Fertility in Finland in the 1900s

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1. Introduction

In recent years there has been much public discussion on the subject of changes in the fertility of Finnish women. After the post-war baby-boom the birth rate has steadily declined and although the large age groups are now passing their most fertile age period, we are still waiting for the birth rate to increase.

The usual and easiest way to follow changes in fertility as far as the gathering of material is concerned, is to depend on periodic material. However, in this case one has to combine material from different birth cohorts and thus even fundamental changes over time might be obscured when aggregating by age. A more natural, although more laborious way is to follow the changes that take place between birth cohorts. It has been possible to do cohort analysis in Finland after Jarl Lindgren (1975) gathered material on cohort fertility for this past century. This study mainly uses material from that analysis. The painstaking calculations have been made by Kari Törmäkangas (1976).

The greatest difficulty in cohort analysis apparently lies in using fresh observation material. For example women born in the 1940s are still of reproductive age and therefore, in anticipating the fertility of these birth cohorts, it becomes necessary to make special adjustments, which will be examined closer in section 2.2.

2. Factors in reproductive behavior

Reproductive behavior will be observed from three points of view. It is essential to know at what age women give birth on the average. To represent this the average age μ_t of women giving birth is calculated for each birth cohort t. Since it is possible to control fertilization at least partly, it can be assumed that this control also affects the way the fertile age period is being used. Information connected to this is assembled in the age variance σ_t^2 of women giving birth. However, it is most important to know how many children, on the average, the women in each cohort are giving birth to. To find this the total fertility rate R_t has to be calculated. In the following we will examine more closely the methods of calculation for these three components.

2.1. Cohorts past reproductive age

In this analysis the reproductive period has been limited to the ages between 15 and 44. Thus, in 1970 when this material was gathered, the cohorts 1905/06—1926/27 had passed their reproductive age. For these cohorts the quantities μ_t, σ_t^2 and R_t are calculated according to the moment principle from the following equations:

$$(1) \qquad \mu_t = \sum_{x=15}^{40} (x + 2.5)F_{x,t} / \sum_{x=15}^{40} F_{x,t},$$

$$(2) \qquad \sigma_t^2 = \sum_{x=15}^{40} (x + 2.5 - \mu_t)^2 F_{x,t} / \sum_{x=15}^{40} F_{x,t} \text{ ja}$$

$$(3) \qquad R_t = \sum_{x=15}^{40} F_{x,t},$$

where $F_{x,t}$ represents the fertility rate per age group for cohort t during the age period [x,x+5). Thus these calculations use five-year age groups and ignore mortality factors, on the grounds that it in this century simplifies calculations and because of the fact that changes in the mortality rate of women in the said reproductive age have not been radical enough, that they might influence the quantities under calculation in a significant way.

The results are shown in Appendix table 1.a.

2.2. Cohorts of reproductive age

For the year 1927/28 and for birth cohorts younger than that the fertility rates of the older age groups are not available. However, in order to be able to include these cohorts in this examination, the following method was used:

According to Hoem and Berge (1975) the function

$$(4) \qquad h(x) = a(x - 14)^{k-1}e^{-c(x-14)}, \text{ for } x > 14$$

is a very suitable adjustment for fertility rates per age group. In addition, the function when compared to other adjustment alternatives is mathematically the most pleasent to work with. For these reasons it was decided to use the function h in the following examinations. If one knows the parameters a, c ank k of function h for cohort t, the quantities μ_t, σ_t^2 anud R_t can be calculated using the following equations:

(5) $$R_t = \int_{14}^{\infty} h(x)\,dx = ak^{1/2}/c^k$$

(6) $$\mu_t = (1/R_t) \int_{14}^{\infty} xh(x)\,dx = (k/c) + 14 \text{ and}$$

(7) $$\sigma_t^2 = (1/R_t) \int_{14}^{\infty} (x - \mu_t)^2 h(x)\,dx = k/c^2.$$

To start with one estimates the parameters a, c and k by fitting function h to the data available (fertility rates of the cohorts per age group) by using the method of the least squares and then using the equations (5), (6) and (7) one calculates the estimates $\hat{R}_t$, $\hat{\mu}_t$ and $\hat{\sigma}_t^2$. The results are shown in Appendix table 1.b.

3. Trend behavior

The main purpose of this study is to examine the developmental features of the fertility of Finnish women during this century. In order to do this we will next see if one can notice any developmental trends in the three components which were calculated above for each cohort.

3.1. Average age of women giving birth

In studying Figure 1 one notices that beginning with cohort 1915/16 the average age of women giving birth has begun a definite decline and this decline has continued up to the last cohort under observation. In estimating the developmental trend it seems natural to use as a trend adjustment the exponent function

(8) $$f(t) = \alpha e^{-\beta t} + \gamma.,$$

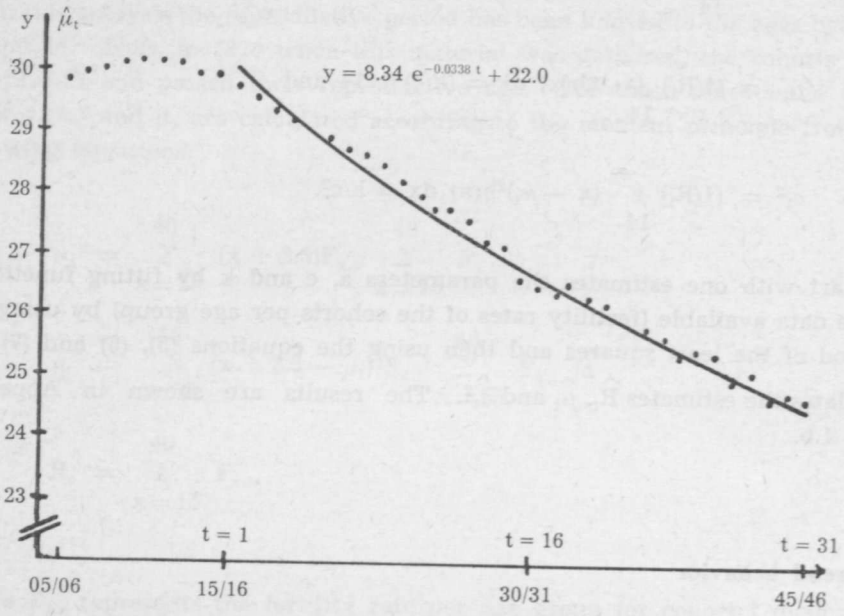
when starting with cohort 1915/16 t is given the values 1, 2, 3, etc.

The ls-trend adjustment is calculated as follows:

(9) $$\hat{f}(t) = 8.34\, e^{-0.0338\, t} + 22.0,$$

according to which $\lim f(t) = 22.0$ is the value which the average age of women giving birth is now approaching in the light of present-day development.

Figure 1. Average age of women giving birth in different cohorts and trend adjustment.



3.2. Age variance of women giving birth

Looking at Figure 2 it can be observed that the development of variance $\hat{\sigma}_t^2$ has not been as clear-cut as that of the average. However, a certain exponential decrease can be noticed. Here we will continue to use as the trend the function as calculated in equation (8), starting with cohort 1915/16.

The ls-trend adjustment is calculated as follows:

(10) $\hat{f}(t) = 19.6\ e^{-0.0323\ t} + 16.9.$

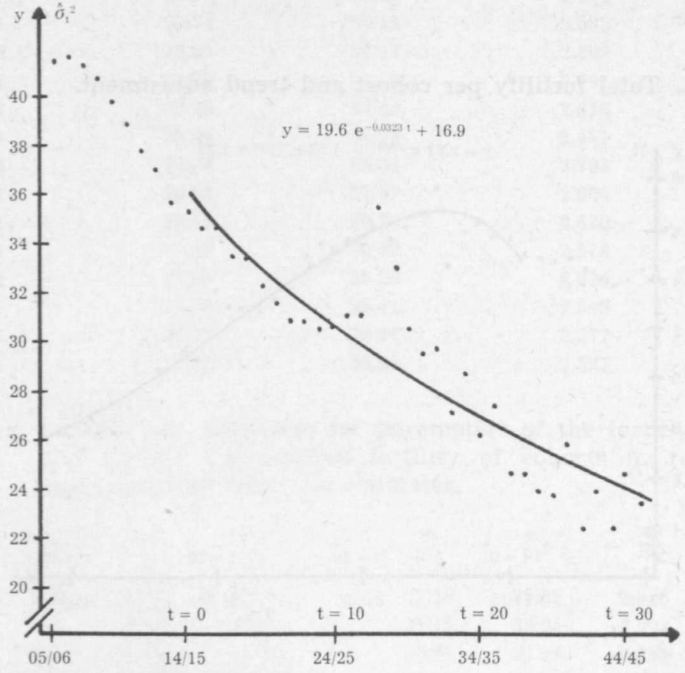
According to this trend the asymptotic standard deviation of the age of women giving birth is $\sqrt{16.9} = 4.11$. Although the trend adjustment is not completely satisfactory, it can still be considered as a guide line.

3.3. Total fertility

In examining the total fertility figures in Figure 3 it becomes obvious that the trend according to equation (8) is not suitable for this material.

In order to analyze asymptotic behavior it is, however, advisable to limit oneself to exponential functions when searching for a trend. A simple generalization of trend (8) is the sum of two exponential functions. By limiting

Figure 2. Age variances per cohort of woman giving birth and trend adjustment.



adjustments to this type one arrives at the following trend adjustment when using the ls-method:

(11) $\hat{f}(t) = 2.63\, e^{-0.0501\,t} - 1.53\, e^{-0.172\,t} + 1.29,$

again beginning with cohort 1915/16.

Although the above trend is unsatisfactory in many ways, it will still have to be accepted for more accurate methods would require the adoption of causal models, which are beyond the limits of this study.

Interpreting the trend is difficult. One possible interpretation could start with the assumption that trend component

(12) $y' = 2.63\, e^{-0.0501\,t} + 1.29$

depicts the birth rate trend and component

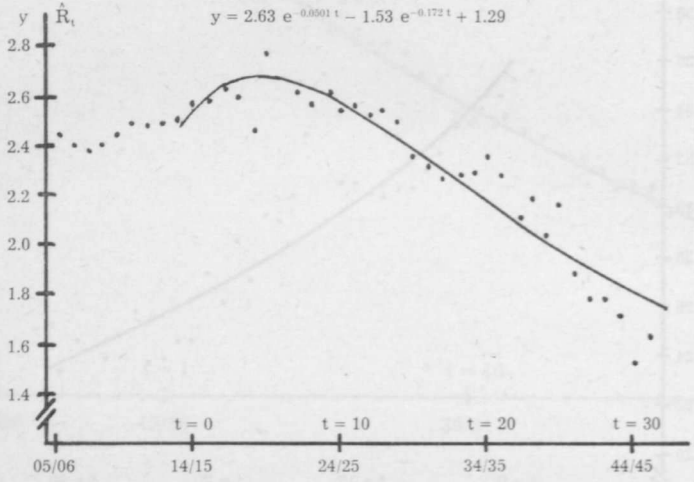
(13) $y'' = -1.53\, e^{-0.172\,t}$

depicts the change caused by the declining rate of stillbirths. However,

defending this interpretation would require additional studies, which have not been made in this connection.

The trend approaches the value of 1.29, which is indeed low as a total fertility rate.

Figure 3. Total fertility per cohort and trend adjustment.



4. Evaluation of the results

It has become obvious on the basis of periodic information that the Finnish population replacement rates have during the past years dropped noticeably below a self-supporting figure. According to this analysis, it is not a question of a new or accidental phenomenon but of a lengthy development, which has not begun to show up in periodic material until this decade.

Naturally one should be cautious in using trends to predict the future. On the other hand, it should be remembered that they might hold true for a long time, if not taken seriously.

Appendix table 1.a. Figures representing fertility of cohorts past reproductive age.

Cohort	Average age $\hat{\mu}_t$	Age variance $\hat{\sigma}_t^2$	Total fertility $\hat{R}_t$	t
1905/06	29.79	41.37	2.465	—
06/07	29.95	41.50	2.241	—
07/08	30.03	41.15	2.400	—
08/09	30.10	40.56	2.429	—
09/10	30.14	39.66	2.463	—

1910/11	30.11	38.75	2.517	—
11/12	30.08	37.69	2.500	—
12/13	29.96	36.88	2.508	—
13/14	29.92	35.52	2.513	—
14/15	29.74	35.15	2.582	0
1915/16	29.53	34.44	2.602	1
16/17	29.29	34.46	2.641	2
17/18	28.28	33.32	2.616	3
18/19	29.04	33.20	2.471	4
19/20	28.94	32.04	2.793	5
1920/21	28.74	31.47	2.664	6
21/22	28.65	30.78	2.630	7
22/23	28.48	30.72	2.576	8
23/24	28.20	30.28	2.624	9
24/25	27.93	30.41	2.549	10
1925/26	27.75	30.97	2.577	11
26/27	27.55	30.98	2 527	12

Appendix table 1.b. Estimates for parameters of the fertility function, and figures representing fertility of cohorts in reproductive age calculated from the estimates.

Cohort	$\hat{a}\cdot 10^6$	$\hat{k}$	$\hat{c}$	$\hat{\mu}_t$	$\hat{\sigma}_t^2$	$\hat{R}_t$	t
27/28	946	4.918	.3730	27.19	35.35	2.556	13
28/29	575	5.248	.3991	27.15	32.95	2.502	14
29/30	874	5.073	.4023	26.61	31.34	2.368	15
30/31	600	5.348	.4268	26.53	29.36	2.336	16
31/32	731	5.217	.4193	26.44	29.67	2.279	17
32/33	300	5.814	.4640	26.53	27.00	2.284	18
33/34	699	5.305	.4320	26.28	28.42	2.296	19
34/35	413	5.719	.4680	26.22	26.11	2.372	20
35/36	852	5.260	.4397	25.96	27.21	2.286	21
36/37	463	6.692	.4822	25.80	24.48	2.103	22
37/38	549	5.602	.4787	25.70	24.45	2.195	23
38/39	605	5.566	.4822	25.42	23.94	2.041	24
39/40	692	5.545	.4844	25.45	23.63	2.166	25
40/41	1144	5.081	.4449	25.42	25.67	1.897	26
41/42	707	5.519	.4982	25.08	22.24	1.785	27
42/43	1077	5.186	.4664	25.12	23.84	1.789	28
43/44	1274	5.168	.4817	24.73	22.27	1.717	29
44/45	1661	4.822	.4440	24.86	24.46	1.525	30
45/46	1615	4.941	.4605	24.73	23.30	1.637	31

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