WHAT FUTURE FOR THE CAR?

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During the seventies, increasing concern for the ability of our planet to sustain the growth in human population without a fall in the standard of living, let alone to avoid the scourges of famine, pestilence or war, has led to questioning about the manner in which we are using up our non-renewable resources. Foremost among these concerns is the transport sector, which currently uses roundly 15 per cent of the resources in the most developed countries, and is a substantial consumer of one of the most precious resources, oil. Whilst these most developed countries have mostly slackened in their growth of car ownership, we are seeing a number of less developed countries entering the phase of rapid growth as their economies take off in turn. The competition for oil with thus intensify, together with other resources used in cars, and a number of developments are thus likely to occur as a result. This paper is an attempt to explore some of these potential developments, and to suggest ways in which government policy may help or hinder the process of change.

Firstly, it cannot be contraverted that the kind of personal transportation offered by the car is far superior to that which can be offered by any form of public transport over short distances. Bus trips, for example, are typically 3 km long in the UK, and for this distance take three times as long as the car. Since people seem to travel about the same total average time per day, irrespective of whether they travel by bus or car, they will typically make three times as many car trips as bus trips in a day, and presumably benefit by so doing. For longer distances, rail and air transport offer superior speeds, but because of travel time constraints will only be used at best for a minority of purposes and journeys (except for journeys in the course of work). Personal individual transport units are thus likely to continue to grow in numbers and supercede public transport, especially road transport.

Such personal individual transport units do not, however, have to be the petrol-fuelled internal-combustion-engine-driven cars as we know them today. Hutcheson (1982) provides a good discussion of why the internal combustion engine is so superior to all other known engines at the moment, in terms of its specific power/specific energy diagram. Nevertheless, the fuel does not have to be petrol, but can indeed be other hydro-carbons, such as alcohol. The advantages of such fuels are that they are renewable, coming from fermentation processes of basic starches and sugars - and the human race has much experience in their production. It must be admitted that the amount of land required to grow the basic feedstock is high, but one does not have to produce cars of the same characteristics as those of today. Hutcheson in fact sees alcohols as the very long-term ultimate fuel for cars.

Gray and Von Hippel (1981) on the other hand, from a US context rather than a UK, describe the measures that could be taken to improve the specific consumption of the internal combustion engine using petrol, in terms of technical changes. They estimate that with currently available technology it is possible to produce an average specific consumption of the entire (US)

population of cars of 60 mpg (4½ 1/100 km). With advanced technology 90 mpg 3 1/100 km) might be achievable. They also believe that "it is necessary for the [US] Government to set before the industry long-term goals for improving automobile fuel economy in the post 1985 period" and, supporting our own thesis to be developed later, that "the [US] Government should also assure the automobile industry that market forces will support the mandatory fuel-economy improvements that are desired by committing itself to two measures". These two measures are essentially a tax penalty on manufacturers for producing cars whose consumption is above the established goal, and a tax on petrol in order to ensure consumers have a price-incentive to buy the efficient cars. They also seem to feel that alcohol-fuelled engines provide the best long-term future.

Now, cars have a life-time which is typically around ten years, and therefore the entire population of cars is effectively replaced each decade. We might have expected therefore that substantial progress towards such higher efficiency might have been made in the ten years since the first oil crisis of 1973 made us aware of the problem of oil as a long-term resource.

This is in contrast to other prime users of energy, such as the space heating/cooling in housing, where one would expect the lifetimes of the equipment to be considerably longer and thus there to be more inertia in the system, preventing a reaction to a change in fuel prices.

Moreover a study before the first oil crisis, by Thomson in 1972, clearly shows that petrol prices affect the specific efficiency of the cars actually used in each country. Tanner (1983), in a careful analysis of a large number of countries showed that the cross-section petrol price elasticities in tonnes of petrol per car per year (his Table 7) has remained near -1 for nearly two decades. Some other studies do not give this result for reasons we will discuss shortly.

Bates and Roberts (1981) show also that governments have a whole battery of fiscal and regulatory measures available to affect the energy efficiency of cars. Such measures include, besides the fiscal policies such as taxation, capital allowances and licence fees, policies on safety such as accident insurance, accident prevention and the standard of maintenance of the car, and regulatory policies on environmental impact such as emission and noise standards. Why then have we not seen the potential for rapid change actualised in the kinds of cars now being bought? What are the pressures resisting such change?

The reason is in fact very simple. Any change in policy towards the car affects two sets of people, the buyers and sellers of cars, plus those who are not changing their current car or cars. The distribution of time that people keep a car before resale has a mean value of about three years normally, which varies from country to country. The distribution has a very wide spread of values and can in principle alter rapidly as people keep their cars longer to reduce their capital outlay in the short-run (not the long run as depreciation stil continues) or alternatively change their car earlier than usual to avoid a potential future burden (like an increase in tax). Such changes in the length of time cars are kept will, however, have offsetting effects in the market place, as sellers can only sell their car to a willing buyer. For example, if petrol prices rise so that the less-efficient cars are less in demand, their price will fall to the point where it is then not economic sense to sell them, and buy more efficient cars.

If petrol prices rise, the only change that can be made to the specific efficiency of the car population as a whole is in the new cars bought and the old cars scrapped. This is quite a small change to the total efficiency.

As we saw after the onset of the first oil crisis, in the UK in 1973, after real petrol prices had been generally falling for the previous two decades, the new cars that were then being bought were much larger in size than those being scrapped, despite the fact that they were smaller than those bought the year before. The car population thus reflects the history of petrol prices, and the rates of change of price. A petrol price at a given moment cannot be correlated with the average specific efficiency as a whole but only that of new cars. This explains why many studies after Thomson have failed to find significance in petrol price/specific efficiency relationships.

After 1975, before the UK new car sizes could adjust fully to the new, higher petrol prices (given that new car purchasers are not typical of the car owning population - especially in the UK where 40 per cent of new car sales are registered in company names), the price of petrol, in real terms (i.e. discounted against the retail price index), began to fall again. It reached a new low in 1978. New car sizes thus rose again between 1975-1978. They started to fall again once more as petrol prices rose in 1979. Shaeffer (1983) gives the equivalent US data for this period.

The adjustment of new car sizes to the current petrol price appears not to be instantaneous, but requires a period at least as long as the average time between purchase and resale before full take-up is achieved. Presumably, it is only when people are faced with the new depreciation rates on the cars they bought that they realise the penalty of buying the less-efficient cars. This lag in behaviour also complicates studies which attempt to relate new car efficiencies to petrol prices (especially in the UK where the company sector is so important for new cars, and in which the process of decision-taking is different from that in a household). Household budget constraints also affect the response in the short-run as we shall discuss shortly.

Such studies as have been made seem to conclude that the long-run elasticity of the specific efficiency of new cars to petrol price is about -0.5 (Dix and Goodwin, 1982) using time-series analysis, but I would argue that the cross-sectional value of Thomson and Tanner (-1) is the more valid, because of the lag in response described above as a result of the length of time people keep cars before resale. Some other related aspects of the dynamics affecting car ownership are described in Goodwin and Mogridge (1981).

It is also possible from UK data to examine the changes in the depreciation rates of cars of different sizes (using size as a proxy for efficiency) and here too the reactions are not directly correlated with the price of petrol. In the period 1973-1975, the depreciation rates of large cars shot up by 15 per cent (from 20 per cent to 35 per cent) whilst that for small cars remained steady at just over 15 per cent (dealers' selling prices - which underestimate true depreciation rates because cars are increasingly sold privately as they get older). This was partly an over-reaction to the price rise, as further and continuing price rises were feared, and the UK did not then have her own oil supply in the North Sea. In 1979-1981, the change in depreciation rates of the larger cars was not so marked, partly because the rate had not fallen back to pre-1973 levels, although the price of petrol had, and partly because the North Sea oil was then in production and UK consumers presumably felt more secure about supplies.

On the other hand, depreciation rates cannot be looked at in isolation from the other costs of running a car, since the point of balance which fixes

the price of a given car also takes into account the cost of running the car, as well as the fixed costs of ownership. This can be seen very clearly if we examine household budgets, as was done in Mogridge (1977, 1983). If we examine only those households which are car-owning, then the proportion of their total expenditure which is spent on cars is remarkably constant through time despite large changes in prices. More specifically, when petrol prices rose in 1973-1975 in the UK, the proportion spent on car running costs increased and that spent on car ownership decreased by the same amount to a first approximation. See also Shaeffer (1983) for a recent analysis of the US data.

As noted earlier, if petrol prices rise, the car population cannot change much in the short-run and so the only variation is in the quantity of distance travelled by car. This has proved to be very inelastic in the short-run, with an elasticity generally estimated at around -0.15 (Dix and Goodwin, 1982). Work trips are hardly affected at all, whereas social and recreational travel, and evening and week-end travel is cut back (with elasticities generally of about -0.5). Very little switching of travel to public transport modes seems to occur (not surprisingly given the cost penalty in time) and very little car sharing and rearrangement of journey patterns (though some government effort has been made to encourage them, particularly in the US).

Given such a reaction, then obviously more money has to be spent on travel than before, and this has to come from that spent on car purchase, since it does not appear to come in general from elsewhere in the household budget. Such an increase in cost for the same output, travel distance, is by definition inflationary. It is doubly so when one considers the effect on car producers, who now have a reduced demand for new cars (since all money spent on car purchase ends up as spent on new cars, because all other transactions are merely transfer payments).

Producers will have the same overheads as before, and a reduced demand, so there is pressure to increase new car prices or to cut overheads. Cutting overheads, by shedding labour etc, has repercussions all through the economy as the car industry is such a large part of the economy of the industrial nations. The effects on producers are thus both inflationary and recessionary. If the petrol price rises are sudden and unexpected, and especially if they are large, this can have very serious effects on the whole operation of the economy. We have seen this process at work twice in the last decade in the UK and in most of the industrial nations, some more affected than others.

Further petrol price rises would be bitterly resisted by many who see only the short-run inflationary consequences, and indeed many who would also see that the cut-back in demand for cars would also prevent the producers from investing in the very machinery needed to produce more efficient cars. It seems to be a dilemma. We need a thriving car industry in order to get the investment in the new, efficient cars, but we can only have a thriving industry if petrol prices are reduced. But then people will not want to buy the efficient cars but will spend the extra money on size, comfort, etc.

This dilemma is in fact false and stems from the lack of appreciation of the difference between short-run and long-run behaviour. It is quite true that large and unexpected price rises in petrol are both inflationary and recessionary. I believe, however, that a predetermined, slow price rise of say 5 per cent per annum or even more, using taxation to offset rises and falls in the basic price of production, is a necessary adjunct to any policy to improve the efficiency of the car population by technical means. Such a slow price rise, announced beforehand and agreed by all the major interest groups, producers, labour and users, is not inflationary, because the car

population can adjust rapidly enough to increase its efficiency at a slow rate of this kind, and thus not increase the amount of money spent on petrol.

Any price rise in petrol will naturally disadvantage those who have bought larger, less-efficient cars. This cannot be helped. Indeed, governments may well find that there is sufficient realisation of the necessity to conserve oil stocks that the possession of a large, less-efficient car may well come to seem anti-social (just as the production of a large family is thought to be anti-social in some cultures).

With such a slow and continuous price rise forcing up the efficiency of cars, a number of consequences follow. First and foremost, the management of the economies of the industrial nations will be freed from the kind of stagflation experienced in the last decade - at least from this source. Manufacturers will be able to plan their production lines with more confidence about demand, both in numbers and kinds of cars required. The increase in price via taxation will enable governments, if they so desire, to spend their increased income at the beginning on supporting either the reinvestment programmes of the manufacturers or public transport, although it should be noted that the long-run government income from higher taxes will not increase as consumption is reduced with more efficient cars. Evidence on the annual distance travelled by cars from different countries, is, I suggest, not yet conclusive as to whether petrol price as such affects it, but I suspect not - other factors such as the degree of urban travel, average speeds on roads, the degree of second car and multiple car ownership etc being more important in the long-run. I would not expect, therefore, the amount of travel to be affected. Tanner (1983) has made an extensive study of the data on annual distance travelled from many countries and its relationship to petrol price over the last two decades, and concludes that speed is probably very important, and by implication the quantity of the road network.

It is particularly to be regretted that much government work on energy consumption at present has in my view been misled by consideration of the short-term elasticities of consumption. Examples from the UK are the Departments of the Environment and Transport (1981) forecast of energy demand, and that of the Transport and Road Research Laboratory (Tanner, 1981) of car ownership and annual distance travelled. The prior study makes no acknowledgement that the long-run is any different from the short-run, though its model structure, with lagged variables, implicitly recognises this. Likewise Tanner's work here is explicitly short-run, and the long-run elasticities derived from his model are not explicitly related to other data, as is now possible with his later work, but are simply related to the short-run elasticities by lagging.

Secondly, with the reduction in consumption of petrol and thus the conservation of oil stocks, we will have longer to plan our transition to a renewable fuel economy. This will also be stimulated by the increase in price of petrol, which will make the search for efficient alternatives more attractive. There is also the advantage that the industrialising world, where most of the new growth in car ownership will occur in the next few decades, will be able to see that we too care about the use of our planet's limited resources, and are not going to continue the profligate consumption of the past. We have also to admit that the tropics and subtropics are the areas where most of the renewable fuels may be grown, as the temperate lattitudes are too poor in solar energy for the cultivation to be worthwhile, and that therefore it is in our own interests to encourage the development of this part of our world.

It will require considerable investment both to boost the production of food and the production of hydro-carbons for energy. Brazil is a particularly good current example of the pioneering problems to be faced in such a transition. Whilst there is no doubt a place for liquefaction of hydro-carbons from coal, I do not expect this source to play a major role in the future, especially as this source too is non-renewable and can probably be better used elsewhere as chemical feedstock. In this, I am at variance with, for example, Willoughby (1980). We have, however, all now seen the problems involved in extracting hydro-carbons from coal, and from the tar and oil shales.

Together with the policy of forcing up the price of petrol in order to encourage the production and use of more efficient petrol engines, governments must also align some of their other policies with it. Taxes on ownership, whether a purchase tax on the vehicle or an annual tax on the ownership, should be reduced if above general levels of taxation as they often are, so that more of the tax burden is on use rather than on ownership. This may well ease the transition to a steadily rising petrol price, as well as encouraging efficiency in consumption. Likewise subsidies on ownership, such as company car tax allowances, should be reduced to levels which are justified in terms of actual company use, rather than the boost to salaries which the subsidy often becomes, as in the UK. Such a reduction will be particularly effective in lowering the proportion of the larger engine-sized cars in the UK.

Many of the other measures discussed by Willoughby (1980) at the last conference affect car use rather than the types of cars bought, and thus their efficiency, but I can add my voice to his plea for more economic rationale behind the allocation of our scarce resources of space in and between cities, using the pricing mechanism properly. This argument is also supported by Lay (1983) at this conference, who describes the impact micro-electronics might make in pricing mechanisms. The first such application seems likely to be in Hong Kong.

I would, however, like to mention some further points which could affect the way we view our personal transport units profoundly. The first affects safety. At present, the horrific death and injury toll on our roads is not properly subject to the pricing mechanism, as we have taken the view that victims of road accidents must have proper care irrespective of their means. If, however, we took the view that road users as a whole should pay for that part of society's medical costs due entirely to road accidents, then the insurance premiums that would impose upon car users would surely lead to rapid reconsideration of the safety of our vehicles. At the moment, with such medical expenses entirely separate from the running costs of a car, there is no financial pressure to redesign cars. Radical solutions, such as those of Groeger (1980), may have more chance of exploitation if there were such pressure.

More profoundly, it seems absurd to me that the basic motive power of our cars should be a reciprocating engine driving a rotating assembly to produce linear motion. Rotatory engines are not the answer, as they suffer from frictional losses. Linear motors must be the eventual answer, using electro-magnetic motors. We are only at the beginning of the technology, mainly in public transport applications, together with such devices as the mass-driver for shifting freight. Such a radical redesign of personal transport units, picking power up from the road itself, would gain impetus if the pollutants from the hydro-carbon-burning engines became recognised as a severe health problem in cities and a high price were imposed on the use of such engines in cities as a result. I do not, however, see much future for 'power roads', as they must be called, beyond the cities and the major links between cities.

Hydro-carbon engines will continue to provide the main means of transport in rural areas. An interesting exploration of some of the consequences of the development of such a technology is given in O'Neill's '2081' (1981).

One interesting point to note is that with complete automation of the control of the personal transport unit as would be possible on a power road, the distinction between public and private transport in so far as the passenger is concerned vanishes, as the person being transported no longer would need to be able to control the vehicle, merely to tell it where to go. Whether we choose to develop this technology sooner or later probably depends on our view of the pollutants from burning hydro-carbons, rather than of the availability of hydro-carbons.

To conclude, it seems to me that if we take a view: that the car ownership levels in the world are going to rise rapidly as industrialisation spreads; that the oil resources that we have should be used in as efficient manner as possible; that we should aim at avoiding the crises caused by rapid changes in price of oil (with all the inflationary and recessionary consequences); that we should aim at encouraging the development of alternative renewable hydro-carbon fuels; that we should aim at encouraging much safer personal transport units; that we should aim at reducing hydro-carbon pollutants; then:

(1) we should adjust our taxation and subsidy policies so that more tax is placed on use and less on ownership,

(2) we should aim at a slow but continuous rate of rise in the pump price of petrol,

(3) we should develop research programmes into other hydro-carbon fuels and offer alternative facilities at petrol stations,

(4) we should alter the insurance basis of medical care for road accidents, and

(5) we should start building more linear motor public transport systems to get experience in 'power roads' in order to replace the internal combustion engine in cities.

All these policies are government policies. It is up to us to choose how we want the development of the future of the car to proceed. The future is in our hands.

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