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SEASONAL VARIATION OF BIRTH RATES IN ISRAEL*

ROGER MARK SELYA
University of Cincinnati, U.S.A

The Jewish and non-Jewish (Arab) populations in Israel display sharply contrasting patterns of seasonal variation in birth rates for the period 1953–1972. It is the purpose of this article to specify the nature of the variations and then sketch a preliminary explanation for the patterns described.

DATA

Data for the number of births per month in the period 1953—1972 were collected for both populations from the *Monthly Bulleting of Statistics,* published by the Israeli Central Bureau of Statistics. Birth rates for each month were then computed using the mid-year population as a base. These rates were then normalized as follows: for each year the mean birth rate and standard deviation were computed, and the monthly birth rates within each year expressed as z-scores. These z-scores were then used as the basis for tracing and analyzing the seasonal variation found. The data in z-score form are included in the appendix, Tables 1 and 2.

In analyzing the data two assumptions were used. First, it was assumed that the Arab population would display a more stable variation; that is, given the longer residence of the non-Jewish population in the area in general, any combination of environmental and socioeconomic factors influencing the seasonal variation would have firmly established themselves. Second, it was assumed that comparison of the seasonal variations in the two populations would permit a filtering out of the shared causal influences.

Sight examination of the graphs of z-scores confirms that the non-Jewish population displays a stable pattern (Fig. 1). Peaks in the birth rates occur during December and January, and the troughs in August. There are no secondary peaks or troughs. In contrast, the Jewish population displays a higly dynamic seasonal variation over the twenty year period. The peak has gradually drifted from December to August; similarly, the trough has drifted from August to April.

Both the stability of the Arab pattern and the dynamism of the Jewish pattern were confirmed by statistical testing. The year-to-year average Pearsonian correlation coefficient for the Arab data is 0.62 (range -0.02 to 0.958). The year-to-year average

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Pearsonaian correlation coefficient for the Jewish data is 0.219 (range -0.327 to 0.726). To establish the nature of the two patterns further, an average Arab pattern was calculated by constructing a mean z-score value for each month. The year-to-year Arab data against the Arab mean yielded a coefficient of 0.756 (range 0.442 to 0.959).

With the basic dynamics of the two populations established the populations were tested against each other. The average coefficient for each year of Jewish data against Arab data was 0.224 (range -0.224 to 0.702); the average coefficient for each Jewish year paired with the Arab mean was 0.223 (range -0.224 to 0.590).

EXPLANATION:

Two aspects of the patterns of variation require explanation:

1) why any variation should exist at all; and
2) why the two populations differ in their patterns.

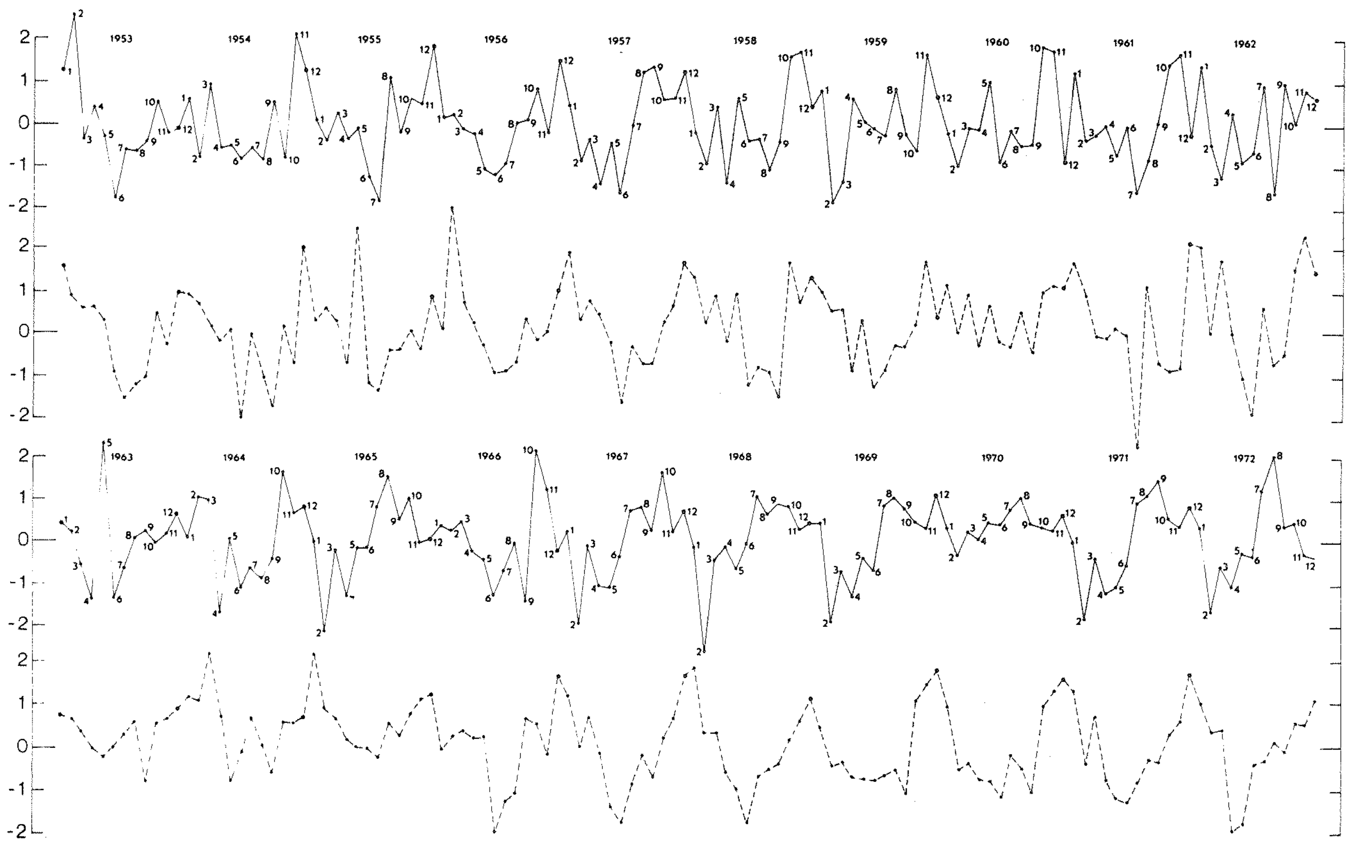
Huntington has postulated that seasonal variation in birth rates is due to meteorological conditions (Huntington, 1938, pp. 6—8). He assumed that, physiologically, humans are best able to reproduce when the mean daily temperature is around 17°C. He based this conclusion on research into the effect of temperature on physical labor in which 17°C–20°C was found to be the ideal range for maximum productivity. For Huntington, maximum productivity in work implies a sort of maximum in physical well-being. Hence, for countries in the northern hemisphere, conception in early June would be ideal (Huntington, 1938, pp.6—8). Mills and Senior confirm this point, stating that changes in temperature do not lessen sexual activity, but rather influence the biological ability to reproduce (Mills and Senior, 1936, p. 927).

Regarding births, Huntington assumed that a birth during a period when the mean daily temperature was in the range 15°C — 17°C had several advantages. First, he concluded from reviewing studies on the effects of temperature on mental activity, the mother would then be more alert mentally, and therefore more likely to look after her child. Hence northern hemisphere Spring is an ideal time to be born. In addition, the mother is said to be physiologically more able to care for her Spring child; her milk supply will gradually improve as Spring fades into Summer and food supplies improve. Finally, a Spring child has three of four months to develop before the unfavorable hot weather associated with various infantile gastrointestinal ailments. Presumably the three- or four-month lead time would make a child more resistent to these illnesses (Huntington, 1938, pp. 8—9).

Huntington argued further that there is a basic biological rhythm which influences the timing of human births. The biological principle is that of survival. Huntington realized that other socioeconomic variables, such as seasonal variation in marriages, seasonal migrations, religious fasts and intercourse taboos, war, improved nutrition, summer vacations, suburbanization, diffusion of birth control, and use of air conditioning, can modify the basic biological rhythm, (Huntington, 1938, pp. 95—115). Nevertheless his major explanatory emphasis is on biological process and survival.

In support of this position Takahashi found that in many areas the peak in conceptions occurs when the mean monthly temperature is 20°C, (Takahashi, 1964, pp. 216—222). The correlation between seasonal variation in temperature and births

Fig. 1: Z-Scores of Monthly Birth Rates



Source: Monthly Bulletin of Statistics — Jewish — Non-Jewish (Arab) for Hong Kong has been computed at -0.97, with no statistically significant differences between urban and rural populations, (Chang, et.al., 1963, p. 372). A lower correlation, -0.64, has been computed for other areas, however, (Parkes, 1971, p. 21).

More rigorous support of Huntingtons's ideas is not found in biological literature, however. This literature does acknowledge the existence of seasonal rhythms in the mammalian biological processes affecting fertility, but beyond this general point there is a wide range of often contradictory fact and opinion.

Basically there are two hypotheses used to explain seasonal rhythms in fartility: the external timing hypothesis and the autonomous endogenous timer hypothesis, (Brown, et.al., 1970). Environment, hormones, and behavior interact to such an extent that it is difficult to know which is cause and which effect. In addition, a wide range of stimuli are said to affect reproductive systems, including photo-period, climate, temperature, auditory and olfactory stimuli, and diet, (Holmes, 1968, pp. 6—32). Yet for any one species these stimuli often operate such that the intraspecies variation in reaction times to any or all of these stimuli is often greater than the interspecies variation, (Marler and Hamilton, 1966).

The evidence from primate studies is only marginally helpful. It is assumed that since all primates have an estrus cycle, early man had one but lost it, (Jay, 1968, p. 493). This would follow also from the notion that domestication tends to cancel out the effects of seasonality, (Jolly, 1972, p. 200). Beyond this the evidence regarding Huntington's assumption about which season is best for conception is equivocal. There is too much variation in the seasonal reproduction rates of primates to relate the patterns of humans and other primates. Furthermore, even within primate behavior, there is a certain danger in extrapolating behavior from one species to another, especially from the lower animals to man, (Holmes, 1968, pp. 29—33).

In contrast, Huntington's assumptions regarding the possible effects of temperature on mental performance finds better ground in industrial psychology and engineering. There is evidence that mental efficiency declines when the temperature drops below 10°C or rises above 27°C — 30°C, (Murrell, 1965, p. 258). There is also evidence, however, that this temperature range represetns an optimum for both physical and mental activity, (Maier, 1955, p. 550).

We find that Huntington's basic theoretical explanation is only circumstantially supported in either the biological or ergonomic literature. Huntington's theory thus remains an apparently reasonable hypothesis, but one which is not subject fo rigorous testing. Nevertheless his ideas are useful. On the one hand his work suggests that one reason the two Israeli populations display any seasonal variation in birth rates is that such a variation is a part of normal demographic process. Furthermore, his notions can be used to provide a framework for testing a series of environmental and socioeconomic variables to ascertain their explanatory power. In addition, most of Israel, except for the area south of Beer Sheva, has meteorological conditions which coincide with Huntington's assumptions regarding the ideal climate for human activities.

I choose to interpret the low correlations between the Jewish year-to-year data paired with the non-Jewish year-to-year data and overall mean to indicate that climate, presumably the major shared element between the two populations, plays a very minor role in explaining seasonal variation in birth rates. This conclusion is further supported if graphs of the z-scores for the two populations are compared with the graph of the photoperiod for 32° north latitude (which I take to represent the general location of Israel). No statistically significant correlation was found for this variable when paired with either set of z-score data.

Three other, non-meteorological, variables were then tested as possible explanations for the variations. Changes in the level of economic activity, as measured by changes in the growth of the GNP, were rejected, since, regardless of the level of economic activity, seasonal variations in birth rates did not contract, within the parameters of variation for the twenty-year period.

Seasonal variation in marriage was also rejected. This variable had seemed to be most promising, since there is a very stable seasonal variation for both populations, with correlation coefficients for successive years averaging 0.81 (range: 0.76 to 0.96) for both populations. The stable pattern is largely due to the fact that marriage is considered an aspect of personal status in Israel, and therefore subject to constraints impsed by the religious courts of the respective religious groups. For both Jews and Muslims there are periods when marriage is forbidden, resulting in a marked seasonality in marriage rates. The strong seasonality for both populations was somewhat unexpected; although both Judaism and Islam use lunar calendars, only the Jewish calendar is intercalated to keep it in phase with the solar calendar. In Islam, then, the occurrence of seasonal prohibitions for marriage would vary from year to year with a backward drift. Nevertheless the strong, consistent seasonal variation is found in both populations. This variable was rejected as an explanation for birth rate variation on the basis of the correlation coefficients between marriage and birth rates, phased with nine to fifteen month delays (in one month increments). For the Jewish population the average correlation was -0.04 (range: -0.04 to 0.25); for the Arab population the average correlation was also -0.04 (range: 0.21 to 0.07). Rejection of this variable is consistent with the findings of other studies on the relationship between variations in seasonal marriage and birth rates (Waggoner and Schachter, 1959, p. 134).

The third variable, by far the most promising, was the differential role played by Jewish and non-Jewish women in the Israeli economy. Since data for the seasonal participation of these two groups in the economy are not readily available, the sort of testing performed on the previous variables is not possible. Nevertheless, several sets of data for the years under consideration show that the participation of Jewish and Arab women in the economy is significantly different. In the period 1955 to 1972 there was a steady growth in the participation of Jewish women in the economy, and especially in the tertiary sector: the average yearly Jewish female participation rate is 29.4 percent, rising from 27.9 percent in 1952 to 33.4 percent in 1972. In contrast, the participation rate of Arab women in the economy has been lower, and much more variable from year to year: the average yearly participation rate is 11 percent, with a range of 7.2 percent to 11.8 percent. If only married women are considered, the contrasts are even sharper: in 1972, for example, 47 percent of married Jewish women were participating in the labor force, as against only 3 percent of married Arab women.

It should be pointed out that the general rate of Arab participation in the labor force is lower than would otherwise be expected, due to the age structure of the non-Jewish population (Ben-Porath, 1966, p. 17). There are reasons beyond this, however, for the sharp contrasts in female labor participation. On the national scale an average of 11 percent of Arab girls in the age group 14—17 are in school in contrast to 58 percent of Jewish girls in the same age group. Due to their lack of education, therefore, Arab women have limited opportunities to participate in the modern Israeli economy, especially in the fields of teaching and clerical work. This limited opportunity is compounded by limited job opportunities in Arab villages and the difficulties in getting from villages to cities to work. Arab women also tend to marry younger than Jewish women: the average age for an Arab bride in Israel is 19.5 years, in contrast to 21.7 years for Jewish women. The higher fertility and larger family size of Arab women also hinder participation in the work force. There is in addition a general social approbation against Arab women working, especially in towns. Finally we note that Arab women, more frequently than Jewish women, tend to be unpaid family workers, or seasonally employed in vegetable picking, (Ben-Porath, 1966, pp. 14—17). In Arab villages, there is also a regular association between the birth rate and the percentage of women employed in agriculture (Ben-Porath, 1970, p. 32).

The precise manner in which the differential between Jewish and Arab female labor-force participation, and the reasons for the low Arab female participation, influence the differences in seasonal variations in birth rates between the two populations is somewhat complex. The basic issue is that, by Israeli law, married women receive three months paid maternity leave upon the birth of a child, and may receive an additional three months unpaid leave without affecting their job tenure. These benefits are in addition to the stipends and other cash benefits which all new Israeli mothers receive, regardless of their employment status. It seems that married Jewish women participating in the labor force plan their pregnancies in order to maximize the amount of time they can have with their newborns. Since the majority of Jewish women are involved in teaching and clerical work, it seems reasonable to find planned pregnancies including an extension of summer vacations. Two pieces of evidence support this contention: some 60 percent of Israeli couples reported that all or some of their children were palnned, (Ben-Porath, 1970, p. 33). In addition, informal interviews conducted during research for this paper confirmed that many Jewish couples take the maternity leave program into account in timing and spacing their pregnancies. As maternity leave benefits have changed and vacations improved, couples presumably have shifted their planned births, thus accounting for the seasonal variation in the birth rate for the Jewish population and its change over time.

The maternity leave/vacation programs would however, account only for the Jewish patterns; the low Arab female participation in jobs where maternity leaves and vacations are their due requires another explanation for the Arab pattern. This involves the participation of Arab women in agriculture, many as unpaid family workers. Presumably a woman would want to time her births so that they occur at the nadir in agricultural activity. As early winter in fact represents a lull in the traditional agriculture economy in the Mediterranean area, this seems to account for the winter births. Late spring and early summer are seasons of peak agricultural activity, and the troughs in Arab birth rates occur during these months, (Antoun, 1972, pp. 10—13).

SUMMARY AND CONCLUSIONS

The discussion and explanation of the two variations suggest that a modification of Huntington's notions is possible, Huntignton's juxtaposition of meteorological-environmental and socioeconomic variables can be viewed as two parts of a parallel, multiple causation chain. It is constantly possible to extend individual causal chains, however, (Harvey, 1969, p. 390). What is suggested here is that the socioeconimic chain holds an intermediate position in a single, not a parallel, causal chain: the influence of climate on seasonal variation in birth rates is via the relation of climate to the functioning of different economic systems. An economic system grounded in subsistnece agriculture would then show a seasonal variation in births closely tied to seasonal variations in agricultural activities, as influenced by seasonal climatic variations. This presumably is the case for the Israeli Arab population. In contrast an economic system closely tied to tertiary activities will display a seasonal variation in specific manpower needs, which may not be tied to climate variations. This presumably is the case for the Israeli Jewish population.

Further testing of this modified form of Huntington's explanation is of course necessary. At present this is not fully possible: for many countries published data of monthly births often reflect the month of registration of the birth rather than the time of occurrence of the birth.

APPENDIX

Table 1: Z-Scores of Monthly Birth Rates: Jewish Population

Year	Months											
	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1953	1.25	2.60	-0.42	0.48	-0.37	-1.82	-0.66	-0.69	-0.43	0.50	-0.23	-0.14
1954	0.56	-0.87	0.92	-0.61	-0.55	-0.85	-0.60	-0.91	0.50	-0.87	2.17	1.22
1955	0.10	-0.42	0.25	-0.38	-0.14	-1.29	-1.88	1.11	-0.24	0.60	0.44	1.88
1956	0.11	0.20	-0.13	-0.26	-1.10	-1.27	-0.99	0.00	0.07	0.85	-0.24	1.52
1957	0.43	-0.83	-0.45	-1.43	-0.47	-1.77	-0.03	1.21	1.40	0.58	0.60	1.24
1958	-0.22	-0.97	0.40	-1.42	0.60	-0.40	-0.37	-1.09	-0.44	1.62	1.75	0.40
1959	0.81	-1.87	-1.39	0.60	0.05	-0.11	-0.30	0.84	-0.27	-0.67	1.68	0.66
1960	-0.22	-1.02	-0.09	-0.14	1.01	-0.91	-0.22	-0.52	-0.51	1.86	1.75	-0.96
1961	1.23	-0.40	-0.27	-0.05	-0.76	-0.09	-1.65	-0.88	0.07	1.47	1.70	-0.31
1962	1.41	-0.52	-1.27	0.30	-0.91	-0.71	0.97	-1.67	0.98	0.03	.80	0.60
1963	0.45	0.22	-0.62	-1.36	2.35	-1.41	-0.70	0.07	0.27	-0.07	0.14	0.67
1964	0.09	1.06	0.59	-1.74	0.03	-1.11	-0.66	-0.91	-0.43	1.65	0.66	0.81
1965	-0.05	-2.15	-0.19	-1.33	-0.14	-0.14	0.85	1.56	0.50	1.06	-0.03	0.08
1966	0.37	0.23	0.45	-0.26	-0.46	-1.29	-0.66	-0.05	-1.40	2.16	1.24	-0.24
1967	0.24	-1.96	-0.14	-1.08	-1.11	-0.34	0.72	0.81	0.25	1.66	0.25	0.72
1968	-0.15	-2.65	-0.45	-0.12	-0.67	-0.06	1.10	0.66	0.89	0.83	0.27	0.42
1969	0.42	-1.96	-0.70	-1.31	-0.36	-0.70	0.82	1.07	0.77	0.49	0.32	1.16
1970	0.33	-0.33	0.26	0.06	0.44	0.39	0.75	1.05	0.46	0.35	0.27	0.62
1971	-0.01	-1.81	-0.38	-1.26	-1.10	-0.58	0.69	1.10	1.49	0.53	0.36	0.84
1972	0.35	-1.70	-0.59	-1.11	-0.29	-0.36	1.22	2.07	0.33	0.46	-0.31	-0.38

Source: Computed by author from data in the *Monthly Bulletin of Statistics.*

Table 2: Z-Scores of Monthly Birth Rates: Non-Jewish (Arab) Population

Year	Months											
	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1953	1.53	0.84	0.57	0.60	0.26	-0.95	-1.54	-1.26	-1.07	0.48	-0.27	0.94
1954	0.90	0.69	0.24	-0.21	0.04	-2.03	-0.09	-0.59	-1.75	0.15	-0.77	2.02
1955	0.28	0.56	0.27	-0.73	2.50	-1.21	-1.41	-0.42	-0.40	0.02	-0.41	0.86
1956	0.10	2.94	0.71	0.22	-0.31	-0.97	-0.91	-0.72	0.32	-0.18	-0.01	0.91
1957	1.90	0.27	0.75	0.37	-0.28	-1.67	-0.32	-0.76	-0.74	0.20	0.61	1.67
1958	1.28	0.20	0.88	-0.24	0.95	-1.26	-0.83	-0.93	-1.51	1.68	0.69	1.32
1959	1.00	0.50	0.54	-0.90	0.26	-1.30	-0.94	-0.30	-0.35	0.20	1.73	0.32
1960	1.14	-0.01	0.93	-0.34	0.69	-0.22	-0.35	0.48	-0.51	0.94	1.11	1.07
1961	1.65	0.98	-0.10	-0.13	0.09	-0.06	-2.76	1.03	-0.71	-0.89	-0.86	2.15
1962	2.08	-0.05	1.77	-0.07	-1.01	-1.97	0.61	-0.77	-0.55	1.44	2.32	0.89
1963	0.85	0.75	0.40	0.09	-0.18	0.07	0.36	0.69	-0.77	0.63	0.72	0.94
1964	1.26	1.15	2.31	0.77	-0.77	-0.07	0.77	0.10	-0.57	0.67	0.63	0.78
1965	2.26	0.97	0.78	0.28	0.05	0.02	-0.16	0.63	0.32	0.84	1.19	1.32
1966	0.00	0.30	0.44	0.27	0.30	-1.98	-1.26	-1.02	0.75	0.60	-0.13	1.76
1967	1.23	0.06	0.75	-0.11	-1.38	-1.76	-0.82	-0.17	-0.69	0.27	0.73	1.76
1968	1.93	0.43	0.42	-0.56	-0.95	-1.77	-0.66	-0.49	-0.35	0.20	0.65	1.18
1969	0.40	-0.41	-0.30	-0.65	-0.70	-0.73	-0.63	-0.48	-1.08	1.17	1.54	1.90
1970	0.98	-0.49	-0.33	-0.72	-0.77	-1.16	-0.12	-0.46	-1.03	1.04	1.39	1.71
1971	1.37	-0.32	0.75	-0.75	-1.19	-1.29	-0.83	-0.27	-0.30	0.31	0.64	1.87
1972	1.09	0.40	0.47	-1.98	-1.79	-0.36	-0.30	0.16	-0.05	0.61	0.59	1.16
Mean	1.22	0.49	0.61	-0.24	-0.21	-1.03	-0.61	-0.28	-0.45	0.52	0.61	1.33

Source: Computed by author from data in the *Monthly Bulletin of Statistics.*

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