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Energy Demand – Rethinking from Basics

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1 Introduction

In overviews of government policies on energy supply, greenhouse gas emissions and energy security, 'energy efficiency' is often give a high priority amongst policy options. It is also given a low expectation, on past track record, of success. This lecture explores the possibility that this mismatch between potential and expectation is the result of a narrow view of the possible interventions. This in turn is a product of embedded simplifications within the conventional 'neoclassical' economic analysis of the market. My argument re-investigates a more classical economic viewpoint, enriched with the insights of later behavioural science. This complementary 'retro-classical' viewpoint is applied to the issue of information provision and regulatory intervention. It is also used to explore a paradox within current emissions projections of greenhouse gas emissions, where events appear to justify 'green' governments acting in the context of 'brown' markets.

2 A Retro-classical Approach

A conventional analysis of energy demand draws on a description of consumer behaviour based on *choice*. Each consumer unit receives an income, and is faced with a wide selection of goods at given prices. This picture is reconfigured in neoclassical economics as a (large) set of clusters or baskets of goods selected from those available and ranked in order of desirability (or utility). This ranking relates to properties of the goods themselves as perceived by the consumer and so is assumed in the most primitive version of the theory to be independent of cost of purchase or the behaviour of other consumers. As an intrinsic property of the consumer it is independent of income. The act of choice is then understood as seeking to maximise the rank of the chosen basket consistent with the constraint that the cost of the basket at the given prices is equal to (or less than) the available income.

This reconfiguration of the problem has an algebraic advantage when trying to understand the behaviour of the whole economy. Maximising utility is the dual of maximising profits, and, with feasible assumptions such as decreasing marginal utility, the algebra leads to a General Equilibrium. The analytic power of this approach is the ability to assess the response of the whole economy to events that push it out of equilibrium. Whether a precise equilibrium actually exists seems doubtful, but as long as General Equilibrium analysis is seen as a 'big picture' model technique rather than totally isomorphic with the messy reality of real economies this is not a fatal flaw.

There is no need to go into any detail to guess the type of policy recommendation that follows from a General Equilibrium analysis. Prices need to be free of subsidy so that they truly reflect marginal resource costs. If poverty needs to be addressed it is through income payments not price subsidies. If environmental constraints need to be addressed they are reflected in environmental taxes not prescriptive legislation. With price signals addressed the consumer needs to be supplied with information to make the best decision. Innovators in markets are rewarded by the readjustment of the equilibrium upon the innovation's successful introduction. These policy prescriptions are widely repeated in energy policy statements, but not always found easy to implement.

Removing price subsidies and introducing environmental taxes can have politically difficult consequences. If Marie Antoinette's peasants were starving it was indeed more efficient for them to eat animal feed ('cake') than feed it to animals, but they may not have seen it that way. Once market distortions are removed we are left with a Pfiaffian[1] perspective, where the fully informed consumer can regret nothing. Limiting government's engagement with the final consumer to the provision of leaflets and awareness campaigns can seem anaemic. But it does not follow that this policy suite is wrong. The question pursued here is whether there are simplifications embedded in the utility model that have excluded *additional* and possibly more effective policies and measures.

Proposed refinements and criticisms of General Equilibrium Theory have continued long after Marxist critique lost its power. For example we have much richer understanding as to how firms operate than is reflected in the theory and a more mature expectation that dynamic systems do not always (hardly ever?) settle in an equilibrium. But these insights do not necessarily improve our capability to form a broad understanding of the economy as a whole. This is in the same sense that insisting that electrical engineers replace Ohm's Law by the unsolvable but elegant quantum theory of the electron cannot be expected to improve the design of electric circuits. .Assessing the usefulness of these variants of the model of consumer behaviour is well beyond the scope of this lecture. The purpose is rather to identify policies and measures that those insights would entail.

Possibly the most celebrated variant of utility maximisation is an argument due to Simon. He asserted that consumers were likely to be overwhelmed by the calculation of the maximum utility (the human brain after all is only a 2kHz, albeit massively parallel, machine). Rather he contended that consumers sought satificing solutions. As long as there was nothing wrong with a choice it did not need to be optimal. While there is a strong thrust in Simon's argument it may still understate the approximation to the real world contained in utility maximisation algebra. A modern hypermarket contains 10^5 different goods and variants of goods. A consumer with $100 bill can easily fill a shopping trolley in over 10^{20} ways. It is not that the store manager does not observe customers making choices as they walk around the store. It is just that they do not make choices all the time, otherwise they would never reach the checkout.

A literary example makes the point. Shakespeare has Hamlet conduct one of the greatest multi-criteria analysis in the theatre ('To be or not to be..'). The soliloquy does everything the decision analysis would want, ranking alternative outcomes against each other. But it takes place in Act III. Up to that point Hamlet has made a string of decisions (not to return to university, when to meet the Ghost etc). Nothing looks irregular to the audience because Hamlet essentially takes his decisions as logical consequences of following his personal narrative.

[1] '*Je ne regret rien' !!*

In this ‘narrative theory’ there is a linguistic distinction absent from utility theory between decisions and choices. Indeed it is meaningful in everyday language to ‘decide to choose’. In a narrative theory a consumer follows a narrative through time. The narrative resolves (or gives the ‘reason for..’) decisions that have to be taken through time (‘he is commuting to work’ resolves ‘train to catch’ etc) until the narrative either becomes externally inconsistent with the world (‘there is a strike by train drivers’) or event expose internal inconsistencies (‘commuting to work’ may not align with ‘conducting oneself with dignity’ when the arriving train is over-crowded, itself provoking reflection as to whether a First Class ticket would be a sensible purchase). It is then necessary to make choices. Making choices costs resources and is usually a chore rather than a pleasure. ‘Rich’ in this framework then describes a fortunate consumer that can always satisfy any ‘whims’ of their narrative without ever feeling constrained and so having to make trade-off choices. ‘Poor’ might then be an unfortunate consumer who has consciously to make trade-offs between every aspect of consumption. ‘Rich’ and ‘Poor’ are then terms relative to a narrative rather than absolute measures of income. While consumers can have low or high incomes in utility theory, it has little use for the common idea of feeling ‘rich’ or ‘poor’,

Several remarks need to be made at this point to avoid exaggerating the novelty of this argument. First this ‘narrative theory’ is not strictly a single theory but simply a generic term for the theories of (all?) other disciplines and observers of consumer behaviour. Indeed it is the descriptive method of the ‘Classical economists’, who continually describe economic behaviour in the form of narratives. This technique reached its apogee in the work of Veblen who provides narratives for the ‘Leisure Class’ that explain their decisions on consumer goods. His narratives principally relate to the need for esteem, resulting in purchasing goods exhibiting ‘conspicuous consumption’. For Veblen the need to exhibit being ‘rich’ manifested itself in consumption decisions that were conspicuously not optimal choices. In the context of this lecture, a Rolls Royce car is a conspicuously impractical vehicle How do you park it at the supermarket? Answer: that is the whole point – the owners of Rolls Royces conspicuously do not shop themselves. To emphasise this historical connection I term the approach developed later as retro-classical in contrast to the neoclassical viewpoint of General Equilibrium.

The second point is that utility maximisation was introduced originally to provide an algebraic route to a unified analysis of the economy, not because of some new empirical work amongst consumers. Third most narrative theories are algebraically too complicated to add value to a general equilibrium analysis. Their strength is better understanding of sub-sectors of the economy. Fourth none of these distinctions between theories has much bearing on the day-to-day task of the applied economist assisting a firm on its pricing strategy. The applied economist only needs knowledge of the current price and income elasticities and is indifferent to speculations about how they arise. It is only in the policy framework that the difference begins to tell.

3 Narrative Theories and Innovation

I now begin to elaborate the narrative theory. A great advantage over Veblen is that there is no real need for the modern analyst to explore new data. All that is necessary is to interpret narratives researched by other sources such as marketing strategies. For a given commodity the market place divides between the ‘rich’, the ‘poor’ and those with mixed or inconsistent behaviour. The evidence supports a fairly sharp distinction for energy. In the UK, for example, there is a policy that relates to ‘fuel poverty’, where the fuel poor are defined to have energy bills greater than 10% of (disposable) income. Similarly energy policy identifies an industrial class called ‘energy intensive industries’, with fuel costs exceeding 20% of production costs. The implication for both groups is that they closely manage their energy costs. If energy costs rise this group do most of the savings reflected in the drop in total market demand. At the same time a smaller number of consumers move from ‘rich’ to ‘poor’ and join those who need to make choices. These groups could be assumed for the sake of an argument to follow ‘neoclassical’ behaviour. The rest simply suffer a loss of disposable income, which in turn may force choices in those goods where they are ‘poor’. The rich group are assumed to follow retro-classical narrative behaviour. Their energy consumption is then a consequence of other decisions (and choices).

Since Veblen’s time, the art of the consumption narrative has been greatly developed. In a retro-classical perspective consumer’s today are sold goods they do not chose them. Firms, and salesmen, seek to elucidate the narratives, of their customers and align the presentation of their products to align with those narratives. Price can play a part since it has to meet expectations, and not entrain unwanted narrative (‘too cheap to be true’, ‘rip off’). In developed economies the expenditure on advertising is substantial (around 5% of GNP), and almost none of it relates to neoclassical data. For some goods the cost of selling the goods to the consumer in the first place is a significant part of the costs underlying the price. The consumer is oblivious to this premium because the value of owning or using such goods is diminished if the brand is not recognised by others. This economic activity gives the modern analyst an advantage over Veblen. Veblen’s observations, while amusing and insightful were also anecdotal and assertions as to motivation were not founded on empirical evidence. If we make the assumption that advertising expenditure is ‘neoclassical’ then it is as far as possible, optimised. Consequently the economic analysts can read the narratives of consumers through the narratives of advertising without needing to undertake the expensive primary research themselves. It is for example easy to see when a good or service is ‘neoclassical’ because the advertisement largely addresses the facts that support choices. A ‘retro-classical’ market will have advertisements that are largely narrative. An advertisement in the highly competitive cigarette market for example will aim to give the nicotine addict a social narrative rather than weight of tobacco, saltpetre content and burning time.

Narrative theories are especially important in understanding technology trajectories. Technology trajectories – the time history of a new product or service in the market place are key to understanding how new energy consuming technology will enter the market place. It is useful to make the distinction between invention, novelty and innovation. An invention is a new product or process. There is no presumption that anyone will actually want to make it or buy it. A novelty is the application of an invention in a market where the principle narrative is to signify ‘the immediate’. Clothing fashion is the most familiar example where each season designer’s need to invent new collections that would distinguish the wearer from anyone holding on to clothes from an earlier year. Shakespeare’s Richard III and Malvolio both make just this point in their respective narratives. An innovation, in contrast, is an invention that diffuses through the market place. This diffusion is either with or against the flow of current narratives. First purchasers usually have a premium for novelty and the narrative of being seen as innovative. The second wave lack this premium and tolerance of failure. The third wave is based on broad endorsement of the invention and so on.

In transport the trajectory is well established. The invention begins in the high technology of Forumula One racing, transfers to top of the range cars and gradually diffuses down to the economy car. Thus at each stage adopting the invention is consonant with the aspiration for a vehicle higher in the chain of aspiration. This is the story of say ABS braking, electronic ignition and so on. Fuel economy technology characteristically introduced into ‘budget’ models, has no aspirational narrative to pull it up the market hierarchy. In truth such trajectories are a result of more than one set of forces. Beginning an innovation in F1 racing has the advantage of directing the R&D effort to making it work, irrespective of cost. The economics are determined by winning races not by cost optimisation! The transfer to premium car marques has a similar incentive with the added advantage of specialist dealer support for in service maintenance. As the invention diffuses to larger and larger markets R&D effort is increasingly directed towards reducing production costs and warranty claims. The strategy of the technical director and marketing director are for once aligned.

In buildings the trajectory for invention is similarly well-trodden. Inventions begin in industry, transfer to commercial, then to 'A' class housing and then finally to 'social' housing. The implication is that a technology parachuted into social housing is swimming against the tide in migrating up this route. As with transport we should not expect an innovation to leap frog stages. Consider for example 'central heating'. This technology was first used in industry and then in large houses (to reduce the labour of setting and keeping fires). When surveys were taken of reactions to central heating in the 1950's the reaction was negative. Respondents did not identify it as too expensive, but unhealthy. Central heating has followed a classic logistic penetration curve since then. Similar curves are traceable for most energy demand technologies in housing.

This argument had an important implication for UK housing in the 1970's. As part of an ambitious housing programme community heating was introduced into UK social housing. It was unpopular with tenants from the outset and it is easy to see why. Tenants in social housing were much more likely to be fuel 'poor'. In contrast community heating had been introduced on the Continent in the context of fuel 'rich' serviced flats and middle class housing. Community heating then was neither particularly practical because of the cost of the metering needed for heating choice, and had the negative cache of socialised provision. The schemes installed in the 1960's and early 1970's had been removed by the mid-1980's and replaced with the 'natural' successor technology individual central heating technology.

The argument also provides an explanation for the notable success of 'energy labelling' in the refrigerator market, otherwise often seen as a triumph for the policy paradigm of the informed consumer. The issue in energy labelling is whether the better ranked products match the ranking of the main narrative. For refrigerators this is true. Corporate decisions had meant that the prestige brands ranked higher than the 'budget' brands. A salesman coaxing a customer to a more expensive model could deploy the better ranking of superior models as an attribute. The incentive of sales commission might even be on his side. Second the use of performance bands is much more powerful than the use of a numerical scale. Bands match narratives in a simple way. In pricing and designing a product there is an incentive for manufacturers to engineer products that are marginally below an aspirational boundary across the line.

It is noteworthy that the continuous measure of fuel efficiency used for private cars is to be superseded by a banding system. However the effect of labelling with either philosophy is not predicted to be as powerful in this sector as for some white goods. This is because the measure is an efficiency per driving cycle and consequently more desirable 'upmarket' cars will have poorer ranking. It is of course possible to design a labelling scheme to provide a very aggressive narrative. Suppose for example that instead of alphabetical categories the categories related to the year in which that performance was 'A-grade'. This creates pressure against the narrative of the novelty of a new design. In environmental legislation the technology generation related 'Euro Standards' play a comparable role in vehicle emissions legislation in world markets. The updating of the A-G grading by adding 'A+' and 'A++' to refrigerators could be interpreted as a weaker form of upgrading.

A similar argument applies to prescriptive legislation. Consumers operating in the neoclassical regime see little benefit from such prescription since it limits their well-informed choices. Consequently traditional neoclassical policy eschews efficiency standards. However this argument is weak for consumers in the retro-classical regime for two reasons. First this sector is the source of innovations that move down the innovation trajectory. .Since they are fuel rich the likelihood that they would be energy efficiency is only coincidental (low energy designs are after all quiet, and cool with high reliability). So while traditional government intervention seems concerned with improving conventional domestic heating, domestic air conditioning moves unregulated down the innovation trajectory. A more aggressive strategy would be to set standards, normalised for size, for 'upmarket' products that induced innovation in energy efficiency. The economic objective is to provide the forcing standard environment for quality R&D. Indeed this is the weakest element in many energy demand side policies – a failure to recognise innovation trajectories, and instead concentrate on immediate mass market innovations frequently in the innovation graveyards of C and D markets..

A comparable example of a technology trajectory is to be found in vehicle emissions legislation. Three-way catalyst technology was introduced across the US vehicle fleet in the 1970's. The technology affected vehicle performance. In contrast EU legislation a few years later essentially mandated 3-catalyst way technology only for the large car market. The reasons for banding vehicles related to other issues, but the effect was that 3-way catalyst was a signifier of 'superior vehicle quality'. Some manufacturers even labelled the marque 'Cat' with the resonance with the vehicle narrative. Manufacturers had the opportunity to refine the technology at the top end of the range before, in subsequent revisions of the standard, the technology was required for smaller vehicles. When applied it both worked and was desirable.

4 Narratives and predictions

In this final section I look at the use of narrative theories in prediction and especially in resolving a paradox in long range emissions forecasting. Let me first explain the paradox. The IPCC has published a wide range of emissions scenarios that run well out to 2100. Some scenarios are described as 'business as usual', and other scenarios as the result of positive policies by government to abate emissions. The projection methodology is traceable to neoclassical capital growth theory. Now consider the situation in around 2030 in the context of the more draconian strategies. . On present projections the climate change experienced then will be self-evident. It would be well above the levels of change predicted by those with contrarian explanations. The models used to interpret the anthropogenic component of this change will be identical to those used to reliably forecast next season's weather. That is a tall order, but fully consistent with the endogenous rate of technological innovation assumed in the growth model. So the 2030 consumer market has no uncertainty about climate change. But surely if the expected view in 2030 is consistent with assuming electorates endorse draconian action, then can it still be consistent to retain the same elasticities (i.e. utility spaces) and available products over the period of the projection? It is as if it were only draconian legislation that holds us all back from buying a few useful household slaves on the internet. Narratives have simply moved on from the 18th century where a negro slave or two was an indicator of wealth and worldliness.

What we would expect from any narrative theory is that new products would mould their 'story' to the emerging narrative that conspicuous carbon dioxide emissions were a social 'bad'. The consumer is almost passive in all this. Firms vying for market share try to rewrite the contemporary narrative. When consumers began to eschew fur coats because of ugly images of fur hunting, consumers did not get cold or avoid going out. Other firms were only too pleased to promote equally expensive winter wear (too pleased indeed since fur coats had an irritating habit of being capital rather than consumption goods!). I will try and show how narratives help us guess where the market would go.

I need make no assumption that the need for narrative about esteem and security and so on have disappeared in 2030. They seem to have been durable over the last 2000 years, and make the plays of Shakespeare intelligible even if signifiers like "cross gartering" need erudite footnotes. By the time of Adam Smith ('the last solar powered economist') land is a great signifier and country parks the most conspicuous of non-productive consumption. By the time of the recovery from the Great Depression conspicuous consumption, Great Gatsby -style, is through conspicuous streams of waste not redundant capital. So while the world by 2030 could have slipped through a fundamental revision of values I need not give such a proposition high probability. I assume only that consumption is low carbon principally when it needs to be conspicuous.

This incongruity is already evident in some markets related to energy consumption. For example the market penetration curve of double glazing when compared to loft or wall insulation is much steeper than a neoclassical argument would lead one to expect Indeed for many years neo-classically minded governments in the UK were minded not to encourage it. But double glazing is a conspicuous good compared with other building products. Similarly when 'green' buildings face crisis in their construction cost it is the invisible low energy boilers that get substituted for poor performance systems, rather than the conspicuous PV panels on the roof. PV panels do of course have the potential to flow with the innovation trajectory. The technology has been perfected for industrial application where performance is premium (e.g. satellites!!). Their appearance lighting the Santa Barbara house pool would not signify poverty but independence of the capricious Californian power grid. The LED light is another example. Its principle attribute is its very long life, not its low cost and this has led to its widespread use in industrial applications. This in turn has given it entry to premium markets (it is used widely in modern passenger jets, while the fluorescent tube doggedly hangs on in public transport). Its progression into consumer markets is much more rapid than the compact fluorescent light bulb, for years marked as an 'economy' measure. It is thus feasible to project penetration curves for these technologies.

The example of the private car has been noted many times in this lecture, as an ideal model of the technology trajectory. The increasing 'electrification' of the engineering follows just this trajectory from F1 vehicles to the humble small car. But it is quite possible that another card will come into play. Apart from the loss of face of taking public transport because the traveller is conspicuously not wealthy enough to pay a congestion charge or important enough for the certainty of travel to be an issue or riche enough not to worry about personal security, private vehicles are associated with convenience, and convenience is a virtue for the travelling 'rich'. But in periods of difficult supply conditions (e.g. in the UK during the tanker driver's dispute) oil powered cars have little status. Taking a gas guzzler into a queue for petrol may not be a way to secure esteem. It is outside the scope of this lecture to explore the oil security issue over the next 30 years. But on the assumption that even if the decade average global consumption is as conventionally forecast the supply is not smooth, it would seem that we should expect top of the range vehicles using non-oil based technology that diversifies the transport fuel vector. One manufacturer, no doubt for a wider coincidence of reasons, has introduced one such car already powered by hydrogen. Notably 'battery powered vehicles' are invariably compared with 'milk floats', but electric diesel hybrids, (which might be seen as underpowered batteries!) driven by film stars are not. Again more intelligently designed interventions by governments could help this trajectory along (CAFÉ and the EU voluntary agreement average across the parc without differentiation or weighting) the narrative theory perceives an opening for the market to carry much more of the change. Non-oil based vehicles would be both conspicuously low emission and conspicuously convenient. At the top of the market 'cost-effectiveness' is just not the issue.

5 Conclusions

This lecture began by revisiting the consumer theory often used in public sector economics. It would be possible to waste much rhetorical energy on theological debate, but I have been at pains to point out that the outcome of such a debate makes little difference to the daily work of applied economists. Nor was there any pretension to provide an analytically tractable modification to General Equilibrium Theory. Nor have I suggested that current policies are wrong. Rather the argument runs that elements of consumer economics that are submerged in work-a-day applied economics and ignored in the simplifications of General Equilibrium Theory add new and effective policy options. As a matter of mere algebra I can always switch between a narrative theory and a maximisation theory and back again. Narrative theories are just more natural as their widespread use in classical economics and modern behavioural science shows. In one sense the classes of ‘retro-classical’ economic arguments used here are a theory of the ‘rich’ that complement ‘neoclassical arguments as a theory of the ‘poor’,

The core of the policy argument is that Government interventions suggested by retro-classical theory upstream of the technology trajectory thwart upward creep in the energy consequences of later consumer durable purchasing decisions by the wider market. This upstream sector is much more likely to be at the premium end of the market where energy costs are a small consideration. The implication is that changes in purchases by the bulk of consumers, which is where existing government interventions focus, would in the long term be carried through by firms rather than governments as they attempt to emulate aspirations. On the most draconian of climate change scenarios there is a much greater likelihood of the market flipping ahead of government intervention than might be supposed on conventional analysis. The actual market complexion of energy saving goods would not necessarily follow a conventional cost benefit analysis, since the original pressure for positional attributes for the good would not necessarily have gone away. All in all the future energy demand could be very different from today in its nature, but government may find that it does not have to do all of the hard work to bring this change about.