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WHAT HAPPENED DURING THE BABY BOOM? NEW ESTIMATES OF AGE- AND PARITY-SPECIFIC BIRTH PROBABILITIES FOR AMERICAN WOMEN

Warren Sanderson

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WHAT HAPPENED DURING THE BABY BOOM? NEW ESTIMATES OF AGE-AND PARITY-SPECIFIC BIRTH PROBABILITIES FOR AMERICAN WOMEN

by

Warren C. Sanderson
Stanford University

The baby boom is over and, with fertility in the United States currently below replacement level, it may well be said that a birth dearth is already upon us. Graph 1 shows the U. S. general fertility rate[1] from 1909 through 1968.[2] The secular movement of this rate is clearly downward. However, this secular decline was interrupted by a period in the 1950's when fertility was both relatively high and increasing. The peak general fertility rate during the baby boom occurred in 1957 and subsequently fertility has fallen every year thereafter with the exceptions of 1969 and 1970.[3] This recent fertility history presents a problem for economists and other interested in fertility. Is the current low level of fertility but a trough in a long cycle which is destined to produce yet another baby boom or is it a manifestation of a continued secular decline in fertility? To put the same problem in somewhat different terms: is a baby boom an anomolous or systematic phenomenon.

Although in recent years, there have been important advances in the economic theory of fertility,[4] these contributions have not yet been sufficiently articulated to throw much light on the course of postwar fertility changes. It is the main purpose of this paper to examine in detail the pattern of fertility fluctuations in the United States since the Second World War and to define, with some precision, the questions these patterns raise for students of fertility behavior. Towards this end I present new estimates of age- and parity-specific monthly birth probabilities for cohorts of native white women born in the twentieth century. These data lend themselves to numerous uses, only one of which is pursued here--the close analysis of the structure of fertility changes after 1950. What they reveal in that connection are hitherto unrecognized patterns of fertility variation across age and parity groups during the baby boom. Perhaps the most startling finding is that, although aggregate fertility measures reach their "baby boom" peak in 1957, the birth probabilities often do not. Looking across groups of women of different ages one finds that probabilities of second and higher order births reached a peak level during the years 1953-1955 as frequently as in the years 1956-1958. The probabilities of second through fourth order births for young women consistently reached their peak during the period 1959-1961. In addition, the new data pertaining to lower order births show that before the Second World War temporal variations in birth probabilities were quite similar across age groups. After the War, that is to say during the height of the Baby Boom, a marked structural change occurred and the positive correlation across age groups disappeared.

To aid further analysis of the mass of birth probability data, I have "decomposed" the time series for different birth orders into an "age", a "current year", and a "cohort" component. For each of the birth orders, this trio of components allows us to disentangle the distinct influences which intertwined themselves, giving rise to the observed birth probabilities. This analysis shows that the cohort influences were very important in creating the pattern of first birth probability fluctuations in the baby boom period. The strength of this source of influence progressively diminished in the case of higher order births, however. The current year components for first birth probabilities exhibit a time profile which is unlike those for higher order births in that its peak precedes 1957 while the peaks of the current year components for higher order births all occur in 1957. In view of the absence of uniformity in the temporal patterns exhibited by the various birth probability series, it may be reassuring to note that the familiar movement to a 1957 peak does emerge in the current year components for each of the birth orders save the first.

While the behavior of the current year components by themselves would have promoted a cyclical swing in aggregate fertility paralleling the one in the postwar period, the amplitude of that movement would have been much smaller. Since the current year effects had to work against the anti-natal influence of the changing age structure of the population, were it not for the "cohort" influence already noticed the outcome may not even have qualified as the "Baby Bubble" much less the "Baby Boom".

Birth Probabilities.

Patterns of fertility variations will be analyzed, in this study, using data, estimated by the author, on age- and parity-specific birth probabilities for cohorts of native[5] white women born after 1899. Birth probabilities were first measured for the United States by Whelpton in his pioneering book, Cohort Fertility, published in 1954. There Whelpton presented annual age- and parity-specific birth probabilities for native white women for the years 1920 through 1950.[6] Whelpton's original work spawned further efforts at measuring birth probabilities[7] and birth probabilities for all U. S. women are now regularly published in Vital Statistics of the United States. Since the first year for which these data are reported is 1956 those interested in the behavior of time series fertility measures are left in something of a quandry. There is one study on birth probabilities of native white women for the years 1920 through 1950 using one methodology and another for all U. S. women covering the period 1956-1968 using a somewhat different methodology. In order to facilitate the interpretation of time series trends it is preferable to study the birth probabilities of native white women rather than those of all U. S. women and so, with an improved methodology,[8] I have re-estimated some of Whelpton's birth probabilities for native white women and extended his series through 1966.[9]

Annual age- and parity-specific birth probabilities are of interest for a number of reasons. Chief among their attractions is that a birth probability is a period fertility measure which is consistent with economic decision-making models of fertility. It is implausible to think of the total fertility rate or the net reproduction rate as being the outcome of a household decision-making process. However, birth probabilities may, quite plausibly, be considered as outcome of such a process as Michael (1973) has already demonstrated.

Another attraction of the birth probability data used in this paper is that they allow the investigator to follow cohorts of women over their life cycles and study the processes through which their completed family sizes are attained. Also, birth probabilities, particularly monthly birth probabilities like those presented here, are parameters in mathematical models of fertility and contraception developed by demographers.[10]

Conceptually, an age- and parity-specific monthly birth probability is a rather simple affair. Let us consider, for example, a highly simplified computation of the monthly birth probability of thirty year old native white women who have had exactly two previous births having a third birth in 1960. This particular monthly probability is, by the way, about 1.2 percent or on an annual basis about 13.8 percent. For ease of exposition, let us assume that all these women were born on January 1, 1930, so that each of them spends the full twelve months in which she is 30 in the calendar year 1960. In addition, let us assume that all of these women had their second births before they were 29 (i.e. before the calendar year 1959). If we were to consider the possibility of second births occurring in 1959, in this simplified example, then the women who had had such births would not be, on the average, at risk of having a third child for a full twelve months in 1960. Neglecting mortality, we may write:

$$(1) \qquad B = N - N(1-p)^{12}$$

where B is the number of third births to 30 year old native white women in 1960, N is the number of 30 year old native white women who are capable of having a third birth at the beginning of 1960, and p is the monthly birth probability we are seeking. From Equation 1, it may be readily seen that:

$$(2) \qquad p = 1 - \left(\frac{N-B}{N}\right)^{1/12} .$$

The two major components of all birth probabilities are data on age- and parity-specific births and age- and parity-specific numbers of women at risk of having a birth.

When monthly birth probabilities are actually computed, we cannot take for granted that all women are born on January 1st, nor that all previous births have occurred sufficiently long before the period of interest that current birth risk status is unaffected, nor can mortality be neglected. In addition, in estimating birth probabilities we must obtain data on births by parity and single years of age for native white women, and estimates of women capable of having a birth of a given order, aggregated according to whether they have had their last birth more than one year[11] before the period of interest or not. When these complications are added to the computation, the birth probabilities can no longer be calculated directly and must obtained using an iterative procedure. This procedure is discussed in more detail in Appendix I.

Looking at the aggregated birth probabilities presented in Appendix II and the underlying disaggregated birth probabilities, one can see what is a rather remarkable fact: birth probabilities often do not have their baby boom peak[12] in 1957. Table 1 summarizes data on the year in which our 205 age- and parity-specific birth probability series[13] have their baby boom peaks. Out of the 205 series, 43 or about 21 percent of them peak in 1957, and 70, or about 34 percent of them peak in the period 1956-1958.

Table 1: Number of Birth Probability Series Peaking Within the Given Time Interval.

Years	Birth Orders								Total
	1st	2nd	3rd	4th	5th	6th	7th	8th +	
1950-1952	6	5	0	0	8	3	1	9	32
1953-1955	3	4	8	11	10	8	10	4	58
1956-1958	15	7	7	7	7	12	10	5	70
(1957)	(15)	(4)	(4)	(4)	(4)	(5)	(5)	(2)	(43)
1959-1961	3	13	12	9	0	1	1	2	41
1962-1966	3	0	1	0	0	0	0	0	4
Total	30	29	28	27	25	24	22	20	205

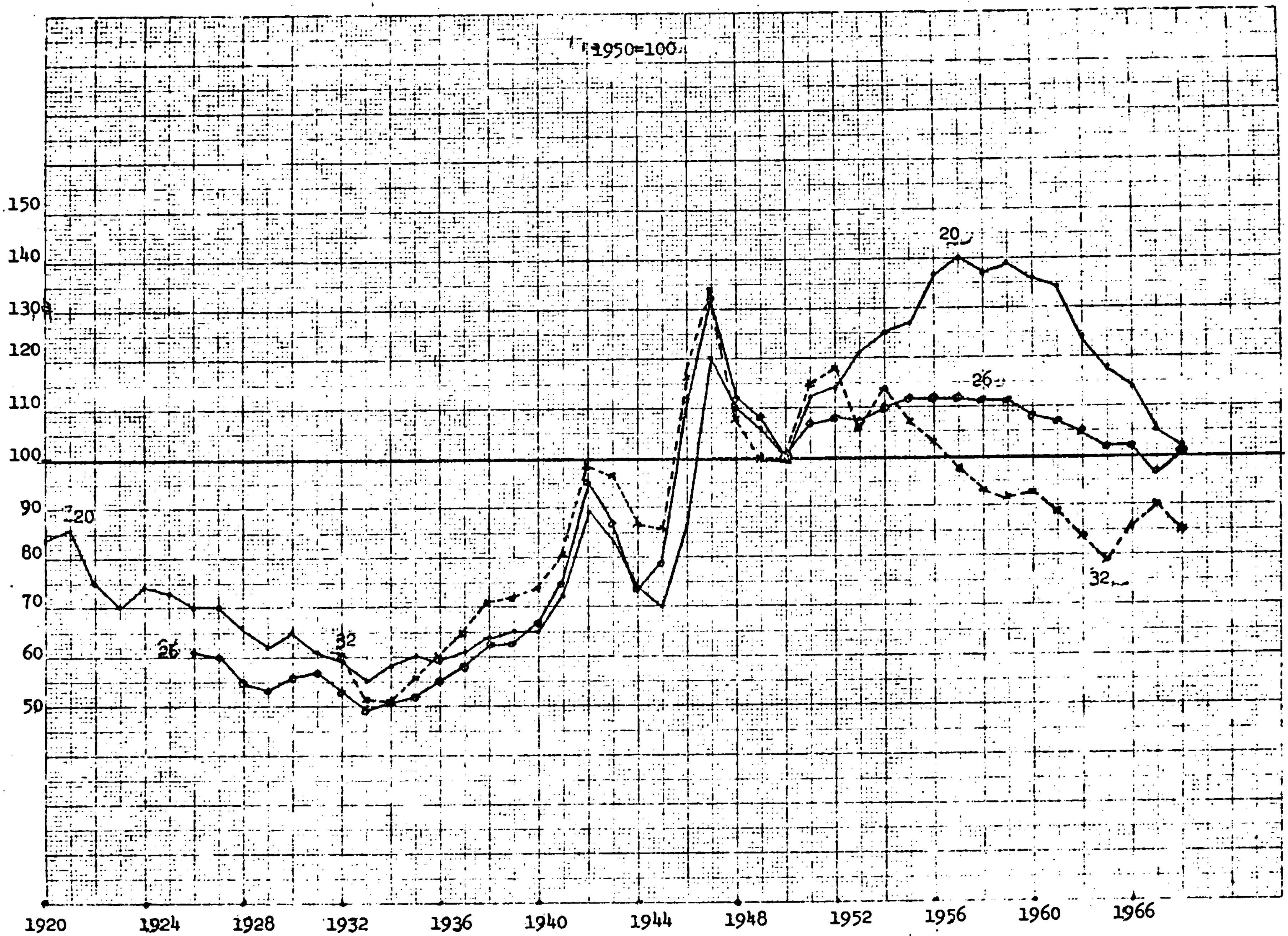
Source: Sanderson (1974).

It is clear from Table 1 that the 1957 peak was most common for first births. In fact, if we consider only second and higher order births, we find that the same number of series peak in 1953-1955 as do in 1956-1958. It is also interesting to note with regard to Table 1 that peaks occurring after the 1956-1958 period are not common except for second, third, and fourth order births. The observation that birth probabilities do not generally peak in 1957 suggests the important question: what regularities, if any, exist in the post-war movements of birth probabilities.

One important and striking regularity in the pattern of birth probabilities is shown by the first birth probabilities of women 27 years old and younger. All the first birth probabilities of women 15 through 27 years old rise in the 'fifties to a peak in 1957. These ages account for 13 of the 15 first birth probability series which peak in 1957. The other series which peak in 1957 do so more or less unsystematically. For example, the four ages for which there are peaks in third order birth probabilities in 1957 are 31, 32, 43, and 44 and the five ages in which there are peaks in sixth order birth probabilities are 31, 36, 37, 41, and 43. Thus, the first birth probabilities of women 27 and under form the only coherent set of birth probabilities which peak in the same year as the crude birth rate.[14] The timing of the fluctuations of these first birth probabilities was an important determinant of the timing of the baby boom fertility peak. Although in 1957 first births to native white women 15 to 27 accounted for only about 25 percent of all births to these women, the decline in the first births to women 15 to 27 accounted for about 50 percent of the decline in all births from 1957 to 1958.

As can be seen from Appendix Graph I-1 in Appendix II, the fact that first birth probabilities for young women tended to peak in the same year as the crude birth rate does not mean that their patterns of change in the 'fifties were similar to one another. By 1957, the first birth probabilities for women 15 to 19 years of age had increased about 31 percent over their 1950 level, those of women 20 to 24 had increased about 38 percent over their 1950 level, but those of women 25 to 29 increased to only 10 percent above their 1950 level. The first birth probabilities of women 15 to 19 fell somewhat more rapidly from its peak than the first birth

GRAPH 2: FIRST BIRTH PROBABILITIES TO WOMEN
20, 26 and 32



probabilities of women 20 to 24 and the first birth probabilities of women 25 to 29 fell the least.

The first birth probabilities for women over 27 years old behaved quite differently in the postwar period from those of their younger sisters. It can be seen from Appendix Graph I-2 that the first birth probabilities of women in the 30-34, 35-39, and 40-44 year old age groups began to fall in the 'fifties before 1957. The differences in the behavior of the first birth probabilities of women of different ages can be clearly seen in Graph 2, where we have plotted the first birth probabilities of women aged 20, 26, and 32. This graph shows that, although before World War II the first birth probabilities of these women tended to move similarly, in the postwar period their first birth probabilities show a rather remarkable divergence. This considerable dissimilarity of the patterns of change of first birth probabilities by age groups is an important feature of the baby boom and any thorough explanation of postwar fertility variations must come to grips with it. We shall return to this question later in the paper.

Second birth probabilities to women 16-19, 20-24, and 25-29 are plotted in Appendix Graph II-1. All three age groups show a substantial increase in their second birth probabilities over the course of the 'fifties. However, unlike the first birth probabilities of women of the same ages, the second birth probabilities do not reach their maximum in 1957, but rather in 1960 or 1961. Thus the baby boom peaks in second birth probabilities for these women lag their first birth probability peaks by about three years. Another interesting aspect of this graph is the difference in the patterns of first and second birth probabilities to women 25 to 29 years.

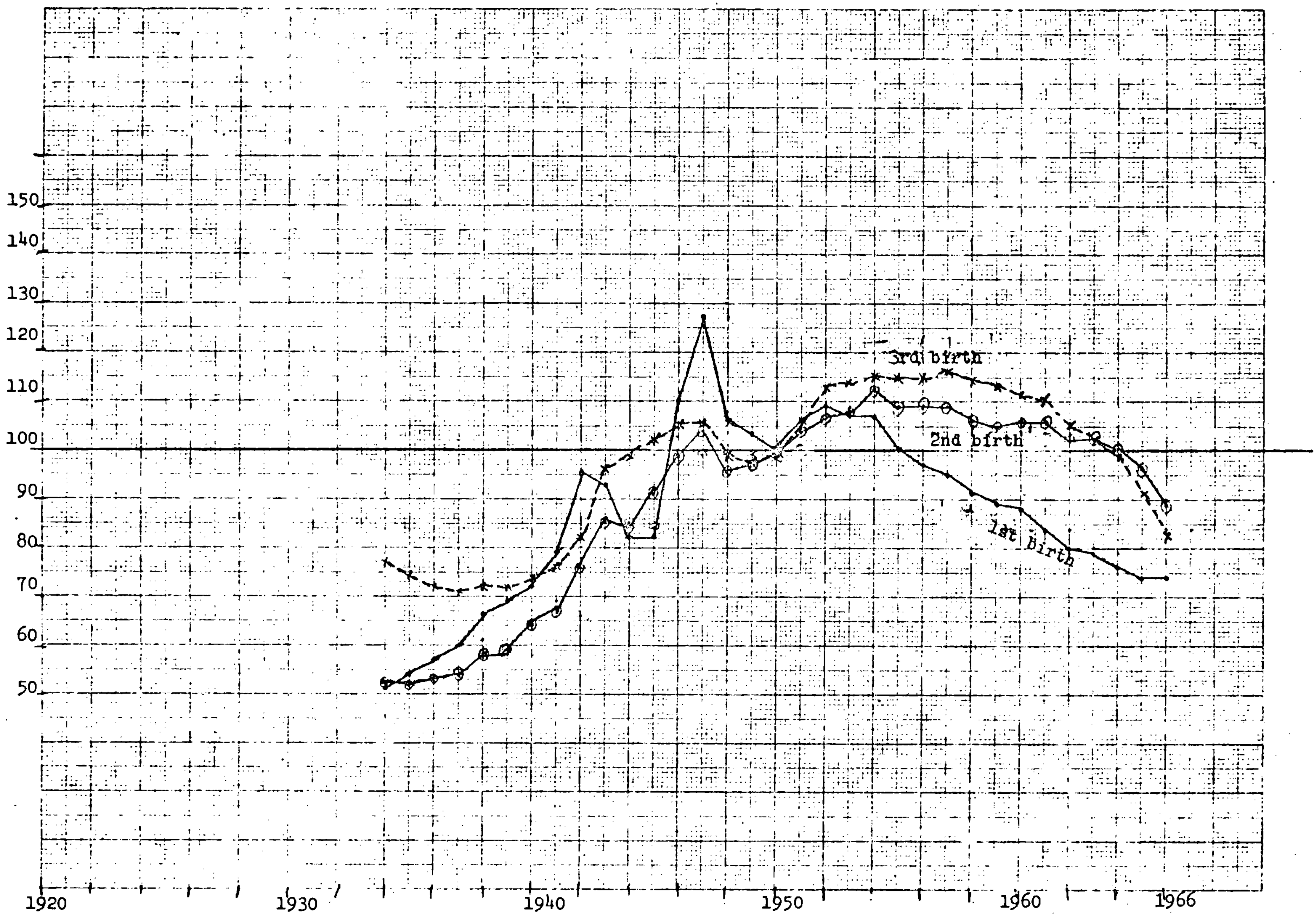
The first birth probabilities of these women are almost constant from 1951 through 1956, but during the same period their second birth probabilities rise by about 25 percent. This difference in the behavior of first and second birth probabilities during the baby boom raises another interesting question and we shall also return to it below.

Appendix Graph II-2 shows the second birth probabilities of women 30-34, 35-39, 40-44. Like the first birth probabilities of these women and in sharp contrast with the second birth probabilities of younger women, the second birth probabilities of these women tend to peak before 1957. The baby boom peak of second birth probabilities to 30-34 year olds lags the peak of first birth probabilities by two years, but the peaks of first and second birth probabilities to women 35-39 and 40-44 occur in the same year.

It can be seen from Appendix Graphs III-1 and III-2 that the patterns of third birth probabilties appear to be similar to those of second birth probabilities. Third birth probabilities for women below 30 tend to peak around 1960 and third birth probabilities for women 35-39 and 40-44 tend to peak before 1957. In this case, third birth probabilities for women 30-34 peak in 1957. In fact, as can be seen from Graph 3, as we move from first through third births the time profile of birth probabilities of 30-34 year old women looks more like the time profiles for younger women.

Although the fourth birth probabilities of women 20-24 peak in 1961 and those for women 25-29 in 1960, their rise over the decade of the 'fifties is considerably smaller than the lower order birth probabilities of women the same age. For example, third order birth probabilities

GRAPH 3: BIRTH PROBABILITIES TO WOMEN 30-34, BY BIRTH ORDER



for women 20-24 rose over 30 percent from 1950 to 1960, whereas fourth birth probabilities to these women rose less than 7 percent during the decade. For women 25-29 the rise in third birth probabilities was about 33 percent and for fourth birth probabilties only about 15 percent. The fourth birth probabilities for women over 30 rose more rapidly in the first half of the baby boom decade than the fourth birth probabilities of younger women. Indeed, as a practical matter it appears that the fourth birth probabilities of women 30-34 and 40-44 peaked in 1957.[15]

With fifth and higher order births, post-1957 peaks in the aggregated birth probabilities presented in Appendix II disappear and the age patterns of the birth probabilities become somewhat less regular. The fifth birth probabilities for women 25-29 peak in 1952, their sixth probabilities in 1953, their seventh birth probabilities in 1954, and their eighth and higher birth probabilities in 1956. The fifth, sixth and seventh birth probabilities for women 30-34 peak in 1956, and the eighth-plus birth probabilities peak a year later.

Component Analysis.

We have seen above that fertility behavior in the postwar period was far from being uniform. All birth probabilities did not rise in the 'fifties to a peak in 1957 and decline thereafter, but rather they showed a number of different patterns. How are we to understand these patterns? In order to make some sense out of the multiplicity of fertility series, we must introduce at least a modicum of analytic structure. In this pursuit, we shall posit the following representation of birth probabilities:

$$(3) \qquad \ln(p_{ijk\ell}) = \alpha_{i\ell} + \beta_{j\ell} + \gamma_{k\ell} + \varepsilon_{ijk\ell}$$

where $p_{ijk\ell}$ is the monthly birth probability of birth order ℓ for women of age i in year j , (the index k represents the year in which these women were born and can be derived from a knowledge of i and j), $\alpha_{i\ell}$ is the age component, $\beta_{j\ell}$ is the current year component, $\gamma_{k\ell}$ is the cohort component, and $\varepsilon_{ijk\ell}$ is a random disturbance term assumed to be independently normally distributed with mean zero and cohort variance

This is a rather broad decomposition because we do not need to know precisely what the current year or cohort influences on birth probabilities of a given order are in order to measure their contribution to variations in birth probabilities. The decomposition proposed here is roughly in the spirit of Easterlin's analysis. In his article on the baby boom in historical perspective,[16] he explains the fertility variations of native white urban women using variations in the unemployment rate and changes in the rate of growth of the size of the group of males 20 to 29 years of age. The influence in the first of these factors would be recorded as variation in the current year component in the proposed decomposition, and the latter, since it is a reflection of relative cohort size, would be recorded as variation in the cohort component. The Easterlin-Fuchs intergenerational relative income hypothesis[17] may also be easily represented in our proposed framework because parental income levels, in as much as they affect tastes, are likely to have influences which remain with cohorts throughout their whole reproductive span, and therefore influences which can be captured as changes in cohort components. The suggested decomposition, broadens somewhat the Easterlin hypotheses since separate age, current year, and cohort components are estimated for each birth order. Separate cohort components, for example, allow for the intergenerational relative income effect, if it is present, to affect the birth probabilities differently for different birth orders.

However, along with certain advantages, the birth probability decomposition in Equation 3 has certain disadvantages. One has to do with the interaction between cohort and current year components. Given the specification in Equation 3, temporal patterns of birth probabilities of women of differing ages, parity held constant, are allowed to differ only because of the variations in the cohort components. Thus certain sorts of influences on fertility may not be correctly captured in this analysis. The influence of veteran's benefits after World War II may be one of these. We do not maintain the total absence of such influences on fertility, but rather that they are of minor importance compared with those influences which are correctly measured.

Another disadvantage of the proposed decomposition is the econometric difficulty of thoroughly disentangling the age, current year and cohort components. We can rewrite Equation 3 as follows:

$$(4) \qquad [\ln p_{\ell}] = \sum_{r=A*}^{A**} \alpha_{r\ell}[A_r] + \sum_{s=Y*}^{Y**} \beta_{s\ell}[Y_s] + \sum_{t=C*}^{C**} \gamma_{t\ell}[C_t] + [\varepsilon]$$

where $[\ln p_{\ell}]$ is a column vector of observations on the natural logarithms of birth probabilities of order ℓ, its general element being $\ln(p_{ijk\ell})$, where $[A_r]$ is a dummy variable vector which is unity if the age referred to in the corresponding element of the observation vector is r and zero otherwise,

where $[Y_s]$ is a dummy variable vector which is unity if the year referred to in the corresponding element of the observation vector is year s and zero otherwise,

where $[C_t]$ is a dummy variable vector which is unity if the cohort referred to in the corresponding element of the observation vector is t, and zero otherwise, where $[\varepsilon]$ is a vector of random numbers assured to be generated independently from a normal distribution with mean zero, and constant variance, and where $A*$, and $A**$ represent the first and last ages used in the analysis, and $Y*$ and $Y**$, and $C*$ and $C**$ have similar meanings for current years and for cohorts.

Equation 4 cannot be estimated directly because of linear dependencies between the age, current year, and cohort dummies. Indeed, since an age and a cohort are associated with each observation we must have:

$$(5) \qquad \sum_{r=A^*}^{A^{**}} [A_r] = \sum_{t=C^*}^{C^{**}} [C_t] \quad .$$

Therefore, we can write:

$$(6) \qquad [A_j] = \sum_{t=C^*}^{C^{**}} [C_t] - \sum_{\substack{r=A^* \\ r \neq j}}^{A^{**}} [A_r]$$

Substituting Equation 6 into Equation 4, we obtain:

$$(7) \qquad [\ln p_\ell] = \sum_{\substack{r=A^* \\ r \neq j}}^{A^{**}} (\alpha_{r\ell} - \alpha_{j\ell})[A_r] + \sum_{s=Y^*}^{Y^{**}} \beta_{s\ell}[Y_s] + \sum_{t=C^*}^{C^{**}} (\gamma_{t\ell}+\alpha_{j\ell})[C_t]+[\varepsilon]$$

However, since each observation is associated with a current year and a cohort component, we must have:

$$(8) \qquad \sum_{s=Y^*}^{Y^{**}} [Y_s] = \sum_{t=C^*}^{C^{**}} [C_t] \quad .$$

Therefore, we can write:

$$(9) \qquad [Y_k] = \sum_{t=C^*}^{C^{**}} [C_t] - \sum_{\substack{s=Y^* \\ s \neq k}}^{Y^{**}} [Y_s]$$

Substituting Equation 9 into Equation 7 we obtain

$$(10) \qquad \ln[p_\ell] = \sum_{\substack{r=A^* \\ r \neq j}}^{A^{**}} (\alpha_{r\ell}-\alpha_{j\ell})[A_r] + \sum_{\substack{s=Y^* \\ s \neq k}}^{Y^{**}} (\beta_{s\ell}-\beta_{k\ell})[Y_s] + \sum_{t=C^*}^{C^{**}} (\gamma_{t\ell}+\alpha_{j\ell}+\beta_{k\ell})[C_t] + [\varepsilon]$$

There is one more linear dependency in the remaining dummy variable vectors. A person who is of age j in year k was born in year $k-j$, which we call year m. The linear dependency can be expressed as follows:

$$(11) \quad \sum_{\substack{r=A^* \\ r \neq j}}^{A^{**}} (j-r)[A_r] + \sum_{\substack{s=Y^* \\ s \neq k}}^{Y^{**}} (s-k)[Y_s] = \sum_{t=C^*}^{C^{**}} (t-m)[C_t]$$

Therefore, we can write

$$(12) \quad [C_n] = \sum_{\substack{r=A^* \\ r \neq j}}^{A^{**}} \frac{(j-r)}{(n-m)} \cdot [A_r] + \sum_{\substack{s=Y^* \\ s \neq k}}^{Y^{**}} \frac{(s-k)}{(n-m)} \cdot [Y_s] + \sum_{\substack{t=C^* \\ t \neq n}}^{C^{**}} \frac{(t-m)}{(n-m)} [C_t]$$

$$(n \neq m)$$

Substituting the value of $[C_n]$ in Equation 12 into Equation 10, we obtain

$$(13) \quad [\ln p_\ell] = \sum_{\substack{r=A^* \\ r \neq j}}^{A^{**}} \left\{ \alpha_{r\ell} - \alpha_{j\ell} + \left(\frac{j-r}{n-m}\right) \cdot (\alpha_{j\ell} + \beta_{k\ell} + \gamma_{n\ell}) \right\} [A_r]$$

$$+ \sum_{\substack{s=Y^* \\ s \neq k}}^{Y^{**}} \left\{ \beta_{s\ell} - \beta_{k\ell} + \left(\frac{s-k}{n-m}\right) \cdot (\alpha_{j\ell} + \beta_{k\ell} + \gamma_{n\ell}) \right\} [Y_s]$$

$$+ \sum_{\substack{t=C^* \\ t \neq n}}^{C^{**}} \left\{ \gamma_{t\ell} - \gamma_{n\ell} + \left(\frac{n-t}{n-m}\right) \cdot (\alpha_{j\ell} + \beta_{k\ell} + \gamma_{n\ell}) \right\} [C_t] + [\varepsilon] \quad (n \neq m).$$

Equation 13 is estimable, and we can identify the $(\alpha_{r\ell}-\alpha_{j\ell})$, $(\beta_{s\ell}-\beta_{k\ell})$, and the $(\gamma_{t\ell}-\gamma_{n\ell})$ if we knew $(\alpha_{j\ell}+\beta_{k\ell}+\gamma_{n\ell})$. Let us denote this latter sum by X_ℓ. Clearly we cannot use the goodness of fit to help us determine X_ℓ, since the regression coefficients are not affected by its value and further there is no observed birth probability for the combination of age j, current year k, and cohort n.[18] Therefore, in order to estimate the component differences we must use some additional information to compute the X_ℓ .

We have estimated Equation 13 for the first four birth orders. For birth orders one through three, we used ages 18 through 39, omitting age 30, current years 1920 through 1966 omitting 1960 and the war-affected years of 1942 through 1947, and cohorts 1900 through 1946, omitting women born in 1931. In terms of the notation of Equation 13, j = 30 , k = 1960 , m = 1930, and n = 1931. For birth order four we followed the pattern of the first three birth orders except that ages 22 through 39, current years 1924 through 1966, and cohorts 1900 through 1942 were used. This procedure yielded three regressions with 107 dummy variables and 705 observations each and one regression with 95 dummy variables and 595 observations. The results of these computations are reported in Appendix III.

Before the results of these regressions can be used we must compute the X_ℓ . We know that the decline in birth probabilities from 1930 to 1933 ought not to be attributed to a fortuitous configuration of age and cohort components, but rather to a decline in the current year component. Similarly the increase in birth probabilities from 1933 to 1934 ought to be accounted for mainly be an increase in the current year component. Let us denote the coefficient of $[Y_s]$ in Equation 13 by $D_{s\ell}$. Then we can write:

$$(14) \qquad \beta_{1933,\ell} - \beta_{1930,\ell} = D_{1933,\ell} - D_{1930,\ell} + 3 \cdot X_\ell$$

and

$$(15) \qquad \beta_{1933,\ell} - \beta_{1934,\ell} = D_{1933,\ell} - D_{1934,\ell} - X_\ell \ .$$

If estimates could be made of $\beta_{1933,\ell} - \beta_{1930,\ell}$, $\beta_{1933,\ell} - \beta_{1934,\ell}$, or indeed any current year component difference, then the value of X_ℓ could be estimated. Any estimate of current year components drawn from observed data must be confounded with age and cohort influences. There is no way around this problem. The tack taken here is to try to minimize the effects of age and cohort influences by choosing to estimate current year component differences using observed data for years for which there is a priori information that changes in current year conditions were of speical importance in explaining fertility variations. The estimate used for $\beta_{1933,\ell} - \beta_{1930,\ell}$ is

$$d_{1,\ell} \equiv \frac{\sum_{i=15}^{30} \ln(p_{i,\,1933,k,\ell}) - \ln(p_{i,1930,k-3,\ell})}{16}$$

where $k = 1933 - i$. The estimate used for $\beta_{1933,\ell} - \beta_{1934,\ell}$ is

$$d_{2,\ell} \equiv \frac{\sum_{i=15}^{33} \ln(p_{i,1933,k,\ell}) - \ln(p_{i,1934,k+1,\ell})}{19}$$

where $k = 1933 - i$ once more. The criterion we used to determine X_ℓ was:

$$\text{Minimize } \{\tfrac{1}{3}(D_{1933,\ell} - D_{1930,\ell} + 3X_\ell - d_{1,\ell})\}^2 + \{D_{1933,\ell} - D_{1934,\ell} - X_\ell - d_{2,\ell}\}^2$$

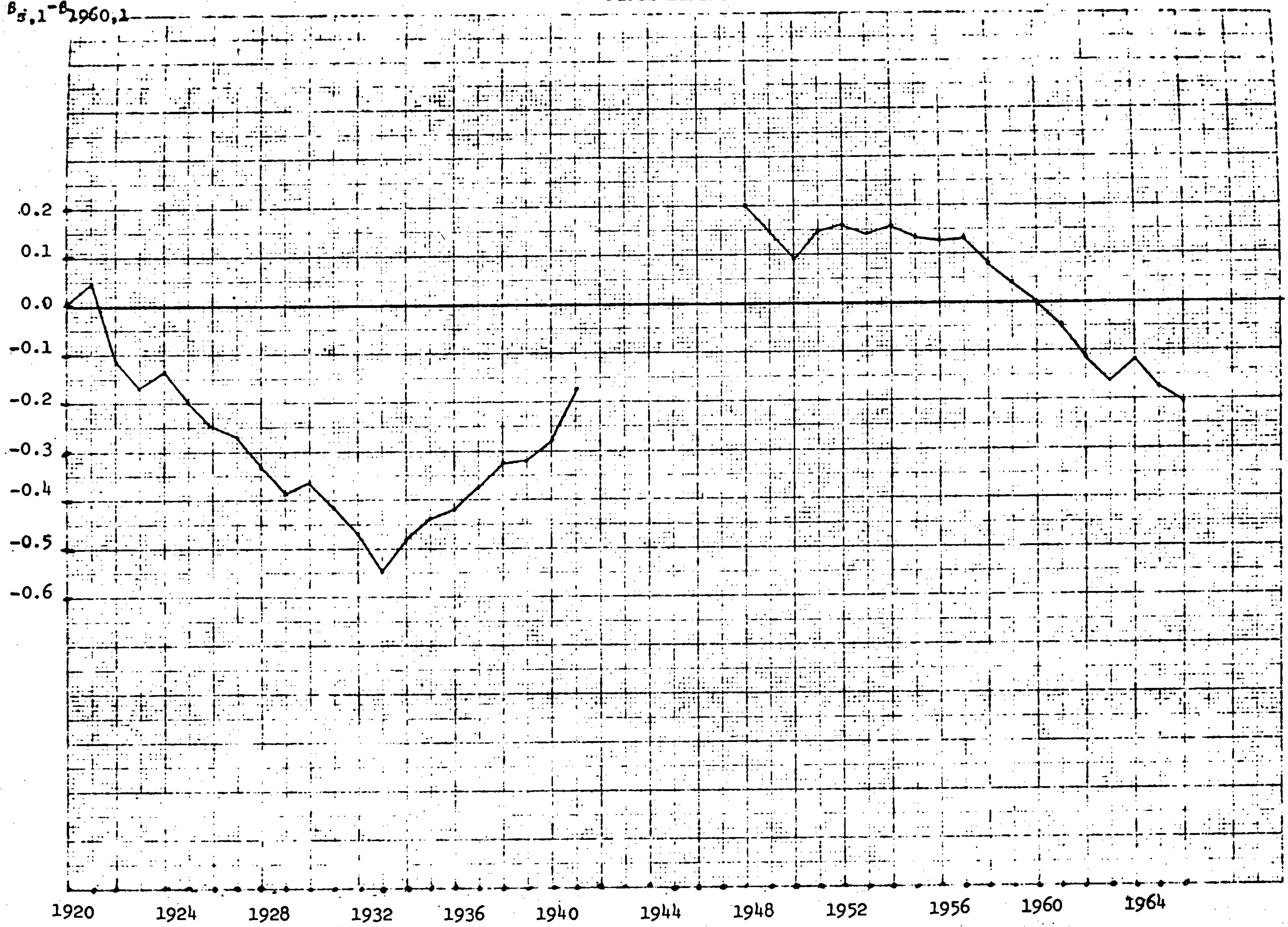
In essence, this criterion allows the selection of that X_ℓ whose implications for current year components fit most closely the notions that the declines in birth probabilities from 1930 to 1933 and the subsequent increases to 1934 were mainly due to changes in current year components.

Given the values of X_ℓ computed from the criterion above, we have computed the current year component differences $(\beta_{s,\ell} - \beta_{1960,\ell})$ and the cohort component differences $(\gamma_{t,\ell} - \gamma_{1931,\ell})$. The current year component differences are shown in Graphs 4, 6, 8, and 10, and cohort component differences in Graphs 5, 7, 9, and 11. The data shown in these graphs are sensitive to the criterion chosen to estimate the X_ℓ and by no means ought the plotted data to be interpreted as being precise. However, the general patterns shown by the component differences remain given any plausible criterion of which we are aware.

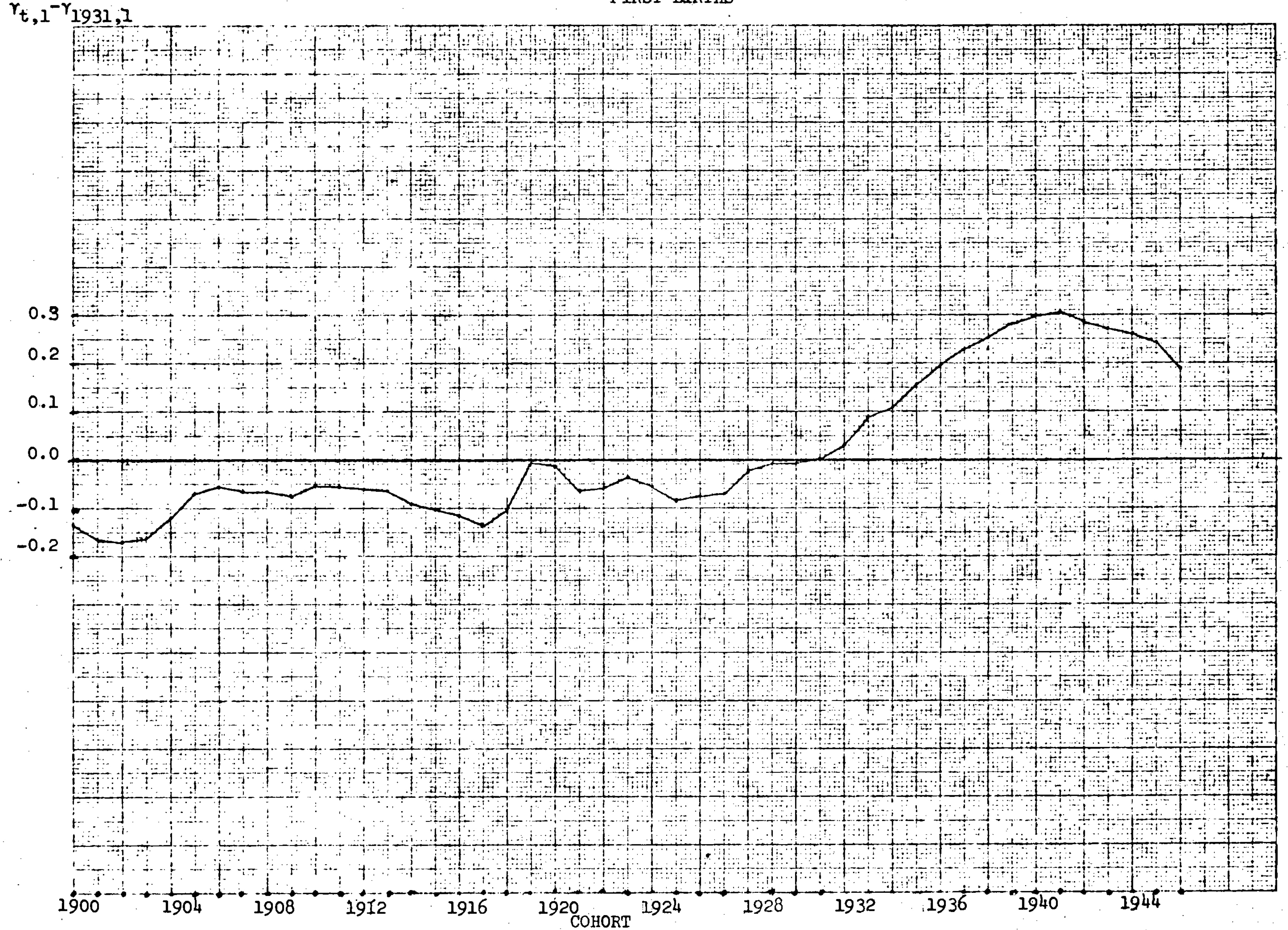
Graph 4 shows the current year component differences for first births. It is somewhat surprising to note that the current year component for first births does not peak in 1957, but earlier in the baby boom decade. How then are we to understand the first birth probabilities of women 15 through 27, all of which peak in 1957? The answer can be found by turning to Graph 5. Here we can see that the cohort component was rising after the middle of the 1920's. It is the rise, particularly the increase for women born in the Depression which is the main cause of the increase in first birth probabilities for young women during the baby boom. The rather large differences in the behavior of first birth probabilities by age group which we noted earlier in the paper can be traced directly to variations in the cohort components.

Clearly, if we are to understand the increase in first births over the course of the baby boom, we must focus our attention on the large upward movement of the cohort component which occurred across the Depression. Apparently relative cohort size has some impact on this component because the small cohort of 1919 has a relatively large component and the relatively large cohort of 1921 a comparatively small one. The year 1917 for which the cohort component has a local trough is also a year in which the birth series has a local peak.[19] Nonetheless, the sheer size of the change in the cohort component over the Depression relative to previous changes suggests that some other factors were also at work. Perhaps one of the other factors is the Easterlin-Fuchs intergenerational relative income effect. However, it is not evident that these two factors taken together would imply a 1941 peak in the cohort component. In any case, one thing is clear from Graph 5, cohort components have been the source of a considerable portion of the variability in first birth probabilities over the baby boom.

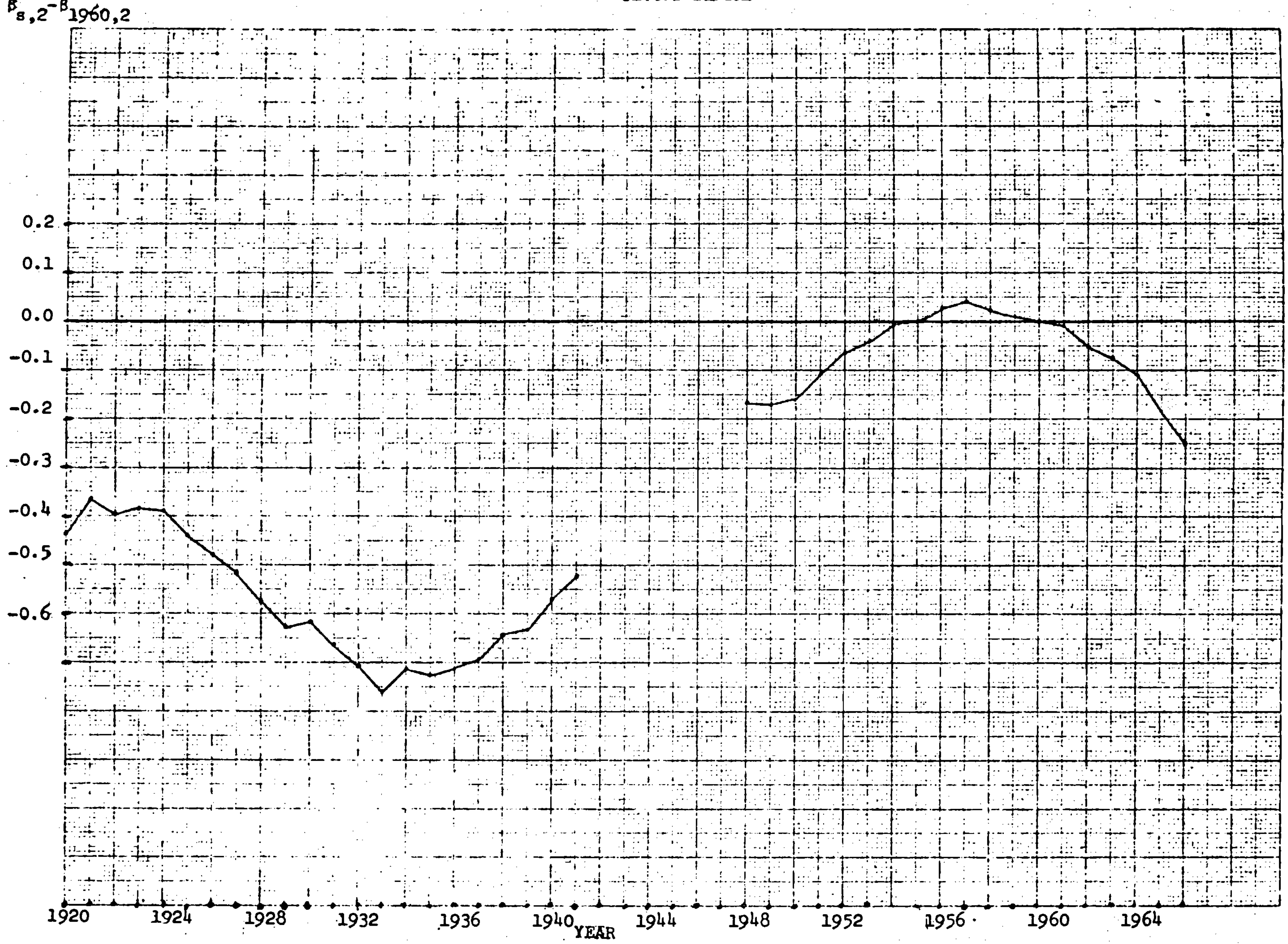
GRAPH 4: CURRENT YEAR COMPONENT DIFFERENCES
FIRST BIRTHS



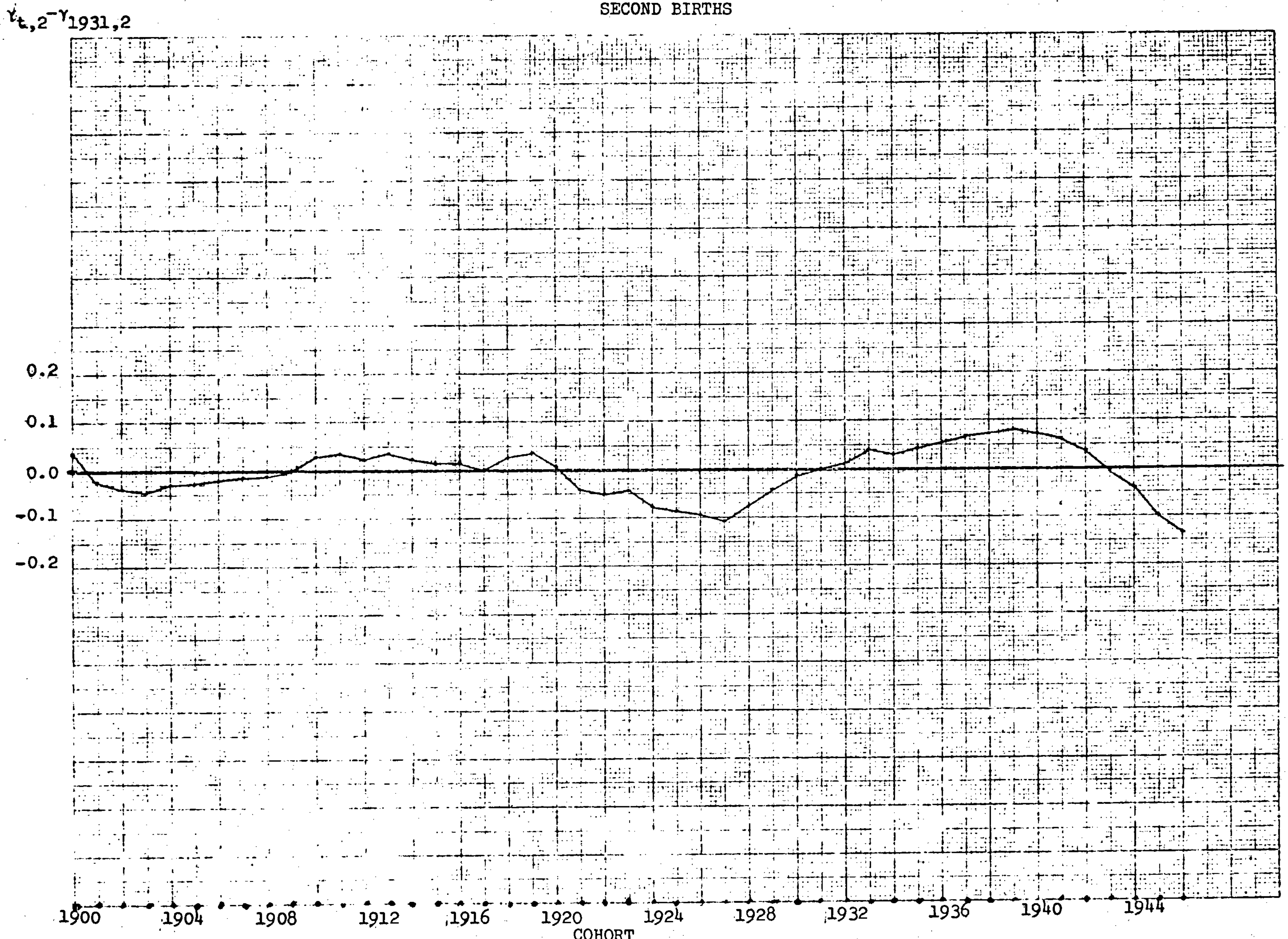
GRAPH 5: COHORT COMPONENT DIFFERENCES
FIRST BIRTHS



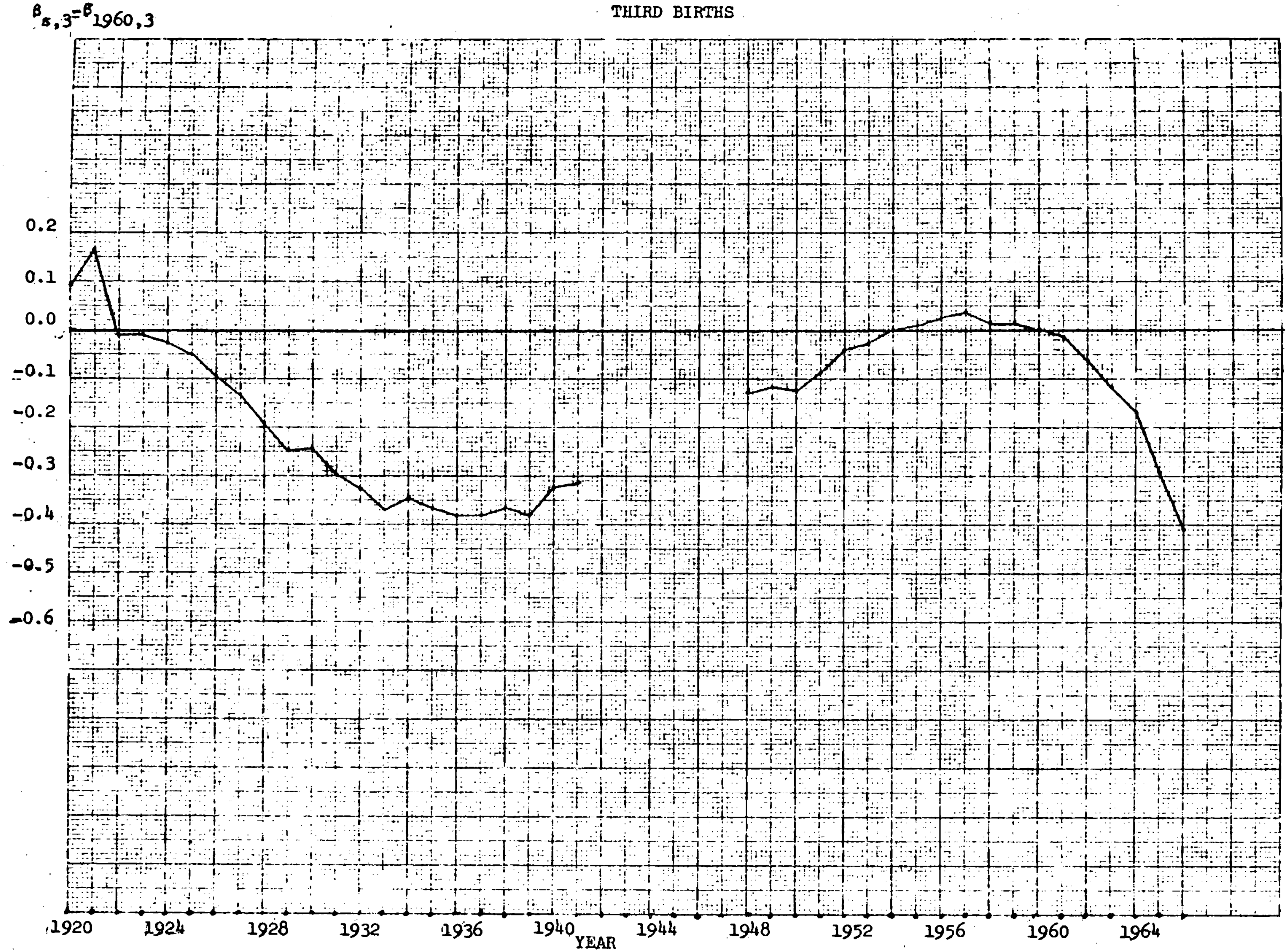
GRAPH 6: CURRENT YEAR COMPONENT DIFFERENCES
SECOND BIRTHS



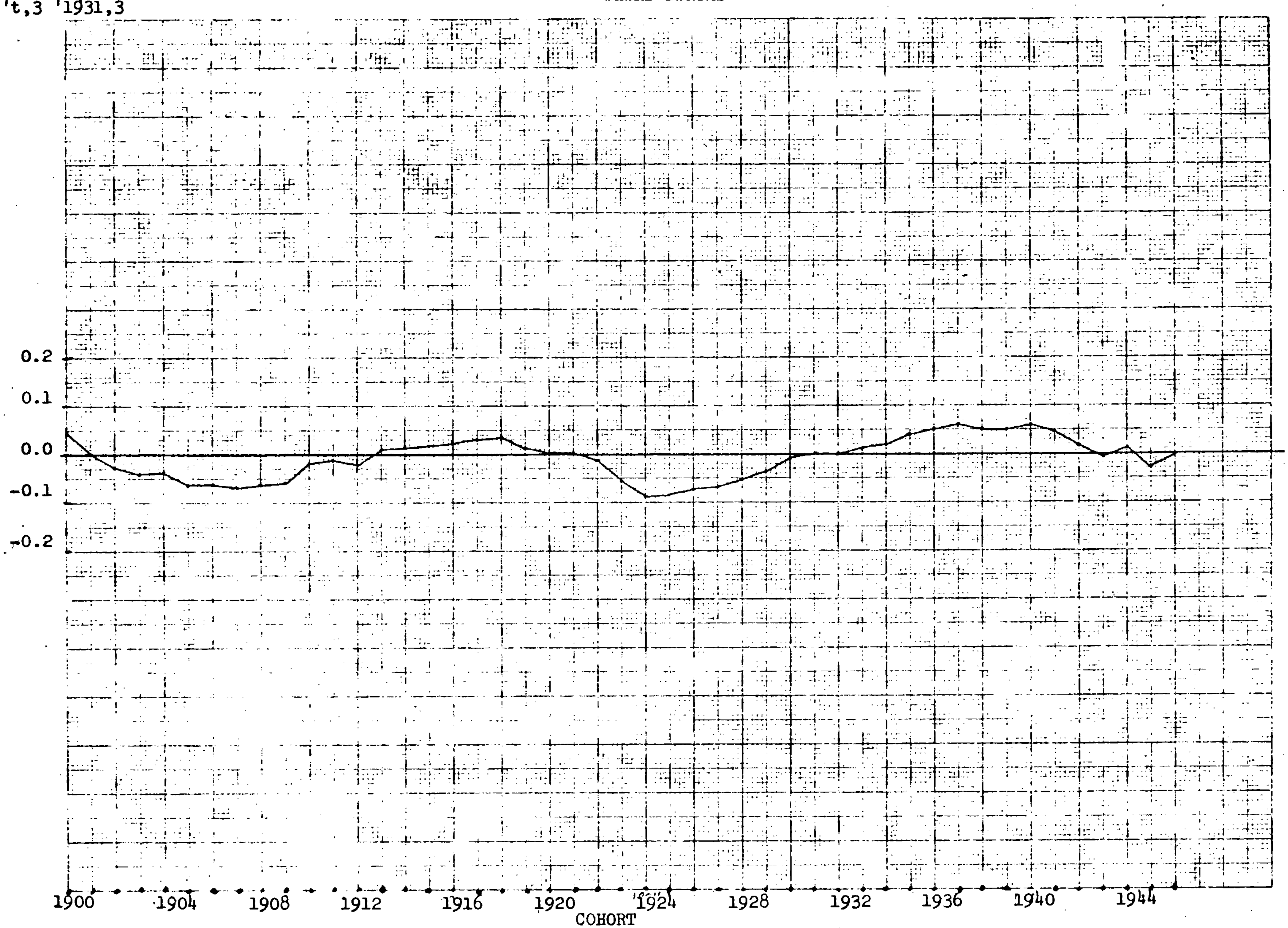
GRAPH 7: COHORT COMPONENT DIFFERENCES
SECOND BIRTHS



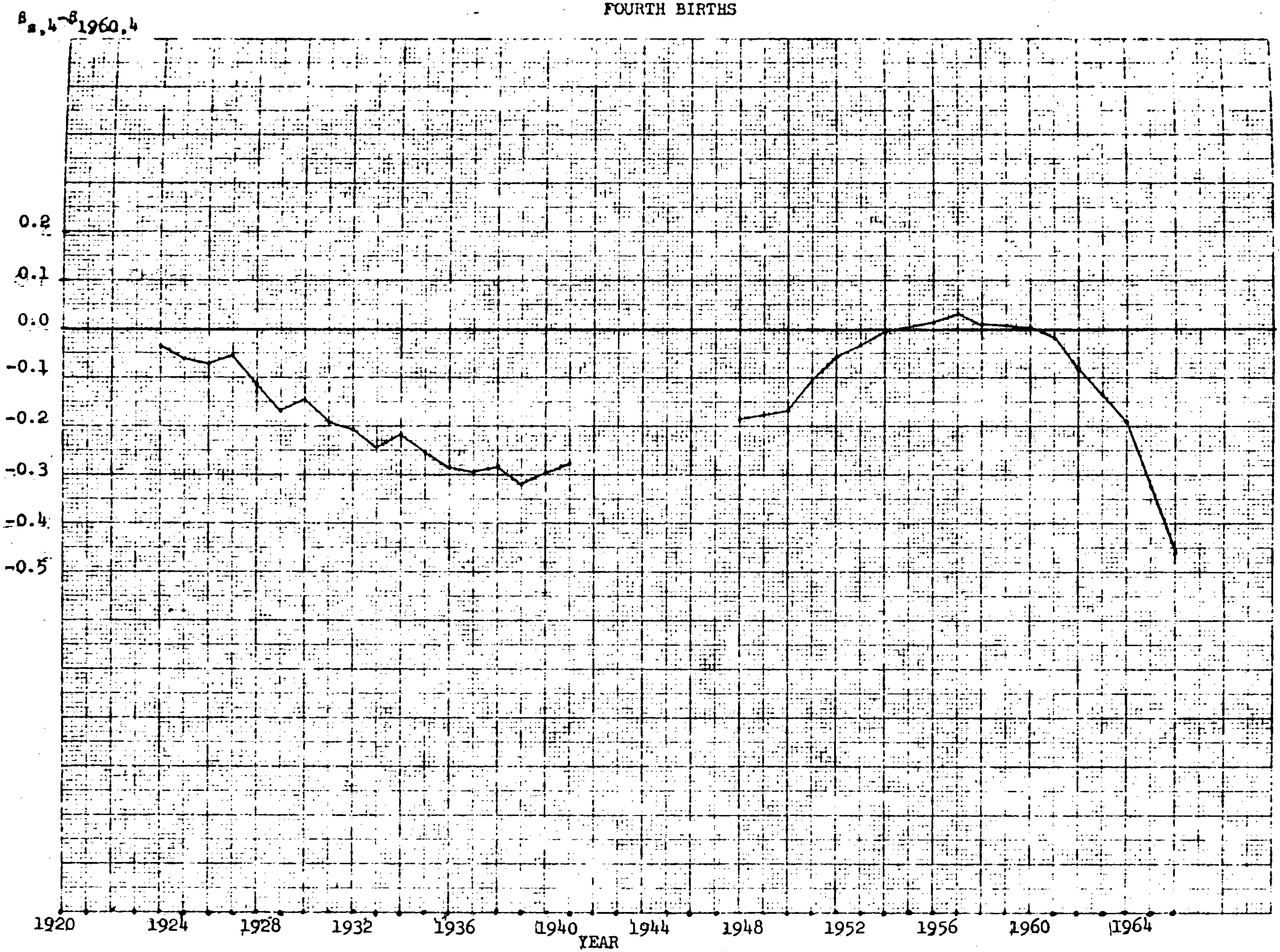
GRAPH 8: CURRENT YEAR COMPONENT DIFFERENCES
THIRD BIRTHS



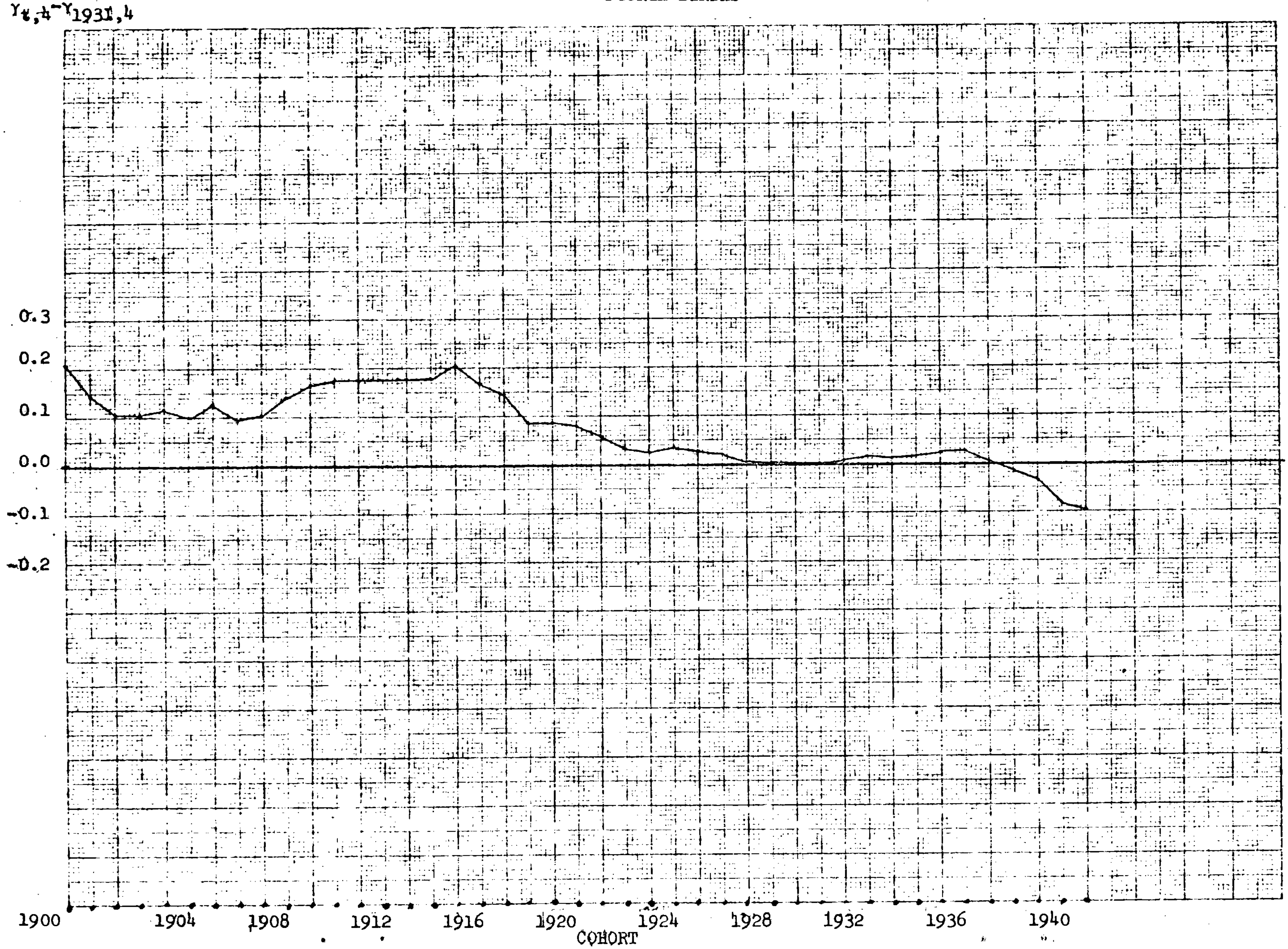
GRAPH 9: COHORT COMPONENT DIFFERENCES
THIRD BIRTHS



GRAPH 10: CURRENT YEAR COMPONENT DIFFERENCES
FOURTH BIRTHS



GRAPH 11: COHORT COMPONENT DIFFERENCES
FOURTH BIRTHS



Looking at Graphs 6, 8, and 10, one can see a common pattern in the current year components; one that is different from that in Graph 4. In Graph 4, we found that the current year component for first births did not rise in the 'fifties to a peak in 1957. In Graphs 6, 8, and 10, we see that the current year components for second through fourth births do rise in the 'fifties to a peak in 1957. It is in part this this difference between the behavior of the current year component for first and for higher order births which explains why birth probability patterns differ by order for women of the same age, the phenomenon we observed in Graph 3 above. This clear differentiation between the current year components of first births and higher order births during the baby boom period is an important observation. It suggests that students of fertility might profitably study first and subsequent births separately.

Considering the cohort components of second through fourth births, it can be seen that the rise in the cohort component over the Depression which was so prominent with respect to first births becomes significantly attenuated as birth order increases. In Graph 11, which shows the cohort components for fourth births, the rise over the Depression is so small as to be almost nonexistent. Thus it appears that at least some cohort influences affect fertility by primary affecting low order births.

We are now in a position to systematize the observations we made on the patterns of birth probability changes over the baby boom. Most of the age differentiation in the patterns of birth probabilities may be explained by a common pattern in the cohort components. Cohort components tended to have a declining phase in the 'twenties followed by an increasing phase beginning in the middle or late 'twenties. This pattern raised the fertility of younger women in the 'fifties and lowered the fertility of older women. The increasing phase of the cohort component clearly grew smaller in amplitude as birth order increased and it is possible that the reverse happened with respect to the decreasing phase. Most order differentiation in the patterns of birth probabilities by age occurs between first and subsequent births due to the change in the pattern of current year components from one which is relatively flat from 1952 through 1957 and which falls thereafter to a pattern for second and higher order births which is more rounded and which peaks in 1957. The less rapid fall from 1957 to 1960 in this latter pattern accounts for why the interaction between it and the cohort components produces peaks around 1960 rather than the earlier peaks in the first birth probabilities of young women.

In this paper we have presented data on monthly birth probabilities for native white women which are age- and parity-specific. We have considered the patterns of variation shown by these probabilities over the baby boom and demonstrated that these patterns may be illuminated by decomposing the birth probabilities into age, current year, and cohort components. It is hoped that the data presented here and the questions which hve been raised will aid in the development of models and data which will deepen our understanding of the intricate processes of fertility change over time.

APPENDIX I

The Methodology of the Creation of Birth Probabilities.

As an example, we shall relate in detail the creation of the monthly probability of 30 year old women having their second birth in 1950. First, we assume that women are only born on the first day of every month. This assumption makes our computations managable without neglecting the substantial variations in monthly births which have occurred. Women who report having a second birth at age 30 in 1950 may have been born between February 1, 1919 and December 1, 1920. In other words, the women may have any one of twenty-three monthly birthdays. Let us call women born on February 1, 1919 members of cohort one, women born on March 1, 1919 members of cohort two, and so on. Women born on December 1, 1920 are members of cohort 23. In order to determine the birth probability we must know how many women are capable of having a second birth at age 30 in 1950 and how many months these women spend as 30 year olds in 1950. We have assumed in the birth probability computations that a woman was not capable of having a birth until twelve months after her last one except in the case of twins.

The assumption that, except in the case of twins, a woman was not capable of having a birth in less than twelve months after her last one, forces us to divide those women capable of having a second birth at age 30 in 1950 into two groups, those who have had their first birth more than a year before they turn 30 in 1950 and those who have had their first birth within a year of the date on which they turn 30 in

1950. Let us consider, for example, those women of cohort 12 (i.e. those born on January 1, 1920) who are capable of having a second birth at age 30 in 1950. Some of these women had their first birth when they were 20 in 1949. If their births were distributed uniformly over the year 1949, these women would have, on average, six months of 1950 in which they were capable of having a second child. Women who had their first birth before they were 29 in 1949 would have a full twelve months of 1950 in which they were capable of having a second child.

Let us define $N_{1,1}$ through $N_{23,1}$ as the numbers of women in cohorts 1 through 23 who have had their first child before age 29 in 1949 and $N_{1,2}$ through $N_{23,2}$ as the numbers of women in cohort 1 through 23 who had their first birth at age 29 in 1949. If these numbers of women are known and the total number of second births to 30 year old women in 1950, called B, is known, we can write the following equation in which p is the monthly probability of having a second birth.

$$(1)\qquad B = \sum_{j=1}^{2}\sum_{i=1}^{23} N_{ij} - \sum_{j=1}^{2}\sum_{i=1}^{12} N_{ij}(1-p)^{i/j} - \sum_{j=1}^{2}\sum_{i=13}^{23} N_{ij}(1-p)^{(24-i)/j}$$

Equation 1 is not easily solved for p in general. However since we know that p is generally quite small, often around 0.02, a Taylor series expansion of the terms involving $(1 - p)$ in which we delete all terms above the quadratic one will yield a good approximation.

In general, we can write

$$(2)\qquad (1-p)^n \approx (1-q)^n + n(1-q)^{n-1}(q-p) + \frac{(n)(n-1)(1-q)^{n-2}(q-p)^2}{2}$$

We can rewrite equation 2 as follows

$$(3)\qquad \begin{aligned}(1-p)^n \approx\ & (1-q)^n + n(1-q)^{n-1}q + \frac{(n)(n-1)(1-q)^{n-2}q^2}{2} \\ & - p[n(1-q)^{n-1} + (q)(n)(n-1)(1-q)^{n-2}] \\ & + p^2\left[\frac{(n)(n-1)(1-q)^{n-2}}{2}\right]\end{aligned}$$

Let us make the following definitions:

$$F(q, n) = (1-q)^n + (n)(1-q)^{n-1}q + \frac{(n)(n-1)(1-q)^{n-2}(q)^2}{2}$$

$$G(q, n) = n(1-q)^{n-1} + (q)(n)(n-1)(1-q)^{n-2} \quad \text{and}$$

$$H(q, n) = \frac{(n)(n-1)(1-q)^{n-2}}{2}$$

Equation 1 may now be written

$$B = \sum_{j=1}^{2} \sum_{i=1}^{23} N_{ij} - \sum_{j=1}^{2} \sum_{i=1}^{12} N_{ij}[F(q, i/j) - pG(q, i/j) + p^2H(q, i/j)]$$

(5)

$$- \sum_{j=1}^{2} \sum_{i=13}^{23} N_{ij}[F(q, \frac{24-i}{j}) - pG(q, \frac{24-i}{j}) + p^2H(q, \frac{24-i}{j})] \;.$$

Writing equation 5 in the standard form of a quadratic equation we obtain

$$p^2 \left[\sum_{j=1}^{2} \sum_{i=1}^{12} N_{ij} H(q, i/j) + \sum_{j=1}^{2} \sum_{i=13}^{23} N_{ij} H(q, \frac{24-i}{j}) \right]$$

(6)

$$+ p \left[- \sum_{j=1}^{2} \sum_{i=1}^{12} N_{ij} G(q, i/j) - \sum_{j=1}^{2} \sum_{i=13}^{23} N_{ij} G(q, \frac{24-i}{j}) \right]$$

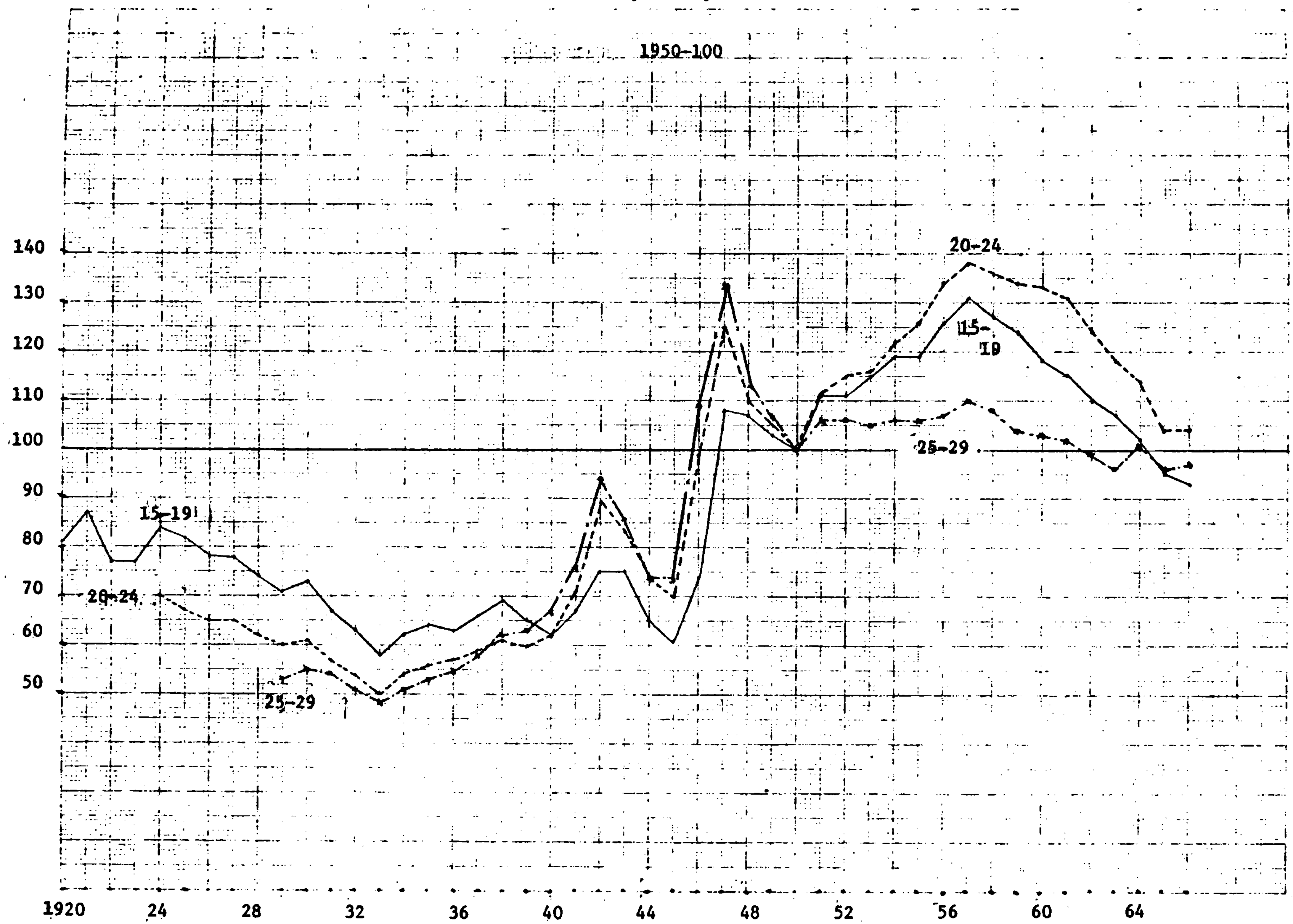
$$+ \sum_{j=1}^{2} \sum_{i=1}^{23} N_{ij} - \sum_{j=1}^{2} \sum_{i=1}^{12} N_{ij} F(q, i/j) - \sum_{j=1}^{2} \sum_{i=13}^{23} N_{ij} F(q, \frac{24-i}{j}) - B = 0.$$

Equation 6 can be easily solved for p and its solution clearly depends on the initial value of q which is chosen. In the computation of the birth probabilities q was initially set at 0.05. After p was computed by solving equation 6, the new p was introduced as the value of q and p was computed once again. Through experimentation it was found that the value of p almost always converged to its true value after two iterations.

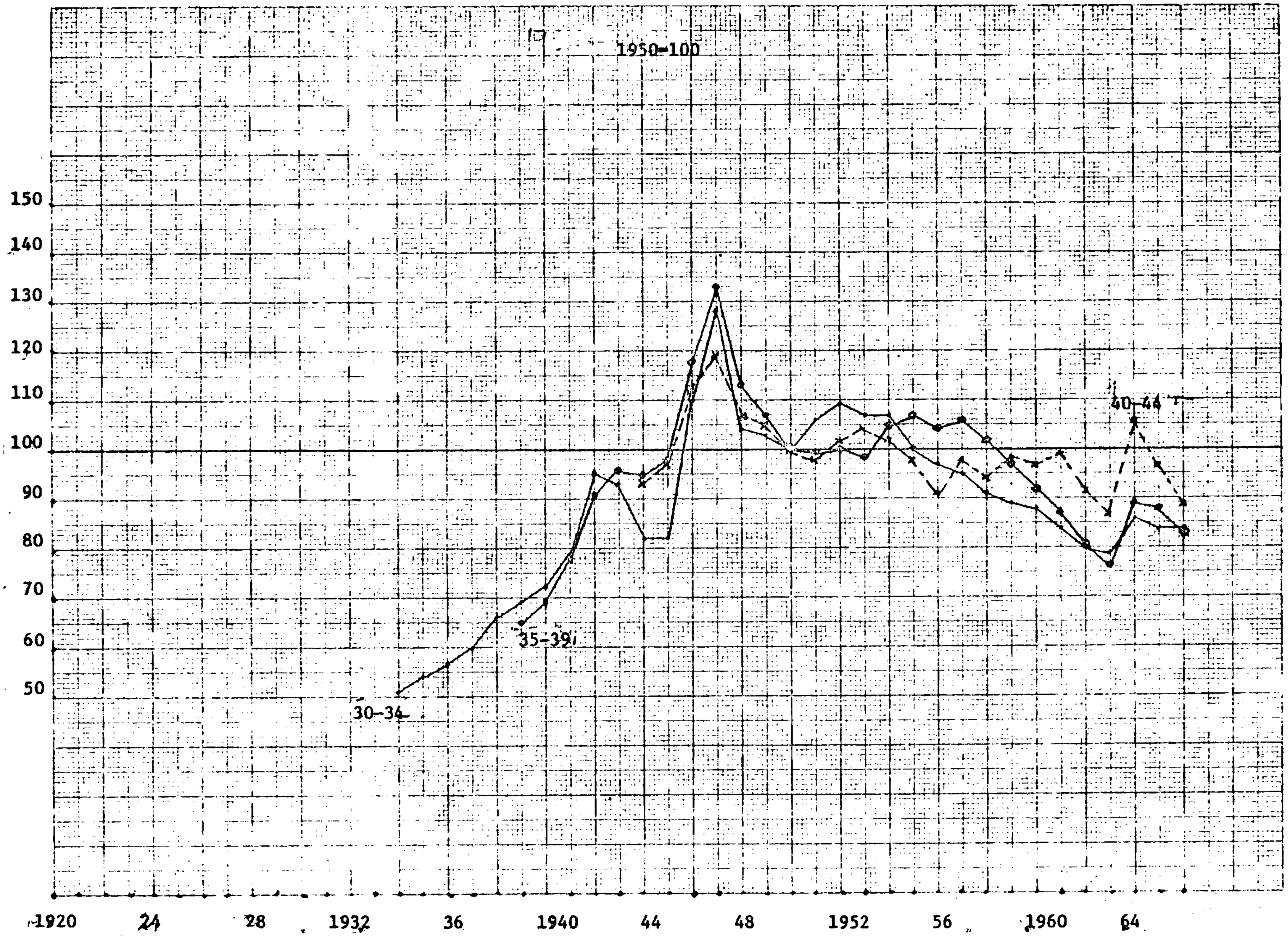
The underlying birth data for the years 1915 through 1946 are implicit in Whelpton (1954), and data for the years 1947 through 1966 are derived from the relevant issues of Vital Statistics of the United States. The data on the number of women capable of having a birth of a given order at a given age in a given year and essentially derived, simultaneously with the birth probabilities. For example, we assume that women do not give birth to children before the age of 15. Therefore, once we have computed first birth probabilities for 15 year old women, we can determine the number of months of exposure to having a second birth 16 year old women have in the subsequent year. For more details on this procedure see Sanderson (1974) Appendix A.

APPENDIX II

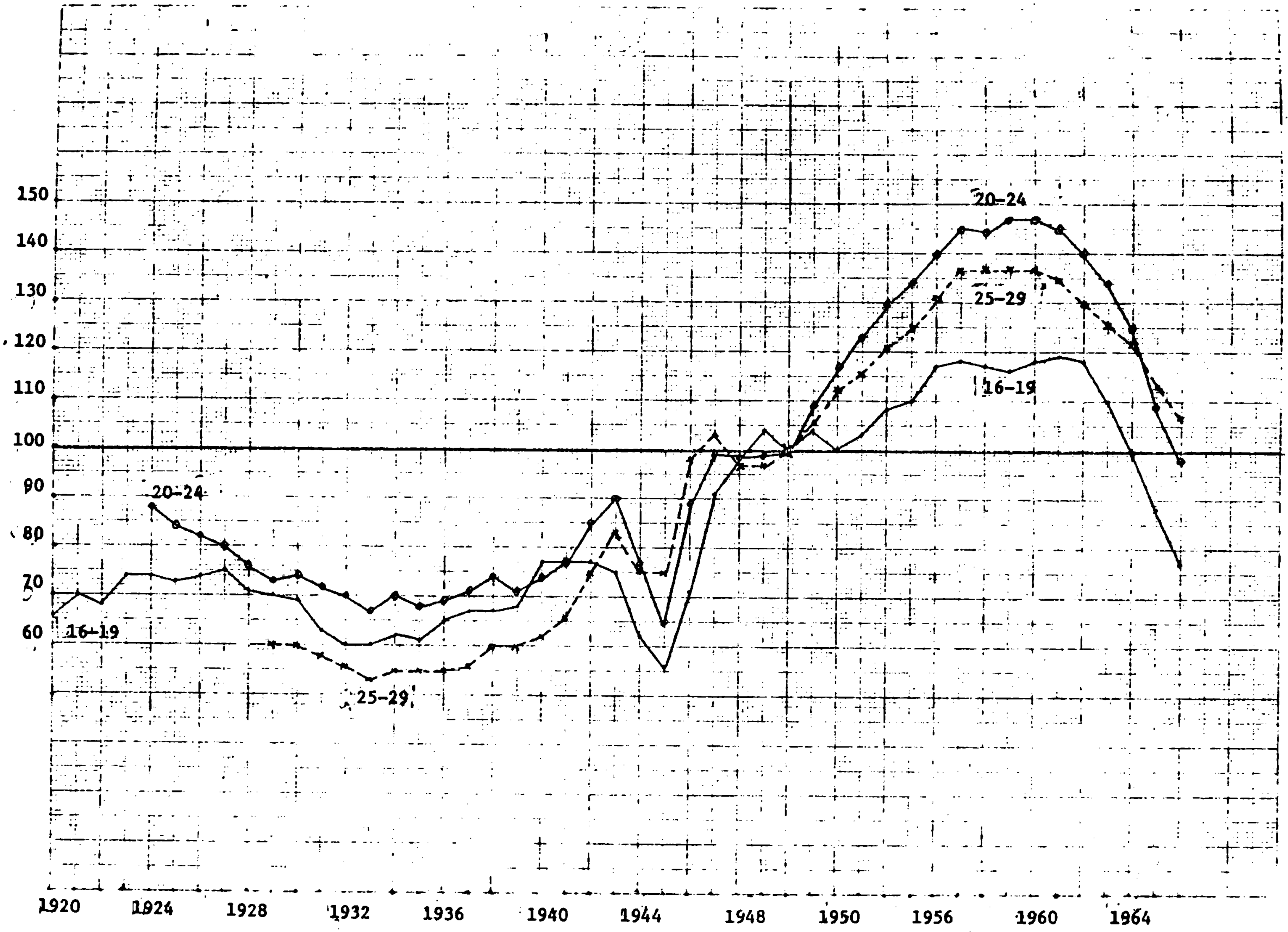
GRAPH I-1: FIRST BIRTH PROBABILITIES TO WOMEN
15-19, 20-24, 25-29



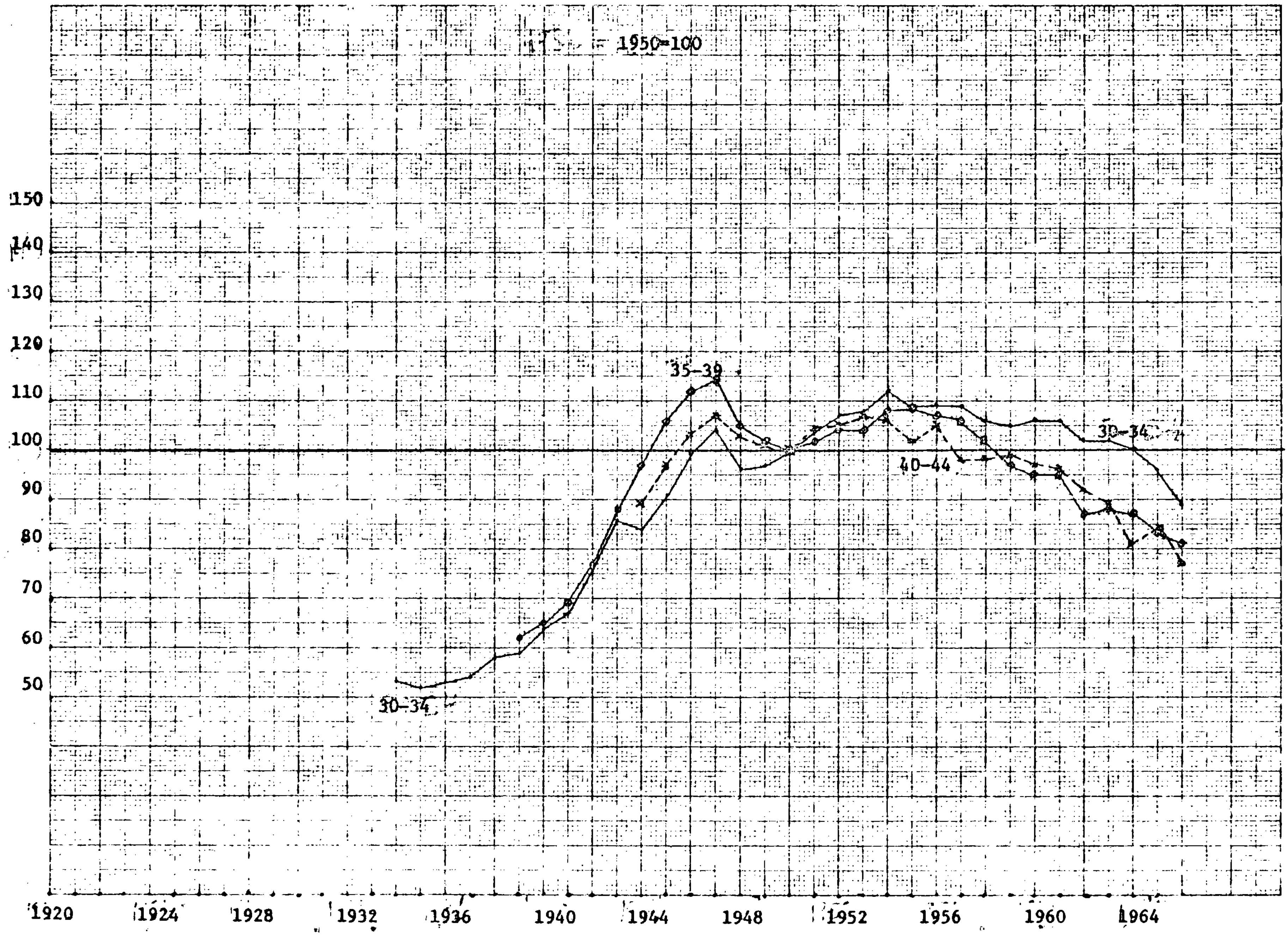
GRAPH I-2: FIRST BIRTH PROBABILITIES TO WOMEN
30-34, 35-39, 40-44



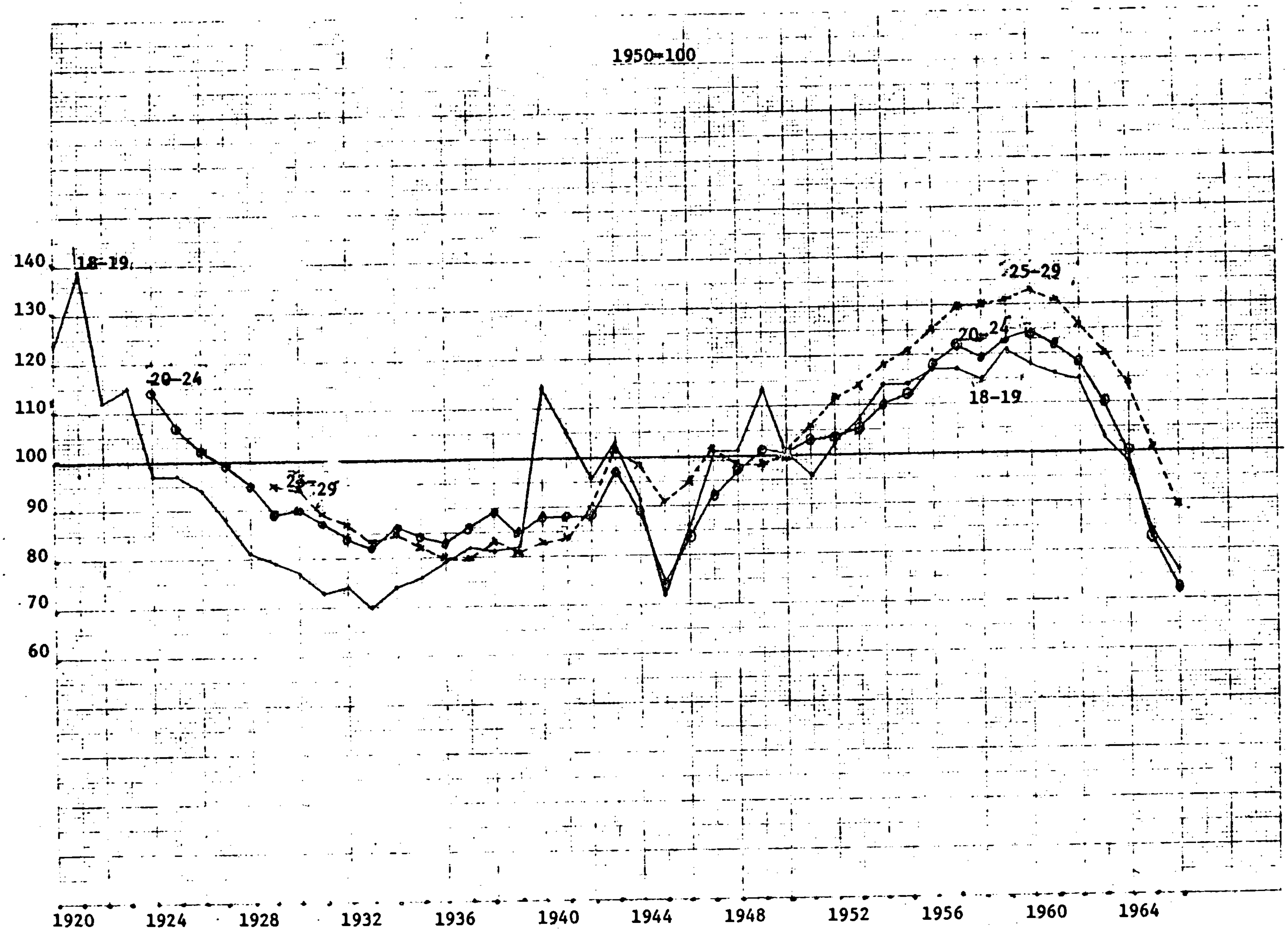
GRAPH II-1: SECOND BIRTH PROBABILITIES TO WOMEN
16-19, 20-24, 25-29



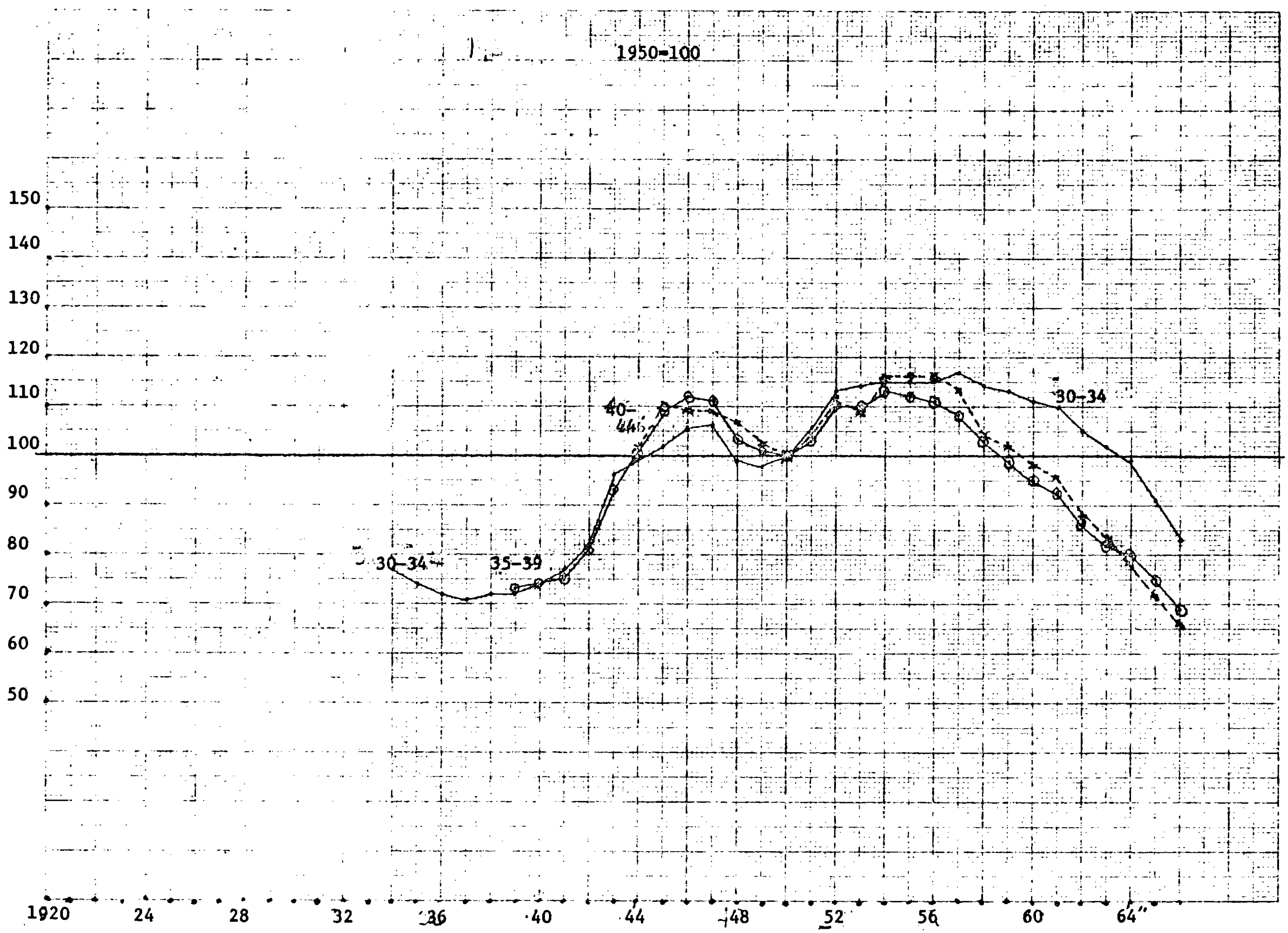
GRAPH II-2: SECOND BIRTH PROBABILITIES TO WOMEN
30-34, 35-39, 40-44



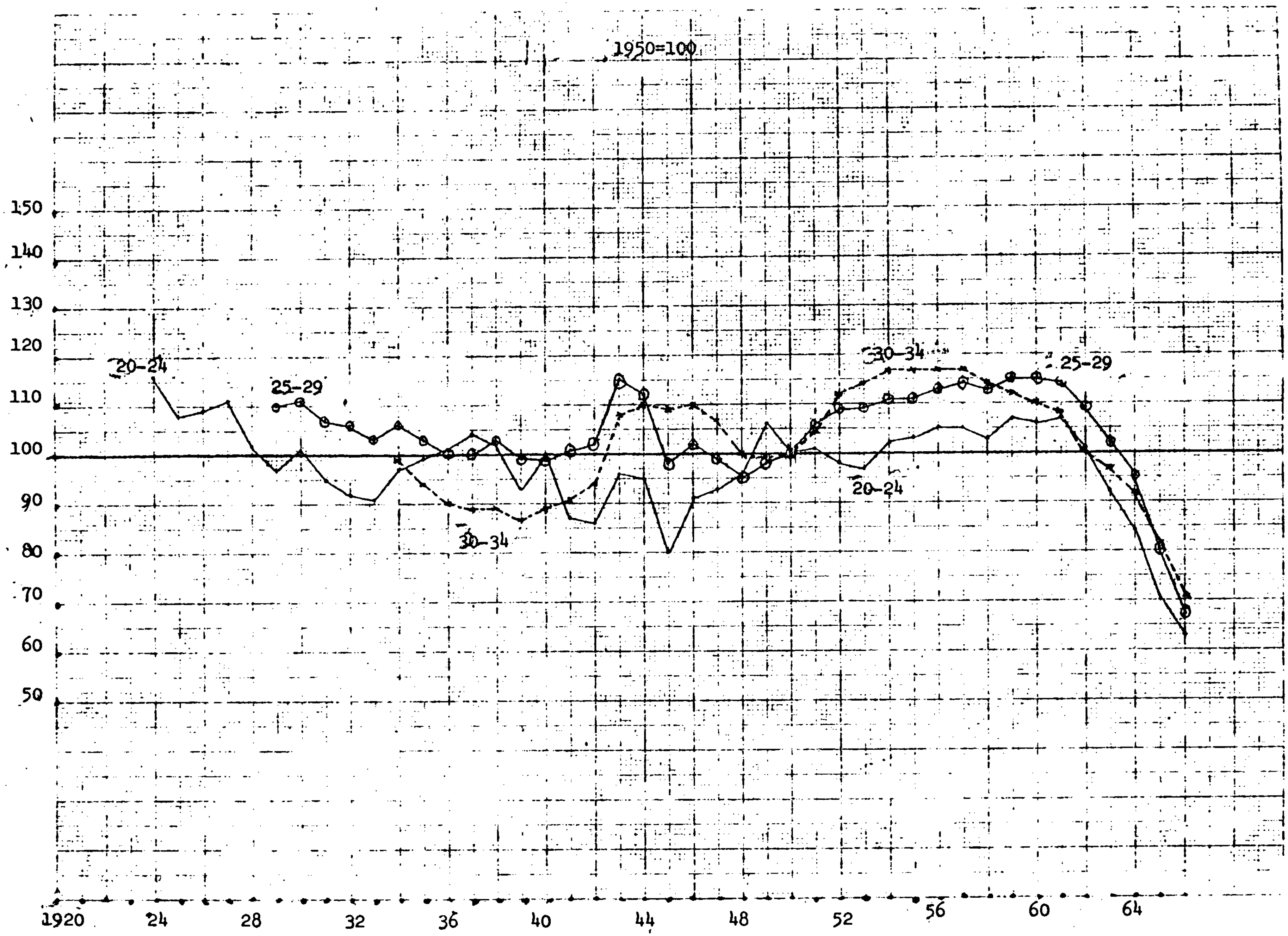
GRAPH III-1: THIRD BIRTH PROBABILITIES TO WOMEN
18-19, 20-24 and 25-29



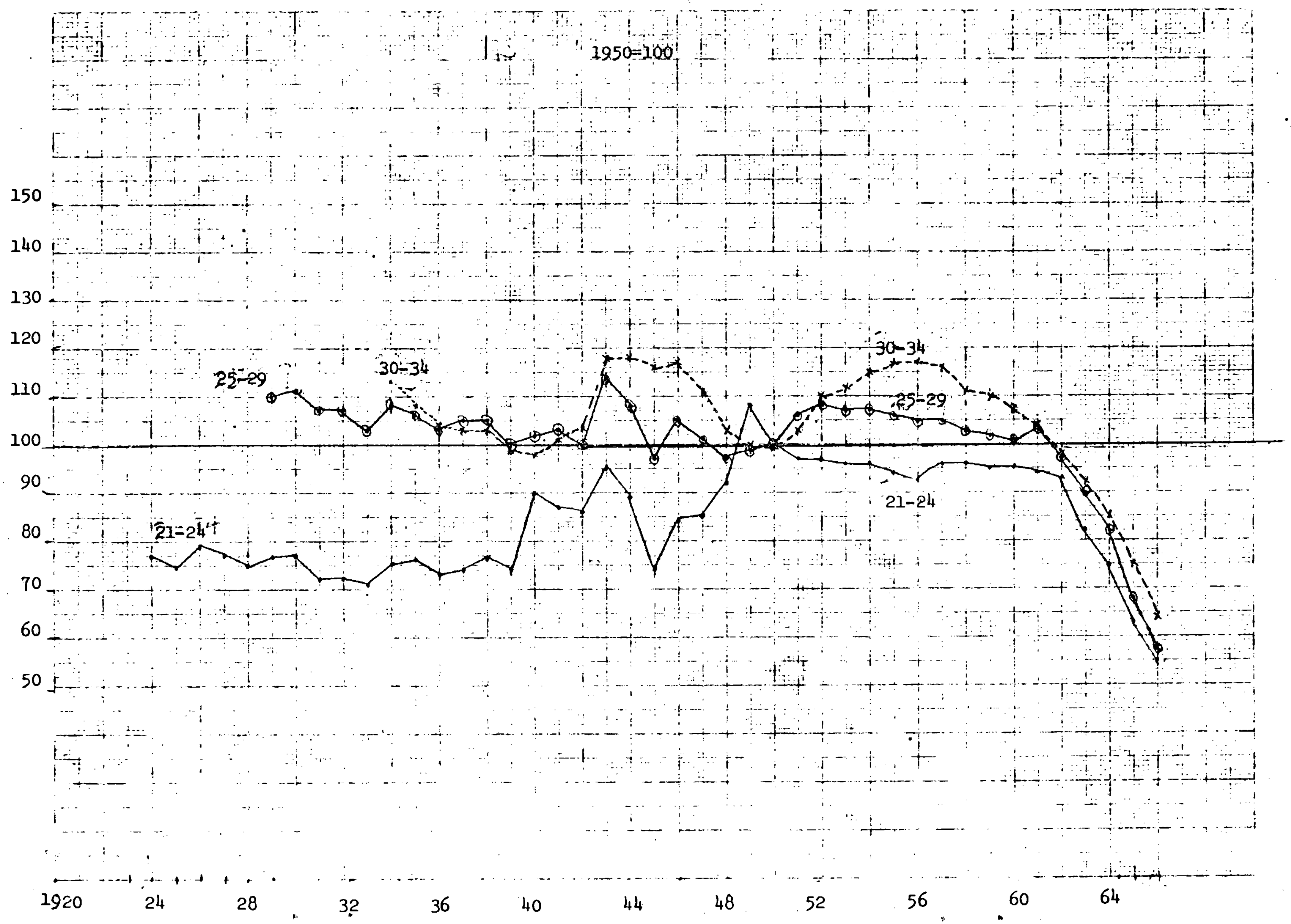
GRAPH III-2: THIRD BIRTH PROBABILITIES TO WOMEN
30-34, 35-39 and 40-44



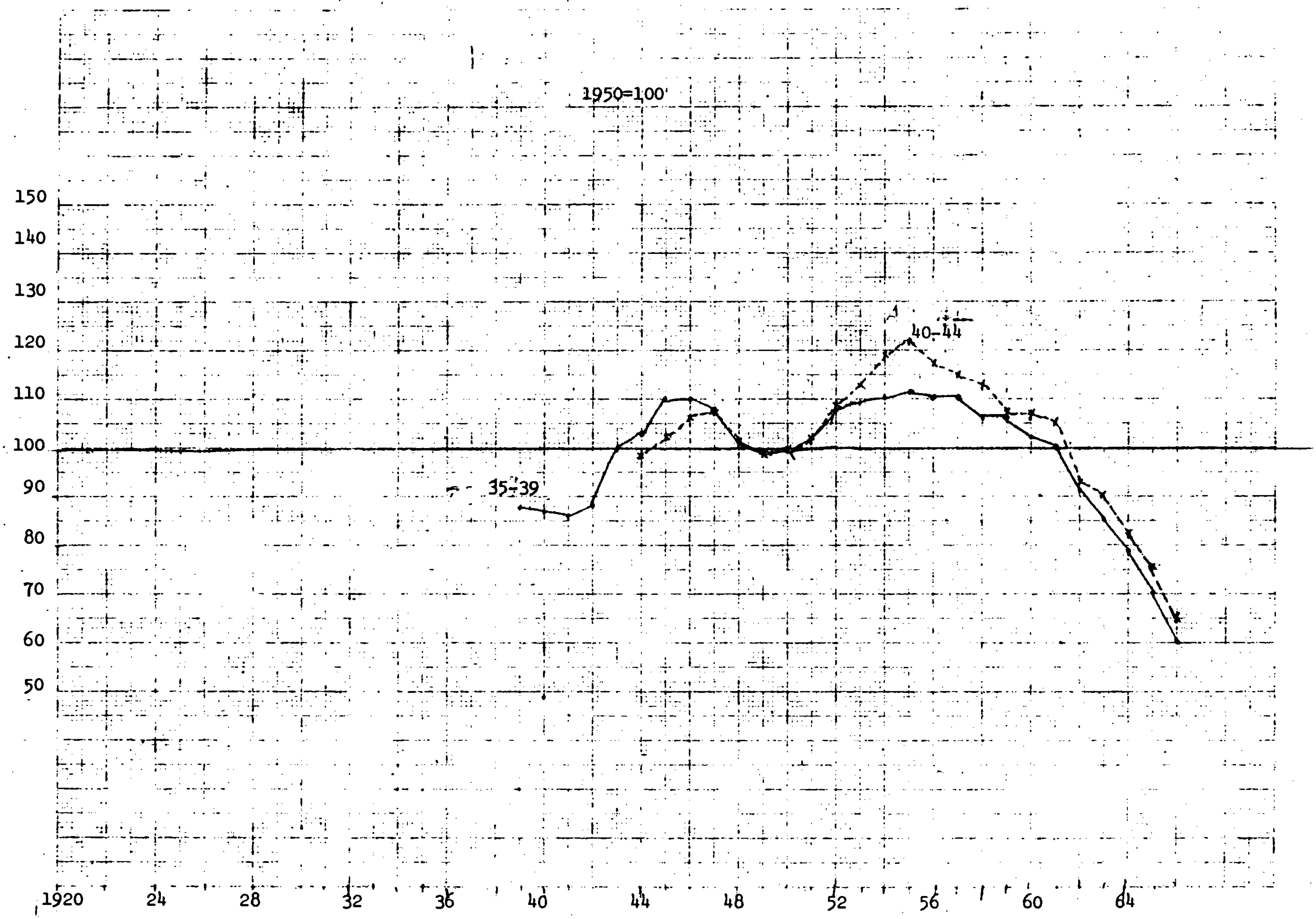
GRAPH IV-1: FOURTH BIRTH POSSIBILITIES TO WOMEN,
20-24, 25-29 and 30-34



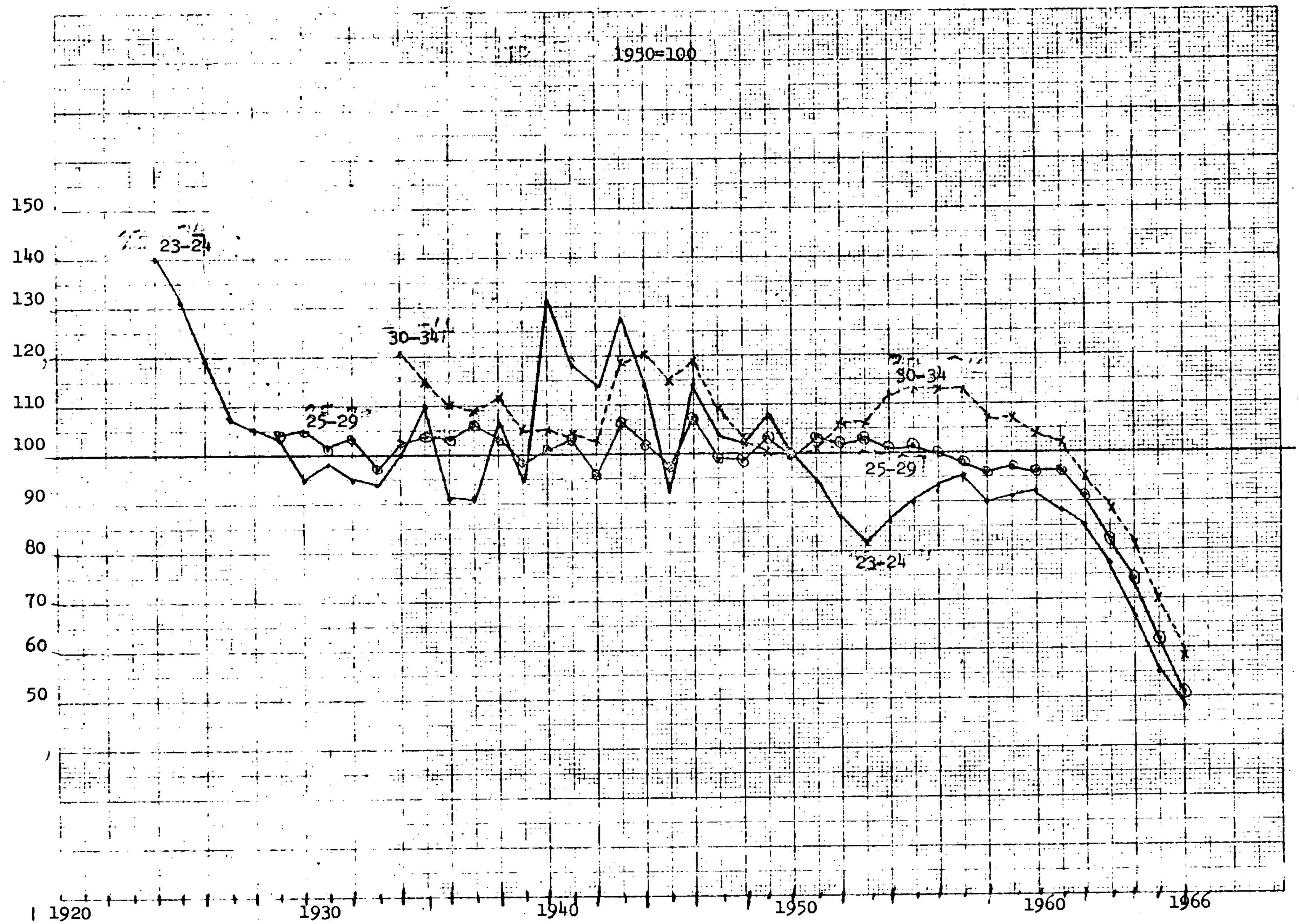
GRAPH V-1: FIFTH BIRTH PROBABILITIES TO WOMEN
21-24, 25-29 and 30-34



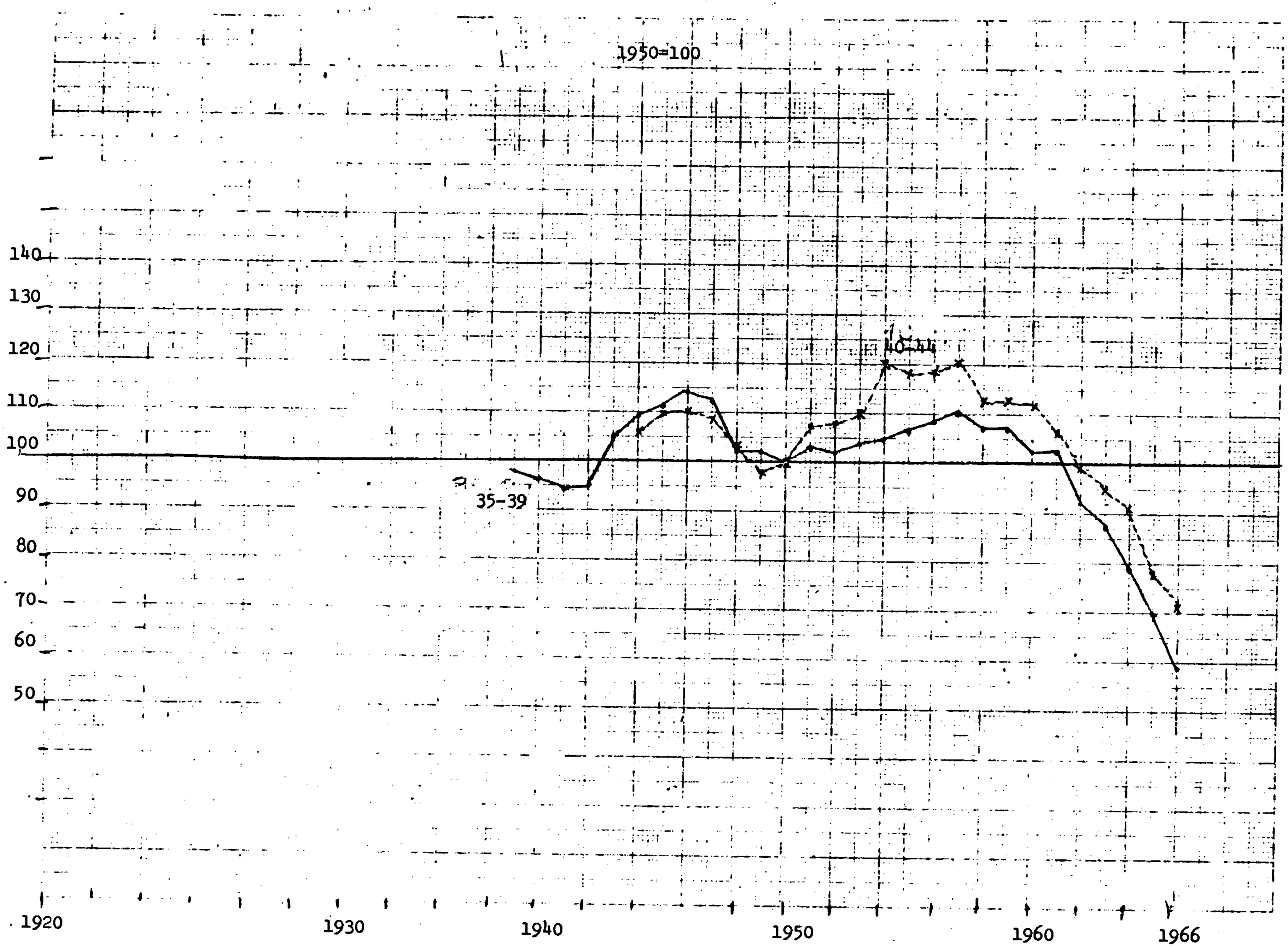
GRAPH V-2: FIFTH BIRTH PROBABILITIES TO WOMEN 35-39, and 40-44



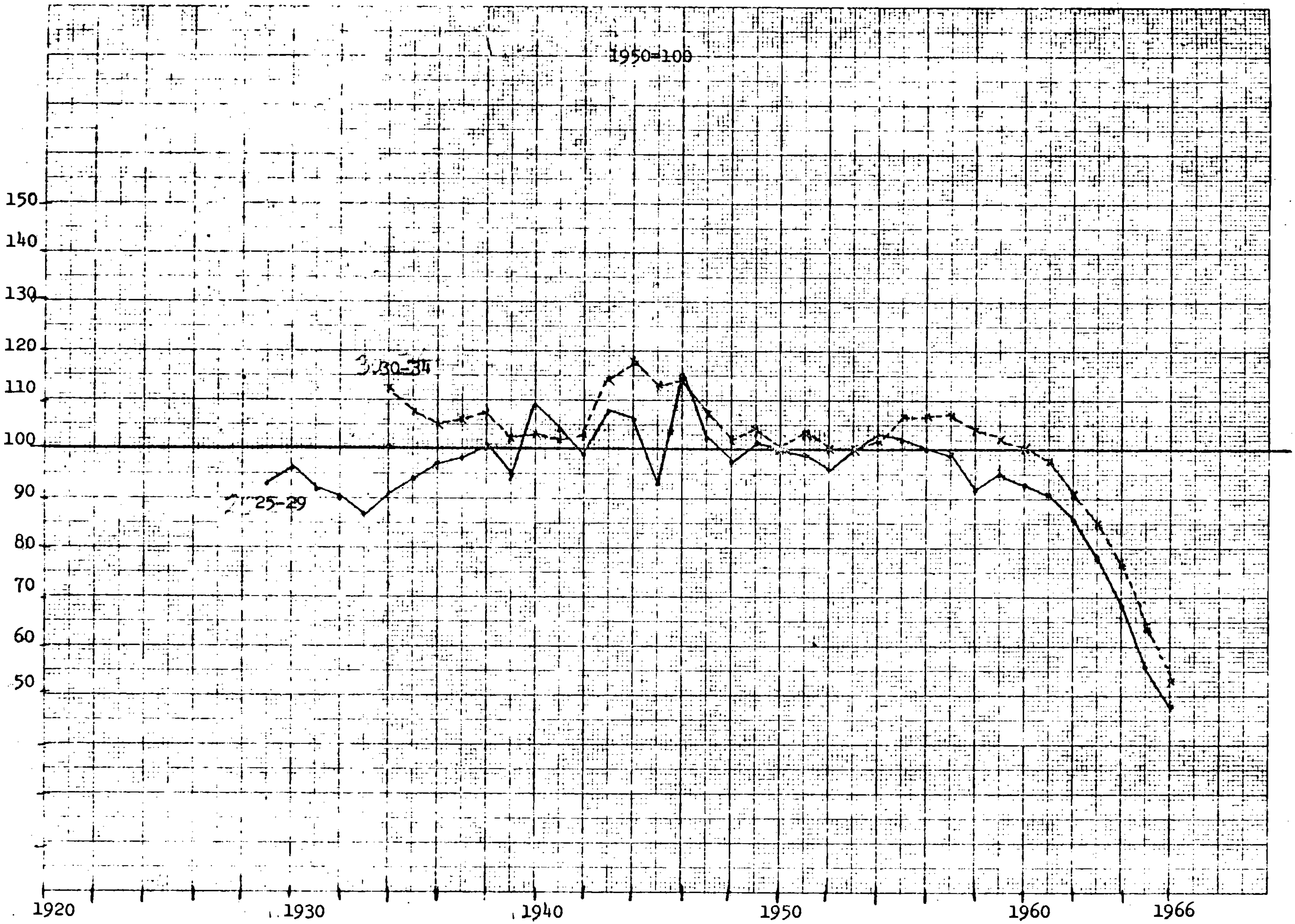
GRAPH VI-1: SIXTH BIRTH PROBABILITIES TO WOMEN
23-24, 25-29 and 30-34



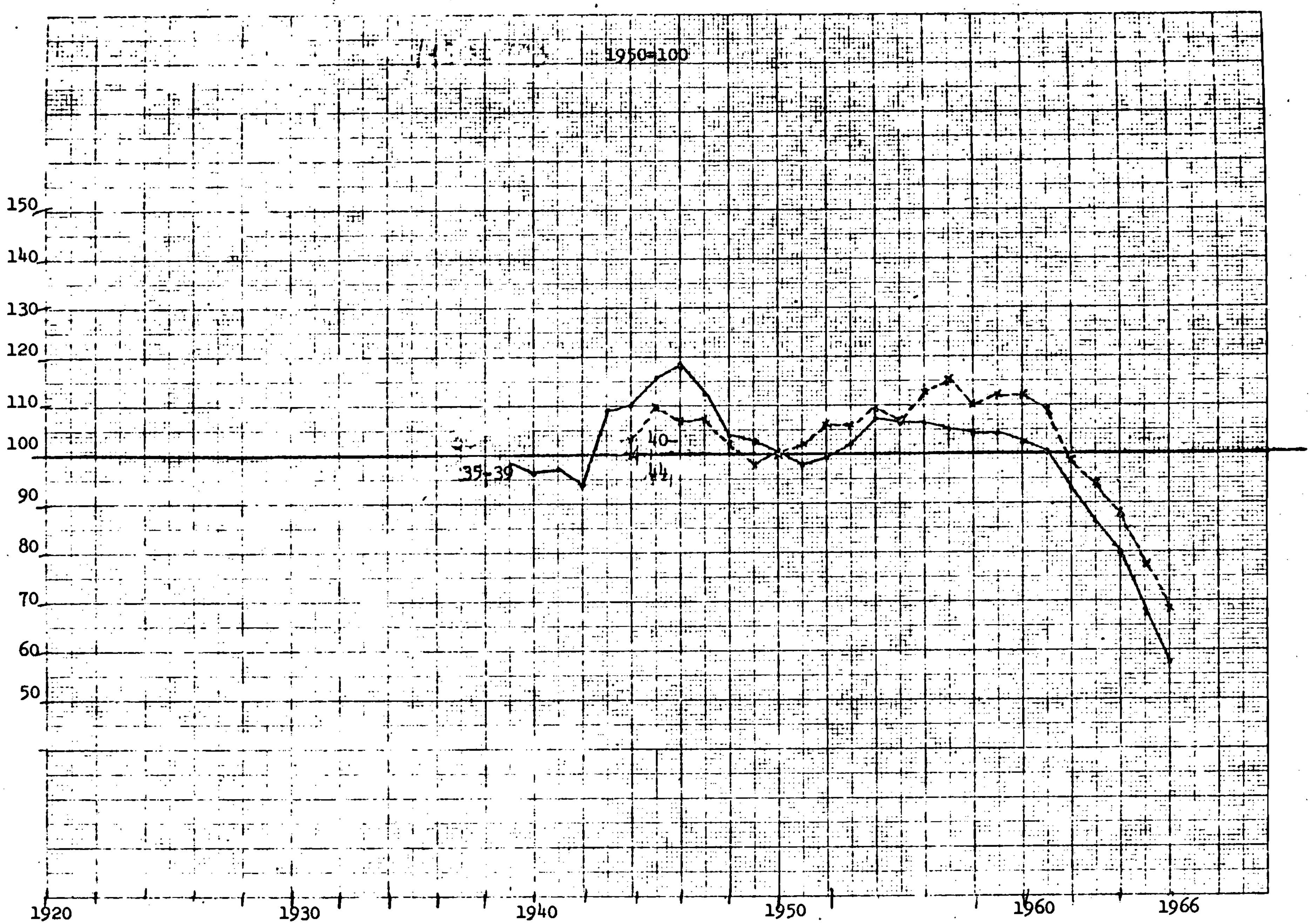
GRAPH VI-2: SIXTH BIRTH PROBABILITIES TO WOMEN
35-39 and 40-44



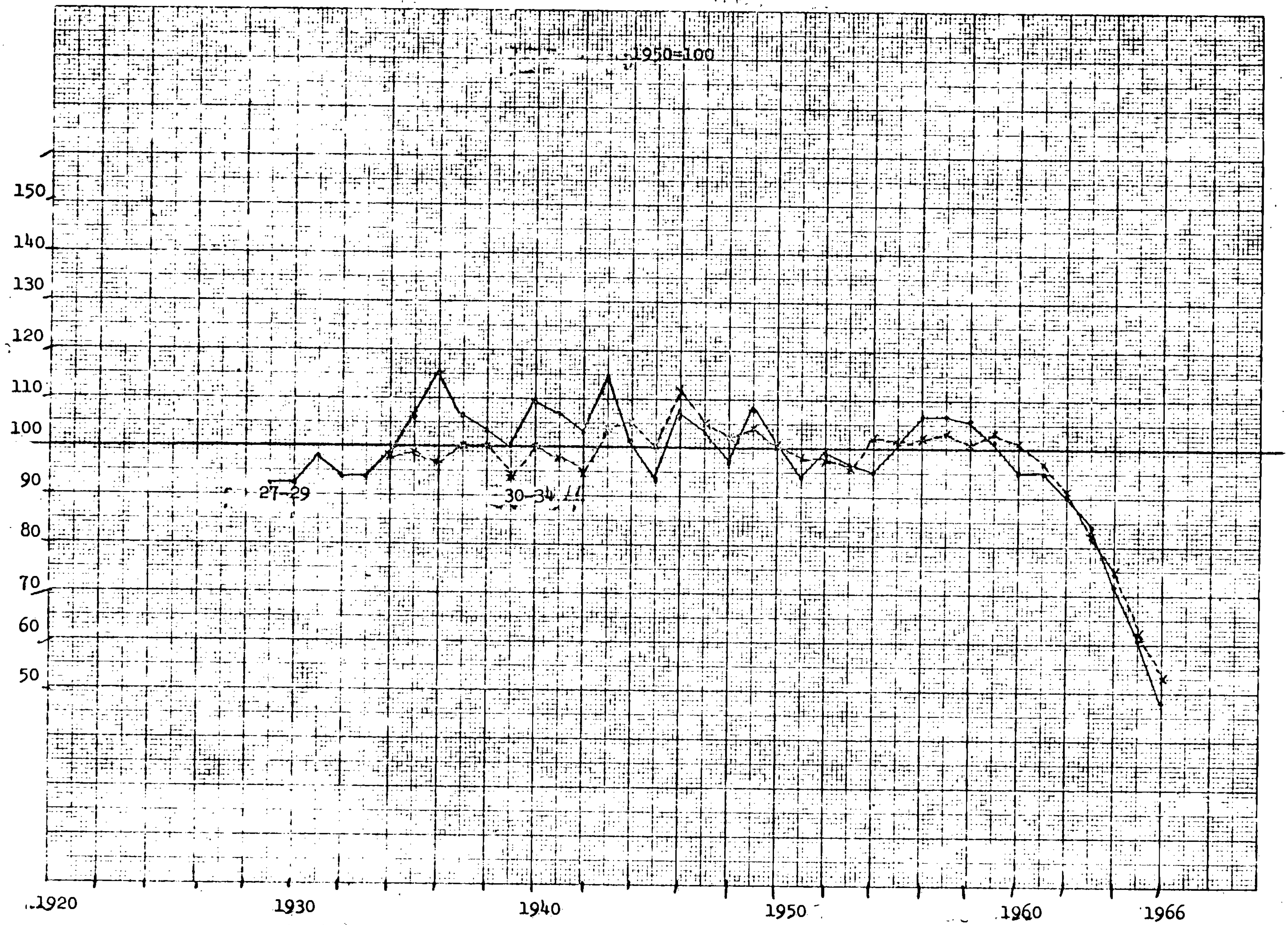
GRAPH VII-1: SEVENTH BIRTH PROBABILITIES TO WOMEN
25-29 and 30-34



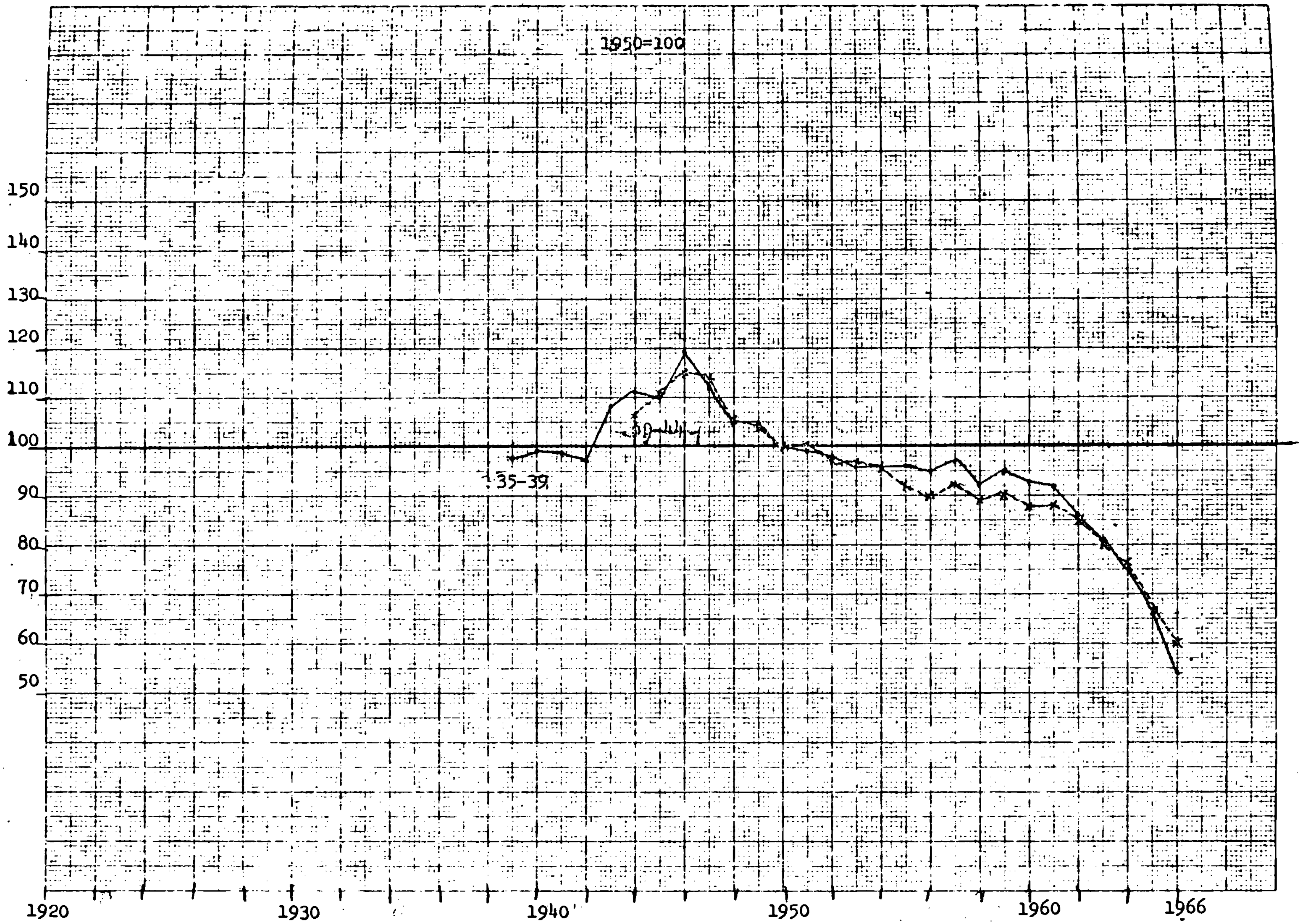
GRAPH VII-2: SEVENTH BIRTH PROBABILITIES TO WOMEN
35-39 and 40-44



GRAPH VIII-1: EIGHTH BIRTH PROBABILITIES TO WOMEN 27-29 and 30-34



GRAPH VIII-2: EIGHTH BIRTH PROBABILITIES TO WOMEN
35-39, and 40-44



APPENDIX III

TABLE A-1
THE MONTHLY PROBABILITY (IN PERCENT) OF HAVING A BIRTH
NATIVE WHITE WOMEN, 1920-1966, FOR SELECTED AGE GROUPS
FIRST BIRTHS

YEAR	15-19	20-24	25-29	30-34	35-39	40-44
1920	0.389					
1921	0.422					
1922	0.372					
1923	0.372					
1924	0.407	0.868				
1925	0.395	0.835				
1926	0.380	0.809				
1927	0.375	0.806				
1928	0.359	0.777				
1929	0.342	0.742	0.556			
1930	0.352	0.759	0.574			
1931	0.322	0.712	0.566			
1932	0.305	0.674	0.535			
1933	0.282	0.625	0.503			
1934	0.300	0.672	0.534	0.262		
1935	0.310	0.701	0.556	0.279		
1936	0.304	0.705	0.571	0.294		
1937	0.320	0.731	0.607	0.313		
1938	0.335	0.762	0.651	0.341		
1939	0.312	0.743	0.659	0.356	0.123	
1940	0.302	0.772	0.701	0.372	0.131	
1941	0.325	0.889	0.796	0.411	0.145	
1942	0.363	1.106	0.985	0.494	0.173	
1943	0.361	1.027	0.896	0.481	0.182	
1944	0.313	0.919	0.772	0.425	0.180	0.035
1945	0.297	0.868	0.763	0.424	0.186	0.037
1946	0.357	1.231	1.143	0.571	0.224	0.042
1947	0.521	1.556	1.389	0.659	0.253	0.045
1948	0.516	1.367	1.181	0.547	0.215	0.040
1949	0.500	1.309	1.115	0.533	0.203	0.039
1950	0.484	1.245	1.045	0.518	0.190	0.038
1951	0.538	1.385	1.109	0.547	0.189	0.037
1952	0.536	1.428	1.118	0.562	0.189	0.038
1953	0.557	1.445	1.102	0.553	0.187	0.039
1954	0.576	1.521	1.106	0.554	0.199	0.039
1955	0.575	1.567	1.106	0.518	0.202	0.037
1956	0.610	1.666	1.120	0.500	0.198	0.034
1957	0.632	1.721	1.154	0.493	0.202	0.037
1958	0.612	1.688	1.125	0.473	0.194	0.034
1959	0.599	1.674	1.092	0.463	0.185	0.037
1960	0.575	1.660	1.078	0.454	0.174	0.037
1961	0.559	1.631	1.067	0.435	0.165	0.037
1962	0.530	1.539	1.031	0.413	0.153	0.035
1963	0.516	1.469	1.008	0.408	0.145	0.033
1964	0.492	1.417	1.052	0.446	0.170	0.040
1965	0.460	1.295	1.001	0.435	0.168	0.037
1966	0.452	1.295	1.013	0.433	0.158	0.033

TABLE A-1
THE MONTHLY PROBABILITY (IN PERCENT) OF HAVING A BIRTH
NATIVE WHITE WOMEN, 1920-1966, FOR SELECTED AGE GROUPS
SECOND BIRTHS

YEAR	16-19	20-24	25-29	30-34	35-39	40-44
1920	3.077					
1921	3.241					
1922	3.166					
1923	3.434					
1924	3.423	2.650				
1925	3.374	2.520				
1926	3.436	2.456				
1927	3.488	2.412				
1928	3.278	2.291				
1929	3.260	2.199	1.201			
1930	3.196	2.226	1.210			
1931	2.928	2.151	1.172			
1932	2.792	2.099	1.122			
1933	2.791	2.002	1.074			
1934	2.880	2.104	1.116	0.573		
1935	2.845	2.047	1.109	0.565		
1936	3.026	2.084	1.109	0.569		
1937	3.106	2.132	1.135	0.584		
1938	3.119	2.217	1.202	0.624		
1939	3.155	2.144	1.199	0.641	0.234	
1940	3.564	2.212	1.257	0.694	0.248	
1941	3.593	2.317	1.323	0.729	0.262	
1942	3.596	2.568	1.503	0.825	0.291	
1943	3.466	2.720	1.675	0.925	0.336	
1944	2.882	2.320	1.534	0.907	0.367	0.059
1945	2.604	1.949	1.513	0.981	0.402	0.063
1946	3.315	2.688	1.850	1.073	0.427	0.068
1947	4.201	2.984	2.071	1.122	0.432	0.070
1948	4.552	2.961	1.947	1.041	0.400	0.068
1949	4.811	2.964	1.958	1.049	0.387	0.067
1950	4.640	3.007	2.014	1.082	0.379	0.066
1951	4.808	3.274	2.141	1.122	0.388	0.069
1952	4.649	3.504	2.265	1.163	0.393	0.069
1953	4.769	3.712	2.335	1.174	0.396	0.070
1954	4.993	3.897	2.444	1.211	0.410	0.070
1955	5.083	4.021	2.517	1.180	0.413	0.067
1956	5.420	4.210	2.634	1.180	0.407	0.069
1957	5.462	4.370	2.761	1.182	0.401	0.065
1958	5.420	4.342	2.764	1.148	0.387	0.064
1959	5.395	4.430	2.763	1.142	0.369	0.065
1960	5.478	4.415	2.765	1.147	0.360	0.064
1961	5.539	4.354	2.715	1.149	0.359	0.063
1962	5.455	4.206	2.608	1.108	0.331	0.060
1963	5.090	4.029	2.531	1.103	0.333	0.059
1964	4.649	3.747	2.463	1.082	0.330	0.054
1965	4.097	3.264	2.284	1.037	0.315	0.055
1966	3.589	2.955	2.158	0.962	0.306	0.051

TABLE A-1
THE MONTHLY PROBABILITY (IN PERCENT) OF HAVING A BIRTH
NATIVE WHITE WOMEN, 1920-1966, FOR SELECTED AGE GROUPS
THIRD BIRTHS

YEAR	18-19	20-24	25-29	30-34	35-39	40-44
1920	5.996					
1921	6.755					
1922	5.415					
1923	5.595					
1924	4.714	3.438				
1925	4.721	3.229				
1926	4.554	3.072				
1927	4.241	3.002				
1928	3.931	2.859				
1929	3.830	2.691	1.369			
1930	3.757	2.725	1.360			
1931	3.520	2.612	1.286			
1932	3.582	2.544	1.258			
1933	3.394	2.480	1.192			
1934	3.567	2.584	1.228	0.612		
1935	3.688	2.549	1.181	0.587		
1936	3.834	2.519	1.159	0.567		
1937	3.985	2.589	1.153	0.562		
1938	3.924	2.679	1.203	0.569		
1939	3.972	2.556	1.174	0.567	0.250	
1940	5.531	2.650	1.202	0.588	0.251	
1941	5.080	2.649	1.221	0.606	0.257	
1942	4.687	2.665	1.289	0.648	0.279	
1943	4.977	2.918	1.467	0.761	0.320	
1944	4.427	2.689	1.423	0.786	0.344	0.069
1945	3.469	2.227	1.316	0.809	0.374	0.075
1946	4.191	2.536	1.379	0.833	0.384	0.074
1947	4.882	2.785	1.469	0.840	0.382	0.075
1948	4.887	2.932	1.410	0.787	0.353	0.073
1949	5.504	3.032	1.416	0.771	0.345	0.070
1950	4.851	3.017	1.445	0.792	0.342	0.068
1951	4.653	3.096	1.531	0.838	0.354	0.071
1952	4.966	3.123	1.620	0.892	0.376	0.076
1953	5.179	3.167	1.641	0.901	0.378	0.075
1954	5.506	3.311	1.708	0.911	0.388	0.079
1955	5.540	3.390	1.755	0.908	0.384	0.079
1956	5.698	3.557	1.812	0.912	0.380	0.079
1957	5.673	3.670	1.882	0.923	0.371	0.077
1958	5.586	3.596	1.874	0.906	0.352	0.071
1959	5.852	3.697	1.900	0.893	0.339	0.070
1960	5.736	3.729	1.920	0.880	0.325	0.067
1961	5.636	3.680	1.896	0.875	0.317	0.065
1962	5.591	3.565	1.820	0.829	0.296	0.060
1963	4.979	3.311	1.736	0.807	0.282	0.057
1964	4.770	3.024	1.653	0.788	0.275	0.054
1965	4.069	2.512	1.462	0.724	0.256	0.049
1966	3.685	2.161	1.288	0.655	0.235	0.045

TABLE A-1
THE MONTHLY PROBABILITY (IN PERCENT) OF HAVING A BIRTH
NATIVE WHITE WOMEN, 1920-1966, FOR SELECTED AGE GROUPS
FOURTH BIRTHS

YEAR	20-24	25-29	30-34	35-39	40-44
1924	4.651				
1925	4.317				
1926	4.392				
1927	4.438				
1928	4.090				
1929	3.885	1.927			
1930	4.053	1.942			
1931	3.811	1.862			
1932	3.714	1.855			
1933	3.664	1.803			
1934	3.912	1.856	0.895		
1935	3.975	1.793	0.850		
1936	4.022	1.748	0.810		
1937	4.196	1.751	0.802		
1938	4.096	1.799	0.798		
1939	3.737	1.724	0.784	0.361	
1940	3.998	1.730	0.804	0.354	
1941	3.508	1.758	0.819	0.365	
1942	3.436	1.787	0.843	0.378	
1943	3.853	2.011	0.976	0.437	
1944	3.809	1.948	0.995	0.463	0.102
1945	3.226	1.718	0.984	0.491	0.113
1946	3.649	1.772	0.994	0.488	0.109
1947	3.749	1.726	0.965	0.490	0.114
1948	3.887	1.658	0.901	0.460	0.109
1949	4.260	1.718	0.895	0.446	0.105
1950	4.016	1.746	0.901	0.444	0.106
1951	4.071	1.849	0.946	0.465	0.111
1952	3.947	1.908	1.013	0.489	0.114
1953	3.906	1.903	1.026	0.505	0.120
1954	4.094	1.938	1.053	0.513	0.122
1955	4.120	1.937	1.050	0.507	0.121
1956	4.234	1.964	1.051	0.496	0.120
1957	4.236	1.994	1.052	0.499	0.122
1958	4.156	1.976	1.028	0.471	0.115
1959	4.308	2.008	1.014	0.460	0.113
1960	4.269	2.013	0.990	0.447	0.108
1961	4.281	1.988	0.975	0.421	0.106
1962	4.044	1.897	0.909	0.388	0.098
1963	3.708	1.778	0.875	0.368	0.087
1964	3.367	1.652	0.831	0.350	0.082
1965	2.827	1.400	0.735	0.315	0.074
1966	2.515	1.170	0.639	0.279	0.066

TABLE A-1
THE MONTHLY PROBABILITY (IN PERCENT) OF HAVING A BIRTH
NATIVE WHITE WOMEN, 1920-1966, FOR SELECTED AGE GROUPS
FIFTH BIRTHS

YEAR	21-24	25-29	30-34	35-39	40-44
1924	3.959				
1925	3.816				
1926	4.031				
1927	3.960				
1928	3.847				
1929	3.926	2.547			
1930	3.898	2.568			
1931	3.676	2.471			
1932	3.691	2.474			
1933	3.649	2.387			
1934	3.821	2.494	1.268		
1935	3.872	2.449	1.208		
1936	3.735	2.370	1.166		
1937	3.769	2.427	1.150		
1938	3.917	2.426	1.156		
1939	3.804	2.304	1.107	0.520	
1940	4.605	2.351	1.097	0.514	
1941	4.463	2.378	1.131	0.510	
1942	4.400	2.320	1.150	0.520	
1943	4.848	2.632	1.320	0.592	
1944	4.572	2.483	1.323	0.611	0.153
1945	3.808	2.232	1.299	0.651	0.158
1946	4.289	2.425	1.303	0.653	0.164
1947	4.359	2.322	1.243	0.640	0.166
1948	4.690	2.243	1.157	0.599	0.156
1949	5.513	2.295	1.117	0.586	0.154
1950	5.118	2.309	1.118	0.591	0.155
1951	4.957	2.442	1.157	0.604	0.158
1952	5.029	2.505	1.234	0.638	0.168
1953	4.936	2.481	1.255	0.642	0.174
1954	4.912	2.498	1.283	0.653	0.184
1955	4.831	2.438	1.307	0.654	0.189
1956	4.736	2.418	1.308	0.651	0.181
1957	4.894	2.420	1.292	0.653	0.178
1958	4.922	2.368	1.246	0.627	0.174
1959	4.869	2.352	1.228	0.627	0.165
1960	4.886	2.336	1.200	0.606	0.166
1961	4.806	2.386	1.168	0.590	0.166
1962	4.738	2.240	1.099	0.537	0.162
1963	4.217	2.067	1.033	0.502	0.145
1964	3.857	1.883	0.955	0.466	0.140
1965	3.230	1.566	0.835	0.415	0.127
1966	2.809	1.316	0.711	0.357	0.118

TABLE A-1
THE MONTHLY PROBABILITY (IN PERCENT) OF HAVING A BIRTH
NATIVE WHITE WOMEN, 1920-1966, FOR SELECTED AGE GROUPS
SIXTH BIRTHS

YEAR	23-24	25-29	30-34	35-39	40-44
1924	8.179				
1925	7.648				
1926	6.965				
1927	6.292				
1928	6.156				
1929	5.991	3.343			
1930	5.563	3.381			
1931	5.716	3.249			
1932	5.558	3.326			
1933	5.520	3.136			
1934	5.830	3.295	1.922		
1935	6.439	3.339	1.823		
1936	5.340	3.320	1.737		
1937	5.343	3.407	1.732		
1938	6.194	3.311	1.770		
1939	5.571	3.153	1.665	0.814	
1940	7.643	3.246	1.665	0.800	
1941	6.899	3.319	1.649	0.783	
1942	6.649	3.110	1.641	0.795	
1943	7.403	3.424	1.881	0.876	
1944	6.691	3.289	1.910	0.908	0.238
1945	5.409	2.964	1.827	0.930	0.249
1946	6.671	3.439	1.895	0.949	0.248
1947	6.064	3.208	1.732	0.934	0.245
1948	5.959	3.195	1.630	0.856	0.232
1949	6.269	3.325	1.593	0.854	0.220
1950	5.845	3.225	1.586	0.836	0.225
1951	5.516	3.310	1.605	0.857	0.240
1952	5.103	3.301	1.680	0.854	0.243
1953	4.808	3.338	1.682	0.866	0.248
1954	5.019	3.273	1.771	0.875	0.269
1955	5.277	3.245	1.786	0.898	0.264
1956	5.413	3.214	1.796	0.903	0.265
1957	5.541	3.163	1.789	0.917	0.271
1958	5.254	3.087	1.703	0.897	0.255
1959	5.297	3.135	1.702	0.891	0.255
1960	5.370	3.115	1.643	0.855	0.253
1961	5.134	3.082	1.614	0.853	0.238
1962	4.984	2.923	1.502	0.770	0.223
1963	4.487	2.650	1.409	0.731	0.214
1964	3.867	2.388	1.291	0.663	0.204
1965	3.242	1.981	1.106	0.583	0.176
1966	2.816	1.639	0.925	0.493	0.159

TABLE A-1
THE MONTHLY PROBABILITY (IN PERCENT) OF HAVING A BIRTH
NATIVE WHITE WOMEN, 1920-1966, FOR SELECTED AGE GROUPS
SEVENTH BIRTHS

YEAR	25-29	30-34	35-39	40-44
1929	4.103			
1930	4.207			
1931	4.052			
1932	3.960			
1933	3.832			
1934	3.987	2.431		
1935	4.121	2.351		
1936	4.263	2.279		
1937	4.317	2.298		
1938	4.398	2.321		
1939	4.196	2.226	1.115	
1940	4.811	2.241	1.095	
1941	4.579	2.225	1.105	
1942	4.355	2.237	1.071	
1943	4.773	2.490	1.239	
1944	4.655	2.569	1.250	0.333
1945	4.094	2.464	1.313	0.355
1946	5.059	2.478	1.338	0.345
1947	4.502	2.333	1.277	0.345
1948	4.323	2.220	1.178	0.330
1949	4.457	2.254	1.169	0.315
1950	4.400	2.176	1.136	0.323
1951	4.358	2.242	1.116	0.328
1952	4.225	2.183	1.123	0.342
1953	4.407	2.186	1.159	0.342
1954	4.537	2.225	1.214	0.350
1955	4.494	2.329	1.199	0.344
1956	4.381	2.331	1.203	0.366
1957	4.365	2.328	1.191	0.371
1958	4.055	2.267	1.179	0.356
1959	4.179	2.215	1.186	0.363
1960	4.094	2.176	1.155	0.346
1961	3.999	2.126	1.137	0.352
1962	3.779	1.978	1.054	0.320
1963	3.416	1.842	0.974	0.302
1964	2.984	1.670	0.913	0.281
1965	2.443	1.403	0.769	0.249
1966	2.124	1.162	0.663	0.218

TABLE A-1

THE MONTHLY PROBABILITY (IN PERCENT) OF HAVING A BIRTH
NATIVE WHITE WOMEN, 1920-1966, FOR SELECTED AGE GROUPS
EIGHTH+ BIRTHS

YEAR	27-29	30-34	35-39	40-44
1929	4.657			
1930	4.651			
1931	4.979			
1932	4.780			
1933	4.776			
1934	4.936	3.358		
1935	5.362	3.390		
1936	5.796	3.330		
1937	5.339	3.450		
1938	5.219	3.435		
1939	5.047	3.242	2.158	
1940	5.533	3.424	2.184	
1941	5.404	3.353	2.169	
1942	5.222	3.266	2.137	
1943	5.748	3.578	2.373	
1944	5.133	3.613	2.434	0.831
1945	4.689	3.446	2.427	0.868
1946	5.345	3.835	2.618	0.899
1947	5.209	3.593	2.473	0.894
1948	4.891	3.497	2.301	0.824
1949	5.470	3.583	2.314	0.813
1950	5.059	3.438	2.200	0.782
1951	4.753	3.373	2.169	0.785
1952	5.015	3.362	2.155	0.756
1953	4.920	3.317	2.108	0.755
1954	4.823	3.510	2.113	0.751
1955	5.116	3.480	2.103	0.718
1956	5.436	3.516	2.085	0.744
1957	5.394	3.543	2.126	0.722
1958	5.343	3.478	2.014	0.699
1959	5.124	3.527	2.078	0.706
1960	4.812	3.465	2.050	0.691
1961	4.798	3.336	2.017	0.682
1962	4.560	3.140	1.894	0.667
1963	4.228	2.869	1.783	0.626
1964	3.663	2.563	1.654	0.594
1965	3.101	2.126	1.454	0.527
1966	2.448	1.824	1.187	0.467

TABLE A-2

Age Coefficients From Component Decomposition Analysis

Age	First Births	Second Births	Third Births	Fourth Births
18	-59.810	-47.666	-51.294	n.a.
19	-54.489	-43.633	-46.989	n.a.
20	-49.382	-39.667	-42.729	n.a.
21	-44.323	-35.710	-38.454	n.a.
22	-39.295	-31.743	-34.195	-33.652
23	-34.293	-27.754	-29.898	-29.409
24	-29.332	-23.774	-25.636	-25.196
25	-24.402	-19.799	-21.388	-21.029
26	-19.480	-15.843	-17.125	-16.838
27	-14.608	-11.863	-12.859	-12.654
28	- 9.718	- 7.880	- 8.551	- 8.414
29	- 4.875	- 3.951	- 4.295	- 4.232
30	0.000*	0.000*	0.000*	0.000*
31	4.775	3.871	4.203	4.139
32	9.620	7.801	8.501	9.397
33	14.400	11.660	12.723	12.581
34	19.232	15.541	16.967	16.784
35	24.045	19.409	21.198	20.976
36	28.812	23.220	25.391	25.142
37	33.578	27.039	29.575	29.293
38	38.342	30.857	33.766	33.452
39	43.010	34.573	37.853	37.507

n.a. = not applicable

* = by assumption.

TABLE A-3
CURRENT YEAR COEFFICIENTS FROM COMPONENT DECOMPOSITION ANALYSIS

YEAR	FIRST BIRTHS	SECOND BIRTHS	THIRD BIRTHS	FOURTH BIRTHS
1920	199.432	162.468	176.214	N.A.
1921	194.493	158.457	171.876	N.A.
1922	189.348	154.353	167.300	N.A.
1923	184.307	150.293	162.898	N.A.
1924	179.355	146.223	158.479	N.A.
1925	174.307	142.098	154.050	152.004
1926	169.270	137.983	149.602	147.651
1927	164.262	133.877	145.165	143.323
1928	159.219	129.741	140.701	138.920
1929	154.176	125.617	136.242	134.519
1930	149.212	121.556	131.842	130.197
1931	144.176	117.437	127.385	125.806
1932	139.135	113.323	122.956	121.447
1933	134.070	109.195	118.507	117.066
1934	129.149	105.167	114.131	112.747
1935	124.209	101.087	109.706	108.367
1936	119.243	97.025	105.286	103.988
1937	114.300	92.971	100.885	99.634
1938	109.367	88.951	96.499	95.299
1939	104.385	84.889	92.082	90.920
1940	99.435	80.877	87.736	86.597
1941	94.558	76.854	83.341	82.273
1942	N.A.	N.A.	N.A.	N.A.
1943	N.A.	N.A.	N.A.	N.A.
1944	N.A.	N.A.	N.A.	N.A.
1945	N.A.	N.A.	N.A.	N.A.
1946	N.A.	N.A.	N.A.	N.A.
1947	N.A.	N.A.	N.A.	N.A.
1948	60.031	48.704	52.710	51.952
1949	54.992	44.627	48.314	47.625
1950	49.951	40.567	43.907	43.290
1951	45.020	36.546	39.538	39.000
1952	40.045	32.514	35.183	34.703
1953	35.043	28.467	30.791	30.378
1954	30.071	24.427	26.420	26.066
1955	25.063	20.363	22.024	21.725
1956	20.070	16.313	17.637	17.391
1957	15.088	12.258	13.247	13.064
1958	10.053	8.165	8.819	8.698
1959	5.026	4.081	4.415	4.352
1960	0.000	0.000	0.000	0.000
1961	-5.033	-4.081	-4.418	-4.366
1962	-10.087	-8.198	-8.868	-8.770
1963	-15.120	-12.292	-13.326	-13.169
1964	-20.061	-16.397	-17.779	-17.570
1965	-25.106	-20.548	-22.306	-22.047
1966	-30.119	-24.684	-26.827	-26.531

TABLE A-4
COHORT COEFFICIENTS FROM COMPONENT DECOMPOSITION ANALYSIS

COHORT	FIRST BIRTHS	SECOND BIRTHS	THIRD BIRTHS	FOURTH BIRTHS
1900	-154.697	-126.207	-136.445	-134.480
1901	-149.743	-122.193	-132.088	-130.200
1902	-144.761	-118.139	-127.710	-125.890
1903	-139.769	-114.073	-123.320	-121.548
1904	-134.740	-109.985	-118.914	-117.193
1905	-129.703	-105.912	-114.538	-112.863
1906	-124.701	-101.830	-110.134	-108.495
1907	-119.728	-97.752	-105.737	-104.175
1908	-114.742	-93.676	-101.327	-99.829
1909	-109.764	-89.595	-96.920	-95.444
1910	-104.758	-85.492	-92.480	-91.076
1911	-99.772	-81.412	-88.068	-86.720
1912	-94.791	-77.353	-83.676	-82.375
1913	-89.808	-73.265	-79.242	-78.028
1914	-84.851	-69.209	-74.833	-73.682
1915	-79.876	-65.147	-70.428	-69.338
1916	-74.904	-61.072	-66.021	-64.968
1917	-69.939	-57.017	-61.610	-60.660
1918	-64.919	-52.918	-57.203	-56.334
1919	-59.838	-48.831	-52.824	-52.052
1920	-54.858	-44.787	-48.429	-47.707
1921	-49.921	-40.764	-44.026	-43.366
1922	-44.931	-36.702	-39.638	-39.043
1923	-39.922	-32.626	-35.230	-34.725
1924	-34.957	-28.586	-30.909	-30.385
1925	-30.003	-24.522	-26.500	-26.033
1926	-25.006	-20.458	-22.086	-21.695
1927	-20.017	-16.395	-17.681	-17.358
1928	-14.985	-12.295	-13.259	-13.030
1929	-9.981	-8.188	-8.841	-8.686
1930	-4.992	-4.085	-4.413	-4.344
1931	0.000	0.000	0.000	0.000
1932	5.018	4.082	4.403	4.353
1933	10.061	8.185	8.817	8.704
1934	15.065	12.248	13.228	13.045
1935	20.101	16.335	17.653	17.395
1936	25.128	20.415	22.064	21.747
1937	30.144	24.498	26.479	26.095
1938	35.152	28.578	30.872	30.415
1939	40.169	32.659	35.273	34.746
1940	45.171	36.722	39.685	39.068
1941	50.163	40.784	44.077	43.365
1942	55.132	44.834	48.450	47.695
1943	60.103	48.862	52.829	N.A.
1944	65.079	52.899	57.249	N.A.
1945	70.045	56.915	61.612	N.A.
1946	74.977	60.949	66.041	N.A.

FOOTNOTES

1. The general fertility rate is defined as the ratio of the number of births to the number of women 15-44, multiplied by 1,000.

2. The data in Graph 1 are from Vital Statistics of the United States: 1968, Volume 1, Natality.

3. The increases in fertility from 1968 to 1969 and from 1969 to 1970 show up not only in the crude birth rate, but in the general fertility rate as well. The following pattern of recent fertility variations has been drawn from various issues of the Monthly Vital Statistics Report, a publication of the U.S. Department of Health, Education and Welfare.

Year	Crude Birth Rate	General Fertility Rate
1967	17.8	87.8
1968	17.5	84.8
1969	17.8	86.5
1970	18.2	87.6
1971	17.3	82.3
1972	15.6	73.4

Source: U. S. Department of Health, Education and Welfare, Public Health Service, Health Records Administration, Monthly Vital Statistics Report.

Issues: Vol. 16, No. 13, July 26, 1968; Vol. 17, No. 13, August 15, 1969; Vol. 20, No. 13, August 30, 1972; Vol. 21, No. 13, June 27, 1973; Vol. 22, No. 7, Supplement, October 2, 1973.

It is possible that more disaggregated fertility measures such as age- and parity-specific birth probabilities do not show the 1969 and 1970 increases.

4. See the March/April 1973 Supplement to the Journal of Political Economy, particularly Willis (1973).

Footnotes (continued)

5. By "native" white women, we mean women born in the United States,

6. Data for the years 1920 through 1949 appear in Whelpton (1954), Table E. Data for 1950 can be found in Table G.

7. See Whelpton and Campbell (1960). Although birth probabilities were not published in that report, it laid the foundation for the birth probabilities which were subsequently published in various issues of Vital Statistics of the United States.

8. Our estimates are created with a methodology which differs from the original Whelpton procedures in a large number of relatively unimportant ways. For example, our estimates explicitly take twinning into account, whereas the Whelpton birth probabilities do not, However, there is one quite important difference in our methods. We have taken into consideration the fact that women who have had a child are not immediately at risk of bearing another child. The Whelpton methodology makes no distinction ebtween women who have had births within the previous year and those who have not. See Sanderson (1974) Appendix A for a more comprehensive discussion of the methodology used in creating the current estimates as well as the methodologies used by others.

9. We have not re-estimated birth probabilities for cohorts born in the nineteenth century. There are a number of difficulty technical problems involved in doing this which seem to make this data considerably less reliable than the data for twentieth century birth cohorts. Our estimates stop in 1966 because this is the latest date

Footnotes (continued)

9. (cont'd.)

for which birth data on native white women are published in the needed detail. Age- and parity-specific birth data for all white women have, at this writing, been published only through 1968. Thus even adjusting the white data as best we could would only give us two extra years of data.

10. For example, see Keyfitz (1971).

11. The birth probabilities presented in this paper have been computed on the assumption that, neglecting twinning, a woman must wait at least a year between births. While twelve months may be slightly longer than the average period of gestation and pst-partum ammenorhia, using that figure iads in our computations without doing much violence to reality.

12. Throughout this paper, we shall use the phrase "baby boom peak" to refer to the highest birth probability in a series during the period 1950 to 1966.

13. These birth probability series are time series of age- and parity-specific birth probabilities. Thus the 30 first order birth probability series referred to in Table 1 are for women from age 15 to age 44. We assume, following Whelpton, that 15 year old women do not have second births (except for twins) and therefore there are only 29 series for second births. It is these minimum age assumptions which cause the number of series to decrease as the birth order increases.

Footnotes (continued)

14. By coherent set of birth probabilities we simply mean a set of birth probability series with adjacent ages. Thus the birth probability series of women 20, 21, and 22 would be coherent, in this sense, but not those of women 31, 35, and 39.

15. The third order birth probability peak for 40 to 44 year old women occurred in 1954, 1955, and 1956, but the fall from 1956 to 1957 is so small that for practical purposes 1957 may also be considered a peak year.

16. This article can be found in Easterlin (1968), Chapter 3.

17. Briefly, this hypothesis suggests that adolescents' tastes and hence ultimately their adult fertility are affected by their parents' standard of living.

18. Above, we have defined m as that cohort which is of age j in year k. Since m and n must differ, it will never be possible to observe women of cohort n at age j in year k.

19. See Coale and Zelnik (1963), page 22.

REFERENCES

Becker, Gary S., "A Theory of the Allocation of Time," Economic Journal, 75 (September 1965), 493-517.

Coale, Ansley J. and Melvin Zelnik, New Estimates of Fertility and Population in the United States, Princeton, Princeton University Press, 1963.

Easterlin, Richard A., Population, Labor Force and Long Swings in Economic Growth: The American Experience, General Series 86, New York, National Bureau of Economic Research, 1968.

Keyfitz, Nathan, "How Birth Control Affects Births," Social Biology, 18, No. 2 (June 1971), 109-21.

Michael, Robert T., "Education and the Derived Demand for Children," Journal of Political Economy, Vol. 81, No. 2, Part II, March/April 1973, S128-S164.

Sanderson, Warren C., Toward an Economc Understanding of the Fertility of American Women in the Twentieth Century, Ph.D. dissertation, Stanford University, pending, 1974.

United States Department of Health, Education and Welfare, Public Health Service, Vital Statistics of the United States, various years, Washington, D. C., U.S. Government Printing Office.

Whelpton, Pascal K., Cohort Fertility, Princeton, Princeton University Press, 1954.

Whelpton, Pascal K., and Arthur A. Campbell, "Fertility Tables for Birth Cohorts of American Women," Vital Statistics - Special Reports, Vol. 51, No. 1, January 1960, National Office of Vital Statistics, Public Health Service, Washington, D. C.