Confronting Jevons' Paradox: Does Promoting Energy Efficiency Save Energy?

By Horace Herring*

Does promoting energy efficiency actually save energy? At first sight this seems a ridiculous question. For why would anyone invest their time and money in improving the energy efficiency of their building and equipment if it didn't save them energy and hence money. If their investment fails to save them energy they can rightly feel a victim of incompetence or fraud. But is what is true on the small, or micro, scale true on the national, or macro, scale. Does the OECD policy of promoting energy efficiency actually lead to a reduction in national energy use, and this is the subject of my speech tonight.

This is a question that has troubled economists for the last 150 years, and has greatly upset environmentalists over the last 25. We can trace the history of this controversy back to the great 19th century English economist, Stanley Jevons. In the mid 1860s there was a great national debate, that has recurred at frequent intervals since then, about whether we were running out of energy and what we should do about it. In their day the prime energy source was coal, and given the limited nature of known coal reserves it seemed inevitable that population and economic growth would soon cause their exhaustion. So what was the solution: there seemed to be no new energy sources, oil and gas were virtually unknown and unused, while electricity was just a scientific curiosity. Wind and water power were of medieval origin and insufficient to power the industrial revolution. One solution proposed was the more economical use of fuel, that is energy efficiency. If coal was better and more sparingly used in boilers and fireplaces then its lifetime could be prolonged. However Jevons argued against this position, and in a sentence frequently quoted since, wrote in his famous work, *The Coal Question,* in 1865:

> "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….Every… improvement of the engine, when effected, does but accelerate anew the consumption of coal"[1]

Thus was born Jevons' paradox, the idea that increased energy efficiency while saving energy on the micro-scale would not save energy on the macro-scale, but would instead lead to an increase in consumption. This idea, that increased productivity in the use of a commodity will lead not to a decrease but any increase in consumption, is at the heart of economics and is widely accepted for all other commodities. This is because increased productivity leads to an implicit reduction in price, and hence greater demand. We can see this effect clearly with telecommunications. Productivity improvements bought about by technical change, reduce the cost per minute of using phones. The result is not less spent on calls but more, as people find it cheaper to use phones than other means of communication, and new applications are developed, such as the internet, to take advantage of cheaper phone rates.

The greater the efficiency improvements, the greater the increase in demand. Factor 4 or factor 10 improvements in efficiency lead not to lower consumption but greater use. This can be clearly seen with electricity generation and lighting. Here technological improvements have resulted in large increases in efficiency, tremendous decreases in prices and vast increases in consumption. For instance in the USA, the fuel input need to produce a kilowatt hour decreased by a factor of ten during the last century, prices fell 30 fold and consumption rose 1300 times, an experience I am sure is found in most OECD countries.[2] Other factor 10 improvements have occurred in industry, such as in pig iron production and nitrogen fixation. There have been big improvements in energy efficiency in households due to insulation and new boilers. Since 1970, in the UK, the efficiency index or SAP rating has more than tripled, but heating energy use per household has remained constant.[2]

For lighting it is even possible to track changes in efficiency and consumption over seven centuries, as has been done in a most fascinating study by Roger Fouquet and Peter Pearson for the UK.[4] There they trace the evolution of demand for lighting as technology of lighting progresses through medieval candles, 18th century oil lamps, 19th century gas lights and finally 20th century electric lamps. Every time a new technology is introduced efficiency is improved and consumption increases dramatically. Our modern electric lights are 700 times more efficient than oil lamps, so do we use less energy for lighting?

In the last 200 years in the United Kingdom, the GDP per capita has increased 15 times, but per capita use is 6,500 times greater and total lighting consumption 25,000 times higher. Even in the era of the electric light, over the past 50 years, there has been a doubling of efficiency but a five fold increase in total consumption. And the opposite can be seen with technologies that have failed to improve efficiency, their demand decreased. For instance the domestic coal or wood fire which was much loved-- and even defended by the great English writer George Orwell as 'the birthright of free-born Englishmen' when he opposed smoke control regulations-- is now rarely used except by the very rich as decoration, or by the very poor who are unable to afford any other fuels, and who scavenge it from spoil heaps.[5] Thus low efficiency leads to low consumption, while high efficiency leads to increased consumption.

So what is the relevance of Jevons' Paradox for us today? The OECD is committed to increasing energy efficiency as a means to combat global warming. The idea is that national energy efficiency policies, such as through raising building standards and setting efficiency standards for appliances, will lead to a reduction in energy use. Whether this reduction is an absolute or a relative one is often left unclear. Polices are

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See footnotes at end of text.

claimed to save so many million tonnes of carbon by such and such a date, but are these savings only hypothetical, that is compared to what might have been used. That is, are they the difference between two computer scenarios, one with efficiency policies and one without. In most such scenarios total energy use and carbon emissions still rise, even though there are claimed to be large 'savings'. This is not to deny at all the value of energy models or scenarios as educational tools which help us to understand the structure and mechanisms of energy consumption, and to evaluate the impact of future options, but they cannot predict the future.

So while we congratulate ourselves about the success of our efficiency policies, national energy use and carbon emissions continue to increase. Over the last 25 years energy consumption in the OECD is up by about a third, and carbon dioxide emissions are up by a quarter. There is indeed an unending race between energy efficiency and economic growth. If growth is faster than the rate of efficiency increase (as it has been historically) then total energy consumption increases. For instance in the UK over the last 35 years energy efficiency (as expressed by energy intensity - a rough proxy) doubled - a Factor 2 improvement. However, GDP more than doubled, so total energy consumption rose by a about 15%. Thus at current rates of efficiency improvement, it is perfectly feasible for there to be a Factor 4 improvement in the next century. But as the RCEP comments:

> There will continue to be very large gains in energy and resource efficiency but on current trends we find no reason to believe that these improvements can counteract the tendency for energy consumption to grow. Even if energy consumed per unit of output were reduced by three-quarters or Factor Four, half a century of economic growth at 3% a year (slightly less than the global trend for the past quarter century) would more than quadruple output, leaving overall energy consumption unchanged.[6]

So will the future be any different than the past? What are we going to do that will alter the outcome of this race between energy efficiency and economic growth? Is the answer more efficiency policies, more regulations, more standards and more innovative schemes. The reason energy efficiency has failed to deliver absolute savings it is argued, is because it has not been imposed enough. Is this not similar to arguing that the Soviet Union collapsed because its economic system was ineffectively applied!

Apologists argue the merits of relative savings, if such and such a policy had not been implemented then energy use would be so much higher. But would such an excuse be tolerated in other policies areas? If a Minister pledges to reduce crime by 20% over 5 years, and total crime increases by 10%, do voters judge the Minister a success because he claims that if he had not implemented his policies crime would have risen 20%, or that crime intensity—crimes committed per GDP--has declined. Basically do we accept hypothetical excuses or a decline in some index, or do we want absolute reductions?

The European Union is committed to an absolute reduction in carbon emissions, thus saying that our energy efficiency policies are successful because they reduce the rate of energy growth or that energy intensity is falling is to my mind wholly inadequate. I believe that the answer to our quest for lower carbon emissions is not lower energy use but shifting to less carbon intensive fuels, basically in the long term renewables or nuclear power. If we want to use less energy, the simple answer is to raise its price, through such mechanisms as a carbon tax, or place restrictions on its use. Neither of these, I am sure, are popular with voters.

So following in the tradition of Stanley Jevons and many economists since, I argue that promoting energy efficiency will not lead to a reduction in national energy use.[7] In the meantime, energy efficiency is a valuable tool to save consumers' money and stimulate economic productivity. For high levels of resource efficiency, whether of energy, labour or capital, are an essential part of a dynamic productive economy with a high 'quality of life'. Low economic productivity and energy inefficiency go hand-in-hand with a low 'quality of life' as the former Soviet Union demonstrates. The aim of energy efficiency should not be to reduce energy consumption but to produce a higher 'quality of life' and enable us, if we so desire, to fund the transition to a green and sustainable future.

Footnotes

[1] See Blake Alcott (2005). Jevons' Paradox. *Ecological Economics* 44(1): 9-21.

[2] See R. U. Ayres and B. Warr (2005). Accounting for growth: The role of physical work. *Structural Change and Economic Dynamics* 16(2): 181– 209.

[3] See L. D. Shorrock & J. Utley (2003). *Domestic energy fact file 2003*. London: BRE bookshop http://projects.bre.co.uk/factfile/BR457prtnew.pdf

[4] Roger Fouquet and Peter Pearson 2006. Seven Centuries of Energy Service: The price and use of light in the United Kingdom (1300-2000). *The Energy Journal*, 27/1: 139-176.

[5] Quoted in John Robert McNeill (2000), *Something New Under the Sun: An Environmental History of the 20th Century World*. Penguin, p.66.

[6] RCEP (2000). *Energy – The Changing Climate*. Royal Commission on Environmental Pollution, 22nd. Report. London: The Stationery Office p.6.13.

[7] Horace Herring (2005). Energy Efficiency: A Critical View? *Energy: the International Journal* 32(1), 10-20.