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Foreword

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> *It is provided in the essence of things that from any fruition of success, no matter what, shall come forth something to make a greater struggle necessary.*
>
> Walt Whitman, *Song of the Open Road*

In January 2002 I was returning to the United States from fieldwork in the Sahel of Mali. My itinerary to and from Mali goes through Paris, where usually I take a layover. On this occasion I arranged to meet friends for dinner, at which we were joined by a Swedish geographer. The conversation turned to various topics, including the platform of the Green Party in upcoming elections. Since we were discussing environmental issues, our Swedish colleague told us about a study he had recently done. It was a project of survey research, in which Swedes had been asked the question, 'If you were to eat less meat in your daily diet, what would you do with the money this saves?' It turns out that if Swedes ate less meat, they would like to use the money to travel more. Travel, of course, carries environmental costs, just as does eating meat. Reducing consumption of meat might not reduce environmental damage and certainly wouldn't eliminate it, a somewhat counter-intuitive outcome. But that is the nature of the Jevons Paradox. An action taken to conserve resources reduces the cost of daily life to such an extent that entirely different kinds of environmental damage become affordable. William Stanley Jevons would have predicted it.

In his 1865 work *The Coal Question*, William Stanley Jevons (1835–1882) expressed the concern that Britain would lose its economic dynamism and pre-eminence in the world due to an inevitable depletion of its reserves of easily mined coal. Of course he did not foresee the dominance of petroleum, even denying its likelihood, and so the central worry of the book turned out to be misplaced. But *The Coal Question* contains a gem that enshrines the book as among the most significant works of resource economics. That gem is known today as the Jevons Paradox. It cannot be expressed better than in Jevons's own Victorian prose:

> *It is wholly a confusion of ideas to suppose that the economical use of fuel is equivalent to a diminished consumption. The very contrary is the truth.* (Jevons, 1866, p123)

> *As a rule, new modes of economy will lead to an increase of consumption* ... (Jevons, 1866, p123)

> *Now, 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.* (Jevons, 1866, p124–125)

In short, as technological improvements increase the efficiency with which a resource is used, total consumption of that resource may increase rather than decrease. This paradox has implications of the highest importance for the energy future of industrialized nations. It suggests that efficiency, conservation and technological improvement, the very things urged by those concerned for future energy supplies, may actually worsen our energy prospects.

The present book is one of the most extraordinary works on the Jevons Paradox. The authors are known for their innovative and eclectic research. The topics covered here are diverse, as are the approaches of the individual chapters. Blake Alcott in Chapter 2 sets the historical scene, discussing Jevons's work in the context of the founders of economics in the 18th and early 19th centuries. Mario Giampietro and Kozo Mayumi in Chapter 3 continue their explorations of epistemology and societal energy metabolism from a thermodynamic perspective. They discuss the important trade-off between efficiency and adaptability, referring to this as a yin–yang tension. In the fourth chapter, John Polimeni conducts a technical analysis to determine whether the Jevons Paradox has been in effect in various countries and regions of the world. The individual chapters are technical, and are valuable for this. They investigate in a rigorous manner the question of whether industrial nations can expect to continue in their present mode based on the hope and expectation of increasing efficiency in energy use.

The Jevons Paradox questions the pervasive assumption – common in colloquial discourse and even in many academic discussions – that sustainability emerges as a passive consequence of consuming less. This assumption comes in two versions. The pessimistic version suggests that it is necessary for people voluntarily to reduce their resource consumption in order to become more sustainable. Examples might include taking shorter or colder showers, using public transportation, drinking tap water rather than bottled, or eating less meat. This is sometimes known as the sackcloth-and-ashes approach to sustainability. The optimistic version, preferred by many economists and most politicians, is that a future of technological innovations and the shift to a service-and-information economy will reduce our consumption of resources to such an extent that we will become sustainable without requiring people to sacrifice the things that they enjoy. In this view of the future, technical improvements will allow us

to produce more gross domestic product per unit of resource consumption than at present, and thereby maintain our way of life. This is exactly the assumption that Jevons showed to be false in the third quotation above. In his day, the assumption of a technical solution involved blast furnaces, coal and pig iron. Today the assumption involves energy and our way of life in the broadest possible sense. The Jevons Paradox is based on a foundation principle of economics: any time one reduces the cost of consuming a valued resource, people will respond by consuming more of it. Or, as suggested in the opening paragraph of this essay, people will consume more of something else, perhaps resulting in no net savings or even greater overall consumption. As the noted journalist Eric Sevareid once said, 'The chief cause of problems is solutions.'

As Blake Alcott shows in this volume, the Jevons Paradox is connected to the work of other distinguished writers in the history of economics. Kenneth Boulding, for example, once developed three theorems from the work of Thomas Robert Malthus, which he presented in a foreword to Malthus's *Population: The First Essay.* Boulding labelled his first theorem the Dismal Theorem:

> *If the only ultimate check on the growth of population is misery, then the population will grow until it is miserable enough to stop its growth.* (Boulding, 1959, pvii)

Theorem two is the Utterly Dismal Theorem:

> *Any technical* improvement *can only relieve misery for a while, for as long as misery is the only check on population, the improvement will enable population to grow, and will soon enable* more *people to live in misery than before. The final result of improvements, therefore, is to increase the equilibrium population, which is to increase the sum total of human misery.* (Boulding, 1959, pvii; emphasis original)

Boulding's third theorem is called the Moderately Cheerful Form of the Dismal Theorem:

> *If something else, other than misery and starvation, can be found which will keep a prosperous population in check, the population does not have to grow until it is miserable and starves, and can be stably prosperous.* (Boulding, 1959, pxi)

Boulding observed that how to implement the Moderately Cheerful Theorem 'is a problem which has so far produced no wholly satisfactory solution' (1959, pxi).

One recognizes, of course, that these theorems are not confined to population. The Utterly Dismal Theorem in particular is quite consistent with

the Jevons Paradox, and seems indeed to be a limited restatement of it. Boulding confined the theorem to technical improvements and population, but as Jevons's analysis implies, the same principle applies to efficiency improvements in any costly thing that people acquire, whether children, automobiles or steaks. Reduce the cost of raising children, Jevons and Boulding would suggest, and people will raise more of them.

The Jevons Paradox has influenced world history, of which the Roman Empire provides an illustration. Early in its history, when it was a small city-state, Rome fought wars for survival against its immediate neighbours. Over time Rome was successful, defeating and subjugating these challengers. Early on the Romans adopted a clever strategy: incorporating the wealth and manpower of defeated rivals into Rome's war machine. In return, former rivals within Italy were given carefully graded rights in Rome's legal and political systems. Each time Rome defeated a rival, it emerged not only safer but stronger as well. When the time came in the third century BC for Rome to expand out of Italy, it had much of the resources of Italy at its command. This included great supplies of manpower. As Rome's empire expanded to the whole of the Mediterranean Basin and northwestern Europe, it continued most of this strategy, turning the resources of conquered nations to its own use. In 167 BC, for example, the Romans captured the Macedonian treasury, and promptly eliminated taxation of themselves. When Pergamon was annexed in 130 BC the state budget was doubled. After conquering Syria in 63 BC, Pompey raised the budget another 70 per cent. Julius Caesar relieved the Gauls of so much gold that its value in Rome fell 36 per cent (Tainter, 1988). In the terms of the Jevons Paradox, Rome's strategy resulted in a great reduction of the cost of conquest. The conquered nations underwrote the cost of Rome's further expansion. Finding conquest so economical, Rome responded by conquering more. A new mode of economy in conquest, Jevons would have observed, led not to contentment, but to an increase in the conquest of rival states. 'It is the very economy of [conquest],' Jevons might have written had he addressed Roman history, 'that leads to its extensive [employment]' (1866, p124).

Beyond such weighty matters as population, resources, and the fates of nations, the Jevons Paradox can be found in operation in many matters of daily life, both great and small. Since the authors of this volume have analysed technical aspects of the Jevons Paradox, I will take the opportunity to explore some examples from *la vie quotidienne*. I am presently at a keyboard, so word processing comes to mind. Early in my career, when professional writing had to be done on a typewriter, it was a costly endeavour to produce a new version of even a paper of ordinary length, let alone a book. The cost was accounted in time, labour, sore muscles of the hands and shoulders, and mental fatigue. When I acquired my first personal computer with a word processor in 1983, I thought naively that it would save me a great deal of work. Many other early adopters thought similarly. It was widely stated at the time that as a society we would now save great quantities of paper – the paperless office, as it came to be called.

Just the opposite has proved to be the case. Word processing has so reduced the cost of producing a single draft of a text that I now edit and generate six to eight drafts of everything I write for publication. In typewriter days I would usually produce only two drafts. While I have not kept a log, I strongly suspect that the amounts of time and labour that I invest producing a text has increased with the availability of the time – and the labour-saving word processor. As for paper, most drafts get printed, so that I consume much more paper than ever. When was the last time anyone predicted the paperless office? New modes of economy such as word processing, as Jevons noted, lead to an increase in consumption and even an increase in work.

The Jevons Paradox affects law enforcement officers who need to subdue violent suspects. A police officer who shoots a suspect with a gun pays a personal cost that is potentially very high. The officer is typically suspended from duty for a few days while a review board investigates the shooting. This period of review no doubt exacts a high emotional cost. The officer could be found to have discharged his or her firearm improperly. In that case, the officer might be dismissed, sued by the suspect or the suspect's family, or even prosecuted and imprisoned. Over the past few years, many police forces in the United States have equipped their officers with a device known as the Taser. The gun and the Taser are both high-energy devices capable of subduing suspects. The Taser imparts an electric shock of 50,000 volts, momentarily disabling a suspect, but usually not fatally. It can even be fired from several metres away. The Taser was initially presented as a humane device, which would allow police to subdue a violent offender without having to use a gun. The overlooked advantage is that the Taser has reduced the personal cost and risk to police officers of employing a high-energy weapon to overpower an offender. Unless the Tasered suspect dies, or the incident is recorded on video (both of which happen rarely), no board reviews ordinary use of the device. Since officers now face less personal cost if they use a high-energy weapon, they will be inclined to use such a weapon more often. Tasers are found at this writing in 11,500 US police forces. Predictably, there are now increasing numbers of complaints that police use Tasers too often (*USA Today*, 2007). Whether or not Tasers are used inappropriately, they are clearly used often enough to generate controversy. Jevons would not have found this surprising. Had he known of such a thing in his day, perhaps he would have written something like 'It is wholly a confusion of ideas to suppose that [reducing the personal cost of using a high-energy weapon] will lead to a diminished [usage of high-energy weapons]. The very contrary is the truth' (Jevons, 1866, p123).

My home community of Corrales, New Mexico has, like any responsible municipality, a board that oversees matters of planning and zoning. Corrales is a small community, but populated by intelligent, creative people, including many who work at the University of New Mexico and Sandia National Laboratories. They are an entrepreneurial population, and the village is home to many small businesses run from peoples' homes. The Planning and Zoning Board is responsible

for approving home occupation permits. One evening when I attended a meeting of this board, I witnessed a proposal from a gentleman who wanted to operate a business from his home placing and servicing soft drink vending machines. It was to be a source of retirement income. His specialty was to place the machines in small offices where only a few people work. How, one might wonder, could one profit from placing these machines in small offices? The answer is that technical innovations in vending machines have reduced their energy consumption. Newer machines meet the Energy Star requirements of the United States Environmental Protection Agency. With reduced energy consumption, the machines can now be operated at a profit even in places where only a handful of people per day might purchase a soft drink. Newer machines even come with motion detectors, to turn on the front panel lighting when a potential customer approaches. These machines will also monitor the ambient temperature and 'learn' customers' habits. One brand claims to save 46 per cent of operating costs per year (www.vendingmiserstore.com). What is the outcome of all of this saving of energy? These machines are now to be found in small offices and other places where previously they would have been uneconomical. There are many more small offices than large ones, so that the population of vending machines is larger than ever. Is the net effect to save energy or to use more? Consider how Jevons might have phrased it: 'The profits of the trade will increase, new capital will be attracted, the price of [vending] will fall, but the demand for it increase; and eventually the greater number of [vending machines] will more than make up for the diminished consumption of each' (Jevons, 1866, pp124–125).

The United States has an antiquated system of air traffic control, with computer technology and displays dating from the days of vacuum tubes. A new system has been in preparation for years. It will, of course, feature updated electronic wizardry, but that is just the start. Currently, large commercial planes fly a 'post-to-post' system. That is, they fly a straight line to a certain point, governed by ground radar, then alter their course slightly to the next point, and so on across the land. The effect is that planes must fly a slightly zigzag course, which increases their time in transit and the fuel that they consume. Newer technology will enable planes to fly with the aid of global positioning system satellites. This will eliminate the need for a zigzag course. Planes will be able to fly straight to their destinations (that is, 'straight' within the constraints of the curvature of the earth), reducing time in the air and making air traffic more efficient overall. Pilots on approach will not need to maintain the large distance between planes that they do now. The system is called Automatic Dependent Surveillance-Broadcast (ADS-B). An early implementation at United Parcel Service's hub airport at Louisville, Kentucky, shows shorter taxi times, and steep cuts in emissions and noise as fewer planes must linger in the air awaiting a chance to land. UPS expects to save 900,000 gallons of fuel a year on 117 planes (Doyle and Gillies, 2007). In the normal way that such technical developments are viewed, this will be seen as a great improvement. We will enjoy more efficient

air transport and safer air travel, and we will save time and fuel. But will this save time and fuel in the long run? Consider again Jevons's insight: 'As a rule, new modes of economy will lead to an increase of consumption' (1866, p123). Whatever savings will be brought by ADS-B will no doubt encourage even greater use of air travel and air freight. In the long run, the time spent in air travel will increase, as will the fuel that it consumes. As Boulding might have written, 'As long as misery is the only check on [air travel], the improvement will enable [air travel] to grow, and will soon merely enable *more* people to [travel] in misery than before' (1959, pvii).

What is to be done about the Jevons Paradox? It is a common human tendency to think locally and short-term (Tainter, 2007). In our history as a species, there was never selective pressure to think in terms of broader scales of space and time. Since humans did not evolve to think broadly, most of us don't. This suggests that people will not forgo currently affordable consumption on the basis of abstract projections about future resource supplies. Thus the Jevons Paradox cannot be circumvented through voluntary restraint or any other *laissez-faire* approach. Giampietro and Mayumi suggest that taxes could make up for any savings introduced by efficiency improvements, thereby avoiding the paradox. In the United States, at least, this approach is politically infeasible, but the general point is sound: The key to avoiding the Jevons Paradox is to adopt the principle that neither efficiency improvements, nor any other approach to reducing resource use (including voluntary conservation), can be allowed to reduce the cost of consumption. This is one way to implement the Moderately Cheerful Form of the Dismal Theorem. It is a principle that can be shown to work, illustrated again through my own experience.

In 1992, the desert city of Albuquerque, New Mexico, discovered that the aquifer from which it was drawing its water was much shallower than had been thought. Albuquerque had been planning to use this aquifer for the city's future growth. Now it was clear that those plans would need to be changed. To their credit, the city's officials acted immediately, implementing a number of conservation measures (including fines for excessive use) and arranging to replace groundwater with surface water. The programme had early success: people reduced their water consumption, so much so that the city's water utility suddenly found itself with insufficient income at a time when new investments were required. It was necessary to raise water rates. People naturally complained: they had done their duty by conserving water but realized no monetary reward for doing so. Instead they paid more to use less. The fortuitous part of this dilemma is that higher rates gave people a continuing incentive to conserve. And conserve they have continued to do. In 2005, Albuquerque recorded its lowest water consumption since 1985, even though its population has grown by 33 per cent in that time (*US Water News*, 2005). The city continues to encourage people to conserve, and the consistency of this message has no doubt helped. But the

increase in water rates and the fines have helped too, circumventing the Jevons Paradox.

John Polimeni goes to great effort in his chapter to investigate nations and regions where the Jevons Paradox is in effect. I applaud his research, which is necessary to satisfy technical specialists. Yet the brief discussion here suggests that we might reverse the question and ask: Where is the Jevons Paradox *not* in effect?

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