



Jevons and His Precursors

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JEVONS AND HIS PRECURSORS¹

BY ROSS M. ROBERTSON

I. INTRODUCTION

"AT THE earliest possible moment after reading your article in the *Fortnightly*, I wish to say how warmly I thank you for so boldly taking up the cause of the *Theory*." So wrote William Stanley Jevons, in 1875, to George Darwin, son of the famed naturalist. "Not only must your article give new courage to those already believing in the possibility of applying mathematical methods to economy," Jevons went on, "but it must go far towards silencing those who have hitherto ridiculed the notion, and opening the eyes of those who have been entirely blind. It seems to me just the kind of article likely to do most good in counteracting the ill-considered criticisms of Cairnes."²

Four years after the publication of his major work in economic theory Jevons had reason to be concerned both about the reception accorded his book and about the future of economics. True, young Darwin, in his article in the *Fortnightly Review*, had defended Jevons' approach and had gently chided the Irish economist for failing to understand what *The Theory of Political Economy* was all about.³ In the United States the famous astronomer and mathematician, Simon Newcomb, had written a hopeful article in which he argued that there was a "pure" subject of economics as well as an "applied" subject, that ". . . back of applied economy, there is a pure or mathematical science, which admits of as much rigor of mathematical treatment as any other branch of pure science . . ." ⁴ That there might be some difficulty in applying ". . . the rig-

¹ This paper was presented at the December, 1950, meeting of the Econometric Society held in Chicago. The frontispiece photograph is reproduced from *Letters and Journal of W. Stanley Jevons*, edited by his wife, London: Macmillan and Co., 1886. For another photograph of Jevons, together with a biographical sketch and a summary of his scientific contributions, see H. Winefrid Jevons and H. Stanley Jevons, "William Stanley Jevons," *ECONOMETRICA*, Vol. 2, July, 1934, pp. 225-237.

² *Letters and Journal of W. Stanley Jevons*, *op. cit.*, p. 330.

³ George H. Darwin, "The Theory of Exchange Value," *Fortnightly Review*, Vol. 17, New Series, February 1, 1875, pp. 243-253. In his review of *The Theory of Political Economy* Cairnes had admitted that Jevons' simple mathematics was beyond him. It is clear that Cairnes simply didn't understand the central ideas.

⁴ Simon Newcomb, "The Method and Province of Political Economy," *North American Review*, Vol. 121, October, 1875, p. 261. See also Newcomb's little-noticed

orous formulae and methods of this pure science to the actual case of human interest . . ." Newcomb was willing to admit, but he was sure that no harm could come of the use of a precise language.⁵ And as ". . . no real progress is ever made in physical science except by men who aim at nothing beyond the discovery of general truth, regardless of its bearing on human affairs . . ." so political economy could advance only if studied in the same way.⁶

Encouraging as such remarks may have been to Jevons, they represented views which were not typical. With the followers of Ricardo and Mill, Jevons was, of course, in some agreement as regards method. Cairnes was quite clear about the need for the economist's "laboratory of the mind" and at least did lip service to the idea of statistical verification of laws arrived at by deductive processes.⁷ He took pains, however, to argue that much of the data necessary to the solution of economic problems could never be ascertained.⁸ And for reasons similar to those which Say had given some years previously, he held that the science did not admit of mathematical treatment.⁹

Nor were the stultifying views of orthodox economists the only ones with which the ideas of Jevons had to contend. For a time it seemed as though a "Historical School" might rise to shunt economics as science at least temporarily to one side. T. E. Cliffe Leslie, in a rather telling essay published in 1876, had inveighed against what he called a priori political economy, insisting that what ". . . still has to be done is to investigate the actual phenomena, and discover their ultimate causes in the laws of social evolution and national history."¹⁰ Failing to comprehend the purpose of abstraction, Cliffe Leslie was willing to relegate political economy to the status of a "department of the Science of Society," which—in the words of the Rt. Hon. Robert Lowe, M.P.—"it is the barbarous jargon of the day to call Sociology."¹¹ But perhaps the sharpest opposition to what Jevons stood for came from no less a person than Professor J. K. Ingram. In his address as President of Section F of the British Association, given in 1878, Ingram called the attention of the

review of Jevons' book in *North American Review*, Vol. 114, April, 1872, pp. 435-440.

⁵ *Idem.*

⁶ *Ibid.*, p. 266.

⁷ J. E. Cairnes, *The Character and Logical Method of Political Economy*, second edition, London: Macmillan and Co., 1875, Lecture III.

⁸ *Ibid.*, pp. 115-125.

⁹ *Ibid.*, pp. vi-vii, 109-111.

¹⁰ T. E. Cliffe Leslie, "On the Philosophical Method in Political Economy," *Essays in Political and Moral Philosophy*, London: Longmans, Green and Co., 1879, p. 241.

¹¹ W. S. Jevons, "The Future of Political Economy," reprinted in *Principles of Economics*, London: Macmillan and Co., 1905, p. 189.

membership to the fact that the claim of Section F to form a part of the British Association had recently been disputed, apparently by an official of importance in the Association. Contending that economic facts admit of scientific investigation, he held that the contemporary mode of studying the facts and the then current generalizations regarding them were unsound.¹² After a sly thrust at Jevons, he argued that “. . . the excessive tendency to abstraction and to unreal simplifications should be checked,” that the historical method should be adopted, and that “. . . economic laws . . . should be conceived and expressed in a less absolute form.”¹³ It was further plain that “. . . though statistics may be combined with Sociology in the title of the Section,” the two subjects could not occupy a coordinate position. Statistics did not partake of the nature of a science, and, by implication, was not important to the methodology which Ingram proposed.

As the decade of the 1870's went on, Jevons' doubts as to the ultimate acceptance of his work in pure economics seemed to lessen. As his personal prestige became great, his views of the future of political economy became more sanguine. Certainly the preface to the second edition of the *Theory*, written in 1879, conveys an unfeigned enthusiasm. In 1881 he could write to Professor Walras: “I am glad to say I think the mathematical view of economics is making much progress in England, and is fully recognized by those competent to judge.”¹⁴ Jevons, always extremely sensitive to the opinions of others, was right. Well received on the continent from the beginning, within a decade of the publication of *The Theory of Political Economy* the central ideas and the general method were gaining acceptance at home and were shortly to take their firm place in economic thinking. Even Marshall, so cool in his review of the *Theory* in 1872, asserted that the body of Jevons' work “will probably be found to have more constructive force than any, save that of Ricardo, that has been done during the last hundred years” and that his statistical studies would be “models for all time.”¹⁵

II. THE SCOPE OF THE ESSAY

The contribution of Jevons to economics is well known. Connections, however, between Jevons and his successors, on the one hand, and between Jevons and his predecessors, on the other, have never been carefully drawn. It is not the present purpose to treat the detailed relation-

¹² J. K. Ingram, “Address of the President of Section F of the British Association, at the forty-eighth meeting, held at Dublin, in August, 1878,” *Journal of the Royal Statistical Society*, Vol. 41, 1878, pp. 602-604.

¹³ *Ibid.*, p. 626.

¹⁴ *Letters and Journal of W. Stanley Jevons, op. cit.*, p. 431.

¹⁵ W. S. Jevons, *Investigations in Currency and Finance*, London: Macmillan and Co., 1884, p. xliii, quoted in the Introduction by H. S. Foxwell.

ship of Jevons to those who followed him, although, as Wicksteed has remarked, his was a great seminal work. In another sense Jevons was a terminal figure. His efforts both in pure theory and in applied economics constitute a synthesis of the first importance, and because of his readiness to acknowledge indebtedness to his precursors it is possible to assign to certain little known writers a place of some importance in the history of economics. Furthermore, when Jevons' work is examined in the light of its historical background, certain of the apparent deficiencies seem unimportant and the revolutionary aspects stand out more clearly than ever.

This paper, then, is a study in the intellectual history of a major figure. It should be emphasized at the outset that no attempt will be made to elaborate the obvious influence of the classical tradition upon Jevonian thought. Nor will it be possible, within the scope of this essay, to treat certain important precursors—notably Cournot, Gossen, and von Thünen—whose works were unknown to Jevons until after he had completed his theoretical system. With few exceptions, only those writers will be considered whose influence on Jevons was both more than incidental and specifically acknowledged by him.

Jevons' work in economics fairly well divides itself into two parts, the pure theory and the inductive studies, and it will be convenient to consider his predecessors according as they informed his thinking in the one direction or the other. The first category, which is treated here at some length, may be subdivided into two groups, one consisting of writers who were primarily concerned with utility theory, the other consisting of those with a mathematical bent who led Jevons to his methodological approach. The second category, which will receive only brief attention, likewise consists of two groups, the one composed of pioneers in the use of index numbers in the treatment of economic aggregates, the other made up of inquirers into the causes of cyclical fluctuations.

III. PRECURSORS OF THE PURE ECONOMICS

The Background of Jevons' Utility Theory

It is worthy of comment at the outset that many of the English economists who had placed the individual at the center of their approach to value theory do not appear to have come to Jevons' attention. He does not, for example, indicate any indebtedness in this regard to John Craig, Samuel Bailey, W. F. Lloyd, or Mountifort Longfield.¹⁶ Both Lauderdale and Senior are mentioned, and Senior's rather offhand statement of the

¹⁶ Jevons was familiar with a mass of the early nineteenth-century economic literature, but most of the work of Seligman's "neglected" British economists seems to have escaped his attention.

law of diminishing marginal utility is quoted in full.¹⁷ Jevons on several occasions expresses admiration for Senior, but Marian Bowley's comment to the effect that Senior's "famous discussion of wants" led to the formulation of the concept of marginal utility seems highly questionable.¹⁸ (On the other hand, the Jevonian theory of distribution originates in Senior's view that cost of production is the sum of the labor and abstinence necessary to production.)

Jevons' remark that T. E. Banfield is the writer who reached "... the deepest comprehension of the foundation of Economy" is hardly borne out upon careful examination, nor does Jevons' book seem to bear the imprint of Banfield's particular approach.¹⁹ *Four Lectures on the Organization of Industry* purports to call attention to the revolutionary opinions of some continental economists, especially to the assertion of Rossi that value is essentially "subjective" (i.e., conferred by the estimating party) and to Friedrich Hermann's proposition that "... the relations that grow up between man and man . . ." are a part of both the wealth and the capital of individual nations.²⁰ Suggestive as Banfield's text may be, however, it contains no systematic treatment of the subjective evaluations of consumers. Jevons was impressed with Banfield's contention that the scientific basis of economics lies in a theory of consumption and with his first proposition of such a theory, that "the satisfaction of every lower want in the scale creates a desire of a higher character."²¹ Oddly, it is at this very point—in the consideration of the interdependence of wants—that Jevons neglects to develop his own theory.

Two writers, above all others, appear to have molded Jevons' construction of utility theory. One of these, of course, is Jeremy Bentham. Yet, one has the feeling as he reads Chapter II of the *Theory*, the chapter on pleasures and pains, that Jevons is simply going through the motions of citing an unquestioned authority before proceeding to an altogether different kind of analysis. This is not Bentham recast. The words pleasure and pain are used, but they are scarcely the pleasure and pain of the Bentham Calculus. No attempt is made to measure them. Nor, for that matter, is there any considerable variety of them. A pleasure is simply *any* motive which attracts to a certain action, and a pain is *any* motive

¹⁷ W. S. Jevons, *The Theory of Political Economy*, first edition, London: Macmillan and Co., 1871, p. 6.

¹⁸ See Marian Bowley, *Nassau Senior and Classical Economics*, London: George Allen and Unwin, 1937, p. 95. Compare W. S. Jevons, *Principles of Economics*, London: Macmillan and Co., 1905, pp. 1-4.

¹⁹ T. E. Banfield, *Four Lectures on the Organization of Industry*, London: Richard and John E. Taylor, 1845, especially pp. v-viii, 11-23.

²⁰ *Ibid.*, p. v.

²¹ Compare Jevons, *Theory*, *op. cit.*, first edition, pp. 49-51, 64, and Banfield, *op. cit.*, p. 11.

which deters action. It is as simple as that; and Bentham is not simple. Yet there can be little doubt that the Benthamite approach was thoroughly understood by Jevons and subtly rejected.

The second, and more important, author to have a major influence on Jevons' thought regarding subjective evaluation is Richard Jennings, an unknown. *Palgrave*s says that Jennings "flourished" in the middle nineteenth century, but there is little evidence that he was either read or esteemed by his contemporaries. Jennings wrote two books on economics, neither of which is easy to obtain. His *Natural Elements of Political Economy*, published in 1855, is so significant, both as an adumbration of Jevons' theory and as a first important statement of some of the relationships between psychology and economics, that there is a temptation to treat it here rather too fully. What follows, then, outlines only the essence of Jennings' contribution which is relevant to the present subject.

Jennings begins with the assertion that he wishes "to exhibit as far as may be possible the causal and formal principles of Value."²² He warns that these principles will be abstract and apparently remote from practical application, but that political economists have up to this time erred in considering only the physical conditions of matter. There is, he complains, nothing in the economic literature "... concerning those normal principles of mind which govern many elementary conditions of Political-economy,—such as the origin and growth of the conception of value, the degrees in which it is entertained, the desires which it engenders, and the productive actions which these cause."²³ The political economist must base his analysis upon the elementary principles of physiology and psychology, but since this requires working through a vast literature, the students in the field have simply done without the required knowledge. To arrive at "ground which offers a firmer footing," Jennings proposes to investigate the pertinent physiological and psychological principles which, he hopes, may assist those who observe "social phenomena known through statistics."

Jennings takes it that economics attempts "... to investigate ... the relations of human nature and exchangeable objects..."²⁴ Although "... it is evident that in both consumption and production there occurs a simultaneous action and reaction of external objects upon man, and of man upon external objects," consumption comprises actions of which the *motive* is the contemplated effect of objects upon man and production comprises actions of which the *motive* is the contemplated effect of man upon objects. Consumption is characterized by the predominant use of

²² Richard Jennings, *The Natural Elements of Political Economy*, London: Longman, Brown, Green, and Longmans, 1855, pp. 8-9.

²³ *Ibid.*, p. 13.

²⁴ *Ibid.*, p. 63.

the *afferent* trunks of nerve fibers, whereas production involves the use of the *efferent* nerve trunks.²⁵ Proceeding to an analysis of consumption, Jennings considers next the nature of sensations. Those which are not regarded with indifference by the human organism, and in which the functions of the afferent nerve fibers are predominant, are analyzed first.

The sensations of consumption may be divided into two classes according as they are conveyed by the nerves of common sensation or by the nerves of special sensation. In the former class are "... all those sensations which are not conveyed by the well-defined organisms of the five senses," such, for example, as sensations of muscular resistance (exercise or repose), of temperature, and of those consequent upon the gratification of appetite and the use of stimulants. In the latter class are the sensations conveyed by the organs of the five senses. Now the commodities which excite these two classes of sensations, while coinciding rather closely with necessities and luxuries, are better designated as primary and secondary commodities, primary commodities being objects of common sensation and secondary commodities being objects of special sensation.²⁶

In order "... to determine the value that these Commodities may be expected to bear in the estimation of each individual, and ultimately the price for which they will be found to be bought and sold in the dealings of civilized life," Jennings next finds it necessary to inquire how sensations vary in degree and duration as the quantity of commodity by which they are excited varies.²⁷ Such an inquiry must be divided into two parts because sensations resulting from the intake of a commodity may be regarded as relative or absolute; that is, sensations may be considered dependent upon the existence of commodities other than the one varying in rate of intake, or they may be considered as dependent only upon changes in the quantity and quality of the commodity which varies. The relative effect of commodities in producing sensations is contained in the proposition that primary commodities (roughly, necessities) are essential to the "fruition" of secondary commodities (roughly, luxuries) but secondary commodities are not essential to the "fruition" of primary commodities. "The satisfaction of our less specially organized senses must precede those which are more specially organized, although the reverse of this is not the case. . . ." There follows the passage, from which Jevons quoted so freely, containing Jennings' state-

²⁵ Compare C. Reinold Noyes, *Economic Man in Relation to His Natural Environment*, New York: Columbia University Press, 1948. The similarity of approach between Jennings and Noyes will be apparent. In the present paper, Jennings' work is presented without criticism of its psychological position.

²⁶ *Ibid.*, pp. 92-93.

²⁷ *Ibid.*, p. 94.

ment of the "absolute" effect of commodities in producing sensations.²⁸ Jennings takes care to remind his readers that the feeling to which he refers ". . . is *sensation*—the first effect of matter on mind, not the complex conception of value, and still less the ideas of unpriced dignity and power usually associated with the idea of large possessions. . . ." With respect to all commodities ". . . the degrees of satisfaction do not proceed *pari passu* with the quantities consumed . . . but diminish gradually, until they ultimately disappear, and further instalments can produce no further satisfaction. In this progressive scale the increments of sensation resulting from equal increments of the commodity are obviously less and less at each step,—each degree of sensations is less than the preceding degree."²⁹

This "law of the variation of sensations" constitutes the very foundation of an analysis of the forces affecting prices and production, but one further observation must be made which will throw more light on the nature of the phenomena of consumption. There is a difference between the variation of the sensations produced by the consumption of primary commodities and the variation of the sensations produced by the consumption of secondary commodities, the satisfaction derived from objects which affect the special senses being far less dependent upon quantity than the satisfaction derived from, say, food or shelter or clothing. "Whilst food . . . may be meted out to the human body with the same degree of exactness as to the stall-fed ox . . . who can mete out to the eye its due amount of visual satisfaction . . . ?" Furthermore, although one common sensation cannot be readily substituted for another, there is a high degree of substitutability among the special sensations. Thus, the law of the variation of sensations must be modified to the extent that ". . . for equal changes in the quantity of commodities, the change in the amount of satisfaction derived from primary commodities is greater than the change in the amount of satisfaction derived from secondary commodities."³⁰

What has been set forth in some detail is indicative of the nature of Jennings' analysis. In similar fashion he develops a relationship between quantity of exertion and degree of toilsome sensation (he does not like the word pain in this connection). Within a period of time, as the number of hours of work increases for any individual, ". . . the amount of toilsome sensation attending each succeeding increment would be found greater than that which would attend the increment

²⁸ Compare Jevons, *Theory, op. cit.*, first edition, pp. 64-68; fourth edition, pp. 55-57.

²⁹ Jennings, *op. cit.*, pp. 98-99.

³⁰ *Ibid.*, p. 102.

preceding. . . ."³¹ Having arrived at these two fundamental generalizations, Jennings proceeds to a lengthy and, at times, obscure examination of such "internal phenomena of mind" as may be pertinent to economic investigation. He describes the psychological laws by which the human mind, remembering the physical sensations in their varying degrees of intensity and in their opposite qualities, arrives at the complex "Conception of Value" and the equally complex "Conception of Labor." Of especial interest to the modern reader is the emphasis on the fact, established by the evidence of both physiology and psychology, that acts of consumption and of productive labor ". . . can be, and frequently are, performed without the attention, or the intention, or even the excitement of consciousness in the mind of the agent. . . ."³² Even so, among the conclusions reached by Jennings is a principle which Jevons was to make famous by putting it into mathematical form. If laborious action be regarded as having a positive value on account of its pecuniary reward and a negative value on account of the toilsome feelings which accompany it, the action will be carried on only so long as the individual contemplates a preponderating amount of satisfaction.³³

Another author who must be considered a significant precursor of Jevons is H. D. MacLeod, perhaps the most important English economist to suffer from being a contemporary of John Stuart Mill. MacLeod's exposition was ordinarily nonmathematical, but Jevons admired his precision of treatment and, although expressing disagreement with him on certain points, acknowledged the assistance which he derived from several of his works.³⁴

MacLeod, believing himself in accord with Archbishop Whately, held that the object of the pure science of political economy is ". . . to discover the laws that regulate the Exchangeable Relations of Quantities."³⁵ He gets quickly from a consideration of value to what he considers the more relevant "theory of prices," and his book on principles has as its theme an insistence upon the need for a perfectly general theory of the determination of prices. His is a consistent demand-and-supply analysis, with demand conditioned by the "intensity" of service rendered, a notion involving the concept of the diminishing marginal significance of wants. Jevons probably was influenced generally by Mac-

³¹ *Ibid.*, p. 120. This law is quoted at length by Jevons. See Jevons, *Theory, op. cit.*, first edition, pp. 166-168; fourth edition, pp. 171-172.

³² Jennings, *op. cit.*, p. 137.

³³ *Ibid.*, pp. 186 and 187.

³⁴ Jevons, *Theory, op. cit.*, second edition, p. xxix.

³⁵ Henry Dunning MacLeod, *The Elements of Political Economy*, London: Longman, Brown, Green, Longmans, and Roberts, 1858, p. vi. This work was intended by MacLeod to elucidate certain principles which he had enunciated in his *Theory and Practice of Banking*.

Leod, especially by his adverse and well-phrased criticism of both Ricardo and J. S. Mill on the grounds that (1) they neglected to consider the importance of the consumer in their discussions of value and (2) they did not recognize clearly that the factors, far from conferring value upon articles, have value and are themselves priced in the market place because they are used to produce goods which people desire.³⁶ Finally, Jevons specifically refers to MacLeod in his discussion of negative and zero value, ideas which lie back of the Jevonian concepts of both discommodity and disutility.³⁷ It is worth noting, however, that Jevons does not go so far as to assert, as MacLeod does, that much economic effort is directed toward the removal of negative values—the doctor, the lawyer, the soldier, and the clergyman furnishing examples of such activity.

It is clear then, that Jevons was assisted by predecessors in the formulation of certain key points in his theoretical system. He would have advanced economics but little, however, if he had not successfully introduced, for the first time in a way which really captured the imagination of economists, a mathematical approach to economic analysis. To a consideration of those who influenced Jevons in this direction it is now necessary to turn.

The Background of Jevons' Mathematical Approach

I have shown elsewhere³⁸ that before Cournot published the *Recherches* some considerable beginnings had been made toward a mathematical method in economic analysis. Before 1838, certain writers in economics had employed the calculus, had written equations without insisting that functions be defined by analytic formulas, and had used geometry to express two-variable functions. The greater part of these early economists were known to Jevons by 1878, the year in which the second edition of the *Theory* was published, for they appear in the famed list of mathematico-economic works which constituted Appendix I.³⁹ Most of the important mathematical economists who published in the period 1838–1878 likewise appear in this list.

In some cases it is impossible to state with certainty whether or not a writer who had published before the appearance of the *Theory* in 1871 was known to Jevons. Two clear generalizations may be made, however. First, the greater part of the bibliography must have been

³⁶ Compare Jevons, *Theory, op. cit.*, second edition, pp. 177–180.

³⁷ See MacLeod, *op. cit.*, pp. 52–56. Cf. Jevons, *Theory, op. cit.*, second edition, especially pp. xlii, 137–145, 62–63, 187–189.

³⁸ Ross M. Robertson, "Mathematical Economics Before Cournot," *Journal of Political Economy*, Vol. 57, December, 1949, p. 524.

³⁹ This list, in very nearly the form which it had as an appendix to Jevons' book, first appeared in the *Journal of the Royal Statistical Society* of June, 1878.

compiled during the 1870's as correspondents called attention to much of the earlier work. Second, the German books were in no case of use to Jevons, for, by his own admission, his considerable scholarly equipment did not include a knowledge of the German language. The number of writers who could have influenced Jevons is thus considerably reduced, and where there is any question the historian can only surmise.

Writing in 1879, Jevons himself said that in the first edition of the *Theory* ". . . I gave a brief account of such writings of the kind as I was then acquainted with; it is from the works there mentioned, if from any, that I derived the idea of investigating Economics mathematically."⁴⁰ As a matter of fact, Jevons had remarked in the preface to the first edition that his enumeration of previous attempts to apply mathematics to economics was not complete, even as regards English writers. His memory was almost certainly faulty then, but his first list furnishes a point of departure. Those from whom he "derived the idea" of a mathematical method were Francis Hutcheson, William Whewell, John Tozer, H. D. MacLeod, Fleeming Jenkin, Dionysius Lardner, Richard Jennings, and Sir John Lubbock. Of this group MacLeod and Jennings may be dismissed as unimportant in the present connection; MacLeod's only mathematical passages are concerned with the computation of yields on bills in the portfolios of commercial banks, while Jennings simply gives a clever statement of the possibilities of mathematical method in the social sciences. Lubbock seems to have been important only as he influenced Jevons' empirical studies and will be treated later.

Scarcely more attention need be devoted to Hutcheson, Whewell, and Tozer; indeed, Jevons probably owed more to Whewell as a logician than as an economist. Hutcheson, Adam Smith's famed teacher, had attempted in *An Essay on The Nature and Conduct of the Passions and Affections* to give quantitative expression to certain essentially subjective concepts.⁴¹ In another work there is an explicit employment of a letter notation, one of the first attempts at symbolic demonstration in a philosophical work. The author deleted the symbols, however, beginning with the fifth edition, because the mathematical expressions were "disagreeable" to some readers.⁴² Whewell and Tozer, on the other hand,

⁴⁰ Jevons, *Theory, op. cit.*, second edition, p. xviii.

⁴¹ Francis Hutcheson, *An Essay on the Nature and Conduct of the Passions and Affections*, London, 1728, pp. 39-40. For example, ". . . The moment of Good in any object, is in a compound proportion of the duration and intenseness . . ." and "The Ratio of the *Hazard* of acquiring or retaining any good must be multiplied into the moment of the good; so also the *Hazard* of avoiding any Evil is to be multiplied into the moment of it, to find its comparative value."

⁴² Francis Hutcheson, *An Inquiry Into The Original of Our Ideas of Beauty and Virtue*, fifth edition, London, 1753, p. xxii. For the algebraic notation see the third edition, corrected, London, 1729, pp. 186-197 and pp. 288-289.

made serious attempts at a mathematical treatment of economic problems. They failed to use the general concept of a function, however, and their algebraic manipulations were so involved as to make their attempts at verifying or refuting existing doctrine (mostly Ricardian) nearly useless.⁴³ The turgid exposition of these writers is quite unlike that of Jevons. It should be remarked, however, that Whewell's clear argument for the use of mathematics and the analogy which he draws between mathematical applications in mechanics and in political economy is strongly suggestive of the views of his distinguished successor.⁴⁴

Jevons himself wrote, in 1879, that it was to Dionysius Lardner's treatise entitled *Railway Economy* that he was probably most indebted for the idea of investigating economics mathematically.⁴⁵ This is indeed odd, for the passages which Jevons thought of especial scientific value contain the first exposition in English of what approximates the modern theory of the firm. And there can be no doubt that Jevons understood it well. He had read the book in 1857, and in the first edition of the *Theory* he gives the gist of Lardner's analysis in a few sentences.

Lardner was a fabulous figure. A prolific writer on mathematical and scientific topics, he has been characterized as a man of great ability though not an original and profound thinker. An elopement, in 1840, with the wife of a cavalry officer necessitated his resigning his professorship of natural philosophy and astronomy at University College, London. After a financially successful lecture trip in the United States, he settled in Paris, where he lived till within a few months of his death in 1859. He is satirized as Dionysius Diddler in Thackeray's *Miscellanies*, a kind of immortality that economists rarely achieve. Indeed, he was hardly an economist, *Railway Economy* and a few articles on various railroad problems constituting his entire work in the field.

The portion of Lardner's book which is of present interest consists of two chapters on the cost and revenue functions of a firm in the railroad industry. Lardner begins by making a clear distinction between the fixed and variable costs of a company. He then classifies the main types of expenditure under these two categories, and proceeds to arrive at algebraic formulas which give the expense chargeable per mile to each car of a passenger or freight train.⁴⁶ Taking data furnished by the state-

⁴³ See William Whewell, "Mathematical Exposition of Some Doctrines of Political Economy," *Cambridge Philosophical Transactions*, Vol. 3, 1829, pp. 191-230. Two other articles appeared in the *Transactions*, Vol. 4, 1831, pp. 155-198, and Vol. 9, 1850, pp. 128-149. See also John Tozer, "Mathematical Investigation of the Effect of Machinery on the Wealth of a Community, etc.," *Cambridge Philosophical Transactions*, Vol. 6, 1838, pp. 507-522, and Vol. 7, 1840, pp. 189-196.

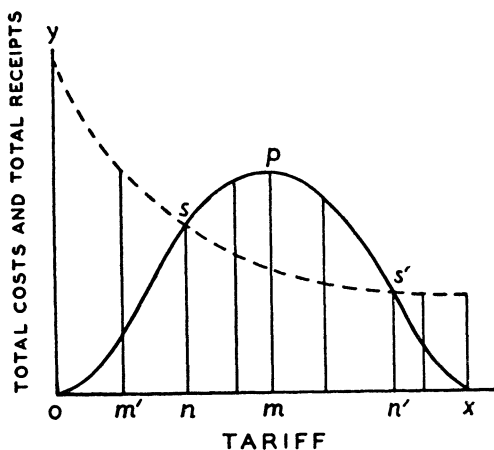
⁴⁴ For further comment on Whewell, see Robertson, *op. cit.*, p. 535.

⁴⁵ Jevons, *Theory*, second edition, p. xviii.

⁴⁶ Dionysius Lardner, *Railway Economy*, London, 1850, p. 59. This was the book which Jevons persuaded Foxwell to buy to start his collection.

owned Belgian System, he then computes the per-mile cost of carriage of different classes of passengers and freight. This done, Lardner turns to the question of receipts. It is a relatively simple matter to compute from data receipts per mile for different classes of freight and passengers; hence, profits on each class are easily determined. However, the chief aim of management is to maximize profits, and this presents an economical problem of a complex and difficult character.⁴⁷ There follows, assuming the essentially monopolistic characteristics of a railroad, a solution of the problem which is remarkable for its clarity and originality.

The gross receipts of a railway depend, for any class of good or passenger carried, upon the average tariff per mile per unit, upon the average number of miles over which each unit is transported, and upon the total number of units carried. Now the managers have no *direct* control over number of units carried nor upon the average number of miles each unit is transported. These two elements, however, are indirectly influenced by an element over which management does have control—the average tariff per mile of transport. As tariffs are lowered, the quantity of traffic and the average distances traveled will increase. With no tariff at all, traffic is at a maximum, but there are no receipts; with a prohibitory tariff, both traffic and receipts vanish. A simple diagram serves to illustrate the functional relationship between tariffs and receipts, and between tariffs and costs.



Let the tariff be measured along the Ox -axis, and let both total receipts and total costs be measured along the Oy -axis. If Ox be the prohibitory tariff, there are no receipts. As the tariff is reduced, both quantity of traffic and average distances traveled increase more than enough to offset the diminution in the tariff, so that total receipts rise to some

⁴⁷ *Ibid.*, p. 285.

maximum mp . But at some point Om , "... the effect of the reduction of the tariff counterpoises exactly the effect of the increase of traffic in quantity and distance," and revenue begins to diminish, becoming zero when the traffic is carried gratuitously.⁴⁸

But the problem of the railroad manager is not simply that of discovering the point at which receipts are a maximum; he must determine the point of maximum profits and thus has to consider the total cost function. Because there are both fixed and variable costs, a certain amount of expense will be incurred when the tariff is prohibitory and no traffic is carried. As the tariff is reduced from the prohibitory rate, with a consequent increase in traffic, costs will rise, reaching a maximum where the charge is zero and traffic is a maximum. Obviously, losses are incurred as the rate per unit increases from zero to On , at which point costs are just covered. As the tariff increases from On , a net revenue is earned. The maximum profit is not received, however, at the point of maximum receipts, but at some point beyond, where, as both total receipts and total revenue diminish, the rate of change of the two functions is equal. Geometrically, this is the point at which the two curves become parallel to each other, somewhere between a rate which maximizes gross revenue and one which is prohibitory.

Lardner's analysis and that of the more famous Fleeming Jenkin, taken together, really do contain a considerable portion of the ideas important in modern partial equilibrium price theory. Jenkin's work is so well known that we may pass over it without comment, except for the remark that in his earlier and nongeometric treatment of supply and demand functions he used a general concept of a function.⁴⁹ So far as can be determined, this was only the second such notation that Jevons had seen in an economic application, but in view of his considerable training in mathematics and symbolic logic this is probably not important. It is worth noting, too, that Jenkin's supply curves and demand curves were never incorporated into Jevons' analysis, although Jevons did remark that from about 1863, in his lectures at Owens College, he used intersecting curves to illustrate the determination of market price.⁵⁰ In the late 1860's Jenkin and Jevons corresponded on the subject of the mathematical treatment of economics, and in a manuscript note discovered by his son, Jevons records that he might have delayed publication of *The Theory of Political Economy* had he not been impelled to action by the appearance of Jenkin's papers in 1868 and 1870.⁵¹

⁴⁸ *Ibid.*, p. 288.

⁴⁹ Fleeming Jenkin, "Trade Unions: How Far Legitimate," originally appeared in *The North British Review*, March, 1868, and reprinted in *Papers of Fleeming Jenkin*, London: Longmans, Green and Co., 1887, Vol. 2, pp. 17-19, 21, 24.

⁵⁰ Jevons, *Theory, op. cit.*, fourth edition, p. 333.

⁵¹ *Ibid.*, p. lvii. For Jenkin's second, and much more important paper, see

Except, then, for the general impact which they must have had on Jevons' thinking in his formative years, the mathematical works to which he acknowledges indebtedness seem to have contributed very little to his formulation. As a matter of fact, only one writer whom Jevons might have read cast his analysis in anything like a form suggestive of the later work. This was Achille-Nicolas Isnard, whom Jevons compliments in the preface to the second edition of the *Theory*. Isnard's *Traité des richesses* was listed in a bibliography of Joseph Garnier with which Jevons was familiar in the 1860's, and it is quite possible that he had read the book. In any case, as I have shown in a previous article, Isnard did develop a method of obtaining ratios of exchange among goods by the solution of simultaneous equations. Isnard did not, however, have the concept of diminishing marginal utility.⁵²

There remains to be considered one other major influence in Jevons' methodology. Pantaleoni has remarked that Daniel Bernoulli developed the logical general theory of which Jevons' idea of final degree of utility is only the application to a particular science. It was Pantaleoni's opinion, however, that Jevons was led to his theory, not directly from a study of Bernoulli, but as a consequence of his work as a student under Augustus De Morgan.⁵³ There can be no doubt that De Morgan, one of the eminent mathematicians of his time, played a great part in directing Jevons' thought. The law of "substitution of similars" which, as Wicksteed has pointed out, was applied in his economic theory as the "Law of Indifference," was developed as a consequence of his association with De Morgan.⁵⁴ In his published letters this teacher and critic is mentioned no less than seventeen times. Nevertheless, De Morgan was primarily a force in the development of Jevons' work in symbolic logic and on probability theory. Bernoulli and Laplace are cited by Jevons, but he refers only to the summary of their work in Todhunter's *History of the Theory of Probability*, which appeared in 1865.⁵⁵ It is extremely doubtful that Jevons' system took its form from the work of either Bernoulli or Laplace.

"Laws of Supply and Demand," originally published in *Recess Studies*, Edinburgh, 1870, and reprinted in *Papers of Fleeming Jenkin*, *op. cit.*, pp. 76-106. This article and one published in the following year "On the Principles Which Regulate The Incidence of Taxes," *op. cit.*, pp. 107-121, certainly merit more thorough consideration than the brief mention usually accorded them in histories of economics.

⁵² Compare Robertson, *op. cit.*, pp. 531-533, and Jevons, *Theory*, *op. cit.*, first edition, pp. 100-101, 113-117.

⁵³ Maffeo Pantaleoni, "Contributo alla teoria del riparto delle spese pubbliche," *Scritti vari di Economia*, Milano-Palermo-Napoli: Libraio della R. Casa, 1940, pp. 54-57.

⁵⁴ W. S. Jevons, *Principles of Science*, second edition, London: Macmillan and Co., 1877, p. xvi.

⁵⁵ Jevons, *Theory*, *op. cit.*, first edition, pp. 154-155.

IV. PRECURSORS OF THE INDUCTIVE STUDIES

A full consideration of the background of Jevons' inductive studies defies treatment within the compass of this paper, and a full treatment would be tiresome. It is here that Jevons is without precursors, in the sense that no one before him approached his sheer ability in the sifting and interpretation of economic statistics.⁵⁶ The essay, *A Serious Fall in the Value of Gold*, marks the beginning of scientific empirical studies in economics and would by itself have assured its author a place in the history of economics. It is equally certain that Jevons' well-directed examination of the mass of data pertinent to a theory of economic fluctuations cannot be compared with anything done before him or, for that matter, for several decades after his death.

It is of some interest, nevertheless, to inquire as to the sources which stimulated this particular activity. Nothing in the way of general background stands out clearly unless it be a pamphlet entitled *On Currency*, published anonymously by Sir John Lubbock in 1840.⁵⁷ Lubbock, justifying his mathematical method with a quotation from Whewell, developed a rather elaborate equation of exchange and a formula for determining, at any time, whether or not an import of gold will be profitable. There is a simple, but rather clever, analysis of the effects of regulating a central banknote issue with reference to the exchanges in which, with the aid of the differential calculus and geometric figures, it is shown that use of such a criterion of regulation, because of time lags, will induce cyclical fluctuations in the currency and in prices. Lubbock wrestles with the problem of a *general* index of prices but fails to reach a correct answer because of his lack of faith in the statistical data with which he labors. Nevertheless, this is a work with which those interested in the history of econometric method ought to be familiar.

As is well known, Jevons' first empirical study was a brief paper on seasonal fluctuations in economic activity which he communicated in 1862 to the Cambridge meeting of the British Association along with his *Notice of a General Mathematical Theory of Political Economy*. This paper was suggested, according to his own statement, by two articles which had appeared in the *Statistical Journal* some years previously, one by J. W. Gilbart and the other by Charles Babbage.⁵⁸ Jevons own

⁵⁶ For the best treatment of this aspect of Jevons' work see J. M. Keynes, "William Stanley Jevons," *Journal of the Royal Statistical Society*, Vol. 99, 1936, pp. 523-531.

⁵⁷ Sir John Lubbock, *On Currency*, London: Charles Knight, 1840. Compare Jevons remarks in the preface to the *Theory*, second edition, p. ix.

⁵⁸ J. W. Gilbart, "The Laws of the Currency, as exemplified in the Circulation of Country Bank Notes in England, since the passing of the Act of 1844," *Journal of the Royal Statistical Society*, Vol. 17, December, 1854, pp. 289-321, and Charles Babbage, "Analysis of the Statistics of the Clearing House during the Year 1839," *Journal of the Royal Statistical Society*, Vol. 19, March, 1856, pp. 28-48.

first work showed no great advance over these studies, and there are many papers in the early issues of the *Journal of the Royal Statistical Society* as suggestive as the ones cited. *A Serious Fall in the Value of Gold*, which appeared in the next year, was apparently suggested by Michel Chevalier's *On The Probable Fall in The Value of Gold* and by discussions of the matter by William Newmarch and MacCulloch. Jevons obviously admired the work of Chevalier, in which it was predicted, after a careful marshaling of facts concerning the supply of and demand for gold, that the value of the metal must fall considerably.⁵⁹ But the French economist was unable to measure the fall which had taken place or to give any means by which it might be measured except that of comparing the relative flows of gold and silver to the mint in a country on a bimetallic standard.

It is typical of Jevons' resourcefulness and courage that, with so little to guide him, he was able to trace changes in the general price level over a period of years, and, making allowances for the seasonal and cyclical variations, to arrive at a definite secular trend. And he did this after manufacturing his own tools.⁶⁰ As always, Jevons was careful to indicate his obligations to predecessors, inconsiderable as his indebtedness may have been. He mentions Sir George Shuckburgh-Evelyn's table of index numbers and G. Poulett Scrope's suggestion that a tabular standard of value be adopted in order that variations in the "purchasing power of money" might be accurately discerned over time.⁶¹ Jevons was especially impressed with the "ingenious" work of Joseph Lowe, whose grasp of the problems connected with the construction of index numbers was considerable. Among other things, he refined Arthur Young's crude method of weighting, considered the perplexities involved in quality changes over time, and even made suggestions for the construction of cost-of-living indices for families in different income groups.⁶² But however important the earlier writers may have been, Jevons states that he adopted, in part, the method of William Newmarch.⁶³ A hasty reading of some of Newmarch's articles might lead one to think that Jevons had used much the same method.⁶⁴ Newmarch had finally come

⁵⁹ Michel Chevalier, *On the Probable Fall in the Value of Gold*, translated by Richard Cobden, New York: D. Appleton and Co., 1859.

⁶⁰ Compare Keynes, *op. cit.*, pp. 524-526.

⁶¹ G. Poulett Scrope, *An Examination of the Bank Charter Question, with an Inquiry into the Nature of a Just Standard of Value*, London: John Murray, 1833, especially pp. 24-29. See also Scrope, *Principles of Political Economy*, London: Longman, Rees, Orme, Brown, Green, and Longman, 1833, pp. 405-409.

⁶² Joseph Lowe, *The Present State of England in Regard to Agriculture, Trade, and Finance*, London: Longman, Hurst, Rees, Orme, and Brown, 1822, pp. 261-291 and Appendix, pp. 85-101.

⁶³ W. S. Jevons, "A Serious Fall in the Value of Gold," *Investigations in Currency and Finance*, London: Macmillan and Co., 1884, p. 35.

⁶⁴ See especially William Newmarch, "Results of the Trade of the United King-

to the use of index numbers and to comparisons with a base period, devices which he had never used in his collaboration with Tooke. However, he made no attempt to construct a *general* index number, and his price changes were simply set down without any interpretation of their economic significance. Newmarch, perhaps the most able of the pre-Jevonian workers in inductive studies, pointed up his own great weakness in his presidential address of 1861, when he remarked that observation and experiment must be *substituted* for deductions arrived at by hypothetical reasoning. The latter method was to be regarded with increasing distrust; the teachings of Experience were the chief foundation of Economic Science.⁶⁵

The remaining influences on Jevons need only be mentioned. It is evident that the early paper on seasonal fluctuations and the researches on price trends had caused him to reflect at length on the nature of a business cycle. It was not, however, until fairly late in his career that Jevons turned his full powers to a consideration of the subject, and by this time his reading was so great that it is difficult to discern the specific impacts on his thinking.⁶⁶ Much of his theory of the cycle was original in that it evolved from study of his own charts and diagrams; such influence as his predecessors had, operated to convince him that natural phenomena furnished the inducing forces of the cycle and to impress him with the strict periodicity of fluctuations.

A scientific work by R. C. Carrington, *Observations of the Spots on the Sun*, apparently started Jevons in search of a physical cause of the cycle.⁶⁷ A single plate at the very end of this large volume, which contains diagrams showing variations in the frequency of solar spots and in the average price of wheat for the period 1750–1861, apparently set Jevons off on his investigations. The work of an obscure author, Hyde Clarke, who felt so strongly that there must be physical causes for observed fluctuations that he even proposed a science of Physical Economy, seems to have strengthened Jevons' belief that he was pursuing a fruitful line of inquiry. William Langton and John Mills ap-

dom during the Year 1859; with Statements and Observations Relative to the Course of Prices since the Year 1844," *Journal of the Royal Statistical Society*, Vol. 23, March, 1860, especially pp. 102 and 106, and "On Methods of Investigation as Regards Statistics of Prices, and of Wages in the Principal Trades," *Journal of the Royal Statistical Society*, Vol. 23, December, 1860, pp. 479–497.

⁶⁵ William Newmarch, "The Progress of Economic Science during the last Thirty Years," *Journal of the Royal Statistical Society*, Vol. 24, December, 1861, pp. 452–453.

⁶⁶ See the bibliography at the end of *Investigations in Currency and Finance*, *op. cit.*, pp. 363–414.

⁶⁷ Richard Christopher Carrington, *Observations of the Spots on the Sun, from November 9, 1853, to March 24, 1861. Made at Redhill, Edinburgh: Williams and Norgate, 1863, especially pp. 247–248 and Plate 166.*

parently created the conviction that the fact of a decennial periodicity was inescapable, and Mills' psychological theory of the cycle, with its emphasis on the creation and destruction of a "bundle of beliefs," could not but impress Jevons.⁶⁸ In a pamphlet of James Wilson, founder of *The Economist*, and perhaps more distinctly in an article by J. T. Danson, lay the clue which enabled Jevons to link sunspot variations with changes in economic activity.⁶⁹ These writers, and particularly the latter, had adduced statistical evidence to show that high prices of commodities necessary to life resulted in reducing the demand for manufactured goods, with consequent depression and unemployment in a large sector of the economy. These men, working in an area of extreme difficulty, probably carried Jevons away from the line of investigation which he was intuitively following at first,⁷⁰ and thus served to cloud and obscure what would have proved to be a contribution of the first rank.

V. CONCLUSION

There is no need to dwell upon the many-sided abilities of Jevons nor to go over old ground to evaluate his contribution; nor is it necessary to call attention to Jevons' errors of detail. It has been repeatedly said that Jevons was not a mathematician; I think that he would have been the first to agree. Yet the fact remains, as both Fisher and Marshall have remarked, that he was the first to attract the serious attention of economists to mathematical method. Indeed, he did more than this. Within his theoretical framework, he moved incisively to the solution of problems in the real world in a way that no one before him had been able to do. If this does not constitute a claim to consideration as the founder of econometric method, I do not know what does. Schumpeter's remark that Jevons "worked with figures" does something less than justice.

It was a part of the stated purpose of this paper to enlighten our views concerning certain lesser writers. Professor Stigler has remarked that an economist's ideas may be important or simply adventitious

⁶⁸ John Mills, "On Credit Cycles and the Origin of Commercial Panics," *Transactions of the Manchester Statistical Society*, 1867-68, p. 19. Mills' definitions of the phases of the cycle are worth noting.

⁶⁹ James Wilson, *Fluctuations of Currency, Commerce, and Manufactures*, 1840, and J. T. Danson, "A Contribution towards an investigation of the changes which have taken place in the condition of the people of the United Kingdom during the eight years extending from the harvest of 1839 to the harvest of 1847, etc.," *Journal of the Royal Statistical Society*, Vol. 11, 1848, pp. 101-140.

⁷⁰ In his first approach to the broad problem of economic fluctuations, Jevons emphasized the importance of changes in the rate of investment as the causal factor. Even his "sunspot" theory of the cycle depended for its validity upon induced changes in foreign demand for the products of the home country.

according as they do or do not enter into the analysis of a number of economists. We cannot, then, say for sure whether a Whewell or an Isnard are important, though we may be reminded here of the relationship of Canard to Cournot. On the other hand a Jennings, a MacLeod, or a Lardner, having participated in that "filiation of ideas" to which Jevons referred, make a contribution of unquestionable significance, for they truly enter into a current of thought.

It is to be hoped that this study may change a prevalent estimation of Jevons which somehow persists over time. Perhaps it has never been put so unequivocally as it was by Professor Bonar, who rose to speak at the conclusion of Lord Keynes' centenary allocution on Jevons' life and work. He thought it a little sad that the critical element figured so prominently in Keynes' address, that somehow the group was left with a slight impression of failure.⁷¹

It does indeed seem sad, perhaps tragic, that there should be ever so slight a cloud over Jevons' contribution. This feeling arises, no doubt, from the fact that there appear to be, from a present point of view, great gaps in his analysis which a first-rater should have filled. Examples come readily to mind. Jevons never draws a demand curve, although he was quite clear about the need for empirical investigations of demand. Jevons, who was perhaps more familiar with the facts of economic life than anyone before him, states no theory of the firm. Although there can be no doubt that by the late 70's he was quite aware of the symmetry of marginal productivity analysis so far as all the factors are concerned, he never took the trouble to work this out.⁷² It can scarcely be thought, however, that these gaps exist because Jevons did not possess sufficient ability and insight to have included in his system what was later thought to be of prime importance. It must not be forgotten that in his theory of capital Jevons developed for the first time in the English literature a significant concept of marginal productivity, a purely original development in that he had not read either Longfield or Rae. As we have seen, Jevons was familiar with supply curves and demand curves. He had mastered Lardner's analysis of the firm, and he remarked how beautifully Lardner had presented the laws of supply and demand—those laws which, he felt, necessarily emerged from his own more basic theory. It is not too much to say, I think, that Jevons considered work of the sort performed by Lardner and Jenkin as being simply descriptive, as being in the area of applied economics rather than the legitimate subject matter of pure theory. Let anyone who questions Jevons' ability in price analysis as we think of it reread *The Coal Question*.

⁷¹ Keynes, *op. cit.*, p. 551.

⁷² Jevons admitted his indebtedness in this regard to Cournot, whom he had read shortly before the appearance of the second edition of the *Theory*. See *Letters and Journal*, *op. cit.*, p. 408.

Jevons' enunciation of the great marginal principle, as it operates in both the consumer's and producer's markets, is so well known that I need not summarize it. But this study should cause us to reflect on Jevons' application of the principle, impressed upon him by Jennings, which emphasizes the real costs of producing anything. For it may be that a considerable portion of the work to be done in applied economics (in cooperation with the psychologist) will be based upon a concept of the supply of and demand for capital and labor measured in the way that Jevons measured them. Anyway, there are signs that this may be so.

But we should not be astonished at finding in Jevons' work that which is persistently fresh and challenging. I need only mention his repeated applications of the theory of probability which, he wrote, "comes into play where ignorance begins."⁷³ His description of the nature of consumption as involving a minimum of destruction of the good consumed is a remarkable statement of the present position.⁷⁴ And perhaps nowhere are we reminded so much of the abiding importance of Jevons' pronouncements, of the pertinence of his thought to the economics of any era, as we are in his feeling for the relationship of the economist to the legislator and of economics to public policy. This man who had contributed so much to the building of a modern body of theory, who, indeed, had almost singlehandedly kept English economics from serious regression for two decades, was still aware of the painful necessity of examining each separate problem with reference to the mass of facts which bore on it. "We must," he wrote, "neither maximise the functions of government at the beck of quasi-military officials, nor minimise them according to the very best philosophers."⁷⁵

Jevons may not, indeed, have come to "the top of the mountains he was climbing." But the work which he did was superb of its kind and has not, I feel sure, fulfilled its usefulness. In any case it seems that we cannot assign to him a place below the first rank of economists.

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⁷³ Jevons, *Principles of Science, op. cit.*, pp. 199, 200.

⁷⁴ Jevons, *Principles of Economics, op. cit.*, pp. 21-35. Compare Kenneth E. Boulding, *A Reconstruction of Economics*, New York: John Wiley and Sons, 1950, pp. 135-137.

⁷⁵ W. S. Jevons, *The State in Relation to Labour*, third edition, London: Macmillan and Co., 1894, p. 171.