Oil Supply Insecurity: Control versus Damage Costs

Anthony D Owen
School of Economics, The University of New South Wales
Sydney, NSW 2030, AUSTRALIA

Introduction

In a recent paper, Ogden et al. (2003) presented estimates of the societal lifecycle costs of fifteen different automobiles based upon alternative fuels and engines. This wide-ranging and comprehensive study derived estimates of the lifecycle private costs associated with the different technologies, and then augmented these with their respective lifecycle external costs in order to derive an estimate of their impact on society. External costs were calculated as damages resulting from air pollution and greenhouse gas emissions, together with an estimate of the cost (to the USA) of providing security of supply for US oil imports from the Middle East. The inappropriate derivation of this latter cost, referred to as Oil Supply Insecurity by the authors, is the motivation for this note given its critical role in determining the viability of fuel cell automobiles, particularly those "fuelled" with hydrogen derived from a renewable energy resource (in their example, wind).

In this note, the reader is reminded about the distinction between control costs (inappropriate methodology) and damage costs (appropriate methodology) for deriving a valuation of the impact of environmental externalities. The cost of oil supply insecurity is then revisited, in order to illustrate the substantial disparity between the two concepts.

Control v. Damage Costs[1]

The two principal methods generally used for assessing the value of externalities are calculation of damage costs and calculation of control (or abatement) costs. Although control costs are often seen as estimates of damage costs, conceptually they are very different. Damage costs are a measure of society's loss of wellbeing resulting from the damage arising from a specific adverse environmental impact. Control costs are what it costs society to achieve a given standard that restricts the extent of the impact to an acceptable level, and are thus likely to be only tenuously related to total damage costs.

Control costs are often used as a surrogate for damage costs as they are a relatively straightforward concept, are relatively easy to derive, and can be applied to most environmental impacts. Essentially, unit control costs can be calculated simply by dividing the cost of mandated controls by the emissions reduction achieved by the controls. In general, however, control costs must be viewed as a poor substitute for estimating damage costs, since the methodology is subject to inherent flaws. The implicit assumption in control costing is that society controls pollution until the benefit of additional controls would be outweighed by the cost of their imposition. But using the cost of regulation to estimate the benefit is rather a meaningless, circular, procedure, given that a cost-benefit ratio of unity will always be achieved. A further flaw is that use of control costs to value externalities implies that legislators are able to make optimal decisions when imposing policy instruments to modify polluting behaviour to achieve such an "optimal" outcome. For example, there are numerous epidemiological studies of cost per life saved that exhibit large variations in the values implied by the costs and benefits of different regulations and policy options.

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[1] The author does not lay claim to any originality in this distinction, which should be well known to economists.

Estimation of damage costs has economic theory as its basis. It focuses directly on explicitly expressed preferences as revealed by willingness to pay to avoid environmental damage or by stated preferences in either real or simulated markets. In addition, it can be combined with financial assessment of investment options in order to provide a societal estimate for the impacts of an investment in a common numeraire. This methodology is fundamental to the attribution of financial values to environmental impacts identified in lifecycle analyses. The last of the four stages in the environmental "impact pathway"[2] involves calculation of the economic value of the biophysical effects in terms of willingness to pay to avoid damage arising from the emission of pollutants[3].

In summary, there is no reason why the two concepts should be of comparable dimension. In fact, rationally, control costs should always be less than the estimated level of damages.

The Cost of Energy Security of Supply

The economic, environmental, and social objectives of sustainable development policies have, as an underpinning tenet, a key requirement of security of energy supplies. The economic and social implications of major breakdowns in the energy delivery system can be very severe. There is a marked asymmetry between the value of a unit of energy delivered to a consumer and the value of the same unit not delivered because of unwanted supply interruption. Further, interruptions, or threats of interruptions, can swiftly lead to widespread disruption given that it is difficult and expensive to store energy. The resilience of energy systems to extreme events is a major problem confronting industrialised society.

Energy "insecurity" is reflected in the level of risk of a physical, real or imagined, supply disruption. The market reaction to prospective disruptions would be a sudden price surge over the expected period of impact of the disruption. A prolonged period of high and unstable prices is, therefore, normally a symptom of high levels of insecurity. Interruptions to supply can also come from unexpected shocks to the energy system, such as deliberate acts of sabotage or unexpected generic faults in energy supply technology. There is also a time dimension to energy security, ranging from the immediate (e.g. power station breakdown) to the distant future (e.g. the low carbon economy).

It is possible to define two categories of risk in the context of energy security: strategic risks and domestic system risks. **Strategic risks** often involve the risk of interruption to the supply of imported fuels. The origin of the problem may be market power, political instability, or insufficient investment in the infrastructure of fuel exporting nations. They involve external events and circumstances. **Domestic system risks** arise from insufficient or inappropriate investment in domestic energy infrastructure, from technical failure, from terrorism, or from social disruption of the market (e.g. labour strikes).

Energy security is widely perceived as being a public good that should be provided by governments. Without such intervention, it may be argued that market imperfections would lead to an under-provision of security. In extreme cases, such as acts of terrorism, this is clearly true. However, risk is an intrinsic factor in all markets and prices should generally

[2] See European Commission (1998) for a detailed methodology of "bottom up" lifecycle analysis in the context of pollutants arising from energy production.

[3] Clearly, however, a major disadvantage may be the scale of the data required for deriving estimates of these damage costs, and hence the attraction of using control costs.

incorporate consumer's willingness to pay for different levels of exposure to risk. The energy market should not be an exception.

Estimation of Damage Costs

The cost of supply disruption is generally assessed in terms of the potential decline in a country's Gross National Product (GNP) arising from interruption to the supply of crude oil in the international marketplace. It is then assumed that this disruption causes a sudden increase in the price of oil, which in turn causes a corresponding reduction in GNP. The extent of the resulting "loss" will be positively related to the country's degree of dependence on imported oil and oil products. Estimation of the economic cost of supply disruption involves the following steps (Razavi (1997)):

- Formulation of supply disruption scenarios. Each scenario relates to a probable political event and is reflected in reduction of oil supplies by a specific amount for a specific period of time.
- Assessment of the impact of each disruption on the oil price trajectory.
- Evaluation of the impact of the oil price increase on GNP.

The latter requires an estimate of the elasticity of GNP with respect to the price of crude oil. It should be noted that this economic loss arises because of a sudden, rather than gradual, price increase. It arises because the economy cannot adjust immediately to higher oil prices. Instead, the oil disruption causes higher unemployment and lower GNP than would have been the case in the absence of a disruption. Estimation of the economic impact would require extensive analysis of macro and micro economic reactions to increases in oil and oil product prices. In the United States, which is dependent on imports for 40 per cent of its oil consumption and holds around 150 days of petroleum inventories, the elasticity of GNP to a sudden increase in oil prices is estimated at –0.25[4]. Thus a 10 per cent increase in the price of oil would result in a 2.5 per cent decrease in GNP (*ceterus parabus*). In the case of Japan, where import dependency is almost 100 per cent and petroleum inventories also amount to around 150 days of consumption, the elasticity could be as high as –1.0.

Estimation of Control Costs

The actual amount of money spent by the US on oil security is very difficult to estimate. US defence expenditure is predicated on a number of varied regional objectives around the globe, and assigning a marginal cost to oil security activities in the Middle East (or, for that matter, elsewhere) involves a considerable element of subjective allocation. Further, the figure is likely to vary significantly over a period of years, depending on prevailing military actions both in the Middle East and elsewhere. Koplow and Martin (1998) have estimated that the total military defence cost to the US of stabilising foreign oil supplies ranges from $10.5 to $23.3 billion annually (in 1995 dollars). The difference in these estimated bounds is, to a large extent, due to the estimation techniques employed.

The US oil industry has also benefited from a number of pieces of selective tax legislation. Those that are based solely on domestic considerations are accelerated depletion, percentage depletion, and expensing of oil exploration and development costs. Koplow and Martin have provided an estimated range of from $1.9 to $3.9 billion as the subsidy arising from these three items.

Finally, established in 1975 in the wake of the 1973/74 OPEC-induced oil price hikes and embargoes, the strategic petroleum reserve (SPR) was intended to help cushion the US from

[4] Razavi (1997).

interruptions to imported oil supplies. The existing storage capacity in the SPR is 700 million barrels. At year-end 2002, the SPR contained about 600 million barrels, or approximately 53 days of US forward requirements. A further 100 days of inventories were estimated to be held by private oil companies. The major cost associated with the SPR is foregone interest on the capital invested in the scheme. Minor costs are incurred in its management and operation. Costs associated with oil purchases are not considered a "cost" since revenue arising from the occasional (or ultimate) sale of stocks can offset these. Only any loss, or gain, in such transactions should be attributed to SPR operating expenses. Koplow and Martin have provided an estimated range of from $1.6 to $5.4 billion as the subsidy arising from the SPR.

Combining the above three categories with miscellaneous other subsidies, Koplow and Martin estimated that the total ($1995) subsidy to the US oil industry, from all sources, ranged from $15.7 to 35.2 billion.

Ogden et al. (2003) only considered the marginal external cost of maintaining a military capability for safeguarding access to Persian Gulf oil exports, which they labelled Oil Supply Insecurity (OSI) costs. All other US oil industry subsidies were omitted from the analysis. Their estimated cost range[5] was very broad, $20-$60 billion, which translated to an implied subsidy of $0.35-$1.05/gallon of petroleum equivalent[6], and the mid-point of this range (i.e. $40 billion or $0.70/gallon) was used in their study to estimate the present value of OSI costs for all automotive technologies using oil-based fuels. As noted previously, however, this is an estimated control cost not an estimated cost of the damage arising from specified supply disruption scenarios. As such, its credibility in a societal life cycle analysis is questionable. Intuitively, it would appear to be very low for conditions prevailing in the international oil market over the early years of the 21st century. In 2000, US GNP was approximately $10,500 billion. Thus $40 billion would represent a little under 0.4% of GNP in that year. Based upon Razavi's estimates, this would be equivalent to the damage arising from an unexpected increase in the price of oil of 1.6% (a figure that would generally be viewed as being within normal tolerance levels for random daily price fluctuations). However, on a positive note, if it were to be regarded as an estimate of the absolute minimum level of "damage" arising from insecurity of Middle East oil supplies, then the societal benefits of fuel cell cars based upon hydrogen technology can only be reinforced by this estimate.

Conclusion

This note has reviewed the distinction between control and damage costs in the context of a lifecycle analysis of oil security costs relating to future automobile and fuel technologies. The conclusions by Ogden et al. (2003) were based upon the use of an inappropriate methodology for deriving an estimate of OSI costs. However, the consequence of this miscalculation is that the fuel cell car based upon hydrogen technology is likely to have a higher societal value than calculated in their paper, and consequently would remain, by a larger margin, the preferred future option of the technologies considered.

[5] Obtained from an informed individual, but with no justification for its magnitude.

[6] These values were calculated by dividing the total cost of maintaining US military activity by 20 per cent of Persian Gulf exports to reflect the fact that the US accounts for 20 per cent of gross oil imports at the global level.

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