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**Discussion paper No. 33**

# W. Stanley Jevons (1835-1882)
# From a Man of Science to an Economist

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June 2007


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## Life and Works

### 1. Background

A look at the life of William Stanley Jevons conjures up that of a typical Victorian. Jevons was born on 1 September 1835, about three years after the death (1832) of J. Bentham, whose work would greatly influence his thinking, and a good eight months after T.R. Malthus passed away. His was a cultured Unitarian family living in Liverpool, one of the largest port cities in Great Britain. Thriving on the 18th-century tobacco, sugar, and slave trade, Liverpool had grown into Britain's second largest city after London. In the 19th century, together with Manchester, it became a veritable boom town able to maximize the benefits of both the industrial revolution that had taken off in Britain late in the 18th century and the free trade policies adopted by the government at the time.

The industrial revolution and free trade policies both bore the legacies of the thinking of A. Smith and others, including D. Ricardo, Malthus, and J. S. Mill, leaders in the development of classical economics. Smith was critical of the economic theories of mercantilism, which stressed control and regulation, arguing that economic problems are solved best by leaving them to "the invisible hand" of the principle of market economy. Ricardo, Malthus, and Mill grappled with the theoretical and policy issues for which Smith had offered no answers. The economists of the Manchester School, who gave voice to the political implications of what Ricardo theorized, were particularly effective in their efforts to realize free trade policies deriving from the principle of market economy.

Their efforts bore fruit in many shapes: first came the establishment in 1839 of the Anti-Corn Law League in Manchester, followed by the enactment in 1844 of Peel's Act, which

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* "*The Thought and Economics of W. Stanley Jevons: From a Man of Science to an Economist*" (1987), which was originally published in Japanese. For their valuable insights and suggestions I thank Tanaka Toshihiro, Professor emeritus at Kwansei Gakuin University in Japan; R.D. Collison Black, Professor emeritus at Queen's University in Belfast; and Michael V. White, Economics Department, Monash University in Australia.

legislated the centralization of money printing and built the gold standard system, namely the price-species flow mechanism, and finally the abolition in 1846 of the Corn Laws, at that time the epitome of protectionism. The surge toward free trade gathered further momentum, resulting in the repeal in 1849 of the Navigation Act and the conclusion in 1860 of the Cobden-Chevalier Treaty (Anglo-French Treaty). This chain of events occurring over approximately two decades firmly established a free trade system based on the gold standard in the island nation and laid the groundwork for the type of capitalism that would develop in late-19th century Britain. The victory of free trade policies over protectionism led the Chamber of Commerce in Manchester, a stronghold of free trade along with the Liverpool Chamber of Commerce, to declare at its 1852 general meeting, "If we liberalize our import market more, we can export more." From that time on until the 1870s, free trade, and later laissez-faire, was the guiding principle for the economic policies of Great Britain.

Conditions affecting the free trade system in Britain, however, took an unexpected turn for the worse in the 1870s. Britain's international trade declined, while its domestic industries grew sluggish. Labour and management disputes increased, and social ills, most conspicuously poverty and unemployment, became increasingly serious problems. In 1845 in his political novel *Sybil* B. Disraeli had called the haves and have-nots in British society "the two nations," then in 1852 he critically observed that a unilateral free trade policy was an old-fashioned idea. The new realities of the 1870s seemed to bear out the ominous prescience of those remarks. Thus began in Great Britain a challenge to the laissez-faire economy based on free trade.

Behind its prosperity, the boom town of Liverpool began to suffer early on in the 19th century from social problems caused by increasing population and industrialization What helped solve those problems associated with urbanization was the Municipal Corporations Act enacted in 1835. And it was Jevons' maternal grandfather, William Roscoe (1753-1831), a middle-class magnate, who called the shots through "the times of reform." Roscoe denounced the slave trade, played a key role in building the Liverpool & Manchester Railway, and was an

enormously important figure in promoting scientific research, art, literature, and other cultural endeavours in Liverpool.

## 2. Jevons' Childhood

Jevons' family had a small nail-making business established in Staffordshire, where small-scale metal processing was a major industry. When they set out in 1798 to seek middle-class status in Liverpool, the city was then on the cusp of becoming a hugely prosperous and important port. Around the same time, Jevons' grandfather, William (1760-1852) established himself as an iron merchant with financial backing from John Yeats (1755-1826), a prominent figure in Liverpool whose son, J.Y. Yeats (1789-1871) would play an important role in founding University College in London. William Roscoe was elected M.P. for Liverpool in October 1806, and spoke in Parliament in favour of the bill to abolish the slave trade. The marriage of Jevons' father, Thomas Jevons (1791-1855) to Mary Anne (1795-1845), daughter of William Roscoe, firmly established the Jevons family in the middle class. Thomas showed deep interest in science and technology, and among his friends were G. Stephenson ("father of the railway") and Joseph Locke, one of Stephenson's assistants. But Thomas Jevons was also an energetic entrepreneur who joined the Corn Laws dispute himself, stood up for free trade, and advocated the decimal monetary system.

Jevons' upbringing in such a family prepared him well to enter University College London, whose educational philosophy was that college education should not be aimed simply at gaining special knowledge; it should also be a way to acquire knowledge of the liberal arts with which to put special knowledge to practical use. It was at University College that he learned the importance of mathematics and logic from A. De Morgan, a leading mathematician, and of experimentation and empirical verification from the prominent chemist A. W. Williamson.

3. Jevons in Australia - From a Man of Science to an Economist

Dropping out of college, Jevons took up a position as assayer at the Australian Royal Mint that had just been built in Sydney. While he worked there, he devoted most of his free time to studying meteorology and geology and through it, gained a solid knowledge of statistics, which he applied to the problems of poverty that plagued Sydney in those days. Also, building on his interest in the railway expansion and nationalization plans in this country in the Southern Hemisphere, he began to familiarize himself with economics. Coming back from Australia in 1859, he returned to University College to study economics and mathematics.

Through his exploration into natural science, he developed the view that science should be rigourous and systematic like mathematics, and empirical and exact like the natural sciences. He became convinced that his idea of science could trace its lineage to Isaac Newton, and, in turn, that economics as a science had to be a kind of mathematics based on the study of cause-and-effect relationships (law of causality) in human activities. This theory was made public in 1862 in two papers sent to the Economic Science and Statistics Section of the British Association for the Advancement of Science at Cambridge: "Notice of a General Mathematical Theory of Political Economy," which announced the birth of mathematical economics, and "On the Study of Periodic Commercial Fluctuations, with five Diagrams," which dealt with the necessity for empirical verification of economic theories. From that time on, he devoted his life as an economist to developing a complete economic theory grounded in those basic convictions.

4. The Way to Professorship

In 1863, Jevons became a tutor at Owens College in Manchester, thus taking up the career of a college professor at a time when that occupation had just been recognized as a profession. Self-help and independence was a motto for his life. Also around that time *The Coal Question* (1865), the account of his research into coal deposits in Australia that he started as an

extension of his forays into geology while he was staying there, attracted considerable public attention as a unique geological study and excellent economic analysis. In fact, the likes of Mill and W. E. Gladstone took to quoting from the book in their parliamentary speeches about the national budget. Having become recognized as an "applied economist" for his work, Jevons was appointed professor of logic and mental and moral philosophy and Cobden professor in political economy at Owens College, Manchester in 1866.

Now an expert on applied economics, Jevons gave speeches for free trade at the Latin Monetary Convention 1865 and later at the Royal Committee for International Currency convened in 1868 to discuss international monetary issues, along with such noted economists as W. Bagehot and W. Newmarch. The same issues were raised at the International Monetary Convention held in Paris as a follow-up to the Latin Monetary Convention. In a speech titled "On the International Monetary Convention, and the Introduction of an International Currency into this Kingdom," which he delivered at the London and the Manchester Statistical Society, Jevons emphasized the importance of maintaining the gold standard and reiterated the need for the introduction of an international currency. Meanwhile, as a professor of economics in the city's only university, he evoked the values of self-help and independence that characterized the Victorian Mind in calling on the leaders of Manchester's trade union movement to support liberalism based on individualism. He also pointed out to those leaders the limitations of the trade union movement.

Supported by the general approval of "amateurism" that prevailed in the 19th century, he made a name for himself as a meteorologist, geologist, explorer, and photographer while he was in Sydney. Back in Britain, he took advantage of his reputation as an applied economist to win appointments as professor at Owens College in Manchester (1866-1876) and University College in London (1876-1881). While working as professor at both institutions, he was active as a statistician, logician, scientific meteorologist, economist, and social reformer. His activities led to his appointment as secretary and director of the Statistical Society in both

Manchester and London, and his election as member of the Political Economy Club and the Athenaeum as well as the Royal Society.

Two generations after his grandfather William Jevons was making his living as a small iron merchant in Manchester, W.S. Jevons was now widely known as an economist, statistician, applied economist, and logician not only in Britain, but also in the rest of the Europe and the United States, and even in Japan, whose long self-imposed isolation policies had recently been lifted. The life of this typical Victorian, however, ended abruptly: a self- professed "good swimmer," Jevons drowned on 13 August 1882 while swimming in the sea of Bexhill near Hastings, where he was on vacation with his family.

**Logic and Metrology of Science**

1. The way to Formal Logic

In Europe the 17th century was a time of rapid advances in the natural sciences. For one thing, there was a strong revival of interest in induction as a method of reasoning from the specific to the general, which lent new importance to the inductive logic developed by F. Bacon. In Britain, however, where traditional logic based on the syllogism—the deductive method of Scholasticism—was entirely out of favour, interest in logic in general was slack. It was *Elements of Logic*, written by R. Whatley, which came out in 1826 that changed the status quo. Then W. Hamilton, building on the influence of Whatley, the "reviver of logic in Britain," redefined logic as "forms (laws) of thought," thus separating it from philosophy and paving the way for its establishment as a science.

De Morgan, one of Jevons' teachers, and G. Boole, among others, followed Hamilton's lead. They worked not only on separating logic from philosophy, but also on making logic a part of mathematics. There were two ways to achieve that goal: one was to formalize logic as a division of mathematics, or a kind of algebra, in order to impose rigour on it; the other was to add logic to mathematics in order to improve its effectiveness as a reasoning method by

making it more strict, and then to add it as a basic part of mathematics. Boole stood for the first method while F. L.G. Frege took the second route.

Jevons, in the meantime, made his position clear by criticizing Boole in *Pure Logic*, which was published in 1864. He argued that Boole made a mistake by introducing addition and subtraction, both being mathematical reasoning methods, into logic, and that such calculations were incompatible with "pure logic." In his view, calculations in logic occurred as words, or their meanings, united with or separated from each other, the former case corresponding to multiplication in mathematics and the latter to division. He pointed out that Boole made this mistake because he regarded logic as part of mathematics. On the contrary, he claimed, mathematics should be construed in terms of logic.

Jevons spoke out against the position of Mill, who rejected the fusion of logic and mathematics, but he also came out strongly against the views of Boole, one of those who vigorously argued for the unity of the disciplines. In Jevons' concept, logic was the cornerstone of all science, and mathematics owed its existence to logic. Only when all branches of science were based on the underlying principles/laws of logic could they stand on their own, he maintained. Thus, though he did not complete the task of unifying mathematics and logic himself, he opened a path for others coming after him, such as Frege and B. Russell, who would pursue the mathematics-logic combination,

Mill, whom Jevons had criticized for arguing against the idea of merging of logic and mathematics, launched his own attack by imputing to Jevons "a mania for encumbering questions with useless complications, and a notation implying the existence of greater precision in the data than the questions admit of." This acid comment stemmed from Mill's conception of "mathematics as an exact science" and a notion that was unique and impossible to apply to economics, insofar as economics remained a deductive science, not an exact science subject always to empirical verification. Jevons, however, was compelled to construe Mill's ideas as the outcome of having taking rigourousness in pure reasoning for exactness in

verification. That distinction—between the elegant precision of pure reason and exactness in empirical verification —was exactly what was born of Jevons' concept of what science should be. In other words, he placed the theory and methods of natural science at the centre of all other sciences.

2. Dispute over Economic Methodology

The Political Economy Club, founded in 1821 to function as an academic society, greatly contributed to the spread of classical economics and the principles of free trade, which was one of its central ideas. In May 1876 the Club held a discussion to commemorate the 100th anniversary of the publication of A. Smith's *The Wealth of Nations.* Among those in attendance were Gladstone, who chaired the meeting; cabinet member Robert Lowe; economists E. E. Chadwick and Newmarch; professors of economics Henry Fawcett of Cambridge University, J. E.T. Rogers of Kings College London, T.E.C. Leslie of Queen's College Belfast, and Jevons of University College Manchester. Of the topics that drew the most attention were two pressing questions: first, what were the possibilities for a science of economics and what should be its methodology, and second, what measures should be taken in response to economic setbacks occurring as a result of laissez-faire policies promoted by the Political Economy Club.

Lowe, on the side of the Ricardo-Mill school, saw science as legitimized by its predictive powers and credited A. Smith with the creation of a deductive and demonstrative science useful in assessing human behaviour and morality. Meanwhile, Rogers, who belonged to the English historical school, commended the writer of *The Wealth of Nations* as an inductivist who attached weight to historical fact. Having established his position, Rogers went on to criticize the classical school after Ricardo for its emphasis on deduction as a basis for economic theory.

Classical economics not only was rapped by economists of the historical school such as Rogers and Leslie, it was also criticized by some natural scientists. They set out to exclude the

Economic Science and Statistics Section from the British Association, a scientific society whose members were mostly natural scientists. The Association had incorporated economic science in 1856 for two reasons. First, it considered statistics to be fundamental to political economy as a discipline that, based on probability, deduced general principles from known facts that had been recorded, accumulated, compared, and classified, while rejecting any *a priori* inference; second, the Association regarded economic science as able to impose the same rigour and precision in mathematics as statistics did when dealing with social activities as a whole, even if it could not wipe out uncertainty in dealing with activities of individuals. As long as it was regarded in that way, economics was treated as a natural science for its scientific features. The 1860s and onward, however, saw little progress in the theoretical research area of economics, and the only themes the Economic Science and Statistics Section reported in meetings of the Association were such issues as local authority, management and labour, trade unions, and so on. Seriously concerned, anthropologist F. Galton in 1877 called the whole enterprise of economic science into question, claiming that it had become an unnatural and nonmathematical science, and he insisted that the Economic Science and Statistics Section be removed from the Association. In response, medical statistician William Farr came to the defense of the section, arguing that with its distinguished membership, including such eminent economists and statisticians as C. Babbage, Rogers, H. Fawcett, and Jevons, it should remain in the Association; economic science and statistics dealt precisely with such scientifically measurable and mathematically expressible phenomena as properties, product, and value, and therefore, Farr insisted, they remained unquestionably scientific.

Jevons had set out to make economics a branch of science by giving it the foundation of statistics and incorporating mathematics into it, but now, challenged both by economists in the historical school and by natural scientists, he felt compelled to make his views clear. This he did in a lecture titled “The Future of Political Economy” given in 1876 at University College London immediately after the event commemorating *The Wealth of Nations* centennial. While

Jevons recognized the importance of inductive approaches in economics, he spoke out against the argument made by some inductivists that economics should be purely inductive and empirical. And he went on to propose that "induction in the essential form" (*The Theory of Political Economy*, 1970 ed., p.84) had made natural science what it was.

3. Newtonian Methodology and Economics

Through his study of the history of the natural sciences, Jevons came to see a parallel between the development of Newtonian physics as a natural science and the course economics should take in its development as a discipline. He believed that as economics became a more fully mathematical discipline and as it moved ahead to incorporate experimental positivism--a course typified by the development of Newtonian physics--economics also would evolve further as a science as it went through the same process. Based on that conviction, he also tried to make it clear that economics could be either a mathematical science or an empirical science, thus explicitly recognizing the distinction between the former, which pursued mathematical rigour, and the latter, which sought exactness, a distinction that was well-known in those days among physicists such as J. C. Maxwell.

In his attempt to make it a mathematical science, he tried to show that economics had mathematical properties by pointing out that things used in people's daily lives, things economics dealt with, could be described in terms of some being larger/smaller than others, and thus basic economic concepts and the technical terms for them could also be described in the same manner. He also tried to show that economics could be dealt with as the infinitesimal calculus (cf. "fluxion") of pleasure and pain insofar as the characteristics of wealth and value could be explained by studying the infinitesimal quantities (1866, cf. "successive increment" in 1862) of pleasure and pain, just as the theory of statics, or the theory of a lever, was based on the concept of infinitesimal energy.

In revising the second edition of *The Theory of Political Economy* published in 1879,

Jevons created a number of new concepts and as many technical terms to represent them in order to complete his "economics is a mathematical science" theory. First, he came up with "positive utility," "zero utility," and "negative utility" to correspond, respectively, with the mathematical concepts of positive amount, zero amount, and negative amount. Then he brought into existence "positive value," "zero value," "negative value," "positive commodity," and "negative commodity," and he gave names to all those concepts. This is but one early example of how he incorporated mathematics into economics, formulating new concepts and then technical terms to represent them, thereby giving economics the momentum to advance on its own. Although he aimed at making economics into a mathematical science, Jevons adhered to the original title, *The Theory of Political Economy*, when he finally came out with the second edition of the book, but he did so for a reason different from that of A. Marshall in the case of Marshall's *Principles of Economics* (1890). Nonetheless, Jevons did replace the term "political economy" with "economics" in the text of his second edition to underscore the methodological similarities in economics and mathematics.

A science, however, was not automatically an empirical science just because it was mathematical. As seen in the development of certain of the natural sciences, a mathematical science had to remain just that—focused on numbers—if it was not equipped to process a sufficient amount of good data for demonstration. The same applied to economics. As Jevons saw it, what was needed for economics to overcome this serious obstacle and become truly empirical was measurements and measurement instruments made for economics, and this he elaborated in *Principles of Science,* which was published in 1874. He incorporated the ideas presented in that book into the second edition of *The Theory of Political Economy*, and made clear the importance of the period analysis accompanying the processing of economic data. Jevons maintained that efforts must to be also made by the government to establish public offices around the country to conduct surveys on a national scale to gather sufficient amounts of statistical data and to standardize all data gathered.

Jevons attributed the advancement of natural science partly to its subdivision into sub-sciences and to the division of labour in each developing field, and not surprisingly, he objected to the movement lead by August C. and H. Spencer, among others, to integrate economics into what they called sociology, along with other disciplines. In Jevons' view, integration of those disciplines was exactly what was causing the confused state of the field of economics at that time. He declared, in fact, in *The Principles of Economics*, which was published posthumously in 1905, that it was wrong to treat economics as a science that could not be subdivided; the division of labour was a fundamental prerequisite for the pursuit of knowledge. Specifically, he proposed in that work that economics be subdivided into commercial statistics, mathematical economics or abstract theories, and policy making or applied economics. This proposal came out of his concept of the process of "induction in the essential form," which, to him, required going through the following phases: Facts → induction → hypothesis → deduction → verification.

Tracing the ideas that had been going through Jevons' mind over the years, we can see how he had been attempting all along to systematize his concept of economics as an integrated whole that included statistical research, pure theoretical studies, and policy-making studies. In its structure and content, he saw it as a natural science along the lines of Newtonian physics in particular. Once he identified Newton's unique science methodology, which combined the mathematization of science with experimentation, Jevons struggled to apply the same methodology to social sciences, especially economics.

In the second edition of his *The Theory of Political Economy*, however, Jevons had to acknowledge that because the subjects of social and moral sciences were so complex, it was difficult to establish theories and verify them through the application of his "induction in the essential form" formulation. For that reason, he said, economics tended to be more deductive than such sciences as physics, in which a high degree of precision could be achieved through verification. That was why he attempted first to make economics mathematical rather than to

develop it into an exact science or econometrics. Indeed, Jevons correctly foresaw the course of the history of economics from that time onward: mathematical economics would flourish in the near future, and econometrics would be established and develop afterwards.

**Jevonsian Economics**

1. From “Plutology” to “Catallactics”

Thus Jevons became immersed in the attempt to develop the field into a mathematical science. But that objective predictably stirred controversy. According to Jevons, Ricardo and Mill, among others, denigrated his belief in the necessity for mathematics, while Malthus and some French economists supported it. Ricardo, Jevons claimed, ignored the existence of the French economists, and as for Mill, while he recognized the significance of treating economics as a mathematical science, he refused to acknowledge the need to systematize it. Jevons also said that unlike his detractors, Malthus had figured out that any economic question could be reduced to *de maximis* and *minimis* in Fluxion; French economists, including Antoine A.Cournot and L. Walras were already moving in the same direction as Jevons.

Making economics a mathematical science, however, was not all that Jevons wanted to achieve. To complete his economic theory, he was strongly convinced, as were the classical economists, of the need for a theory of value that would serve as a base. However, he could not be satisfied with the labour theory of value on which classical economics was based, because, as he pointed out, it was derived from the invalid assumption that any labour was equal by nature. Instead, he drew on Bentham’s theory of pleasure and pain as a base for his economics. Bentham theorized that pleasure and pain in one person could still be pleasure and pain in another, because they were controlled by the most basic of human feelings and because they remained with a person as long as he/she lived.

While the classical economists regarded economics as a science able to explain the

production of wealth, Jevons treated it as, among other things, a science of the exchange of wealth, and consequently he turned to the pioneering work of N. W. Senior and adopted marginal utility theory as his theory of value. Jevons was persuaded by Senior's definition of wealth: "All those things, and those things only, which are transferable, are limited in supply, and are directly or indirectly productive of pleasure or preventive of pain"(*An Outline of the Science of Political Economy*, (1836) p.1). Jevons considered Senior to be the most solidly-grounded economist. He found A. Cournot's theory of supply and demand lacking in a utility theory as its basic concept, and he could not accept the utility theory of A. J. E. Dupuit, H. H. Gossen, and others that Jevons considered did not constitute viable theories of exchange.

Thus Jevons waged a double-edged revolt against the school called the "classical economists," led first by Smith and then by Ricardo and Mill, by (1) giving a mathematical character to his own economics, and (2) adopting utility theory as a theory of value. In fact, he singled out another group of Smith's disciples, namely Malthus and Senior, as Smith's legitimate successors. Jevons' view of the history of economics is a good example of what M. Blaug calls "absolutist approaches," or approaches based on the Newtonian perspective on science.

Established in this way, Jevons' economics was publicized as soon as it was organized, first as "Notice of a General Mathematical Theory of Political Economy," and later as "Brief Account of a General Mathematical Theory of Political Economy"(1866), which included some important changes. For example, the concept of marginal utility was first defined as "final ratio of utility," but later Jevons replaced that with a stricter definition: "coefficient of utility. " The reason he rushed to publish *The Theory of Political Economy* in 1871 was that he feared the credit for what he had come up with first would go to H. C. F. Jenkin, engineer and author of "The Graphic Representation of the Laws of Supply and Demand, and their Application to Labour" (1870).

2. *The Theory of Political Economy* (1871, 1879)

*The Theory of Political Economy* consisted of eight chapters: Introduction, Theory of Pleasure and Pain, Theory of Utility, Theory of Exchange, Theory of Labour, Theory of Rent, Theory of Capital, and Concluding Remarks. To Jevons, who viewed economics as dealing with exchange, the most important part of his book was the theory of exchange, which was deduced from the theory of utility.

He set forth the following four premises in developing his theory of exchange: (1) a market, is theoretically perfect only when all traders have perfect knowledge of the conditions of supply and demand, and the consequent ratio of exchange; (2) every trading body is either an individual or an aggregate of individuals, and the law, in the case of the aggregate, must depend upon the fulfilment of law in the individual. [… ] The aggregate, or what is the same, the average consumption, of a large community will be found to vary continuously or nearly so. [ … ] Thus our laws of Economics will be theoretically true in the case of individuals, and practically true in the case of large aggregates, (3) more or less of a commodity may be had, down to infinitely small quantities, (4) there can only be one ratio of exchange of one uniform commodity at any moment (the law of indifference, he presented in the second edition of *The Theory of Political Economy*). Jevons justified this premise by saying that in the same open market, at any one moment, there cannot be two prices for the same kind of articles. That is because if, in selling a quantity of perfectly equal and uniform barrels of flour, a merchant arbitrarily fixed different prices on them, a purchaser would of course select the cheaper ones.

After presenting these four premises, Jevons went on to give specific examples to explain his theory of exchange: “Suppose that the first body A, originally possessed the quantity *a* of corn, and the second body, B, possessed the quantity *b* of beef. As the exchange consists in giving *x* of corn for *y* of beef, the state of things after exchange will be as follows….” From this example, he concluded: “The ratio of exchange of any two commodities will be the reciprocal of the ratio of the final degrees of utility of quantities of commodity available for

consumption after the exchange is completed.”

In a letter he sent to Jevons 23 May 1874, Walras complained that Jevons’ equations of exchange did not contain an equation for effective demand as a function of prices, and that this was essential for solving the question of determining equilibrium price. Walras’ criticism stemmed from his belief that in a market, prices should be based on which competitive economic entities were active. He referred to such market price mechanisms when he explained his theory of general equilibrium for competitive exchange. Jevons, however, tried to establish the premise that Walras himself established in arguing that prices were exchange rates that would be determined in exchange processes in a perfect competitive market.

Another area where Jevons showed originality was in the theory of capital. He criticized the concept of capital in classical economics, especially the theory of Mill, while he attempted in vain to come up with a concept of marginal productivity of capital using the idea of “free capital,” as he indicated he would in the second edition of *Theory of Political Economy*.

His theories of capital, of labour, and of rent were often regarded as part of a factor price and distribution theory. They were, however, only supplementary explanations for Jevons’ theory of exchange, as R.D.Collison Black points out. What Jevons actually did in the second edition of *Theory of Political Economy* was simply to suggest a direction that a systematization of those theories might take. But as Walras made clear *in Elements d’économie politique pure, ou théorie de la richesse sociale* (1874-77), in order to systematize them, Jevons would have had to replace his approach with a new one. That is, he would have had to adopt the idea that the price of a product determines the costs of the production factors that go into it by reversing the conventional assumption of the British School, or at least that of Ricardo and Mill, instead of clinging to the idea that costs of production factors determine price of the product of those production factors. Such a reversal of thinking, however, would have been too much to take for the British economists because they all based their thinking on the universal law of successive phenomena, which is the law that every invariable consequent has an ‘invariable antecedent’

( see J.S. Mill's *System of Logic*, *Collected Works*, vol. IX, p.326 ). In fact, this about-face issue also troubled Marshall, who followed Jevons.

In the end, Jevons had no choice but to admit that his economics was only statics. He saw the central issue of economics in the following way: "Given, a certain population, with various needs and powers of production, in possession of certain lands and other sources of material: required, the mode of employing their labour which will maximise the utility of the produce." His concept of pure economics was a foundational concept in the emergence of microeconomics and, microeconomics and, on that point, of modern economic science.

**Policy-Making Theories of Modern Economics**

1. Policy Disputes

The second subject of the 1876 discussion held by the Political Economy Club to commemorate the centennial of *The Wealth of Nations* was whether or not the laissez-faire policy, including the free trade principles, that the club had been promoting, was good policy. The question was, that is, how much or how little the state should intervene in the economy.

This issue came up when Newmarch indicated that he had misgivings about the growing role that the government had been playing in the field of education since the education law took effect in 1870. He thought the trend was going against the principle that Smith had established of limiting the role of government as much as possible. His remark prompted Gladstone to say that economists still had to play the role of opinion leaders so that the government would in no way interfere with the economic activities of individuals, and at the same time economists should try to limit the role of the government to its original realm of activities. This set off an argument between the economic "laissez-faire stalwarts" and the new "individualists" over how far the state should go in applying the principle of laissez-faire to the economy. At that point the disagreements began to grow more conspicuous than the agreements among the club members on such issues as economic methodology and the

principles of policy making in the government. It was a sharp reflection of how confused the world of economics in Great Britain was at that time.

## 2. A Policy-Making Methodology and Utilitarianism

Amid these disputes over policy-making method, Jevons changed from a "laissez-faire stalwart" to a new "individualist." That was the result of his having established his own methodology and having applied it to Bentham's utilitarianism.

As I pointed out earlier, Jevons saw economics as a science that dealt with human beings as they were, and on that basis put utility theory at the centre of his pure economics. He achieved this by rejecting in his economic theory any moral or ethical element of utilitarianism of the type Mill emphasized. But then, as he attempted to theorize his policy-making methodology, he had to face the question of how to handle the kind of elements needed to deal properly and acceptably with human beings. It was in *The State in relation to Labour* (1882), the last of his books to be published while he was alive, that he squarely tackled the issue.

In that book he reached the conclusion that concrete legislation connected with law, custom, and property rights was only a means to "the greatest happiness of the greatest number," which was the "what ought to be" position of utilitarianism. To be more specific, he believed that industrial freedom as a policy was nothing but a means to achieve the end, which was happiness; industrial freedom could not be an end in itself. That was why he was critical of the position that industrial freedom was sacrosanct and should never be restricted. These developments in his thinking were what enabled him to metamorphose as an economist from a "laissez-faire stalwart" into a new "individualist."

## 3. Proof as a Policy-Making Methodology

According to Jevons, a given law or policy had to go through a process called "proof" by him to ascertain if it would promote "the greatest happiness of the greatest number." Unlike

"verification," which enabled a judgment whether something was true or false, proof was a method of presenting and using persuasive evidence to prove that a bill should be passed or a policy should be implemented. It also functioned to allow study of evidence for potential adverse effects of the legislation, through direct experience. Using this method, the legislation in question could be found appropriate even if its advantage outweighed its disadvantage by only a small margin; in the context of "the greatest happiness of the greatest number," that small margin was enough. It was as if the bottom line of the balance sheet came out black.

By introducing this proof into policy-making, Jevons resolved the methodology questions posed by "scientific legislation" called for in late-19th century Britain. In other words, he offered those in authority a way to scientifically judge legislation and policies just when the Benthamite notion of the masses as only passive beings subject to legislation had become obsolete, and the public had come to expect a more "scientific" approach from the government. All this means that while Jevons was in agreement with Bentham's utilitarianism, what he really achieved was to transcend that theory and make it into a set of ideas that would meet the demands of the times.

## 4. The Age of Experimental Legislation and Social Reform

Jevons called his method of testing to determine the appropriateness of a bill "the blind or test experiment," which he explained in *The Principles of Sciences* (1874). Furthermore, he applied that method of proof to a number of moral, social, and political issues, and presented the cases in a thesis titled "Experimental Legislation and the Drink Traffic" (1880). In that essay he argued that when "an agricultural chemist or a scientific farmer wished to ascertain the effect of a new kind of manure…the obvious mode of procedure is to spread the new manure over a part only of each experimental field, so that the difference of the crops on the different patches brings out, in a most unquestionable way, the effect of the manure." This is exactly the kind of experimental approach that Jevons advocated; he suggested that legislators learn how to be

more scientific by following the example of people who were engaged in agriculture.

Having proposed a new policy-making methodology, Jevons went on to contend that for such scientific tests, or social experiments, to have any significance for society, they should be capable not only of being carried out, but also capable of being done on a universal scale across the country. It was because of such experiments, he said, that society made progress. He then gave specific examples of social experiments: laying railways, organizing a volunteer force, giving penny readings for people, and establishing free public libraries. Jevons was generally critical of government-guided reform, something that had become increasingly common in Great Britain; the right of regional governments to interpret and enact state law was important, he argued, because conditions differed from region to region and the policy implications varied accordingly. In his view, every local government should be allowed to weigh the significance of each legislation or policy of the state, presumably with the result that, each municipality having had the chance to judge the act or policy in question as being conducive to "the greatest happiness of the greatest number," the legislation would be more widely acted upon throughout the country. On that basis Jevons believed that legislative experiments would help avoid the risks associated with centrally guided legislation or policies. That position was also laid out in *The State in relation to Labour*. However, in the same work, he conceded the difficulty of social experiments in practice, as opposed to theory. This important difficulty, in fact, was endemic to social science in general, and it plagued the natural sciences as well, regardless of the fact that they had progressed through, and because of, experimentation.

Jevons' methodology influenced actual policy-making processes in later governments. Joseph Chamberlain, who led the Unionists in Parliament in 1886, was instrumental in securing the enactment of the Workmen's Compensation Act of 1897, and he drew heavily on Jevons' experimental legislative method to make a strong case for the act. Chamberlain also proposed a bill for an eight-hour working day for mine workers. It was clear that if the law was

enacted, it might give the state more power and thus go against the traditional understanding of laissez-faire, but Chamberlain viewed such interference as permissible, even obligatory, on the part of the government if the legislation benefited the whole nation. Chamberlain let it be known later that when he put forward these policies and pushed that legislation, Jevons' ideas had been a major influence on his thinking.

The reason that Jevons gave his pure economics a limited field for application was not to make light of legislation and policy making, but rather to make his policy-making theory into a tool with which legislators and politicians could scientifically evaluate government decisions free from personal bias. And his theory was exactly what the times called for a scientific policy- making theory.

Jevons' early interest in the natural sciences in his childhood lay behind his obvious affinity for numbers, statistics, and mathematics, and that affinity was combined with a social vision in Australia. His ideas, skills, and techniques were needed in the social sciences of Britain at the time, when many natural scientists wanted the social sciences, especially the science of economy, to be mathematized. Jevons' pure economics contributed to the emergence and development of microeconomics and econometrics. And his scientific policy-making theory contributed to the scientific legislation that the government and many politicians sought.

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