

A Reasonable Outcome

The Politics of Earthquake Prediction. RICHARD STUART OLSON, with Bruno Podesta and Joanne M. Nigg. Princeton University Press, Princeton, NJ, 1989. xii, 187 pp. \$19.95.

An American scientist predicts a natural disaster in the Third World: the destruction by a massive earthquake of Lima, Peru. If this book were popular fiction, it would no doubt feature the struggle of the young scientist against scientific and bureaucratic obscurantism, political efforts to quash his enthusiasm, triumphant recognition of his virtuous rectitude, and a heroic effort to save a city that the First World was all too ready to see buried in rubble.

But the story is true, and the lessons quite different. A U.S. Bureau of Mines scientist, convinced in the mid-1970s that his laboratory work on fracturing of rocks was relevant to earthquakes, predicted a devastating earthquake off the coast of Peru, to take place in June–July 1981. The prediction was given an open hearing before a prestigious scientific panel in January 1981 and rejected. The earthquake did not occur, but the widely publicized prediction brought high-level political consciousness of the potential consequences, some improvement in Peru's emergency preparedness, and an upgrade of its seismic detection network. A government-ordered evacuation of Lima was avoided, though some voluntary evacuation occurred. Relations between the United States and Peru were not seriously damaged.

This relatively benign outcome was not the result of scientific objectivity and bureaucratic devotion to the public good. At the time, a fiasco seemed likely. Passions ran high. Puzzlingly absent from this account are the personality conflicts. Particularly clear are the bureaucratic passions: of the U.S. Bureau of Mines, Geological Survey, Agency for International Development, and State Department and the Peruvian Geophysical Institute. Each had its own interests at stake and was prepared to defend them. Just as important are the scientific passions: "real" seismologists lined up against an intruder to their field, a Peruvian geophysicist used the prediction to strengthen his underfunded institute, one of the supporters of the prediction abandoned his colleague in

midstream. News coverage, both in Peru and in the United States, amplified and distorted the entire affair.

What, then, accounts for how matters came out? The authors do not address this question. They are much more concerned with what went wrong than with what went right. This is especially true of their account of what they regard as the heterodox theory that led to the prediction and of its treatment by the scientific panel, an account that unfortunately lacks any detailed description of the scientific merits of the dispute. The book opens with the claim that Thomas Kuhn's paradigm shifts are somehow relevant, a theme it focuses on periodically, but it closes with the admission that the theory involved did not represent a major paradigm shift but lay well within the realm of plate tectonics.

The concluding view seems much more on the mark. The matter seems to have nothing to do with Kuhn. The scientific panel that examined the prediction may have been biased against our young hero, and it certainly started from a skeptical point of view. But it gave him a fair, and lengthy, hearing. And it came to a correct conclusion, five months or so before the predicted earthquake failed to materialize. Anything but a tough, doubting, scientific examination would have been foolhardy under the highly publicized circumstances, with the destruction of a major city at stake.

This suggests to me a moral of the story. The scientists and bureaucrats involved were unquestionably self-interested and a good deal less than objective. But the very plurality of conflicting interests involved, the public attention and risk of public disgrace, ensured that the result was a reasonable one. The authors bemoan the "political" nature of the controversy, as if only scientific objectivity can lead to correct results. Would it not be better to laud the politics? There is merit in a pluralistic system that provides a hearing for opposing views and threatens consequences to those who are wrong. That is what keeps both scientists and bureaucrats on the straight and narrow.

DANIEL SERWER
U.S. Embassy,
Rome, Italy

Views from Chicago

Memoirs of an Unregulated Economist. GEORGE J. STIGLER. Basic Books, New York, 1988. xii, 228 pp. + plates. \$17.95.

This book provides both information and pleasure, and not to economists alone. Readers unassociated with Stigler's discipline will find it a delightful means to learn some of the subjects economists like to investigate and some of the ways in which they think about them. Still, it is important to warn the general reader that Stigler's writing is unrepresentative of the practitioners of the field in a number of ways. His enthusiasm for the accomplishments of economics is somewhat greater than the norm. His conclusions, the set of writings by others that elicit his approbation, and even his research methods are all to some degree colored by his membership in the "Chicago school." And, above all, the attractiveness of his writing is far from typical.

Much of the book is built upon an autobiographical foundation. But, as for many of us academics, this by itself is hardly enough. Nothing in Stigler's life story constitutes the stuff of drama—not even anything comparable to the one exciting incident in the life of Adam Smith, a kidnapping by gypsies as a child. Thus, Stigler makes this the engrossing book it is by means much like Kirkpatrick's in his biography of Domenico Scarlatti (about whom extremely little is known)—by devoting most of the little volume to many other interesting subjects. Thus, we are offered essays on the economics of monopoly, on the determinants of the behavior of governmental regulatory agencies, on empirical research in economics, on university politics, and on a variety of other subjects. On each, the reader is instructed on the logic of the Chicago analysis of the subject and is offered a variety of ancillary insights.

The Chicago school, of which Stigler is justly proud, offers a good deal more than the political conservatism that is widely considered to be its hallmark. It is characterized by the brilliance and cleverness of its leaders as well as many of their followers, by considerable inventiveness in the subjects it has selected for investigation, and by a choice of research methods and assumptions that sometimes differ considerably from those adopted by the rest of the profession. Thus, it has provided pioneering studies on the economics of race discrimination and divorce, on the role of education interpreted as an act of investment in oneself (investment in "human capital"), and on the possibility that government policy can be undermined by the public's expectations about its consequences.

Example: Suppose a government seeks to raise the purchasing power of wages by holding back the rate of growth of the money supply as a means to curb inflation. If employers expect success in the attempted moderation of inflation they may resist wage demands comparable to those agreed to in earlier and more inflationary years, and unions with similar expectations about the price level may be less militant about those wage demands. The net result may be wage increases that are more modest; and so the attempt to raise workers' purchasing power may be frustrated, perhaps completely.

In its methods Chicago school research has been characterized by intimate marriage of theoretical and empirical analysis, with perhaps some inclination to avoidance, where possible, of the more esoteric tools of statistical analysis, and explicit disinclination to assign much weight to "realism" in the assumptions that theoretical models employ. For, in the Chicago view, a theory should be tested primarily in terms of the correspondence of the results derived from the models to actual economic behavior, and not on the basis of its premises. Another characteristic of the school's research is its recurrent use of the premise that humans calculate with considerable rationality the course of behavior that best promotes their economic self-interest (broadly interpreted) and act accordingly with some consistency. This maximization assumption has been used to explain phenomena ranging from the behavior of government agencies to the decision on the number of children to be contained in the family. It is perhaps ironic that this premise, which can with some justice be described as "economic determinism," is widely associated with the writings of Marx, who probably never used it, but is instead actually favored by the group of modern economists most generally considered to constitute the center of political conservatism.

But much more than this awaits the reader of Stigler's charming and informative little book. The author manages to make light and pleasant reading of the dismal science and to convey to the reader some feeling for the reasons for his deep affection for the discipline and his pride in its accomplishments. He does this without sacrifice of substance, relying rather on his way with words, his sense of humor, his wide-ranging erudition, and the charm of his personality. The book deserves to be read, and the reader will be pleased to have done so.

WILLIAM J. BAUMOL

Department of Economics, Princeton University,
Princeton, NJ 01904, and
Department of Economics,
New York University,
New York, NY 10003

Geologic Collisions

Impact Cratering. A Geological Process. H. J. MELOSH. Clarendon (Oxford University Press), New York, 1989. x, 245 pp., illus. \$65. Oxford Monographs on Geology and Geophysics, vol. 11.

When this reviewer began high school seemingly a short while ago, lunar craters were a result of volcanic processes, dinosaurs had died of natural causes, and large holes in the ground were of only casual interest to planetary scientists. Now we view impact cratering as one of the predominant geological processes in the solar system. Impact craters ranging in diameter from a few meters to thousands of kilometers are observed to dominate the surface of the moon and the other bodies of the solar system. The moon itself may have formed from material squirted off Earth during the impact of a Mars-sized body, and many think that dinosaurs were zonked in the aftermath of an extraterrestrial object's hitting Earth. The finite probability of such a collision involving Earth during one's lifetime is a sobering thought.

This recognition of the importance of impact processes in planetary history can be attributed to the robust planetary exploration programs of the United States during the last couple of decades. The understanding of the processes themselves has benefited from defense research into high-energy and high-pressure processes.

Cratering mechanisms involve extreme ranges in physical processes. Pressures during the initial stages of an impact commonly exceed a million atmospheres. Initial energy densities and temperatures can be higher by several factors of ten than those of conventional explosives and can approach those of nuclear devices. Under these conditions, ordinary rocks behave as fluids. At the other end of the spectrum during the later stages of an impact, the flow producing the final observable crater occurs at pressures comparable to an atmosphere. The sciences of soil and rock mechanics are needed to describe these low-pressure processes.

The literature on these phenomena encompasses a number of sciences including physics, geophysics, astronomy, engineering mechanics, statistics, and geology and is scattered through diverse journals and reports. There has been no single source of current research on impact cratering. Few persons have the breadth of knowledge to describe the entirety of sciences applicable to impact problems. The difficulty this poses to students and researchers is rectified by this important monograph by Melosh.

The book begins with an informative

chapter on the history of the study of craters. The next chapter gives an overview of observable morphologies, from the micro-meter-sized craters formed from the hyper-velocity impact of dust particles to the thousand-kilometer multi-ringed basins on Mars, Mercury, Callisto, and the Moon. These two chapters make interesting reading for both the novice and the expert.

The following chapters present the core of the science of impact cratering. They include summaries of shock-wave propagation, descriptions and details of the contact, excavation, and modification phases, descriptions of the ejecta and the emplacement processes, and summaries of the current understanding of the scaling laws of these processes. The book gives an appropriate mix of descriptive material and quantitative estimates and formulas. Final chapters emphasize the observational aspects of planetary cratering and discuss the role of those observations in understanding the history and evolution of planetary bodies.

All in all, this is a well-written and comprehensive book. Since the field is new, a number of aspects of cratering are not yet



A microcrater 30 μ m in diameter on a glass sphere obtained by Apollo 11. "Microcraters are evidently due to high velocity impacts of small particles of cosmic dust or, rarely, to small secondary ejecta particles from larger impacts." [Courtesy D. McKay. From *Impact Cratering*]



Meteor Crater, Arizona. "This crater is thought to have been formed 50,000 years ago by the impact of a 100,000-ton iron meteorite roughly 30 m in diameter which struck at a speed in the vicinity of 20 km/second. The crater's rim-to-rim diameter is approximately 1100 m." [Courtesy D. Roddy. From *Impact Cratering*]