WORKING PAPER

THE TWO DEMOGRAPHIC TRANSITIONS OF FINLAND

Wolfgang Lutz

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INTRODUCTION

> It might be said that western Europe has experienced two demographic transitions. The first—the extent, date, duration, and some might say even the existence of which are conjectural—was a transition from early and universal marriage to the west European form of nuptiality.

Ansley Coale who made this point in 1973 (Coale 1973) calls this first transition the Malthusian transition since Malthus—at a time of already late marriage—advocated a still higher age at marriage as the solution to the problem of unfavourable high fertility. The second transition then refers to the decline in marital fertility and the introduction of conscious family limitation; hence it might be called the Neomalthusian transition.[1]

The second demographic transition is obvious in all European countries. It began in France around 1800; for the bulk of the countries marital fertility started to decline on a significant scale between 1890 and 1910. These marital fertility transitions occurred at a time when national population statistics had already started to register the structure of the population and the incidence of marriages, births and deaths. For most countries at least crude fertility indicators can be calculated to show the extent and timing of this secular fertility decline.

For the first, the "Malthusian" transition empirical evidence seemed to be lacking. In Sweden—the country with the longest series of population statistics—the "European Marriage Pattern" (see Hajnal, 1965) which is characterized by late marriage and a high proportion of unmarried women can be traced back to 1751 when official statistics started. This pattern is very different from marriage behavior in Eastern Europe (see, for example, Sklar, 1974) and non-European countries where marriage seems to have been early and almost universal from an-

[1] When we speak about the demographic transition in this context, we do not refer to mortality trends. In this study mortality is only taken into account as a possible determinant of fertility fluctuations.

cient times until recently. Hajnal (1965) speculates that a nuptiality transition occurred in western Europe during the 16th and 17th century which might have to do with the Reformation and its consequences on parish registration and voluntary agreement of spouses because for the middle ages fragmentary taxation records and genealogies give still hints of a "non-European" pattern.

In Finland which was part of the Swedish kingdom until 1809 official population statistics also started in 1751. However, a cross-classification of marital status and age was not given before 1880. For this reason most studies of Finnish nuptiality—including the comparative analysis in the European Fertility Project (see, for example, Coale and Treadway, 1979)—started at the end of the 19th century when nuptiality in Finland was definitely "European". Data available for the 18th century include the annual numbers of marriages, births, and deaths, and the age and sex structure of the population (every third year until 1775, thereafter every fifth year). Since 1776 births and deaths are provided in five-year age groups.

The Finnish historical demographic data originate from parish registers which at the beginning were purely ecclesiastical records that were later used by the government. Since the middle of the 18th century the population registration has been conducted by the Finnish Evangelical Lutheran Church under the supervision of the government. There have been two types of report sheets (population status and population movement) which were regularly submitted by the parish priests to the church authorities. Published data are available only on national level. For this reason the present study essentially focuses on national trends.[2] The quality of data—especially on vital events—can be assumed to be excellent by historical European standards. Compared over time, 18th century figures seem to be more reliable than later ones because of bureaucratic measures introduced in the early 19th century which prohibited deletion of "inofficial outmigrants" from the registers which consequently might have resulted in some underestimation of vital rates (see Pitkänen, 1980).

[2]All demographic data used in this study come from the Official Finnish Population Statistics. Annual age-specific fertility rates for 1776-1925 were taken from Turpeinen (1979).

TWO HUNDRED YEARS OF FINNISH AGE-SPECIFIC FERTILITY AT A GLANCE

Figure 1 presents a shaded contour map of Finnish age-specific fertility 1776 to 1978. As discussed elsewhere (see Vaupel et al., 1986), such Lexis surfaces defined over age and time permit visualization of age, period, and cohort variations. One graph summarizes the information otherwise given in very extensive tables making it easy to identify the most interesting changes in the fertility regime over the last two centuries.

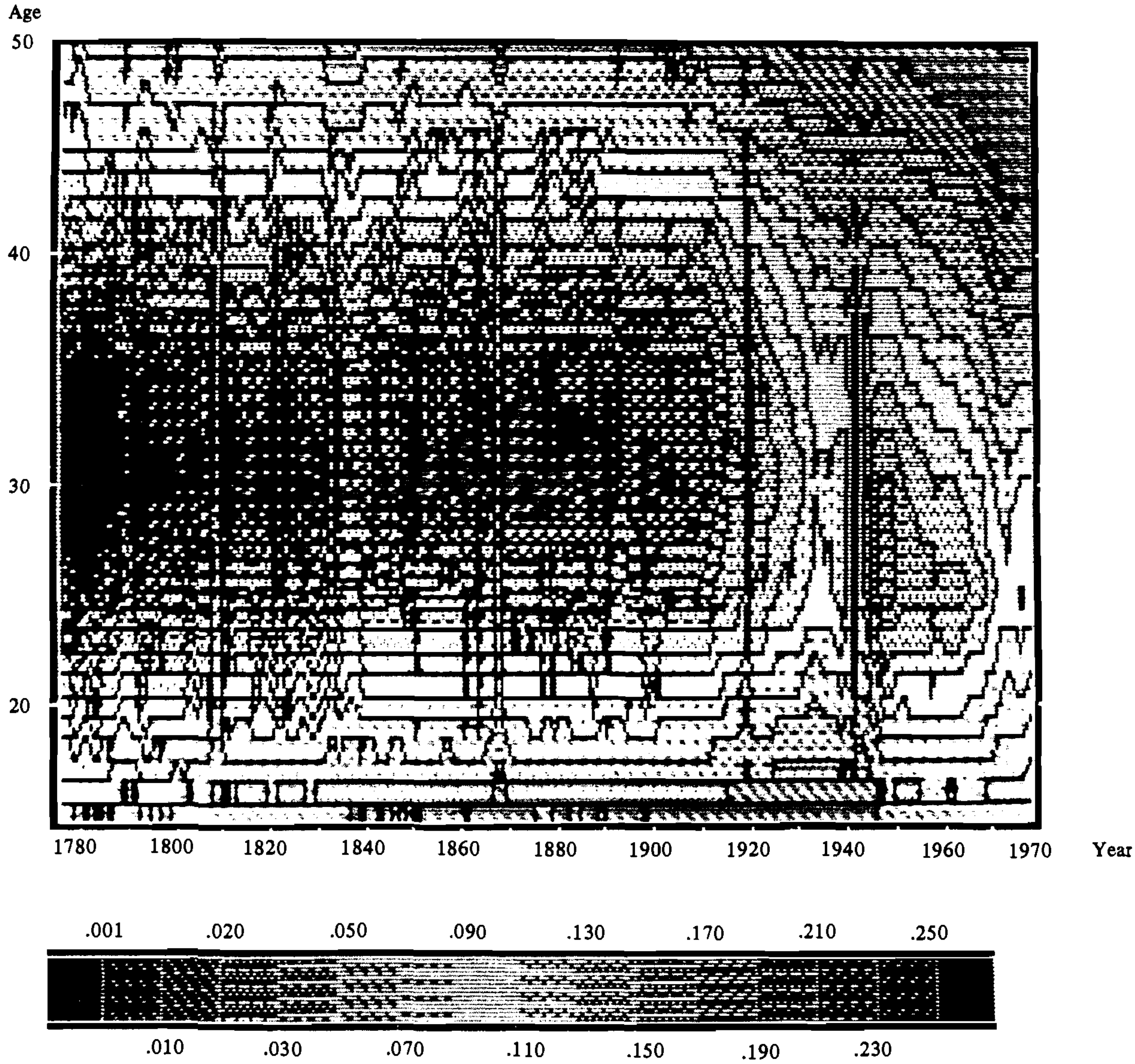


Figure 1. Finnish age-specific fertility rates, 1776-1978.

Since in Figure 1 the vertical axes only refers to 35 years but the horizontal axes to more than 200 years, the cohort lines are very steep in this graph. The contour map reveals long-term trends as well as short-term fluctuations:

It is a well-known finding of historical demography that in preindustrial societies fertility and mortality strongly fluctuated and showed an inverse relationship. In years of very high mortality due to wars, harvest failures, and epidemics, fertility was depressed for biological reasons (increased foetal mortality, reduced fecundability, etc.) and behavioristic reasons (absence of men, abstinence or voluntary postponement of births, etc.). Due to the waiting time to conception and the duration of pregnancy the recovery in fertility usually lags somewhat (one or two years) behind the improvement in environmental conditions.

There were four major events resulting in diminished fertility across all ages. In 1809 the Swedish-Russian war caused a peak in mortality and a gap in births for mothers of all ages for about three years. After that for a few years fertility recovered to a level slightly above average, especially in the prime childbearing ages. The next reduction across all ages resulted from the great famine of 1868, which was due to a complete harvest failure because of climatic conditions. The last two shafts stand for World Wars I and II with fertility at its lowest around 1917-1918 and 1942. In addition to these four major events there have been a number of strong period fluctuations, which affected mainly the prime childbearing ages. After the start of the fertility transition (around 1910) no such annual fluctuations have appeared, with exception of the two war periods.

These short-term fluctuations induced by identifiable external events are superimposed to some long-term trends that also can be read from the contour maps. In the preindustrial period fertility in Finland had not been constant around a certain high plateau, as is often assumed for such societies but a remarkable fertility decline took place between the beginning of statistics and 1800. It began at younger ages and finally brought down the total fertility rate by about one child per woman. In the following section we will show that this fertility decline was induced by changes in the marriage pattern. This early period is also the only instance when a clear cohort effect is visible in the contour map. Already-married women continued childbearing in the old pattern, whereas younger cohorts reduced their propensity to marry, and if they married did so at higher ages. This resulted in reduced fertility along the cohort lines for the younger age groups.

Above age 40 fertility is relatively invariant until around 1910, when fertility suddenly started to decrease at all age groups. This is the time when family limitation, i.e., parity-specific fertility control, spread through Finland. It is the real fertility transition that seems to be irreversible. Even the high fertility of the post World War II baby boom which, for women aged 20-24 resulted in higher fertility rates than before the transition, affected only the prime childbearing ages and consisted mainly of births of lower order.

After World War II marriage became more frequent again and the mean age at marriage declined. This was one of the factors behind the baby boom. If one draws cohort lines it becomes also apparent that part of the exceptionally high fertility was a compensation for previously depressed fertility. After 1950 both cohort and period fertility have declined significantly. This trend is parallel to most other European countries.

AN ATTEMPT TO RECONSTRUCT THE EIGHTEENTH CENTURY NUPTIALITY TRANSITION BY SIMULATION

There is no direct way of obtaining the age schedule of marriage and the proportion of women ever-marrying for the pre-1880 period. We can only try to combine different pieces of information derived from official statistics. For this purpose we will use the Coale-McNeil marriage model[3]

$$G(a) = C\,G_s\left(\frac{a - a_0}{k}\right) \quad , \qquad (1)$$

where $G(a)$ is the proportion ever-married at age a; $G_s(x_x)$ the standard schedule of proportions ever-married with the following three parameters: a_0 the origin; k the "speed" of the observed schedule of first marriage frequencies; and C the proportion of women that eventually marry.

Information from Overall Proportions Married

The proportion of women ever-married above age 15 shows an almost monotonic decline from 1751 to 1865. The pace of decline in the proportions ever-married was fastest between 1751 and 1775, followed by a period of slower decline between 1775 and 1825, and at a somewhat faster rate of decrease after 1825.

[3]For the given formulation of the marriage model, see Coale (1971).

Table 1. Proportions married, unmarried, widowed and divorced above age 15 for different years.

Year	Proportion never-married (1)	Proportion married (2)	Proportion widowed and divorced (3)	Proportion ever-married (2)+(3)
1751	30.71	55.60	13.69	69.29
1775	34.85	54.18	10.97	65.15
1800	35.57	53.15	11.28	64.43
1825	35.49	51.92	12.59	64.51
1850	37.27	50.24	12.49	62.73
1865	38.37	49.42	12.21	61.63
1880	36.97	50.34	12.69	63.03
1890	36.59	51.15	12.26	63.41

To express the proportions ever-married above age 15 in terms of the three parameter marriage model, the following equation can be written:

$$PEM_{15+} = C \int_{a=15}^{\infty} c(a) G_s\left(\frac{a - a_0}{k}\right) da \quad , \qquad (2)$$

where $c(a) = \frac{W(a)}{W_{15+}}$ is the proportion of women aged a, out of all women aged 15 or more, and PEM_{15+} the proportion of women ever-married above age 15.

If we make the assumption that this model pertains not only for a cohort but also for a cross-section at one point in time, PEM_{15+} and $c(a)$ would be given empirically from the official census data.

Information from the Annual Number of Marriages

Let $g(a)$ be the frequency of first marriages as defined by Coale (1971) then the number of first marriages (denoted by FM) in a cohort of women can be expressed in the following way assuming that the model also holds for marriages in a given period t:

$$FM^{(t)} = C^{(t)} \int_{a=15}^{50} W(a)^{(t)} g_s\left(\frac{a - a_0^{(t)}}{k^{(t)}}\right) da \quad . \qquad (3)$$

According to this, by definition, nobody can marry (for the first time) before age

15 and after age 50. This final assumption is not particularly unrealistic and corresponds, as far as the lower limit of 15 is concerned, to empirical data and to the legal situation that made it impossible for a woman to marry before age 15.

But still equation (3) cannot be used because only the total number of marriages is given for the period under consideration. Hence, another unknown parameter $PFM^{(t)}$ representing the proportion of first marriages among all marriages $M^{(t)}$ of a certain year t must be introduced, and (3) becomes:

$$M^{(t)} = \frac{C^{(t)} \int_{a=15}^{50} W(a)^{(t)} g_s\left(\frac{a - a_0^{(t)}}{k^{(t)}}\right) da}{PFM^{(t)}} \quad . \tag{4}$$

Although equation (4) together with a period-specific formulation of equation (2) will be the basis for the simulation model, more independent information is needed to achieve unique solutions.

Information on the Proportion Remaining Unmarried from Comparing the Sizes of Marriage Cohorts and Mortality-Adjusted Birth Cohorts

The basic idea underlying this approach is as follows:[4] Let us first assume, for the reason of simplicity, that all women of a certain birth cohort that eventually marry, do so only at age N. Then the following equation holds:

$$FM^{(t)} = B_f^{(t-N)} P(N)_f^{(t)} C^{(t)} \quad , \tag{5}$$

where the number of first marriages at time t ($FM^{(t)}$) equals the number of female births at time $t-N$, times the probability prevalent at time t that a baby girl survives up to age N ($P(N)_f^{(t)}$) times the factor C from the Coale-McNeil model which gives the proportion of all women that will eventually marry. After decomposing $FM^{(t)}$ into $M^{(t)}$ and $PFM^{(t)}$, a ratio $R^{(t)}$ can be defined as follows:

$$R^{(t)} := \frac{C^{(t)}}{PFM^{(t)}} = \frac{M^{(t)}}{B_f^{(t-N)} P(N)_f^{(t)}} \quad . \tag{6}$$

[4] A similar approach was also suggested by Livi-Bacci (1977). Since the structure of his data is quite different, and no attention is paid to the problem of remarriages, his method will not be discussed here.

In reality women do not all marry at one age; first marriages are, however, concentrated heavily within an age span of 8-10 years.[5] For this reason more years have to be summed up, and assumptions on the stability of the prevailing marriage pattern must be made. For the empirical analysis $P(N)_j^{(t)}$ can be best obtained from comparing census data to the number of births N years before. With this definition $P(N)_j^{(t)}$ would also include net-migration, which is of great importance especially for the second half of the nineteenth century. Since census data give only 5-year age groups, the survival ratio up to the age group 20-25 will be calculated. The results are given in Table 2. The proportion of female births among all births was assumed to be constant at .495.

For calculating the ratios R it seems desirable to aggregate a large number of years in order to eliminate the effect of short-term changes in the "timing" of marriages within a period. For both ends of the period of aggregation, however, it has to be assumed that the number of women born as members of the birth cohorts under consideration, but marrying outside that period, equals the number of women who marry within the period of summation but are not members of the birth cohorts considered. Sensitivity analysis with 20-year averages, however, showed that these assumptions are especially problematic in periods of rapid population growth or when the survival ratios tend to change rapidly. To adjust for some of these problems, Table 2 gives ratios resulting from a method that averages twice: First, the period of summation for births and marriages is shortened to 9 years to make the assumption of compensating errors more likely for periods of long-term changes. Secondly, the 9-year periods are shifted up the time scale year by year (like a 9-year moving average) and the average of the ratios for 5 periods around the census year is taken. This procedure also makes the assumption of constant survival ratios more likely.

The R ratios (given in Table 2) are quotients of two unknowns: the proportions ever-marrying (C) and the proportions of first marriages among all marriages (PFM). Even without going through the simulation the series of R-ratios indicates a clear decrease in proportions ever-marrying between 1751 and 1800. Since mortality conditions were worsening during the late eighteenth century—as is seen from the survival ratios in Table 2—it is very unlikely that the proportion of first marriages among all marriages increased over that period. A possible improve-

[5] For instance, in the Coale standard schedule of first marriages, 88% of all first marriages occur within the 10 years centered around the median age of marriage if k = 0.5, and 77% if k = 0.8.

Table 2. R-ratios of surviving women over women marrying (5-year average of 9-year averages around the census year).

Census year	Women aged 20-25 in census	Sum of births 20-25 years before census	Female survival ratio	R-ratio
1751	21,338	61,900	.696	.993
1775	27,837	99,900	.563	.934
1800	37,985	130,400	.589	.911
1825	58,692	166,300	.713	.914
1850	74,068	246,300	.608	.891
1880	87,299	303,700	.581	.907

ment in birth registration would also not affect the estimated value of C. This can be seen from equation (5) where an increase in the B's would also result in a decrease of the survival ratio P.

The Simulation Model

The three independent sources of information described so far can be combined in a simulation model to yield estimates of the marriage-model parameters. There are, however, four parameters to be estimated, namely, a_0, k, C, and the proportion of first marriages PFM.

Since two of the parameters, a_0 and k, are closely related to each other, the omission of a_0 as an unknown is the least distorting simplification that can be made in our case, since the value of k will compensate for wrong assumptions on a_0. Three parameters remain to be estimated. Further assumptions on the stability of the first marriage schedules allow us to build a system of the equations (1), (4), and (6) with three comparable parameters $k^{(t)}$, $C^{(t)}$, and $PFM^{(t)}$.

The only way to find parameter values that meet the conditions given through the model equations, is to write a simulation program which varies the values of two parameters step by step and compares the resulting values for the third parameter. If all assumptions were perfectly true and the population stable in respect to its marriage behavior, then there should be one set of the two parameters $k^{(t)}$ and $PFM^{(t)}$ that yields identical values for the $C^{(t)}$'s in equations (1), (4), and (7). Since this is not the case, criteria for selection of the "best" set of parameters had to be specified by weighing two goodness-of-fit measures D1 and D2, which stand for the differences between the resulting values of $C^{(t)}$ from the different equations.[6]

Table 3 presents the parameter estimates resulting from the simulation, the goodness-of-fit measures, and the "Princeton Index" of proportions married (I_m), together with a modification of the index suggested by Knodel (1974) that eliminates the influence of age structure.

Table 3. Estimated parameters, goodness-of-fit measures, and "Princeton Index" of proportions married.

	Parameter estimates			Goodness-of-fit		Marriage indices	
Year	k	C	PFM	D_1	D_2	I_m	I_m^*
1751	.42	.82	.81	.001	.019	.653	.696
1775	.84	.78	.84	.000	.005	.628	.658
1800	.70	.75	.85	.090	.022	.534	.571
1825	.60	.79	.82	.000	.055	.594	.614
1850	.50	.75	.80	.000	.033	.591	.611

One of the basic assumptions made was that the marriage pattern resulting in the given proportion married above age 15 was equal to that of current period nuptiality. Consequently the estimates for the period after the obvious transition 1751-1800 are much less stable and have worse goodness-of-fit measures. It is clear that this assumption had to be violated by the preceding change in the marriage patterns. For this reason more weight was given to the criterion minimizing the difference between equations (4) and (6) that do not involve this assumption. But still the individual parameter estimates for the nineteenth century were not very robust. In particular, k and C seem to compensate easily for each other, i.e., if the speed is slower (= k higher) than expected, the proportion ever-marrying C becomes higher than expected.

[6] D1 is the absolute value of the difference between the C's coming from equations (2) and (4); D2 from equations (2) and (6). Normally equal weight was given to D1 and D2. For 1800 more weight was given to D2. For 1800 PFM was also forced to .85 or below.

Hence, an aggregate indicator combining the effects of k and C—like the "Princeton Index" I_m—seems to be the appropriate measure to be considered as a relatively reliable result of this simulation model. Like all the other evidence presented the series of I_m shows a significant decrease in the proportions married. Another study (see Lutz and Pitkänen, 1986) using a slight modification of this model to reconstruct the marriage pattern in the four provinces of Finland in 1751-1754 and 1769-1772 yields results that are generally consistent with the national estimates presented here. Within those 20 years I_m declined significantly in all provinces. In the eastern province of Kymenkartano and Savo I_m fell from the very high level of .76 to .59. In the most advanced south-western province of Turku and Pori, I_m declined from .65 in 1751-1754 to as low as .49 in 1769-1772.

Other Independent Evidence

Two other independent sources of information allow to check the plausibility of our results. First, a method that correlates the sizes of subsequent marriage cohorts with the series of birth cohorts lagged by 15 to 30 years yields correlation coefficients for each specified lag. The expectation is that the lag with the highest correlation coefficient corresponds to the modal age at marriage in that period. Our method which is a modification of a procedure suggested by Livi Bacci (1977) yields bimodal distributions of coefficients for most periods considered. It seems straightforward to assume that the first peak corresponds to the female and the second to the male modal age at marriage. For the period 1751-1775 the modes were 19 and 24 years, for 1776-1800, however, the modal ages at marriage seem to have increased dramatically to 23 and 27 years. Although the correlation coefficients are not very robust in respect to slight changes in the time period to which they pertain, they support the assumption of a nuptiality transition with a strong increase in age at marriage in eighteenth century Finland.

Finally, the trends in age-specific fertility rates (see Figure 1) indicate a decrease in fertility until 1800 which begins at younger ages, and finally brings down the total fertility rate by about one child per woman between 1776 and 1800. Never again in Finnish history has fertility reached the level of 1776-1780 with a total fertility rate of almost 6 children per woman. In the light of the preceding discussion, speculation that Finland was the first country in Europe—even before France—to show family limitation become obsolete. Most likely this fertility decline was induced by changes in the marriage pattern.

THE EMERGENCE OF FAMILY LIMITATION AND ITS COVARIATES

Decomposition of Fertility Trends: The "Princeton Indices"

To describe trends in fertility and nuptiality in a relatively simple fashion that allows cross-national comparisons, Coale (1969) developed a set of interrelated demographic indices which can be calculated if the number of married and unmarried women are given by five-year age groups and the total numbers of legitimate and illegitimate births are known. These indices found wide application and were calculated for most European countries on a provincial level starting in most instances in the late nineteenth century.

As described above for Finland, calculation of the indices could not start before 1880 because of lacking information on unmarried women by age groups. Our simulation model, however, allows us to go 130 years further back into history and calculate the indices on the basis of the reconstructed proportions married at different age groups. The index of overall fertility (I_f) is not subject to the assumptions of the reconstruction model since it results directly from official statistics. All other indices (for 1751-1850) are partly based on the reconstructed data.[7]

Table 4. "Princeton Indices" of fertility (I_f), marital fertility (I_g), illegitimate fertility (I_h), and proportions married (I_m), 1751-1960.

Year	I_f	I_g	I_h	I_m
1751	.468	.706	.019	.653
1775	.410	.638	.026	.628
1800	.393	.705	.035	.534
1825	.382	.602	.059	.594
1850	.376	.590	.066	.591
1880	.375	.698	.054	.499
1890	.369	.689	.048	.501
1900	.353	.685	.044	.482
1910	.320	.647	.043	.459
1920	.240	.548	.034	.400
1930	.200	.455	.027	.404
1940	.190	.387	.025	.456
1950	.259	.433	.031	.567
1960	.215	.343	.022	.602

[7]The figures for 1880-1960 were taken directly from the data file of the European Fertility Project at Princeton University.

After a rapid decline between 1751 and 1800 overall fertility (as measured by I_f) fell only very slowly until 1910 when it entered a precipitous decline. Between 1910 and 1940 I_f fell from 0.320 to 0.190. When looking at the components of this trend, we discover that both the proportions married (I_m) and marital fertility (I_g) declined during those 30 years, but the overwhelming share of the decline may be attributed to I_g. Before 1910 marital fertility had fluctuated but on the average remained constant at a high plateau for 160 years. Illegitimate fertility has not played a significant role in Finland, except for the mid and late nineteenth century when it increased to a maximum of 10% of all births.

A Modification of the "Index of Family Limitation"

Family limitation may be defined as the control of fertility in dependence on the number of children already born. Since parity-specific fertility rates are not available one has to take advantage of the strong correlation between parity and age and focus the analysis on age-specific marital fertility rates. In the case of Finland those rates are available since 1880-1881.

For rural communities in 1880 to 1920 the curves of age-specific marital fertility rates are convex, a shape that corresponds to the "typical natural fertility pattern" described by Henry (1961) for populations without deliberate fertility control. Coale (1971) also found that there is a typical pattern of departure of marital fertility from the pattern of natural fertility. His model of marital fertility is not only a useful tool for estimating fertility from incomplete or inaccurable data, but it has also proved to be a powerful analytical tool for quantitatively examining whether fertility in a given population was natural or not. Coale and Trussell (1978) suggested a regression procedure to estimate the two parameters of the model: m being the index of family limitation and M being a scale factor of the level of fertility. Equation (7) expresses the ratio of observed marital fertility $r(a)$ to natural fertility $n(a)$ in terms of those two parameters and the typical deviation from natural fertility $r(a)$. $n(a)$ and $r(a)$ were empirically derived and are assumed to be invariant over time and different populations

$$\frac{r(a)}{n(a)} = M\, e^{m r(a)} \quad . \tag{7}$$

In the case of Finland, age-specific marital fertility rates before 1880 could not be reconstructed as a consequence of the simulation model above because of lacking information on the age distribution of illegitimate fertility. As an alternative approach to identify possible family limitation behavior during the period 1776 to 1880, a slight modification of the Index of Family Limitation is suggested to make it applicable to overall age-specific fertility rates instead of marital fertility rates only (see Lutz, 1984a).

Let $f(a)$ be the schedule of overall age-specific fertility rates, $PLB(a)$ the proportion of legitimate births among mothers aged a, and $PM(a)$ the proportion of women at age a then age-specific marital fertility can be expressed as

$$r(a) = f(a)\frac{PLB(a)}{PM(a)} \quad . \tag{8}$$

Assuming that the percentage of illegitimate births is constant over age for women between 30 and 50 and that the proportion of married women varies only insignificantly between age 30 and 50, equation (8) can be rewritten as:

$$r(a) = f(a)\frac{PLB}{PM} \quad a = 30,\ldots,50 \tag{9}$$

where $r(a)$ is only a function of $f(a)$ and a constant factor. Now, $f(a)$ can be substituted for $r(a)$ in equation (7)

$$\frac{f(a)}{n(a)} = \frac{M\ PM}{PLB} e^{m^{*} r(a)} \quad , \ a = 30,\ldots,50 \quad . \tag{10}$$

After a logarithmic transformation the new parameter m^* can be estimated like m with the exception that only age groups above age 30 are considered. This is not a serious restriction because family limitation mainly occurs in those age groups. The scale parameter in our case also includes the effects of proportions married and the percentage of illegitimate births.

Generally, we can expect that m^* is higher than m due to the loss of cases (in the regression) in the prime childbearing ages that usually come closest to natural fertility. Figure 2 clearly suggests a threshold between natural and controlled fertility around a level of m^* of 0.8-1.0, since before 1910 the index is rather constant at a low level and once it passes this threshold it never comes back to its premodern level.

In addition to the secular trend m^* exhibits annual fluctuations, especially in the pre-modern period. To test the hypothesis that these fluctuations were induced by environmental conditions a correlation analysis was conducted between m^* and the death rate with lags from zero two two. This allows for some reaction time to changing conditions. Only in the pre-1870 period m^* and the death rate

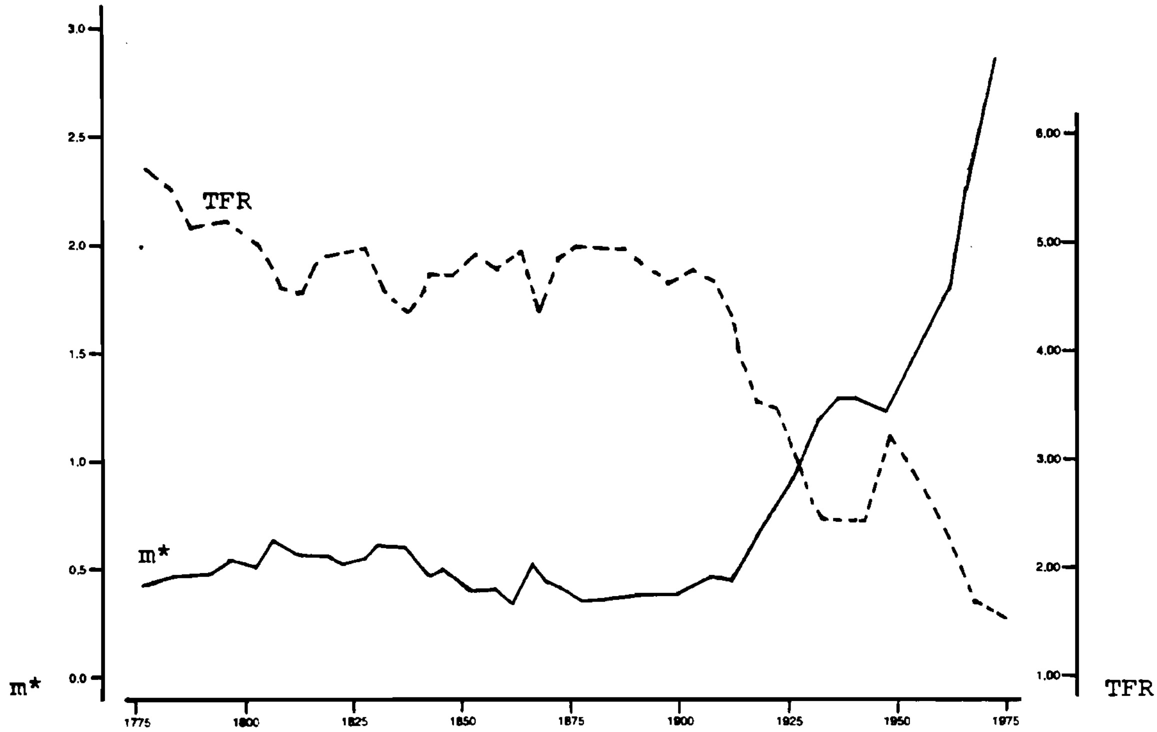


Figure 2. Plot of the total fertility rate (TFR) and modified Index of Family Limitation (m^*) against time for Finland, 1776-1978.

are positively correlated. In the two other periods trends of declining mortality and an increasing extent of family limitation led to a negative association. An analysis of annual percentage changes overcomes that problem but does not indicate any consistent relationship for the post-1870 period. The strong positive correlation at lag zero in the pre-1870 period, however, suggests that the link between environmental stress (war, disease, famine, etc.) as measured by the death rate and stronger deviation from natural fertility as measured by m^* was more of biological nature than of behavioral. There is no indication of preventive fertility inhibiting measures in a year of crises which should have resulted in higher correlations at lags 1-2.

Infant Mortality and Fertility

At least since Wappäus published his "Allgemeine Bevölkerungsstatistik" in 1861 the notion that infant mortality is an essential determinant of fertility has become a commonplace in demographic literature. Well before fertility started to decline in Germany, Wappäus had distinguished between a physiological effect of infant mortality via breastfeeding and a voluntaristic one through replacement of dead children. — Almost a century later authors of demographic transition theory (e.g. Heer 1966) saw declining mortality and especially infant mortality as a prerequisite for a fertility decline. Their argument was that parents would have to give birth to fewer children under improved infant and child mortality conditions in order to achieve a certain desired number of surviving offsprings.

While the assumption that fertility is in part determined by the level of infant mortality became widely accepted, and was expressed and analyzed through various hypotheses of child replacement strategies, the possibility that infant mortality might be determined by fertility attracted little attention until recently. The logic behind this "opposite" direction of causation is that parents with large families are less able to give infants the care they need.

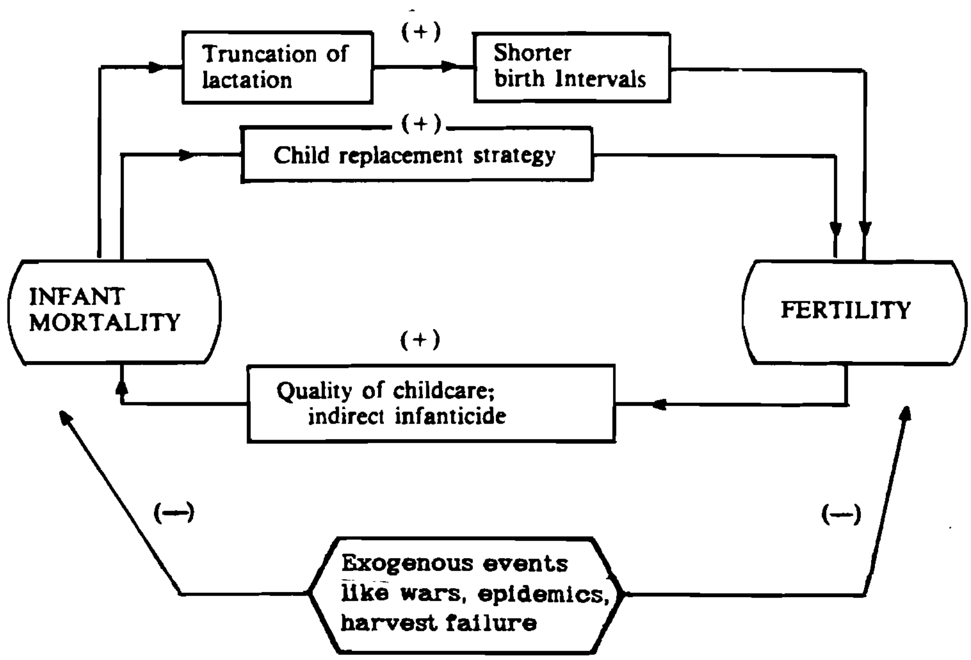
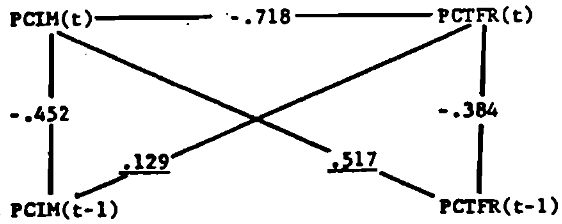


Figure 3. Short-term causal links determinants of period fertility.

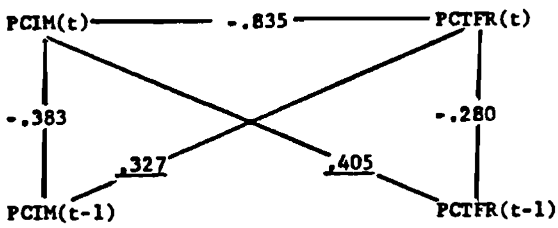
Figure 3 illustrates different possible links between infant mortality and fertility. The signs (+,-) indicate the kind of association that can be expected for each mechanism. Superimposed to this mutual determination is the influence of exogenous factors like was, epidemics and harvest failures that depress fertility and increase infant mortality. To test the relative importance of those links between fertility and infant mortality in different periods of Finnish history, a cross-lagged correlation analysis between those two variables was performed. This approach assumes that there is a certain lag (in our model one year) that fertility needs to respond to higher infant mortality and vice-versa. To eliminate the influence of long-term trends in this model, annual percentage changes were taken.

Table 5. Cross-lagged correlations for annual percentage changes in infant mortality (PCIM) and total fertility (PCTFR).

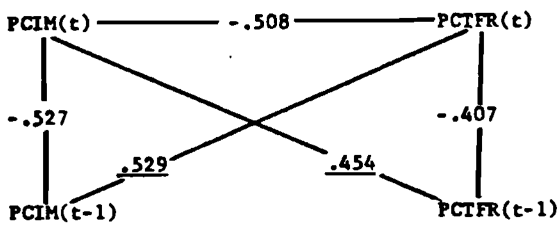
1777 - 1859:



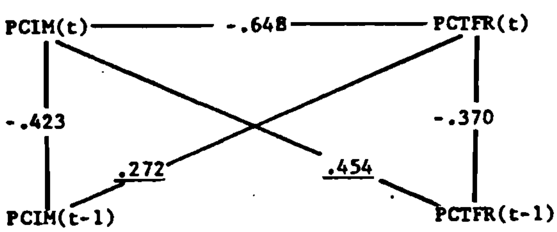
1860 - 1916:



1917 - 1978:



Overall 1777-1978:



As could be expected through the existence of exogenous events, infant mortality and fertility in the same year *t* are negatively associated. First-order autocorrelations which, because of the trend, are highly positive for absolute values of IM and TFR become also negative for annual percentage changes. But our real interest lies in the cross-lagged correlation coefficients: They are all positive as could be expected from Figure 5 but their pattern changes significantly over time. During the first 90 years the association between current infant mortality and fertility of the previous year is much stronger than that between current fertility and lagged infant mortality. This suggests that in this early period the link via fertility stress and child care was much stronger than that via conscious replacement and truncation of lactation. A similar pattern appears for the period 1860-1916 but it is already less pronounced. After the great fertility transition in the period 1917-1978 the structure of this relationship has been reversed. Now, changes in infant mortality seem to induce fertility changes. Generally, we can conclude from this that replacement strategies seem to be a modern phenomenon which could not be found in pre-industrial Finland.

Further empirical support for these findings is given by a number of more sophisticated, distributed lag models which relax the assumption that the reaction time is not more than one year.[8] When an additional control for annual percentage changes in the death rate (PCDR) as a proxy for exogenous factors is introduced into the equation, the pattern becomes even more pronounced in the way indicated above. Further analysis of the mortality of children aged 1-2 instead of infant mortality indicates that the possible measurement error due to the definition of the infant mortality rate which also includes the deaths of the children born in the previous year does not affect our findings. Age-specific analysis for the premodern period finally shows that the negative influence of a period of high fertility on a child's chance to survive was stronger for women above age 25 than for younger women who still had less children to care for.

Literary evidence from Finnish social history shows that direct infanticide was rather unusual, but that infanticide by neglect and abusive child care were quite normal. The death of a child was seen as the will of God and a relief from this miserable world (see, for example, Pitkänen, 1983). Besides these behavioral mechanisms we may also assume biological ones. Short birth intervals being associated with high period fertility bring nutritional and other stress to the newborn as well as to the last baby because of curtailment of breastfeeding.

When we try to abstract from the short-term fluctuations discussed above and look at the secular trend in infant mortality we find that since the beginning of population registers in 1751 infant mortality has on the average declined. In 1750-

[8]For a detailed description of these models, see Lutz (1984b).

1770 about 23% of all babies died within the first year. In 1880-1890 this proportion had already been reduced to an average of 15%. One of the reasons for this early decline was probably the propagation of breastfeeding by health authorities in regions where it had been uncommon (see Pitkänen, 1983). After the mortality crisis in 1868-1870 the decline in infant mortality accelerated. Simultaneously the variation which was very high in the premodern period (showing peaks of above 36% of all infants dying in 1808 and 1868) diminished and after World War II the trend looks like a line approximating zero.

This implies that infant mortality had been slowly declining for at least 130 years before marital fertility started to decline. Even the time when infant mortality entered a steep decline lies 40-50 before the onset of the fertility transition. Does the Finnish evidence support or contradict the widespread nation that the decline in infant mortality initialized the subsequent fertility decline? Evidence from German provinces (see Knodel, 1974) raised doubts about this postulate because fertility and infant mortality declined there simultaneously; in some cases even fertility started to decline earlier. The Finnish case casts doubts on this from the other side since 130 years or even the 40 years after 1870 seem to be quite long for the assumed perception lag that should link fertility directly to infant mortality.

Socioeconomic Covariates of the Fertility Transition

From 1871 onward it is possible to derive annual time series of selected socioeconomic indicators from official Finnish statistics. The following indicators were selected to stand for relevant sectors of the socioeconomic structure: NAGR (= share of non-agricultural population in total active population); GDP (gross domestic product real per caput, in index form); MATRF (number of females passing matriculation examination as fraction of the corresponding age group); and MATRD (difference between MATRF and the corresponding figure for males). In addition to that, the following demographic indicators were considered: MR (marriage rate), AAFM (average age at first marriage of brides), IM (infant mortality rate), and LEF5 (female life expectancy at age 5).

Statistical findings on associations between variables are meaningless without consideration of the underlying model. Figure 4 gives an analytical framework indicating some mechanisms that determine the level of period fertility during the course of the demographic transition and thereafter. It is important to notice that in this model [following Freedman (1963)], the social and economic structure of a society does not directly affect the so-called intermediate variables or proximate determinants of fertility, but that there is something in between which shall be called normative transformation. This includes all mechanisms through which changes in living conditions and the cultural environment affect personal opinions on family size. In this process of transformation individual propensities are conceived and consequences are drawn within the framework of social norms prevalent in the society. These mechanisms and norms, however, cannot be regarded as being stable over longer periods, especially during times of transition. The mechanisms are themselves subject to structural changes induced by revolutions in the way to think and feel and behave in respect to the family. Norms that govern those changes—we might call them meta-norms—are dependent on the general socio-cultural development. They also determine the extent to which reproductive behavior is governed by individual rationality in competition to social conformity, and they change not only the contents of norms but also the degree of their comprehensiveness.

How can we translate these rather abstract ideas into a quantitative model? The structure of the mechanisms within the normative transformation cannot be specified in any detail because we know very little about them; this transformation must be seen as a "black box" which is only defined in terms of input and output. Changes in the input/output ratio, however, which may be interpreted as changes in the structure of the transformation can be quantified by means of analysis of covariance. In addition to the socioeconomic indicators of development—like female education or the structure of the economy—time is introduced into the models as a categorical variable to catch the residual effect of certain historical periods. This period-variable may be interpreted as a proxy for many aspects of socio-cultural development not covered by changes in the socioeconomic variables.

Based on the ideas described above a regression model was specified which distinguishes between long-term determinants of reproductive behavior including changes in the normative system and short-term developments which govern the decisions *pro* or *contra* a birth at a specific point in time and result in increased or depressed fertility after a certain time lag. This model may be regarded as a step towards a synthesis of economic and sociological fertility analysis: it accounts for the sociological approach in referring to long-term normative changes as determinants of the intermediate variables; it reflects economic thinking in allowing for short-term decisions based on cost-benefit considerations.

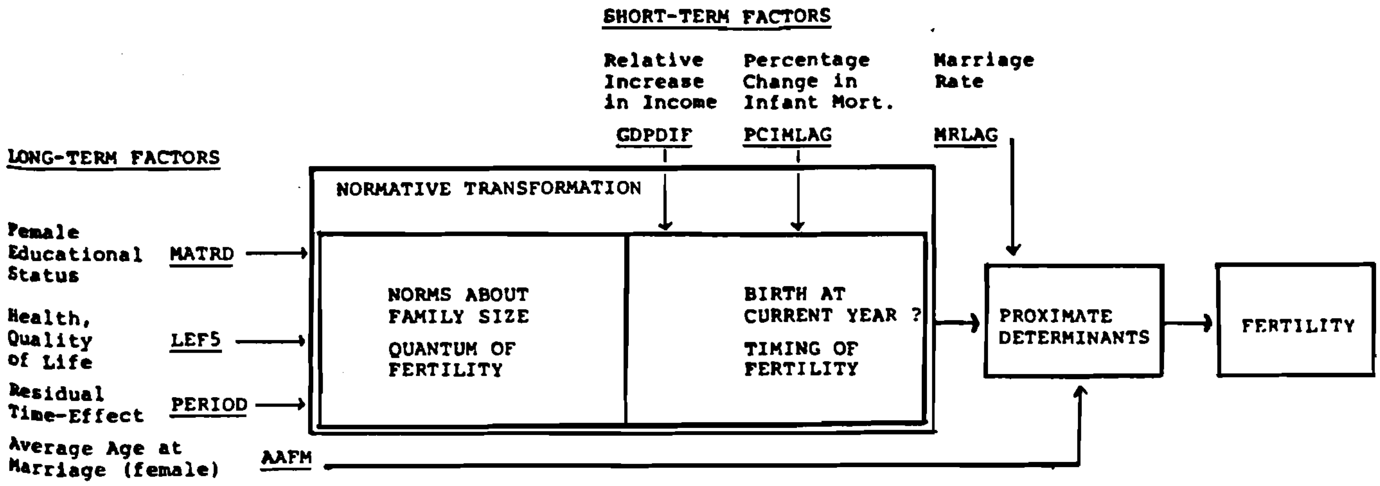


Figure 4. Long-term and short-term determinants of period fertility.

Only two metric variables were selected to stand for long-term socioeconomic changes, MATRD to represent the female educational status and LEF5 to stand for health and quality of life in a more general sense. We restricted the model to these two variables in part to avoid multicollinearity among the independent variables which inevitably appears if a higher number of long-term indicators is considered. Life expectancy at age 5 is very closely linked to economic development during the period under consideration. It also correlates strongly with an increase in the proportion of non-agricultural population. Life expectancy also includes factors exogenous to purely economic trends since it is not only an outcome of concrete living conditions and medical care, but it also reflects an awareness of individual responsibility for one's life. The relative educational status of women represents another side of social development: it reflects changes in the status of women in familial decision making processes and may be assumed to be very closely related to the shift from desired "quantity" to "quality" of children.

In addition to the indicators of the socio-cultural and economic development the categorical variable PERIOD is introduced into the equation to account for period-specific effects on the level of fertility. Since the norms about family size mainly relate to marital fertility but the dependent variable considered reflects total fertility, the effect of changing marriage patterns must be eliminated from the trend. The mean age at first marriage is selected as a proxy for the marriage effects on fertility, because age at marriage and the proportion ever-marrying seem to correlate highly during the period considered. Marriage trends are long-term changes which directly effect the exposure variables without going through the "normative transformation".

Superimposed to this long-term development of socioeconomic factors and norms are short-term changes in economic well-being and other factors that influence the level of period fertility. They either influence the decision *pro* or *contra* a birth in a specific year or work through biological or demographic mechanisms. The relative increase or decrease in GDP per caput stands for fluctuations in the material standing which possibly influences the decision making in respect to current reproductive behavior. Relative changes in the infant mortality rate lagged by one year are introduced as indicators for years of crisis or disease. As discussed above, increased infant mortality tends to be accompanied by depressed fertility in years of war and disease, but for the following year there might be some positive effects on fertility due to truncation of lactation or possible "replacement strategies" for deceased children. Finally, the marriage rate lagged by one year is introduced to cover the timing of marriage effects on period fertility. In a way this differentiation between long-term and short-term effects may be interpreted as referring to the "quantum" and "timing" aspects of fertility.

The model is operationalized by using a stepwise regression procedure where in a first step only the long-term indicators are considered, in a second step the short-term factors and in a third step dummy variables for 20-year periods.

Table 6 gives the results of this three-step regression model for explaining period total fertility. Other dependent variables considered were the age-specific fertility rates and the modified index of family limitation m^*. For all of these dependent variables, regressions were calculated for different periods separately. The tables cannot all be given here.[9] The most important findings shall be summarized in the following:

1. The average age of brides at first marriage (AAFM) seems to be more significant for the fertility of younger women than for those in older ages of childbearing, a pattern that is very plausible.

2. The effect of the marriage rate lagged by one year shows a positive sign for all periods and over all age-specific fertility rates (except for women aged 45-49) and is very significant especially in the prime childbearing ages. This confirms *apriori* expectations that a year of high marriage rates should be

[9] For those tables, see Lutz (1985).

Table 6. Results of the stepwise regression model with total fertility as the dependent variable.

Dependent variable: TFR Period: 1873-1976

	Step I	Step II	Step III
LEF5	-169.41***	-190.07***	-145.35***
	(-13.7)	(-13.7)	(-5.6)
AAFM	-712.36***	-775.67***	-553.54***
	(-7.5)	(-8.1)	(-4.7)
MATRD	-41.68***	-38.07***	-20.66***
	(-3.9)	(-3.6)	(-2.2)
PCIMLAG		60.46	203.92
		(.1)	(.7)
GDPDIF		3.39	1.88
		(.6)	(.4)
MRLAG		127.12***	72.88**
		(3.1)	(2.2)
D 1901	(Reverence period 1873-1900)		-350.68***
			(-3.2)
D 1921-40			-1046.62***
			(-5.71)
D 1941-60			-268.32
			(-.9)
D 1961-76			-1042.91***
			(-2.8)
Constant	31415.65	33241.94	25938.63
R^2	.8063	.8237	.9155

followed by a year of increased fertility.

3. The most general indicator of socioeconomic development and quality of life in this study, LEF5, has a consistently negative effect on fertility of all ages of mothers and the coefficients are generally very significant. In many cases the effect of female life expectancy on fertility was even reinforced by the inclusion of the short-term variables into the equation, thus controlling for certain fluctuations superimposed to the strongly negative long-term association between fertility and life expectancy at age 5.

4. Women's relative educational status (MATRD) also has a significant negative effect on fertility, more so in the younger and prime childbearing ages than above age 35.

5. The influence of annual increases in GDP per caput on fertility is positive in most models though never statistically significantly.

6. The effect of annual percentage changes in infant mortality lagged by one year (PCIMLAG) is mostly positive. It is not statistically significant for the pre-industrial period and is most important—especially for women aged 20-34—for the period 1918-1942. This may be interpreted as an indication for child replacement strategies or a strong lactational effect during that period.

7. The explanatory value of these regression models, measured in terms of R^2, increases from .50 for the younger age groups to as high as .95 to .97 for the fertility of the older childbearing ages. This pattern holds for the periods covering the great fertility transition but is not clear for the pre-industrial fertility pattern. The reason may be found in the development of parity-specific fertility control which by definition is more pronounced in the older reproductive ages. The fertility of young women is to a lesser extent governed by the quantum aspect of fertility. Hence, the variation explained for younger age groups mainly accounts for period effects in the timing of fertility.

8. As can be expected from the high negative correlation between fertility and the modified index of family limitation (m^*), the pattern of regression coefficients for explaining this dependent variable is quite similar to that of fertility, but with reversed signs. The extent of parity-specific fertility control seems to be much more dependent on long-term developments than on short-term changes. In other words, the reaction to short term economic or other stimuli is not through parity-specific fertility control, but rather through changes in the timing of fertility across all ages.

9. In the case of separate regression models for the different periods, the period 1943-1976 which includes the great fertility peak of the post-war baby boom results in the least significant coefficients. Taking TFR as the dependent variable yields significant coefficients with a reasonable sign only for the lagged marriage rate and MATRD; no positive income effect or a negative effect of LEF5 appeared for that period. The reason for this poor performance of the regression model for the period including the baby boom may be explained by the fact that none of the socioeconomic indicators showed an

evolution that would account for the extraordinary high fertility rates during the 1940s and 1950s. Probably a more sophisticated model accounting for intergenerational patterns of reproductive behavior could be applied, a task that cannot be carried out here.

LESSONS FROM THE STUDY OF FINNISH FERTILITY TRENDS

This case study of Finland may help us to evaluate various hypotheses which were expressed in the context of the European demographic transition:

The hypothesis of a ***nuptiality transition prior to the transition in marital fertility in Western Europe occurring in recent centuries*** found strong support from the Finnish evidence. Information from various independent sources as well as their combination in a simulation model suggests a dramatic decline in proportions ever-marrying and an increase in the age at marriage during the second half of the eighteenth century. Hence, Finland might be the only case in Western and Northern Europe where this nuptiality transition occurred late enough and statistics started early enough to make it subject to quantitative analysis.

The hypothesis of ***natural fertility before the onset of the marital fertility transition*** was also supported by the present study. At least on aggregate level parity dependent fertility control was not practised until the end of the nineteenth century. The analysis of short-term reactions to environmental adversities also indicated that before the great fertility transition depressed fertility was not a consequence of family limitation strategies. Even when we assume that the ***timing*** of births might have been governed by more or less conscious behavior in addition to biological factors, there is no indication that the ***quantum*** might have been subject to conscious choice before the onset of the transition.

The same evidence serves in supporting the ***innovation hypothesis*** which, in contrast to the adjustment hypothesis, assumes that the widespread practice of family limitation was not the adoption of already existing patterns of behavior but that it was a new mentality. Urban-rural differentials also suggest the spreading of a new idea from urban elites where family limitation started around 1870-1880 to the other urban population and finally to the rural areas (see Pitkänen, 1982). Neither when parity-specific fertility limitations appeared in urban areas in 1880-1890 nor when it spread to the countryside around 1910, this was accompanied by revolutions in the socioeconomic environment. Hence, this new fertility regime is more likely to result from an ***innovation*** than from an ***adjustment*** of traditional behavior to new economic conditions.

This finding also helps to reject the ***industrialization hypothesis*** for Finland which assumes that the change from a peasant society to an industrial society is the main reason for the modern fertility transition. In Finland, however, the demographic transition took place in an almost completely agricultural setting. Finland was the country in Europe with the highest percentage rural at the time of a 10% decline in marital fertility (see Knodel and van de Walle, 1979). Furthermore, the variable representing the proportion of persons in non-agricultural activities did not show any explanatory value in the multivariate case.

Concerning the causal links between infant mortality and fertility the ***replacement hypothesis*** could already be rejected for the pre-modern period. Furthermore, the fact that infant mortality started to decline long before fertility cast serious doubts on the assumption that declining infant mortality initialized the fertility transition. This does not mean, however, that the secular declines in fertility and infant mortality are completely independent phenomena. It seems very likely that there is some link, at least through a common determinant: modernization of living conditions.

One of the most general hypotheses in historical demography is the so-called ***homeostasis hypothesis***. This general concept is based on the functionalist assumption that societies strive to maintain equilibrium and that any disequilibrium tends to generate a correcting response. In the short run this hypothesis obviously does not hold because fertility and mortality vary inversely, even if we consider time lags of one to three years. In the very long run we might find support for this hypothesis if we look at it in the sense of multiphasic responses as stressed by Kingsley Davis (1963). Continued population growth in the southern parts of Finland led to population pressure and as a preventive Malthusian check to the nuptiality transition during the late eighteenth century; around the middle of the nineteenth century population pressure increased again and mortality started to increase—a positive Malthusian check—together with overseas migration; around 1910, finally, society reacted by reducing marital fertility—a neo-Malthusian response. But the picture is far from conclusive. Why did those responses take place in the given order and timing, resulting in a very irregular pattern of natural increase, far from equilibrium?

The answer to this might be found in some of the results from our study. Both demographic transitions of Finland—the nuptiality transition and the marital fertility transition—can only be understood if we explain them not only by demographic and economic factors but by cultural diffusion processes that brought new mentalities and new ways of living to broad segments of the population.

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