continued from page 15

DRESDEN REPLIES: Both Akira Isihara and R. Byron Bird observe that although Hendrik Kramers wrote only one paper on polymer statistics, that paper had an enormous and lasting influence. This observation is in complete harmony with the ideas expressed in my paper: Kramers's contributions to statistical mechanics, few as they are, are gems full of technical mathematical innovations, combined in a most original way with deep physical insight.

I am most thankful to Isihara and Bird for calling attention to yet another one of Kramers's seminal contributions, which like many others has not always received the recognition it deserves. This particular paper was not mentioned in the original article for lack of space, so it is gratifying that these letters give an idea of Kramers's contribution in this area, especially his unusual and perhaps unexpected use of Riemannian geometry.

The thesis by R. M. F. Houtappel to which D. ter Haar calls attention was clearly strongly influenced by Kramers. The elegant mathematics, the ingenious way in which explicit group theory is avoided in a clever adaptation of Bruria Kaufman's method—these are as characteristic of Kramers as his signature. Thus Kramers was certainly aware of and explicitly conversant with the developments in the Ising model that followed the celebrated Kramers–Wannier paper. In that sense my statement that Kramers never worked on the Ising model after World War II is too strong. He clearly stayed informed and thought about it. Still, I believe that the general idea I expressed is probably correct. Comparing Kramers's intense, deep preoccupation with the Ising model during the war years with his subsequent more casual involvement, almost by proxy, indicates to me that his own personal involvement declined sharply if not precipitously. Of course Kramers, even if only casually interested, could make contributions of such depth and brilliance that any totally committed investigator would have been pleased and proud to have made them.

I believe that all the correspondents and I agree that Kramers was an unsurpassed master in using and inventing mathematical procedures that were miraculously suited to the elucidation of physical problems in statistical mechanics.

MAX DRESDEN
Stanford Linear Accelerator Center
Stanford, California

8/89

Profiles in Publishing Productivity

We recently completed a study of publishing patterns of PhD physicists trained and employed in the United States.[1] We were particularly interested in the relationship between publishing activity and age. Because the average age of physicists, and scientists in general, has increased dramatically in the past 10–15 years, a concern of US science policy makers is whether this older group is as productive as a younger group was a decade or two earlier. Given the inherent difficulty of measuring research productivity, and given that there is some evidence that publishing is a reasonable measure of productivity,[2] our study focused on the relationship between publishing activity and age. Specifically, we counted the number of journal articles authored in a two-year period. Adjustments were also made to this count for the number of coauthors as well as for the quality of the journal in which each article was published, where quality was measured by the impact the journal has on the science literature as reflected by citation practices.[3] Physicists in the 1973, 1975, 1977 and 1979 Survey of Doctorate Recipients, administered biennially by the National Research Council, were included in the study.[4] Information on their publishing patterns was taken from the Science Citation Index with the cooperation of the Institute for Scientific Information.

Past work by Stephen Cole[5] and by Alan E. Bayer and Jeffrey E. Dutton[6] on age–publishing profiles of physicists suggests that article production increases until early middle age and declines thereafter. Cole's sample was restricted to physicists employed in doctorate-granting departments in the late 1960s, while Bayer and Dutton's sample consisted of physicists employed at colleges and universities during the 1972–73 academic year. A strength of the SDR data base used in our study is that it is drawn from a later period and includes scientists in five employment sectors: graduate academic (universities offering a PhD in physics), nongraduate academic, Federally funded research and development centers, government, and business and industry.

Our results for physicists in academic employment are somewhat different from those of Cole or Bayer and Dutton. In particular, when we grouped our sample by five-year age intervals, we found that for physicists in graduate departments the productivity of the 35–39-year-old group is

always significantly less than that of their younger colleagues, and output does not rebound to the pre-age-35 level for any age group. On the other hand, publishing activity does not continuously decline with age, although it does decline in the last years of the career regardless of the way articles are measured.

For physicists in nongraduate physics departments, the story is different. Although output is highest for the youngest group, until age 45–49 output never differs at the 5% level of significance between the youngest and older groups. Those 45–54 years old, on the other hand, produce significantly less than the youngest of their colleagues, while the 55–59-year-olds publish more, perhaps because productive physicists are lured into the nongraduate sector from the graduate sector toward the end of their careers, or perhaps because less productive scientists tend to retire earlier.

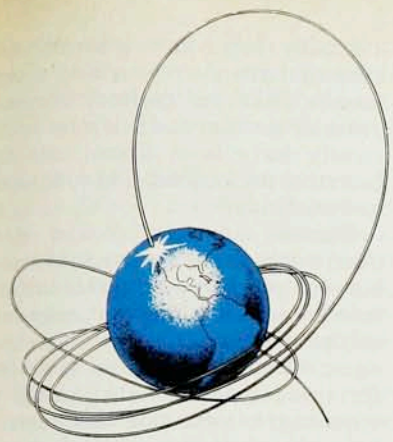
At Federally funded R&D centers, peak output is also produced by those under 35; for the next ten years output dramatically declines. It then increases or stays fairly stable for the next ten years, after which it again declines. Government is the only sector in which the peak productivity occurs in the middle of the career, not the beginning. In business and industry, publishing activity declines until age 49, then increases for ten years before declining again. This age pattern for business and industry is not inconsistent with what Donald C. Pelz and Frank M. Andrews[7] found in the 1960s.

Our results also suggest that the age–publishing profiles depend upon how one measures publishing activity. The profiles are generally steepest when the article count is adjusted for quality, suggesting that the young are more likely to publish in prestigious journals. On the other hand, as physicists age, the straight count and the count adjusted for coauthorship converge, showing that a disproportionate amount of early output is coauthored. This result holds in all sectors and is contrary to the view that older physicists, through their administrative roles, "ride piggyback" on the shoulders of younger physicists.

The age–publishing profiles discussed thus far are drawn from cross-sectional data. Since different age groups are observed at the same time in a cross-sectional analysis, the age effects found may be contaminated by what are called cohort or generational effects. If, for example, physicists in their sixties come from a particularly weak cohort and physicists their thirties from a particularly strong cohort, we would infer aging effects from a cross section even if they did not exist.

There are several reasons to believe cohort effects might be present. One theory—more popular, we might add, among social scientists than physical scientists—is that certain cohorts may be at a disadvantage because their members were educated prior to a major innovation in theory or experimental technique. If one subscribes to a "latest educated are best educated" philosophy, this would imply that the decline in publishing activity with age may be an artifact of "vintage" and not a true aging effect. On the other hand, the best vintage need not always come from the latest cohort, since science does not always advance smoothly but may experience for a time what are eventually regarded as "false turns."

Perhaps the most important reason to expect cohort effects is that



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research productivity, particularly as manifested in article counts, is strongly affected by characteristics of the employing institution. In particular, there is strong evidence that physicists employed in top PhD-granting departments and Federally funded R&D centers are more likely to publish than their colleagues in places where resources are scarcer and the environment is less conducive to research.[8] It is clear that not all generations of physicists have had equal access to the most productive sector. Indeed, one need only look at the pages of PHYSICS TODAY to see how job opportunities for physicists have changed over time. A cohort particularly hurt was that of the late 1960s and early 1970s—the cohort from which the "young" in our study are drawn.

Finally, some have expressed concern that the average ability of new science PhDs has declined in recent years as the best and brightest in our society have been drawn into the lucrative professions of law, business and medicine.[9]

Because our data allowed us to observe physicists as they aged over a six-year period, we were able to draw inferences concerning the presence of cohort effects and to see whether true aging effects exist once we controlled for these cohort effects. Using an econometric technique that controls for both cohort and aging effects, we found evidence that except for particle physicists employed in PhD-granting departments, true aging effects exist. Furthermore, when we held the aging effects constant, we found evidence that for the period of our study the latest PhD cohorts were not the most productive in any of the subfields of physics we studied.

References

1. P. E. Stephan, S. G. Levin, "Demographic and Economic Determinants of Scientific Productivity," Georgia State U., Atlanta (1987).
2. R. Evenson, Y. Kislev, *Agricultural Research and Productivity*, Yale U. P., New Haven (1975).
3. E. Garfield, ed., *SCI Journal Citation Reports*, Institute for Scientific Information, Philadelphia (1975).
4. National Research Council, *Science, Engineering, and Humanities Doctorates in the United States, 1979 Profile*, Natl. Acad. Sci., Washington, D. C. (1980).
5. S. Cole, Am. Sociol. Rev. **84**(4), 958 (1979).
6. A. E. Bayer, J. E. Dutton, J. Higher Ed. **48**(3), 259 (1977).
7. D. C. Pelz, F. M. Andrews, *Scientists in Organizations*, revised edition, U. Michigan P., Ann Arbor (1976).
8. J. S. Long, Am. Sociol. Rev. **43**, 889 (1978).
9. H. R. Bowen, J. Schuster, *American Professors: A National Resource Imperiled*, Oxford U. P., New York (1986).

PAULA E. STEPHAN
Department of Economics and Policy Research Program
Georgia State University
SHARON G. LEVIN
Department of Economics
University of Missouri, St. Louis

2/89

Bread Shortage in the Nation's Breadbasket?

In the December 1987 issue (page 9), George E. Pake writes: "Through its extensive nationwide system of research universities, centers of basic research are ubiquitous in the US.