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Jevons, William Stanley

 (*b.* Liverpool, England, 1 September 1835; *d.* Hastings, England, 13 August 1882)

logic, *economics*, *philosophy of science*.

Jevon's name is purportedly of Welsh origin, akin to Evans. His father, Thomas, was a notable iron merchant with an inventive trait, and his mother, Mary Anne Roscoe, belonged to an old Liverpool family of bankers and lawyers with a literary bent. The ninth of elevan children, Jevons was brought up, and always in spirit remained, a Unitarian. He was a timid, clever boy and not narrowly studious, showing unusual mechanical aptitude. At University College, London, he took science courses, and his prowess in chemistry was such that he was recommended, while still an undergraduate and only eighteen years of age, for the job of assayer at the newly established Australian mint. In part to help ease a shrunken family budget, he decided to interrupt his education and to accept the post, which carried the handsome remuneration of over £600 a year. In Sydney he cultivated his interests in meteorology, botany, and geology and published papers in these fields. After five years he renounced a prosperous future in Australia and went back to England to further, his education with a view to becoming an academic;he was already saying that "my forte will be found to lie. . .in the moral and logical sciences."

The first subject Jevons concentrated on was political economy, which he felt he could transform. His early and sustained interest in economics must have owed something to two disjoint features of his youth: a family bankruptcy caused by a trade slump, and his having been involved in the physical creation of money. The fluctuations of the national economy always fascinated him.

Having earned his master's degree at University College in 1863, Jevons was appointed junior lecturer at Owens College, Manchester, thus beginning a long association with that city. Two years later he became a part-time professor of logic and political economy at Queen' College, Liverpool, and in 1866 the Manchester institution raised him to a full-time double professorship of "logic and mental and moral philosophy," and of political economy. The following year Jevons married Harriet Ann Taylor, daughter of the founder and first editor of the *Manchester Guardian*, and the couple was soon enjoying the lively intellectual atmosphere of Victorian Manchester. They had three children, of whom one, Herbert stanley, became a well-known economist. Jevons was made a fellow of the royal society in 1872.

In 1876, tired of his teaching chores (he was a poor lecturer and hated to speak in public), Jevons moved to a less onerous but more prestigious professorship at University college, Four years later, he resigned, anxious to spend all his time writing, but his health had begun to deteriorate, despite many long recuperative vacations in England and Norway. A few weeks before his forty-seventh birthday he drowned (possibly as the result of a seizure) while swimming off the Sussex coast.

Jevons had a strong and almost visionary sense of his own destiny as a thinker, and he worried about its fulfillment. A prodigious worker, he sustained many side interests and was passionately fond of music. Among his tributary writings are articles on the Brownian movement, the spectrum, communications, muscular exertion, pollution, skating, and popular entertainment. He tried hard and successfully to improve his literary style, and his later writings are more concise and readable than his earlier ones.

Whether economics or the rationale of scientific methodology benefited more from Jevon'attention is still arguable, but it was certainly as an economist that he became a public figure. Ironically, his popular fame rested on two achievements that now seem slight or even misguided. The first was his book *The Coal Question* (1865), a homily about dwindling English fuel supplies in relation to rocketing future demands The work was Malthusian in the sense that he discussed industry and coal in much the terms that the earlier author had discussed population and food. It was a tract and obviously, as Keynes remarked, *épatant*. Gladstone, then chancellor of the Exchequer, was deeply impressed by the book, whose"grave conclusions" influenced his fiscal policy. A royal commission was subsequently appointed to look into the matter. Jevon'second achievement was the thesis, developed in the late 1870' from tentative suggestions made by earlier writers, that trade cycles could be correlated with sunspot activity through agrometeorology and, at a further remove, through the price of wheat. It was an ingenous and inherently plausible argument, but the data could not be mainpulated pulated to yield convincing evidence and the theory has no standing today.

Jevons brought to economic theory a fruitful insistence on a mathematical framework with an abundance of statistical material to fill out the structure. He was a diligent collector and sifter of statistics, and his methods of presenting quantitative data showed insight and skill. He strongly advocated the use og good charts and diagrams (colored, if possible), which he said, were to the economist what fine maps are to the geographer. (At one time he toyed with a project to sell illustrated statistical

information bulletins to businessmen.) He clarified certain concepts, particularly that of value, which he regarded as a function of utility, a property he wrote about with luminance. Indeed, this was his major contribution, and one that led to the explicit use of the calculus and other mathematical tools by economists.

Utility, said Jevons, "is a circumstance of things arising out of their relation to man's requirements and that normally diminishes," One of his favorite examples concerns bread, a daily pound of which, for a given person, has the "highest conceivable utility," and he went on to show that extra pounds have progressively smaller utilities, illustrating that the "final degree of utility"declines as consumption rises. In effect he was arguing that the second derivative of the function $U_a = U (Q_a)$ where U_a is the total utility or satisfaction derived from the consumption of a in the amount Q_a, is negative. This simple prrposition was quite new, for the classical theorists, including Marx, had analyzed value from the supply side only, whereas Jevon'analysis was from demand. Later writers were to recognize the necessity of both approaches. Incidentally, Jevons'approach was the forerunner of the idea of"marginal utility," the first of the"marginal"concepts on which modern economics may be said to rest.

Jevons'work on price index-numbers deserves mention, as his setting them on a sound statistical footing enormously advanced understanding of changes in price and in the all-important value of gold.

Although some of Jevons' ideas can be found inchoate in the works of his predeccessors Augustus Cournot and H. H. Gossen, and of his contemporaries Karal Menger and Léon Walras, he arrived at his theories independently and can be seen as a pathbreaker in modern economics. His stress on the subject as essentially a mathematical science was judicious, and he held no exaggerated notions about the role of mathematics-he had observed, he said slyly, that mathematical students were no better than any others when faced with real-life problems.

Economics and logic have traditionally been associated in England, and Jevons belongs to the chain of distinguished thinkers, from John Stuart Mill to Frank Ramsey, who are linked to both disciplines. He was opposed to Mill in divers particulars, and at times he looked upon the older man's deep influence on the teaching of logic as hardly short of disastrous. Mill's mind, he once averred, was "essentially illogical," and Jevons eagerly seized on Boole's remarkable new symbolic logic to show up what he deemed the vastly inferior warmed-over classical logic of Mill. Jevons actually improved on Boole in some important details, as, for instance, in showing that the Boolean operations of subtraction and division were superfluous. Whereas Boole had stuck to the mutually exclusive "either-or," Jevons redefined the symbol+ to mean "either one, or the other, or both,"This change, which was at once accepted and became permanent, made for greater consistency and flexibility. The expression a+a, which was an uninterpretable nuisance in the Boolean scheme, now fell into place, the sum being a.

At the same time Jevons deprecated certain aspects of Boole's work. He thought it too starkly symbolic and declared that "the mathematical dress into which he [Boole] threw his discoveries is not proper to them, and his quasi-mathematical processes are vastly more complicated than they need have been"mdash;an extravagant statement, even in the light of Jevons' own logic. Indeed, some of Javons' writings about Boole's system, and especially his worries about the discrepancies between orthodox and Boolean algebras, suggest that he did not fully grasp Boole's originality, potential, and abstractness. Nevertheless, he can certainly be reckoned a leading propagandist for Boole, Particularly among those who could not understand, or who would not brook, Boole's logic. Moreover, Jevons was led through Boole's ideas to some original work on a logical calculus.

Jevons'logic of inference was dominated by what he called the substitution of similars, which expressed "the capacity of mutual replacement existing in any two objects which are like or equivalent to a sufficient degree." This became for him "the great and universal principle of reasoning" from which "all logical processes seem to arrange themselves in simple and luminous order."It also allowed him to develop a special equational logic, with which he constructed various truth-tablelike device for handling logical problems. He did not foresee that a truth-table calculus could be developed as a self-contained entity, but he was able to devise a logic machine—a sort of motional from of the later digrammatic scheme of John Venn. Jevons'' "logical piano"(as he eventually called it in preference to his earlier terms "abacus,""abecedarium" and "alphabet") was built for him by a Salfford clockmaker. It resembled a small upright piano, with twenty-one;-keys for classes and operations in an equational logic. Four terms, *A, B, C*, and *D*, with their negations, in binary combinations, were displayed in slots in front and in back of the piano; and the mechanism allowed for classification, retention, or rejection, depending upon what the player fed in via the keyboard. The keyboard was arranged in an equational form, with all eight terms on both left and right and a "copula"key between them. The remaining four keys were, on the extreme left, "finis" (clearance) and the inclusive "or," and, on the extreme right, "full stop"(output) and the inclusive "or again,", In all 2^{16} (65, 536) logical selections were possible.

The machine earned much acclaim, especially after its exhibition at the Royal Society in 1870. At present it is on display in the Oxford Museum of the History of Science. Although its principal value was as an aid to the teaching of the new logic of classes and propositions, it actually solved problems with superhuman speed and accuracy, and some of its features can be traced in modern computer designs.

Jevons'various textbooks on logic sold widely for many decades, and his *Elementary Lessons in Logic* (London, 1870) was still in print in 1972. Moreover, he considered his ambitious work on the rationale of science to be an extension of his logic into a special field of human endeavor. His biggest and most celebrated book, *The Principles of Science*, is firmly rooted in Jevonian logic and contains practically all his ideas on, and contributions to, the subject. Inescapably, the matter of induction, the basis of scientific method and the bugbear of scientific philosophy is lengthily explored and analyzed. Jevons confidently

declared the "induction is, in fact, the inverse operation of deduction." Such a statement—in one sense a truism and in another a travesty—might be thought a feeble beginning for a study of the how and why of science, but Jevons acquits himself admirably. He does not confuse the formal logic of induction with the problems of inductive inference in the laboratory, and he is obviously under no illusions about the provisional nature of all scientific "truth."

Nineteenth-century English scholars, inspired by the phenomenal explicatory and material success of science, had been taking an increasing interest in its philosophy. John Stuart Mill and William Whewell are particularly associated with these early studies; and in Jevons'view their work contained serious flaws. He thought that Mill, first, expected too much of science as a key to knowledge of all kinds and, second that he was overly respectful of Bacon'view of science as primarily the collection and sortation of data. His criticism of Whewell centered on that writer'apparent assumption that exact knowledge is a reality attainable by scientific patience.

Jevons was perhaps the first writer to insist that absolute precision, whether of observation or of correspondence between theory and practice, is necessarily beyond human reach. Taking a thoroughly modern position, Jevons held that approximation was of the essence, adding that "in the measure of continuous quantity, perfect correspondence must be accidental, and should give rise to suspicion rather than to satisfaction." He also felt that causation was an overrated if not dangerous concept in science, and that what we seek are logically significant interrelations. All the while, he said, the scientist is farming hypotheses, checking them against existing information, and then designing experiments for further support. There can be no cut-and hyphen;dried conclusion to most investigations and no guarantee that correct answers can be issued. The scientist must act in accordance with the probabilities associable with rival hypotheses, which probabilities or, as many would prefer to say today, likelihoods, constitute the decision data. Thus "the theory of probability is an essential part of logical method, so that the logical value of every inductive result must be determined consciously or unconsciously, according to the principles of the inverse method of probability." An entire chapter of *The Principles* is devoted to direct probability and another to inverse probability.

As a probabilist Jevons was fundamentally a disciple of Laplace, or at least of Laplace as reshaped by Jevons' own college teacher and mentor Augustus De Morgan—that is to say, he was a subjectivist. Probability, he maintained, "belongs wholly to the mind" and "deals with quantity of knowledge." Yet he was careful to emphasize that probability is to be taken as a measure, not of an individual's belief, but of rational belief—of what the perfectly logical man would believe in the light of the available evidence. In espousing this view, Jevons sidestepped Boole's disturbing reservations about subjectivism—mainly because he had difficulty grasping them. Writing to Herschel, he stated, frankly: "I got involved in Boole's probabilites, which I did not thoroughly understand. . . . The most difficult points ran in my mind, day and night, till I got alarmed. The result was considerable distress of head a few days later, and some sings of indigestions." In general Jevons was silent about the movement toward a frequental theory of probability that was growing out of the work of Leslie, Ellis, and Poisson, as well as that of his contemporary, Venn.

To the modern reader, however, Jevons may seem altogether too self-assured in this notoriously treacherous field. For example, he wholeheartedly accepted Laplace's controversial rule of succession and offered a naive illustration of its applicability: Observing that of the sixty-four chemical elements known to date (Jevons was writing in 1873) fifty are metallic, we say that the quantity (50+1)-(61+2) equil 17-22is the probability that the next elements discovered will be a metal. To the frequentist, insistent on a clearly delineated sample space, this statement is almost wholly devoid of meaning. Another, more bizarre example of his naive Laplaceanism is his contention that the proposition "a platythliptic coefficient is positive" has, because of our complete ignorance, a probability of correctness of 1aol-2. Boole had rightly objected to this sort of thing and would agree with Charles Terrot that such a probability has the numeric but wholly indeterminate value of 0-0. To understand Jevons' position, however, we must bear in mind that the prestige of Laplace, especially in this area, was then enormous.

Curiously, in discoursing on what he calls"the grand object of seeking to estimate the probability of future events from past experience,"Jevons made only one casual and unenlightening reference to Thomas Bayes, who, a century earlier, had been the first to attempt a coherent theory of inverse probability. Today the implication of Bayes's work from the subject of lively discussion among probabilists.

Some of the most illuminating sections of *The Principles of Science* are those dealing with technical matters, such as the methodology of measurement, the theory of errors and means, and the principle of least squares. Yet the books offers only a shallow treatment of the logic of numbers and arithmetic, and it has been criticized for the absence of any serious discussion of the social and biological science. By and large, however, *The Principles* is something of a landmark in the bleak country of nineteenth-century philosophy of science.

BIBLIOGRAPHY

I. Original Works. According to Harriet Jevons' bibliography (see below), Jevons' first appearance in print was a weather report (24 Aug. 1856) in the *Empire,* a Sydney, Australia, newspaper, for which he wrote weekly reports until 1858. His first publication in a scholarly journal was "On the Cirrus Form of Cloud, With Remarks on Other Forms of Cloud," in London, *Edinburgh and Dublin Philosophical Magazine*,**14** (July 1857), 22-35. His account of the logical piano is "On the Mechanical performance of Logical Inference," in *Philosophical Transactions of the Royal Society*,**160** (1870), 497-518.

His books, all published in London, include *Pure Logic* (1863); The Coal Question (1865); *The Theory of Political Economy* (1871); *The Principles of Science* (1874); *Studies in Deductive Logic* (1880); *The State* in Relation to Labour (1882); Methods of Social Re-Form (1883); *Investigations in Currency and Finance* (1884); and *Principles of Economics* (1905). The last three were published posthumously, and the very last is a fragment of a large work that he was writing at the time of his death.*The Principles of Science,* A *Treatise on Logic and Scientific Method* the frontispiece of which is an engraving of the logical piano, is available as a paperback reprint (New York, 1958).

For information on the 1952 exhibition of Jevons' works at the University of Manchester, see *Nature,***170** (1952), 696. The library of that university has Jevons' economic and general MSS, and Wolfe Mays of the Department of Philosophy owns the philosophic and scientific MSS; much of this material is still unpublished.

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Norman T. Gridgeman