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At the final Beesley lecture of this year's series, on reducing the costs of lowering carbon emissions[2], an old chestnut of an economic argument was raised, to the effect that UK shale gas production, even if it starts to happen in the relatively near future, "will not affect UK prices for many years to come *because it will not be marginal supply* for a long time yet."

The context here is an interesting one: the main thesis of the lecture was that current policies of providing subsidies to favoured technologies had foreclosing or excluding effect on alternative approaches to decarbonisation, and that part of the exclusionary effect occurred by way of attempts to prevent the development of lines of analysis and reasoning that threatened the privileged policy narratives. Shale gas production on a significant scale is clearly one of the alternatives to the current, very heavy emphasis on technologies labelled 'renewables'; and the proposition that it would have negligible effects on UK prices for many years to come is clearly one that helps buttress the dominant, privileged, policy narrative (built around renewables in general, and the large scale roll out of off-shore wind facilities in particular, supplemented by nuclear power). Conversely, a view that shale gas production could put downward pressure on prices in the nearer term would make it much more difficult to sustain the arguments against its relatively rapid development.

What impact shale gas will have on prices is, of course, ultimately an empirical question. US developments indicate that there have already been substantial price effects in North American, and, as was pointed out in the discussion following the Beesley lecture, that in turn has led to reductions in world coal prices: US coal production, displaced by shale gas output in the US market, has come on to international markets, depressing coal prices elsewhere. Since coal is an economic substitute for gas – meaning that a fall in coal prices can be expected to reduce the demand for gas – the consequent reductions in demand for gas[3] can already be expected to be having at least some effect on gas prices across the globe. Moreover, US shale gas output is beginning to have more significant, direct impacts on world gas prices via its export in the form of Liquefied Natural Gas (LNG), including, over the course of the next few years, to the UK.

The point being made at the Beesley lecture was, however, a narrower one, and was based upon a fallacy that has appeared before in UK policy assessment. In 2000, the then Monopolies and Mergers Commission (MMC) was required to reach a view on an Ofgem proposal to introduce a Market Abuse Licence Condition for major electricity generating

[1] I am grateful to Nigel Evans and Steve Smith for comments on a first draft of this note. The usual disclaimer applies

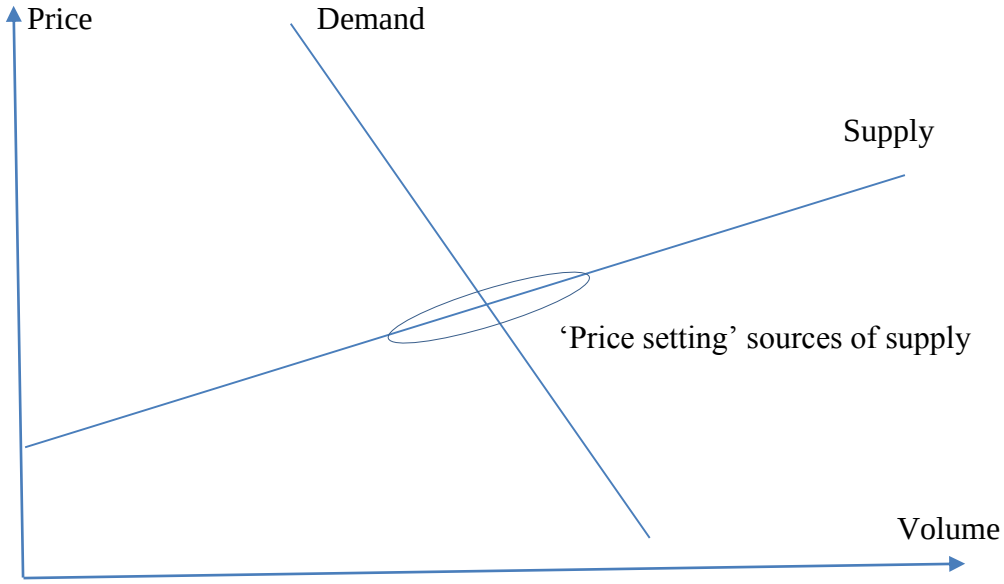
[2] George Yarrow, *Alternatives to Wooden Headedness: (very) much less costly ways of regulating carbon emissions*, Institute of Directors, London, 23 November 2013. Presentation slides available at www.rpieurope.org

[3] Relative to a counterfactual in which US shale gas reserves had not been exploited on a significant scale.

companies. One of the arguments made at the time – which appears to have carried weight with the MMC – was that such a condition was redundant for nuclear generators because the relevant output (from nuclear facilities) was never 'marginal' on the system, i.e. it was never on its own sufficient to meet all demand, even in low demand periods such as summer nights. The argument was linked to a number of ancillary propositions – such as, for example, that there was a relevant market for base-load electricity that was separate from the markets for other load shapes – and to a standard use of language (among electricity sector analysts at that time) which referred to electricity generating units close to the margin as 'price-setting' plant, a terminology that can easily mislead.

At a basic level, the notion that increased supply will have no effect on price is a counter-intuitive one, and it can be conjectured that it may have developed from a half-understood, textbook picture of supply and demand such as that shown in Figure 1 below. The supply curve in this picture is built up from the economic / avoidable costs of each the various sources of production[4]. Costs vary from power station to power station, and from gas field to gas field, and the supply curve is derived from the stack of alternatives available, starting with lower cost sources at low output requirement levels and adding increasingly higher cost sources as output requirements rise. The ringed region of the supply curve shows the costs of those sources that might potentially be marginal in the relevant period

Figure 1



[4] For current purposes, it is not necessary to engage with the complexities of differences in economic costs according to the time period over which costs are measured.

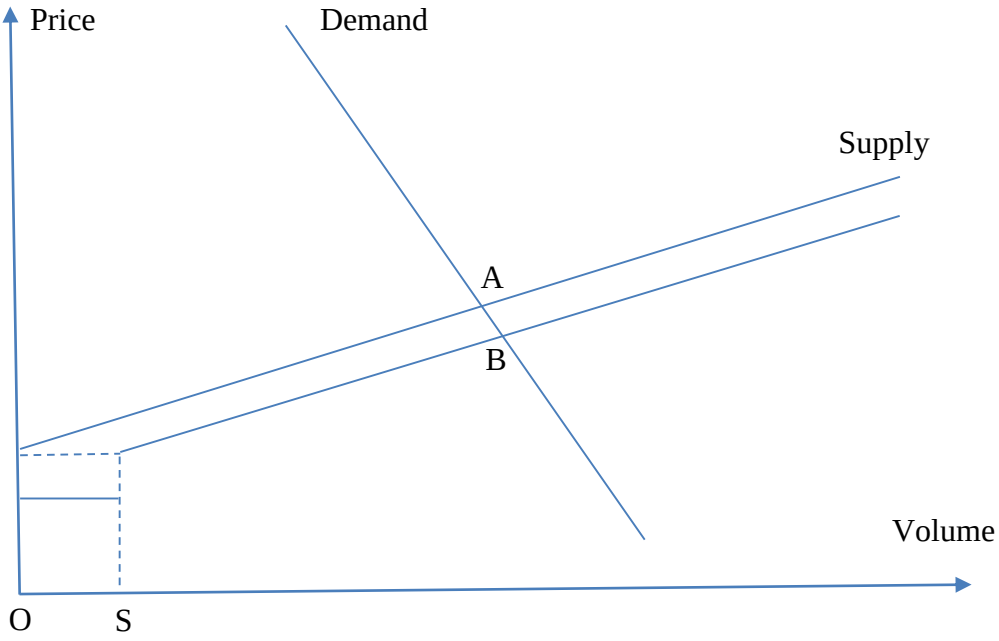
when demand is subject to a degree of uncertainty (which it always is *ex ante*). Under the England and Wales electricity pooling arrangements, these would be the potential sources of output designated as price-setting plant.

That the proposition of interest – *output from non-marginal sources of supply can have no effect on prices* – can only be a fallacy is obvious from the fact that, if, under the old linguistic usage, all plant other than price-setting plant had for some or other reason fallen off the electric system, the consequence would have been a failure to maintain system balance, leading to loss of load and, in effect, to *infinite or unaffordably prices* (a customer could not, in these circumstances, obtain supply at any finite or affordable price).

The point that is missed in the fallacious reasoning, is that, whilst it is true that price is determined by the intersection of demand and supply curves, and hence that equilibrium price is equal to the cost of the marginal source of supply, *the supply source that is marginal in any given state of demand is a function of output from non-marginal sources.* Since costs vary across supply sources, when new, low-cost supplies come on to the market *they tend to displace the highest-cost sources*. Thus, somewhat lower-cost sources of supply become marginal, and the market price is lower in consequence.

The process is illustrated in Figure 2, which shows the price impact of a tranche of supply from a new, low-cost source such as shale gas, equal to OS in the diagram. Although the new supplies are very from marginal, and although it may take many year for them to

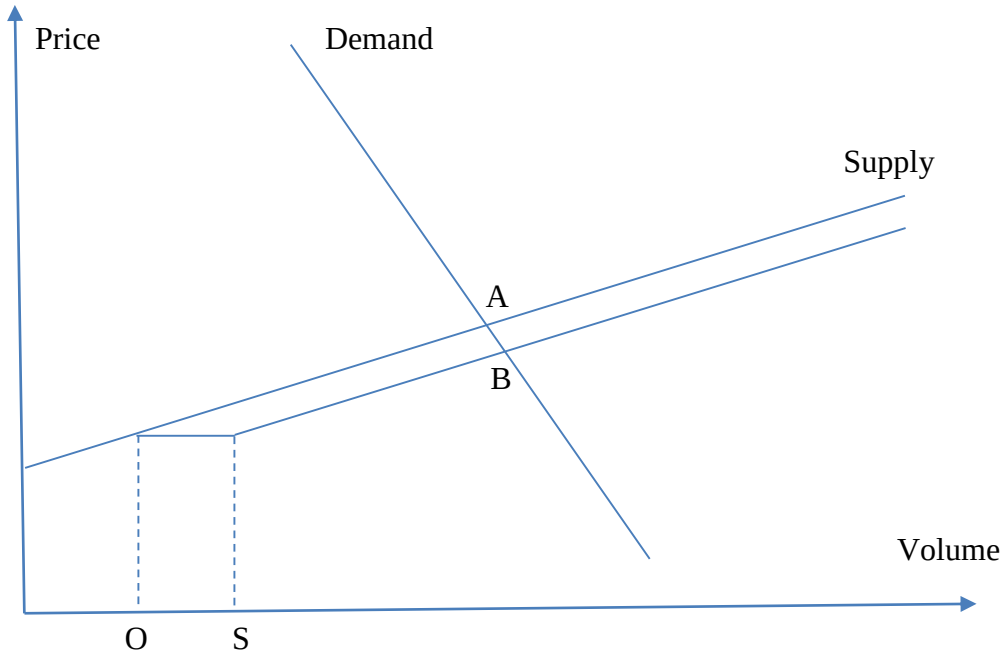
Figure 2



reach such a position, they have an immediate effect on the supply curve, which is shifted outwards (to the right).[5] As shown, the market equilibrium moves from A to B, involving a mixture of volume expansion and demand reduction. The larger is the volume of the new, low-cost supplies the greater are the price reductions. If volumes from the new source of supply increase steadily over time, then, other things equal, there will be a sustained downward movement in prices.

The story is much the same if the new sources of supply are more expensive than some existing sources, as could be the case, for example, because of geological and regulatory compliance issues in the UK. In this case, there will be an effect on the supply curve of the type shown in Figure 3. It can be seen that the price effect, resulting from the displacement of the currently highest cost sources of supply, persists.

Figure 3



In the case of UK production of shale gas it can be noted that one of the existing, more marginal sources of prospective supply that could be displaced by domestic supplies is shale gas imported from the US in the form of LNG. Such imports involve substantial costs associated with liquefaction, with transportation of liquefied gas, and with re-gasification, all of which activities could be avoided by domestic production.

Figures 2 and 3 aid in understanding why the notion of price-setting plant or, more generally, price-setting source of supply, is potentially misleading, particularly when used

[5] The new supply curve comprises the solid, horizontal line between O and S (reflecting the cost of the new source, here assumed constant), and the old supply curve displaced by an amount OS to the right.

in a regulatory context where alternative (to competitive) forms of price determination might be familiar. When price is set by a regulator, the traditional methods rely heavily on cost assessments to 'set' or to determine prices. In a competitive market, in contrast, prices are co-determined or 'co-set' by a mix of supply-side and demand-side factors. Those (many) factors include non-marginal supplies such as shale gas output in the early stages of its market entry; and what is and what is not a marginal source of supply is *endogenous* to the system, not a given.

The confusion is related to another, common misunderstanding of the economics, based upon an over-expansive interpretation of the condition that price is equal to marginal cost in *perfectly* competitive markets. Whereas a statement such as "quantity demanded is an decreasing function of price" is a behavioural proposition, implying a direction of causality (if prices fall, quantity demanded will increase), the statement that "price is equal to marginal cost" is an equilibrium condition, implying no such directionality. These are two different types of statement, which should not be confused.

Returning to the diagrams, limited experimentation with the shapes of the demand and supply curves indicates that, as might be taught in a first economics course, the size of the price effects for any given increment in output from low-cost sources is a function of the supply and demand elasticities in the neighbourhood of the market equilibrium.[6] High elasticities make for small price effects, low elasticities make for high price effects; and it is to these two elasticities, in conjunction with the volume of new, low-cost supplies, that empirical work should be directed when seeking to get a sense of the quantitative significance of the potential price effects.

Finally, two further points might be noted. First, in a wholesale electricity market that (a) relies to a significant extent on gas-fired generation and (b) is free from the distorting effects of policy interventions other than those associated with general policy instruments (such as a cap-and-trade system for carbon emissions or a carbon tax), the development of shale gas can be expected to put downward pressure on electricity prices, as well as on gas prices. Thus, falling gas prices will shift wholesale electricity supply curves outwards by reducing generating costs – and in this case a fall in gas prices might directly affect the costs of *existing* marginal and near marginal plant – putting sustained, downward pressure on electricity prices. Again, the process starts as soon as the low-cost gas starts coming to market.

Second, the general picture is complicated to some extent by the existence of long-term contracts in gas markets, and the price dynamics can be expected to depend upon the terms of contracts in place. To illustrate, where contract prices are indexed to spot gas prices – a practice much more prevalent in the UK than in continental Europe – the price impacts might be relatively rapid. New, low cost-supplies could have quite substantial spot price effects, since they would likely account for a much higher share of spot purchases by

[6] Strictly speaking it is the slopes of the demand and supply curves that matter, but if assessments are limited to a narrowly defined region of price-quantity space – e.g. the neighbourhood of the equilibrium – the more widely useful concepts of supply and demand elasticities are not misleading.

downstream gas suppliers than of total purchases, and these spot price effects would be quickly and automatically translated into lower contract prices. (This, of course, is one reason why shale gas developments might be unwelcome news for incumbent gas producers.)

The translation of downward pricing pressure from spot markets to contract markets can be expected to be slower when gas contracts are at fixed prices or are indexed chiefly to oil prices. Given the prevalence of oil indexation in Europe, it is to be expected, therefore, that the price effects of shale gas development in the UK would be slowed, but not eliminated, by the interconnection of the UK and continental European gas pipeline systems. However, during the course of the slower adjustment process that this would entail domestic consumers of gas and electricity would potentially enjoy lower prices than elsewhere in the EU. Since a substantial fraction of total demand is accounted for by commercial and industrial consumption of gas and electricity, the UK could enjoy an across-the-board competitive advantage for the duration of the transition. Past history indicates, however, that such transitions can sometimes occur relatively quickly, the UK 'gas bubble' of the 1990s being a case in point.