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Brett Clark and John Bellamy Foster  
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## WILLIAM STANLEY JEVONS AND *THE COAL QUESTION*

An Introduction to Jevons's "Of the Economy of Fuel"

BRETT CLARK

JOHN BELLAMY FOSTER

University of Oregon

William Stanley Jevons (1835-1882) is best known as a British economist who was one of the pioneers of contemporary neoclassical economic analysis, with its subjective value theory rooted in marginal utility. His applied economics and theoretical insights marked new points of departure for later economists who would more fully shape the neoclassical tradition. But Jevons is also remembered as an early contributor to ecological economics and energetics as a result of his pioneering work *The Coal Question* (1865/1906), which raised fundamental issues regarding energy efficiency and the economy of fuel (Martinez-Alier, 1987).

Jevons's intellectual career bloomed for a mere 20 years due to a late start and an early death. Likewise, his development as an economist included various detours that contributed to his economic theories. The well-to-do Jevons family was disrupted by the death of Jevons's mother in 1845 and the failure of his father's iron merchant business in 1848 (Black, 1981, pp. 2-4). The economically vulnerable position of the family later contributed to Jevons's decision to leave University College at London, where he was studying chemistry and mathematics, to accept a position as an assistant assayer to the Royal Mint in Sydney, Australia, in 1853. In Australia, Jevons explored the colony, studying nature and meteorology. But his interests in studying and defining the operations of the human world led him to forgo the lucrative position in 1859 so that he could return to London to study philosophy, logic, political economy, mathematics, classics, and history. By 1862, Jevons had completed his BA and MA and was in the process of creating the synthesis of logic, mathematics, and philosophy that underlined his economic thought. He viewed economics as a mathematical science, dealing with quantities of time, consumption, production, and investment (Black, 1987, p. 1009). Jevons's laws of logic were so mechanically structured that he built a "logic machine," which is recognized as a forerunner of modern computers, to perform processes of reasoning.

Starting as a tutor at Owens College in Manchester in 1863, Jevons was promoted to Cobden professor of political economy and professor of logic, mental, and moral philosophy by 1865 on the merits of his contributions to these fields of science (Black, 1981, pp. 4-6). Jevons's published works were on the laws of reason-



ing (developing the “substitution of similars”), changes in the value of gold, trade and price cycles, economic policy (free trade), and the role of the state. A type of Benthamite utilitarianism lay at the heart of Jevons’s economic model as presented in *The Theory of Political Economy* (1970, originally published in 1871). Labor for production was pain (disutility), and consumption was pleasure (utility). Equilibrium in prices was proportional to degrees of utility and costs of production (pp. 203-205). Jevons assumed that individuals greedily operated to maximize satisfaction, thus laying the foundation for later theories of consumer behavior.

Jevons’s obsessive drive to learn and write made him one of the leading thinkers of economics and logic, leading to his election by Chancellors Gladstone and Lowe as a fellow of the Royal Society in 1872. But Jevons’s health suffered under his relentless pace, leading to his resignation from Manchester in 1876. Jevons took a position at University College at London due to the lighter teaching duties, but in 1880 he resigned to pursue his studies and writings full-time. However, his health continued to decline, until the day he drowned while swimming on vacation in 1882.

In the 1860s, the House of Commons raised questions related to whether Britain’s world supremacy in industrial production and economic competitiveness could be threatened in the long run by the exhaustion of coal reserves. At the time, no extensive study had been conducted on coal reserves and their impact on industrial consumption and economic growth. Edward Hull’s *Coalfields of Great Britain*, published in 1861, only estimated the quantity of coal. Jevons seized the opportunity to study the topic, hoping it would bring him national recognition due to the popular concern over coal and British economic power. With his usual intensity, Jevons wrote in 1864, in a single summer, the book *The Coal Question: An Inquiry Concerning the Progress of the Nation, and the Probable Exhaustion of Our Coal-Mines* (1865/1906), which brought him national prominence and academic promotions. Jevons argued that British industrial growth had relied on cheap coal and that the increasing cost of coal, as deeper seams were mined, threatened economic stagnation. Substituting coal for corn, within the general Malthusian argument, he observed, “Our subsistence no longer depends upon our produce of corn. The momentous repeal of the Corn Laws throws us from corn upon coal” (pp. 194-195). Jevons argued that neither technology nor substitution of other energy sources for coal could alter this.

Jevons was stunningly wrong in his calculations. His chief mistake was to underestimate the importance of coal substitutes such as petroleum and hydroelectric power. Obviously, Jevons had unnecessarily confined his own vision, but the ironic part of this analysis lies in Jevons’s (1865/1906, pp. 368-386) comments regarding the history of the iron trade. Jevons draws attention to the use of timber, as charcoal, for the production of iron, preceding widespread use of coal in this process. Jevons noted, “The increase of the [iron] trade threatened to denude England of the forests which were considered an ornament to the country, as well as essential to its security, as providing the oak timber for our navy” (p. 373). When the woods were near exhaustion, production moved to Ireland, clearing (and depleting) their forest to produce iron for export to Britain (pp. 376-377). Jevons pointed out that “the substitution of coal for charcoal had become a necessity” to effectively compete due to the loss of wood to sustain growth and developments in the production process (p. 379). Thus, Jevons knew that coal had replaced timber use in this production, but he could not see any further substitution for coal. Jevons presented this history as if it were simply the natural development of productive systems, ignoring the social

relationships that shaped these changes and the ecological ramifications of this process. In 1936, Keynes commented on Jevons's argument regarding coal consumption, stating that it was "over-strained and exaggerated" (Keynes, 1951, p. 259). We might also add narrow in scope.

But there is one aspect of Jevons's argument that continues to be considered one of the pioneering insights into ecological economics and that is now known as the "Jevons Paradox" (Giampietro & Mayumi, 1998, pp. 24-26). Chapter 7 of *The Coal Question*, reprinted in this issue (minus the footnotes), was titled "Of the Economy of Fuel." Here, Jevons argued that increased efficiency in using a natural resource, such as coal, only generated increased demand for that resource, not decreased demand as one might expect. This was because improvement in efficiency led to further economic expansion. "*It is wholly a confusion of ideas,*" Jevons (1865/1906) wrote,

*to suppose that the economical use of fuel is equivalent to a diminished consumption. The very contrary is the truth. As a rule, new modes of economy will lead to an increase of consumption according to a principle recognised in many parallel instances. . . . The same principles apply, with even greater force and distinctness, to the use of such a general agent as coal. It is the very economy of its use which leads to its extensive consumption. . . . Nor is it difficult to see how this paradox arises. . . . If the quantity of coal used in a blast-furnace, for instance, be diminished in comparison with the yield, the profits of the trade will increase, new capital will be attracted, the price of pig-iron will fall, but the demand for it increase; and eventually the greater number of furnaces will more than make up for the diminished consumption of each. And if such is not always the result within a single branch, it must be remembered that the progress of any branch of manufacture excites a new activity in most other branches, and leads indirectly, if not directly, to increased inroads upon our seams of coal. . . . Civilization, says Baron Liebig, is *the economy of power*, and our power is coal. It is the very economy of the use of coal that makes our industry what it is; and the more we render it efficient and economical, the more will our industry thrive, and our works of civilisation grow. (pp. 140-142)*

Jevons went on to insist that the entire history of the steam engine was a history of successive economies in its use—and each time this led to economic expansion and increased aggregate demand for coal. "Every such improvement of the engine," he observed, "when effected, does but accelerate anew the consumption of coal. Every branch of manufacture receives a fresh impulse—hand labour is still further replaced by mechanical labor" (pp. 152-153).

The present-day significance of the Jevons paradox can be seen with respect to the automobile in the United States. The introduction of more energy-efficient automobiles in the United States in the mid-1970s did not decrease the demand of fuel because driving increased, and the number of cars on the road eventually doubled. Likewise, technological improvements in refrigeration merely resulted in more and larger refrigerators. Furthermore, this tendency is not confined to individual consumption but applies with even greater force within industry itself.

Although Jevons is credited for introducing his paradox, the main impetus behind the problem he raises is not analyzed in *The Coal Question*. As one of the early neoclassical economists, Jevons had abandoned the central emphasis on class and accumulation that distinguished the work of the classical economists. His economic analysis took the form of static equilibrium theory. Hence, it was ill equipped to deal with dynamic issues of accumulation and growth. Jevons, who saw capital-

ism more as a natural phenomenon than a socially constructed reality, could find no explanations for continuously increasing demand, other than to point to individual behavior and Malthusian demographics. The idea of class-based accumulation of capital, as the source of capitalism's unrelenting growth dynamic, was beyond his vision of things.

Although the Jevons paradox has great significance for the ecological problems of today (relating, for example, to attempts to decrease the rate of global warming through greater fuel efficiency), it would be a mistake to see his argument in *The Coal Question* as primarily ecological in character. Despite his importance to ecological economics, Jevons himself was not concerned with the ecological and social problems associated with the exhaustion of energy reserves in Great Britain or in the rest of the world. He even failed to address the air, land, and water pollution that accompanied coal production. The occupational illnesses and hazards confronting workers in the mines did not enter his analysis. Jevons's primary concern was how the rapid rate of coal consumption would affect the economic growth, competitiveness, and power of Great Britain within the global capitalist system. Jevons wanted to perpetuate British industry, even if it meant exhausting coal reserves.

Coal was the source of economic power for Great Britain, and Jevons feared that the (unlikely) development of an alternative energy source would destroy British industrial supremacy (pp. 15-16, 189-190). Given British industrial development and trade relations, "food and raw materials are poured upon us from abroad, and our subsistence is gained by returning manufactures and articles of refinement of an equal value" (p. 221).

The human relationship with nature, he believed, "consists in withdrawing and using our small fraction of energy in a happy mode and moment" (p. 163). "The resources of nature," he wrote, "are almost unbounded."

Economy consists in discovering and picking out those almost infinitesimal portions which best serve our purpose. We disregard the abundant vegetation, and live upon the small grain of corn; we burn down the largest tree, that we may use its ashes; or we wash away ten thousand parts of rock, and sand, and gravel, that we may extract the particle of gold. Millions, too, live, and work, and die, in the accustomed grooves for the one Lee, or Savery, or Crompton, or Watt, who uses his minute personal contribution of labour to the best effect. (p. 163)

Jevons (1865/1906) simply assumes that this mass disruption and degradation of earth is a natural process to be approached only from the standpoint of the pursuit of a growing economy. Although shortage of coal generates questions in his analysis about whether growth can be sustained, the issue of ecological sustainability is never raised. Because the economy must remain in motion to accumulate wealth, natural forces of energy, such as water and wind, were disregarded by Jevons as unreliable sources of constant energy, limited to a particular time and space (pp. 164-171). Coal offered capital a universal energy source to operate production without disruption to business patterns.

This disregard for nature can be contrasted with the views of Jevons's contemporaries Marx and Engels, who, although they have been compared unfavorably to Jevons in ecological terms (see Georgescu-Roegen, 1971, p. 2), nonetheless argued against the abuse of nature—which Jevons did not. Marx developed an overarching concept of the "metabolic rift" in the human relation to nature, which took into account the degradation of the earth and the conservation of energy (see Foster, 1999). Writing to Marx in 1882, Engels observed that

the working individual is not only a stabiliser of the *present* but also, and to a far greater extent, a squander of *past* solar heat. As to what we have done in the way of squandering our reserves of energy, our coal, ore, forests, etc., you are better informed than I am. (Marx & Engels, 1975, vol. 46, p. 411)

Engels (1966) warned against the cutting of trees on hillsides, which later led to flooding, destruction of cultivated land, mudslides, and loss of soil (p. 180). The Spanish planters in Cuba burned the forest for fertilizer, which allowed for a single year of profit, but the heavy rains washed away the soil because no trees covered the hillsides. In regards to the larger political economy and social relationship to nature, Engels commented,

The present mode of production is predominately concerned only about the immediate, the most tangible result; and then surprise is expressed that the more remote effects of actions directed to this end turn out to be quite different, are mostly quite the opposite in character; that the harmony of supply and demand is transformed into the very reverse opposite. (p. 183)

Engels (1966) recognized the ecological destruction that took place under the capitalist system and called into question a system based on short-term profit and the accumulation of wealth. In regards to a sustainable, regulated interchange with nature, Engels stated, “A complete revolution in our hitherto existing mode of production, and simultaneously a revolution in our whole contemporary social order” was needed (p. 182). These comments resonate with an awareness that overshadows the predicament that Jevons describes.

Despite the ecological and social limitations of Jevons’s overall analysis, the Jevons paradox represents an important element of ecological economics. The following selection, “Of the Economy of Fuel,” chapter 7 of *The Coal Question*, represents Jevons’s most important analysis of how the consumption of coal will not be alleviated by new technological developments or efficiency. These advancements in efficiency will only increase the scale of production, increasing the pressures placed on the environment.

Jevons (1865/1906) had no real answer to the paradox he raised. Britain could either use up its cheap source of fuel—the coal on which its industrialization rested—rapidly, or it could use it up more slowly. In the end, Jevons chose to use it up rapidly:

If we lavishly and boldly push forward in the creation of our riches, both material and intellectual, it is hard to over-estimate the pitch of beneficial influence to which we may attain in the present. *But the maintenance of such a position is physically impossible. We have to make the momentous choice between brief but true greatness and longer continued mediocrity.* (pp. 459-460)

Expressed in these terms, the choice was clear: to pursue glory in the present and a drastically degraded position for future generations. Insofar as Jevons’s paradox continues to apply to us today—and insofar as technology by itself (given certain patterns of production and accumulation) offers no way out of our environmental dilemmas, which increase with the scale of the economy—we must either adopt Jevons’s conclusion or pursue an alternative that Jevons never discussed and that doubtless never entered his mind: the transformation of the social relations of production in the direction of a society governed not by the search for profit but by people’s genuine needs and the requirements of socio-ecological sustainability.

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