MARCHETTI-1 Pt.2

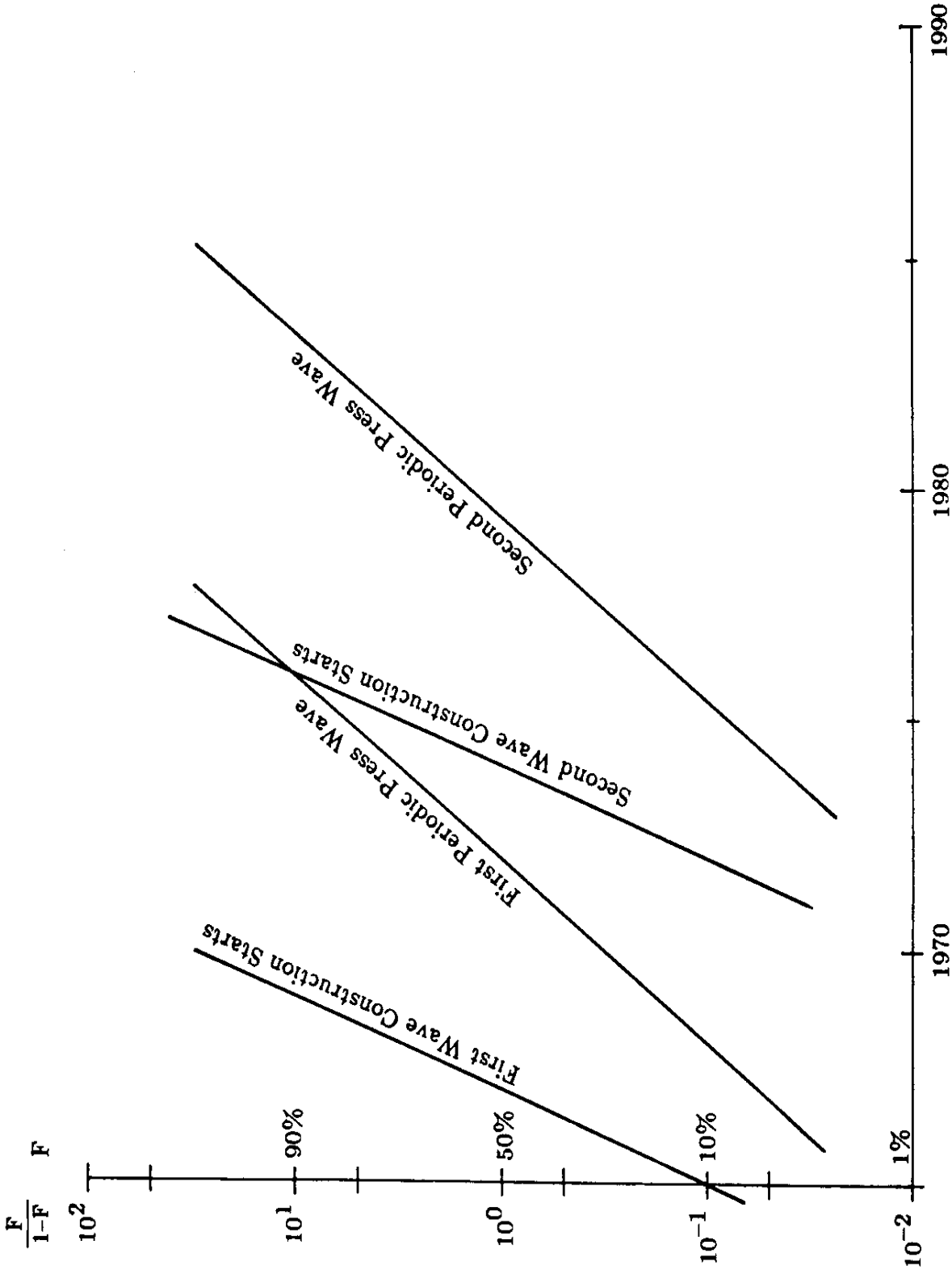


FIGURE 34. Construction Starts of Nuclear Power Plants in the US and Attention Waves in Periodic Press.

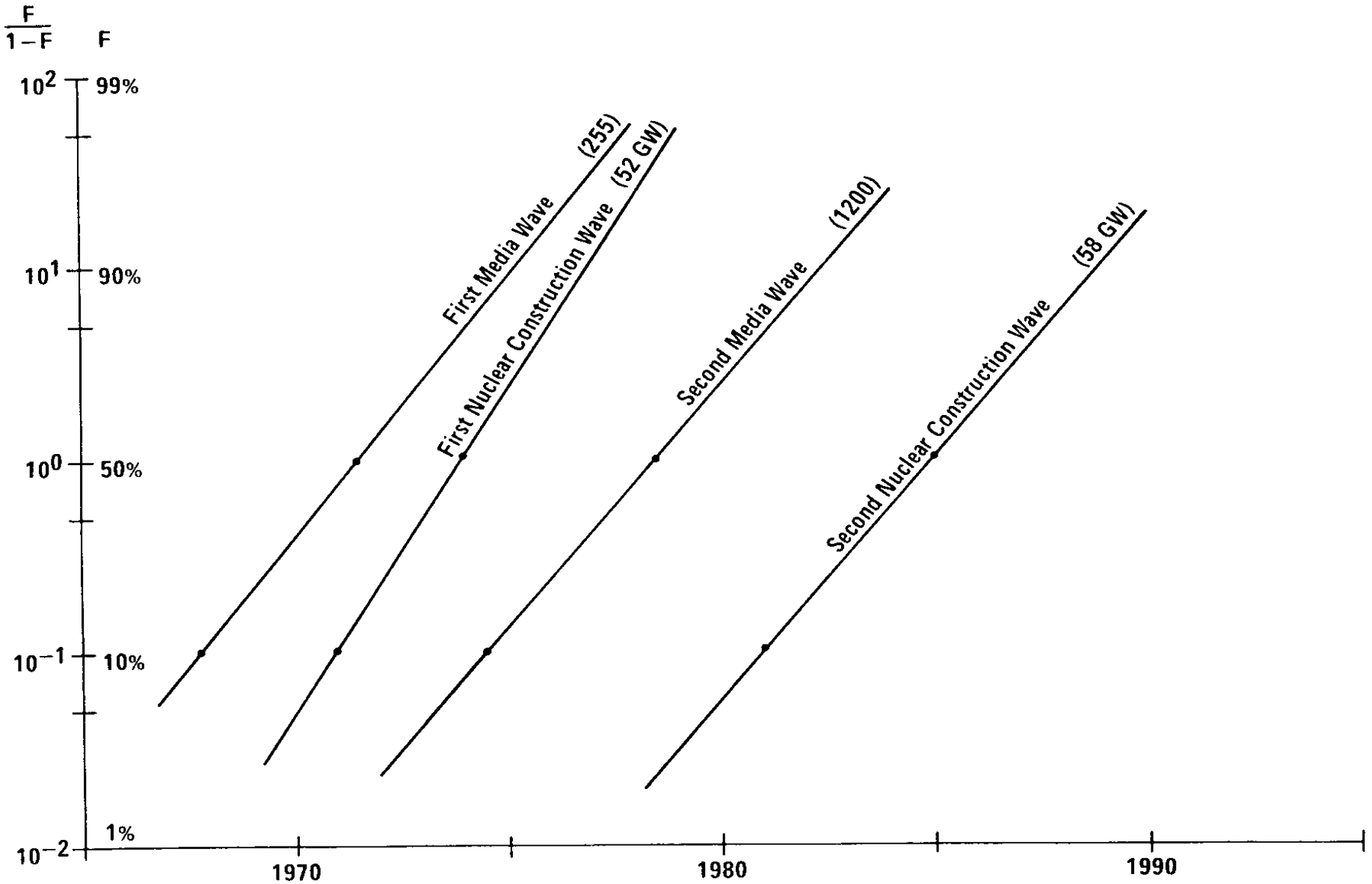


FIGURE 35. US Waves of Nuclear Plant Construction (GW connected to grid, cumulative) and of Attention of Periodical Press (cumulative number of articles).
DATA SOURCE: *Reader's Guide to Periodical Literature*, Nukem (1980), and Nukem (1984).

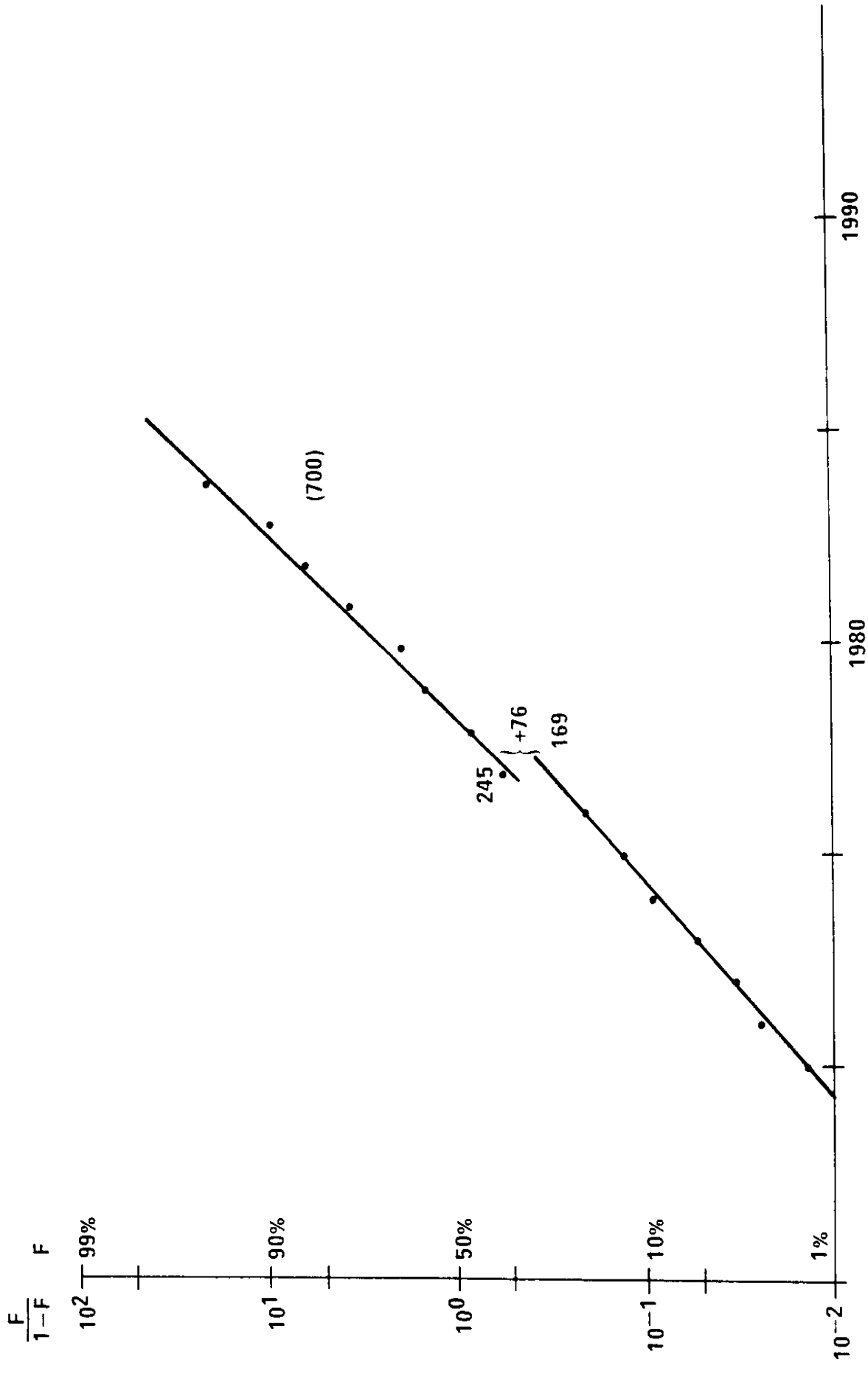


FIGURE 36. Long-Term Pulse of Interest in Nuclear Energy reported in *Der Spiegel* (cumulative number of articles). DATA SOURCE: *Spiegel* Sachregister, corresponding years.

Table 2. Analysis of Articles Related to Nuclear Energy in *Der Spiegel*, 1977.

1	32	33	35							
2										
3										
4	30	94								
5	102	105								
6	16	26	102							
7	18	31	32	110						
8	18	86	89	90	102	150	158	161	162	163
9	16	24	29	31	34	134	137			
10	66	92	132	145						
11	44	46	62	106	108	156				
12	19	35	36	42	110					
13	32	34	139							
14	44	49								
15										
16	34									
17	30	31	32	105	106					
18	34	82								
19	21	27								
20	90	125								
21	18									
22										
23										
24										
25										
26										
27	18									
28	6	19	20	55	56	59				
29										
30										
31	18	25	29							
32	40	41	42							
33	54	55	56							
34	23	24								
35	73									
36	28	184								
37										
38	14	44	49							
39	18									
40	21	63	65							
41	124	132								
42										
43	16	28	30	32	34					
44	105	106								
45	136	139								
46	16	18	116	123						
47	21	22	76	134						
48	17	21	44	46						
49	18									
50	18									
51										
52	28	29	30	32	93					
53	19									

NOTE: The numbers in the left column refer to *Spiegel's* issue number. The numbers in the right column are the page numbers of articles on nuclear.

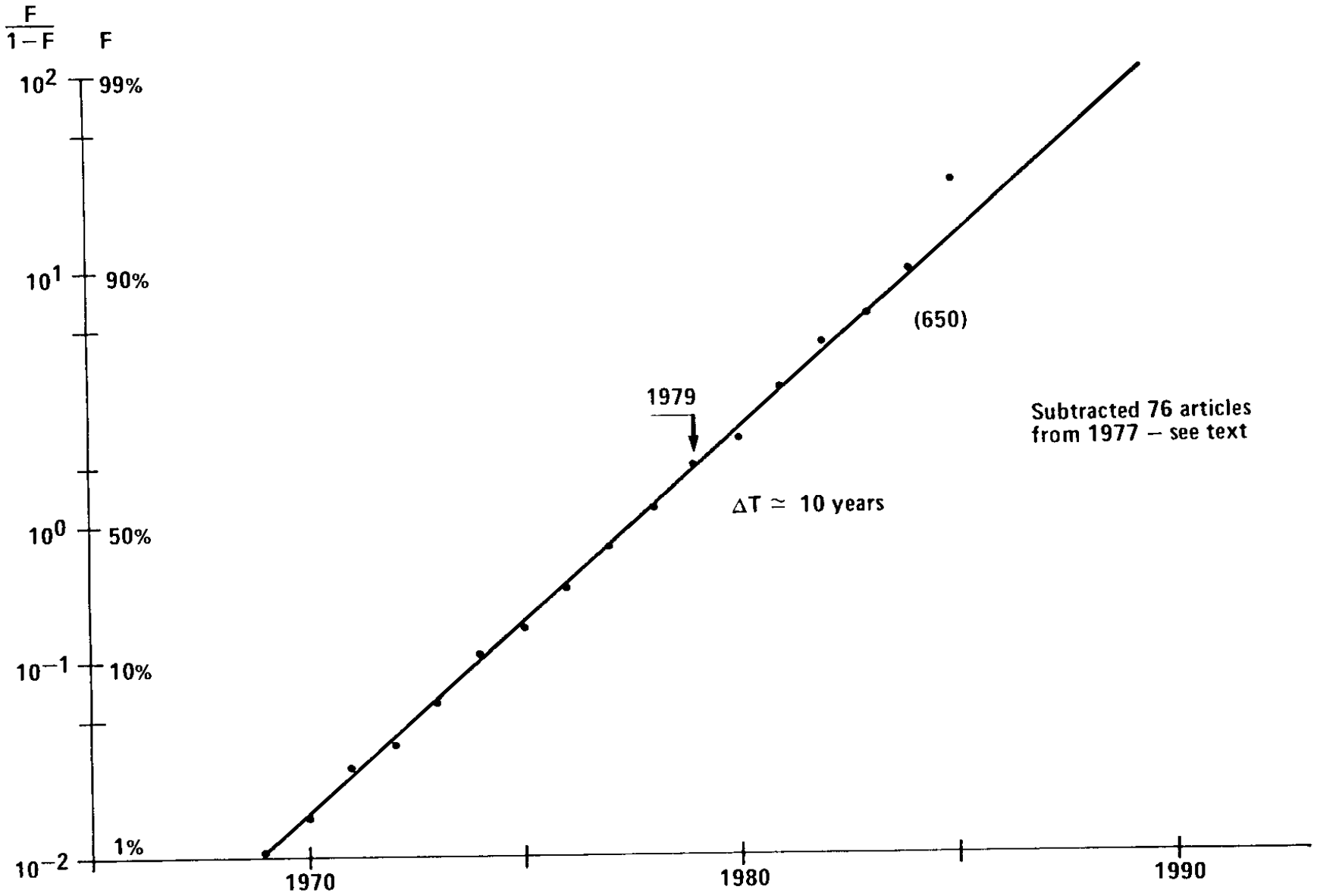


FIGURE 37. Long-Term Pulse of Interest in Nuclear Energy reported in *Der Spiegel* (cumulative number of articles). DATA SOURCE: *Spiegel* Sachregister, corresponding years.

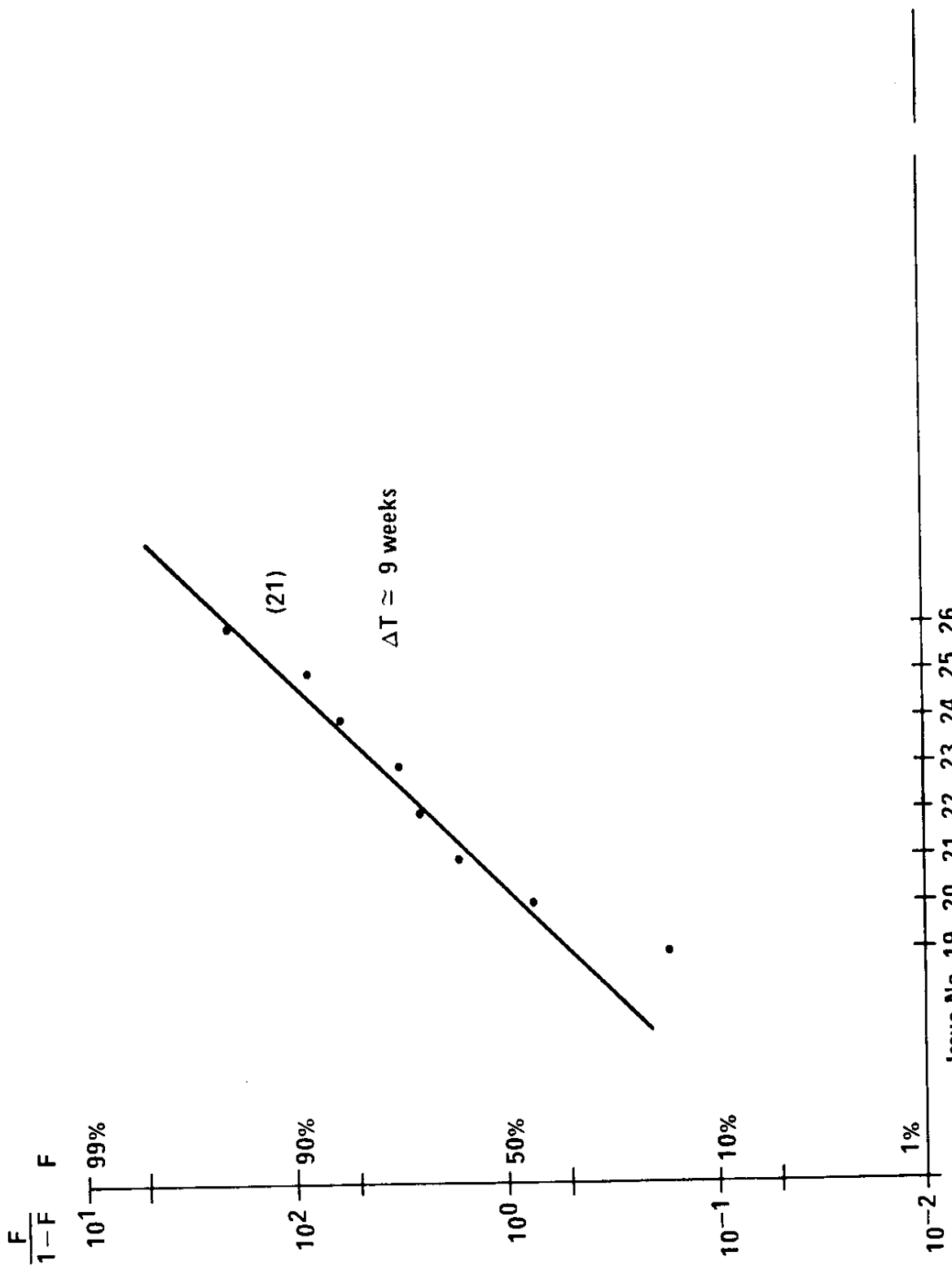


FIGURE 38. Attention Pulse on Chernobyl, number of articles in *Der Spiegel*.
DATA SOURCE: *Spiegel* Sachregister (1986).

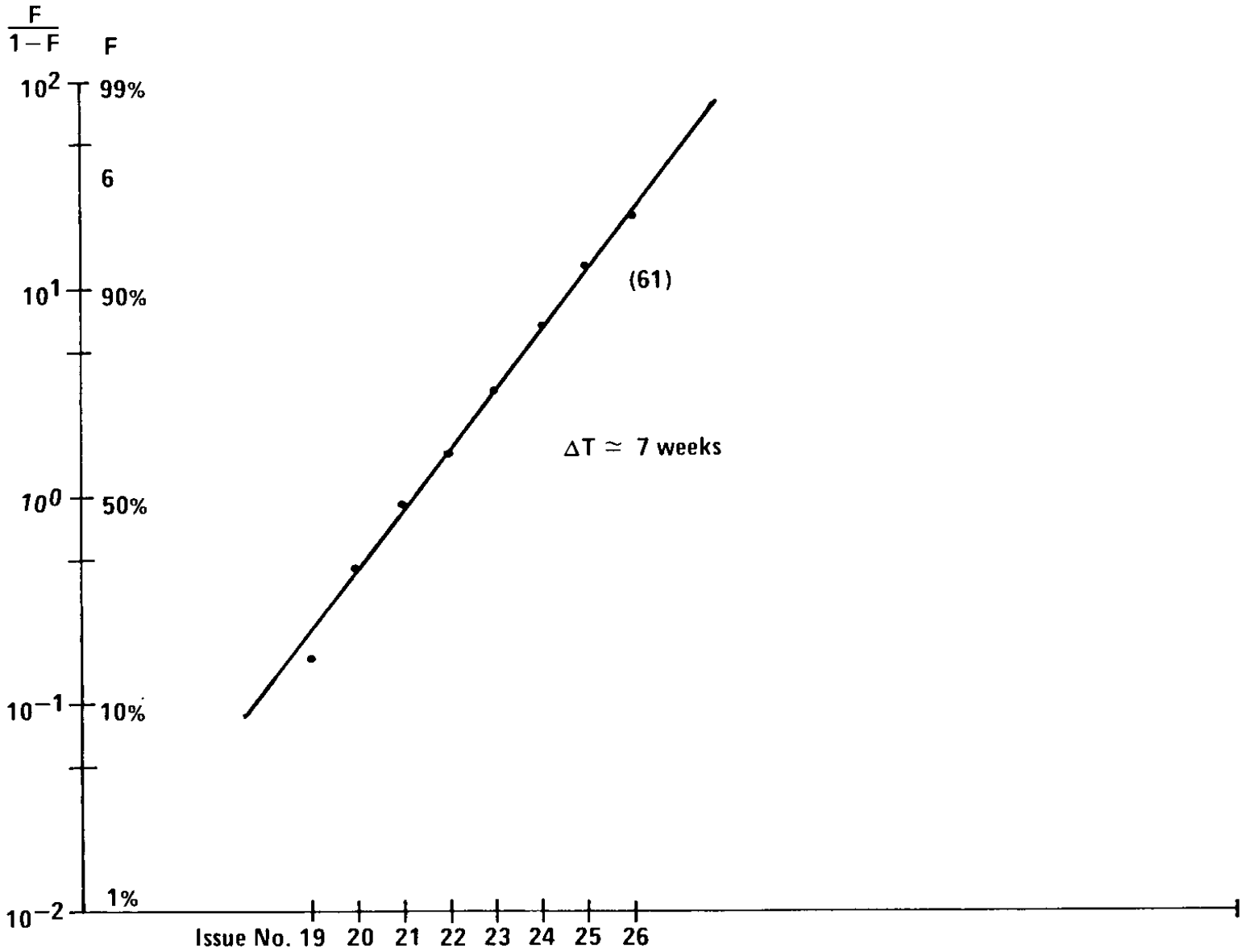


FIGURE 39. Attention Pulse on Nuclear Energy Induced by Chernobyl (included) reported in *Der Spiegel*. DATA SOURCE: *Spiegel* Sachregister (1986).

7. ARE NUCLEAR ACCIDENTS REALLY STOCHASTIC? THE CASE OF THE USA

An accident in a nuclear plant is usually treated as a stochastic occurrence. One of thousand components of the plant may malfunction, and this starts a chain of events that in most cases results in normal operation or in maintenance stop. In some very rare cases the causal trees can enter into spaces not foreseen by the designers and finally lead to situations where operators rush behind, trying to understand what is happening, instead of being in control of the situation.

In abstract terms, accidental chains of events have an experimenting character, which is similar to that of mutations exploring the environment. This system is designed to eliminate mutations, but exploratory branches can enter an unforeseen channel of events. Therefore, runaway situations have intrinsically stochastic character, reflecting this mechanism.

The objective of the safety engineer is to develop, through physical design and operational procedures, a *mutation-killing system* that lets none of them escape. Because the world is more complex than models, some will escape anyway. As most experience shows, the number will be linked in a complex functional way to the number of reactors and how long each has been in operation.

The United States, with the largest number of reactors in operation and the largest number of reactor years of experience, is a natural object for analyzing the structure of the accident process. Furthermore, as a consequence of an inbred glasnost and a very active press, the system appears much more explicit than the European one.

An accident is also the result of the interaction between a social system and a technological system and, following the usual procedures, this study tested if the social context could be separated. In other words, if the social context is dominant in the process. The time structure of the accidents should then reveal characters that are typical of social processes.

The analysis is presented in Table 3 and Figure 40. The list of nuclear accidents is taken from Mazur (1984b); however, the last three accidents, which occurred later, were extracted from IAEA reports on reactor operation. The fitting function is the usual logistic, matching the cumulative number of accidents. The number of accidents in the list being 11, as the saturation level of the logistic, the last accident does not appear because it is past the range of the chart.

It seems clear that the sequence of important nuclear accidents in the history of the US nuclear industry has quite a rigid time structure, which cannot be reduced to stochastic mechanisms. The result would be obvious, however, if one accepts the hypothesis that a *cultural epidemic* makes reactor operators accident prone. Unlimited examples of these cultural epidemics exist and pervade the actions of human societies. Reactor operators are not martians. However, Figure 41 reports the cumulative reactor years of reactor operations in the USA together with the reactor accident curve. This may provide material for more conventional interpretations.

Table 3. List of Major U.S. Nuclear Accidents

Site	Date
Browns Ferry fire	23 November 1976
Rancho Seco	20 March 1978
Three Mile Island	28 March 1979
Prairie Island	2 October 1979
Crystal River	2 February 1980
Browns Ferry rods	28 June 1980
Ginna	25 January 1982
Salem	25 February 1983
David Besse	July 1984
Susquehanna	June 1985
Rancho seco	December 1985

List from Mazur (1984b) up to Salem accident.
The last three cases are taken from IAEA reports.

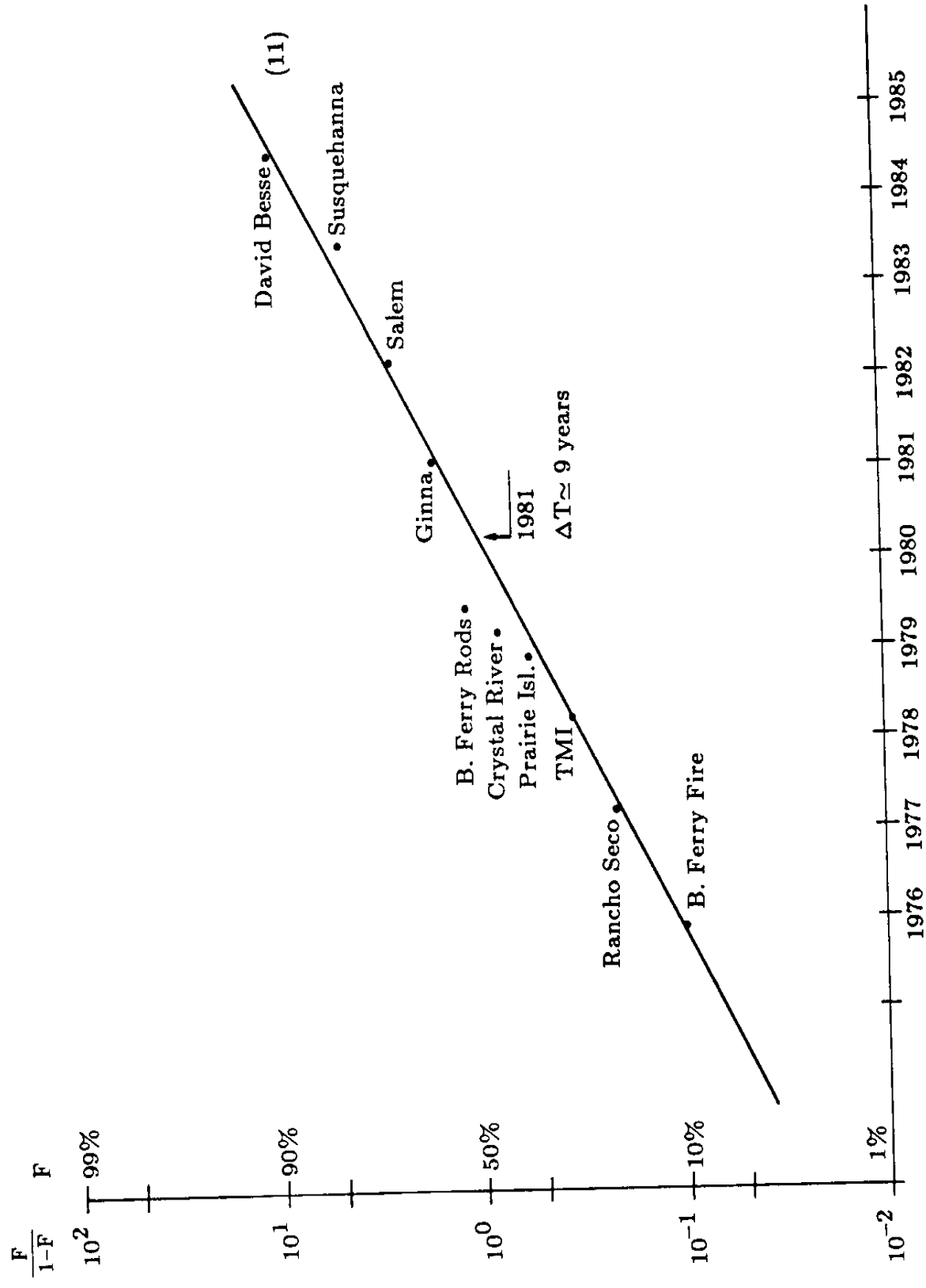


FIGURE 40. US: Cumulative Number of Important Nuclear Power Plant Accidents.
SOURCE: Mazur (1984b) and IAEA.

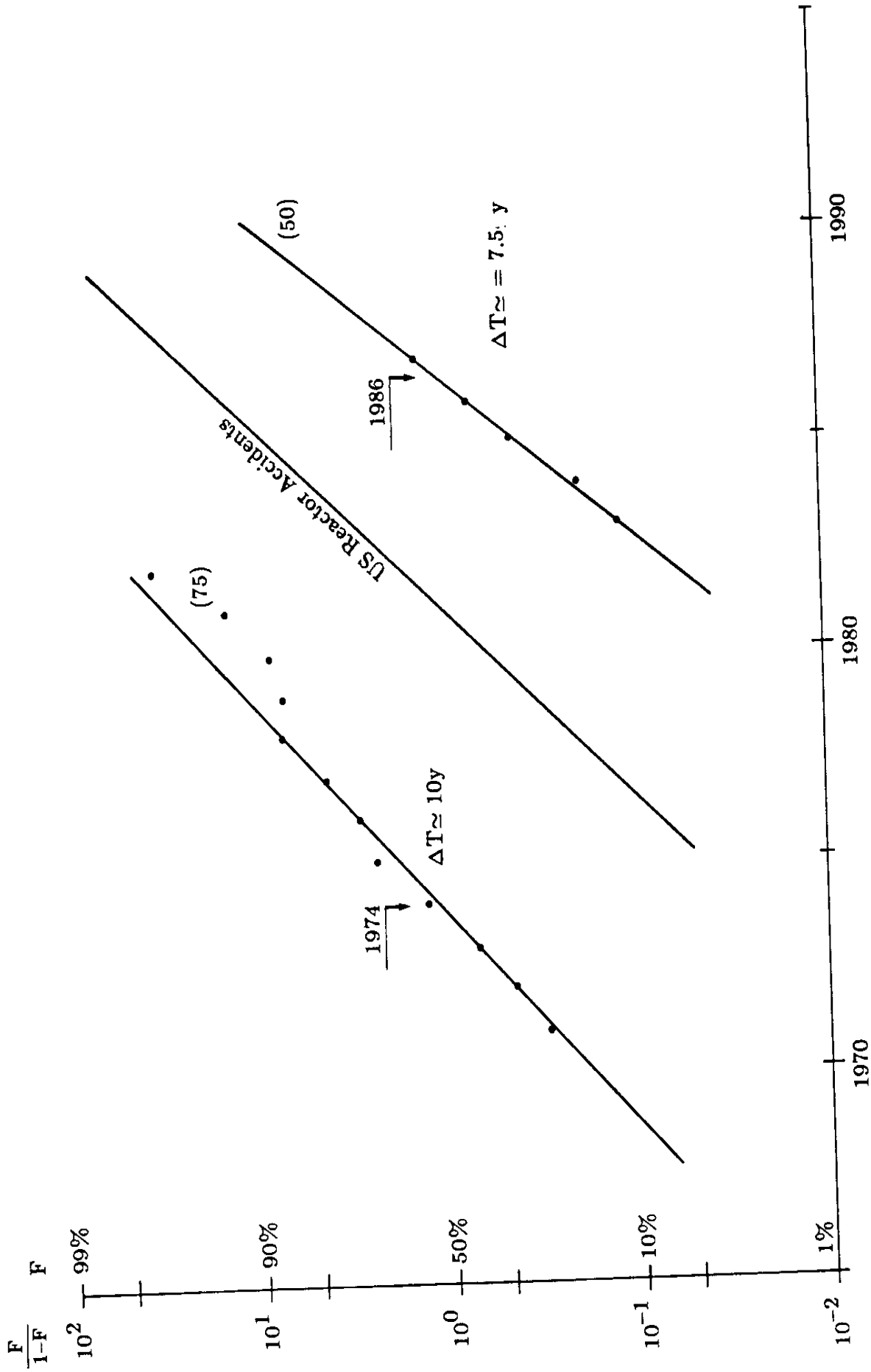


FIGURE 41. US: Nuclear Plants Operation, Reactor Years/Year and Reactor Accidents.
DATA: IAEA.

8. NUCLEAR POWER PLANTS, THE MEDIA, AND THE ACCIDENTS: AN ANALYSIS OF THE USA

This section analyzes the US case to reveal the interrelations and their regularities, linking the three actors in the play: power plants, media, and plant accidents.

The Plants

The analysis for the US nuclear power plants is illustrated in Figures 42–45. The data refer to the actual number of GW connected to grid per calendar years. To prepare a meeting with the media, a similar analysis should be done for reactor construction starts. After all, much more noise is raised by the media during the initial construction than during the ceremony of switching on the power.

The result of the analysis on the first wave of construction starts is reported in Figure 42. Because the objective is to study the interaction between the starts and the press, the (cumulative) *numbers* of power stations initiated were analyzed. The reason for that is that the media will react more to the number of nuclear plants than to their power capacity. The cumulative number of starts splices in two logistics, one centered in 1967 and the second in 1974.

The time constant for these two segments is the same, i.e., four years. This could be interpreted as the time constant for spreading a cultural wave inside the utility industry management in the USA. The center point of grid connections (GW) from this set of reactors was in 1974, as shown in Figure 42, with a little larger spread represented by a time constant of six years.

Curiously, the center point for the second wave of start-ups is in 1974, Figure 43. It appears as if the second wave of construction were seeded by the first sign of success, i.e., connection to the grid, shown by reactors in the first wave. The second wave, however, took longer to succeed. The center point of the second wave grid connection was in 1985, eleven years after the center point of the start-ups. However, the center point for the first grid connection was in 1967, only seven years away from its beginning. The process is shown synoptically in Figure 44. The information in these three figures provides the information necessary to compare press activity with nuclear plant construction during a 30-year period. With this information one may determine if construction has stimulated the activity of the media and if this activity may have stimulated (or inhibited) construction.

The three charts map the essentials of the US nuclear industry's history with aseptic precision. The random components of the process, so often quoted, do not emerge here in the world of action, even for the case of the accidents. If nuclear plant accidents were essentially the result of social process, like the generation of ecological laws or the publication of papers on a particular subject (for instance, CO_2 and the greenhouse effect), then their time structure would be as it appears in the chart. One could also muse that the time warp appearing in Figure 40 after the accident at Three Mile Island was due to the precarious psychological position of US reactor operators.

However, other causes may have generated that peculiar shape. Figure 45 illustrates some of the factors that may causally correlate with the accidents, reactor starts, reactor connections to the grid, and television and press attention on nuclear plants. The connections are done in a combinatorial spirit, as it is not known *a priori* what connection might work. The ones thought to be most interesting are reported.

Construction starts should not be too closely connected with accidents, except for the fact that they may be linked to a certain level of technology. All accidents listed in Table 2 belong in fact to reactors built during the first construction pulse, but most reactors in operation at the time of the accidents also belong to that wave.

What is reported in Figure 45 is the wave of reactor connections to the grid. The time elapsed measures the reactor years of operation and consequently a build up of the probability of having an accident. As the figure shows, the second wave of reactor connections appears a bit too late to be involved in the wave of cumulative nuclear accidents. This factor helps to assess the possibility of purely statistical links to the set of accidents observed. As the system is techno-social, the figure also includes public opinion as represented by the press coverage of the subject. Public opinion can be represented by the two waves of articles shown in Figure 31, the second one much more intense than the first. If the amount of coverage is measured instead, i.e., percentage of annual space given to a certain type of news, as Mazur has done (for the second pulse), a slightly more significant measure is indicated.

This is what is reported in Figure 45, although the two measurements are only slightly different. What is observed is a strict parallel of the accident wave, with the press wave *as if* opinion intensity preceded accident probability by a couple of years. This certainly does not establish a cause-effect relationship, but the time sequence proves invalid the reverse cause-effect, i.e., that the accident wave is the stimulus for press coverage.

There are interesting coincidences. For example, the Three Mile Island accident occurred at the peak of the press-attention wave. And it is also extraordinary that the film *The China Syndrome*, which described many of the events that occurred during the Three Mile Island accident, entered the movies a few weeks before the accident.

All that can be coincidence, however, the parallelism of the past 12 years of the press-attention index wave and the reactor-accidents wave calls for further investigation of the possible connections. After all, reactor operators are people who live immersed in a social context and may strongly recent its moods and whims. Social analysis has shown unexpected connections between the level of accidents – e.g., in aviation where all sorts of severe measures are taken to avoid them – and facts that the press has made public – like violent deaths of public figures (Phillips, 1980).

Certainly more safety measures incorporated in the machinery will help to reduce the chances of accidents, but special attention should be given to the operator who is after all part of this machinery.

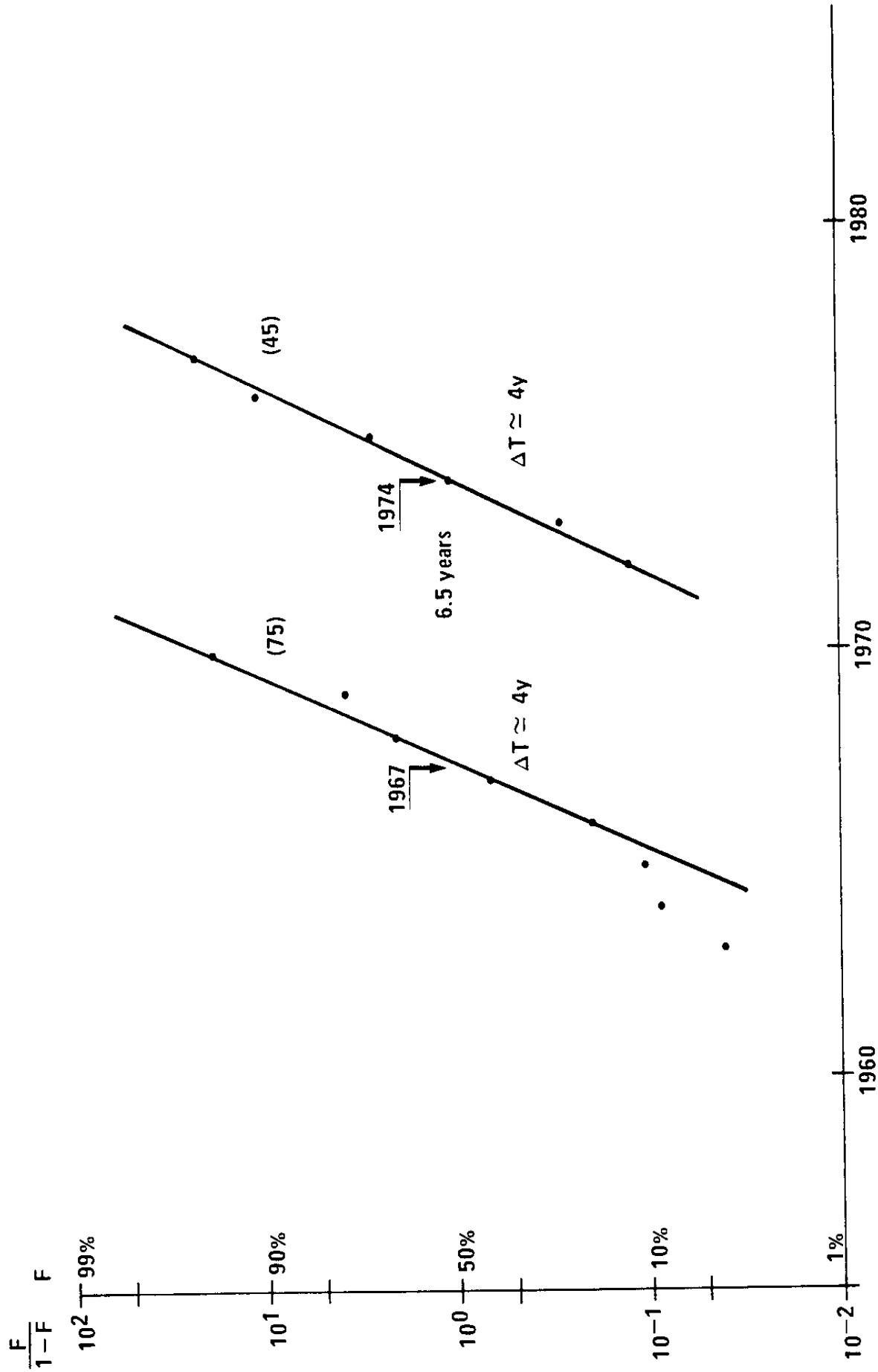


FIGURE 42. US: Cumulative Number of Nuclear Power Stations Construction Starts.
DATA SOURCE: Nuclear Power Reactors in the World, IAEA (1986).

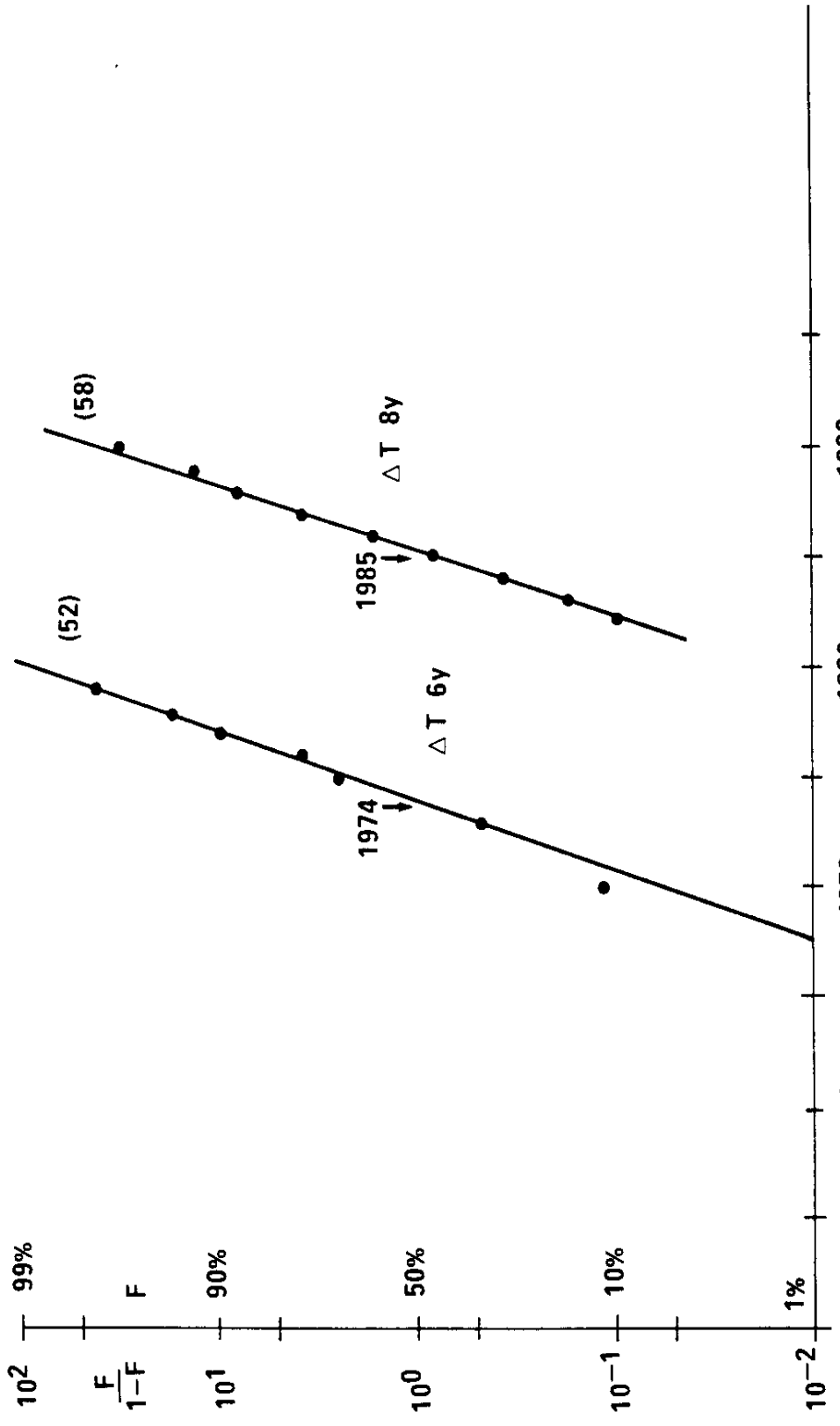


FIGURE 43. US: Installed Nuclear Capacity (GW net).
DATA AND FORECAST: Nukem (1980) and Nukem (1984).

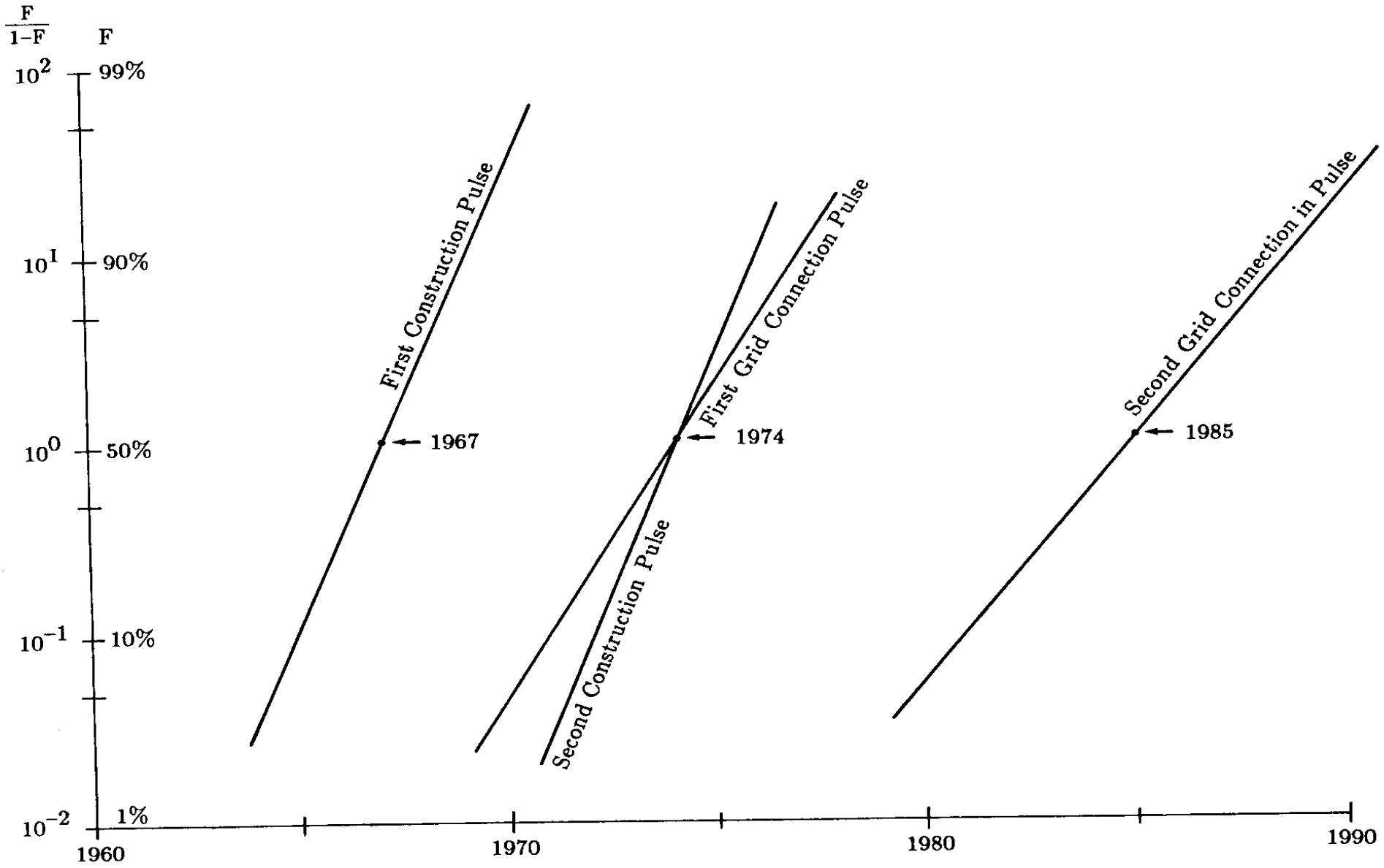


FIGURE 44. US Nuclear Power Plants: Construction Starts (cumulative number of plants) and Construction Ends (grid connection, GWT).

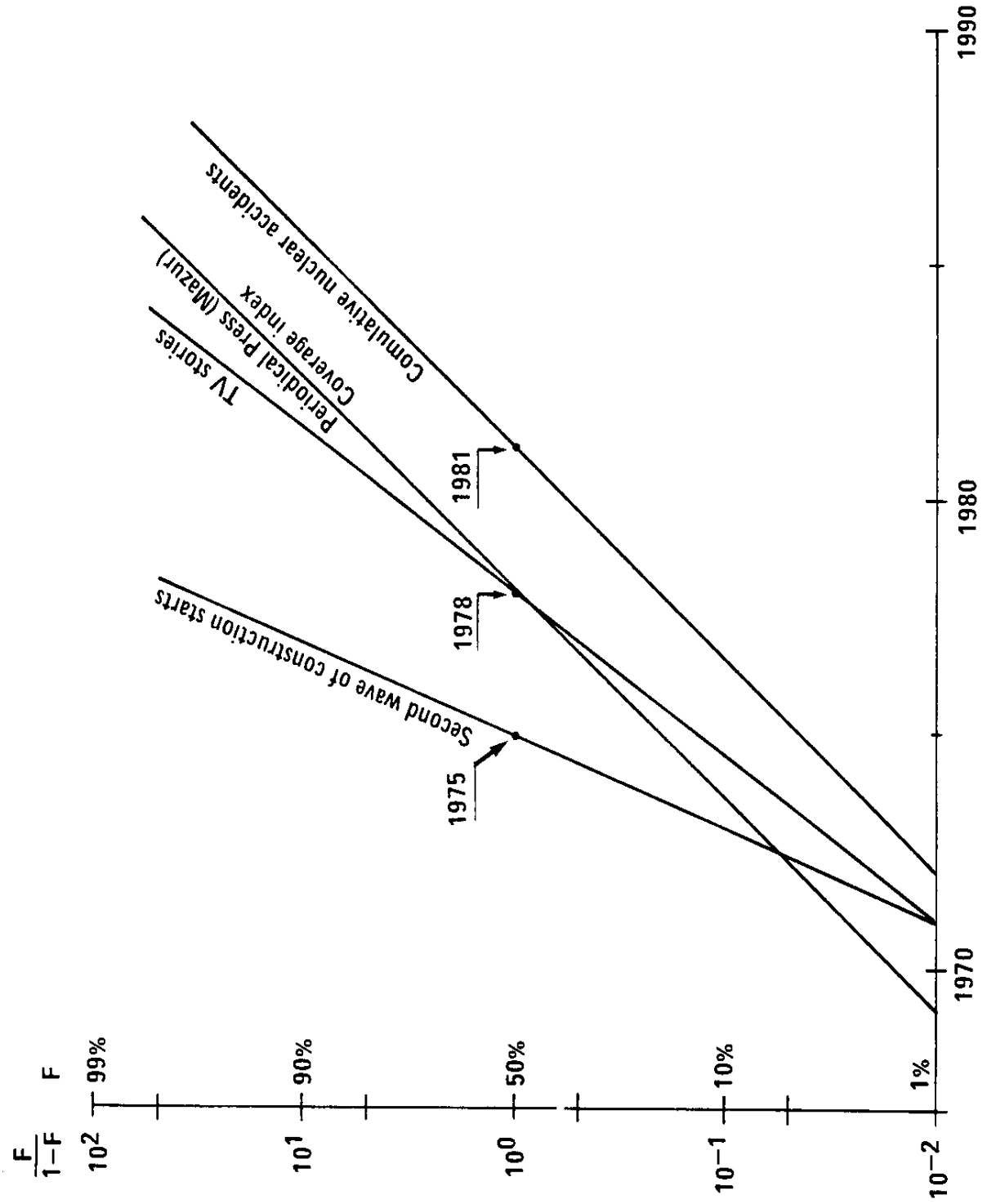


FIGURE 45. US Press and Nuclear Accidents.

References and Related Publications

Blackman, Jr, Wade A. (1972), A mathematical model for trend forecasts, *Technological Forecasting and Social Change, 3*:441-452.

Bossert, R.W. (1977), The logistic curve revived, programmed, and applied to electric utility forecasting, *Technological Forecasting and Social Change, 10*:357.

Covello, V.T. (1983), The perception of technological risks: A literature review. *Technological Forecasting and Social Change 23*(4):285-297.

Debecker, A. and T. Modis (1986), *Determination of the Uncertainties in S-Curve Logistic Fits.* Geneva: Digital Equipment Corporation.

European Environmental Handbook 1987 (1987). London: DocTer International.

Fisher, J.C. and R.H. Pry (1970), A simple substitution model of technological change. *Technological Forecasting and Social Change 3*:75-88.

Flynn, C.B. (1984), The local impacts of the accident at Three Mile Island. *Public Reactions to Nuclear Power: Are There Critical Masses?* W.R. Freudenburg and E.A. Rosa (eds.). AAAS Selected Symposium 93. Washington, DC: American Association for the Advancement of Sciences.

Frizelle, C. (1988), A million years in the life of a waste site, *New Scientist*, 15 October, pp. 44-47.

Funkhouser, G.R. (1973), The issues of the sixties: An exploratory study in the dynamics of public opinion. *Public Opinion Quarterly 37*:62-75.

Grübler, A. (1987), personal communication. Laxenburg, Austria: International Institute for Applied Systems Analysis.

Grübler, A. (1988), *The Rise and Fall of Infrastructures. Dynamics of Evolution and Technological Change in Transport*, Ph.D. dissertation. Vienna: Technical University.

Haldane, J.B.S. (1924), The mathematical theory of natural and artificial selection, *Transactions, Cambridge Philosophical Society, 23*:19-41.

Hobsbawm, E.J. and G. Rude (1968), *Captain Swing.* Pantheon Books, New York

Hohenemser, C., R. Kasperson, and R. Kates (1977), The distrust of nuclear power. Science 196(4285):25-34.

Kasperson, R.E., G. Berk, D. Pijawka, A.B. Sharaf, and J. Wood (1979), Public opposition to nuclear energy: retrospect and prospect. *Sociopolitical Effects of Energy Use and Policy*, C.R. Unseld et al. (eds.). Washington, DC: National Academyof Sciences.

La Porte, T.R. and D. Metlay (1975), Technology observed: Attitudes of a wary public. *Science 188*(4184:121-127.

Levi, D.J. and E.E. Holder (1986), Nuclear power. The dyamics of acceptability. *Environment and Behavior 18*(3):385-395.

Lotka, A.J. (1925), *Elements of Physical Biology.* Baltimore, MD: Williams and Wilkins.

Lotka, A.J. (1956), *Elements of Mathematical Biology.* New York: Dover Publications, Inc.

Marchetti, C. and N. Nakicenovic (1979), *The Dynamics of Energy Systems and the Logistic Substitution Model.* Research Report RR-79-13. Laxenburg, Austria: International Institute for Applied Systems Analysis.

Marshall, V.C. (1988), A perspective view of industrial disaster. *Atom*, February, pp. 2-7.

Mazur, A., A.A. Marino, and R.O. Becker (1979), Separating factual disputes from value disputes in controversies over technology. *Technology in Society 1*:229-237.

Mazur, A. (1984a), The journalists and technology: Reporting about love canal and Three Mile Island. *Minerva 22*(1):45-66.

Mazur, A. (1984b), Media influences on public attitudes toward nuclear power. *Public Reactions to Nuclear Power. Are There Critical Masses?*, W.R. Freudenburg and E.A. Rosa (eds.). AAAS Selected Symposium 93. Washington, DC: American Association for the Advancement of Science.

Mazur, A. (1987), *Mass Media Effects on Public Opinion About Nuclear Power Plants.* Syracuse, New York: Syracuse University.

Montroll, E.W. and N.S. Goel (1971), On the Volterra and other nonlinear models of interacting populations, *Rev. Mod. Phys., 43*(2):231.

Nakicenovic, N. (1979), *Software Package for the Logistic Substitution Model.* Research Report RR-79-12. Laxenburg, Austria: International Institute for Applied Systems Analysis.

Oliver, F.R. (1964), Methods of estimating the logistic growth function, *Applied Statistics, 13*:57-66.

Otway, H.J., D. Maurer, and K. Thomas (1978), Nuclear power. The question of public acceptance. *Futures 10*(2):109-118.

Pearl, R. (1924), *Studies in Human Biology.* Baltimore,MD: Williams and Wilkins Co.

Pearl, R. (1925), *The Biology of Population Growth.* New York: Alfred A. Knopf, Inc.

Pemberton, H. Earl (1936), The curve of culture diffusion. *American Sociological Review 1*(4).

Peschel, M. and W. Mende (1986), *The Predator-Prey Model.* Berlin, Heidelberg, and New York: Springer Verlag.

Peterka, V. (1977), *Macrodynamics of Technological Change - Market Penetration by New Technologies.* Research Report RR-77-22. Laxenburg, Austria: International Institute for Applied Systems Analysis.

Philipp, H.J. (1985), Der beduinische Widerstand gegen die Hedschasbahn. *Die Welt des Islams 25*:31-83.

Phillips. D.P. (1980), Airplane accidents, murder, and the mass media: Towards a theory of imitation and suggestion. *Social Forces 58*(4):1001-1024.

Rappaport, R.A. (1971), *The Sacred in Human Evolution.* Ann Arbor, MI: University of Michigan, Dept. of Anthropology.

Rüdig, W. (1987), Outcomes of nuclear technology policy: do varying political styles make a difference? *Journal of Public Policy* 7(4):390-430.

Schumpeter, H. (1939), *Business Cycles. A Theoretical, Historial and Statistical Analysis of the Capitalist Process*, volumes I and II. New York: McGraw-Hill.

Smith, V.K. and F.R. Johnson (1988), How do risk perceptions respond to information? The case of radon. *The Review of Economics and Statistics* 52(1):1-8.

Trevor-Roper, H.R. (1969), *The European Witch Craze.* New York: Harper and Row.

Verhulst, P.F. (1845), in *Nouveaux Memoires de l'Academie Royale des Sciences, des Lettres et des Beaux-Arts de Belgique 18*:1-38.

Volterra, V. (1931), *Lecon sur la Theorie Mathematique de la Lutte Pour la Vie.* Paris: Gauthier-Villars.

Webber, D.J. (1982), Is nuclear power just another environmental issue? An analysis of California voters. *Environment and Behavior 14*(1):72-83.

Wynn, B. (1979), The rationality and ritual of nuclear decision making. *Scientific Expertise and the Public. Conference Proceedings*, H. Skoie (ed.). Oslo: Institute for Studies in Research and Higher Education of the Norwegian Research Council for Science and the Humanities.

Appendix A

MATHEMATICAL APPENDIX

The equations for dealing with different cases are reducible to the general Volterra–Lotka equations

$$\frac{dN_i}{dt} = K_i N_i + \beta_i^{-1} \sum_{n}^{j=1} a_{ij} N_i N_j \quad , \tag{1}$$

where N_i is the number of individuals in species i, and a, β, and K are constants. The equation says a species grows (or decays) exponentially, but interacts with other species. A general treatment of these equations can be found in Montroll and Goel (1971) and Peschel and Mende (1986). Since closed solutions exist only for the case of one or two competitors, these treatments mainly deal with the general properties of the solutions.

To keep the analysis at a physically intuitive level, I use the original treatment of Verhulst (1845) for the population in a *niche* (Malthusian) and that of Haldane (1924) for the competition between two genes of different fit. For the multiple competition, a computer package has been developed that works perfectly for actual cases (Marchetti and Nakicenovic, 1979), but whose identity with the Volterra equations is not fully proved (Nakicenovic, 1979). Most of the results are presented using the coordinates for the linear transform of a logistic equation originally introduced by Fisher and Pry (1970).

The Malthusian Case

This modeling of the dynamics of population systems started with Verhulst in 1845, who quantified the Malthusian case. A physically very intuitive example is given by a population of bacteria growing in a bottle of broth. Bacteria can be thought of as machinery that transforms a set of chemicals in the broth into bacteria. The rate of this transformation, *coeteris paribus* (e.g., temperature), can be seen as proportional to the number of bacteria (the transforming machinery) and the concentration of the transformable chemicals.

Since all transformable chemicals will be converted eventually into bacterial bodies, one can measure broth chemicals in terms of bacterial bodies using homogeneous units. So $N(t)$ is the number of bacteria at time t, and $\bar{N}$ is the amount of transformable chemicals at time 0, before multiplication starts. The Verhulst equation can then be written

$$\frac{dN}{dt} = aN(\bar{N} - N) \quad , \tag{2}$$

whose solution is

$$N(t) = \frac{\bar{N}}{1-e^{-(at+b)}} \quad , \tag{3}$$

with b an integration constant, sometimes written as t_0, i.e., time at time 0; a is a rate constant that is assumed to be independent of the size of the population. This means that there is no "proximity feedback". If we normalize to the final size of the system, $\bar{N}$, and explicate the linear expression, equation (2) can be written in the form suggested by Fisher and Pry (1970)

$$\log\frac{F}{1-F} = at + b \quad , \quad \text{where } F = \frac{N}{\bar{N}} \quad . \tag{4}$$

Most of the charts are presented in this form. The variable $\bar{N}$ is often called the *niche*, and the growth of a population is given as the fraction of the niche it fills. An example is given in Figure A.1, reporting the case of mainframe computer penetration in the Japanese market. It is obvious that this analysis has been made with the assumption that there are no competitors. A single species grows to match the resources ($\bar{N}$) in a Malthusian fashion.

The fitting of empirical data requires calculation of the three parameters $\bar{N}$, a, and b, for which there are various recipes (Oliver, 1964; Blackman, 1972; Bossert, 1977). The problem is to choose the physically more significant representation and procedure. I personally prefer to work with the Fisher and Pry transform, because it operates on ratios (e.g., of the size of two populations), and ratios seem to me more important than absolute values, both in biology and in social systems.

The calculation of $\bar{N}$ is usually of great interest, especially in economics. However, the value of $\bar{N}$ is very sensitive to the value of the data, i.e., to their errors, especially at the beginning of the growth. The problem of assessing the error on $\bar{N}$ has been studied by Debecker and Modis (1986), using numerical simulation.

The Malthusian logistic must be used with great precaution because it contains implicitly some important hypothesis:

- that there are no competitors in sight
- that the size of a niche remains constant
- that the species and its boundary conditions (e.g., temperature for the bacteria) stay the same.

The fact that in multiple competition the starts are always logistic may lead to the presumption that the system is Malthusian. When the transition period starts there is no way of patching up the logistic fit.

The fact that the niches keep changing, due to the introduction of new technologies, makes this treatment, generally speaking, unsuitable for dealing with the growth of human populations, a subject in which Pearl (1924) first applied logistics. Since the treatment sometimes works and sometimes does not work, one can find much faith and disillusionment among demographers.

One-to-One Competition

The case for the penetration of a mutant or a variety of mutants having some advantage with respect to the preexisting mutants was studied by Haldane (1924). These results can be described quantitatively by saying that variety (N_1) has a reproductive advantage of k over variety (N_2). Thus, for every generation the ratio of the number of individuals in the two varieties will be changed by $\frac{1}{(1-k)}$. If n is the number of generations, starting from $n = 0$, then we can write

$$\frac{N_1}{N_2} = \frac{R_0}{(1-k)^n} \quad , \tag{5}$$

where

$$R_0 = \frac{N_1}{N_2} \text{ at } t = 0 \quad .$$

If k is small, as it usually is in biology (typically 10^{-3}), we can write

$$\frac{N_1}{N_2} = \frac{R_0}{e^{kn}} \quad . \tag{6}$$

We are then formally back to square one, i.e., to the Malthusian case, except for the very favorable fact that we have an initial condition (R_0) instead of a final condition ($\bar{N}$). This means that in relative terms the evolution of the system is not sensitive to the size of the niche, a property that is extremely useful for forecasting in multiple competition cases. Since the generations can be assumed to be spaced equally, n is actually equivalent to time.

As for the biological case, it is difficult to prove that the "reproductive advantage" remains constant in time, especially when competition lasts for decades and the technology of the competitors keeps changing, not to mention social and organizational changes. But the analysis of hundreds of cases shows that systems behave in a similar manner. An example is given in Figure A.2 with the substitution of horses by automobiles in personal transportation in the UK.

Multiple Competition

Multiple competition is dealt using a computer package originally developed by Nakicenovic (1979). A simplified description says that all the competitors start in a logistic mode and end in a logistic mode. They undergo a transition from a logistic-in to a logistic-out during which they are calculated as "residuals", i.e., as the difference between the size of the niche and the sum of all the *ins* and *outs*. The details of the rules are found in Nakicenovic (1979). This package has been used to treat about two hundred empirical cases, all of which show an excellent match with reality. For example, see Figure A.3 dealing with multiple substitution of transport infrastructures in the USSR. An attempt to link this kind of treatment to current views in economics has been made by Peterka (1977).

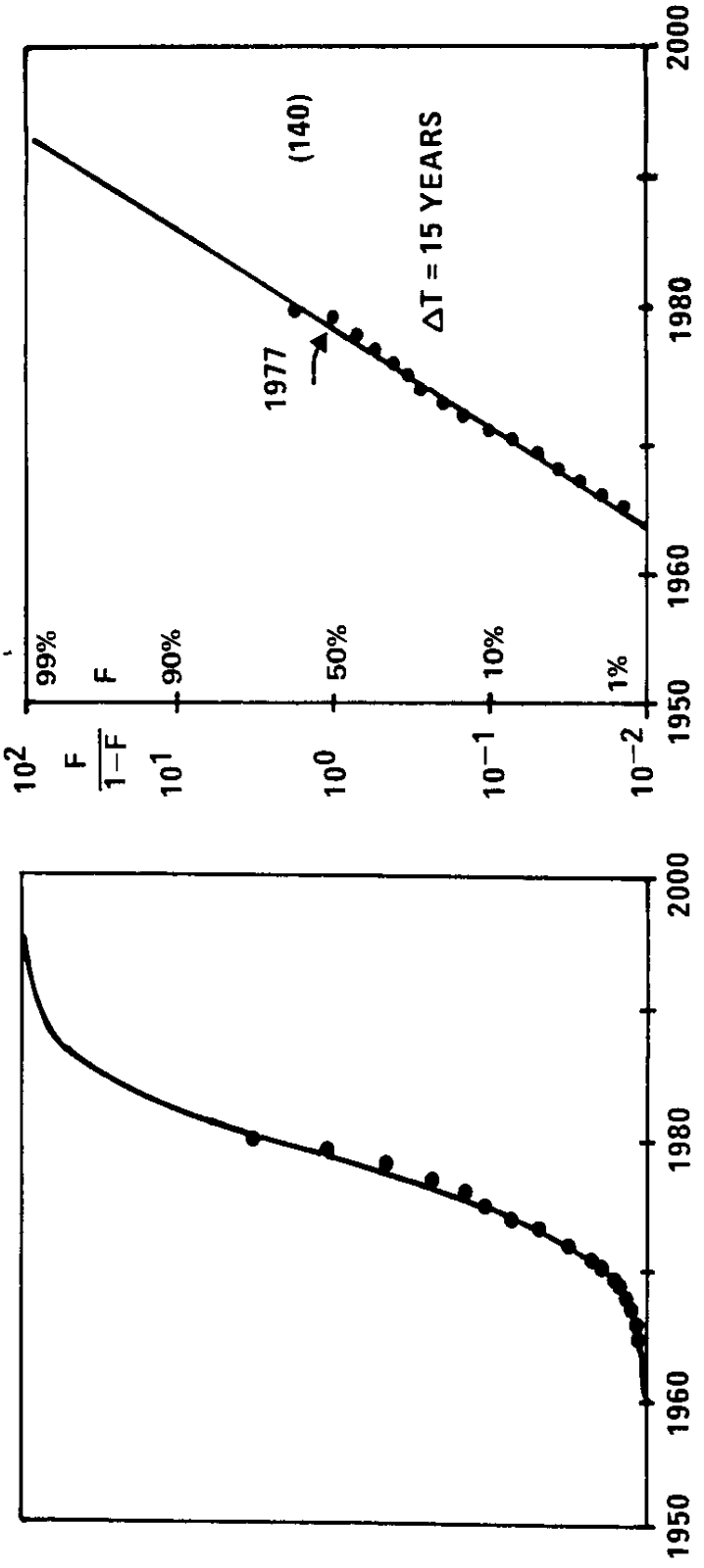


FIGURE A.1. Penetration of Mainframe Computers in Japan.

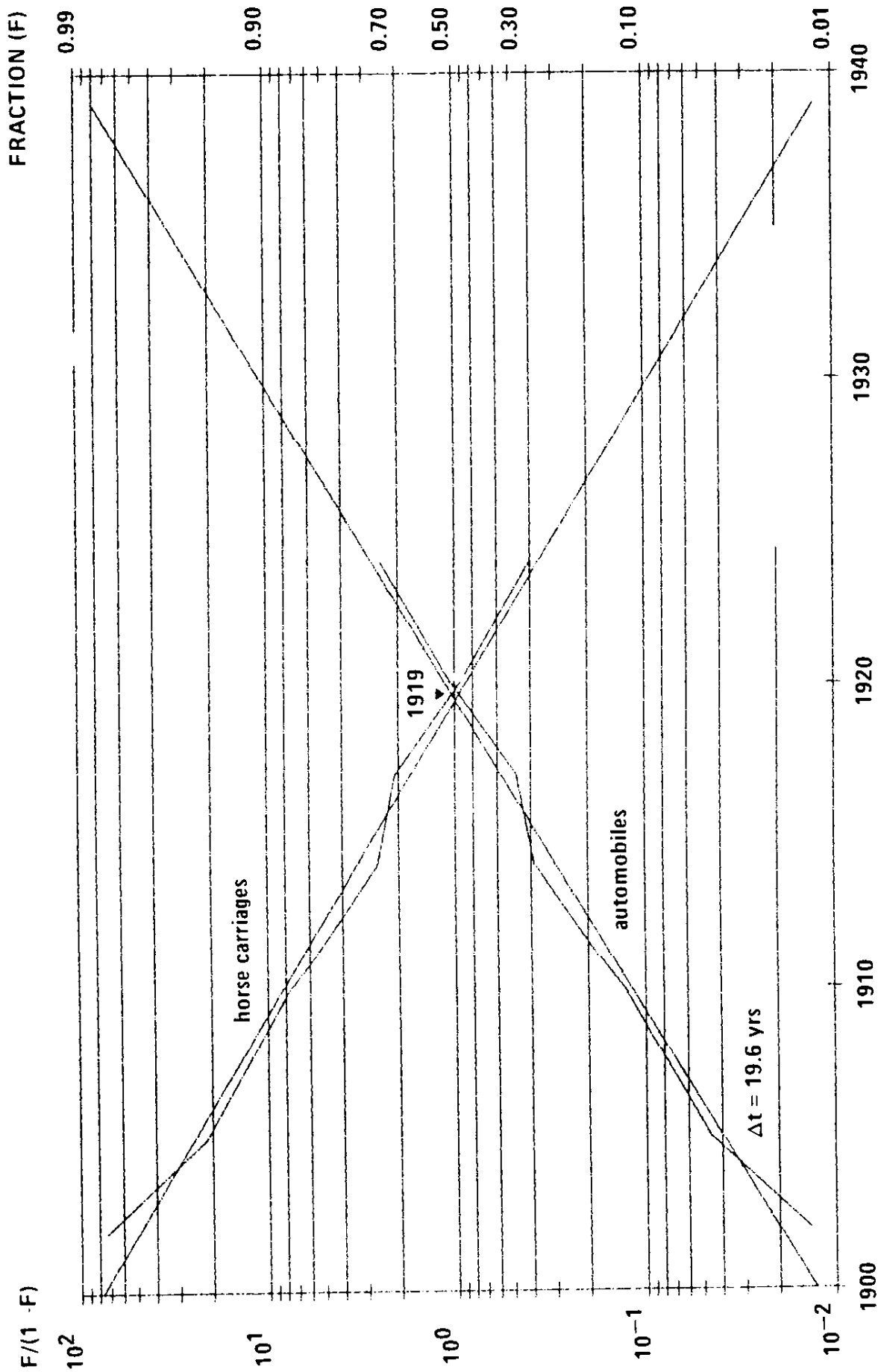


FIGURE A.2. United Kingdom: Road Vehicle Fleet.
SOURCE: Grübler (1988).

Figure A.3

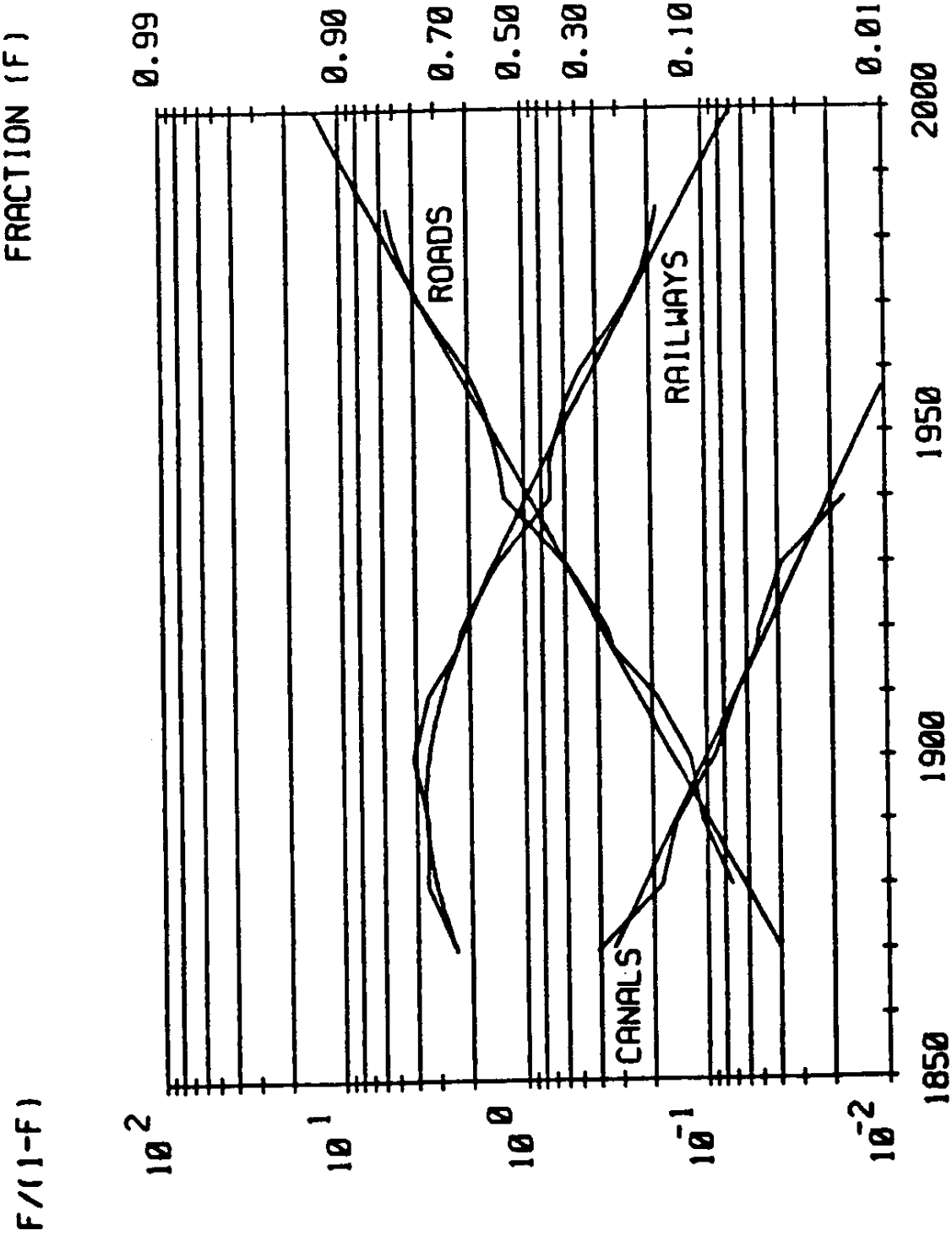


FIGURE A.3. Growth of Infrastructure in the USSR.
SOURCE: Grübler (1988).

Appendix B

Der Spiegel's "Green Monster"

With respect to *Der Spiegel's* "Green Monster" of 1977 (Figure B.1), the attention pulse does not appear to be linked to any particular nuclear event. To look deeper into the matter, all the 55 articles related to nuclear business in the first 20 issues of the magazine were read to try to see if a content analysis could give a hint about their primary cause. There must be a special cause because the pulse is so similar to that of Chernobyl (or Three Mile Island for the US media).

The wave starts with a cover article in the first (double) issue of 1977. The cover says *"Atom Strom, die grosse Illusion"* and the cover article is entitled *"Atomenergie: Eine chaotische Entwicklung"*. The title was selected from a statement made by a famous US Professor, Barry Commoner, who was quoted in the article: *"In jeder Phase der chaotischen Entwicklung der Nuklear-Industrie haben technische Schwierigkeiten zu unerwarteten wirtschaftlichen Problemen geführt"*.

The statement is moody and clearly indicates the indestructible if empty logic of the opponents. It is a negative statement applicable to any enterprise containing technology. The chaotic development may refer to some personal impression. Certainly it does not fit the very clean curves shown in Figures 36 through 39. The article could have been written by Amory Lovins, so many of his logical monsters have crept in. I picked just 20 of them, and they are listed at the end. What is extraordinary is that a critical and usually well-documented journal such as *Der Spiegel* publishes this kind of article on its front page.

But the story just begins here. After three issues of silence with no coverage on nuclear power, *Der Spiegel* began a series of lengthy articles with the common title *"Alarm auf Station SL-1"*, dealing, with extreme details, about nuclear reactor accidents of all sorts since the beginning of nuclear energy, including experimental reactors. *Nuclear means death* can be considered the central theme, aptly illustrated with somber cartoons.

The author, John Grant Fuller, is a famous American journalist and documentary film producer. Fuller has written a number of books on nuclear accidents including *We Almost Lost Detroit* (1975), *The Poison that Fell from the Sky* (1978), and also *Aliens in the Sky*. He has received many awards and obviously is very capable of mounting a good story on many subjects. He wrote the first five lengthy and detailed articles in the *"Alarm auf Station SL-1"* series.

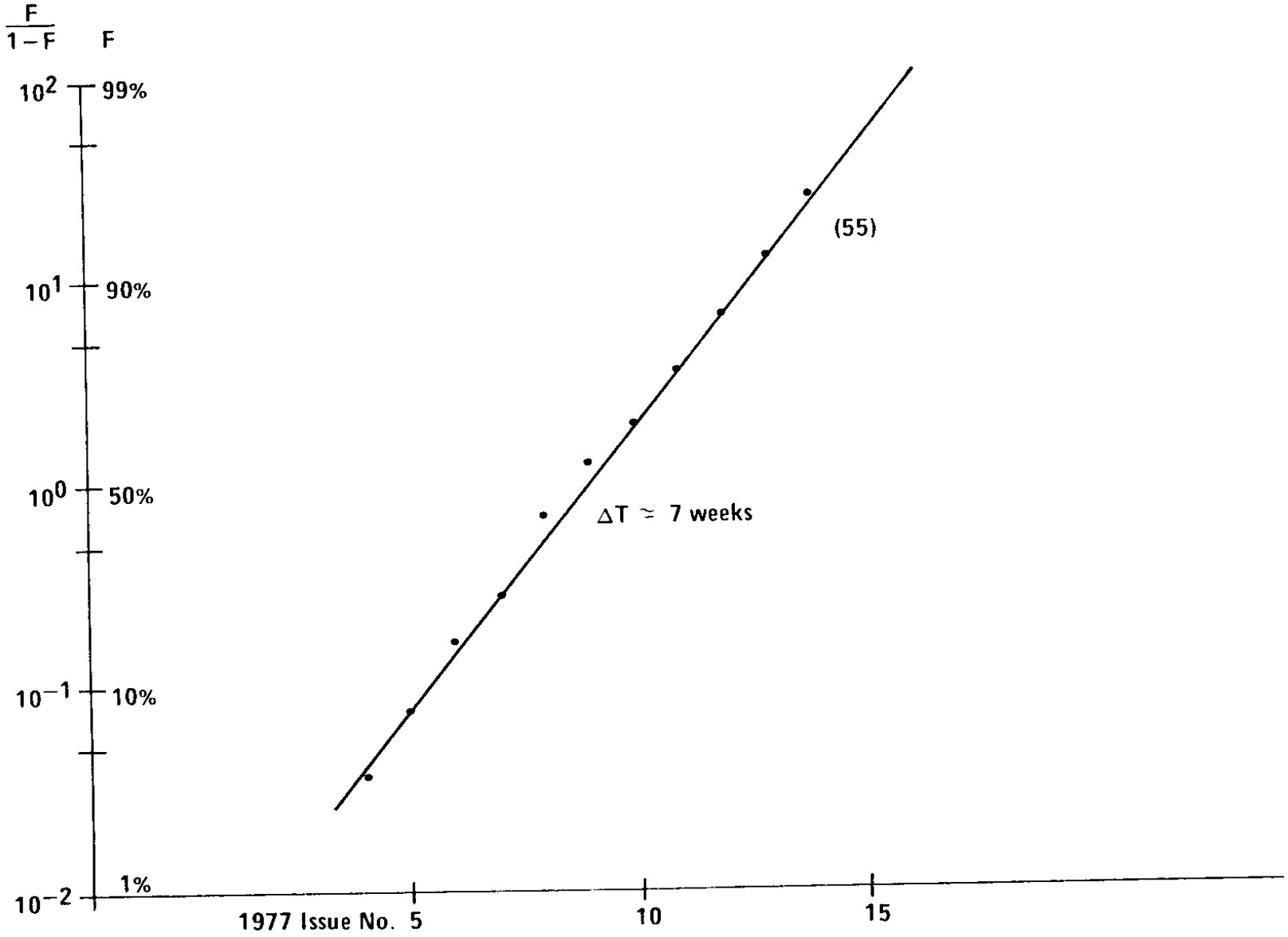


FIGURE B.1. Short Pulses of Articles on Nuclear Energy in *Der Spiegel*, Spring 1977.
DATA SOURCE: *Spiegel* Sachregister (1977).

The next three articles in the series were written by Frank Haensche, a German chemist writer, politician, and, for a period, member of the parliament. He is well known for a 1982 book written from an environmental perspective entitled *Die gigantische Verschwendung: Hintergründe und Ursachen der Energiekrise.* The articles he wrote for the series in *Der Spiegel* dealt with the FRG's internal affairs in nuclear energy. The articles were subtitled *"Bonn's Energie-Programm: Ein risikoreiches Konzept."*

In these three articles, much more amateurish and less technically documented than the previous five, he deals with a lot of amusing subjects like solar houses *"showing their teeth to oil sheiks"*, or on the nuclear plants hearing in Bonn. The illustrations have synthetic scripts saying: *"100,000 dead instantly, and 1.6 million in due time"* or with the grin of a politician, *"atom opposition in Sweden - the government brought down"*.

The last article is illustrated by a cartoon where a nuclear power station sits in the background of a cemetery filling all land, with lights on the crosses and the script *"Sicherheit beruhigt. Kernkraft sorgt auch für Ihr ewiges Licht"*.

This set of eight articles was enriched by contributions of famous stars like Robert Jungk and a roster of political opponents, representatives of the *Bürgerinitiativen* and the Greens. A contour of all sorts of short articles dealing in a very alarmistic way with all parts of the nuclear plants aspects (*"we will get fishes already boiled!"*) make up the logistic pulse already analyzed.

It seems that the system reacted well. In fact if one looks *a posteriori* at the evolution of nuclear GW installed in the FRG (Figure 19), one sees that the process of introducing nuclear reactors finally proceeded with astral precision.

Large social systems in general, according to our numerous analyses, seem to have feedback systems that keep them on one course. This should not be interpreted fatalistically, as it is sometimes done looking at our charts. We are all active parts of the feedback system.

Why *Der Spiegel* did all this is an open question that may carry very interesting answers. Following is a list of personal comments on the leading article.

Some Big Bugs in the Cover Article

Cover article *Der Spiegel*, Vols. 1-2 (1977) – "Atomenergie: Eine chaotische Entwicklung."

General comments

Emotional, confusing, contradictory. Technically wrong or very imprecise. The title is taken from a statement by Barry Commoner.

It is written in the typical style of Amory Lovins. Here are listed some of the blunders or emotional hints.

Specific points

(1) Rockets and outer space disposal of waste. Suggestion: No place on earth.

(2) Never in capitalistic countries so much invested into new technologies. (What about aviation spent to develop a technology?)

(3) "Komplott" atmosphere, politico-capitalist, schoolboy network. (Isn't that business as usual?)

(4) Across 1974, costs of nuclear power stations did increase fourfold. (Curiously, as much as oil and coal. Price homeostasis).

(5) Found contradiction! Companies who claim we are short of electric capacity also suggest to use night electricity. (Understand nothing of load cycle.)

(6) Truman suggested peaceful use of nuclear energy to sooth his guilty conscience for Hiroshima. (Oh my!)

(7) Big pusher for nuclear (H. Mandel) head of utility (RWE). (If nuclear energy is so wildly anti-economic, utilities are committing suicide.)

(8) Barry Commoner quoted as an authoriatative (and objective!) speaker on nuclear energy. (Oh my!)

(9) If one large nuclear station stops, others must rush to keep the network alive. (Great news. This in fact defines the size of a NPS.)

(10) Great hopes from nuclear, but only 5% of primary energy in the year 2000. (Time constants for penetration in energy business is very long. Oil was not faster.)

(11) Uranium will end before oil. (Little feeling about the search and find game.)

(12) Coal is scarce because miners are scarce. (And the ones who exist are very sticky. Nobody can get rid of them.)

(13) Americans are great wasters of energy, Swedes great savers. Germans so, so. (Cars are the culprits as usual.)

(14) Solution available: Take biomass and ferment it to methanol. (Biomass is there, but no way to ferment it to methanol.)

(15) Methanol (from crude oil!) too expensive (four times). Solution: Reduce (eliminate) taxing. (Very cheap solution. But who pays for the lost revenues from these taxes?)

(16) According to NASA, 20,000 GW available from wind using wind rotors "at no risk". (Transport, accumulation, maintenance, risks, not mentioned. Not even probable costs.)

(17) Solar houses available for DM 20,000 (solar cells and heating). (Let us hundred flowers blossom. Penetration constants low. Electricity still from net.)

(18) The assurance from the experts that major reactor accidents, *with hundreds of thousand lives lost*, are improbable, is not reassuring. (See Chernobyl.)

(19) Russians go to nuclear because the story of their large reserves of oil and gas (e.g., in Siberia) is a bluff. (They saw it.)

(20) Water power. (Curiously, only tidal. What about inter-tidal ecology? Greens love it.)

Appendix C

In order to give an idea of the extent of periodic literature covered by the *Readers Guide to Periodical Literature*, the periodics reviewed for 1986 are listed below.

PERIODICALS INDEXED

All data as of latest issue received

*50 Plus. $15. m (ISSN 0163-2027) 50 Plus, 99 Garden St., Marion, OH 43302

A

Aging. $5. q (ISSN 0002-0966) Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402

America. $25. w (except first Saturday of the year, and alternate Saturdays in Jl and Ag) (ISSN 0002-7049) America Press Inc., 106 W. 56th St., New York, NY 10019

American Artist. $21. m (ISSN 0002-7375) American Artist, 1 Color Court, Marion, OH 43305

American Craft. $39.50. bi-m (ISSN 0194-8008) Membership Dept., American Craft Council, P.O. Box 1308-CL, Fort Lee, NJ 07024

American Education. $23. m (bi-m Ja-F, Ag-S) (ISSN 0002-8304) Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402
Ceased publication with Vol. 21, No. 3, 1985

*American Heritage. $45. bi-m (ISSN 0002-8738) American Heritage Subscription Office, P.O. Box 977, Farmingdale, NY 11737

American History Illustrated. $18. m (except Jl, Ag) (ISSN 0002-8770) American History Illustrated, Box 8200, Harrisburg, PA 17105

The American Scholar. $16. q (ISSN 0003-0937) The American Scholar, Editorial and Circulation Offices, 1811 Q St., N.W., Washington, DC 20009

Americana. $11.90. bi-m (ISSN 0090-9114) Americana Subscription Office, 205 W. Center St., Marion, OH 43302

Américas. $15. bi-m (ISSN 0379-0940) Américas Subscription Service, P.O. Box 973, Farmingdale, NY 11737

Antiques. $38. m (ISSN 0161-9284) The Magazine Antiques, Old Mill Rd., P.O. Box 1975, Marion, OH 43306

Antiques & Collecting: Hobbies. See Hobbies

Architectural Digest. $39.95. m (ISSN 0003-8520) Architectural Digest, P.O. Box 10040, Des Moines, IA 50350

Architectural Record. $45. m (semi-m Ap, S) (ISSN 0003-858X) Architectural Record, P.O. Box 2025, Mahopac, NY 10541

Art in America. $39.95. m (ISSN 0004-3214) Art in America, 542 Pacific Ave., Marion, OH 43306

Art News. $29.95. m (q Je-Ag) (ISSN 0004-3273) Art News, Subscription Service, P.O. Box 969, Farmingdale, NY 11737

Astronomy. $21. m (ISSN 0091-6358) Astronomy, 1027 N. Seventh St., Milwaukee, WI 53233

*The Atlantic. $9.95. m (ISSN 0276-9077) Atlantic Subscription Processing Center, Box 2547, Boulder, CO 80322

Audubon. $16. bi-m (ISSN 0097-7136) National Audubon Society, 950 Third Ave., New York, NY 10022

Aviation Week & Space Technology. $70. w (ISSN 0005-2175) Aviation Week & Space Technology, P.O. Box 1505, Neptune, NJ 07753

B

*Better Homes and Gardens. $12.97. m (ISSN 0006-0151) Better Homes and Gardens, P.O. Box 4536, Des Moines, IA 50336

BioScience. $72. m (bi-m Jl, Ag) (ISSN 0006-3568) BioScience Circulation, AIBS, 730 11th St. N.W., Washington, DC 20001-4584

Black Enterprise. $15. m (ISSN 0006-4165) Black Enterprise, Circulation Service Center, P.O. Box 3009, Harlan, IA 51537

Blair & Ketchum's Country Journal. $16.95. m (ISSN 0094-0526) Country Journal, P.O. Box 392, Mt. Morris, IL 61054
Name changed to Country Journal with October 1986

The Bulletin of the Atomic Scientists. $29.50. m (bi-m Je/Jl, Ag/S) (ISSN 0096-3402) Bulletin of the Atomic Scientists, Circulation Dept., 5801 S. Kenwood, Chicago, IL 60637

Business Week. $39.95. w (except 1 issue in Ja) (ISSN 0007-7135) Business Week, P.O. Box 430, Hightstown, NJ 08520

Byte. $21. 13 times a yr (ISSN 0360-5280) Byte Subscriber Service, P.O. Box 328, Hancock, NH 03449

C

Car and Driver. $16.98. m (ISSN 0008-6002) Car and Driver, P.O. Box 2770, Boulder, CO 80302

The Center Magazine. $25. bi-m (ISSN 0008-9125) Center Magazine, Box 4068, Santa Barbara, CA 93103

Change. $40. bi-m (ISSN 0009-1383) Heldref Publications, 4000 Albemarle St., N.W., Washington, DC 20016

*Changing Times. $15. m (ISSN 0009-143X) Changing Times, The Kiplinger Magazine, Editors Park, MD 20782

Channels (New York, N.Y.: 1986). $39.50. 10 times a yr (ISSN 0276-1572) Channels, Subscription Service Dept., Box 2001, Mahopac, NY 10541
Formerly Channels of Communications; name changed with September 1986

Channels of Communications. $39.50. 10 times a yr (ISSN 0276-1572) Channels of Communications, Subscription Service Dept., Box 2001, Mahopac, NY 10541
Name changed to Channels (New York, N.Y.: 1986) with September 1986

Children Today. $16. bi-m (ISSN 0361-4336) Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402

The Christian Century. $28. w (occasional bi-w issues) (ISSN 0009-5281) Christian Century, Subscription Service Dept., 5615 W. Cermak Rd., Cicero, IL 60650

Christianity Today. $19.50. semi-m (m Ja, My, Je, Jl, Ag, D) (ISSN 0009-5753) Christianity Today Subscription Services, 465 Gundersen Dr., Carol Stream, IL 60188

Commentary. $36. m (ISSN 0010-2601) American Jewish Committee, 165 E. 56th St., New York, NY 10022

Commonweal. $28. bi-w (m Christmas-New Year's and Jl, Ag) (ISSN 0010-3330) Commonweal Publishing Co., 232 Madison Ave., New York, NY 10016

Congressional Digest. $24. m (bi-m Je-Jl, Ag-S) (ISSN 0010-5899) Congressional Digest Corp., 3231 P St., N.W., Washington, DC 20007

The Conservationist. $5. bi-m (ISSN 0010-650X) Conservationist Circulation Office, P.O. Box 1500, Latham, NY 12110

*Consumer Reports. $16. m (ISSN 0010-7174) Subscription Director, Consumer Reports, Box 2480, Boulder, CO 80322

*Consumers' Research Magazine. $18. m (ISSN 0095-2222) Circulation Dept., Consumers' Research Magazine, P.O. Box 642, Holmes, PA 19043

Country Journal. $16.95. m (ISSN 0094-0526) Country Journal, P.O. Box 392, Mt. Morris, IL 61054
Formerly Blair & Ketchum's Country Journal; name changed with October 1986

Current Health 2. $4.95. m (S-My) (ISSN 0163-156X) Curriculum Innovations, Inc., 3500 Western Ave., Highland Park, IL 60035

Current History. $27. m (except Je, Jl, Ag) (ISSN 0011-3530) Current History, 4225 Main St., Philadelphia, PA 19127

Current (Washington, D.C.). $37. m (bi-m Mr-Ap, Jl-Ag) (ISSN 0011-3131) Current, 4000 Albemarle St., N.W., Washington, DC 20016

Cycle. $13.98. m (ISSN 0574-8135) Cycle Circulation Dept., P.O. Box 2776, Boulder, CO 80302

PERIODICALS INDEXED

D

Dance Magazine. $23.95. m (ISSN 0011-6009) Dance Magazine, P.O. Box 960, Farmingdale, NY 11737
Department of State Bulletin. $21. m (ISSN 0041-7610) Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402
Design for Arts in Education. $35. 6 times a yr (ISSN 0011-9253) Design for Arts in Education, 4000 Albemarle St., N.W., Washington, DC 20016
Discover. $24. m (ISSN 0274-7529) Time Inc., Time & Life Building, Rockefeller Center, New York, NY 10020-1393
Down Beat. $18. m (ISSN 0012-5768) Down Beat, 222 W. Adams St., Chicago, IL 60606

E

Earth Science. $10. q (ISSN 0012-8228) Earth Science, 4220 King St., Alexandria, VA 22302
*__Ebony.__ $16. m (ISSN 0012-9011) Ebony, 820 S. Michigan Ave., Chicago, IL 60605
The Education Digest. $18. m (S-My) (ISSN 0013-127X) Prakken Publications, Inc., 416 Longshore Dr., P.O. Box 8623, Ann Arbor, MI 48107
Environment. $40. m (bi-m Ja-F, Jl-Ag) (ISSN 0013-9157) Environment, 4000 Albemarle St., N.W., Washington, DC 20016
Esquire. $17.94. m (ISSN 0194-9535) Esquire Subscriptions, 1225 Portland Pl., Boulder, CO 80323
Essence. $12. m (ISSN 0014-0880) Essence, P.O. Box 53400, Boulder, CO 80322

F

The Family Handyman. $11.97. m (bi-m My-Je, Jl-Ag) (ISSN 0014-7230) Family Handyman, Subscriber Service Dept., 52 Woodhaven Rd., Marion, OH 43302
FDA Consumer. $9.50. m (bi-m Jl-Ag, D-Ja) (ISSN 0362-1332) Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402
*__Field & Stream.__ $15.94. m (ISSN 0015-0673) Field & Stream, P.O. Box 2822, Boulder, CO 80302
Film Comment. $12. bi-m (ISSN 0015-120X) Film Comment, 140 W. 65th St., New York, NY 10023
Flower and Garden. $9. bi-m (ISSN 0162-3249) Circulation Dept., Flower and Garden Magazine, 4251 Pennsylvania Ave., Kansas City, MO 64111
Flying. $18.98. m (ISSN 0015-4806) Flying, Circulation Dept., P.O. Box 2772, Boulder, CO 80302
Focus (New York, N.Y.: 1950). $10. q (ISSN 0015-5004) Focus/AGS, Suite 600, 156 Fifth Ave., New York, NY 10010
Forbes. $45. bi-w (except w 2 weeks in Ap and 2 weeks in O) (ISSN 0015-6914) Forbes Subscription Service, 60 Fifth Ave., New York, NY 10011
*__Foreign Affairs.__ $28. 5 times a yr (ISSN 0015-7120) Foreign Affairs Reader Services, 58 E. 68th St., New York, NY 10021
Foreign Policy. $21. q (ISSN 0015-7228) Foreign Policy Subscription Dept., P.O. Box 984, Farmingdale, NY 11737
*__Fortune.__ $44.50. bi-w (3 issues in O) (ISSN 0015-8259) Fortune, 541 N. Fairbanks Court, Chicago, IL 60611
The Futurist. $30. bi-m (ISSN 0016-3317) World Future Society Headquarters, 4916 St. Elmo Ave., Bethesda, MD 20814

G

Glamour. $15. m (ISSN 0017-0747) Glamour, Box 5203, Boulder, CO 80322
*__Good Housekeeping.__ $14.97. m (ISSN 0017-209X) Good Housekeeping, P.O. Box 10055, Des Moines, IA 50350
Gourmet. $18. m (ISSN 0017-2553) Gourmet, P.O. Box 2980, Boulder, CO 80302

H

*__Harper's.__ $18. m (ISSN 0017-789X) Harper's Magazine, P.O. Box 1937, Marion, OH 43305
Harper's Bazaar. $16.97. m (ISSN 0017-7873) Harper's Bazaar, P.O. Box 10055, Des Moines, IA 50350
*__Health (New York, N.Y.).__ $22. m (ISSN 0014-7249) Health Subscription Dept., P.O. Box 6030, Palm Coast, FL 32037-6030
*__High Fidelity (Musical America edition).__ $27.94. m (ISSN 0018-1463) High Fidelity/Musical America, P.O. Box 10765, Des Moines, IA 50340
Musical America edition ceased publication with December 1986
History Today. $39. m (ISSN 0018-2753) Expeditors of the Printed Word, Ltd., 527 Madison Ave., New York, NY 10022
Hobbies. $18.50. m (ISSN 0018-2907) Hobbies, Circulation Dept., 1006 S. Michigan Ave., Chicago, IL 60605
At head of title: Antiques & Collecting
Holiday. See Travel Holiday
Home Mechanix. $13.94. m (ISSN 8755-0423) Home Mechanix, Subscription Dept., P.O. Box 2830, Boulder, CO 80322
*__Horizon (Tuscaloosa, Ala.).__ $21.95. m (bi-m Ja-F, Jl-Ag) (ISSN 0018-4977) Horizon Subscription Service, P.O. Box 37104, Washington, DC 20013
House & Garden. $24. m (ISSN 0018-6406) House & Garden, Box 5202, Boulder, CO 80322
The Humanist. $18. bi-m (ISSN 0018-7399) Humanist, 7 Harwood Dr., Amherst, NY 14226

I

International Wildlife. $15. bi-m (ISSN 0020-9112) National Wildlife Membership Services, 1412 16th St., N.W., Washington, DC 20036

J

Jet. $36. w (ISSN 0021-5996) Johnson Publishing Co. Inc., 820 S. Michigan Ave., Chicago, IL 60605

L

*__Ladies' Home Journal.__ $19.95. m (ISSN 0023-7124) Ladies' Home Journal, P.O. Box 4565, Des Moines, IA 50340
Life. $27. m (ISSN 0024-3019) Time Inc., 3435 Wilshire Blvd., Los Angeles, CA 90010

M

Maclean's. $60.50. w (ISSN 0024-9262) Subscription Dept., Maclean's, P.O. Box 1600, Postal Station A, Toronto, Ont. M5W 2B8, Canada
Mademoiselle. $15. m (ISSN 0024-9394) Mademoiselle, Box 5204, Boulder, CO 80322
The Magazine Antiques. See Antiques
McCall's. $12.95. m (ISSN 0024-8908) McCall's Customer Relations Manager, Box 56093, Boulder, CO 80322
*__Money.__ $31.95. m (ISSN 0149-4953) Money, P.O. Box 14429, Boulder, CO 80322
Monthly Labor Review. $16. m (ISSN 0098-0818) Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402
The Mother Earth News. $18. bi-m (ISSN 0027-1535) Mother Earth News Subscription Office, P.O. Box 70, Hendersonville, NC 28791
Motor Boating & Sailing. $15.97. m (ISSN 0027-1799) Motor Boating & Sailing, P.O. Box 10075, Des Moines, IA 50350
Motor Trend. $15.94. m (ISSN 0027-2094) Petersen Publishing Co., 8490 Sunset Blvd., Los Angeles, CA 90069
Ms. $16. m (ISSN 0047-8318) Ms. Magazine Subscription Dept., 123 Garden St., Marion, OH 43302
Musical America. See High Fidelity (Musical America edition)

N

The Nation. $45. w (except for the first week in Ja and bi-w Jl, Ag) (ISSN 0027-8378) Nation, Subscription Services, P.O. Box 1953, Marion, OH 43305
*__National Geographic.__ $18. m (ISSN 0027-9358) National Geographic Society, 17th and M Sts., N.W., Washington, DC 20036
*__National Geographic World.__ $10.95. m (ISSN 0361-5499) National Geographic World, 17th and M Sts., N.W., Washington, DC 20036
National Parks. $7. bi-m (ISSN 0027-9870) National Parks & Conservation Association, 1701 18th St., N.W., Washington, DC 20009

PERIODICALS INDEXED

*National Review. $34. bi-w (48p issue only, pub. in alternate weeks) (ISSN 0028-0038) National Review, Circulation Dept., 150 E. 35th St., New York, NY 10016

National Wildlife. $15. bi-m (ISSN 0028-0402) National Wildlife Membership Services, 1412 16th St., N.W., Washington, DC 20036

Nation's Business. $22. m (ISSN 0028-047X) Chamber of Commerce of the U.S., 1615 H St., N.W., Washington, DC 20062

*Natural History. $20. m (ISSN 0028-0712) Natural History, Box 5000, Harlan, IA 51537

The New Leader. $24. bi-w (except occasional combined issues) (ISSN 0028-6044) New Leader, 275 Seventh Ave., New York, NY 10001

The New Republic. $56. w (except 4 bi-w issues) (ISSN 0028-6583) Subscription Service Dept., New Republic, P.O. Box 955, Farmingdale, NY 11737

New York. $33. w (bi-w year-end issue and first 2 weeks in Jl) (ISSN 0028-7369) New York Magazine Subscription Dept., Box 2979, Boulder, CO 80322

The New York Review of Books. $34. bi-w (m Jl, Ag, S) (ISSN 0028-7504) New York Review, Subscription Service Dept., P.O. Box 940, Farmingdale, NY 11737

The New York Times Book Review. $26. w (ISSN 0028-7806) New York Times Co., Times Sq., New York, NY 10036

The New York Times Magazine. $77.75 (complete Sunday ed; not sold separately). w New York Times, Times Bldg., 229 W. 43rd St., New York, NY 10036

The New Yorker. $32. w (ISSN 0028-792X) New Yorker Magazine, 25 W. 43rd St., New York, NY 10036

*Newsweek. $41. w (ISSN 0028-9604) Newsweek, The Newsweek Bldg., Livingston, NJ 07039

O

Oceans. $19.95. bi-m (ISSN 0029-8174) Oceanic Society, P.O. Box 10167, Des Moines, IA 50340

Omni (New York, N.Y.). $24. m (ISSN 0149-8711) Omni Publications International Ltd., 1965 Broadway, New York, NY 10023-5965

Opera News. $30. m (Jl-N, My-Je) (bi-w during Metropolitan Opera broadcasting season) (ISSN 0030-3607) Opera News Circulation Dept., 1865 Broadway, New York, NY 10023

Organic Gardening. See Rodale's Organic Gardening

*Outdoor Life. $13.94. m (ISSN 0030-7076) Outdoor Life, Subscription Dept., Box 2851, Boulder, CO 80322

P

Parents. $18. m (ISSN 0195-0967) Parents, P.O. Box 3042, Harlan, IA 51537

People Weekly. $58.50. w (bi-w year end issue) (ISSN 0093-7673) People Weekly, Time & Life Bldg., Chicago, IL 60611

Personal Computing. $18. m (ISSN 0192-5490) Personal Computing, P.O. Box 2941, Boulder, CO 80321

Petersen's Photographic Magazine. $15.94. m (ISSN 0199-4913) Petersen Publishing Co., 8490 Sunset Blvd., Los Angeles, CA 90069

Phi Delta Kappan. $25. m (S-Je) (ISSN 0031-7217) Phi Delta Kappa, Inc., 8th & Union, P.O. Box 789, Bloomington, IN 47402

Physics Today. $70. m (ISSN 0031-9228) AIP S/F Division, 500 Sunnyside Blvd., Woodbury, NY 11797

*Popular Mechanics. $13.97. m (ISSN 0032-4558) Popular Mechanics, P.O. Box 10064, Des Moines, IA 50350

Popular Photography. $11.97. m (ISSN 0032-4582) Popular Photography Subscription Service, P.O. Box 2775, Boulder, CO 80302

Popular Science. $13.94. m (ISSN 0032-4647) Popular Science Subscription Dept., Box 2871, Boulder, CO 80322

*Prevention (Emmaus, Pa.). $13.97. m (ISSN 0032-8006) Rodale Press, Inc., 33 E. Minor St., Emmaus, PA 18049

The Progressive. $23.50. m (ISSN 0033-0736) The Progressive, 409 E. Main St., Madison, WI 53703

*Psychology Today. $15.99. m (ISSN 0033-3107) Customer Service Dept., Psychology Today, P.O. Box 2563, Boulder, CO 80322

Publishers Weekly. $89. w (bi-w year end issue) (ISSN 0000-0019) Publishers Weekly, P.O. Box 1979, Marion, OH 43302

R

Radio-Electronics. $16.97. m (ISSN 0033-7862) Radio-Electronics Subscription Dept., Box 55115, Boulder, CO 80321-5115

*Reader's Digest. $13.97 (plus .96 for postage) Available in a special Large-Type Edition at $8.95. m (ISSN 0034-0375) Reader's Digest Association, Pleasantville, NY 10570

Redbook. $11.97. m (ISSN 0034-2106) Redbook Consumer Relations Manager, Box 5242, Des Moines, IA 50340

Road & Track. $17.94. m (ISSN 0035-7189) Road & Track, P.O. Box 5331, 1255 Portland Pl., Boulder, CO 80321

Rodale's Organic Gardening. $12.97. m (ISSN 0884-3252) Rodale Press, Inc., 33 E. Minor St., Emmaus, PA 18049

Formerly Organic Gardening; name changed with August 1985

Rolling Stone. $23.95. bi-w (except combined issues in Jl and at year end) (ISSN 0035-791X) Straight Arrow Publishers, Inc., 745 Fifth Ave., New York, NY 10151

S

The Saturday Evening Post. $12.97. m (bi-m Ja-F, My-Je, Jl-Ag) (ISSN 0048-9239) Saturday Evening Post Subscription Offices, P.O. Box 10675, Des Moines, IA 50336

Saturday Review. $16. bi-m (ISSN 0361-1655) Saturday Review, Subscription Dept., P.O. Box 10010, Des Moines, IA 50340

Publication suspended with August/September 1986

Scholastic Update (Teachers' edition). $19. bi-w during the school year (ISSN 0037-2242) Scholastic Update, P.O. Box 644, Lyndhurst, NJ 07071-9985

Formerly Senior Scholastic; name changed with April 1, 1983

Science. $98. w (except for last week in December; extra issue in February) (ISSN 0036-8075) American Association for the Advancement of Science, 1333 H St., N.W., Washington, DC 20005

Science 86. $18. m (bi-m Ja/F and Jl/Ag) (ISSN 0193-4511) Science 86, Subscription Department, P.O. Box 10790, Des Moines, IA 50340

Continuation of: Science 85. Ceased publication with July/August 1986

*Science Digest. $13.97. m (ISSN 0036-8296) Science Digest, P.O. Box 10076, Des Moines, IA 50350

Ceased publication with September 1986

Science News. $29.50. w (bi-w year end issue) (ISSN 0036-8423) Science News, Subscription Dept., 231 W. Center St., Marion, OH 43305

Scientific American. $24. m (ISSN 0036-8733) Scientific American, Subscription Manager, P.O. Box 5969, New York, NY 10017

Sea Frontiers. $22. bi-m (ISSN 0036-9993) International Oceanographic Foundation, 3979 Rickenbacker Causeway, Virginia Key, Miami, FL 33149

Incorporating: Sea Secrets

Sea Secrets. See Sea Frontiers

Senior Scholastic. See Scholastic Update (Teachers' edition)

*Seventeen. $13.95. m (ISSN 0037-301X) Seventeen Subscription Dept., Radnor, PA 19088

Sierra. $12. bi-m (ISSN 0161-7362) Sierra Club, 730 Polk St., San Francisco, CA 94109

Skiing. $9.98. 7 times a yr (S-Mr) (ISSN 0037-6264) Skiing, P.O. Box 2777, Boulder, CO 80302

Sky and Telescope. $20. m (ISSN 0037-6604) Sky Publishing Corp., 49 Bay State Rd., Cambridge, MA 02238-1290

Smithsonian. $20. m (ISSN 0037-7333) Smithsonian, P.O. Box 2955, Boulder, CO 80322

Society. $38. bi-m (ISSN 0147-2011) Society, Box A, Rutgers-The State University, New Brunswick, NJ 08903

Southern Living. $19.95 in 17 Southern States and District of Columbia. $24 in other states. m (ISSN 0038-4305) Southern Living, Box 523, Birmingham, AL 35201

Space World. $18. m (ISSN 0038-6332) Palmer Publications, Inc., Amherst, WI 54406

Sport Magazine. $12. m (ISSN 0038-7797) Sport, P.O. Box 5016, Des Moines, IA 50306

*Sports Illustrated. $58.86. w (except semi-w issue in S and N and bi-w year end issue) (ISSN 0038-822X) Sports Illustrated, 541 N. Fairbanks Court, Chicago, IL 60811

Stereo Review. $9.98. m (ISSN 0039-1220) Stereo Review, Circulation Dept., P.O. Box 2771, Boulder, CO 80302

PERIODICALS INDEXED

Successful Farming. $10. m (semi-m Ja, F, Mr, Ap, bi-m My-Je, Jl-Ag) (ISSN 0039-4432) Successful Farming, Customer Service, P.O. Box 4536, Des Moines, IA 50336
Iowa edition indexed with January 1987

Sunset (Central edition). $14 in Alaska, Ariz., Calif., Colo., Hawaii, Idaho, Mont., Nev., N.Mex., Ore., Utah, Wash., Wyo. $18 in other states. m (ISSN 0039-5404) Sunset Magazine, Menlo Park, CA 94025

T

Technology Review. $27. m (bi-m N-D, F-Mr, My-Je, Ag-S) (ISSN 0040-1692) Technology Review, Room 10-140, MIT, Cambridge, MA 02139

*Teen. $12.95. m (ISSN 0040-2001) Petersen Publishing Co., 8490 Sunset Blvd., Los Angeles, CA 90069

Theatre Crafts. $24. m (bi-m Je-Jl, Ag-S) (ISSN 0040-5469) Subscription Dept., Theatre Crafts, P.O. Box 630, Holmes, PA 19043

Time. $58.24. w (ISSN 0040-781X) Time, 541 N. Fairbanks Court, Chicago, IL 60611

Today's Education (Annual edition). Available only to members. ann (ISSN 0272-3573) National Education Association of the United States, 1201 16th St., N.W., Washington, DC 20036
Absorbed by: NEA Today with September 1985

*Travel Holiday. $11. m (ISSN 0161-7184) Travel Subscription Office, Travel Bldg., Floral Park, NY 11001

U

U.S. Catholic. $15. m (ISSN 0041-7548) U.S. Catholic, 221 W. Monroe St., Chicago, IL 60606

*U.S. News & World Report. $34.50. w (except 2 issues combined at year end) (ISSN 0041-5537) U.S. News & World Report, Subscription Dept., P.O. Box 55929, Boulder, CO 80323-5929

UN Chronicle. $14. q (ISSN 0251-7329) United Nations Publications, Room DC2-0853, United Nations, New York, NY 10017

The UNESCO Courier. $7.55 (58 French francs). m (ISSN 0041-5278) Unipub, 345 Park Ave. S., New York, NY 10010

Update. See Scholastic Update (Teachers' edition)

USA Today (Periodical). $79. m (ISSN 0161-7389) The Society for the Advancement of Education, 1860 Broadway, New York, NY 10023

V

Vital Speeches of the Day. $25. semi-m (ISSN 0042-742X) City News Publishing Co., 389 Highway 17 By-Pass, Mount Pleasant, SC 29464

Vogue. $24. m (ISSN 0042-8000) Vogue, Box 5201, Boulder, CO 80322

W

The Washington Monthly. $30. m (bi-m Jl-Ag) (ISSN 0043-0633) Washington Monthly, 1711 Connecticut Ave., N.W., Washington, DC 20009

Weatherwise. $32. bi-m (ISSN 0043-1672) Weatherwise, Circulation Office, 4000 Albemarle St., N.W., Washington, DC 20016

Wilderness. $20. q (ISSN 0736-6477) The Wilderness Society, 1901 Pennsylvania Ave., N.W., Washington, DC 20006

Women's Sports & Fitness. $14.95. m (ISSN 8750-653X) Women's Sports & Fitness, P.O. Box 3734, Escondido, CA 92025
Formerly Women's Sports; name changed with May 1984

Workbench. $6. bi-m (ISSN 0043-8057) Workbench Circulation Dept., 4251 Pennsylvania, Kansas City, MO 64111

Working Woman. $18. m (ISSN 0145-5761) Working Woman, P.O. Box 10132, Des Moines, IA 50340

World Health. $12.50. 10 times a yr (ISSN 0043-8502) World Health, WHO, Avenue Appia, 1211 Geneva 27, Switzerland

World Press Review. $24.95. m (ISSN 0195-8895) World Press Review, Subscription Dept., Box 915, Farmingdale, NY 11737

World Tennis. $15.94. m (ISSN 0043-910X) World Tennis Magazine, Subscription Dept., P.O. Box 6042, Palm Coast, FL 32037

*The Writer. $19. m (ISSN 0043-9517) The Writer, Inc., 120 Boylston St., Boston, MA 21116

* Available for blind and other physically handicapped readers on talking books or in braille. For information address National Library Service for the Blind and Physically Handicapped, Library of Congress, Washington, D.C. 20542

Appendix D

Opposition to Farm Machinery and Thresher Destruction in England in 1830

The Luddite revolution of farm hands in England is quite an interesting case of interaction between a social system and a technological innovation, with the typical set of elements at work: a preexisting technology, some sort of social equilibrium built around it, and a new technology that increases productivity in a certain activity – in this case threshing.

Part of the society is interested in introducing a new technology (in this case landowners, mostly made up of farmers), while another part sees its income (in this case actual base metabolism income) threatened by the new contrivance. This latter group of the social system, farm laborers, expresses its grievances in many ways and tries to win public opinion and the help of philanthropic institutions like the church. The pressure mounts for years, with occasional "experiments" such as destruction of farm machinery or burning farms. But the process remains endemic and stochastic.

The "quality" of the situation, however, changes between 1820 and 1825: when criminals were convicted, judges gave them small punishments; when a farm was burnt, people looked and commented with some satisfaction, and even joked about it ("pity I don't have a sausage to roast"). Firemen were first looked at with disdain. Later their machines were sabotaged, water hoses cut, and so on. It was in this atmosphere of social support that the real troubles began in 1830.

First came menacing letters signed "Swing" (Figure D.1), and then small gangs destroyed treshing machines. Hobsbawm and Rude (1968) have collected an admirable set of data from which some quantitative analysis can be gleaned.

Figure D.2 reports the fitting of the cumulative number of threshers destroyed during a wave in November 1830 (Grübler, 1988). Figure D.3 charts the destruction together with the cumulative number of Swing letters (in Fisher and Pry transform). These letters are obviously a sample as certainly not all went into the archives or were registered. But their number have been plotted with the assumption that the sample is significant, i.e., it conserves the structure of the total set.

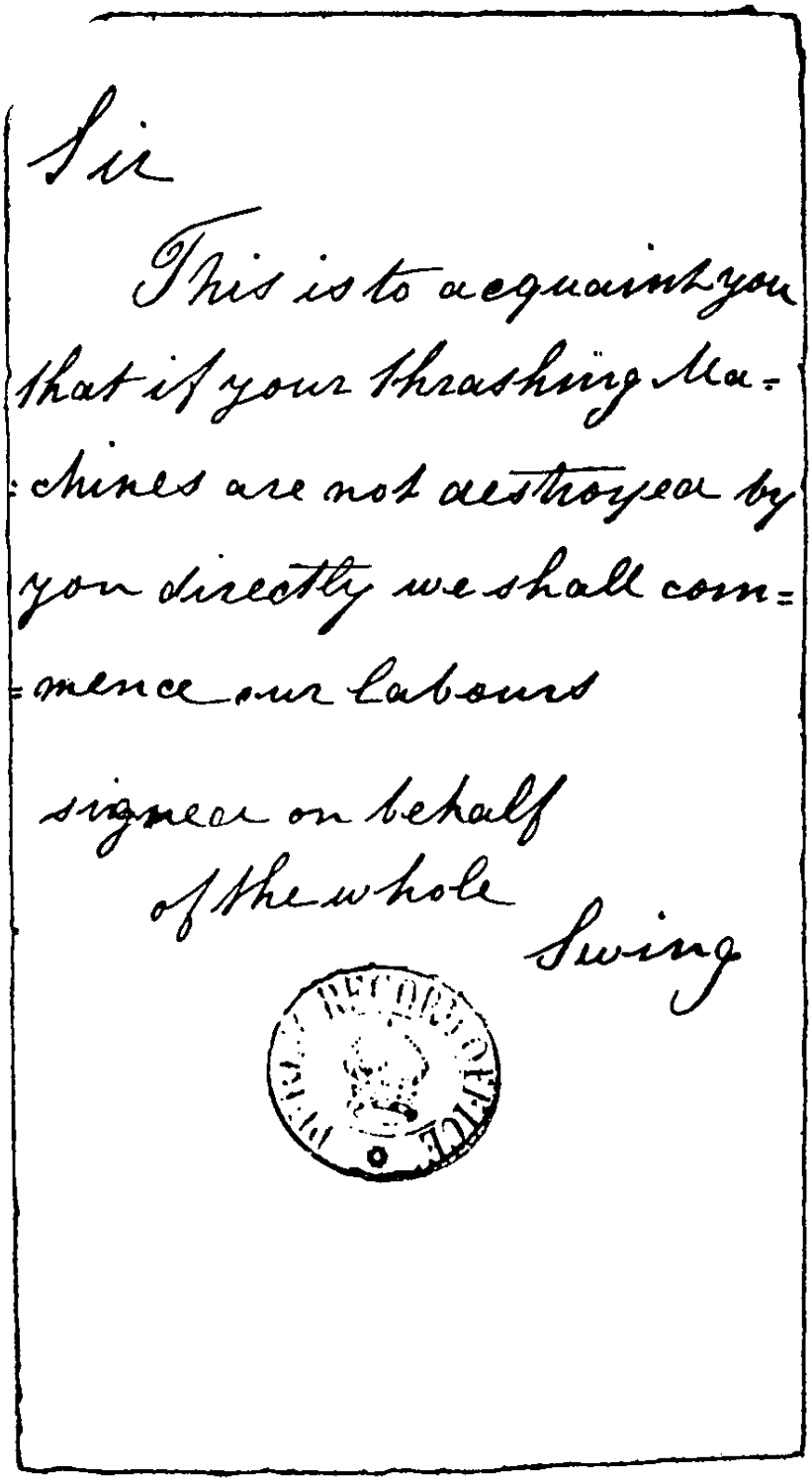
The hypothesis is supported by the fact that the data fit the equation very well. Furthermore, the central point (November 23) coincides with that of the destruction of the threshing machines, which is a significant coincidence. The time constant is somehow longer, 30 days instead of 13 days for the attacks on the machinery. The entire process can be seen then as the superposition of a broad (30-day) *action-write* pulse, enveloping a narrower (13-day) *action-break* pulse.

The letters could be considered a *direct-press*, since they did not go through an editorial process. Because the letters were probably much more numerous than the cases of machine breaking, they may be considered as a form of expression by all sorts of social strata (including farmers and priests).

The lessons that can be learned from this analysis include:

- our model can be applied to events occurring in the 1830s
- the meshing of moods and action is remarkably precise
- threshers are still in use today in one form or another, and their operators get excellent salaries.

In other words, social recognition has completely absorbed the innovation.



Sir

This is to acquaint you that if your thrashing Ma-
-chines are not destroyed by you directly we shall com-
-mence our Labours

signed on behalf
of the whole
Swing

FIGURE D.1. An Example of a "Swing" letter.

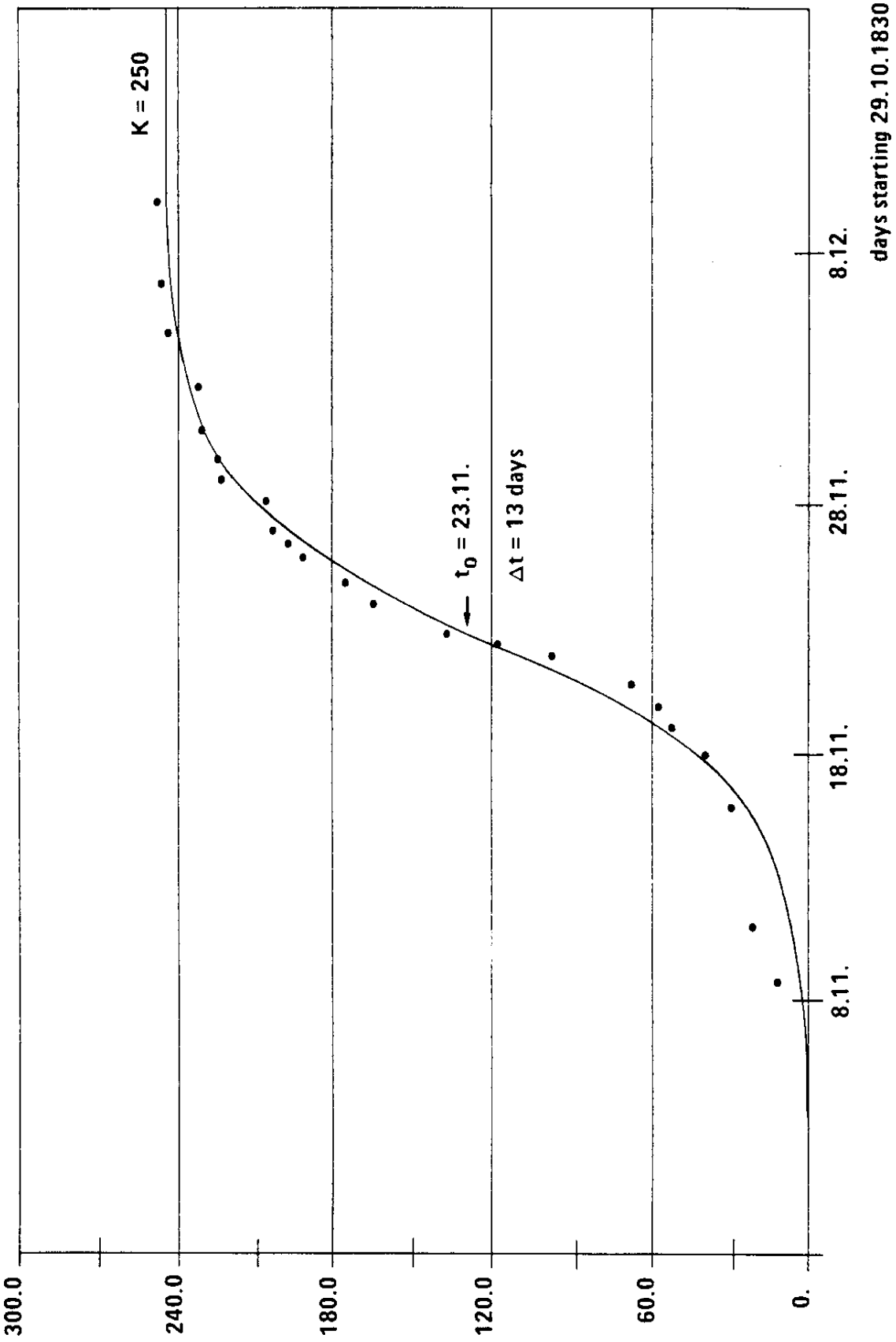


FIGURE D.2. England: Machine Breaking During 1830. Cumulative number of attacks on threshing machines reported during the "swing" movement. DATA SOURCE: Hobsbawn and Rude (1968).

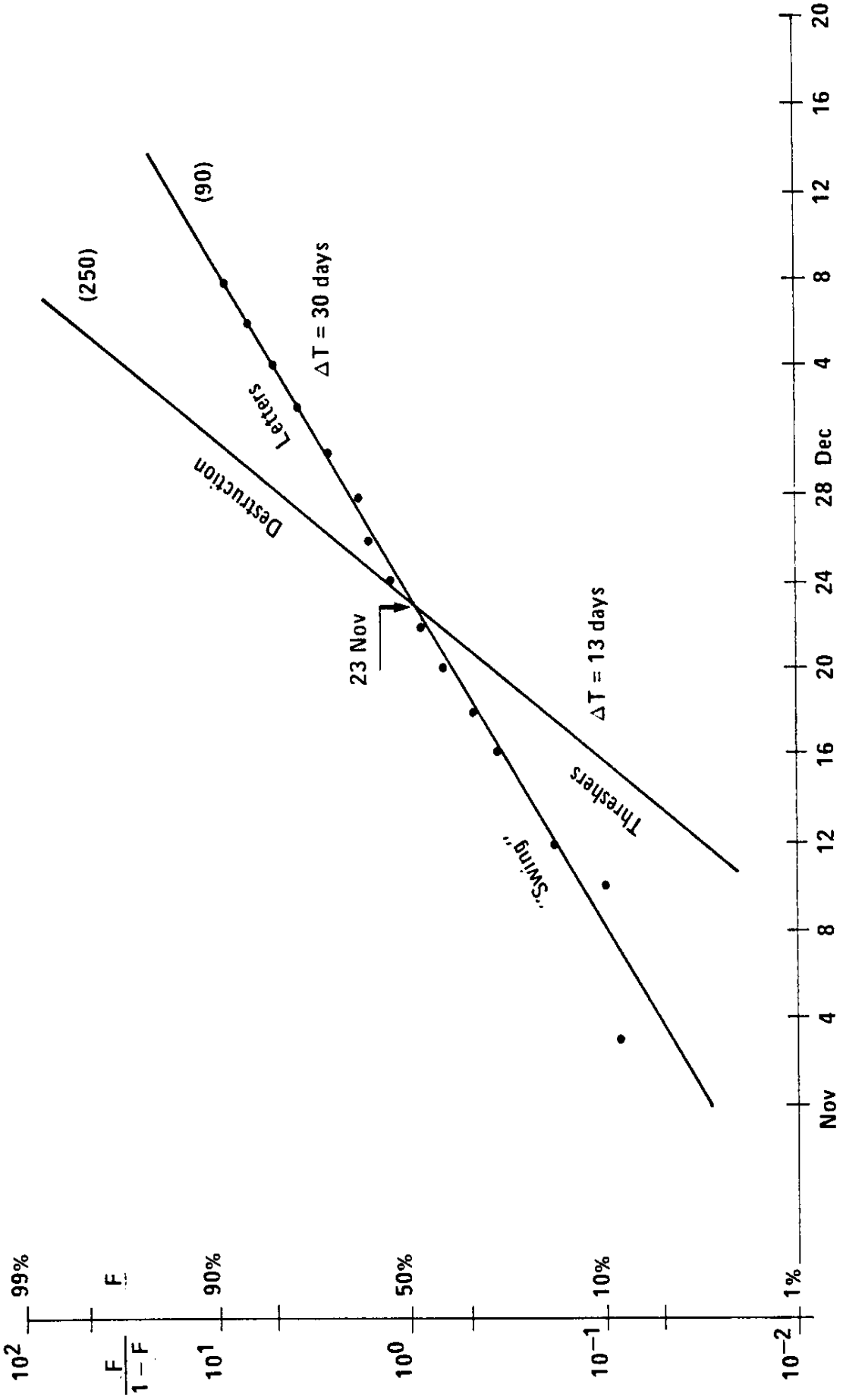


FIGURE D.3. England: Number of "Swing" Letters and Threshers Destruction, November 1830.
SOURCE: Hobsbawn and Rude (1968).

Appendix E

Railways

The railways serve as a good example of strong social opposition to the diffusion of a new technology. It may sound preposterous now that when a third level line closes because it is not producing income and carrying passengers, the local population violently protests. One of the objections is that the area is going to be isolated. Since the railway carries neither passengers nor goods, the concept of isolation must be a cultural construct that is historically transmitted.

Another argument from the supporters of railways today is that they protect the environment. It is curious to find that in the chronicles of 150 years ago, when railways were starting their inroads in the transportation system, exactly the same argument was used only in reverse. This means that railways were accused of breaking the privacy of landowners and city dwellers and were a major source of pollution, soot, and noise. Reported below are some statements from people of different social standing that help to give an overview of the situation.

- The *man of principles, hand of the destiny*: "I have felt my duty always to stand in opposition to every proposition of every railroad whatever" (Colonel Sibthorp, House of Commons, 5 February *1844*).
- The situation was still tense after 50 years, as was noted by a *top politician*: "It is rather a difficult task in this house, and anyone who has been here long enough will realize it, to recommend any measure which seems in the slightest degree to favor railway companies" (David Lloyd George, House of Commons, 30 January *1919*).
- *Lower class people* were more straightforward, as usual, and more synthetic: "Here comes old Hell in Harness" (Lee Walter, Royston Coachman, looking at a train, *1850*).
- The sweet old, *great historian*, dazzled by the present: "We who had lived before railways and survive out of the ancient world, are like Father Noah and his family out of the Ark" (Thackeray, *1860*).
- *Sweet-sour enthusiasts* were also present to provide the appropriate equilibrium: "We then took this machine which had no open parts but complete handsome coaches in succession, but forming only one machine, each having a separate name, for instance the *Hero, March of Intellect* . . . and at the end

on a platform sat a gentleman lounging at ease in his barouche. This part we traveled about 15 or 20 miles an hour... As a style of conveyance I cannot imagine anything to exceed it, if you could wholly free yourself from the idea of being blown to Hell or hurled into the air in 1000 pieces" (from a letter of W. Dalton to John Gwilt, 16 October *1831*).

- In between there were the *skeptical engineers.* As de Tocqueville reports in his *Journeys to England and Ireland*, some French engineers came to see the railways and inspect its technology: "Not so long ago M. Navier and some other came. They visited the railway, and when someone told them a fact, M. Navier, after making some calculations, often said: the thing is impossible, it does not fit with the theory. These gentlemen have not left the English greatly impressed with their ability at least in practical matters" (diary entry of 5 July *1835*).

A fascinating aspect in the history of railways is its connection with accidents and risk. One may think that a vehicle moving alone on a protected road, and with steering incorporated, is the quintessence of safety and is impervious to accidents. However, accidents plagued the 150-year life of the railways, and they were never eradicated is spite of the incessant measures taken with regard to people, technology, and operational rules.

As one of the historians of the British railways wrily observed, many grave accidents were caused by derailments. Most derailments occurred because train engineers ran trains, *inexplicably*, at high speeds over sharp curves, against very strict rules prohibiting it. Allocating stretches of the rails to a single train may seem a trivial problem, but in complex systems like railway networks (and apparently also for single lines) the problem was never reliably solved to bring the probability of accidents close to zero.

In 1910, the death toll from railway accidents in the USA was about 10 per 100,000 population per year. It is comparable to the number of deaths caused by car accidents today in the USA, which amounts to about 25 per 100,000 population per year. It has to be noted, however, that looking at passenger miles and mean speed of trains in 1910, the time traveled by train was about one minute per day per person, averaged over the whole population. Time traveled by car in the USA today is above 30 minutes per person per day. Risk exposure being so much higher means that in 1910 trains were intrinsically very dangerous. They also were at the peak of their popularity as a method of transportation.

It should be pointed out that when car usage amounted to one minute per day, in the mid-1920s in the USA, the mortality rate was the same as today. And assuming that the mileage of a car is half intra-city and half inter-city, the inter-city death rate of car travel (in terms of total population) is not much different from that of train travel as indicated above.

Apart from this numerology, the actual figures are appalling. In Germany alone, between 1900 and 1910, the number of people killed by train traffic oscillated between 1500 and 2000 per year (Ritzau, 1972). Due to high exposure, railway employees were at maximum risk and accounted for nearly half of the fatalities. Chernobyl looks insignificant by comparison, even taking into account that much of the European population was exposed to a carcinogenic dose almost equivalent to the smoke from one cigarette (Veronesi, 1986).

In spite of continuous political, public, and press opposition and criticism, railways grew steadily everywhere (Figures E.1–E.4), in an extremely regular process, quantified by niche penetration logistics. Now the whole system is in dismay, but before World War II trains provided very decent transportation with an accepted level of risk and a relatively high level of comfort. Much of the merit goes to the opponents that kept popular attention focused on these two items. In the words of Jack Simmons, a historian of British railway development, describing the situation at its best:

> "By the end of the nineteenth century the British railways had struggled through to attain a safety system that appeared to many people to be complete: as perfect as any system could be that still had to be operated by human beings. Not a single passenger was killed in an accident in the United Kingdom in the year 1901. It was the first time a record has been set. But there was no cause for complacency. A run of 1903–15, ending with the worst that has ever occurred in Britain, at Quintinshill on the Caledonia. Not all these disasters were due to the failure of safety precautions: the extraordinary series at Salisbury, Grantham and Shresbury in 1906–7 were caused by *excessive speed over sharp curves*, maintained by the drivers in a quite inexplicable defiance of stringent regulations. Every year the accidents in the system investigated by the Inspectors showed that deficiencies in the system continued."

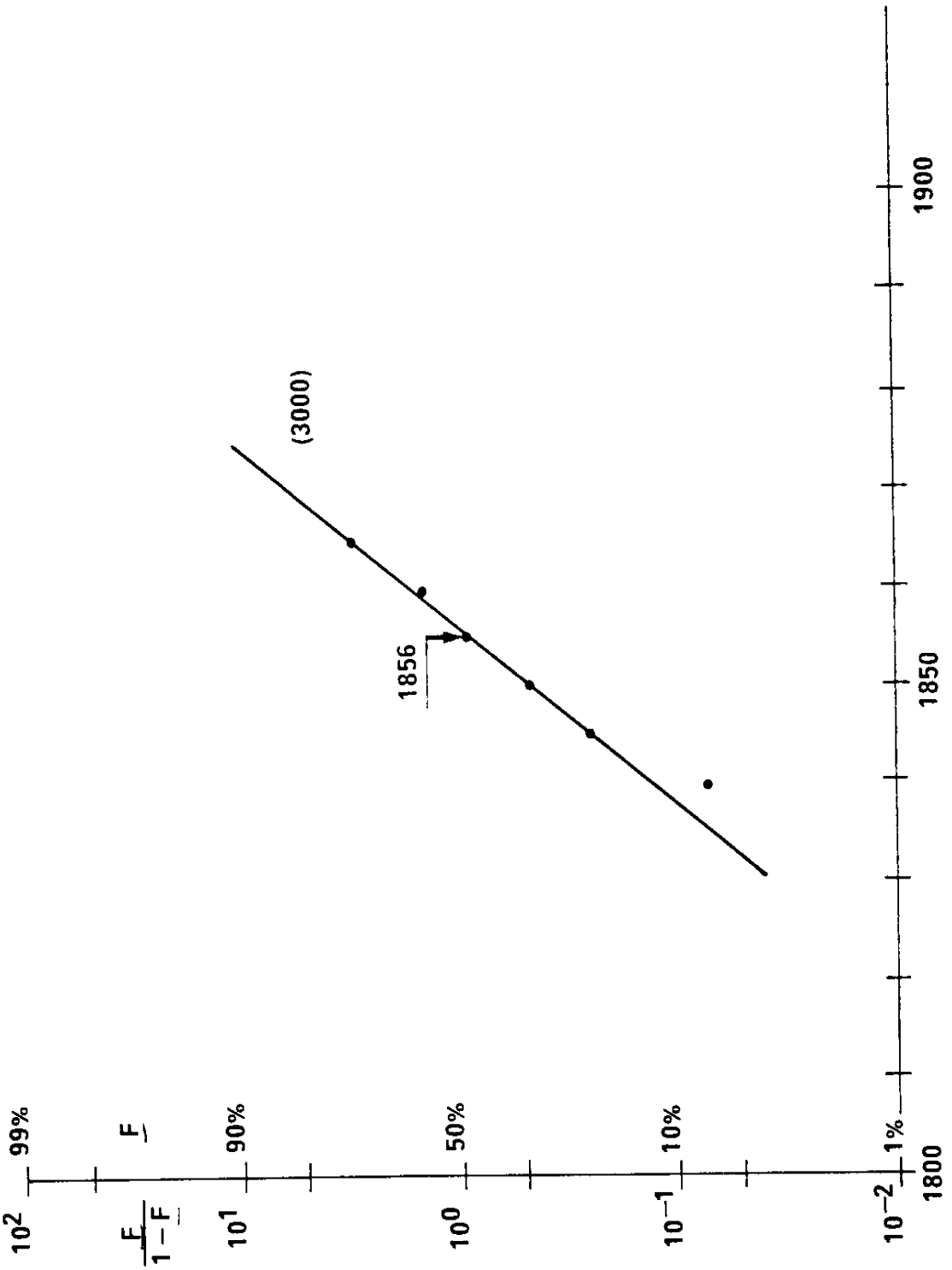


FIGURE E.1. England and Wales: Passenger Kilometers (10^6) on Railways.
DATA SOURCE: Hauke (1970).

Figure E.2

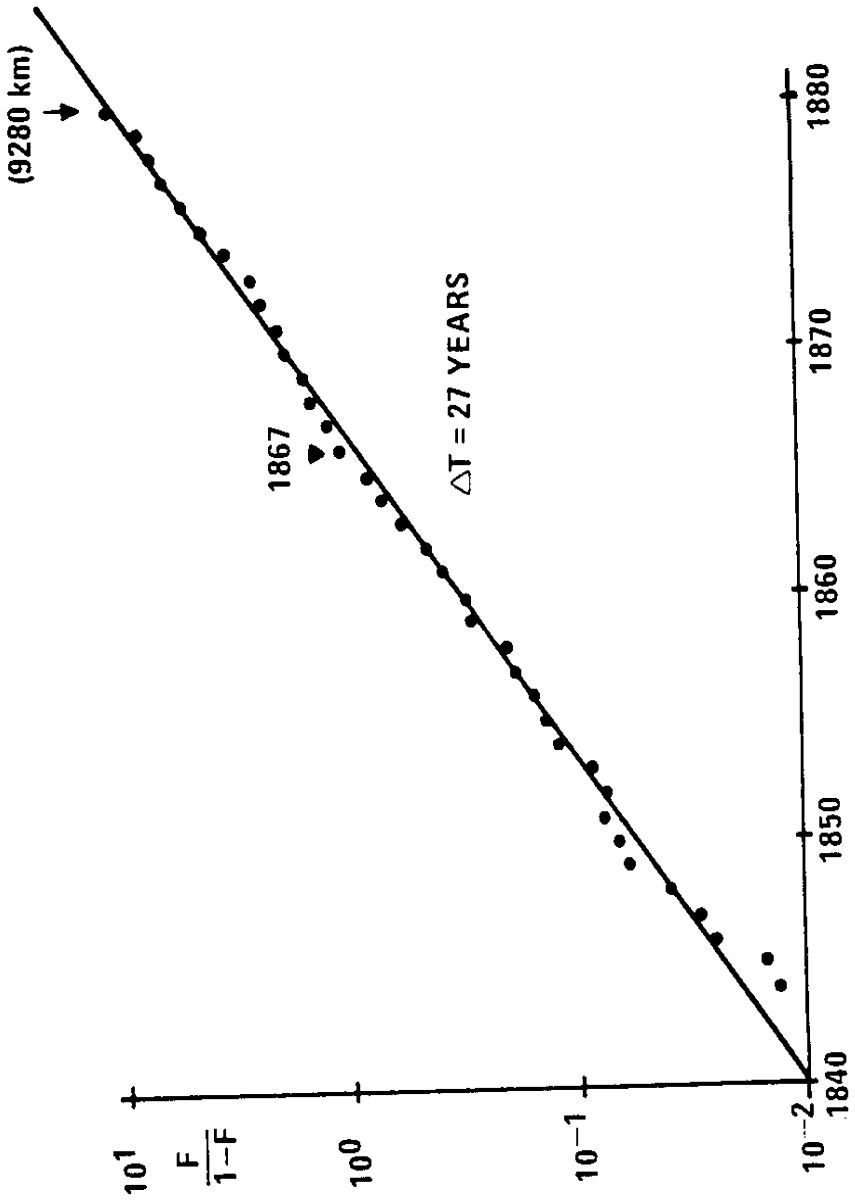


FIGURE E.2. Italian Railways: First Spurt (10,000 km).

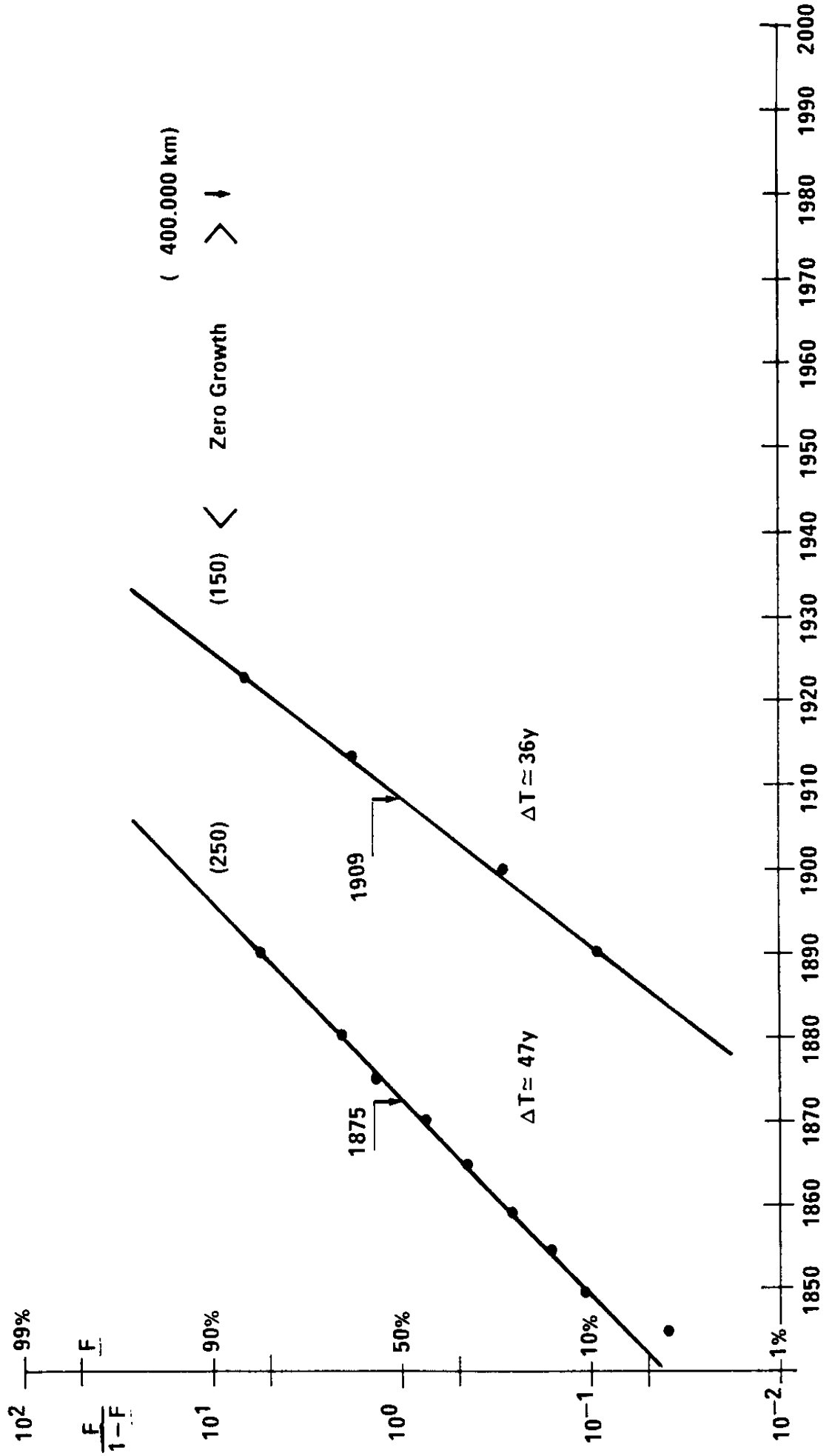


FIGURE E.3. Europe (including the USSR): Railways Network Length (.000).
DATA SOURCE: Stürmer (1830-1875), Woytinski (1875-1923), Mitchell (1923-1975).

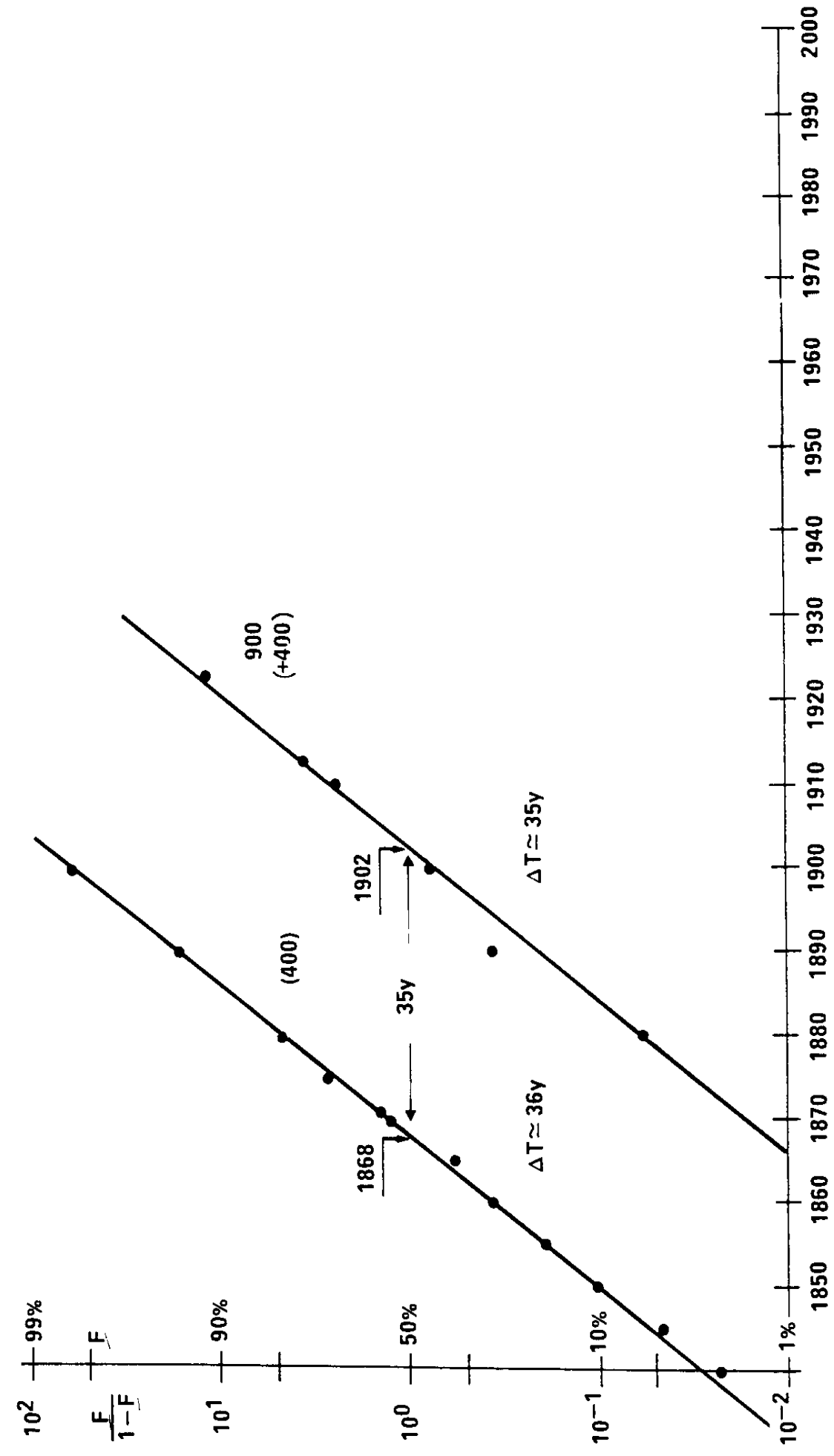


FIGURE E.4. World Railways Track Length (.000).
DATA SOURCE: Stürmer (1840-1870), Woytinski (1870-1923).

References

Adams, Jr., C.F. (1878), *Railroads: Their Origin and Problems.* New York: G.P. Putnam's Sons.

Bahn im Bild. Band 13: Unfälle und Schadensfälle, (1980). Vienna: Verlag Pospischil.

Godwin, Jr., G. (1837), *An Appeal to the Public on the Subject of Railways.* London: J. Weale.

Hawke, G.R. (1970), *Railways and Economic Growth in England and Wales, 1840-1870.* Oxford: Clarendon Press.

Krafft, E. (1925), *100 Jahre Eisenbahnunfall.* Berlin: J.H.W. Dietz Nachfolger.

Ritzau, H.J. (1972), *Von Siegelsdorf nach Aitrang.* Landsberg, F.R.G.: Verlag für Eisenbahngeschichte.

Ritzau, H.J. (1979), *Eisenbahn-Katastrophen in Deutschland.* Landsberg, F.R.G.: Verlag Zeit und Eisenbahn.

Ritzau, H.J. and J. Hörstel (1983), *Die Katastrophenszene der Gegenwart.* Landsberg, F.R.G.: Verlag Zeit und Eisenbahn.

Schneider, A. and A. Mase (1968), *Katastrophen auf Schienen.* Zurich: Orell Füssli Verlag.

Simmons, J. (1978), *The Railway in England and Wales, 1830-1914.* Leicester University Press.

Statistische Angaben über die Deutsche Reichsbahn (1974). Landsberg, FRG: Verlag Zeit und Eisenbahn.

Veronesi (1987), Conferenzia Nazionale sull'energia. February 24-27, 1987.

Von Stockert, L. Ritter (1913), *Eisenbahnunfälle. Band I.* Leipzig: Verlag von Wilhelm Engelmann.

Von Stockert, L. Ritter (1913), *Eisenbahnunfälle. Band II.* Leipzig: Verlag von Wilhelm Engelmann.

Young, M. and T. Schuller, eds. (1988), *The Rhythms of Society.* London and New York: Routledge.

Appendix F

Fluoridation: Pro and Con

Adding small amounts of fluorides to drinking water helps prevent tooth decay. Tooth decay is a scourge in sweet toothed America, so one would *rationally* think that the additive to the water would be welcome. Objections are, as always, possible. However, nature in a sense has conducted a one-thousand year experiment by letting some fluorides seep into wells and springs in many US regions. If the fluoride content is below a certain level, then local populations do not resent any harm and can show intact teeth.

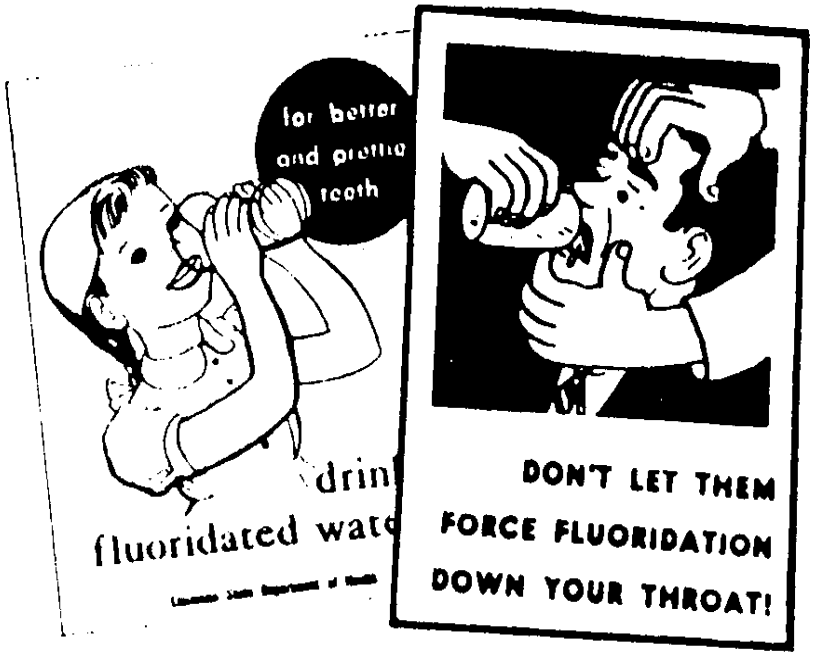
The situation has some parallels with low-level radiation effects. The natural background is very variable around the world, with ratios between maxima and minima that can reach a factor of 100. Populations living where the background radiation level is particularly high do not show the extraordinary features that opponents of nuclear energy should expect to be present.

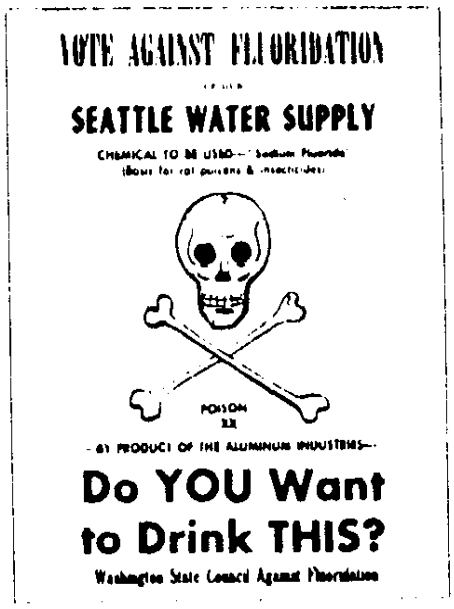
The historian Donald R. McNeil has recently summed up the fluoride situation in an article entitle *America's Longest War: The Fight over Fluoridation, 1950-19??*. After 40 years one can say that the war is either half won or half lost. In fact, half of the US citizens do not have fluoridation of their drinking water.

The arguments made by the opponents are as original as ever. Fluoridation is "conspiracy of experts" and causes everything from communism to mongolism. The decision to add fluoride is determined by local communities. Thus far, the controversy does not seem to be easying. Between 1980 and 1983, according to the Centers for Disease Control, fluoridation was approved by 232 communities and rejected by 69. Nevertheless, dentist bills in the USA are approximately 20 billion dollars per year.

It is curious that the largest consumers of junk food in the world have a long tradition of protecting nature from human tampering. Milk was not pasturized during the 1920s, and vaccination against diphtheria and smallpox generated a public outcry. Water in the USA mains are now chlorinated, but when the idea was first proposed at the turn of the century opposition was fierce.

The famous personalities ideologically supporting the anti-fluoridation movements have nothing to lose when compared with the best ones in the anti-nuclear movements. Dr. Paul Manning, a dentist from Springfield, MA, formed the *Research 44 Association* in 1949 to combat what he viewed as forced


for better
and prettie
teeth
drin
fluoridated wat
DON'T LET THEM
FORCE FLUORIDATION
DOWN YOUR THROAT!


VOTE AGAINST FLUORIDATION
SEATTLE WATER SUPPLY
CHEMICAL TO BE USED—
POISON
—a PRODUCT OF THE ALUMINUM INDUSTRIES—
Do YOU Want
to Drink THIS?
Washington State Council Against Fluoridation

experimentation on human beings. Fluoridation was, according to Manning, simply a case in point. As testimony to the successes of "godless medical technocrates", he wrote to sympathizers in the early 1950s "lie Buchenwald and Grand Rapids, Dachau, and Newburg".

The church also became involved in the controversy. During the 1950s and 1960s many of the State Committees of the church vigorously campaigned against what members felt was forced "mass medication". Some sued for relief. When one case came to trial in Missouri in 1961, the State Supreme Court ruled that fluoride was not a medication but a trace element found naturally in food and water. It was added only when there was an insufficient concentration to prevent cavities.

However, when crazes are rampant, rationality is useless. During the 1950s, Golda Franzen, a San Francisco (not Timbuktu!) housewife, became the leading exponent of the idea that *"fluoridation was a red conspiracy"*. She predicted that fluoridation would produce *"moronic atheistic slaves who would end up praying to the communists"*. Her movement was not isolated. Golda Franzen's warnings, echoed by such groups as the John Birch Society and the Ku Klux Klan, acquired particular salience during the anti-Communist fever of the McCarthy era.

Science can be invoked at various levels, and C. Leon de Aryan, editor of an anti-Semitic publication in San Diego, described the spread of fluoridation as a plot to *"weaken the Arian race by paralyzing the functions of the frontal lobe"*. This may be seen as personal paranoia, but on the occasion of a fluoridation vote the Association of Chiropractors of Seattle publicized fluoride's alleged deleterious effects: *"tumors, brittleness of the bones, oily sweat, undue financial anxiety, loss of memory and nymphomania"*. The opposition won the vote by a two-to-one margin. It is also curious to observe that the most progressive state of the USA, California, provides only 17% of its population with fluoridated water. As McNeil observes, heterogeneous though they were, the various opponents of fluoridation proved in fact to be surprisingly effective right from the start. California has a well-established tradition of organized and vocal movements.

It may be interesting now to give, as usual, a quantitative look at the situation. The patterns of past oppositions can be very revealing. The simplest method is to count water supply systems in operation where fluorides are added, Figure F.1 This number grows linearly (not logistically!), with a new line starting in 1966. We did not find any evident reason for this new branch. Also we could not find detailed statistics after 1970. The number of communities linked to a fluoridated water system are shown in Figure F.2. Their number can reasonably be split in two logistic growth pulses with saturation levels at 1500 and 4000 communities, respectively.

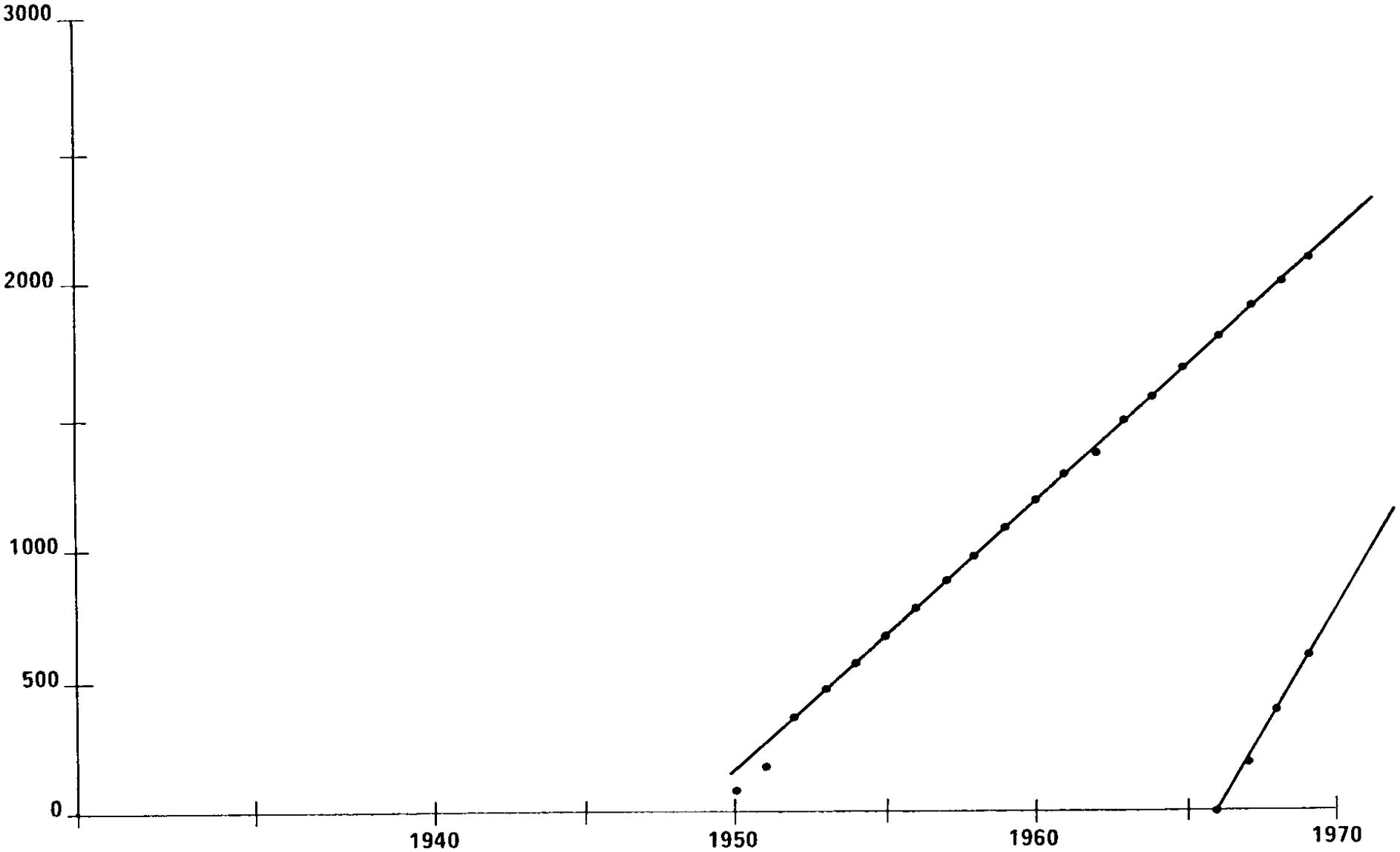


FIGURE F.1. Number of US Water Supply Systems with Fluoridated Water.
DATA SOURCE: US Statistics through 1970.

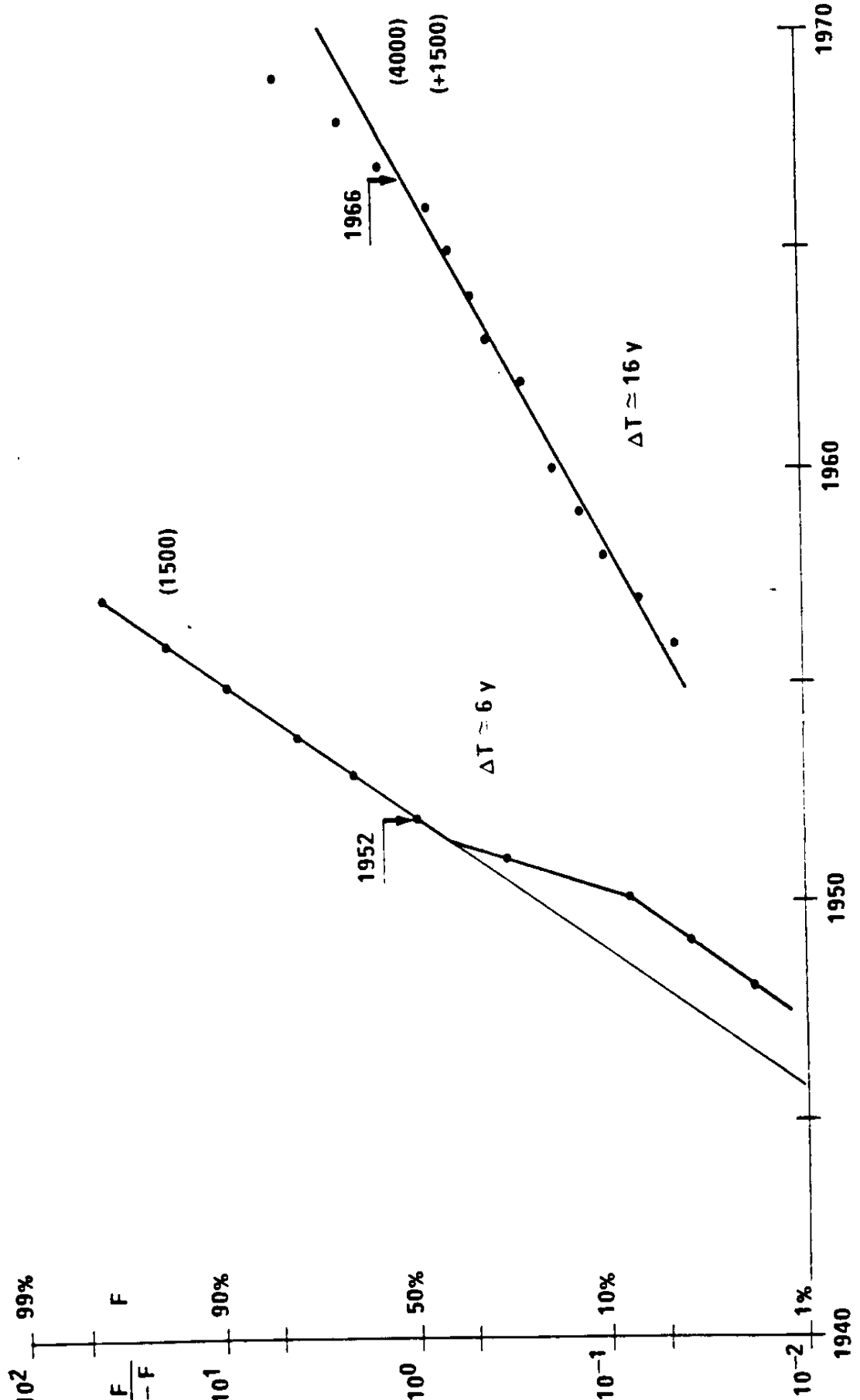


FIGURE F.2. Number of US Communities with Fluoridated Water. DATA SOURCE: US Statistics through 1970.