5778	0.6642	0.6588	0.6360	0.5764	0.6494	0.6384	0.6284	0.6272	0.6111	0.6175	0.6481	0.09
1975	0.4685	0.5035	0.5000	0.5605	0.5275	0.5239	0.5074	0.5126	0.4467	0.5281	0.4653	0.3864	0.17
1976	0.4281	0.4296	0.3958	0.3851	0.4244	0.4202	0.3281	0.3889	0.3716	0.3957	0.3642	0.3024	0.13
1977	0.2386	0.2568	0.2556	0.2304	0.2460	0.2691	0.2268	0.2607	0.2010	0.2259	0.2147	0.2399	0.07
Mean	1.9256	2.0359	2.0081	2.0157	2.0187	2.0498	2.0386	2.0136	1.9348	2.0220	1.9355	1.9078	0.29

APPENDIX A10. Mean offspring count and difference between maximum and minimum mean offspring count per month of birth of all women occupied in higher nonelementary (see methods) in our sample (n = 53,060) born between January 1950 and December 1977 (light grey boxes represent months with minimum, dark grey boxes months with maximum mean offspring count per year)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Max-Min
1950	2.5435	2.7480	2.5895	2.4146	2.6370	2.6387	2.4433	2.4683	2.5217	2.5928	2.7273	2.4463	0.33
1951	2.5301	2.5250	2.0161	2.3220	2.5395	2.6842	2.5493	2.3210	2.1389	2.4516	2.6327	2.4750	0.67
1952	2.2135	2.5688	2.1702	2.4118	2.3969	2.3889	2.3636	2.4857	2.5556	2.5065	2.4058	2.3509	0.40
1953	2.2111	2.3511	2.3333	2.1789	2.2846	2.3694	2.3838	2.2273	2.2375	2.4101	2.1176	2.2059	0.29
1954	1.9798	2.3363	2.2320	2.4286	2.4069	2.2680	2.2427	2.1958	2.2581	2.4023	1.9605	2.1275	0.47
1955	2.1212	2.3053	1.9550	2.2214	2.2762	2.0811	2.0822	2.2047	2.2328	2.2637	2.1444	2.0486	0.35
1956	2.1231	2.3276	2.1527	2.2292	1.9299	2.1564	2.1613	2.0930	2.1129	2.0429	2.0185	2.0850	0.40
1957	2.1226	2.0803	2.1234	2.1169	2.1667	1.9758	2.0052	2.0667	2.0382	2.1815	1.9926	2.1279	0.19
1958	1.9416	2.1364	1.9719	2.0000	1.8889	2.0000	1.9735	2.0819	2.0098	2.1651	2.0818	2.1070	0.28
1959	1.9553	1.9948	1.8589	1.9946	1.9623	1.8667	1.9538	1.9707	1.9828	2.1087	1.8951	1.9597	0.25
1960	1.9958	1.9044	1.8905	1.8667	1.9247	2.0324	1.9083	2.0110	2.0050	1.9574	1.9512	1.9331	0.17
1961	1.8534	1.8333	1.8435	1.8034	1.8483	1.9884	1.8255	1.8545	1.9200	1.8955	1.8305	1.9219	0.19
1962	1.6357	1.8811	1.8305	1.7713	1.7915	1.7933	1.7215	1.8478	1.7753	1.8110	1.7313	1.8235	0.25
1963	1.8077	1.7516	1.6848	1.6835	1.8269	1.6836	1.6647	1.7489	1.7421	1.7344	1.6144	1.7500	0.21
1964	1.5672	1.6190	1.6273	1.4976	1.5864	1.6080	1.5192	1.6825	1.6528	1.6439	1.5685	1.6258	0.18
1965	1.6076	1.5333	1.6108	1.6087	1.5860	1.4826	1.5549	1.6649	1.4970	1.6174	1.6266	1.5951	0.18
1966	1.3692	1.5161	1.5290	1.4586	1.4966	1.4585	1.3889	1.3369	1.5208	1.5345	1.6053	1.4214	0.27
1967	1.3111	1.4531	1.3333	1.3438	1.3529	1.3274	1.3245	1.3548	1.3171	1.3131	1.2481	1.3077	0.21
1968	1.1631	1.2587	1.2353	1.1386	1.2060	1.1605	1.1871	1.1085	1.2798	1.2908	1.3810	1.2249	0.27
1969	1.0604	1.2336	1.1404	1.0827	1.1622	1.2897	1.0970	1.1696	1.2079	1.1453	1.1727	1.1707	0.23
1970	1.0144	0.9667	1.0076	0.9826	0.8916	1.0298	0.9494	1.1166	0.9565	1.0214	0.8605	1.0000	0.26
1971	0.8019	0.7574	0.8169	0.9935	0.8994	0.8528	0.8655	0.8967	0.9024	0.9400	0.7222	0.7813	0.27
1972	0.6621	0.6011	0.6571	0.7616	0.7371	0.7403	0.7769	0.7196	0.7333	0.7605	0.6438	0.7095	0.18
1973	0.6275	0.5405	0.5875	0.5735	0.6012	0.5436	0.5886	0.5870	0.5833	0.5749	0.4878	0.6432	0.16
1974	0.4453	0.5677	0.4375	0.4658	0.5090	0.4074	0.4258	0.4087	0.3898	0.4631	0.3497	0.4172	0.22
1975	0.2945	0.3450	0.4162	0.2565	0.3317	0.3131	0.2941	0.3282	0.2083	0.2573	0.2628	0.3289	0.21
1976	0.1748	0.1299	0.1503	0.1825	0.1603	0.1634	0.1226	0.2051	0.1484	0.1422	0.1131	0.1250	0.09
1977	0.1800	0.1197	0.0778	0.0943	0.1154	0.0541	0.1296	0.1296	0.0818	0.1000	0.1075	0.1286	0.08
Mean	1.4755	1.5495	1.4743	1.4958	1.5184	1.5128	1.4823	1.5102	1.5004	1.5474	1.4733	1.4943	0.26

APPENDIX 11. Percent childless individuals of all women in our sample (n = 493,853) born between January 1950 and December 1977 (light grey boxes represent months with the lowest percentage, dark grey boxes months with the highest percentage of childless individuals per year)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1950	6.1	6.9	9.1	7.9	6.2	7.5	8.3	8.0	6.4	6.1	6.4	8.2
1951	9.1	5.8	7.8	7.9	7.5	7.7	7.1	6.1	9.3	6.6	5.9	7.9
1952	8.2	6.1	8.3	7.9	8.0	7.5	8.0	7.4	5.2	5.9	8.4	7.0
1953	8.7	8.3	6.6	8.3	6.7	7.1	7.0	7.5	6.5	6.7	7.3	7.6
1954	6.6	6.9	8.0	7.1	6.8	7.1	8.5	5.6	6.0	7.0	9.3	7.4
1955	6.7	6.1	8.6	7.9	7.5	6.6	7.2	7.3	8.2	7.5	6.9	7.1
1956	9.1	6.1	7.7	6.6	7.5	6.5	6.2	7.3	6.8	6.0	6.4	7.8
1957	6.8	7.0	7.2	8.4	6.6	8.1	7.1	5.8	6.4	5.6	7.3	5.0
1958	7.1	7.4	7.5	6.6	8.1	6.4	6.6	6.2	7.6	6.3	6.1	6.0
1959	6.8	6.5	7.2	7.1	6.8	7.6	7.6	6.2	6.6	6.7	7.7	7.3
1960	7.9	7.7	7.8	8.2	6.5	5.8	8.2	6.7	7.3	6.2	6.9	7.2
1961	8.1	7.4	7.6	7.5	8.8	8.4	8.4	7.1	7.7	7.4	9.2	7.5
1962	8.7	7.5	7.7	10.0	7.6	8.0	9.5	7.1	8.8	7.1	8.9	6.8
1963	7.8	8.8	8.3	7.9	8.2	8.9	9.9	8.4	7.9	8.5	8.6	9.4
1964	8.7	9.4	10.6	8.7	9.4	10.4	10.0	7.9	8.3	8.2	9.6	8.6
1965	10.7	9.1	9.8	10.2	9.0	10.8	9.7	9.1	10.2	7.3	9.5	10.3
1966	11.5	11.9	11.3	11.0	10.9	9.5	10.7	11.6	10.8	8.5	11.2	11.5
1967	15.0	10.0	11.9	13.0	11.7	12.5	11.7	11.5	11.9	12.0	12.0	12.1
1968	13.7	12.6	13.3	12.5	12.6	12.9	13.5	12.4	13.6	11.7	15.1	12.4
1969	16.5	14.8	15.5	14.1	14.6	13.4	13.7	14.2	14.0	12.8	14.8	14.6
1970	19.2	16.7	19.6	16.8	17.6	16.6	17.9	16.9	19.6	17.3	21.7	20.1
1971	22.8	20.6	21.3	19.2	18.3	20.5	20.7	20.5	21.6	18.1	23.2	22.0
1972	27.9	26.2	25.8	25.6	23.8	21.7	25.6	23.3	26.8	24.4	27.4	26.6
1973	30.4	30.2	30.7	29.2	26.8	29.0	31.1	31.1	34.1	30.1	33.9	31.4
1974	40.5	34.5	38.9	36.5	34.2	35.6	38.8	37.5	40.0	36.5	42.8	39.1
1975	49.6	44.8	46.5	44.5	42.4	39.0	43.8	44.8	46.6	46.0	50.5	49.1
1976	53.9	53.2	54.8	52.6	51.4	52.2	54.4	52.8	58.0	55.1	59.8	60.8
1977	70.1	65.0	65.5	64.6	62.9	61.5	66.3	63.6	70.3	66.3	72.5	69.8
Mean	17.8	16.3	17.3	16.7	16.0	16.0	17.1	16.2	17.4	16.0	18.2	17.5