

Period Parity Progression Measures of Fertility in Japan

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A B S T R A C T

A series of period parity progression measures for Japan for the years 1950-1982 is estimated and used to analyze recent fertility trends. It is concluded that the decline in Japanese fertility during 1973-1976 was largely due to changes in marital fertility, with less than 20 percent of the decline accounted for by changing marriage patterns.

Annual series of period parity progression ratios are calculated retrospectively from surveys taken in 1974, 1981 and 1984. Comparisons of these series indicate significant discrepancies. A technique for testing the consistency of the survey data on parity progression with vital registration data on births by order is devised and applied, and it is concluded that the survey data substantially overstate the level of progression to next birth.

A technique for estimating period parity progression ratios indirectly from annual births classified by birth order is presented and a series of robustness tests made. It is concluded that the indirect estimation provides better estimates than direct calculation from the survey data.

I. Introduction

Period parity progression measures of fertility have many useful properties, particularly for population in which fertility is both controlled and low. They are not readily calculated from standard demographic data sources, however, and have for this reason been relatively little used. This paper looks systematically at the various possibilities for calculating these measures for Japan.

We begin by calculating period parity progression ratios directly from birth history data from fertility surveys taken in 1974, and 1984. Each survey provides an annual series of retrospective estimates for some 20 years prior to the survey, whence we are able to check the consistency of the estimates from the different surveys. The 1984 survey, for example, provides estimates of progression from marriage to first birth back to 1964. The values for the years 1964-1980 may be compared with estimates for the same years from the 1981 survey. Since both surveys provide an estimate of the same quantity for the same year, any discrepancies in the series demonstrate the presence of errors in the data.

We then test the consistency of the parity progression data from a survey with vital registration data on births by birth order. Since the vital registration data are accurate, any substantial discrepancies must be due to errors in the survey data. In this way we are able to get an indication of the absolute error for each survey.

On the basis of these consistency checks we establish the accuracy of the survey data on parity progression. The data turn out to be less good than one would have hoped. We therefore turn to an indirect estimation procedure utilizing vital registration data on births by birth order together with the broad patterns of progression to next birth derived from the surveys. Though this approach is substantially more complicated than direct calculation, we are able to show, through a series of robustness tests, that it gives superior results.

The result of these rather considerable labors is a 23 years time series of period parity progression ratios for Japan, ending in 1982- the most recent years for which data is available. Combining this series with the estimates of progression to first marriage given in

Feeney and Saito (1985), we obtain a full set of period parity progression measures for Japan from 1960 through 1982. The remainder of the paper is devoted to analyzing this series. The principal conclusion of this analysis concerns the decline in fertility that took place between 1973 and 1976, which is shown to have been due largely to changes in marital fertility, with only about 20 percent of the decline accounted for by changes in age at marriage.

II. Definitions

Parity progression ratios, like age-specific birth rates, may be calculated both on a cohort and a period basis. The cohort calculation is elementary, though care must be taken to specify clearly the group of women for which the ratios are calculated. For a birth cohort, one first considers all women in the cohort and asks for the proportion of these women who have at least one child. One then considers the set of all women in the cohort who have one or more children and asks for the proportion of these women who go on to have a second child, and so on for all higher birth orders and parities of women. The same calculation may be made for a marriage cohort. Finally, cohort parity progression ratios for progression to second and higher order births may be calculated for parity cohorts, groups of women who have a birth of a given order during a given time period. One considers the group of all women having an i -th birth during a given year or other period and asks what proportion of these women ever go on to have an $(i+1)$ st birth.

The calculation of parity progression ratios for parity cohorts gives rise, by analogy with period and cohort life tables, to the notion of period parity progression ratios, which go back to the pioneering work of Henry (1953: chapter III). The measures defined below are modeled on Henry's measures, but differ in one important aspect. Henry focused on fertility of marriage, and the unit to which his measures refer is the marriage rather than the woman. The measures defined here refer to the woman. This apparently subtle distinction has a number of important consequences, the most important of which is that our measures provide an overall measure of fertility in the population and so may be compared directly with measures based on age-specific rates. The comparison of Henry's measures with measures

based on age-specific rates is confounded by the effects of marriage, marital dissolution, remarriage, and illegitimacy.

We turn now to the formal definition of various parity progression measures. Let $r_E^i(y)$ denote the proportion of women having an i -th birth in year y who have an $(i+1)$ st birth in the same year, and let $r_x^i(y)$ denote the proportion of parity i women with x completed years duration in parity at the beginning of year y who have an $(i+1)$ st birth during year y . We refer to these statistics as parity progression rates for progression from i -th to $(i+1)$ st birth.

For given y and i , the rates $r_x^i(y)$, $x = E, 0, 1, \dots$, are referred to as a period schedule of parity progression rates for year y , and the rates $r_E^i(y)$ and $r_x^i(y+x)$, $x = 0, 1, \dots$, are referred to as a cohort schedule of parity progression rates for the parity cohort of women who have an i -th birth in year y .

Let $p_i^C(y)$ denote the proportion of women having an i -th birth in year y who ever have an $(i+1)$ st birth. This proportion is referred to as the cohort parity progression ratio for progression from i -th to $(i+1)$ st birth for the cohort of women who have an i -th birth in year y . It may be expressed in terms of the parity progression rates $r_x^i(y)$ as

$$p_i^C(y) = 1 - [1 - r_E^i(y)] \prod_{x=0}^{\infty} [1 - r_x^i(y+x)] \quad (1)$$

We define the period parity progression ratio $p_i^P(y)$ for year y by

$$p_i^P(y) = 1 - [1 - r_E^i(y)] \prod_{x=0}^{\infty} [1 - r_x^i(y)] \quad (2)$$

The period parity progression ratio may be thought of as the ratio that would be observed in an hypothetical cohort that experiences the parity progression rates of year y .

The parity progression ratios p_i , $i = 1, 2, \dots$, describe the movement of women in a population from first to second and on to higher order births, but they tell us nothing about the incidence of first births. If premarital fertility is negligible, we may define

parity progression rates $r_x^0(y)$ and parity progression ratios $p_0^c(y)$ and $p_0^p(y)$ for progression from first marriage to first birth by analogy with the above definitions. We need only think of i -th birth as "event A" and $(i+1)$ st birth as "event B," recast the definitions in terms of progression from event A to event B, and then take event A to be first marriage and event B to be first birth. We shall of course have to replace "parity cohort" by "marriage cohort."

We relate first birth to first marriage in this way, but we still say nothing about the incidence of first marriage. To do so, apply the same device as before, taking event A to be the birth of a woman and event B to be the birth of her first child. We must drop the word "parity" in these definitions, as no change of parity is involved, and replace "parity cohort" by "birth cohort," but except for these changes the definitions carry over as before. Note that duration in parity is age for parity zero women. We use the notation $r_x^M(Y)$, $p_M^c(Y)$ and $p_M^p(Y)$ for the statistics so defined.

Observe that these statistics take account of marriage only in the sense that first marriage is assumed to precede first birth. No account is taken of marital status subsequent to first marriage. Thus the proportions of women progressing from first marriage to first birth include women, if any, who divorce and have an illegitimate first birth, divorce, remarry and have a legitimate first birth in their second marriage, and so on.

Illegitimacy is thus problematical in this context only insofar as it consists of illegitimate first births occurring to never married women. If the incidence of such births is not negligible, of course, we could simply ignore the marital status of zero parity women altogether and replace the statistics of progression from birth to first marriage and progression from first marriage to first birth by statistics of progression from birth of woman to birth of first child.

III. Period Parity Progression Ratios from Survey Data

Table 1 compares period parity progression ratios (PPPRs) for progression from first marriage to first birth from surveys taken in 1981 and 1984 (Population Problems Research Council 1984). Values are calculated for calendar years so as to be comparable to vital statistics data, with which they are compared in the following

section. Thus the most recent values for any survey are for the year prior to the year in which the survey was taken. The data from which the calculations are made are given in the Appendix.

The 1981 survey provides values of the PPRs for the years 1980 back to 1961, the 1984 survey for the years 1983 back to 1964. Since both series represent the same value, they should coincide during the period of their overlap, from 1964 through 1980. Differences between them signify errors in either or both series, and the pattern of these differences provides evidence of the quality of the series.

The single year differences in Table 1 are erratic, ranging in absolute terms from -22 to +58 per thousand, but the agreement is better in the latter years of the series and there is a clear preponderance of positive differences in the earlier years. It is notable that the 1984 survey gives higher levels of progression for these years than the 1981 survey, thus eliminating the simple explanation that events more remote from the time of the survey tend to be less completely reported. The overall level of agreement may be gauged by averaging over the 17 years during which the series overlap, which yields a progression ratio of 0.967 for the 1984 survey and a ratio of 0.951 for the 1981 survey, a difference of 0.016, or about one and a half percent in relative terms.

This is a reasonably good agreement in relation to the proportion of women who progress from marriage to first birth. Since nearly all women progress, however, it might be argued that the statistic of interest is really the proportion of women who do not progress, and from this point of view the agreement is not nearly so good. The 1984 survey indicates 3.3 percent of married women remaining childless, the 1981 survey 4.9 percent. The absolute difference, 1.6 percent, is nearly 50 percent of the lower value.

Table 1 also shows comparisons based on 5 and 15 year moving periods. These aggregations, which have the effect of attenuating random fluctuations and smoothing systematic errors, confirm the pattern of decreasing differences between the surveys as we come closer to the time of the survey, as well as the overall level difference between the two surveys.

Table 2 makes the same comparison for progression from first to second birth for the surveys taken in 1974, 1981 and 1984. Looking first at the single year series, the discrepancies between the 1981

Table 1. Comparison of Period Parity Progression Ratios for Progression from First Marriage to First Birth Directly Calculated from the 1984 and 1981 Surveys, Japan

Year	Single Year			Moving 5 Year			Moving 15 Year		
	1984	1981	Diff	1984	1981	Diff	1984	1981	Diff
1983	965	--	--	--	--	--	--	--	--
1982	980	--	--	--	--	--	--	--	--
1981	941	--	--	949	--	--	--	--	--
1980	945	967	-22	952	--	--	--	--	--
1979	977	967	+2	948	--	--	--	--	--
1978	960	970	-10	949	954	-5	--	--	--
1977	949	945	+4	957	953	+4	--	--	--
1976	924	926	-2	955	945	+10	959	--	--
1975	969	963	+6	956	946	+10	961	--	--
1974	971	926	+45	965	948	+17	964	--	--
1973	961	971	-10	974	953	+21	965	952	+13
1972	981	942	+39	975	952	+23	967	952	+15
1971	981	951	+30	971	953	+18	969	950	+19
1970	974	963	+11	976	947	+29	--	947	--
1969	963	939	+24	979	956	+23	--	949	--
1968	985	947	+38	973	950	+23	--	951	--
1967	989	979	+10	973	952	+21	--	--	--
1966	951	906	+45	980	955	+25	--	--	--
1965	977	971	+6	--	952	--	--	--	--
1964	988	930	+58	--	947	--	--	--	--
1963	--	952	--	--	946	--	--	--	--
1962	--	952	--	--	946	--	--	--	--
1961	--	934	--	--	--	--	--	--	--
Mean*	967	951	+16	968	951	+17	967	951	+16

* Means are calculated in each case only for the years overlap; e.g., for the single year values, the years 1964-1980.

Table 2. Comparison of Period Parity Progression Ratios for Progression from First to Second Birth Directly Calculated from the 1984, 1981 and 1974 Surveys, Japan

Year	Single Year					Year	Moving 5 Year				
	1984	1981	1974	Diff ^a	Diff ^b		1984	1981	1974	Diff ^a	Diff ^b
1983	858	--	--	--	--	1983	--	--	--	--	--
1982	863	--	--	--	--	1982	--	--	--	--	--
1981	865	--	--	--	--	1981	878	--	--	--	--
1980	920	866	--	+54	--	1980	888	--	--	--	--
1979	882	865	--	+17	--	1979	891	--	--	--	--
1978	912	880	--	+32	--	1978	885	880	--	+5	--
1977	881	911	--	-30	--	1977	889	884	--	+5	--
1976	843	880	--	-37	--	1976	896	900	--	-4	--
1975	940	891	--	+49	--	1975	902	900	--	+2	--
1974	908	931	--	-23	--	1974	920	898	--	+22	--
1973	928	878	901	+50	-23	1973	940	900	--	+40	--
1972	912	912	871	+45	+41	1972	945	913	--	+32	--
1971	950	901	858	+49	+43	1971	948	921	884	+27	+37
1970	961	953	899	+8	+54	1970	953	936	871	+17	+65
1969	938	962	909	-24	+53	1969	952	947	881	+5	+66
1968	977	952	860	+25	+92	1968	939	936	862	+3	+74
1967	970	955	930	+15	+25	1967	937	933	869	+4	+64
1966	782	789	677	-7	+112	1966	942	920	865	+22	+55
1965	887	920	923	-33	-3	1965	924	924	878	0	+46
1964	924	929	866	-5	+63	1964	879	910	873	-3	+32
1963	--	1000	908	--	+92	1963	--	925	886	--	+39
1962	--	803	909	--	-106	1962	--	936	878	--	+58
1961	--	792	773	--	+19	1961	--	936	881	--	+55
1960	--	--	896	--	--	1960	--	--	868	--	--
Mean ^c	915	904	--	+11	--	Mean ^c	923	913	--	+10	--
	--	904	868	--	+36		--	929	875	--	+54

Notes:

^a1984 minus 1981

^b1981 minus 1974

^cMeans are calculated in each case only for the years of overlap; the first line gives the 1981-1984 comparison, the second the 1981-1974 comparison.

and 1984 surveys range from -37 to +54 per thousand, with no time pattern evident. This range contracts to -4 to 40 per thousand in the five year series, and the average over the years of overlap is only about one percent, less than in the previous comparison.

The discrepancies between the 1974 survey (World Fertility Survey 1979) and the 1981 survey are substantially larger. The range in the single year series is of -23 to +112 per thousand, with the average proportion progressing from first to second birth 0.904 for the 1981 survey and 0.868 for the 1974 survey. Interestingly, the five year series shows uniformly positive differences between the 1974 and 1981 surveys, with the 1974 survey more than five percent low relative to the 1981 survey.

Table 3 makes a third such comparison, this time for progression from second to third birth between the 1974 and 1981 surveys. The range of discrepancies in the single year series is -68 to +142 per thousand, with an average of 20 per thousand. For the five year series there are only four years of overlap, with an average discrepancy of 29 per thousand. Note that here we are dealing with quite low parity progression ratios, an average of 0.388 for the 1984 survey and 0.359 for the 1981 survey in the five year series, so that a difference of 0.029 is a relative error of some eight percent.

Two conclusions emerge from these comparisons. First, the survey data do not provide reliable information on year trends. We do not know the precise extent to which this may be due to sampling error, but the aggregate series and the average values, in which sampling error is attenuated, suggest that there are substantial systematic discrepancies between the surveys as well as discrepancies due to sampling error. Given these somewhat negative results, we proceed to a further test of the survey data, this time comparing them with vital registration data.

IV. A Vital Registration Consistency Check

Following the procedure outlined in Feeney (1985:131) we test the consistency of the survey data on progression from i -th to $(i+1)$ st birth with vital registration data on total numbers of i -th and $(i+1)$ st births. We estimate the number of $(i+1)$ st births in year $y+t$ to women who had their i -th birth in year y by multiplying the

Table 3. Comparison of Period Parity Progression Ratios for Progression from Second to Third Birth Calculated Directly from 1981 and 1974 Surveys, Japan

Year	Single Year			Moving 5 Year		
	1984	1981	Diff	1984	1981	Diff
1980	375	--	--	--	--	--
1979	337	--	--	--	--	--
1978	323	--	--	313	--	--
1977	271	--	--	306	--	--
1976	250	--	--	312	--	--
1975	332	--	--	330	--	--
1974	366	--	--	346	--	--
1973	427	285	142	389	--	--
1972	355	414	-59	395	--	--
1971	445	402	+43	397	343	+54
1970	383	295	+88	384	370	+14
1969	383	319	+64	402	363	+39
1968	341	409	-68	369	358	+11
1967	465	376	+89	--	397	--
1966	243	380	-137	--	412	--
1965	--	509	--	--	412	--
1964	--	379	--	--	436	--
1963	--	425	--	--	465	--
1962	--	500	--	--	461	--
1961	--	538	--	--	513	--
1960	--	531	--	--	548	--
Mean*	380	360	+20	388	359	+29

* Means calculated for periods of overlap, 1966-73 for the single year series, 1968-71 for the 5 year series.

registered number of i -th births in year y by the proportion of survey women having their i -th birth in year y who have an $(i+1)$ st birth in year $y+t$, $t=0,1,\dots$. The total number of $(i+1)$ st births in any year z is then estimated by summing the estimated number of $(i+1)$ st births in any year z to women who had their first births in year z , year $z-1$, year $z-2$, and so on. We then calculate the ratio of these estimated numbers of $(i+1)$ st births to registered numbers of $(i+1)$ st births. Ratios of unity indicate perfect consistency, ratios above (below) one that the level of progression indicated by the survey is too high (low).

The same procedure may be applied to progression from first marriage to first birth and from fourth and higher order births to fifth and higher order births. A qualification regarding illegitimate births is required in the former case, however. As noted in Section 2 above, illegitimacy concerns us only insofar as it involves first births to never married women. In tabulating the survey data on progression from marriage to first birth we exclude any women that do not experience first marriage before first birth, but we include women, if any, who marry and then divorce, or marry, divorce and remarry, perhaps repeatedly, before having their first birth. The distributions of intervals between first marriage and first birth thus incorporate the effects of whatever incidence there may be of multiple change of marital status between first marriage and first birth.

The overall incidence of illegitimacy in Japan is low--13,862 out of 1,502,687 births in 1983--or 0.9 percent. Of these illegitimate births, only 8,216, or 0.5 percent of total births, are first births. We have no information on what proportions of these illegitimate first births are to never-married, as opposed to ever-married, women, but in any case the incidence is so low as to be insignificant in the present context.

Table 4 shows the results of the consistency check for the data on progression from first to second birth from the 1974 survey (Appendix Table 1). Vital registration numbers of first and second births used in the calculation are given in Appendix Table 8. To illustrate the calculation, the implied number of second births in 1973 is

$$\begin{aligned}
& 950,464 \frac{0}{134} + 936,388 \frac{17}{115} + 901,167 \frac{40}{163} + 878,979 \frac{32}{113} + 855,063 \frac{9}{105} \\
& + 864,609 \frac{8}{113} + 887,971 \frac{4}{115} + 705,478 \frac{1}{110} + 866,485 \frac{1}{127} + 820,766 \frac{1}{89} \\
& + 787,054 \frac{0}{126} = 856,798
\end{aligned}$$

The ratios of the implied to the registered numbers of second births are shown in the fifth column, and because these values fluctuate widely, ratios for moving five and eleven year periods are given as well in the columns to the right. Similar calculations, not shown in detail, have been made for the other surveys and progressions. The data necessary for the calculations are given in the Appendix.

Table 5 shows the eleven year aggregate ratios for all surveys and progressions considered. We see that the survey data levels of progression to first and next birth are uniformly biased high, with the average bias ranging from three to eleven percent. The results for progression from first to second birth indicate that the 1984 and 1981 surveys are high by eight or nine percent, whereas the 1974 survey is high by about four percent. There is some tendency for consistency ratios to increase as we move back in time from the surveys, which would be consistent with the expected effect of age-selection bias (Rindfuss, Palmore and Bumpass 1982), but the indication is not consistent.

These results show beyond reasonable doubt that the survey data on parity progression contain a relatively high level of error, given the very high standard set by Japanese demographic data generally. Relative errors of five percent or more appear to be the norm, and this is based on relating the error to the proportion of women progressing. Since proportions of women progressing to first and second birth are around 90 percent, the errors here would be a great deal larger if the error were related to the proportion of women who do not progress. It turns out, rather surprisingly, that we can do much better with an indirect estimation technique, to which we now turn.

Table 4. Vital Registration Consistency Check Illustrated for 1974 Survey Data on Progression from First to Second Birth

Year	Registered First Births	Registered Second Births	Implied First Births	Single Year Ratio	Five Year Ratio	Eleven Year Ratio
1973	950,464	796,254	856,798	1.076	--	--
1972	936,388	776,654	768,434	0.989	--	--
1971	901,167	781,588	736,301	0.942	1.047	--
1970	878,979	753,834	871,753	1.156	1.007	--
1969	855,063	744,060	798,827	1.074	1.017	--
1968	864,609	735,209	641,843	0.873	1.020	1.032
1967	887,971	773,831	804,391	1.039	1.018	1.039
1966	705,478	459,412	419,118	0.912	0.999	1.036
1965	866,485	685,027	796,109	1.162	1.050	1.048
1964	820,766	625,683	613,076	0.980	1.081	--
1963	787,054	592,116	661,407	1.117	1.080	--
1962	763,216	561,737	670,668	1.194	1.055	--
1961	720,783	541,864	504,776	0.932	--	--
1960	714,827	522,867	550,846	1.054	--	--
1959	695,764	--	--	--	--	--
1958	667,823	--	--	--	--	--
1957	589,399	--	--	--	--	--
1956	596,552	--	--	--	--	--
1955	573,592	--	--	--	--	--
1954	548,405	--	--	--	--	--
1953	569,885	--	--	--	--	--
1952	591,365	--	--	--	--	--
1951	612,884	--	--	--	--	--
1950	634,324	--	--	--	--	--

Note: See text for explanation.

Table 5. Vital Registration Consistency Ratios for Moving
Eleven Year Periods, Japan, 1965-1978

Year	Marriage to 1st Birth		1st to 2nd Birth			2nd to 3rd Birth
	1984	1981	1984	1981	1974	1974
1978	1.025	--	1.017	--	--	--
1977	1.026	--	1.031	--	--	--
1976	1.032	--	1.043	--	--	--
1975	1.035	1.045	1.061	1.034	--	--
1974	1.036	1.041	1.055	1.046	--	--
1973	1.032	1.029	1.055	1.065	--	--
1972	1.063	1.031	1.102	1.075	--	--
1971	1.043	1.027	1.079	1.077	--	--
1970	1.041	1.034	1.101	1.083	--	--
1969	1.061	1.025	1.109	1.081	--	--
1968	1.055	1.027	1.188	1.087	1.032	1.046
1967	1.074	1.029	1.271	1.092	1.039	1.106
1966	--	1.020	--	1.082	1.036	1.111
1965	--	1.019	--	1.101	1.048	1.089
Mean*	1.049	1.032	1.113	1.071	--	--
	--	--	--	1.091	1.039	1.088

* Means calculated for years of overlap only.

Note: See text for explanation.

V. Indirect Estimates of Period Parity Progression Ratios

In this section we apply the indirect estimation procedure described in Feeney (1985: 131-133) to obtain annual estimates of period parity progression ratios for Japan for the years 1960-1982. We then carry out a number of robustness tests to establish the accuracy of the estimates.

The estimation procedure requires certain "standard" schedules of parity progression rates as input. We use the fertility surveys to provide these schedules. The surveys thus play an essential but indirect role in generating the estimates.

The estimation procedure is as follows. We have given as input the following:

- registered numbers of i -th and $(i+1)$ st births each year 1950-1982;
- a standard schedule of rates of progression from i -th to $(i+1)$ st birth;
- an initial distribution of parity i women at the beginning of 1950 by completed years duration in parity.

Note that the initial distribution is an open birth interval distribution (on the relation of open birth interval distributions and parity progression see Feeney and Ross 1984).

Multiplying the standard rates by a suitably chosen constant yields a set of adjusted rates that, when applied to the initial open birth interval distribution and the number of i -th births in 1950, gives the observed number of $(i+1)$ st births in 1950. This constant is obtained by solving the equation that implicitly defines it. The estimated period parity progression ratio for 1950 is calculated from these adjusted rates. The arithmetic complements of the adjusted rates are then applied to the initial open birth interval distribution and the number of i -th births in 1950 to give the open birth interval distribution of parity i women at the beginning of 1951. The same process may then be repeated for 1951, and so on for every year through 1982.

This procedure ignores the effect of mortality, which would result in slightly fewer women remaining in parity i at the end of the

year. It would not be difficult to take mortality into account, but the quantitative effect would be too small to justify even a modest effort.

The same procedure may be used to estimate progression from first marriage to first birth and to estimate aggregate progression from fourth and higher order births to fifth and higher order births, with suitable terminological changes in each case. We cast the following discussion in terms of progression from i -th to $(i+1)$ st birth, leaving it to the reader to substitute terms appropriate to these special cases.

Table 6 shows the standard schedules used in the calculation. They are calculated from the fertility survey data by aggregation over the fifteen most recent years. Table 7 shows the initial open birth interval distributions used in the calculation. They are calculated, by one of two methods, from the standard schedules of parity progression rates and the numbers of i -th births in 1950, assuming a stationary population of parity i women. The first method, applied to parities zero and one, simply uses the standard rates as given, calculating the proportions of women in any parity cohort remaining in parity at the end of each successive year. These cumulative proportions are shown in the lower panel of Table 6. To illustrate the calculation, there would be 634,324 (the number of first births in 1950, from Appendix Table 8) times 0.993 (from the lower panel of Table 6), or 629,884 parity one women at the end of 1950 with zero completed years duration in parity, 634,324 times 0.860931, or 546,109 parity one women with one completed year duration in parity at the end of 1950, and so on. The proportions in the lower panel of Table 6 are given only to four decimal places, but the initial open birth interval distributions have been calculated by machine carrying a large number of places.

This first method is sensible if the level of progression reflected in the standard schedules is roughly the same as the level of fertility in the early 1950s, as is the case for progression from first marriage to first birth and progression from first to second birth. If the level of progression in the early 1950s is substantially higher than that of the standards, however, as is the case for the higher parities, this procedure will yield initial open birth interval distributions with too many women at high durations in

Table 6. Standard Schedules of Parity Progression Rates for Indirect Estimation of Period Parity Progression Ratios

Duration in Parity	Marriage to 1st Birth	1st to 2nd Birth	2nd to 3rd Birth	3rd to 4th Birth	4+ to 5+ Birth
E	0.137	0.007	0.005	0.007	0.007
0	0.600	0.133	0.042	0.022	0.022
1	0.534	0.346	0.090	0.042	0.042
2	0.355	0.471	0.097	0.040	0.040
3	0.281	0.360	0.068	0.034	0.034
4	0.157	0.238	0.047	0.023	0.023
5	0.184	0.172	0.033	0.010	0.010
6	0.114	0.123	0.014	0.007	0.007
7	0.029	0.071	0.008	0.006	0.006
8	0.066	0.045	0.011	0.001	0.001
9	0.000	0.034	0.011	0.000	0.000
Mean	1.44	2.81	3.39	3.24	3.24
Stationary Population Values					
0	0.8630	0.9930	0.9950	0.9930	0.9930
1	0.3452	0.8609	0.9532	0.9712	0.9712
2	0.1609	0.5630	0.8674	0.9304	0.9304
3	0.1038	0.2979	0.7833	0.8932	0.8932
4	0.0746	0.1906	0.7300	0.8628	0.8628
5	0.0629	0.1453	0.6957	0.8429	0.8429
6	0.0513	0.1203	0.6727	0.8345	0.8345
7	0.0455	0.1055	0.6633	0.8287	0.8287
8	0.0441	0.0980	0.6580	0.8237	0.8237
9	0.0412	0.0936	0.6508	0.8229	0.8229
10	0.0412	0.0904	0.6436	0.8229	0.8229

Sources: Marriage to first birth from 1984 survey, rates for 1969-1983, Appendix Table 6. 1st to 2nd birth from 1984 survey, rates for 1969-1983, Appendix Table 7. 2nd to 3rd birth from 1981 survey, rates for 1966-1980, Appendix Table 5. 3rd to 4th birth from 1976 survey, rates for 1961-1976, data not available. 4+ to 5+ birth same as 3rd to 4th birth.

Note: The numbers in the lower panel of the table show the proportions of women still in parity at indicated completed years duration in parity in a stationary parity population with the given standard rates. They are obtained by cumulative multiplication of the arithmetic complements of the standard rates.

parity. We correct for this by adjusting the standard schedules to the level of progression in the 1950s in the following way. Beginning with the initial birth interval distribution obtained from the first method, we carry out the first step of the estimation procedure. This yields a value, k , say, by which the standard schedule must be multiplied to give the observed number of $(i+1)$ st births in 1950. Since the levels of progression are higher in the early 1950s, k will be larger than one, perhaps substantially larger. We multiply the standard rates by this k value and then calculate the initial open birth interval distribution again, by the first method, using the resulting rates. We then carry out the first estimation procedure again, yielding a second value of k . Since the standard rates have been adjusted to the level of progression in 1950, we would expect this value of k to be closer to one than the first value. We then repeat the entire process again, yielding a third k value, and so on repeatedly. This process does not converge rapidly, but it does converge. The initial distributions for parities two and above in Table 7 were obtained using 20 iterations in each case, which resulted in a final k value equal to 1.0000.

This second method may fail if it results in k values that give rates of progression greater than one. This does not happen for parities two and higher, but it does happen for parities zero and one, and this is why the first method has been used in these cases. The adjustment is unimportant for these parities, however, since levels of progression from first marriage to first birth and from first to second birth have changed relatively little.

These calculations of the initial open birth interval distribution were worked out before the robustness calculations described below were made, and in view of the results of these calculations, the complications of the second method make far too little difference to justify the extra trouble involved. The method may be useful in other applications, however, and is therefore recorded here.

Table 8 shows the resulting estimates of period parity progression ratios:

- progression from first marriage to first birth, p_0
- progression from first i -th to $(i+1)$ st birth, p_i , for $i=1,2,3$

Table 7. Initial Open Birth Interval Distributions for Indirect Estimation of Period Parity Progression Ratios and Resulting Final Open Birth Interval Distributions

Duration in Parity	Parity				
	0	1	2	3	4+
Initial					
OBID					
0	523,442	629,884	648,220	371,089	642,062
1	209,377	546,109	595,377	330,544	574,934
2	97,570	357,155	491,373	261,596	460,179
3	62,932	188,935	398,862	209,628	372,703
4	45,248	120,919	346,218	174,231	312,482
5	38,144	92,140	314,635	154,325	278,327
6	31,126	76,292	294,482	146,664	265,100
7	27,577	66,908	286,480	141,566	256,281
8	26,778	62,157	282,031	137,347	248,973
9	25,010	59,360	276,010	136,665	247,790
10	25,010	57,342	270,117	136,665	247,790
Final					
OBID					
0	625,085	645,011	597,760	224,376	40,187
1	314,023	579,900	585,114	218,294	37,654
2	174,757	418,707	567,624	215,768	35,654
3	125,976	257,655	553,689	212,977	33,966
4	97,978	190,277	555,933	207,292	34,379
5	87,729	159,554	548,295	198,367	34,536
6	78,424	146,960	549,306	194,742	35,520
7	74,842	141,500	549,362	196,803	37,204
8	74,050	143,280	559,321	229,566	43,603
9	70,967	139,729	557,883	245,251	47,837
10	69,267	129,057	528,287	229,103	43,849

Note: See text for explanation.

- aggregate progression from fourth and higher order to fifth and higher order births, p_4^+

For convenience of reference, below we have also recorded the estimates of period progression from birth of woman to first marriage, p_M , given in Feeney and Saito (1985: 24, Table 13, Series 3).

The estimation procedure results in an open birth interval distribution for the end of each year for which it is carried out. The final open birth interval distributions for each parity are shown in the lower panel of Table 7 along with the initial distributions. The effect of declining fertility on the distributions is seen both in the decreasing numbers of women at all durations in parity as parity increases and in the relatively large numbers of women at high durations in parity as compared with numbers at low durations in parity.

The estimates in Table 8 are in fact our final estimates of period parity progression ratios for Japan, but before accepting them, we subject them to the robustness tests described in the following section.

VI. Robustness of the Indirect Estimates

Table 9 shows the robustness of the estimates in Table 8 against variations in the initial open birth interval distribution. For each parity, two alternative series of estimates have been calculated, one in which the initial open birth interval distribution is taken to be 0.8 times, and one in which it is taken to be 1.2 times, the initial open birth interval distribution given in Table 7, on which the estimates in Table 8 are based. The table entries are percent deviations of the alternative series of estimates from the estimates given in Table 8.

We see that the initial open birth interval distribution has a substantial but diminishing effect for the first ten years of the series, 1950-1959. The deviations are as high as 15 percent in 1950, but by 1960 the largest deviations are for parity one (1-2 percent), and the deviations for the other parities are well under one percent. We conclude that, so long as attention is restricted to the years since 1960, the effect of errors in the specification of the initial

Table 8. Indirect Estimates of Period Parity Progression Ratios for Japan, 1950-1982

Year	B to M	M to 1	1 to 2	2 to 3	3 to 4	4+ to 5+
1982	925	916	856	320	137	221
1981	924	917	850	307	131	210
1980	928	917	853	304	129	208
1979	932	915	855	302	127	203
1978	933	919	856	299	128	213
1977	939	919	850	291	126	216
1976	947	925	853	291	127	217
1975	953	931	859	299	134	228
1974	958	937	873	346	165	252
1973	964	939	883	373	188	279
1972	966	939	880	365	186	259
1971	965	939	881	366	194	252
1970	972	941	870	358	198	251
1969	971	938	870	362	206	243
1968	970	939	863	353	205	233
1967	970	938	863	355	207	225
1966	968	894	707	260	174	203
1965	970	943	862	368	218	211
1964	972	935	842	373	222	206
1963	970	932	835	388	233	208
1962	969	934	830	406	245	210
1961	963	932	833	438	276	229
1960	958	939	840	476	309	248
1959	955	943	845	512	355	277
1958	953	946	849	545	399	297
1957	945	937	830	541	431	304
1956	938	947	835	570	497	338
1955	940	949	838	592	545	362
1954	943	952	846	597	569	386
1953	947	966	886	581	589	452
1952	953	972	914	575	609	515
1951	960	974	932	577	628	575
1950	--	973	939	583	644	627

Note: See text for explanation.

Table 9. Robustness of Indirect Estimates Against Variations in Initial Distributions: Percent Deviations from Period Parity Progression Ratio Estimates Given in Table 8 of Estimates Based on Two Alternative Initial Open Birth Interval Distributions

Year	Parity 0		Parity 1		Parity 2		Parity 3		Parity 4+	
	0.8	1.2	0.8	1.2	0.8	1.2	0.8	1.2	0.8	1.2
1980	+0.09	-.07	+0.02	-.02	.00	.00	.00	.00	.00	.00
1975	+.13	-.10	+.07	-.05	.00	.00	.00	.00	.00	.00
1970	+.23	-.18	+.18	-.11	+.03	.00	.00	.00	.00	.00
1965	+.45	-.35	+.56	-.41	+.14	-.11	+.05	-.05	+.05	-.05
1960	+1.0	-.8	+2.1	-1.5	+1.1	-.9	+.6	-.5	+.5	-.4
1959	+1.1	-1.0	+2.6	-2.0	+1.7	-1.5	+.9	-.7	+.8	-.6
1958	+1.2	-1.1	+3.1	-2.4	+2.4	-2.2	+1.4	-1.2	+1.3	-1.1
1957	+1.6	-1.5	+4.2	-3.3	+3.2	-2.8	+2.2	-1.9	+2.3	-2.0
1956	+1.7	-1.6	+5.0	-4.1	+4.0	-3.4	+3.1	-2.6	+3.3	-2.9
1955	+1.9	-1.7	+5.9	-5.0	+5.1	-4.4	+4.0	-3.4	+4.6	-4.0
1954	+2.1	-2.1	+7.0	-6.0	+6.5	-5.6	+5.8	-4.9	+6.9	-5.8
1953	+1.8	-2.1	+6.6	-6.5	+8.7	-7.3	+8.1	-6.9	+9.5	-7.8
1952	+1.7	-2.1	+6.2	-7.0	+11.9	-9.7	+10.6	-8.8	+12.0	-9.7
1951	+1.8	-2.4	+5.3	-6.6	+14.9	-11.7	+13.1	-10.7	+14.2	-11.3
1950	+2.0	-2.9	+4.1	-4.9	+15.0	-11.8	+13.0	-10.6	+13.4	-10.9

Note: See text for explanation.

open birth interval distribution is entirely negligible.

Table 10 shows the robustness of the estimates against variations in the standard schedules of progression. As in Table 9, two alternative series of estimates have been calculated for each parity, and the columns of the table show the percent deviation of these estimates from those given in Table 8. Since two standard schedules that differ only by a constant factor will give the same series of estimates, we choose the alternative schedules on the basis of the implied mean interval to next birth. Specifically, for each parity we calculate rates aggregated over moving three year periods and choose the two schedules that have the highest and the lowest implied mean interval. The alternative standard schedules on which each series is based are shown in the lower portion of the table.

Since the test of robustness against the choice of initial open birth interval distribution has shown that the estimates for the 1950s are relatively unreliable, the ratios in Table 10 are shown only from 1960 forward. It will be seen that, within each parity, the alternative standard schedules differ very substantially, both from each other and from the standard schedules on which the estimates in Table 8 are based. Some of these differences are certainly due to random fluctuations in the survey data. We do not attempt to reduce these fluctuations, however, so as to have a more stringent test of robustness.

The estimates are generally very robust against variations in the standard schedules. For progression from first marriage to first birth, the deviations are one percent or less with the single exception of alternative (2) in 1982, for which the deviation is 1.2 percent. For progression from first to second birth, the deviations from 1970 forward are on the order of one or two percent. Interestingly, the deviations for the 1960s are greater, with extreme values of +4.5 and -4.9 percent in 1966. This was of course the year of Hinoe Uma, in which fertility was drastically depressed. Deviations of similar magnitude occur in earlier years, however, so this change is not the primary explanation of the relatively large deviations. Progression from second to third and third to fourth birth likewise show deviations on the order of one or two percent, with an extreme value of 3.6 percent for parity 2, alternative 2, in 1982. Progression from fourth and higher to fifth and higher order

Table 10. Robustness of Indirect Estimates of Period Parity Progression Ratios against Variations in the Standard Schedules of Parity Progression Rates

Year	Parity 0		Parity 1		Parity 2		Parity 3		Parity 4	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
1982	-0.0	-1.2	-1.9	+2.2	+1.5	-3.6	-0.3	+0.3	-0.2	+1.1
1981	-0.0	-1.0	-1.8	+2.0	+1.2	-3.3	-0.8	+0.3	-0.9	+1.0
1980	-0.0	-1.0	-1.2	+1.6	+0.1	+2.7	-0.1	+0.1	+0.8	+1.3
1979	+1.0	-0.8	-0.4	+1.0	+0.3	-2.5	+0.9	+1.8	0.0	+2.6
1978	0.0	-0.9	+0.4	+0.4	+0.2	-2.1	-0.2	0.0	-0.8	+0.9
1977	-0.0	-0.9	+1.2	-0.2	0.0	-2.1	-0.6	-1.2	-1.3	-0.6
1976	-0.0	-0.8	+1.6	-0.4	0.0	-0.3	-1.6	-0.2	-1.8	+0.7
1975	-0.0	-0.8	+1.6	-0.4	-0.9	-2.1	-0.8	+0.1	-1.2	+1.4
1974	0.0	-0.5	+1.7	-0.1	-0.9	-0.8	+0.7	-1.5	+0.6	+0.3
1973	+0.0	-0.2	+1.3	+0.3	-0.9	-1.3	+1.4	-0.4	+0.6	+0.9
1972	+0.1	+0.0	+1.2	+0.3	+0.5	+0.3	+0.2	-1.9	-0.7	+0.7
1971	+0.2	+0.2	+1.3	+0.2	-1.4	-0.2	+0.7	-2.4	-0.4	+1.2
1970	+0.1	+0.2	+1.6	+1.6	-1.5	+0.2	+2.1	+2.0	0.0	+4.0
1969	+0.1	+0.2	+1.7	-1.0	-2.6	-1.0	+0.2	-0.1	-1.1	+3.7
1968	+0.1	+0.2	+2.3	-0.9	-1.3	-1.0	+2.9	-2.0	-0.6	+3.6
1967	+0.1	+0.2	+2.8	+0.4	-0.1	+0.1	-2.6	+0.3	-2.8	+5.3
1966	+0.2	+0.4	+4.5	-4.9	-1.5	-0.6	-0.6	+2.4	-2.2	+6.6
1965	+0.1	+0.4	+2.9	-0.9	-1.7	-0.3	-0.4	+0.7	-2.3	+5.9
1964	+0.2	+0.5	+3.3	-1.7	-1.4	-0.6	-0.5	+1.3	-2.2	+6.6
1963	+0.2	+0.5	+3.6	-2.0	-1.0	-1.0	-1.5	+1.2	-3.4	+5.3
1962	+0.2	+0.6	+3.8	+1.9	-0.7	-1.3	-2.0	+0.9	-3.1	+4.8
1961	+0.2	+0.7	+3.7	-1.3	-0.3	-1.7	-1.5	+1.7	-2.8	+5.5
1960	+0.2	+0.8	+3.5	-1.8	-0.0	-2.2	-1.6	+1.7	-3.2	+4.1
DIP	<u>Standard Distributions</u>									
E	0.118	0.065	0.003	0.010	0.012	0.000	0.003	0.015	0.003	0.015
0	0.636	0.547	0.088	0.174	0.067	0.038	0.005	0.020	0.005	0.020
1	0.534	0.549	0.311	0.222	0.106	0.076	0.044	0.027	0.044	0.027
2	0.415	0.429	0.392	0.263	0.089	0.083	0.031	0.040	0.031	0.040
3	0.295	0.150	0.313	0.500	0.065	0.075	0.032	0.050	0.032	0.050
4	0.114	0.038	0.298	0.000	0.044	0.058	0.017	0.010	0.017	0.010
5	0.128	0.125	0.269	0.000	0.045	0.047	0.000	0.000	0.000	0.000
6	0.067	0.000	0.286	0.000	0.015	0.011	0.011	0.013	0.011	0.013
7	0.179	0.059	0.429	0.000	0.000	0.014	0.006	0.000	0.006	0.000
8	0.056	0.222	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
9	0.000	0.250	0.000	0.000	0.011	0.036	0.000	0.000	0.000	0.000
Mean	1.42	1.72	3.33	2.58	2.99	3.74	3.44	2.98	3.44	2.98
	1.44		2.81		3.39		3.24		3.24	

Note: See text for explanation. DIP signifies duration in parity. Mean values given in last line are from Table 6.

births shows the largest deviations overall, but even here the values from 1970 forward are only one or two percent.

To summarize the results of the robustness calculations, we find that the influence of the initial open birth interval distribution is substantial in the initial years of the estimated series, but that it rapidly declines to small and finally negligible proportions. The errors due to deviations of the actual from the assumed initial open birth interval distributions are around one percent in 1960 and decline steadily until they are one tenth of a percent or less in 1980. The errors due to deviations of the assumed standard schedule of parity progression rates from an optimal schedule (optimal in the sense of providing a series of estimates closest overall to the actual period parity progression ratios) are generally on the order of one or two percent, with occasional deviations as high as five percent. The conditions assumed in both cases have been stringently set, in the sense that we judge them to be more extreme than the actual departures of assumed from actual conditions, and we therefore consider these results to be conservative.

VII. Total Fertility Rates

The idea of summary fertility measures based on period parity progression ratios goes back to Henry (1953: chapter XIV). Though Henry deals with marital fertility only, the ideas extend without difficulty to overall fertility. The general formula is

$$\text{TFR} = p_0 + p_0 p_1 + p_0 p_1 p_2 + \dots \quad (3)$$

where p_0 denotes the proportion of women born who ever have a first birth and p_i denotes the proportion of women having an i -th birth who ever have an $(i+1)$ st birth. If the p_i are defined for a birth cohort, this expression gives the same result as the summation of the age-specific fertility rates. If the p_i are taken to be the period statistics for a given year, however, defined as in Section 2 above, the TFR given by (3) represents the completed fertility that would be observed in an hypothetical cohort that experienced these p_i values.

Because first marriage has been introduced explicitly, we calculate p_0 as $p_M p_0^*$, where p_M denotes period progression to first

marriage and p_0^* denotes period progression from first marriage to first birth. Also, because our parity progression ratio values end with an aggregate ratio for progression fourth and higher to fifth and higher order births, we approximate the terms

$$p_0 p_1 p_2 p_3 (p_4 + p_4 p_5 + p_4 p_5 p_6 + \dots)$$

by

$$p_0 p_1 p_2 p_3 p_4^* / (1 - p_4^*)$$

where p_4^* denotes the ratio for progression from fourth and higher to fifth and higher order births, as given in the far right column of Table 8. This expression is obtained by assuming that p_4 and all higher order ratios equal p_4^* and pulling out a geometric series. The formula for calculating TFRs from the estimates in Table 8 is thus

$$\begin{aligned} \text{TFR}_{\text{PPR}} = & P_M P_0 + P_M P_0 P_1 + P_M P_0 P_1 P_2 + P_M P_0 P_1 P_2 P_3 \\ & + P_M P_0 P_1 P_2 P_3 p_4^* / (1 - p_4^*) \end{aligned} \quad (4)$$

Table 11 shows, on the left, total fertility rates (TFRs) calculated in this way from the estimates in Table 8 compared with total fertility rates calculated in the usual way from age-specific birth rates. A similar comparison for China is shown on the right. Looking first at the Japanese data, which are plotted in Figure 1, the broad picture conveyed by the two series is remarkably similar. The two TFRs differ by a maximum of about 0.1 children per woman, or about five percent in relative terms. There is a clear tendency for the age-specific birth rate TFR to exaggerate movements relative to the period parity progression ratio TFR. Thus when the parity progression measure rises from 2.04 in 1964 to 2.08 in 1973, the age-specific birth rate measure rises from 2.04 in 1964 to 2.08 in 1973, the age-specific birth rate measure rises from 2.04 to 2.14, and when the parity progression measure falls to 1.83 in 1981 the age-specific birth rate measure falls to 1.74. These are not large movements, but in relative terms the difference is substantial. Thus the age-specific birth rate TFR falls by 0.41 children per woman between 1971

Table 11. Period Parity Progression Ratio TFRs and Age-Specific Birth Rate TFRs Compared, Japan, 1960-1982, and China, 1966-1982

Year	Japan				China			
	PPR	ASBR	DIFF	%	PPR	ASBR	DIFF	%
1982	1.84	1.77	-0.07	-4	2.65	2.62	-.03	-1
1981	1.82	1.74	-0.08	-4	2.70	2.23	-.47	-17
1980	1.83	1.75	-0.08	-4	3.19	2.72	-.47	-15
1979	1.84	1.77	-0.07	-4	3.16	2.67	-.49	-16
1978	1.85	1.79	-0.05	-3	3.23	2.78	-.45	-14
1977	1.84	1.80	-0.04	-2	3.47	3.15	-.32	-9
1976	1.88	1.85	-0.03	-2	3.73	3.46	-.27	-7
1975	1.92	1.91	-0.01	-1	4.14	4.02	-.12	-3
1974	2.01	2.05	+0.04	+2	4.37	4.37	.00	0
1973	2.08	2.14	+0.06	+3	4.73	4.74	+.01	+0
1972	2.07	2.14	+0.07	+3	5.08	5.22	+.14	+3
1971	2.07	2.16	+0.09	+4	5.43	5.58	+.15	+3
1970	2.07	2.12	+0.05	+2	5.41	5.48	+.07	+1
1969	2.07	2.12	+0.05	+2	5.68	6.17	+.49	+9
1968	2.05	2.12	+0.07	+3	4.98	5.08	+.10	+2
1967	2.05	2.22	+0.17	+8	5.75	5.97	+.22	+4
1966	1.67	1.60	-0.07	-4	5.96	5.81	-.15	-3
1965	2.07	2.13	+0.06	+3				
1964	2.04	2.04	0.00	0				
1963	2.04	1.99	-0.05	-2				
1962	2.06	1.97	-0.09	-4				
1961	2.09	1.95	-0.14	-7				
1960	2.16	1.99	-0.17	-8				

Source of values for China: Table 4 of Feeney and Yu (forthcoming).

and 1980, whereas the period parity progression ratio TFR falls by only 0.24 children per woman over the same period.

Similar patterns are observed in the series for China. They are explained in part by the formal demographic mechanism described in Feeney and Yu (forthcoming; see Figure 4 for a plot of the Chinese series), by which changes in age at first birth lead to larger fluctuations in TFRs calculated from age-specific birth rates than in TFRs calculated from period parity progression ratios.

Despite these differences, the two TFR calculations lead to broadly similar results. The two series plotted in Figure 1 paint the same broad picture of recent fertility trends in Japan and we may analyze these trends using either approach. This is important, for the parity progression calculation has substantial advantages over the age-specific birth rate calculation when we come to look at the marriage and birth order components of fertility, as we shall now see.

VIII. Birth Order Components

The components on the right of formula (4) above may be interpreted as the contributions of births of each order to the total fertility rate, as in Feeney and Yu (forthcoming). The first term on the right represents the contribution of first births to the TFR, the second term the contribution of second births, and so on to the last term, which represents the contribution of fourth and higher order births.

Birth order components and TFR values calculated from the estimates in Table 8 are shown in Table 12. We see that the contribution of first births to the TFR hovers around 0.9 children per woman from 1960 through the early 1970s. The contribution of second births rises over the same period from around 0.75 to nearly 0.80 children per woman. The contribution of third and higher order births, in contrast, declines sharply. During the 1970s the contribution of first births falls from around 0.90 to about 0.85, the contribution of second births from nearly 0.80 to about 0.72. There is very little to surprise one in the overall picture, a possible exception being the rise in the contribution of second births during the 1960s.

Age-specific birth rate TFRs may also be expressed as a sum of

Table 12: Birth Order Components of Period Parity Progression Ratio
TFRs, Japan, 1960-1982

Year	Birth Order					TFR
	1	2	3	4	5+	
1982	0.847	0.725	0.232	0.032	0.009	1.845
1981	0.847	0.720	0.221	0.029	0.008	1.825
1980	0.851	0.726	0.221	0.028	0.007	1.833
1979	0.853	0.729	0.220	0.028	0.007	1.837
1978	0.857	0.734	0.219	0.028	0.008	1.846
1977	0.863	0.733	0.213	0.027	0.007	1.843
1976	0.876	0.747	0.217	0.028	0.008	1.876
1975	0.887	0.762	0.228	0.031	0.009	1.917
1974	0.898	0.784	0.271	0.045	0.015	2.013
1973	0.905	0.799	0.298	0.056	0.022	2.080
1972	0.907	0.798	0.291	0.054	0.019	2.069
1971	0.906	0.798	0.292	0.057	0.019	2.072
1970	0.915	0.796	0.285	0.056	0.019	2.071
1969	0.911	0.792	0.287	0.059	0.019	2.068
1968	0.911	0.786	0.277	0.057	0.017	2.048
1967	0.910	0.785	0.279	0.058	0.017	2.049
1966	0.865	0.612	0.159	0.028	0.007	1.671
1965	0.915	0.788	0.290	0.063	0.017	2.073
1964	0.909	0.765	0.285	0.063	0.016	2.038
1963	0.904	0.755	0.293	0.068	0.018	2.038
1962	0.905	0.751	0.305	0.075	0.020	2.056
1961	0.878	0.748	0.327	0.090	0.027	2.090
1960	0.900	0.756	0.360	0.111	0.037	2.164

Note: See text for explanation.

birth order components, calculated by summing age-order specific birth rates for each birth order over age. These TFRs and birth order components are shown in Table 13. The age-order-specific birth rates from which these values were obtained were calculated directly from registered births by birth order and age in five year groups and the female age distribution of the 1980 census. No adjustment was made for mortality of females (in effect, the reverse survivorship ratios were taken equal to one), nor for the difference between midyear and the census date of October 1. The errors incurred by these simplifications are small, as may be seen by comparing the total fertility rates in Table 13 with the official series.

Looking first at the first birth contributions in the first column of Table 13, we see that they are substantially more variable than the parity progression ratio values in Table 12. Between 1973 and 1979, for example, the first birth component falls from 0.960 to 0.769, a fall of 0.197 children per woman, or about 20 percent. The corresponding period parity progression ratio values fall from 0.905 to 0.847 over the same period, a drop of 0.058 children per woman, or about six percent. In Feeney and Yu (forthcoming) it is shown that this exaggeration of effects is a result of the improper relation of events to exposure in the age-specific first birth rates, in which first births are related to all women rather than to zero parity women. The sort of distortions to which this can lead are illustrated in extreme form in 1967, following Hinoe Uma, when the age-specific first birth component leaps to 1.231.

There are substantial differences between the parity progression ratio and the age-specific birth rate values of the higher order birth components, but no obvious patterns. It is notable that the agreement between the TFRs is a good deal better than the agreement between the birth order components, indicating that differences in the latter are tending to cancel each other out.

IX. The Fertility Decline of 1973-76

Perhaps the most remarkable feature of Japanese fertility in recent years is the sudden decline that occurred during the years 1973-76. The TFR had been rising very slightly during the late 1960s and early 1970s. It then fell sharply in 1973 and again in 1974 and

Table 13. Birth Order Components of Age-Specific Birth Rate TFRs,
Japan, 1960-1980

Year	Birth Order					TFR
	1	2	3	4	5+	
1980	0.774	0.695	0.234	0.030	0.010	1.743
1979	0.769	0.727	0.240	0.031	0.011	1.778
1978	0.774	0.744	0.236	0.032	0.011	1.797
1977	0.786	0.740	0.228	0.033	0.013	1.800
1976	0.813	0.741	0.232	0.038	0.015	1.839
1975	0.866	0.719	0.201	0.031	0.014	1.831
1974	0.950	0.801	0.275	0.044	0.017	2.087
1973	0.966	0.834	0.307	0.050	0.018	2.175
1972	0.946	0.836	0.299	0.048	0.018	2.147
1971	0.919	0.871	0.302	0.049	0.018	2.159
1970	0.907	0.829	0.282	0.047	0.018	2.083
1969	0.900	0.820	0.269	0.047	0.020	2.056
1968	0.945	0.833	0.252	0.046	0.021	2.097
1967	1.231	0.894	0.253	0.057	0.025	2.221
1966	0.818	0.542	0.171	0.041	0.025	1.597
1965	0.975	0.810	0.258	0.061	0.034	2.138
1964	0.908	0.750	0.241	0.058	0.070	2.027
1963	0.916	0.712	0.241	0.065	0.046	1.980
1962	0.894	0.679	0.245	0.072	0.056	1.946
1961	0.864	0.663	0.261	0.089	0.074	1.951
1960	0.868	0.649	0.284	0.106	0.099	2.006

Note: See text for explanation.

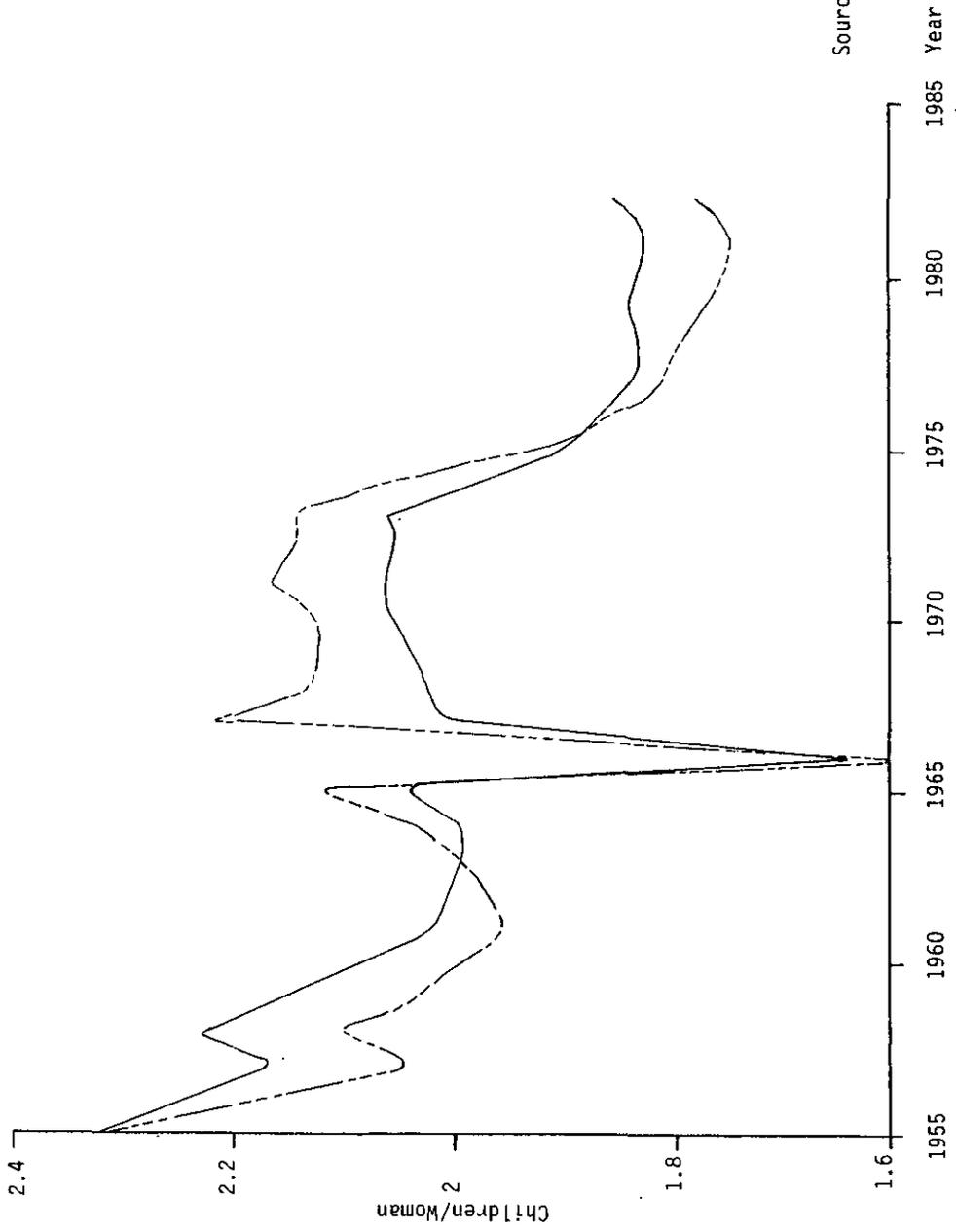
1975. The TFR calculated from age-specific birth rates fell from 2.18 in 1973 to 1.84 in 1976, a fall of nearly a third of a child per woman, and a drop of 16 percent. The period parity progression ratio TFR fell from 2.08 to 1.88 during the same period, a smaller but equally distinct drop. The age-specific birth rate TFRs show the decline continuing for the rest of the 1970s, but at a much slower rate. The period parity progression ratio TFRs are virtually constant from 1976 forward. In either case, there is a striking discontinuity during the years 1973-76 (Figure 1).

The decline might be explained by a postponement of marriages and births during this period, and this explanation has been advanced, e.g., in Council on Population Problems (1980: 20). If all women postponed marriage and childbirth during this period, the TFR could in principle go to zero, and a relatively low incidence of postponement could effect the decline that is observed. Postponement implies, of course, that the events postponed are subsequently made up, so that the proportion of women ever marrying and completed family size are unaffected. This means that the period decline in fertility observed during the period of postponement will be reversed when the postponed events are made up, with fertility returning to the pre-postponement level.

This explanation for the decline thus leads to an interesting and important consequence, the expectation that fertility will rise to the original level when the events postponed are finally made up. We thus look for an increase of the TFR in Japan back to the 1973 level of around 2.1 children per woman. There is no evidence of such an increase in Figure 2. If events were postponed during 1973-76, they were certainly not made up during the following six years. How many years should we allow to elapse before we conclude that the decline was what it appeared to be--a decline in the level of fertility?

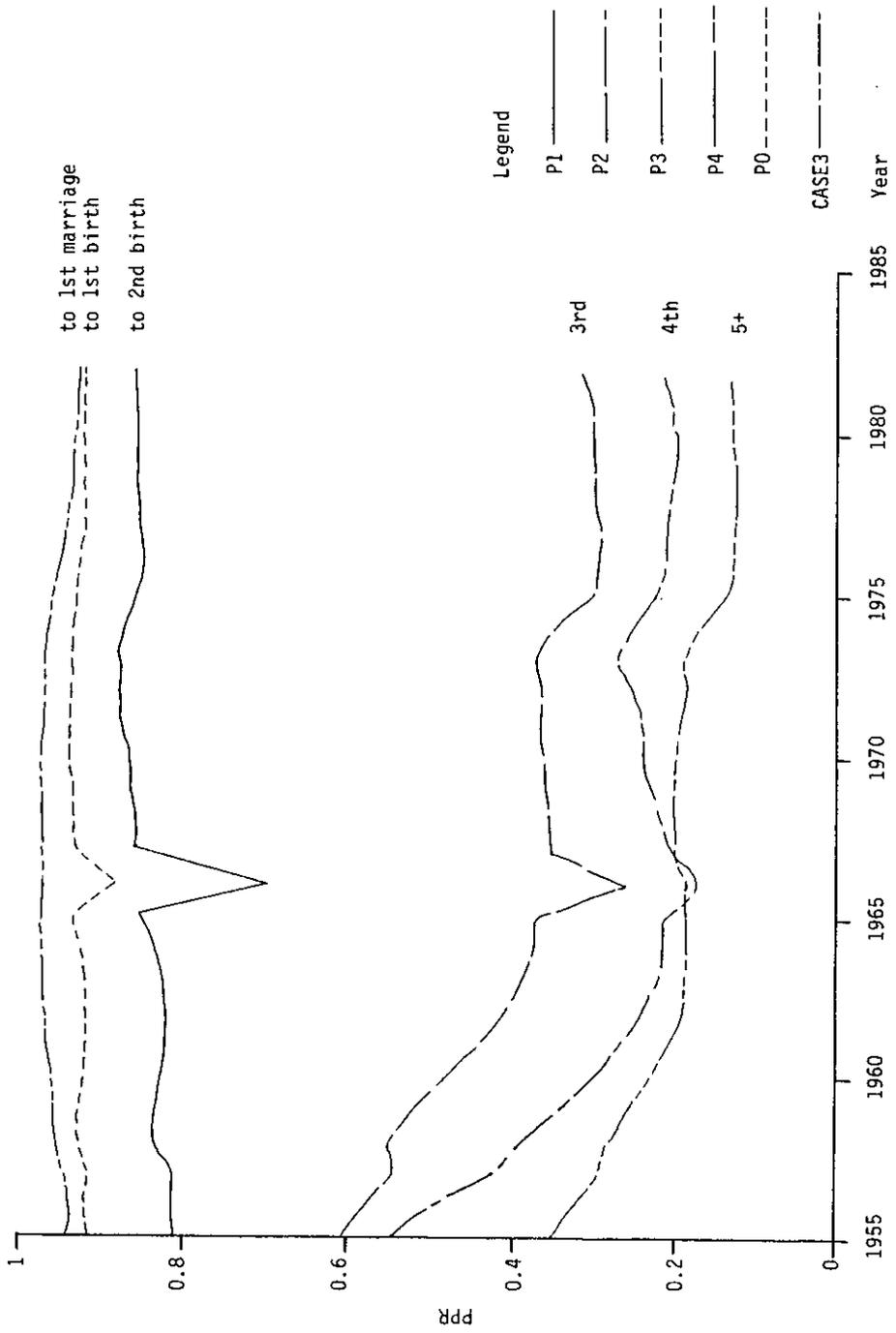
Before attempting to answer this question we should observe that women or couples may have thought to themselves, at the time of the fertility decline, that they were deferring births they would later go on to have. If the women did indeed go on to have these births in later years, we may conclude that the decline was an effect of postponed births. If they do not go on to have these births, however, the demographic effect is the same as if they had decided to stop childbearing, and in this case we conclude that the decline reflected

Figure 1. Comparison of Total Fertility Rates for Japan



Source: Table 11

Figure 2. Period Parity Progression Ratios for Japan



reduced family size, whatever may have been in the minds of the women or couples at the time. Our concern is not ultimately with whether women or couples intended to have these births, but whether they did in fact have them. Births deferred and never made up represent a real decline in cohort fertility, whatever the intentions of the parents at the time of deferment.

The deferral of any event evidently decreases the chance that this event will occur, if only because the person in question may die before its occurrence. Given low levels of mortality at the ages at which most Japanese women bear children, however, the quantitative effect of mortality here will be negligible. If postponed births tend not to be made up, the explanation must lie in the changing circumstances of the family.

Lapse of time is a crude proxy for changing circumstances, but by no means a useless one. Most obviously, the circumstances of mothers change with the aging of their children: infants become children and pre-school children become school children. In this context, a delay of six years is a long time indeed, enough for the last child to enter primary school, and so free the mother from substantial childcare duties.

Another standard for gauging the significance of elapsed time is the typical birth interval. From the standpoint of biological possibility, there is little reason why we should not observe average intervals of ten or more years between first and second birth. The potential of postponement for complicating the analysis of fertility trends in a low fertility population is thus very great indeed. If the current interval is two to three years on the average, and if it is in the process of shifting to an average of ten years, we shall have to wait a decade or so to know whether or not a current decline reflects a change in spacing or a decline in completed fertility.

In fact, however, something over 90 percent of all progression to next birth occurs within five years, and this is true in low fertility populations as well as in high fertility populations. Biological possibility does not necessarily become social reality, and the same factors that might be put forward to explain observed patterns of birth intervals provide a basis for supposing that these patterns will persist. There is an obvious economy in having births spaced two or three years apart, rather than five or ten years apart, and

considerations of social interaction in the family might be considered to favor children not too widely spaced in age. From this perspective also, then five years is a long time.

The absence of any significant rise in fertility between 1976 and 1982 thus constitutes fairly powerful evidence against the idea that the decline of fertility between 1973 and 1976 was due to a postponement of births that will eventually be made up. This is not to say that fertility may not rise in the future. It is to say that (i) if such a rise occurs it will not be attributable to the making up of postponed births and (ii) that a rise should not be expected on this basis.

There remains however the possible effect of postponement of first marriage. While there are some similarities between the postponement of first marriage and the postponement of births, both the demographic and the social context are very different. Intervals from birth to first marriage are something like ten times as long as birth intervals, and the range of variation is much greater as well. Even in Japan, where the variation in age at marriage is relatively low, the shortest span of ages that includes 90 percent of all marriages is something like 15 years. Considerable shifts, occurring over a long period of time, are possible within this range.

Nor do the considerations that support limited variation of birth intervals apply to changing age at marriage. The circumstances of single women change, certainly, the longer they remain in this status, and beyond a certain point, they probably change in ways that make eventual marriage increasingly unlikely. Nonetheless, it is possible that postponed marriages, more so than postponed births, could be made up many years into the future. Postponement of marriage may not be a terribly plausible explanation of the decline in fertility during 1973-1976, given the failure of the TFR to rise in subsequent years, but it is less easily dismissed than an explanation by postponed births.

To study the effects of changes in marriage patterns, whether due to postponement of marriage or otherwise, we need to isolate the effects of these patterns from the effects of fertility proper. This is most often done by making the age-specific fertility rates that enter into the TFR specific for marital status and/or parity as well as age. See for example Tsuya (1986: chapter IV) for an admirable

example of this approach. This approach does not deal with shifts in timing of marriage, however, because it controls only for the effects of changing marriage patterns on the denominators of the birth rates. Rising or falling age at marriage influences the numerators of birth rates as well as the denominators. Given constant completed fertility within birth cohorts, rising age at marriage temporarily depresses period fertility because, during the period over which the rise occurs, the same number of births is spread out over a longer time period. In the same way, a falling age at marriage may lead to a temporary rise in period fertility. Our knowledge of these effects is due primarily to the pioneering work of Norman Ryder (see for example Ryder 1980 and the references contained therein). Marital age-specific birth rates are affected in this way quite as much as ordinary age-specific birth rates because the influence of changing marriage patterns operates on the numerators of the rates, which are the same.

The period parity progression ratios shown in Table 8 and plotted in Figure 2 provide an alternative in which the effects of changing marriage patterns are more fully controlled for. If the decline in fertility during 1973-76 was due to rising age at first marriage, we should see its effect in the period progression ratio for progression from birth to first marriage. Progression from birth to first marriage does decline from 0.964 in 1973 to 0.947 in 1976, a decline of 1.7 percent in three years. This decline is not particular to the 1973-76 period, however, but is part of a longer term decline that brings the progression ratio down from 0.972 in 1970 to 0.925 in 1982, a change of 4.7 percent in 12 years, or by 1.2 percent each three years. The progression ratio thus does decline slightly faster during 1973-76 than during the 1970-82 period as a whole, but the difference is very slight indeed. This may be seen graphically as well, by replotting the lower order progression ratios on a finer scale.

It is in fact a simple matter to calculate the change in the TFR that will occur given any assumed changes in the progression ratios. Consider for example the period 1973-76, during which the TFR declined from 2.080 to 1.876 children per woman, a decline of 0.204 (Table 12). If we assume, for example, that progression from birth to first marriage changed as, in fact, it did, but that all other ratios remained constant at their 1973 levels, we find that the TFR would

have declined by 0.036 children per woman, which is 18 percent of the observed change during the 1973-76 period. The same calculation applied to the higher order ratios yields the following results.

Ratio	Decline	Percent
P_M	.036	18
P_0	.026	13
P_1	.039	20
P_2	.083	42
P_3	.024	12
P_{4+}	.003	1.5
Total	.211	106.5

The column on the right expresses the changes as a percent of the observed change during the 1973-76 period, 0.204. The various changes do not of course sum to the observed change because of the interactions between them. The impact of a given change in p_3 , for example, depends on the proportion of women who reach parity three, and this depends on the levels of the preceding ratios. Rather remarkably, however, the interactions in this instance are quite minor, so that the component changes come quite close to summing to the observed change.

This calculation shows that roughly 80 percent of the change in the total fertility rate during 1973-1976 was due to changing progression to first and higher order births, with only 20 percent due to changing levels of progression to first marriage. Nearly all of the remaining 80 percent of the change is due to progression to first through fourth births, with progression from second to third birth contributing half of this decline.

The time series of parity progression ratios provides, indeed, a very useful elaboration of the trend of the total fertility rate. We see in Figure 2 that all the progression ratios beyond those for progression to first marriage and first birth show a clearly defined drop during 1973-76, being more or less constant both before and after this period. The absence of any increase in the progression ratios

between 1976 and 1982 shows how unlikely it is that the declines have been due in any substantial part to an increase in the spacing between births.

It is of course possible for changing age at marriage to affect progression from i -th to $(i+1)$ st birth by raising the average age at which i -th births occur. This will occur, however, only when the ages at which women are having i -th births are sufficiently high so that raising the age by a few years will push significant numbers of women into secondary sterility. Given the relatively young ages at which the births in question are occurring, however, it would appear most unlikely that the declines in the progression ratios are due to this effect.

We could of course go to the vital statistics distributions of age at marriage in pursuit of this question, but there is a simpler approach. If the decline in the higher order parity progression ratios were due to a rise in age at marriage, we should see a lag in the decline of the parity progression ratio series with increasing parity. Progression from marriage to first birth would decline as the age distribution of women at first marriage becomes older. Since pushing up age at first birth necessarily pushes up age at second birth as well, progression from first to second birth will decline as well but only after a time lag approximately equal to the mean interval between marriage and first birth, and similarly for higher order births. Thus the declines in the successively higher parity series should lag each other by approximately the mean interval between the corresponding events. There is no trace of such a lag in Table 8 and Figure 1. The period parity progression ratio series all turn down at the same time and fall over the same period.

X. Conclusion

The principal purpose of the work reported here has been to generate an historical series of period parity progression measures of fertility for Japan. The data necessary for direct calculation does not exist, however, whence what would otherwise be a mere calculation requires substantial analysis and indirect estimation. It should be observed here that the data necessary for direct calculation of period parity progression measures exists for very few countries, even among

developed countries with long histories of complete vital registration. The difficulty is that the birth certificates used in vital registration system frequently do not include data of last birth or, if they do, the information is not available, or tabulated, for a sufficiently long period of time. (The few exceptions occur in European countries, e.g., Belgium; see Willems, Wijewickrema and Lesthaeghe 1981.) Thus the methods developed here for Japan may find application in other countries.

We have seen that the closest thing to direct data that exists for Japan, the fertility survey data, do not provide adequate estimates, partly because of sampling variability and partly because of systematic errors, the nature of which remains unclear. Fortunately, the indirect estimation of period parity progression ratios from historical series of registered births by orders provides very good results.

Our principal substantive conclusion concerns the causes of the decline in fertility that occurred between 1973 and 1976. Previous analyses have suggested that this decline was not due primarily to a decline in marital fertility, that it was due to some combination of a rising age at marriage and lengthening birth intervals. This explanation implies a rise in fertility once age at marriage stops rising and birth intervals stop lengthening, however, and it has become more and more suspect as more and more years pass without the expected rise in fertility. We have concluded that, on the contrary, some 80 percent of the fertility decline in Japan between 1973 and 1976 was due to a reduction of family size within marriage and have argued that the methods used favor this conclusion.

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Appendix

Appendix Tables 1-7 give the survey data from which the period parity progression ratios given in section 2 of the paper are calculated. The first column of the table from progression from event A to event B gives the tabulation of survey women who have experienced event A by year of event A. The remainder of the table gives the tabulation of women who have experienced both event A and event B by year of event A and year of event B minus year of event A. Both tabulations exclude (i) women for whom year of event A and/or year of event B is not stated and (ii) women for whom year of event B precedes year of event A.

Observe that multiple births are incorporated in these tables simply as two births occurring in the same year. Thus if a woman's first confinement results in twins, she is counted as a woman who has both her first birth and her second birth in the same year. Birth and birth order are thus literally understood, consistent with usage in most vital statistics and with Japanese vital statistics in particular. This is in contrast to usage often encountered in the analysis of survey data, in which "birth interval" refers not to birth intervals proper but to interval between confinements that result in one or more live births.

The reading of the tables may be illustrated by reference to Appendix Table 1, which shows data on progression from first to second birth for the 1974 Japan Fertility Survey. Each row of the table gives data for the parity cohort of the year indicated at left. In the row for 1968, for example, we see that 113 survey women had a first birth in this year, that none of these women had a second birth in the same year, that 10 of them had a second birth in the following year, 1969, and so on. The column headings "0", "1", . . ., represent the difference between the year of first birth and the year of second birth.

The data have been tabulated for calendar year parity cohorts to secure comparability with vital registration data, and as the data for calendar 1974 is incomplete, it is omitted. The upper right triangle of the table corresponds to second births that occur after 1973, whence the "na" (not applicable) entries.

The usual life table approach would classify second births to

each parity cohort by duration in parity of mother, in suitably defined duration in parity groups. We have chosen the alternative of classifying second births by calendar year for several reasons. First, we are primarily concerned with ultimate progression, rather than with birth interval distributions, and for this purpose the two approaches serve equally well because of the low incidence of second births at high durations in parity. Second, the calendar year classification does provide considerable information on the birth interval distribution, and with a moderate number of terms. Mean birth intervals may be computed from this data, and they will err only to the extent that first births to parity cohorts are not uniformly distributed over the year. While departures from uniformity might affect comparisons between populations, seasonal fluctuations in marriage and childbearing varying considerably from one country to another, the effect on trends within a single country is surely negligible. Thirdly, and least importantly, the calendar year classification simplifies the tabulation procedure. Finally, we shall eventually (though not in this paper) be concerned with population projection, and this would require reversion to calendar year data in any case if the duration in parity classification were used.

We calculate proportions of women who progress to second birth within ten years exact duration parity, and the tables have been truncated accordingly. Women having a first birth in any given year reach ten years exact duration in parity in during the tenth subsequent year. As we shall calculate proportions of women who have progressed to second birth at the beginning and end of this year, and average these values to obtain the desired result, we require data on second births through the tenth year following the year of first birth. Progression to second birth does occur in latter years, of course, but the incidence is extremely low, a fraction of one percent.

From the data in Appendix Table 1 we compute the rates $r_E^1(y)$ and $r_X^1(y)$ at which parity one women at various durations in parity progress to a second birth. The calculations for the cohort of women who had a first birth in 1970 are illustrated below.

Year	Duration in Parity	Parity One Women	Second Births	Rate
1970	E	113	1	0.009
1971	0	112	13	0.116
1972	1	99	28	0.283
1973	2	71	32	0.451

Of the 113 women who had a first birth in 1970, one had a second birth in the same year, for a rate of $1/113 = 0.009$. This left 112 parity one women with zero completed years duration in parity at the beginning of 1971, of whom 13 had a second birth during the year, for a rate of $13/112 = 0.116$. This left 99 parity one women with one completed year duration in parity at the beginning of 1972, and so on. We continue in this way through 1973, the latest year for which complete data are available. In general, the calculation is continued until we reach the latest year for which complete data are available or until we reach ten completed years duration in parity.

Aggregate rates for two or more years together may be calculated by summing the numerators and denominators of the single year rates and dividing each numerator sum by the corresponding denominator sum. Referring to Appendix Table 1, for example, we might calculate the rate at which women who have a first birth in 1969-73 have a second birth in the same year as their first birth. The sum of the numerators is $0 + 1 + 1 + 0 + 0 = 2$, the sum of the denominators is $105 + 113 + 128 + 115 + 134 = 595$, and the rate $2/595 = 0.003$. We refer to this aggregation over moving n year periods as "scrolling."

It will be observed that the numbers in Appendix Table 1 are rather small and so are subject to substantial random fluctuation. To get a rough idea of the extent of this variation we may identify each rate with the outcome of n binomial trials with probability p of success, where p is the probability of birth reflected in the rate and n is the number of women counted in the denominator. The standard deviation of the rate is then the square root of $p(1-p)$ and assigning p the value of the rate gives the standard error. By the normal approximation to the binomial, there is approximately a 95 percent

change that the observed rate will lie within two standard deviations of the underlying probability. To suggest the range of variation in the calculated rates, a rate of $1/21 = 0.048$ gives a standard error of 0.047 and a rate of $40/110 = 0.364$ gives a standard error of 0.046.

Appendix Table 1. 1974 Japan Fertility Survey Data on Progression from First to Second Birth, Japan

Year	First Births	Second Births in Subsequent Years											
		0	1	2	3	4	5	6	7	8	9	10	
1973	134	0	na										
1972	115	0	17	na									
1971	128	1	17	40	na								
1970	113	1	13	28	32	na							
1969	105	0	11	35	29	9	na						
1968	113	0	10	40	19	16	8	na	na	na	na	na	na
1967	115	1	10	31	32	16	5	4	na	na	na	na	na
1966	110	0	7	26	32	22	3	1	1	na	na	na	na
1965	127	2	7	30	26	27	7	4	3	1	na	na	na
1964	89	0	10	17	25	14	5	2	3	0	1	na	na
1963	126	1	15	37	12	26	9	2	0	0	0	0	0
1962	111	0	9	26	33	15	8	2	3	1	0	0	1
1961	101	0	9	30	20	21	2	9	3	2	0	0	0
1960	101	0	9	30	20	13	3	2	2	0	0	0	1
1959	91	0	7	22	23	14	9	2	0	1	0	0	0
1958	84	0	7	23	19	12	10	2	2	0	0	0	0
1957	90	0	10	20	22	12	8	3	2	1	0	0	2
1956	74	0	5	18	17	8	3	5	3	1	2	1	1
1955	79	1	4	20	29	7	6	1	3	1	0	1	1
1954	63	0	3	20	13	13	6	2	0	0	0	0	0
1953	68	0	5	24	19	5	0	2	2	0	1	0	0
1952	60	1	10	16	13	4	3	0	1	2	0	0	0
1951	52	1	5	15	15	2	2	4	0	0	0	0	1
1950	75	1	6	23	20	10	2	2	1	0	2	1	1
1949	59	1	10	16	16	5	2	3	1	0	0	0	1
1948	58	0	8	23	7	4	7	0	0	1	1	1	1
1947	33	0	7	15	5	3	1	0	0	0	0	0	1

Appendix Table 2. 1974 Japan Fertility Survey Data on Progression from Second to Third Birth, Japan

Year	Second Births	Third Births in Subsequent Years											
		0	1	2	3	4	5	6	7	8	9	10	
1973	113	0	na										
1972	102	0	2	na									
1971	94	1	6	9	na								
1970	116	1	5	16	9	na							
1969	114	0	1	14	5	3	na						
1968	91	0	5	8	8	5	3	na	na	na	na	na	na
1967	110	0	4	5	12	9	4	2	na	na	na	na	na
1966	57	0	0	6	5	1	3	2	0	na	na	na	na
1965	113	0	5	10	15	3	4	2	1	0	na	na	na
1964	89	0	3	9	10	2	2	1	1	2	0	na	na
1963	91	0	1	13	6	9	2	2	0	0	1	0	0
1962	92	2	3	14	13	5	0	2	0	1	0	2	0
1961	67	0	4	10	8	8	1	2	1	0	0	0	0
1960	72	0	5	8	5	4	2	2	1	3	3	0	0
1959	63	1	1	9	8	3	1	1	0	0	0	0	0
1958	71	0	2	7	10	10	1	1	1	1	0	1	1
1957	52	0	6	9	7	3	1	0	0	0	1	1	1
1956	53	0	0	9	7	6	3	0	1	0	1	1	1
1955	48	0	1	8	7	5	2	0	0	3	0	0	0
1954	48	0	1	10	8	1	3	0	1	0	0	0	0
1953	57	1	1	11	14	8	2	4	1	0	0	0	0
1952	50	0	5	8	16	2	7	2	0	1	1	1	1
1951	33	0	2	7	12	1	3	0	1	0	0	0	0
1950	41	0	3	15	6	6	5	1	1	0	0	0	0
1949	26	0	1	10	9	4	1	0	0	0	0	0	0
1948	13	1	1	4	1	1	0	2	0	0	0	0	0

Appendix Table 3. 1981 Mainichi Survey Data on Progression from First Marriage to First Birth, Japan

Year	First Marrs	First Births in Subsequent Years										
		0	1	2	3	4	5	6	7	8	9	10
1980	72	9	na									
1979	86	11	44	na								
1978	96	10	52	19	na							
1977	100	11	63	18	4	na						
1976	122	10	69	18	10	6	na	na	na	na	na	na
1975	140	9	79	32	8	3	1	na	na	na	na	na
1974	128	17	66	21	7	4	1	1	na	na	na	na
1973	124	9	65	32	4	1	2	1	0	na	na	na
1972	134	16	72	17	10	3	0	3	1	2	na	na
1971	138	12	75	33	5	1	2	3	1	2	0	na
1970	148	14	71	42	6	3	1	0	1	1	0	0
1969	109	10	54	22	7	7	1	3	0	0	1	0
1968	95	7	52	25	3	0	1	1	1	1	0	0
1967	131	12	65	26	9	6	2	2	1	0	0	0
1966	100	8	56	22	6	2	0	1	0	1	0	1
1965	116	9	56	29	8	2	2	3	0	0	0	1
1964	99	3	56	16	12	3	1	1	0	0	0	0
1963	121	8	61	33	6	4	2	0	0	0	0	3
1962	128	12	64	30	11	1	4	0	1	1	1	0
1961	107	10	55	20	10	1	1	2	0	1	0	2
1960	97	6	45	23	6	4	0	2	1	0	0	0
1959	96	12	45	23	11	3	0	0	0	0	0	0
1958	86	4	43	20	6	2	2	1	0	0	0	2
1957	86	6	40	20	7	3	0	1	0	1	2	1
1956	47	3	26	7	10	0	0	1	0	0	0	0
1955	61	6	22	20	9	1	0	1	1	0	0	1
1954	43	3	18	14	2	1	2	0	0	0	0	0
1953	29	1	16	5	4	0	1	0	0	0	0	0
1952	11	2	5	3	0	0	0	0	0	0	0	0
1951	7	2	2	2	0	1	0	0	0	0	0	0
1950	10	1	7	1	1	0	0	0	0	0	0	0
1949	5	0	3	0	1	0	0	0	0	0	0	0
1948	3	1	0	0	0	0	0	0	0	0	0	1
1947	1	0	1	0	0	0	0	0	0	0	0	0

Appendix Table 4. 1981 Mainichi Survey Data on Progression from First to Second Birth, Japan

Year	First Births	Second Births in Subsequent Years										
		0	1	2	3	4	5	6	7	8	9	10
1980	86	0	na									
1979	100	1	11	na								
1978	113	2	18	30	na							
1977	128	0	17	33	37	na						
1976	124	1	12	44	31	11	na	na	na	na	na	na
1975	129	0	19	41	31	11	6	na	na	na	na	na
1974	114	0	18	37	20	13	7	2	na	na	na	na
1973	138	1	19	40	26	19	6	3	3	na	na	na
1972	147	1	12	57	34	19	6	3	1	0	na	na
1971	124	1	20	42	25	15	2	5	1	0	0	na
1970	110	1	19	37	20	17	2	2	0	0	0	0
1969	100	0	13	33	24	10	5	1	0	1	0	0
1968	115	1	18	43	21	8	8	1	2	2	3	0
1967	127	0	14	37	32	13	8	1	3	1	1	0
1966	97	1	10	24	25	17	4	2	2	2	1	0
1965	114	0	6	40	39	15	6	1	2	0	0	0
1964	113	1	16	19	28	23	6	5	1	0	0	1
1963	106	0	11	26	18	24	11	5	0	2	0	0
1962	110	0	5	33	37	9	14	2	1	2	0	1
1961	92	1	11	28	17	12	4	5	3	4	0	2
1960	85	0	6	21	29	7	4	2	1	2	2	1
1959	89	0	7	26	19	14	9	6	0	2	0	1
1958	65	0	7	28	13	5	4	1	1	1	0	0
1957	55	0	5	18	14	6	1	4	3	0	0	0
1956	44	0	3	14	14	5	1	2	1	1	0	1
1955	35	1	5	9	8	9	1	0	0	2	0	0
1954	25	0	6	6	6	2	2	2	0	0	0	0
1953	10	0	1	1	1	4	1	0	0	0	0	0
1952	8	0	0	1	3	1	1	2	0	0	0	0
1951	10	0	2	4	1	2	0	0	0	0	0	0
1950	4	0	1	2	0	1	0	0	0	0	0	0
1949	0	0	0	0	0	0	0	0	0	0	0	0
1948	2	0	0	1	1	0	0	0	0	0	0	0
1947	0	0	0	0	0	0	0	0	0	0	0	0
1946	0	0	0	0	0	0	0	0	0	0	0	0
1945	0	0	0	0	0	0	0	0	0	0	0	0
1944	0	0	0	0	0	0	0	0	0	0	0	0
1943	0	0	0	0	0	0	0	0	0	0	0	0

Appendix Table 5. 1981 Mainichi Survey Data on Progression from Second to Third Birth, Japan

Year	Second Births	Third Births in Subsequent Years											
		0	1	2	3	4	5	6	7	8	9	10	
1980	102	0	na										
1979	107	1	1	na									
1978	117	0	2	8	na								
1977	106	1	4	14	12	na							
1976	107	1	3	8	10	6	na						
1975	114	3	3	6	8	4	5	na	na	na	na	na	na
1974	131	1	6	8	11	7	5	4	na	na	na	na	na
1973	96	0	7	6	5	3	2	2	2	na	na	na	na
1972	102	0	9	8	7	3	4	4	0	1	na	na	na
1971	97	0	5	15	6	3	2	0	0	0	1	na	na
1970	119	1	9	12	10	8	3	1	2	0	0	1	1
1969	112	0	3	13	8	5	4	6	1	0	2	0	0
1968	120	0	4	10	16	4	4	3	1	2	0	1	1
1967	124	0	3	11	11	12	4	2	0	0	0	0	0
1966	62	0	4	6	6	2	0	1	2	0	0	0	0
1965	103	1	4	7	2	10	7	3	1	0	0	0	0
1964	85	0	5	5	11	5	2	0	1	1	0	2	2
1963	88	0	5	9	7	6	4	1	0	0	1	0	0
1962	60	0	2	6	9	2	3	3	1	0	1	1	1
1961	53	1	1	6	6	2	1	2	1	1	3	0	0
1960	57	0	4	8	3	6	4	0	0	0	0	1	1
1959	51	0	1	13	11	2	0	0	0	1	0	0	0
1958	32	0	2	8	3	2	1	0	0	0	0	0	0
1957	23	0	1	3	5	1	1	1	0	2	0	1	1
1956	13	0	0	4	3	1	1	0	1	0	0	0	0

Appendix Table 6. 1984 Mainichi Survey Data on Progression from First Marriage to First Birth, Japan

Year	First Births	First Births in Subsequent Years										
		0	1	2	3	4	5	6	7	8	9	10
1983	64	11	na									
1982	92	15	41	na								
1981	78	10	34	16	na							
1980	95	9	56	15	3	na						
1979	94	13	41	15	11	4	na	na	na	na	na	na
1978	95	14	51	19	5	4	1	na	na	na	na	na
1977	91	9	51	18	5	3	0	2	na	na	na	na
1976	99	20	53	17	1	1	0	3	0	na	na	na
1975	108	17	49	21	5	2	3	1	1	0	na	na
1974	126	15	64	25	8	3	1	2	0	0	0	na
1973	140	17	79	21	6	2	3	2	0	0	0	0
1972	131	14	69	28	10	2	1	0	5	0	0	0
1971	125	20	69	19	6	3	2	1	0	0	0	0
1970	130	16	73	23	7	4	1	0	1	0	0	0
1969	98	14	54	16	4	3	1	2	0	0	1	0
1968	114	15	55	24	8	7	1	1	0	0	0	0
1967	111	7	60	26	9	5	1	1	0	0	0	0
1966	97	6	61	17	4	3	1	0	0	0	1	0
1965	106	9	44	34	7	1	2	2	1	0	1	0
1964	92	12	45	18	8	4	0	0	1	1	0	0
1963	89	7	52	19	7	1	1	1	0	0	0	0
1962	103	13	54	22	7	2	1	2	0	0	0	0
1961	81	5	46	13	7	2	0	3	1	1	1	0
1960	69	1	38	14	7	4	1	1	1	0	0	0
1959	60	3	31	11	7	1	3	2	0	0	0	0
1958	45	6	18	10	6	0	1	1	0	0	0	0
1957	43	1	18	14	3	1	2	1	1	0	0	1
1956	14	2	8	3	1	0	0	0	0	0	0	0
1955	8	0	3	4	0	0	0	0	0	0	0	0
1954	3	0	1	1	1	0	0	0	0	0	0	0
1953	7	0	6	0	1	0	0	0	0	0	0	0
1952	3	0	2	0	0	0	0	0	0	0	0	0
1951	2	0	0	0	1	0	0	0	0	0	0	0
1950	0	0	0	0	0	0	0	0	0	0	0	0
1949	1	0	1	0	0	0	0	0	0	0	0	0
1948	0	0	0	0	0	0	0	0	0	0	0	0

Appendix Table 7. 1984 Mainichi Survey Data on Progression from First to Second Birth, Japan

Year	First Births	Second Births in Subsequent Years										
		0	1	2	3	4	5	6	7	8	9	10
1983	80	0	na									
1982	80	0	10	na								
1981	90	0	11	26	na							
1980	81	1	7	28	23	na						
1979	96	1	18	29	16	8	na	na	na	na	na	na
1978	96	1	10	26	21	7	6	na	na	na	na	na
1977	96	0	15	30	30	6	4	2	na	na	na	na
1976	105	0	12	27	34	12	2	1	0	na	na	na
1975	124	0	11	37	32	16	6	4	5	0	na	na
1974	137	2	16	41	33	17	5	3	4	0	0	na
1973	119	2	19	39	23	13	9	1	1	0	0	0
1972	124	3	20	30	34	10	4	3	2	2	2	2
1971	125	0	18	35	34	18	2	2	1	0	0	0
1970	111	1	19	38	32	8	5	1	1	1	0	0
1969	102	0	14	28	30	13	3	3	2	0	0	0
1968	109	0	11	28	34	13	6	5	0	1	1	0
1967	118	1	17	44	33	8	7	1	0	1	0	1
1966	78	1	9	21	20	15	4	2	0	0	0	0
1965	87	1	9	32	22	10	5	2	0	0	1	0
1964	102	1	6	22	29	14	7	6	5	2	1	0
1963	87	1	9	29	15	10	11	3	1	2	1	0
1962	82	2	9	25	26	4	5	3	1	1	0	0
1961	61	0	6	15	15	10	3	4	1	1	0	0
1960	45	0	5	13	9	10	2	1	1	0	0	0
1959	36	0	7	13	5	2	1	0	1	1	2	1
1958	30	0	4	6	10	6	1	1	0	0	1	1
1957	16	0	2	5	3	0	1	0	1	0	0	1
1956	7	0	0	2	3	1	0	0	1	0	0	0
1955	1	0	0	0	0	0	0	0	0	1	0	0
1954	7	0	1	5	0	0	1	0	0	0	0	0
1953	3	0	0	2	1	0	0	0	0	0	0	0
1952	0	0	0	0	0	0	0	0	0	0	0	0
1951	0	0	0	0	0	0	0	0	0	0	0	0
1950	1	0	0	0	0	0	0	0	0	0	0	0
1949	1	0	0	0	0	0	0	0	0	0	0	0
1948	0	0	0	0	0	0	0	0	0	0	0	0

Appendix Table 8. First Marriages and Births by Order for Japan, 1950-1983

Year	First Marriages	First Births	Second Births	Third Births	Fourth Births	Fifth+ Births	Total Births
1983	686,477	649,085	589,743	228,364	32,513	8,982	1,508,687
1982	704,840	648,833	600,436	225,574	31,454	9,095	1,515,392
1981	702,259	656,797	610,457	223,128	30,183	8,890	1,529,455
1980	701,415	667,683	642,573	227,604	29,901	9,128	1,576,889
1979	715,551	676,616	682,811	231,256	29,678	9,362	1,629,727
1978	722,577	711,484	725,470	230,539	30,666	10,484	1,708,647
1977	750,756	745,788	742,815	224,032	31,178	11,287	1,755,100
1976	801,264	804,685	762,463	221,239	32,327	11,903	1,832,617
1975	871,445	862,356	767,669	224,576	33,994	12,845	1,901,440
1974	929,824	925,770	785,071	263,568	41,242	14,338	2,029,989
1973	1,002,656	950,464	796,254	283,619	45,538	16,108	2,091,983
1972	1,032,967	936,388	776,654	268,327	42,406	14,907	2,038,682
1971	1,026,772	901,167	781,588	261,751	41,657	14,810	2,000,973
1970	967,716	878,979	753,834	245,824	40,207	15,395	1,934,239
1969	925,538	855,063	744,060	234,589	40,163	15,940	1,889,815
1968	900,586	864,609	735,209	216,223	38,952	16,846	1,871,839
1967	897,129	887,971	773,831	214,899	40,317	18,588	1,935,647
1966	886,108	705,478	459,412	143,078	33,762	19,244	1,360,974
1965	900,304	866,485	685,027	203,913	44,523	23,749	1,823,697
1964	909,165	820,766	625,683	196,330	46,404	27,578	1,716,761
1963	884,756	487,054	592,116	195,760	51,027	33,564	1,659,521
1962	874,667	763,216	561,737	196,971	56,275	40,417	1,618,616
1961	838,354	720,783	541,864	207,103	67,126	52,496	1,589,372
1960	812,597	714,827	522,867	221,595	79,718	67,034	1,606,041
1959	793,413	695,764	507,497	237,581	97,823	87,423	1,626,088
1958	771,529	667,823	502,032	257,612	118,509	107,493	1,653,469
1957	717,305	589,399	460,540	258,587	135,555	122,632	1,566,713
1956	659,673	596,522	457,769	290,668	168,325	151,994	1,665,278
1955	656,591	573,592	455,512	330,192	193,906	177,490	1,730,692
1954	637,350	548,405	451,870	360,708	206,421	202,176	1,769,580
1953	618,669	569,885	502,546	366,645	216,763	255,724	2,384,050
1952	606,538	591,365	553,221	372,582	227,106	309,271	2,589,922
1951	606,538	612,844	603,897	378,518	237,448	362,819	2,795,792
1950	606,538	634,324	654,572	384,445	247,790	416,366	2,337,507

Sources: Vital Statistics (Year): Japan, for indicated years. First Marriages. First marriages for recent years are taken from Table 3, which gives marriages registered during the year by previous marital status of bride and groom, by adding marriages involving a first married bride. Note that some marriages registered in any given year occur in previous years. Marriages registered in a given year but occurring in previous years are approximately balanced by marriages occurring in the given year but not registered in this year (See Feeny and Saito 1985: section III). Thus we use the numbers registered each year to estimate the numbers occurring each year. Births. Births by order for recent years are taken from Table 6, which gives live births registered each year by sex, single year of age of mother, live birth order, and legitimacy. Live birth order of a birth is defined as the number of live births to the mother immediately following the birth. Some births tables involve total birth order, in which the number of births includes fetal deaths of gestation period 20 weeks or more. Births by order are unavailable for 1951-53; values have been obtained by linear interpolation between 1950 and 1954.