Period Fertility Measures: The Construction of Different Indices and their Application to France, 1946-89

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PERIOD FERTILITY MEASURES
The construction of different indices and their application to France, 1946-89

Calculating projections of the French population in 1954, Louis Henry considered that it was reasonable to prolong the stable fertility behaviour observed in the years 1949-52. But, among the multitude of indices which had been concocted in the post-war demographic cauldron, which ones should he choose to hold constant? The classic age-specific general fertility rates, the age at marriage- and duration-specific marital fertility rates analysed by Jean Bourgeois-Pichat, their simplified version by marriage duration only, or Henry's own freshly proposed rates by birth order and interval? Depending on the choice made, the number of births would fall by anything between –10,000 and –110,000 in 15 years.* Jean-Louis RALLU** *and* Laurent TOULEMON** *examine a new array of synthetic indices for measuring period fertility and apply them to the French data. They come to the same conclusion: that it is risky to represent the demographic phenomena in a single metric.*

The conventional summary measure of period fertility, the total fertility rate (TFR), is only one of a family of synthetic indicators. When detailed information is available, more complete period indices can be calculated, which provide greater consistency and are free of certain flaws which are often considered inherent to the very principle of 'period measure'. In particular, the combining of parity-specific birth probabilities is preferable to the summing of incidence rates (*taux de deuxième catégorie*: see footnote 5) for estimating fertility by birth order.

To interpret period indices which summarize the performance of a hypothetical, or synthetic, cohort whose members would live each age of their lifetime in the fertility conditions of the specified year ('current conditions'), it is necessary to assume that fertility depends *only* on the conditions in that particular year, and not at all on past fertility. We shall first discuss this assumption, then apply it to the construction of five period fertility indices. Finally, these indices will be used to measure total fertility and its parity components in France since 1946.

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* Louis Henry, *Perspectives démographiques*, 2nd Edition, INED, 1973, 115 pp.
** INED.

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I. – The assumptions underlying the period fertility measures

How to measure period fertility? To analyse fertility in a given year, the first step is to disaggregate the population into homogenous sub-groups (with respect to age, marital status, number of children, duration of interval since last birth, occupational status, contraceptive use, and so on), for which specific fertility rates are calculated (ratio of births to mean population in each group) [Henry, 1981; Keyfitz, 1984].

The synthesis of these rates is much more complicated, and a variety of solutions have been proposed. *Standardization* techniques are used to eliminate the effects of one, or several, variables. In direct standardization, observed rates are applied to a population with an arbitrary structure for that, or those, particular variable(s) (standard population). In practice, this method is rarely used to eliminate the structural effects of variables other than age or marital status [Hajnal, 1947]. In indirect standardization, observed behaviour is compared to that of a population with the actual structure, but with arbitrary behaviour (standard rates). Studying variations in divorce rates in Sweden, Hoem [1991] demonstrates the value of indirect standardization by using log-linear regressions to isolate the effects due to period, to number of children, to age and to duration. Such regressions permit a close-up of the interactions between effects, or, inversely, more or less global recombinations. In this type of analysis, the idea of representing the current conditions by a single measure is eliminated *a priori*; the aim is to isolate the different components of change. Another approach consists of summarizing the differences between groups by applying appropriate coefficients based on empirical or logical relations between their rates [Bourgeois-Pichat, 1950]. Finally, the rates can be summarized by constructing a *synthetic cohort*, having the properties of a population derived from the observed rates. In this approach, the conventional indicators of cohort fertility all have a period counterpart: completed fertility, mean age, parity progression ratios can all be calculated from the fertility behaviour observed in a given year.

Direct standardization techniques lead to fertility estimates expressed as *children per woman per year*; indirect standardization methods or the construction of appropriate coefficients lead to *specific scales*, while the construction of a synthetic cohort yields measures expressed in *children per woman per lifetime*.

The total fertility rate (TFR) may be viewed from two different angles. First, it may be interpreted as summarizing the births occurring *in the course of one year* in a standard population of *35 women* (one per fertile age, 15-49); this is the 'reduced events' approach (the *somme des naissances réduites*). Second, and most commonly, it is interpreted as summarizing the number of children borne *in the course of 35 years* (the fertile lifespan) by *one woman*. This definition – "the mean number of children a woman would have had by the end of her reproductive life, if the conditions of the present year were to repeat themselves endlessly" [INED, 1991] – implies the construction of an indicator which, by summing all the age-specific performances in turn, measures a woman's *lifetime* fertility. These two definitions are not equivalent: the former is an example of direct standardization, while the latter corresponds to the construction of a synthetic cohort of women who would live their whole lives to age 50 (assuming none would die) under 'current fertility conditions'.

The demographic handbooks warn against the dangers of such an interpretation. Pressat [1983], for instance, observes that "[on mortality...] a group of people might conceivably experience, throughout their lives, the mortality conditions reigning in one particular year. With respect to nuptiality and fertility, such a postulate is generally unreasonable, since the life-fragments gathered, in a given year, from different birth or marriage cohorts, depend on their past history; this non-independence of the fragments introduces great inconsistency when they are lined up in a synthetic result".

Within birth cohorts, the structure of the population observed at each age is consistent with past fertility behaviour, if we put aside the disturbing influences of mortality and migration. For instance, the proportion of childless women at age 30 can be inferred from first-birth fertility rates up to age 30. This consistency between the structure observed at a given age and behaviour at the younger ages results in a single value for completed cohort fertility, assuming independence and continuity (see below) [Henry, 1966]. This is not the case for period fertility, which can be measured by several different synthetic indicators. The aim of the present study is to determine how best to eliminate the influence of the past, to obtain indices which are 'increasingly transversal', by defining as far as possible the *current conditions* (or conditions prevailing in the year considered) in which the synthetic cohorts are supposed to live their whole reproductive lives.

A necessary assumption: fertility depends only on current conditions

We shall deal only with methods based on the synthetic cohort principle, in order to compare the conventional period measure, TFR, with others expressed in the same unit: *children per woman*. These indices require the assumption that fertility behaviour in a given year is independent of that in previous years. We suppose the existence of a 'period fertility' which, *in groups of women defined by a certain number of variables*, depends only on 'current conditions'. The number of births in each group is then taken to be the product of two *independent* factors: on the one hand, the specific fertility rate defines the current conditions for the group, and on the other, the size of the group depends on the size and structure of the general population, both of which are the result of the past.

This strong assumption is essential for combining the rates observed in each group into more or less complex fertility schedules. We can speak of a *general model of period fertility*, the only framework in which a population structure can be derived step by step from the rates observed in a given year, and the observed rates then be applied to this stable population. The synthetic cohort assumption used to represent TFR in terms of children per woman per lifetime is thus extended, by attributing to this cohort not only a fixed age structure (zero mortality and migration between ages 15 and 50), but also structures relative to other variables which depend each year on the 'current conditions'.

The construction of the indices

All the indices presented here are measures of *female fertility,* expressed in terms of *children per woman*(1), and of *crude* fertility, since the effects of migration and mortality are eliminated. They are based on assumptions of independence – mortality and migration are independent of past fertility – and continuity – women who have emigrated or died would have had the same fertility as those remaining, and immigrants have the same fertility as the rest of the population. These assumptions are improbable, but are conventionally used for measuring fertility, since migration and mortality have insufficient weight at the reproductive ages to significantly alter the estimates [Henry, 1959; 1966].

We shall measure fertility in single-year time periods, so that the rates are comparable to proportions of women having borne a child during the year(2). For each group, what counts in the final calculation is the number of events per woman during the year(3).

The constitution of groups which are homogeneous with respect to fertility is, of course, only a theoretical possibility, and in practice it is necessary to limit the number of such groups. *Age* is an obvious variable: fertility varies substantially with age, age data are easily collected, and any look into fertility timing requires mother's age at each birth. Age is defined as the 'age reached during the year' (current calendar year minus year of birth) and is constant throughout the year. To take into account women's past history (replaced in the model by that inferred from the 'current conditions') implies entering the *number of previous births to the mother* in

(1) Male fertility indicators could be calculated if reliable data were available on father's age and number of children. In times of upheaval, the general fertility rates of men and women can be quite different [Brouard, 1977]. Furthermore, time trends in male and female infertility in France have diverged substantially: among men, the proportion remaining childless has barely varied from c.1900 to c.1940 (almost 17%), while among women, it has fallen from 25% to 10% [Toulemon, 1991]. An accurate measure of male fertility would thus be useful, but this question is beyond the scope of the present study.

(2) Supposing a woman can have only one birth a year and neglecting multiple births. Alternatively, we could first consider the probability of pregnancy, then the probability of a multiple birth. Entering the probabilities of being pregnant twice and of having twins would not alter the final estimate.

(3) Since no 'disturbing event' is entered in the calculation, the synthetic fertility measure for each group will be the same whether it is measured by annual birth probabilities, specific occurrence-exposure rates (*taux de première catégorie*) or instantaneous rates [Keyfitz, 1977]. In particular, discrete and continuous formulations lead to the same results, and the former, although more unwieldy [Hoem, 1970], facilitates comparison with presentations based on conventional fertility rates.

the calculation. Births are then studied by *parity* or *birth order* and considered as *non-renewable* and *successive* events. Another variable describes the effects of past fertility: the *duration of interval since previous birth,* which divides the population into very different groups [Henry, 1953] (this applies to parous women only).

These variables are not the only ones involved, and we could include others which are suspected of strongly influencing fertility, e.g. *marital status*. To introduce such variables, we would need to know not only the fertility of each category of women (married, single...), but also *the reciprocal influence of fertility on category changes*, so as to construct a truly transversal model, in which the structure of the synthetic cohort would depend only on behaviour in the current year. For instance, marriage and divorce rates should be available by number of children already born, to take into account the influence of the latter, and perhaps also of age of lastborn child. But it would be preferable to have *de facto* marital groups (married, cohabiting, living alone) rather than legally defined statuses, and to consider the situation at time of *conception* rather than at birth, to eliminate bias resulting from category changes between the two events.

Other variables (occupational or health status, etc.) also affect fertility, and the 'perfect' indicator, totally free of the influence of the structures observed and providing a truly transversal measure of fertility, is an illusion. Consequently, we decided to take into account only those variables which directly describe fertility. The influence of previous births will be summarized by the number of children and the age of the lastborn, supposed sufficient to sum up the timing of past fertility.

II. – Various measures of period fertility

The indices presented here all measure period fertility in terms of the number of children that would be borne, on average, by a woman who would live each year of her fertile life under 'current conditions', these conditions being defined with increasing precision.

The conventional measures

The general fertility rate can be transformed into a general fertility index (GFI)(4)

The crude birth rate is obtained by dividing the total number of births by the total population. A first improvement consists in dividing the population into two more homogenous groups: the persons susceptible of giving birth, i.e. *women aged 15-49,* and the others. By relating the total number of births to this first group, women of reproductive ages, we obtain the

(4) For the interested reader who wishes to consult the more complete original study in French (*Population* 1 and 2, 1993), and in particular the additional tables and figures, we give the French equivalent of the abbreviations used here: GFI = IGF; TFR = ISF; PATFR = ISFRA; PDTFR = ISFRD; PDiTFR = ISFRDtx; PADTFR = ISFRAD.

general fertility rate, expressed in births per year per 1,000 women [Henry, 1981].

This rate is sensitive to the definition of reproductive ages, and it might be preferable to use the *general fertility index (GFI)*, obtained by multiplying the general fertility rate by the number of ages considered to be 'reproductive' (here, 35 = 50–15) and dividing by 1,000 [Dittgen and Lamy-Festy, 1989]. The upper bound selected for the reproductive ages (45, 50 or 55, for instance) then has very little effect on the value of the index, which represents the number of children a woman would have if, for 35 years (or 30 or 40), she experienced fertility equal to the general fertility rate.

The total fertility rate (TFR)

When information on mother's age is available, heterogeneity within the reproductive group can also be taken into account. Thus, we calculate the *age-specific fertility rates* (births to mothers of a specified age over all women of that age), which are then summed to obtain a synthetic measure of period fertility, the *total fertility rate* (or *somme des naissances réduites*). Maternal age being generally known, this index is very commonly used. *Summing the age-specific fertility rates amounts to calculating the mean value of the rates – the same weight being given to each age – and multiplying it by the number of reproductive ages.* Alternatively, different weights could be applied, using other standard age structures. Two principal arguments are classically put forward to justify the use of identical weights. In the first, the sum of the rates is considered as the area below the age-specific fertility curve, i.e. as an approximation of the integral of the age-specific fertility function, age being assimilated to a continuous variable. If the aim of this measure is only to eliminate the structural effect of age, other methods are statistically preferable (regressions, standard rates...) [Hoem, 1991; Toulemon, 1992], and the result is a *standardized fertility rate* expressed in children per woman per year. In the second argument, a *fertility model* is, more or less explicitly, defined. The sum of the age-specific rates observed in a given year – and not the mean value of these rates – is presented as the number of children a woman would bear if she experienced, *at each age of her life*, the conditions prevailing in that year. This presentation is correct only *assuming that fertility depends on nothing but age*.

To measure fertility by birth order, the number of births by order and mother's age can be related to all women of that age (however many children they had at the beginning of the year): this gives age- and order-specific incidence rates (*taux de deuxième catégorie*)[5] [Lotka and Spiegelman, 1940]. By summing these rates, we obtain order-specific TFR components [Calot, 1979]. The resulting estimates are not always interpretable in terms of quantum. For instance, during the 1940s, the first birth component exceeded unity in many Western countries, which would mean more than one first birth per woman. This problem may be considered of secondary importance: L. Henry [1953], studying marital fertility, remarked that "such a formally absurd result [first-order fertility exceeding unity] recalls the conventional nature of the indices used and tangibly demonstrates the existence of a catching-up process". However, the result, without being "formally absurd", may be far removed from a measure obtained by replacing the observed composition by age and number of previous births by the composition inferred from the behaviour in the year considered. The differences are generally interpreted with reference to *cohort behaviour* (births occurring earlier or later) [Sardon, 1991], whereas a more convincing approach is to study *differences in population composition at a given date* (see below).

When parity is entered in the calculation

When births are considered *by order among children born to a same mother*, they become *successive* and *non-renewable* events: only women with r children can give birth to a child – and only one child – of order $r+1$.

An index controlling for parity and age (PATFR)

A summary index of period fertility based on age- and parity-specific fertility rates was first used for the US by Whelpton [1946, 1954], who went on to derive net mortality, nuptiality and sterility indicators from it, then by Das Gupta and Long [1985]; for China by Feeney et al. [1989]; for the Netherlands by de Jong [1986]; and for Italy by de Simoni [1991][6]. In France, Desplanques [1985, 1986] calculated parity progression ratios for orders 6 and lower, but proposed no global fertility measure. *For the present calculations, fertility behaviour in a given year is defined by the probabilities of giving birth, by age and number of children already borne.* For year t (implicit parameter), we denote:

x : age reached during the year (i.e. current calendar year – year of birth);

r : number of children already born;

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(5) French-speaking demographers widely employ incidence rates: *taux de deuxième catégorie*. Age- and order-specific incidence rates are computed as the ratio of births of order $r+1$ at maternal age x to the *total* number of women aged x, *irrespective of their parity* at the beginning of the period. Duration and order-specific incidence rates are the ratio of births of order $r+1$ occurring at duration d since previous birth to the *total* number of women who had a child of order r duration d ago, *irrespective of their parity* at the beginning of the period. Parity-specific birth probabilities are the ratio of the number of births of order $r+1$ occurring during a period to the number of women of parity r at the beginning of the same period. They may be age- or duration-specific. Probabilities are combined in a life table, while age- or duration-specific incidence rates are summed to obtain a synthetic measure of intensity.

(6) The last two authors group together all births of orders 4+, which biases the total fertility results. Lutz [1989] proposes a fertility measure constructed from parity-specific birth data and mean age of mothers at each birth, which is useful when working on data from small samples or having substantial inaccuracy. This index is derived from Chiang [1984] (multiplicative fertility model by age and parity).

$q(x, r)$: the birth probability at parity r and age x, i.e. the probability that a woman aged x with $r-1$ children at beginning of year will give birth during the year[7];

$N(x, r)$: the number of women aged x, of parity r at beginning of year, thus at risk of having a child of order $r+1$, given that x varies from 15 to 50 and r from 0 to 10;

$N(x) = \sum_r N(x, r) = N$ number of women of each age, supposed constant.

The probabilities $q(x, r)$ enable us to calculate the following estimates, relative to a population of N women who would live each age of their lives in the year considered, without mortality or migration. Let N be 1,000:

$$N(15,0) = 1{,}000 \tag{1}$$

For $x \geq 16,\ r = 0$

$$N(x, 0) = N(15, 0) \prod_{15 \leq y < x} [1 - q(y, 1)] \tag{2}$$

For $x \geq 16, r \geq 1$

$$N(x, r) = \sum_{15 \leq y < x} \left\{ N(y, r-1)\, q(y, r) \prod_{y < z < x} [1 - q(z, r+1)] \right\} \tag{3}$$

The first equation corresponds to the initial population: at age 15, at beginning of year, no woman has had a child. The second represents the 'survivors' of the parity-1 fertility schedule: the women aged x who have no children at beginning of year are those who have had no births at previous ages. The third defines the women aged x having r children as women who have had a child of order r at an age y younger than x, and who have had no more children since. If $x < 15+r$, then: $N(x, r) = 0$.

The populations at age 50[8] $N(50, r)$ give the ultimate parity distribution of the synthetic cohort (here, in per 1,000). They permit the construction of the usual indicators (parity- and age-specific TFR and its parity components):

For $1 \leq r \leq 10$

$$\text{PATFR}(r) = \frac{1}{N} \sum_{s \geq r} N(50, s) \tag{4}$$

$$\text{PATFR} = \sum_r \text{PATFR}(r) = \frac{1}{N} \sum_r r\, N(50, r) \tag{5}$$

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(7) Age x is taken to vary from 15 to 49, and parity r from 1 to 10, fertility being negligeable before and after these ages and parity. For parities higher than 1, the birth probabilities are not very accurate for the youngest ages (mostly due to collection errors), but this concerns few women and so does not affect the ultimate parity distribution.

(8) That is, the number of women aged 49 at end of year, as inferred from the model.

Equation 4 defines period fertility for each birth order r as the proportion of women who, having lived their entire life under 'current conditions', have borne at least r children, i.e. one child of order r. The fifth equation represents the *summary index of parity- and age-specific fertility* (PATFR), expressed in *children per woman.*

A period counterpart of all the conventional fertility indicators can also be calculated, using the equations employed to measure cohort fertility. Period parity progression ratios (a_r), age- and order-specific fertility rates $tx(x, r)$ (incidence rates) and age-specific general fertility rates $tx(x)$ are defined by:

For $0 \le r \le 9$

$$a_r = \frac{\sum_{s \ge r+1} N(50, s)}{\sum_{s \ge r} N(50, s)} = \frac{\text{PATFR}(r+1)}{\text{PATFR}(r)} \tag{6}$$

For $1 \le r \le 10$

$$tx(x, r) = \frac{1}{N} N(x, r-1)\, q(x, r) \quad \text{and} \quad tx(x) = \sum_r tx(x, r) \tag{7}$$

The similarity with cohort analysis ensures the consistency of the indicators: the parity progression ratios range from 0 to 1, because they are defined from ultimate parity distribution. The incidence rates can be presented as intermediary results in the PATFR calculation, in the same way as the birth probabilities:

For $1 \le r \le 10$

$$\text{PATFR}(r) = \sum_x tx(x, r) \quad \text{and} \quad \text{PATFR}(r) = \sum_x tx(x) \tag{8}$$

Equations 7 show the difference with the conventional incidence rate calculation. *In the calculation of the PATFR index, the 'fertility behaviour' $q(x, r)$ is applied to populations $N(x, r-1)$ which depend only on current behaviour $q(y, s)$ at ages y lower than x, for women having less than r children ($s < r$; $y < x$); inversely, the conventional incidence rates apply the current behaviour $q(x, r)$ to a population whose structure by number of previous births, at each age, depends on past behaviour.*

Parity and duration since previous birth (PDTFR)

In the PATFR calculation, the numbers $N(x, r)$ of women of age x and parity r change from year to year, due to exits (birth of a child of order r+1 at age x) and entries (birth of a child of order r at age x), and to combine the age-specific probabilities at parity r is contrary to the conventions of demographic analysis, which consider *time elapsed since previous* *event* as the primary factor of heterogeneity. This leads us to control simultaneously for parity and duration since previous birth.

The fact that marital fertility depends more, in our modern societies, on marriage duration than on age, together with the lack of information on non-marital birth order, has led a number of demographers to construct duration-specific marital fertility indices (duration since marriage, for first births, and duration since previous birth, for births of higher orders). A general fertility index can then be inferred by adding correcting factors which allow for the probability of marrying and for non-marital births.

The English-speaking authors [Feeney, 1983; Feeney and Yu, 1987; Ní Bhrolcháin, 1987; Zeng, 1991] use duration- and parity-specific marital birth probabilities, while the French-speaking authors, following the example of L. Henry [1953], give preference to incidence rates (see note 5) [Blayo, 1986]. When birth data (marital or non-marital) are available by order, age can be used as an indicator of duration for the first birth (the previous event being the mother's birth), and interval since previous birth as duration for births of higher orders.

The index based on parity- and duration-specific birth probabilities can be written as follows, where:

r : number of children already born;

d : duration of interval since previous event. For first births, d corresponds to the time elapsed since a selected baseline event (marriage, birth or mother's 15th birthday). Duration d ranges from 1 to an upper duration *dmax* defined *a priori*(9);

$q(r, d)$: the birth probability at parity r and duration d;

$N(r, d)$: the number of women having r children at beginning of year, the last of whom was born d years earlier. $N(0, 1) = 1{,}000$.

For $d \geq 2,\ r = 0$

$$N(0, d) = \prod_{1 \leq e < d} [1 - q(1, e)] \tag{9}$$

For $d = 1,\ r \geq 1$

$$N(r, 1) = N(r-1, 1) - N(r-1, dmax) \tag{10}$$

For $d \geq 2,\ r \geq 1$

$$N(r, d) = N(r, 1) \prod_{1 \leq e < d} [1 - q(r+1, e)] \tag{11}$$

(9) For first births, d measures the duration since January 1st of the year of the 14th birthday, and varies from 1 to 35; for higher orders, d measures the age of the last child (current calendar year – year of birth) and varies from 1 to 17, fertility being negligible at higher durations.

For $1 \leq r \leq 10$

$$\text{PDTFR}(r) = \frac{1}{N} \sum_{s \geq r} N(s, dmax) = \frac{N(r, 1)}{N} \tag{12}$$

$$\text{PDTFR} = \sum_{r} \text{PDTFR}(r) \tag{13}$$

For $0 \leq r \leq 9$

$$a_r = \frac{\sum_{s \geq r+1} N(s, dmax)}{\sum_{s \geq r} N(s, dmax)} = \frac{N(r+1, 1)}{N(r, 1)} \tag{14}$$

Equation (9) is identical to equation (2). The index is now simplified, since births of order r become survivors in $r+1$ at duration 1 (eq. 10). It does not permit the reconstruction of age-specific incidence rates, despite the fact that duration at first birth is measured by age, and so the corresponding equations are not presented.

Duration-specific incidence rates (PDiTFR)

The major advantage of duration-specific incidence rates (births of order $r+1$ at duration d related to the 'initial' number of women having experienced the event of order r (birth of a child of order r or marriage for $r = 0$)) is that the only data required are registration data (homogeneity). Using the same notation as for the PDTFR calculation, the period parity progression ratios are defined as sums of incidence rates, by age (for first births) and by duration since previous birth (for all others), from which the parity-specific fertility indices PDiTFR(r) are derived. L. Henry [1953] devised and popularized in France the use of these parity progression ratios to estimate marital fertility. But presently, the availability of more detailed information and the greater facilities for computing and controlling the quality of large data files, permit the calculation of duration-specific probabilities and their combining into the PDTFR index.

A 'complete' synthetic measure of fertility

We can also construct an index in which birth probabilities vary with age, parity and duration since previous event[(10)]. This index is 'complete' inasmuch as all the information on past fertility is taken into account[(11)].

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(10) A similar model has been proposed by Wolf [1988] to estimate divorce rates by age and marriage duration.

(11) It is 'complete' only in comparison to the preceding indices. Increasingly detailed models could be devised.

Parity, age and duration (PADTFR)

For each parity and each age at previous event, we construct a duration-dependent life table. We denote:

x : age reached during the year (current calendar year – year of birth);

r : number of children already born;

d : duration since previous event. For first births, d corresponds to duration since January 1st of the year of the 14th birthday;

$q(x, r, d)$: the birth probability at parity r, age x and duration d;

$N(x, r, d)$: the number of women aged x, having r children at beginning of year, the last of whom was born d years earlier ($d > 0$). $N(15, 0, 1) = 1{,}000$. If $r = 0$, d is duration since the baseline event; an upper duration $dmax$ is defined *a priori*.

For $x \geq 16,\ r = 0,\ d = x - 14$

$$N(x, 0, d) = N(15, 0, 1) \prod_{15 < y < x} [1 - q(y, 1, y - 14)] \tag{15}$$

For $x \geq 16,\ r \geq 1,\ d = 1$

$$N(x, r, 1) = \sum_{0 < d \leq dmax} [N(x - 1, r - 1, d)\, q(x - 1, r, d)] \tag{16}$$

$$N(x, r, d) = N(x - d + 1, r, 1) \prod_{0 < e < d} [1 - q(x - d + e, r + 1, e)] \tag{17}$$

$$N(x, r) = \sum_{d} N(x, r, d) \tag{18}$$

Equation (15) represents the 'survivors' of the parity-1 fertility schedule. It is identical to (2) and (9) defining zero-parity women for the PATFR and PDTFR indices. Equation (16) defines the women of age x having had r children for duration 1 year as women having had a child of order r at age x–1. In other words, this is the initial population of a simple table of 'survivorship in parity r attained at age x–1'. The number of these tables is determined by the number of (x, r) combinations. The number of survivors is calculated using (17).

For the probabilities $q(x, r, d)$ to be non-nil, (x, r, d) must verify the following three conditions: $1 \leq r \leq 10$; $14 + r \leq x \leq 49$; $1 \leq d \leq x - r - 14$. For the number of women $N(x, r, d)$ to be non-nil, the conditions $0 \leq r \leq 10$; $15 + r \leq x \leq 50$; $1 \leq d \leq x - r - 14$ must hold.

As was the case for the previous indices, the numbers of women at age 50 $N(50, r)$ define the ultimate parity distribution (per 1,000) (equation 18) and permit the construction of the *summary index of parity-, age- and duration-specific fertility PADTFR* and of its parity components:

$$\text{PADTFR} = \sum_r \text{PADTFR}(r) = \frac{1}{N} \sum_r rN(50, r) \tag{19}$$

The preceding indicators can also be derived conventionally: parity progression ratios, fertility rates by age and birth order (incidence rates), and age-specific general fertility rates are defined by equations analogous to (6) and (7) above. Given that the age- and parity-specific birth probabilities:

$$q(x, r) = \frac{\sum_d N(x, r, d)\, q(x, r, d)}{\sum_d N(x, r, d)} \tag{20}$$

Then equation (7) becomes, for instance:

for $1 \leq r \leq 10$

$$tx(x, r) = \frac{N(x, r-1)}{N} \frac{\sum_d N(x, r, d)\, q(x, r, d)}{\sum_d N(x, r, d)} \tag{21}$$

These new incidence-rate equivalents verify, for the same reasons as previously, the equations:

$$\text{PADTFR}(r) = \sum_x tx(x, r) \quad \text{and} \quad \text{PADTFR} = \sum_x tx(x)$$

By analogy with (20), parity- and duration-specific birth probabilities $q(r, d)$ can also be defined, as well as age- and duration-specific ones $q(x, d)$, at least for parities higher than 1.

The required estimates

Such a construct requires the estimation of a great many parameters (3,865 per year, supposing the probabilities become zero after 20 years for parities higher than 1). Even with a set of large-scale survey data, it is not feasible to estimate all the parameters without imposing a number of constraints. We verified that diversity of the estimates (see appendix to part II of the original paper in French) had practically no effect on the final index: the constraints set by consistency with the registration data guaranteed their robustness.

The timing of fertility

For births of all orders, or of a specified order, the mean age of the women weighted by the fertility rates (incidence rates) (obtained directly for the TFR calculation, or reconstructed using equations (7) for the PATFR and (21) for the PADTFR) provides the mean childbearing age in the year considered. The mean age $y(r)$ at birth of children of a specified order is equal to:

For $1 \leq r \leq 10$

$$y(r) = \frac{\sum_x x \, tx(x, r)}{\sum_x tx(x, r)} \tag{22}$$

For births of all orders combined, the mean age y is equal to:

$$y = \frac{\sum_x x \, tx(x)}{\sum_x tx(x)} \tag{23}$$

III. – Application to French data, 1946-89

The application of the different indices to the French data since World War II will show their specificities, and also the limits of the general model of period fertility. It will also provide more insight into the baby boom phenomenon and into current fertility, by isolating the order-specific components of fertility over the past 40 years.

The results presented here are derived from calculations based essentially on the Family Survey conducted by the French Institute of Statistics (INSEE) in 1982[12] (kindly communicated by Guy Desplanques), from the 1946 census data (to estimate the parity distribution in 1946) and from registration statistics. After the reconstitutions described in the appendix (to paper II in French), we had a complete set of age- and parity-specific birth probabilities $q(x, r)$ for 1946 to 1989, and of parity- and duration-specific probabilities $q(r, d)$ and age-, parity- and duration-specific probabilities $q(x, r, d)$ for 1975 to 1989 (women aged 15-49).

Almost two children per woman in 1989

The indices which do not take duration into account

Figure 1 illustrates the time trends 1946-1989 for the general fertility index (GFI), the summary index taking age into account (TFR), and the summary index taking parity and age into account (PATFR).

The age structure of the female population 15-49 is favourable to natality when most women are in the 'peak fertility' age range, 20-35.

(12) See Desplanques [1985; 1986] and Rallu [1986].

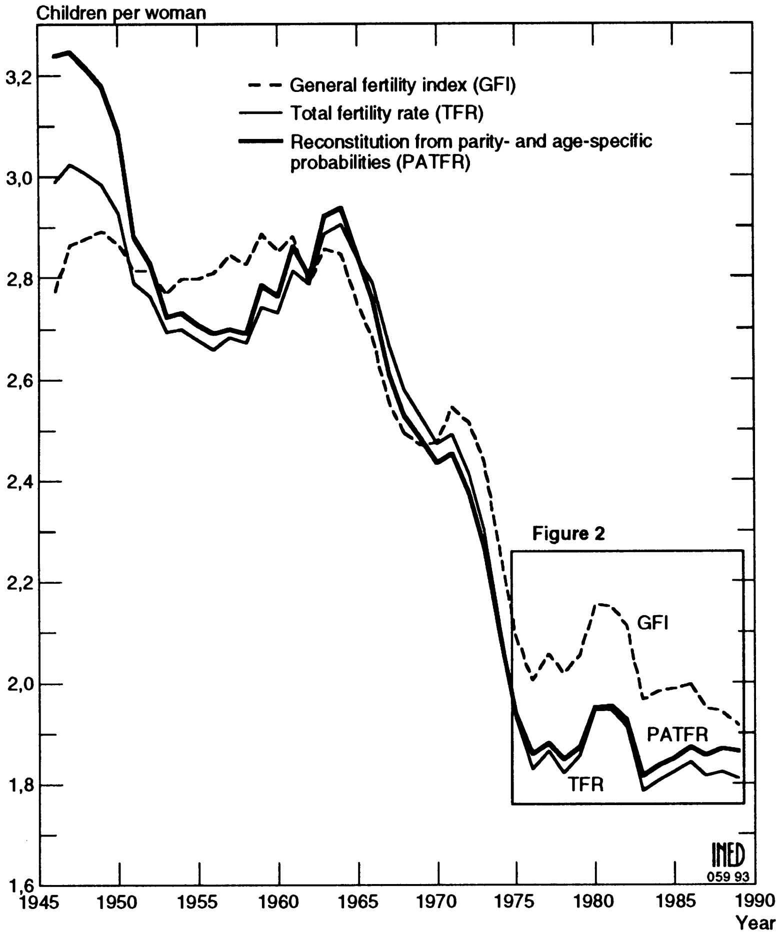

Figure 1. – Three synthetic fertility indices for France, 1946-89

Births fell steadily in France from 1900 to 1945, with a dip during World War I; from 1945 to 1973, they rose rapidly, then levelled off; after 1973, they started to decline. GFI is seen to be higher than TFR from 1955 to 1960, and then again after 1970. PATFR is very close to TFR between 1950 and 1985. For the late 1940s, the PATFR calculation 'inflates' the baby boom compared to TFR: more than 3.2 children per woman instead of 3.0 in 1947. It is again higher after 1985: 1.86 vs 1.81 in 1989. In both these periods, the actual number of children already born in each cohort is therefore unfavourable to fertility. But a closer look into fertility by age and birth order and into parity distributions is needed to interpret these differences. First, let us consider the summary measures for recent years.

The PADTFR index: 1.94 children per woman in 1989

From 1975 on, we have a set of fertility estimates by age, parity (higher than 1) and duration since previous birth (see appendix table). Introducing duration instead of age (PDTFR) substantially modifies the estimates for the 1980s (Figure 2): the rise from 1976 to 1982 increases

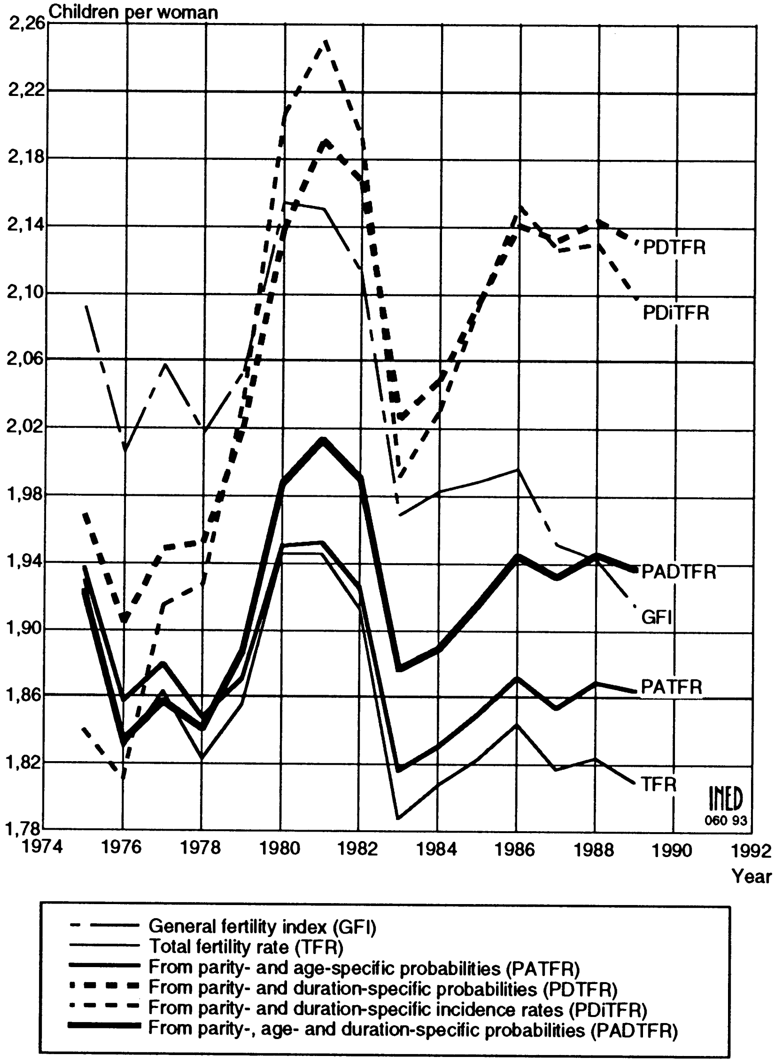

Figure 2. – Six synthetic fertility indices for France, 1975-89

slightly, but, above all, that between 1983 and 1986 is greatly accentuated, then a stabilization emerges.

Adding the variable duration together with age leads to a summary measure of 1.94 for PADTFR, 0.13 higher than TFR, in 1989. Thus, *period fertility has increased since 1983, and stabilized since 1986.* This stabilization is less visible with the TFR, since the numbers of children already born and the durations since previous birth are increasingly unfavourable cohortwise. The indices controlling for duration but not for age (PDTFR and PDiTFR) yield higher estimates. In all, the period fertility values for 1989 range from 1.81 for TFR and 1.86 for PATFR to 2.13 for PDTFR, with 1.94 for the 'complete' synthetic measure PADTFR.

Fertility by birth order

The baby boom

When birth order is taken into account (PATFR), the post-war baby boom appears to have been more considerable than the classic TFRs suggest (Figure 1). TFR overestimates first birth fertility (1.2 first births per woman, vs 0.9 for PATFR), but this is more than offset by the relative underestimation at higher orders (Figure 3).

The PADTFR calculation would yield an even higher fertility estimate for 1946, since the distribution by duration since previous birth was then unfavourable. The war led many couples to postpone childbearing, which means higher durations, for a given age and parity, in the actual population than in the population constructed from the birth probabilities in 1946, while fertility declines with age of lastborn. If the nuptiality rates and marriage durations in 1946 were taken into account, the estimate would be different, the actual population in 1946 being certainly richer in newlyweds than the population derived from the 'current nuptiality conditions' of that year. But the construction of the synthetic cohort poses a problem here: in the logic of the general model of period fertility, it would be necessary to distinguish between the women the war had prevented from having a baby and the others. In the population derived from the current conditions in 1946, the former group would not exist, and fertility would be calculated without the extra births which had been postponed then made up. The distinction is obviously impossible in practice, and the general model can be challenged, for there is no way of knowing how much of the baby boom was 'making up for lost time' and how much was 'end-of-war euphoria'.

In such a context, no period measure expressed in children per woman is really appropriate. But TFR is even less satisfactory than PATFR: the birth order components of TFR are highest in 1947 for order 1, in 1949 for order 2, in 1950 for order 3, in 1952 for order 4, etc. (Figures 3 and 4). This progressive diffusion of the baby boom from one birth order to the

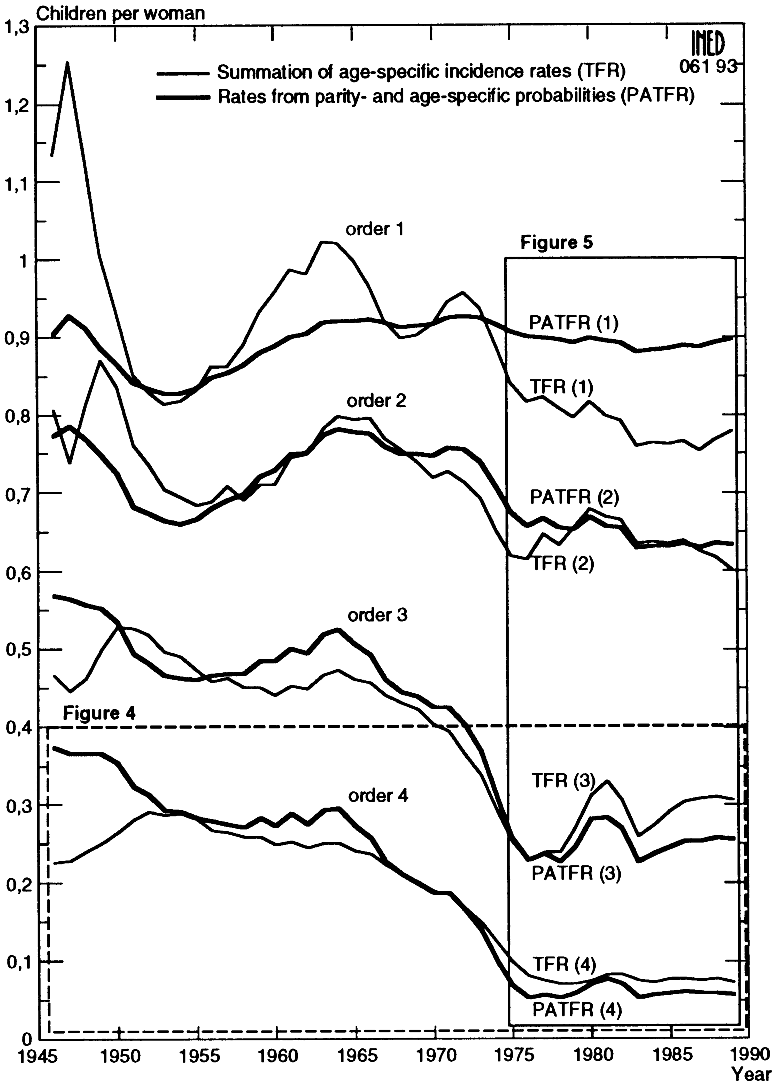

Figure 3. – Birth order components 1-4 of two synthetic fertility indices for France, 1946-89

next is due entirely to the fact that the TFR calculation does not take parity distribution into account. After 1950, many women already have several children (because of the high fertility between 1945 and 1950) and births of higher orders are increasingly numerous, *despite a decline in birth probabilities at higher orders.* Indeed, the birth order components of PATFR

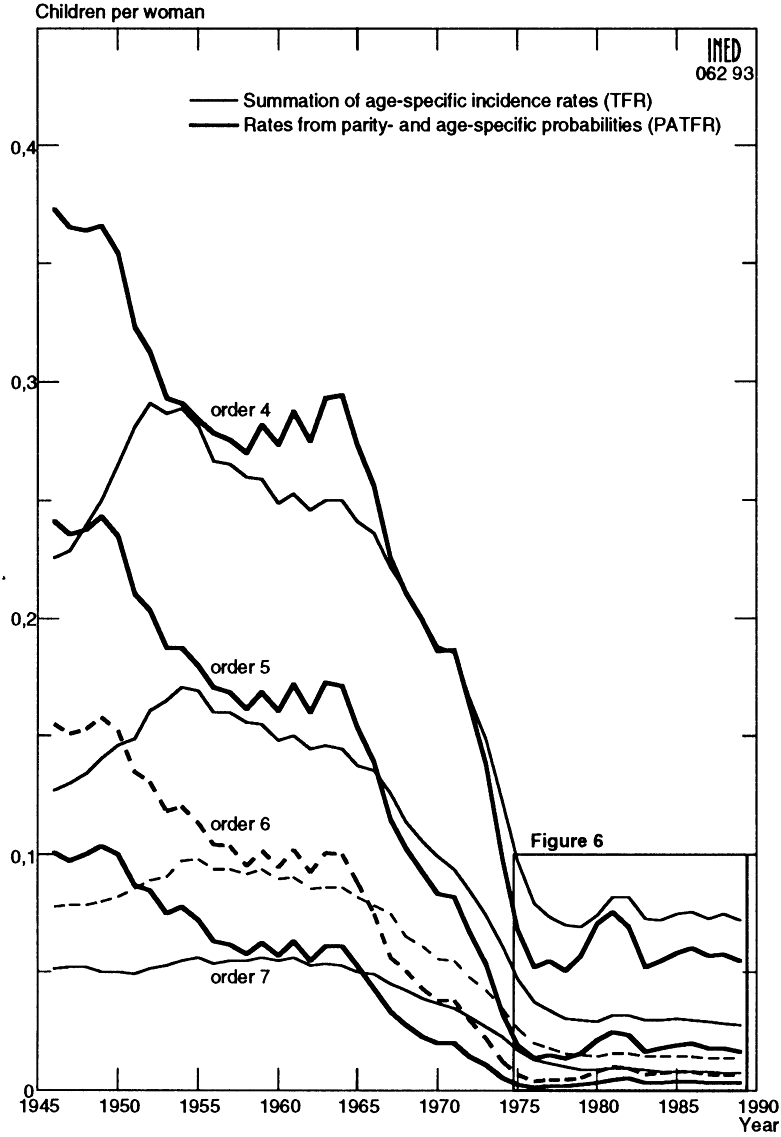

Figure 4. – Birth order components 4-7 of two synthetic fertility indices for France, 1946-89

are all maximal between 1946 and 1950: *fertility rose sharply and fleetingly at the end of the war, and the 'later' increase in the TFR components of orders higher than 1 is a mere 'rebound', not the sign of an actual increase in the probabilities of having children of high birth orders.*

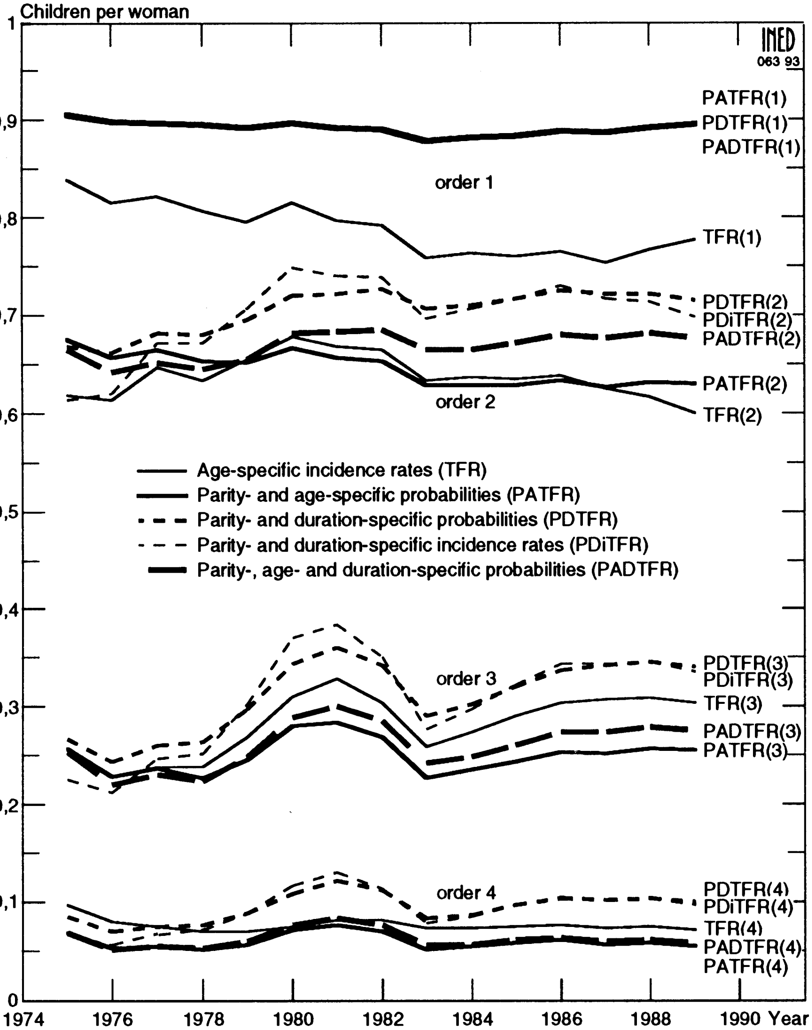

Figure 5. – Birth order components 1-4 of five synthetic fertility indices for France, 1975-89

During the 1950s, the secular standardization of family size continues: births of first and second orders gain ground, while fourth births and beyond are increasingly rare [Festy, 1979]. Starting in 1964, overall fertility embarks on a long downward trend, marking the end of the baby boom. *This is due entirely to the emergence of a decline in third-birth fertility and to an acceleration of that already existing for births of higher orders.* The drop in the first and second order components of TFR is, again, due

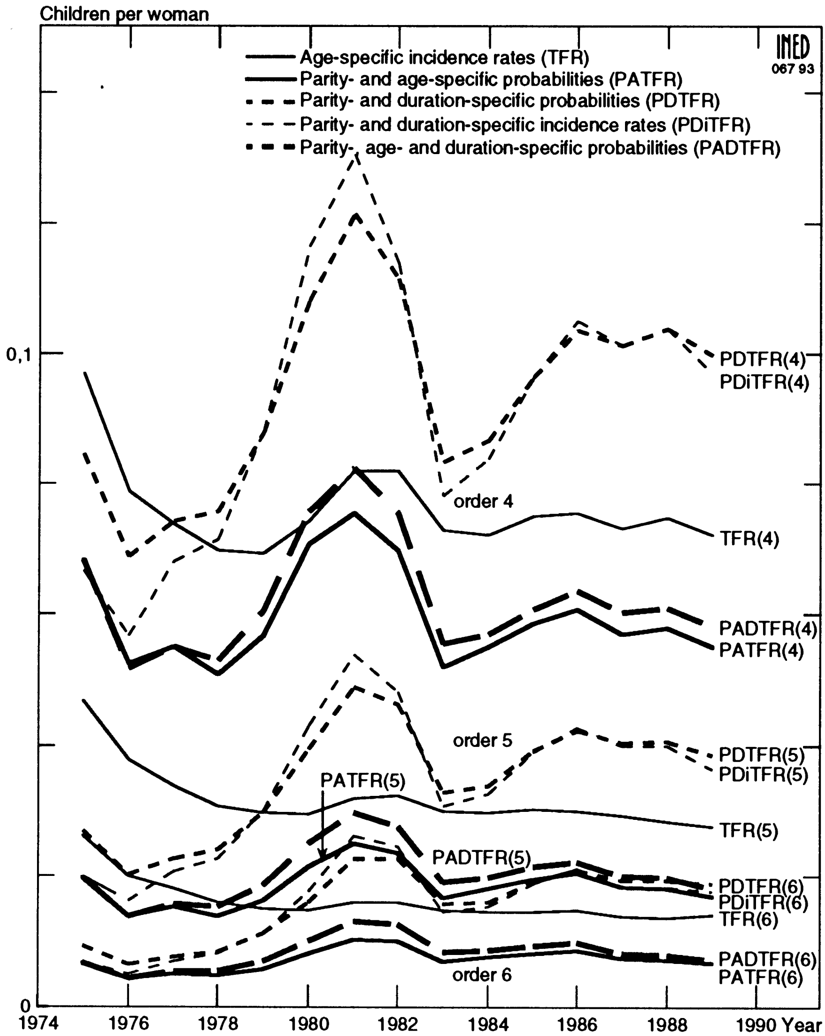

Figure 6. – Birth order components 4-6 of five synthetic fertility indices for France, 1975-89

to 'contagion': after a rise or a fall, the order-specific TFR components tend to exaggerate the backswing, thus generating artificial cycles.

Fertility during the 1970s and 1980s

In 1976, all the synthetic fertility measures are of the order of 1.8-1.9 children per woman. The first-birth probabilities then remain very high

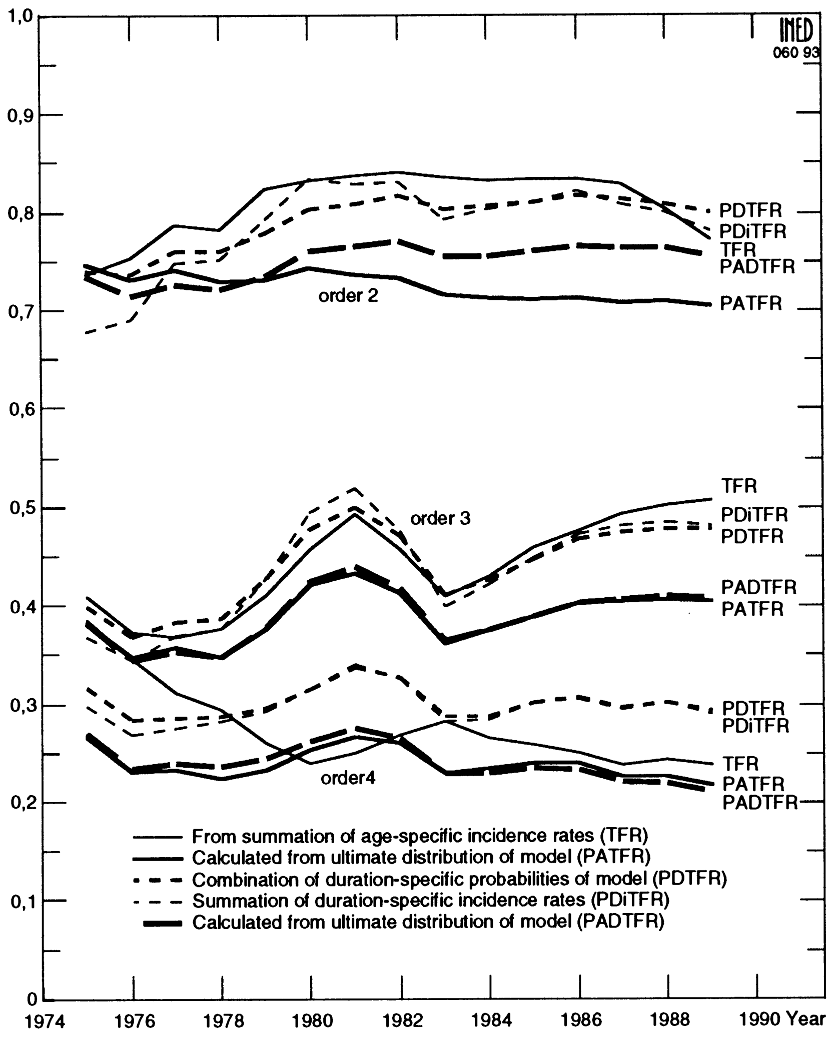

Figure 7. – Period parity progression ratios, birth orders 2 to 4. Five measures for France, 1975-89

(between 0.88 and 0.90), while the first birth order component of TFR begins a substantial reduction. Owing to the fertility decline among younger women, the proportion of women who have already borne one child is higher, from 1976 on, than that derived from the 'current conditions'. Young women have fewer first births, but also older women, *simply because they have already had their first child in previous years, when the* *rates were higher among young women.* At age 30, for instance, the first-birth incidence rate in 1989 is only 35 first births per 1,000 women, whereas the first-birth component of the rate corresponding to the PATFR (equation 7) is 45 per 1,000 [Toulemon, 1991]. The first birth order component of

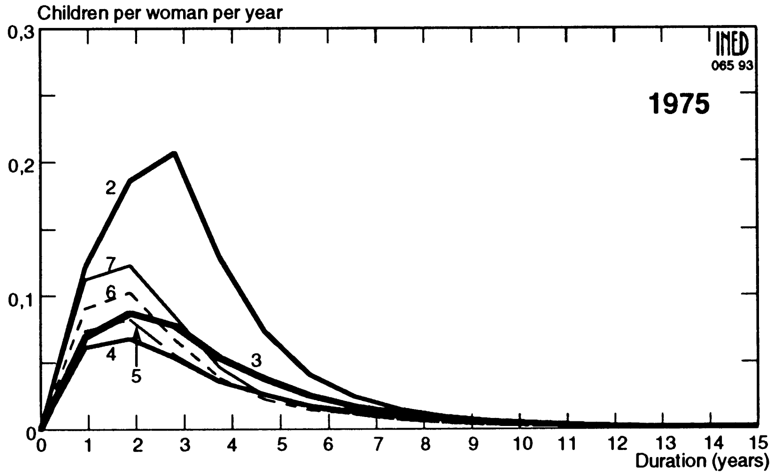

Figure 8. – Birth probabilities by duration since previous birth, orders 2 to 7, 1975. PDTFR model

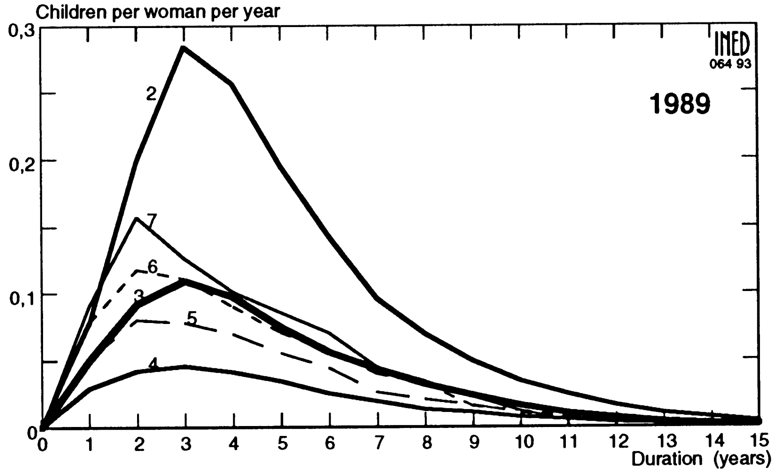

Figure 9. – Birth probabilities by duration since previous birth, orders 2 to 7, 1989. PDTFR model

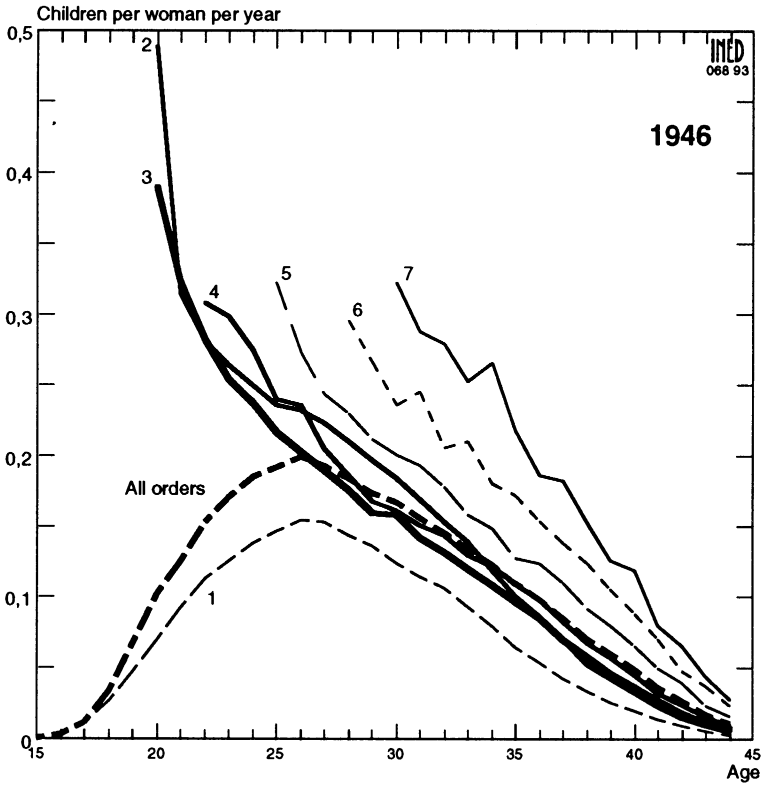

Figure 10. – Birth probabilities by age, orders 1 to 7, 1946. PATFR model

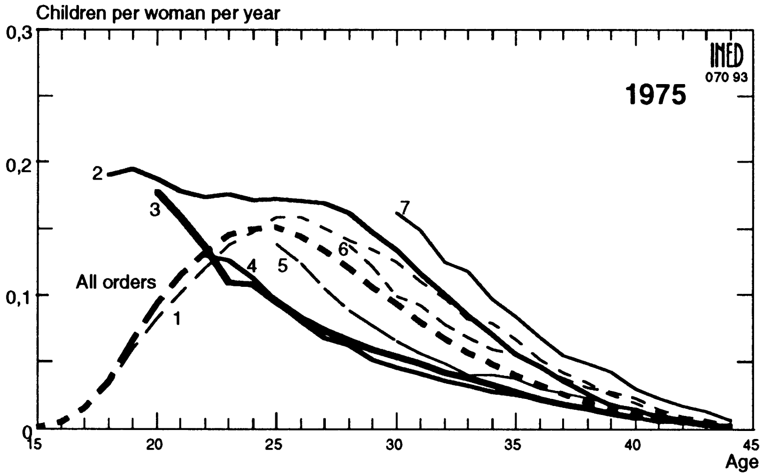

Figure 12. – Birth probabilities by age, orders 1 to 7, 1975. PATFR model

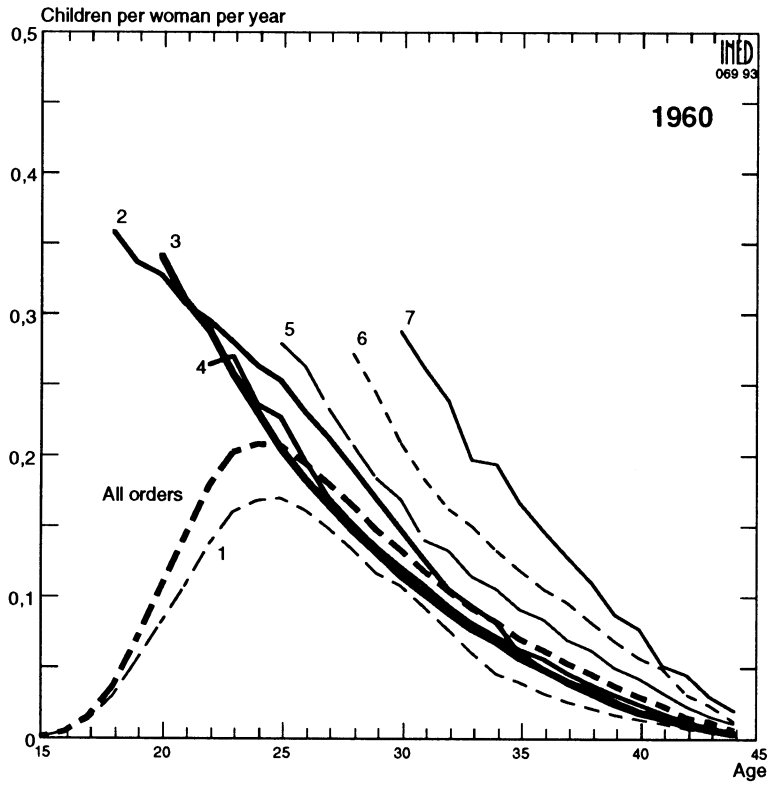

Figure 11. – Birth probabilities by age, orders 1 to 7, 1960. PATFR model

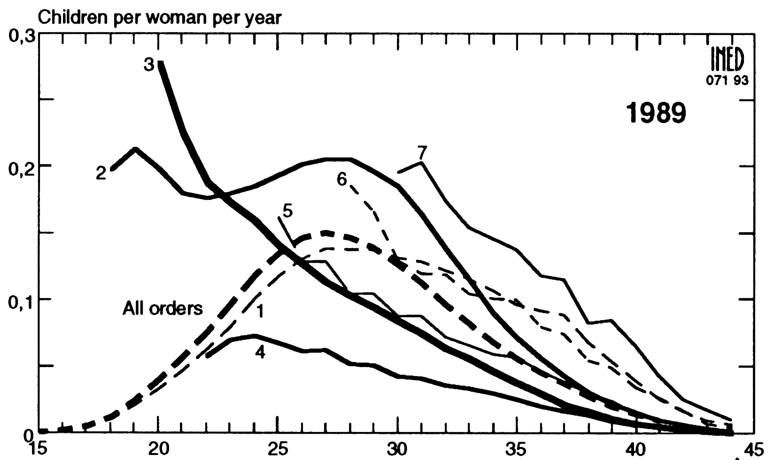

Figure 13. – Birth probabilities by age, orders 1 to 7, 1989. PATFR model

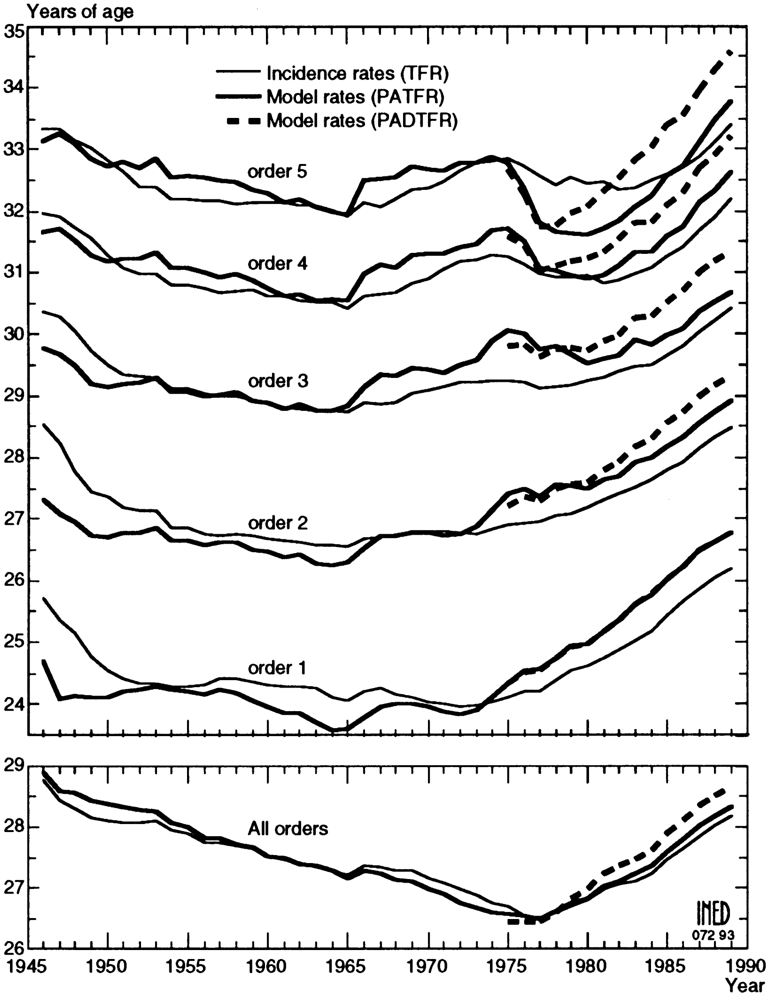

Figure 14. – Mean age of mothers at birth of children of orders 1 to 5, 1946-89

TFR (sum of age-specific incidence rates) suggests that 20% to 25% of the synthetic cohort for 1989 would remain childless, while the result obtained by combining the age-specific first-birth probabilities points to only 10% remaining childless in the 'conditions of 1989'(13).

For birth order 2, the two indices yield similar results, but TFR shows variations that the parity-specific index does not. For third-birth fertility, TFR increases more between 1975 and 1989 than PATFR. For births of higher orders, the two curves stabilize, at a higher level for TFR. The reasons are the same as for third-birth fertility (see appendix tables to part II in French), namely, that at each age, there are more women who have already borne at least two children in the observed population than in the population derived from the 'current conditions'.

When duration since previous birth is taken into account, the fertility estimates show an upward trend starting in 1983 (Figure 2). The corresponding birth-order components indicate that the preceding temporary rise between 1978 and 1983 only occurred for births of *third and higher orders* (Figures 5 and 6). The changes which have emerged in fertility behaviour and can be summed up, for the 1980s, by steadily later childbearing – due, to a large extent, to postponement of first births – lead PATFR to underestimate fertility increasingly during the decade. Finally, the fertility level remains stably high for first and second births in the course of the decade (around 0.90 and 0.68 births per woman), rises slightly for third births (from 0.25 to 0.28), and is very low for the higher birth orders.

The birth order components of TFR contain the traces of past behaviour, while PATFR underestimates second-birth fertility, and the PDTFR overestimates fertility at orders higher than 1, compared to the PADTFR. *Consequently, it appears very useful, for a precise period analysis of order-specific fertility, to include information on duration since previous birth, as well as keeping age, even if that entails estimating specific birth probabilities for each combination of variables.*

* *
*

The related series of period parity progression ratios and birth probabilities by age, parity and/or duration are illustrated in Figures 7 to 13. The time trends in these components and their combination into the different synthetic indices were discussed in part II of the original paper in French. For lack of space, these remarks are not included here, nor are the observations on fertility timing (Figure 14). The interested reader is encouraged to consult the original paper, with the help of footnote 4.

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(13) The same phenomenon is observed for all *frequent* events whose timing changes. For instance, in 1985 in France, the *synthetic first marriage index* obtained by combining the age-specific probabilities – that is, taking into account the fact that only never-married persons can marry for the first time – amounted to 0.73 first marriages per woman, whereas the *total first marriage rate* (period sum of incidence rates) was only 0.54, because of marriage postponement [INED, 1990]. For rarer events, on the other hand, there is little difference between the two calculations, since the proportion of persons not having experienced the event depends relatively little on the population's history. In the case of divorces, for example, the proportion of marriages broken in the space of 40 years can be estimated, in 1985, at 28.9% by the probabilities and at 30.2% by the rates, for all marriages combined (calculations based on [INED, 1987] Table 23). The gap would be greater if divorces were more frequent: when we tripled the rates for each cohort and duration (to obtain levels equivalent to those of first-birth fertility), the total divorce rate in 1985 came to 0.76 divorces per marriage from the probabilities and to 0.91 from the incidence rates, reflecting increasingly early divorce.

IV. – Which index to use?

The values of the birth probabilities by parity and age and by parity and duration permit a description in terms of unobserved heterogeneity of the differences between the period fertility measures.

Comparison in the framework of the general model

If we accept the assumption that birth probabilities by age, parity and duration since previous birth are independent of past fertility, or that the categories defined by cross-classifying these variables are homogeneous, then the PADTFR index is the most satisfactory synthetic measure of period fertility. GFI, TFR, PATFR, PDTFR and PADTFR can be considered as progressively more successful attempts to eliminate the influence of past fertility on the population's structure.

During the 1970s and 1980s, the age structure of the female population aged 15-49 was 'favourable' to natality: with the baby boomers replacing the sparser cohorts born between the two world wars, women were most numerous in the peak fertility ages. This structural effect is 'neutralized' with TFR, the synthetic cohort having a standard age structure (same number of women of each age). The result is TFR estimates lower than GFI between 1970 and 1990 (1.81 vs 1.92 in 1989, see Figures 1 and 2).

The structure by number of children already born, or parity distribution, was unfavourable to natality during the 1980s: the higher the parity, the lower the birth probabilities, and the actual parities at beginning of year were higher at each age than in the population derived from the 'current fertility conditions', because of the fertility decline among younger women. Consequently, the summary measure taking parity and age into account (PATFR) is higher than the conventional TFR (1.86 vs 1.81 in 1989). At the end of the 1940s, the parity distribution was just as unfavourable, and PATFR exceeds TFR *for an opposite reason*: fertility then increased with parity (the selection effect of non-controllers dominated the parity trends) and women had fewer children already born than in the population constructed from current fertility, owing to the war years. From 1950 to 1980, the PATFR and TFR values are very similar, omission of the variable *number of children previously born* having little effect on the final result: fertility variations by birth order were not linear (rise from order 1 to 2, then fall between orders 2 and 4, rise at higher orders), and replacing the observed parity/age distribution by that of the population derived from current fertility conditions does not modify the measure.

Inversely, the observed structure by parity and duration since previous birth is presently unfavourable to fertility (in the population based on current conditions, women have fewer children and the lastborn is younger), and PDTFR exceeds GFI (2.13 and 1.92 respectively in 1989).

Finally, the PADTFR measure, in which fertility depends on age, number of children already born and duration since last birth (for orders higher than 1), amounts to 1.94 in 1989, very close to GFI, because a favourable age structure is offset by unfavourable parity and duration distributions.

PATFR is closer than PDTFR to PADTFR. Omitting duration since previous birth does not have much impact, since fertility variations by duration are slight for birth orders higher than 2, while age, omitted in the PDTFR calculation, is more discriminating at a given parity than duration.

Criticism of the general model: the times of upheaval

Nonetheless, the 'complete' index is far from giving full satisfaction. It can be criticized on four counts. First, the fact that the probabilities are estimated from modelled survey data means that a fine level of accuracy is not possible; yet the resulting imprecision is much more limited than the differences between indices, at least for recent years (see appendix table). Second, entering many variables in the calculation reduces an index's applicability. A simpler index may be preferred to a more 'complete' one when it can be calculated for a longer period or for more countries. Third, although already complex, the PADTFR estimate is one of 'pure fertility': it does not take into account marital situation, occupation, health, etc. Fourth, a more fundamental objection, which concerns the validity of the working assumption of independence between current fertility conditions and the size and structure of the population. Under what conditions can the population structure derived from the current birth probabilities be considered realistic?

When discussing the beginning of the post-war baby boom, we mentioned that, for the synthetic cohort assumption to hold, it would be necessary to distinguish, in each sub-group, between the women whom the war had prevented from having a child and the others. Were this possible, we could then measure fertility within a 'non-disturbed' population. But the 'current conditions' in the period just after the war are defined, to a large extent, by the possibility of making up for lost time and children, and the general assumption does not seem relevant. In this case, *no index can, more than any other, be presented in terms of children per woman.* This brings us back to the criticism levelled by L. Henry [1953], who considered that the period fertility measure (TFR) was not applicable in times of upheaval:

> "to attribute to a fictitious cohort a set of rates observed during a period of birth recovery [the post-war years] amounts to imagining a cohort of women who would spend their whole lives striving to make up ground they had never lost".

The objection applies to all the indices, but TFR in particular can be accused of diluting and masking these 'perturbations'; we have seen that PATFR yielded more suitable estimates of baby boom fertility, at least by birth order.

Period and cohort fertility are complementary

The assumption which is necessary for interpreting synthetic cohort measures, that the stable population constructed from the current birth probabilities could actually experience the fertility described by these probabilities, cannot therefore hold in the case of demographic perturbations [Karmel, 1950; Ryder, 1956]. But the interpretation of period fertility variations as a consequence of cohort timing changes is barely more satisfactory. In 1965, fertility plunged rapidly, at all ages, and the decline continued for several years [Calot and Hémery, 1967; Calot, Hémery and Piro, 1969]. This was principally due to a sudden acceleration of the drop in large families, whereas the interpretation of a cohort timing change in a framework of constant completed fertility [Pressat, 1969] implied on the contrary that there was no substantial modification of family size.

From a statistical point of view, successive age-specific fertility rates have a more consistent form when they are observed for a specified period (a calendar year) than for a specified cohort (women born in a same year). On the one hand, variations from year to year are greater than from cohort to cohort, and on the other, the form of the age-specific fertility curves is easier to model in a period framework. This empirical observation, evident for 20th century France, is of much more general significance [Ryder, 1953, cited in Hobcraft *et al.*, 1982]. From a descriptive point of view, transversal synthesis (for a year or group of years) cannot, however, be compared to longitudinal synthesis. *Period* consistency in fertility behaviour is expressed by a regular age pattern, despite annual variations which may be substantial. Inversely, cohort changes in age-specific fertility are much more complex, while completed fertility varies only slightly, as though period fluctuations offset each other in part, conforming to a logic inherent in the history of the individuals [Festy, 1986].

The present fertility variations seem to obey a transversal logic: the assumption of sometimes chaotic post-transitional fertility dynamics [Bonneuil, 1989; 1991] is necessarily situated in a period framework. Inversely, Brass [1990], following Ryder [1956; 1964], proposes to adjust PDiTFR, which controls for parity and duration since previous birth, by a factor measuring tempo changes in parity cohorts. Finally, it seems that there can be no direct translation of period into cohort fertility variations and vice versa [Festy, 1986], and referring to *cohort* fertility favours confusion between two consequences of the current fertility 'delay'. Take the example of a recent year. On the one hand, the delay in period fertility for the past five years results in an underestimation of fertility quantum by TFR; *this bias is eliminated by PADTFR*. On the other hand, a delay in period fertility can be likened to a fertility delay in the corresponding cohorts, but this implies abandoning the period logic and supposing that the births which have not yet occurred will be 'made up' in the future. *This interpretation steps out of the framework of period fertility analysis.* It can be translated as follows: if the synthetic measure remains constant (PADTFR = 1.94) and if the period mean age at childbearing continues to increase, *the completed fertility of women born around 1955 will, in all probability, exceed 1.94*. Indeed, the projections of completed fertility for cohorts born around 1955 were upgraded during the 1980s, as the fertility of older women continued to increase, and what is now interpreted as a delay in cohort fertility was first described as a probable reduction of completed fertility. It seems more simple to explain the stable fertility of cc. 1950 to 1955 as the result of a fertility decline at younger ages during the 1970s and a rise at older ages during the 1980s, *without supposing a priori any causal relationship between these two trends.*

Conclusion

Period fertility measures expressed in simple terms (number of children per woman, parity progression ratios, age at birth of children of each order) are useful, but require the construction of synthetic cohorts of women who would live their whole lives, birthday after birthday, in the 'current conditions' defined for each calendar year. The comparison of the conventional synthetic measure of period fertility (TFR) with others built on the same principle (fertility of a fictitious cohort) shows that a summary index taking into account not only age, but also parity and duration since previous birth (PADTFR), provides more satisfactory results. In times of demographic 'upheaval', no period index can be interpreted in terms of children per woman per lifetime, but the conventional TFR artificially dilutes the phenomenon. In 'non-disturbed' times, the trends follow a period logic, and the most complete index, while being just as sensitive to period variations as TFR, eliminates the presently unfavourable effect of the fertility decline among younger women. The PADTFR value is 1.94 for 1989, compared to 1.81 for TFR(14). This phenomenon is common to most Western European countries, and explains to a large extent the low TFRs presently observed. In France, first birth rates are very high (0.90), second births are stable (0.68), third births are slightly more frequent than five years ago (0.28), while births of higher orders now represent only 0.09 children per woman. The PADTFR values have been stable since 1986, and a rise in TFR is probable, *if there is no sudden change in current conditions, and if age at childbearing becomes stable.*

The period fertility measures proposed here are by no means intended to make cohort analysis superfluous. On the contrary, a *more transversal* measure than the conventional TFR facilitates the comparison between period and

(14) PADTFR: the period summary index taking parity, mother's age and duration since previous birth into account; the estimates for this index range from 1.92 to 1.96 in 1989 (see appendix to paper II in French). For the period measures which control for only two variables, the estimates are more precise, but are biased (PATFR: 1.86, PDTFR: 2.13 in 1989). The 1990 census data yield slightly lower TFR estimates for 1989 (1.79 instead of 1.81) [Lévy, 1992].

cohort behaviours. Period quantum and tempo are not simple to calculate, but these notions are just as concrete as their cohort counterparts. In general, the indicators calculated using probabilities are preferable to those based on incidence rates, because the latter depend not only on performance in a given year, but also in preceding years. Replacing births of all orders combined (renewable events) by births of each order (non-renewable and successive events) means that the estimates can be derived from probabilities, the only way to situate parity-specific fertility in a period perspective, and to distinguish between period quantum and tempo without referring to cohort behaviour.

The calculation of several period indices (given some degree of estimation) puts the conventional TFR on a relative footing. It becomes one of a number of possible measures of 'current fertility quantum'; it may sometimes be the only practicable solution, but its values may be biased in terms of level as well as trends.

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APPENDIX TABLE. – VARIOUS PERIOD MEASURES OF TOTAL FERTILITY AND MEAN AGE AT CHILDBEARING, FRANCE, 1946-89

Total fertility (births per woman)							Mean age (years)			
Year	GFI	TFR	PATFR	PDTFR	PDiTFR	PADTFR	Year	TFR	PATFR	PDTFR
1946	2.773	2.989	3.239	–	–	–	1946	28.77	28.88	–
1947	2.866	3.025	3.246	–	–	–	1947	28.42	28.59	–
1948	2.879	3.006	3.214	–	–	–	1948	28.31	28.55	–
1949	2.893	2.986	3.180	–	–	–	1949	28.15	28.44	–
1950	2.868	2.928	3.087	–	–	–	1950	28.10	28.38	–
1951	2.816	2.791	2.882	–	–	–	1951	28.08	28.33	–
1952	2.814	2.763	2.829	–	–	–	1952	28.08	28.28	–
1953	2.766	2.694	2.724	–	–	–	1953	28.10	28.24	–
1954	2.799	2.699	2.732	–	–	–	1954	27.94	28.07	–
1955	2.799	2.677	2.707	–	–	–	1955	27.90	28.00	–
1956	2.809	2.659	2.690	–	–	–	1956	27.74	27.81	–
1957	2.844	2.682	2.699	–	–	–	1957	27.75	27.82	–
1958	2.829	2.671	2.691	–	–	–	1958	27.70	27.72	–
1959	2.888	2.741	2.785	–	2.757	–	1959	27.64	27.66	–
1960	2.853	2.730	2.764	–	2.668	–	1960	27.51	27.50	–
1961	2.883	2.815	2.863	–	2.802	–	1961	27.46	27.48	–
1962	2.787	2.787	2.805	–	2.741	–	1962	27.40	27.40	–
1963	2.859	2.887	2.924	–	2.926	–	1963	27.33	27.35	–
1964	2.848	2.906	2.939	–	2.912	–	1964	27.27	27.29	–
1965	2.749	2.840	2.845	–	2.723	–	1965	27.21	27.17	–
1966	2.680	2.791	2.756	–	2.672	–	1966	27.36	27.30	–
1967	2.554	2.665	2.609	–	2.512	–	1967	27.34	27.23	–
1968	2.494	2.581	2.529	–	2.444	–	1968	27.30	27.14	–
1969	2.469	2.526	2.482	–	2.419	–	1969	27.27	27.10	–
1970	2.476	2.472	2.435	2.465	2.372	–	1970	27.16	26.97	–
1971	2.546	2.490	2.453	2.449	2.422	–	1971	27.09	26.90	–
1972	2.514	2.412	2.374	2.364	2.304	–	1972	26.98	26.75	–
1973	2.436	2.302	2.267	2.228	2.180	–	1973	26.88	26.66	–
1974	2.253	2.101	2.085	2.087	1.977	–	1974	26.76	26.59	–
1975	2.092	1.929	1.937	1.969	1.841	1.922	1975	26.69	26.57	26.45
1976	2.006	1.830	1.858	1.904	1.811	1.834	1976	26.56	26.54	26.44
1977	2.058	1.864	1.880	1.948	1.915	1.858	1977	26.51	26.49	26.44
1978	2.017	1.823	1.848	1.952	1.928	1.841	1978	26.60	26.62	26.60
1979	2.054	1.855	1.872	2.021	2.038	1.887	1979	26.70	26.75	26.82
1980	2.154	1.945	1.951	2.138	2.209	1.987	1980	26.81	26.84	26.97
1981	2.150	1.945	1.953	2.192	2.255	2.013	1981	26.98	27.03	27.24
1982	2.113	1.913	1.926	2.166	2.196	1.991	1982	27.06	27.12	27.35
1983	1.968	1.787	1.817	2.026	1.993	1.876	1983	27.11	27.22	27.45
1984	1.983	1.808	1.837	2.049	2.033	1.889	1984	27.24	27.36	27.60
1985	1.989	1.823	1.852	2.096	2.097	1.916	1985	27.46	27.59	27.88
1986	1.996	1.844	1.874	2.141	2.155	1.945	1986	27.64	27.78	28.10
1987	1.951	1.817	1.855	2.132	2.128	1.932	1987	27.85	28.01	28.35
1988	1.942	1.824	1.870	2.144	2.133	1.946	1988	28.02	28.17	28.51
1989	1.915	1.810	1.865	2.131	2.100	1.937	1989	28.17	28.32	28.65

GFI : general fertility index, corresponding to the general fertility rate
TFR : total fertility rate (the conventional period measure)
PATFR : summary index taking parity and age into account (probabilities)
PDTFR : summary index taking parity and duration since previous birth into account (probabilities)
PDiTFR : summary index taking parity, age and duration into account (incidence rates)
PADTFR : summary index taking parity, age and duration into account (probabilities)