Babies and the Blackout: A Time Series Analysis of New York City Birth Data

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1. Babies and the Blackout. At exactly 5:27 p.m., November 9, 1965, most of New York City was plunged into darkness because of a massive power failure affecting much of the Northeastern United States. On Wednesday, August 10, 1966, the New York Times carried a front page article with the headline "Births Up 9 Months After the Blackout," which began: "A sharp increase in births has been reported by several large hospitals here, nine months after the 1965 blackout." Above average numbers of births the previous Monday were said to have occurred at Mount Sinai, Bellevue, Columbia-Presbyterian, St. Vincent's, Brookdale and Coney Island hospitals, while births at New York and Brooklyn Jewish Hospitals were reported to be normal. The article added that "there were 16 births at Mount Sinai yesterday [Tuesday], 13 at Columbia Presbyterian and 10 at St. Vincent's, all above average;" this was contrasted with Nassau and Suffolk counties, "many of whose commuters were stranded in the city Nov. 9," and where "the number of births was reported normal," as well as "hospitals in Albany, Rochester, New Haven and Providence," where "the lights went on in midevening."

Next day (Thursday, August 11), a follow-up article appeared (buried on page 35) with the somewhat more cautious lead "Theories Abound on Birth Increase - Possible Link With Blackout Will Not Be Determined for Two More Weeks." By Friday readers were informed that "The birth rate began returning to normal in several leading hospitals here yesterday [Wednesday] following a sharp rise nine months after the 1965 blackout," and the case was closed on Saturday with a short article on page 50 entitled "Birth Rate in City Returns to Normal."

A week later the British magazine New Scientist reported the "Apparent sharp rise in births in New York City" [7]; a year later The Lancet, a respected medical journal, stated unequivocally "the last time New Yorkers demonstrated an unexpectedly vigorous procreative urge they were stimulated... by the stygian darkness of electric-power cuts." [2] At present the story of the 'blackout babies' appears to be an accepted part of American folklore. The episode seems plausible, the story carried by a respected and usually reliable newspaper. But just how good is the evidence for an increase in births nine months after the blackout? Is it really credible that a one-day increase in conceptions would result in a one- or two-day elevation in births 271 days later with virtually no variability or spread? Considerations such as these suggested that, 10 years after the New York Times articles had appeared, an assessment of the published evidence was in order.

2. The Times' Evidence. The first article carried by the Times cited six hospitals as having experienced a sharp increase in births on Monday, August 8. Of these six, Mount Sinai hospital certainly experienced a sharp rise in deliveries (28 compared to a daily average of 11). But one hospital does not a baby boom make. Of the five other hospitals mentioned, four (see Table 2.1) reported increases of no more than four over their daily average, hardly convincing evidence given that two other hospitals are said to have had normal numbers of births and the absence of any information in the article about the variability in these numbers or how the hospitals cited were chosen (there are over 100 hospitals in New York). Finally Bellevue, the last hospital for which data is given, presents somewhat different problems. On Wednesday the Times had reported that "At Bellevue there were 29 new babies in the nursery yesterday, compared with 11 a week ago and an average of 20." This statement is ambiguous as to whether the new babies referred to were born on Monday or Tuesday. Far worse, it is simply wrong. Without remarking on the inconsistency with the Wednesday article, both the Friday and Saturday reports in the Times state the average number of births per day at Bellevue to be 6. Data we present later show, in fact, that there were only 4 deliveries at Bellevue on Monday, 7 on Tuesday. The 'baby boom' has begun to burst.

The three subsequent articles in the Times series describe a pattern of continued increase in births on Tuesday, followed by a decline and return to normal on Wednesday and Thursday. (To facilitate the discussion we shall refer to the four articles in the series as T1, T2, T3, and T4.) The data given in T1-T4 are summarized below in Table 2.1. There are a number of inconsistencies, none serious. (It is interesting to note that St. Vincent's, whose 10 births on Monday were cited as evidence for a "sharp increase in births," is listed in T1 as having 10 births on Tuesday but in T2 as only having an "average" number of births that day.) All in all, the data seem inconclusive and one inclines to adopt the opinion of Dr. Christopher Tietze (quoted in T1), that "I am skeptical until I see data from the entire city. There can be daily fluctuations in individual hospitals that can be misleading."

Such data, giving the number of live births in New York City occurring by day from 1961 to 1966, was obtained by us from the New York City Department of Health. Detailed information about the series is given in Section 4. In Table 2.2 we list a portion of the data, the number of births for each day in August 1966; these numbers are graphed in Figure 2.1. As Figure 2.1 clearly shows, although an increase in births did indeed take place on Monday and Tuesday, August 8 and 9, 1966, similar increases took place on every other Monday and Tuesday of that August! In fact, the fluctuation in births throughout the week from a low on the weekends to a high in the early part of the week is a characteristic feature of the entire series of birth data throughout all six years. (Such weekday-weekend variation is attributed in [9] to a preference for performing elective deliveries on weekdays when the patient is delivered by her personal physician, while [5] opines that it is "probably caused by induced or delayed labor through conscious intent of the mother with or without medical assistance.") Figure 2.1 also shows that births on August 8th and 9th were not appreciably different from those on any other Monday and Tuesday in August. In fact, as seen in Table 2.2, births on those two days were, if anything, slightly lower than usual: 449 births on August 8 (compared to 452, 453, 470 and 451 births on other Mondays in August) and 440 on August 9 (compared to 470, 499, 519 and 468 births on other Tuesdays in August). The 'baby boom' has vanished.

3. A Review of the Literature. Despite such (to us) unequivocal evidence against a one- or two-day surge in New York City's birth rate nine months after the blackout, an article has appeared in the professional literature claiming precisely such an effect. In 1968, Professor L. B. Borst reported in the American Journal of Obstetrics and Gynecology that "daily birth records in New York City disclose a 30% increase in live births at five Manhattan hospitals on August 7 [(!!)], 1966, 270 days after the blackout of Nov. 9-10, 1965." [4] Noting that while power had not been "restored until the following day in Manhattan and parts of the Bronx, whereas in Brooklyn and Queens power was restored at various times during the evening and, in Richmond, almost immediately," Borst reasoned that computing the ratio of Manhattan births to total New York City births would simultaneously correct for the weekday-weekend effect discussed above and detect a blackout effect on the birthrate in the form of a percentage increase in the number of NYC births occurring in Manhattan. Using statistics for the number of live births in five (unspecified) Manhattan hospitals from August 1 to 13 and dividing the sum of these by total NYC births, Borst observed a distinct peak on August 7 which he concluded was a "very special day" (the percentage for August 7 differing from the mean percentage excluding August 7 by 7 average deviations from the mean).

Professor Borst omits from his article two pieces of information necessary to assess the validity of his conclusions. On the one hand, there is the disturbing issue of data selection: no mention is made of how the five hospitals studied were chosen. On the other, although the aggregate percentage of NYC births which occurred in the five hospitals under study can be approximately read off from a bar graph, the raw data for the individual hospitals is not given. Upon request, Professor Borst provided us with a copy of his data which is given in Table 3.1. (Note that data for Mt. Sinai was collected but not used by Borst in his article.)

Several interesting points emerge from inspection of Table 3.1. First, as mentioned earlier, the data for Bellevue Hospital show that births there were not unusually high on August 8-9, 1966, and in any case, were not as high as 29 on either day. Second, the total births in the five hospitals studied by Professor Borst (last row of Table 3.1) do not display noticeable nonrandom variation throughout the 13-day period for which statistics are provided. Certainly nothing exceptional appears to have happened on Sunday, August 7. The effect reported is entirely due to the seemingly innocent "normalization" of dividing these totals by total NYC births (which decrease on Sundays). If the daily trend in the five hospitals under study were the same as that for New York as a whole, this would seem a reasonable procedure. If, however, the trend in these five hospitals differs from that of the city as a whole, then the computed birth ratio of the two will exhibit variations unrelated to hypothesized blackout effects. We suggest that this is the case here. If the weekday-weekend variation exhibited in total NYC births is due to induction and/or delay of labor at some hospitals to avoid weekend deliveries, scheduling of elective deliveries primarily on weekdays, etc., this would be an effect more likely to occur in private hospitals where patients are frequently delivered by their own personal physician or a specialist than in large municipal hospitals with a large charity caseload and interns on duty at fixed hours. Indeed, such a difference has been reported by Menaker and Menaker [9], who state that "considerably less variation occurred in this regard at the municipal hospitals as compared with the "private" hospitals, which showed a weekend decline, most marked on Sunday." Three of the five hospitals used by Professor Borst fall into the former category (Bellevue, Harlem, and Metropolitan); the other two (Sloan and New York) are "private voluntary" (as opposed to "proprietary"). All but New York handle a large volume of so-called "service" cases. (It is perhaps not insignificant that Mount Sinai, the one hospital not used, alone displays a sharp increase in births on Monday.) Taking a ratio with a roughly stable numerator and a denominator which is minimized on Sunday, Professor Borst has observed a percentage increase in births which is an artifact of his methodology.

If the above explanation is correct, we should expect to see similar peaks in this birth ratio the Sundays before and after August 7. Unfortunately it is not possible to check this from Professor Borst's data as his statistics range only from the Monday before until the Saturday after August 7. However, in 1970 Dr. Walter Menaker [8] obtained statistics allowing him to compute the ratio of total Manhattan births to NYC births for the three Sundays in question; the results--98/356 (or 27.5%) on July 31, 97/344 (or 28.2%) on August 7 and 110/377 (or 29.2%) on August 14, --show that August 7 was in no way exceptional.

While a 1 or 2 day effect on births seems clearly ruled out, it is still possible that an effect on the birth rate took place over a longer period of time. Indeed, going on to note that 800,000 people were caught in the subways during the blackout and citing newspaper headlines such as "30% of Labor Force Too Weary To Work," Dr. Menaker felt it far more likely that the blackout would depress rather than increase the city's birthrate. Looking at births one week before and one week after August 9, Menaker noted that total births for this period were lower than the combined total for the week immediately prior and the week immediately following.

In Figure 3.1 we have graphed a smoothed version of the NYC birth data for 1961-1966 (see Figure 4.1); details of the method of smoothing appear in Section 4. Notice the regular seasonal pattern, namely two peaks, the first of which is smaller in magnitude and also of shorter duration than the second; the second peak occurs during the summer and is typically bifurcated with a single dip whose extent varies from year to year. (Such seasonal birth patterns for a number of countries have been extensively studied in [10].) In 1966, however, the summer peak contains two distinct dips, the first (indicated by an arrow in Figure 3.1) occurring in late July-early August and corresponding to the decrease noted by Menaker. The yearly variations in the summer peak make it impossible to conclude from simple inspection of Figure 3.1 whether or not this decrease in births is "significant". In any case the effect is quite small (a decline of at most several hundred births during a one-month interval in which over 12,000 births occurred). Indeed, Dr. Menaker himself concluded that "the evidence presented here for a decrease in conceptions during the Blackout cannot be considered direct or conclusive. 'Statistical significance' would have little or no meaning here. It should be emphasized that those who have postulated an increase in conceptions during the Blackout have failed to produce satisfactory evidence for such an increase. The evidence presented here suggests a decrease."

An attempt to give "statistical significance" to such aggregate birth statistics was later undertaken by Professor J. Richard Udry of the School of Public Health at the University of North Carolina, Chapel Hill [12]. Udry reasoned that "if there were an unusual number of conceptions on November 10th, then the period between June 27 and August 14, 1966, would contain a greater percentage of the year's births than that contained by the same period in other years." Udry's calculations (which we have confirmed) are given in Table 3.2. The results appear to support Udry's conclusion that "1966 is not an unusual year...we therefore cannot conclude from the data presented here that the great blackout of 1965 produced any significant increase (or decrease) in the number of conceptions."

Professor Udry's article, however, contains several "loose ends." Little attempt is made to contrast the seasonal pattern for 1968 with that of previous years nor is there any mention of the downward trend in NYC births that Figure 4.1 exhibits. (The existence of this trend makes the comparison of yearly percentages such as those in Table 3.2 somewhat dubious.) More troubling is the lack of attention to considerations of statistical power. A simple order of magnitude calculation will make the problem clear. Assume that on the night of the Blackout the incidence of intercouse in NYC rose 25%. If such an increase resulted in a corresponding increase in conceptions, approximately 110 extra births would occur nine months later, spread over a two month interval. (There were approximately 446 births per day during the 1961-1966 period.) Professor Udry's test attempts to detect this increase of 110 during a seven-week interval in which 21,290 births occurred. In terms of the percentages given in Table 3.2, an increase of 0.06% is in question, although the percentages involved are only calculated to the nearest tenth! If a (still sizeable) increase in conception of 10% occurred, the possibility of detection is even worse. At a very minimum, a power calculation to determine an optimal test interval is in order.

This last point highlights the real fallacy of a 'baby boom'. Even if a sizeable increase in intercourse took place on the night of the Blackout, the intervention of natural and human agencies would result in few additional conceptions. (E.g. contrast the average of 446 births per day with any reasonable estimate of the number of acts of intercourse taking place in New York City on any given night.) These additional births, at most several hundred in number, would occur over an eight week period nine months later. Engulfed in a sea of variability resulting from long-term trends, seasonal effects, weekend-weekday effects and random fluctuation, even the most sophisticated of statistical techniques will be hard put to detect any effect actually present.

4. Analysis of the Birth Data. As mentioned in Section 2, the data obtained from the NYC Department of Health consists of the total number of births per day in NYC over the 6 year period, 1961-1966, a total of 2191 days of birth data. These daily birth totals are graphed in Figure 4.1. They range from a low of 303 to a high of 563, with a mean and standard-deviation of 446.74 and 40.84 respectively. There is a clear decline in births for the last three years, 1964-6, whereas for the first three years the overall level is relatively stable. In addition, the series exhibits a regular seasonal pattern.

The spectrum of the data was estimated by first employing a cosine taper extending over the first and last 10% of the data (see Section 5.2 of [3]), adding a sufficient number of zeroes to the end of the tapered data to make the total length 4096, computing the raw periodogram (using the Fast Fourier Transform), and then smoothing the result by taking moving averages of 7 adjacent periodogram values. This is graphed (log-scaled) in Figure 4.2(a); an even smoother version obtained by successively applying moving averages of 15, 31 and 63 is graphed in Figure 4.2(b). Features of these graphs include a trend-seasonality component at low frequencies and also two large peaks, the second of which is clearly a harmonic of the first, which in turn occurs at a frequency of 0.143, or a 7-day cycle. This 7-day cycle is the "day-of-the-week" effect noted by Menaker [8] and suggests that there are significant differences in the number of births between different days of the week.

The data was first smoothed to provide an estimate of the sum of the trend and seasonal components. This was done by employing a suitable low-pass filter (see Section 6.4 in [3]) with cutoff frequency $\omega_c = 0.1122$, corresponding to picking up a 28-day cycle. This smoothed version of the data is graphed in Figure 3.1. The resulting residuals after smoothing are graphed in Figure 4.3; these range from a low of -127 to a high of 111, and have a mean and standard-deviation of zero and 35.10 respectively.

Next, averages for each of the seven days of the week over the length of the data set (which is now the residuals from smoothing the data) were computed; a graph of them is given in Figure 4.4. Notice the relatively high level of 5 consecutive week-days compared with the 2 weekend-days. These 7 values were successively subtracted from the series of residuals to give a new series ("filtered-deweeked" residuals). These are graphed in Figure 4.5. They range from a low of -106 to a high of 95, and have a mean and standard-deviation of zero and 25.51 respectively.

The spectrum of these second-stage residuals was then estimated as before. The trend-seasonality component has been removed, leaving an expected "dip" in the spectrum at the low frequencies and the two spikes of Figure 4.2 have now been reduced to the general level of spectrum values. A full-normal probability plot of these ordered residuals is graphed in Figure 4.6. The bulk of the points fall on a straight-line through the origin, while the lower-tail of the data is somewhat heavier (fatter) than that of the normal indicating an excess of large negative residuals. A graph of the residuals for the period in question, namely May-September 1966, is given in Figure 4.7; clearly nothing unusual is happening.

This last set of residuals was finally analyzed for outliers. This was done by setting up bands at the yearly mean plus-and minus two standard-deviations, the standard-deviation being estimated for each year separately; hence, residuals were termed "extreme" relative only to other residuals of the same year. Table 4.1 lists the estimated standard-deviations for each of the six years, together with their extreme-residual day numbers (a minus sign next to the number indicates a negative residual). Five days that appear more-or-less regularly in the table are the fixed holidays of New Year (day 1), Memorial Day (day 150/151), and Christmas Day (day 359/360), and the variable holidays of Labor Day (days 247, 246, 245, 251, 248, 247) and Thanksgiving (days 327, 326, 332, 331, 329, 328). In several instances, the day preceding or succeeding a holiday will also occur in the table. Independence day (day 185/186) is a curious omission from this list (it only appears once). Since these days may be regarded as somewhat "special", there is a valid case for omitting them in any further consideration of the set of residuals; a revised full-normal probability plot of the residuals (leaving out the 28 holiday-days) looked much better, the peculiarities in the left-hand tail having been removed. This effect has also been noted in [5].

Looking at the data now after estimating a trend-seasonality component, a day-of-the-week component, and computing residuals, we arrive at the following conclusions.

(a) There was no increase in births due to the Blackout;

(b) If there was any change in the general level of births, it was both small in magnitude and in a downward direction.

A more careful and detailed analysis of this data set will appear elsewhere. However, preliminary studies using simple ARIMA models (see [6]) indicate that the decline mentioned above in (b) is not significant.

5. Discussion. The episode of the missing baby boom highlights a number of issues only partly statistical in nature. The first of these concerns journalistic responsibility. Despite the paucity of evidence adduced in the New York Times articles, there is at present a widespread belief in a baby boom 9 months after the Blackout, an impressive testament to the power of the press as an opinion-maker. Although in this case the issue is hardly one of national importance, it does highlight the problems both journalists and the public face as issues of increasing statistical complexity become common in public affairs.

A second issue is the statistical refereeing of articles appearing in nonstatistical scientific journals. Most of the objections to the published literature that we have raised are of an elementary nature that surely would have been picked up had adequate refereeing taken place. Its absence is particularly hard to understand given an already unmanageable flood of scientific literature and the inability of many non-statisticians to independently evaluate evidence of a statistical nature.

Finally, there is an issue of data availability. A number of sources were contacted for data related to our study. What was originally thought of as a simple request for data ended up lasting 4 months and requiring 5 letters, 2 phone-calls, and a personal visit! In our case we were fortunate--all persons contacted were quite cooperative and the major difficulty involved was the problem of recovering records often 5 to 7 years old. Others have been less fortunate. As illustrated by our study, it is essential that data analysed in the scientific literature be given in full (if possible) or at least be readily available for scrutiny.

Acknowledgements. We should like to thank Frieda Nelson of the New York City Department of Health for providing us with tabulations of births by day for the 6 years of the study, and also Earl Westfall for carrying out the computations referred to in Section 4.

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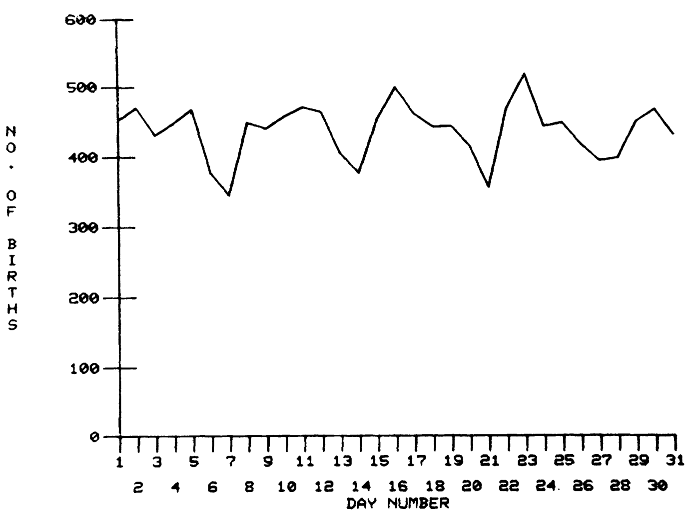
	Average	(Aug. 8) M	(Aug. 9) Tu	(Aug. 10) W	(Aug. 11) Th
BELLEVUE	20[a] or 6[c,d]	29	slightly above average	1	2
BRONX MUNICIPAL	7	16	16	9	8
BROOKDALE	10	13[a] or 15[b,c]	15	14	13
BROOKLYN JEWISH	15	normal	slightly above average	18	8
COLUMBIA-PRESBYTERIAN	11[a] or 12[d]	15	13	average	18
CONEY ISLAND	4[b] or 5[a]	8	7	average	average
FRENCH	3		5	average	10
MOUNT SINAI	11	28	16	17	15
NEW YORK	13	normal	slightly above average	average	5
ST. LUKE'S	5	14-15	14-15	9	7
ST. VINCENT'S	7	10	10; average	average	average

Table 2.1. Daily birth data as reported in four New York Times articles.

a. In T1
b. In T2
c. In T3
d. In T4

Figure 2.1
TOTAL BIRTHS IN NYC: AUGUST, 1966



August 1	Mon	452	17	Wed	461
2	Tues	470	18	Thurs	442
3	Wed	431	19	Fri	444
4	Thurs	448	20	Sat	415
5	Fri	467	21	Sun	356
6	Sat	377	22	Mon	470
7	Sun	344	23	Tues	519
8	Mon	449	24	Wed	443
9	Tues	440	25	Thurs	449
10	Wed	457	26	Fri	418
11	Thurs	471	27	Sat	394
12	Fri	463	28	Sun	399
13	Sat	405	29	Mon	451
14	Sun	377	30	Tues	468
15	Mon	453	31	Wed	432
16	Tues	499			

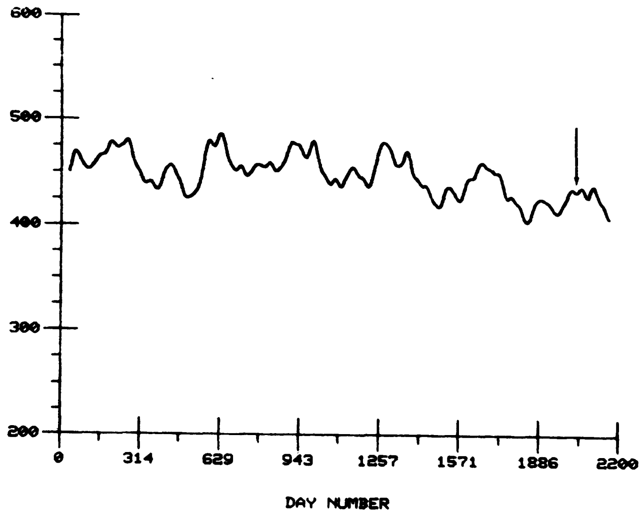
Table 2.2. Total live births occurring in August, 1966, for New York City.

August	1	2	3	4	5	6	7	8	9	10	11	12	13
Bellevue	2	1	5	7	7	6	10	4	7	2	2	1	2
Harlem	13	6	7	11	6	8	3	5	3	8	7	10	9
Metropolitan	11	14	5	10	11	6	6	8	7	10	8	9	6
Mt. Sinai	6	14	14	11	17	12	9	28	16	20	16	20	11
New York	8	11	6	13	10	10	11	12	10	13	6	11	16
Sloan	10	14	14	8	11	5	13	15	13	12	18	11	12
Total*	44	46	37	49	45	35	43	44	40	45	49	42	45

Table 3.1. Daily birth data for 6 individual hospitals in New York City, August 1966. (We should like to thank Professor L. B. Borst for providing us with these numbers, which originate with the New York Department of Health.)

*omitting Mt. Sinai births.

Figure 3.1
NYC BIRTHS (FILTERED: OMEGA=.1122,S=30) 1961-66



Year	1961	1962	1963	1964	1965	1966
% of year's total births	13.9	13.9	13.9	13.9	14.1	13.9

Table 3.2. Percentage of year's total births occurring in New York City, June 29-August 16 (1964: June 28-August 15), during 1961-1966 (Table 1 in [12]).

Figure 4.1
NYC BIRTHS -- 1961-1966

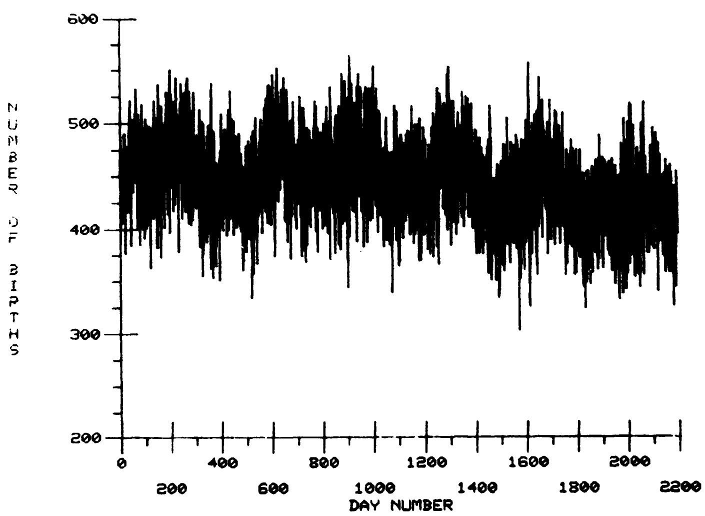


Figure 4.2a
LOG SPECTRUM: RAW;MA 7

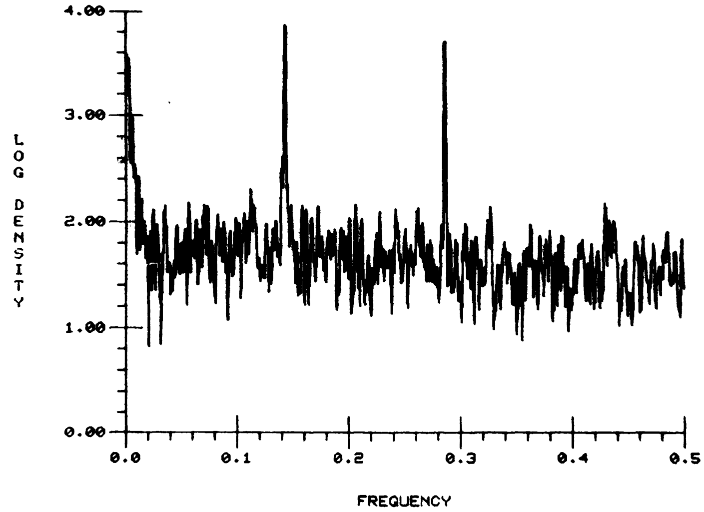


Figure 4.2b
LOG SPECTRUM: RAW;MA7,15,31,63

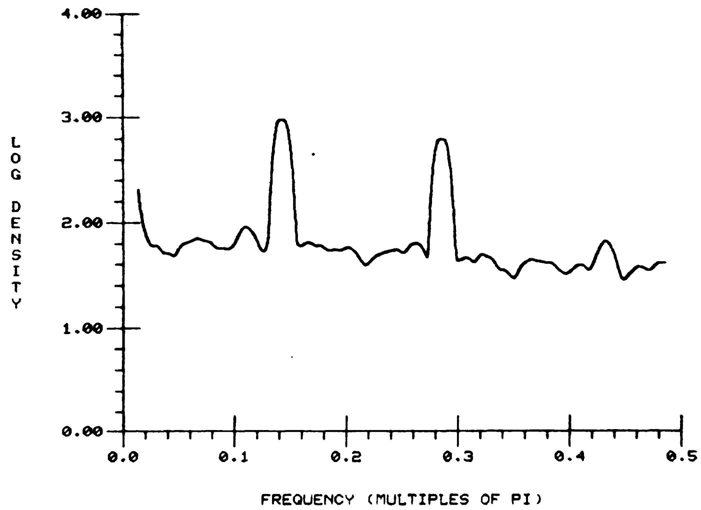


Figure 4.3
RES: FILTERED

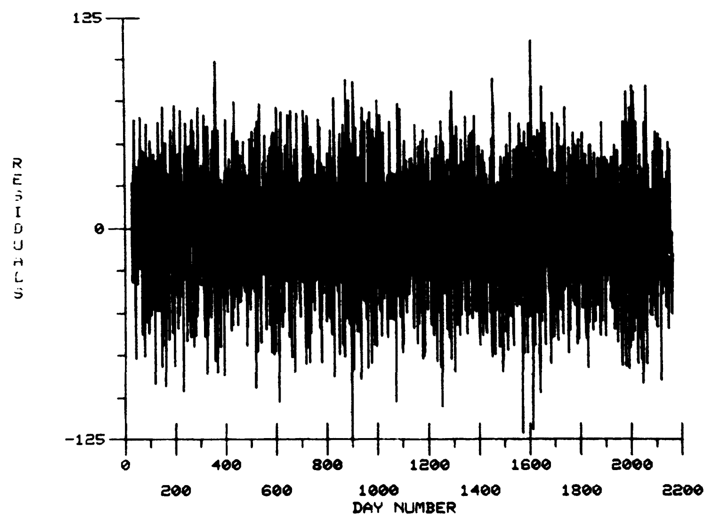


Figure 4.6
NORM P PLOT: RES(FILT,DWK)

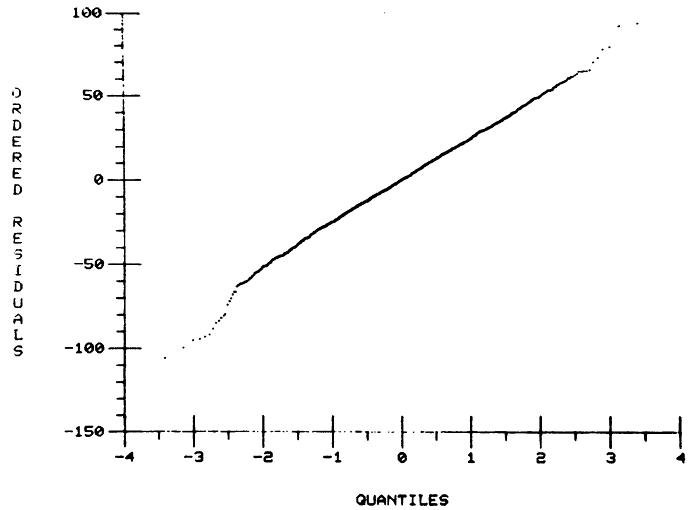
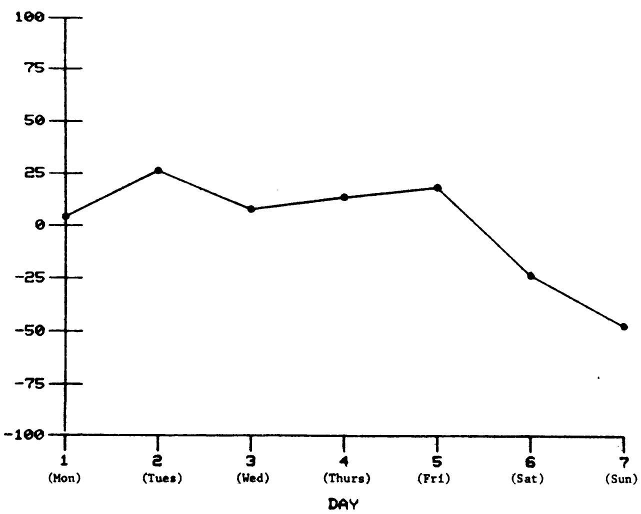


Figure 4.4
DAY-OF-WEEK EFFECT



	1961	1962	1963	1964	1965	1966
1.	31^{-}	1^{-}	1^{-}	1^{-}	1^{-}	1^{-}
2.	84	94^{-}	101	29^{-}	7^{-}	146
3.	111^{-}	122^{-}	113^{-}	77^{-}	30^{-}	150^{-}
4.	150^{-}	162	148	88^{-}	108^{-}	151^{-}
5.	154	171	150^{-}	130	137	158
6.	196	176^{-}	158	145	148	174^{-}
7.	247^{-}	245	167^{-}	159^{-}	150^{-}	181
8.	292	246^{-}	177	203	151^{-}	185^{-}
9.	327^{-}	300	180	252^{-}	168^{-}	187
10.	359^{-}	315	186^{-}	289	190	195
11.	362	319	245^{-}	359^{-}	205	235
12.	363	326^{-}	249^{-}	360^{-}	251	248^{-}
13.		359^{-}	269	364	281	255^{-}
14.		361	316^{-}	365	329^{-}	256^{-}
15.			332^{-}			283
16.			342^{-}			303
17.			347^{-}			328^{-}
18.			352			332^{-}
19.			359^{-}			
s_i	27.07	25.28	27.34	23.17	25.59	24.46,

Table 4.1. Residuals after filtering and removing "day-of-week" effec having $|\text{residual value}| > 2s_i$, where i denotes year. Entry is day number.

Figure 4.5
RES: FILT,DWK

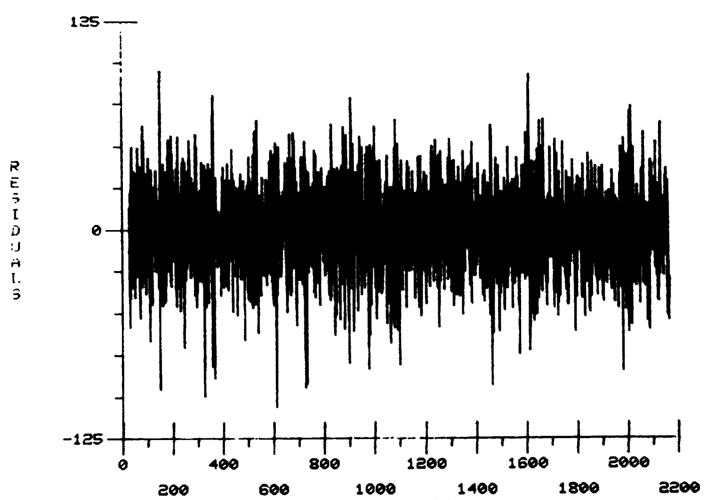


Figure 4.7
RES: FILT,DWK (MAY 1 - SEPT 30, 1966)