CAN PEOPLE RESPOND TO COMPLEX PRICING SIGNALS?

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Abstract

This paper reports and extends the findings of an investigation conducted on behalf of the UK Department for Transport against the background of proposals to introduce a national road charging scheme whereby drivers might be charged according to the distance travelled on congested roads. It addresses a problem inherent in any congestion charging scheme; namely that the theoretically optimum, first-best, pricing structure might be so complicated and dynamically variable that it would be unreasonable to expect road users to predict, let alone respond to, the prices on any given road at any given time – and hence that a better overall result might be achieved with a simpler pricing structure.

The project brief required us to consider the extent to which the public could cope with, and respond to, pricing structures such as distance-based charges varying by degree of congestion, time of day and type of road. Existing studies of road pricing schemes and tolls were reviewed to assess what relevant information and evidence already exists. Evidence from other transport modes and other industries (notably telecommunications) was examined and its transferability assessed. The evidence from case studies was evaluated in the light of theories about human decision making and information-processing abilities.

Our main conclusions were that people have a strong preference for simple tariffs but that they are able to respond to quite complex tariffs provided that the tariff has a clear and logical structure. However, people's difficulties in estimating distance will severely limit the accuracy of their estimates of distance-based charges and their response to complex pricing signals will be influenced by their attitude to the fairness of the charge. These conclusions are summarised in a general model of response to complex prices. The paper concludes by considering the implications that this has for the design and performance of road pricing schemes.

1. INTRODUCTION

1.1 Background

The economic efficiency case for the introduction of road charges in general and congestion charges in particular, is well known and rarely disputed (Pigou, 1920). The argument is based on the premise that, using pricing signals which reflect the full social costs attributable to the marginal user of each facility, travellers can be persuaded to alter their behaviour in such a way as to maximise net social welfare. The behavioural responses, such as

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re-routeing, rescheduling, changing mode or cancelling the trip, would be voluntary and each individual would be encouraged to react as they see fit in the light of the prices being charged. This first-best outcome would require prices to vary over time and space so as to reflect variations in the amount of capacity and, if environmental externalities are being considered, variations in the impact of the marginal traveller in different locations and under different meteorological conditions. Even if we restrict our consideration to the road sector we will find that the prices should, in theory, vary according to vehicle type and driving style, should vary from link to link and should change over time in response to ambient conditions.

For many years first-best pricing remained a theoretical concept because its requirements for real-time system monitoring, short term forecasting and advanced telecommunications were beyond the then state of the art. However, the technical barriers are now being overcome and concept is re-emerging as a potentially important policy instrument. Indeed, the I15 and SR91 HOT lane projects and the Singapore Electronic Road Pricing Scheme have, in their different ways, already demonstrated the principle of demand management through dynamic pricing to considerable effect. However, despite the success of these and other pioneer projects, a question remains as to whether a theoretically optimal, fully dynamic, pricing regime could work in practice or whether the resulting price signals would be too complex for the motorists to understand and too variable for them to predict, thus making it impossible for them to respond in the desired, rational, manner.

If people are unable to respond effectively to theoretically optimal pricing signals it becomes important to establish the trade-off between pricing complexity and theoretical efficiency – to locate the degree of complexity which captures as much as possible of the theoretical benefit while remaining simple and stable enough for motorists to understand.

Recognising the potential benefits of road pricing, and in the light of the early results of the London Congestion Charging Scheme, the UK Government is contemplating the introduction of a national road pricing scheme (DfT, 2004). The importance of the trade-off between practicality and theoretical efficiency was raised during the preliminary research for such a scheme and the issue was seen by the UK Department for Transport (DfT) to be of sufficient importance to warrant an investigative research project seeking evidence on people's abilities to respond to complex pricing regimes.

1.2 The DfT Study

The project was conducted during the summer of 2004 by a team at the University of Leeds and its findings form the basis of this paper. The full report (Bonsall et al, 2004), amounting to some 60 pages, describes the study and its conclusions in some detail - what follows is necessarily only a summary.

The study included three main elements; assembly of relevant theory on peoples' ability to cope with complex information, collection of evidence on peoples' responses to complex pricing regimes, and drawing conclusions on the implications for the design and implementation of road pricing schemes. The study did not seek to collect new data but drew its evidence from published literature, 'grey' literature, and from expert commentary and opinion. Evidence was drawn from the transport sector where possible but considerable use

was made of evidence from other industries and sectors, notably the telecommunications sector, where complex or differentiated pricing is much more widespread. Where evidence was drawn from other sectors or countries, its transferability to a (UK) road pricing context was carefully considered.

The study involved upwards of 20 interviews with people with specialist knowledge of consumer response to complex pricing and a fairly comprehensive search of published literature covering studies of pricing within the utility and transport industries, studies of traveller behaviour, and research on human judgement and decision making. Seventy-six papers or reports were examined.

2. MAIN CONCLUSIONS FROM AVAILABLE EVIDENCE

2.1 Findings from Case Studies

Most, if not all, organisations responsible for the supply of services recognise that they can operate more efficiently if they can influence the pattern of demand to match their ability to supply the service. The use of price differentiation is an obvious means to achieve this end. Thus the use of peak premiums, or off-peak discounts, is long established in the electricity supply, telecommunications and public transport industries. As in the case of road pricing, theory would suggest that dynamic variations in price might be used to fine-tune the demand hour by hour and even minute by minute and, at least in the case of telecommunications, there is no technical reason why this should not be done. And yet, most pricing regimes are relatively simple and there are few, if any, examples of fully dynamic pricing. Indeed there is distinct trend, notably in the mobile phone and internet markets, towards customers being offered a completely unmetered service where a single lump-sum payment buys unlimited access at any time of day or night. Research (Nahata et al, 1999; Szabo,1999) suggests that the additional effort ("transaction cost") required to calculate prices may explain the popularity of fixed charges in lieu of usage pricing in a variety of markets (buffet meals, local telephone service in the US, flat fares throughout the New York City and Moscow subway systems, the Eurail pass, employer-provided family health care premiums that are independent of family size and amount consumed, Disneyland entry fees).

Decisions, such as that by AOL in the 1990s, to withdraw, or not to offer, fixed-price packages generally reflect operational problems caused by excessive peak-time consumption rather than an assessment that they are not popular with customers (Nahata et al, 1999; Odlyzko, 2001). Most suppliers of phone and internet services seem to have concluded that the ability to influence the pattern of demand over time can be an unaffordable luxury in a competitive market. Customers have a preference for simple price structures, or perhaps more accurately, for predictable expenditures, and market share is gained by those prepared to offer this.

The fact that a supplier may offer a wide range of tariff options is not necessarily inconsistent with their perception of a general preference for simple structures or predictable prices (AARP Research, 2004 ; Glazer et al, 2001) – rather it reflects the recognition that different types of user will prefer different price and service packages reflecting their personal pattern of consumption or their personal preference for fixed vesus variable prices. It is

interesting to note, however, that although some suppliers, particularly those who already have a large market share, emphasise in their marketing material that customers can choose the package that most suits them, others, particularly new entrants, offer a single simple tariff and emphasise this simplicity in their marketing material. These organisations have clearly recognised that customers are generally put off by the prospect of complex tariff structures.

Research within the telecommunications industries has suggested that customers are rarely very accurate in their estimate of call charges – often overestimating the price of a given call by up to a factor of three (Ovum, 1998). The research also reveals that many, if not most, customers are not sure which tariff would be most advantageous to them and that substantial minority have consciously chosen to opt for simplicity while recognising that they might not be getting the cheapest deal. This behaviour is again consistent with the notion that their choices are conditioned by search costs or transaction costs.

The public's general preference for simplicity and predictability of prices clearly limits the extent to which, in a competitive market such as telecommunication, suppliers can seek to use variable prices to influence the pattern of demand. But what of the transport sector where suppliers may have a virtual monopoly?

Two high-profile attempts to introduce variable pricing in the transport sector were defeated by adverse public opinion ; the capacity related discounts and advance booking incentives introduced by the German rail operator Deutsche Bahn in 2003, and the yield management pricing introduced by the French rail operator SNCF. The public objection was in each case based on the supposed unfairness of the new pricing regime and its failure to achieve its stated objectives (Seidel et al, 2004). It was suggested that the complexity of the pricing structure and uncertainty as to the availbility of tickets made made it difficult or impossible for would-be travellers to plan their journeys effectively. This complaint was broadened to include wider accusations of management failure (DB's supposed failure to operate its trains to timetable, and SNCF's problems with its booking software which led to spectacular own goals such as the widely publicised occasion on which a train was sent out empty because no tickets had been sold due to a glitch in the software).

The accusation of unfairness in these two cases is interesting because it has not featured in the discussion of peak pricing in the telecommunications or utilities industries. The concept of fairness does not seem to arise in the context of competitive markets, presumably because the public know that they can always change their supplier, but it is interesting that peak/off peak differentials in tariffs set by monopolistic suppliers of telecommunications or electricity services have not, apparently, let to accusations of unfairness. Perhaps the key question is whether the peak/off peak differential was perceived as an off-peak discount or a peak surcharge. In the two transport examples quoted about it seems that the differentiation was seen as an unfair penalty on those who were unable to book ahead or avoid using the peak rate services. This point has obvious implications for the introduction of congestion-related charges for road use.

It seems that, in the two rail examples quoted above, the accusation of unfairness was linked in some way to the question of complexity – that it was *unreasonable* to expect travellers to be able to work out when to travel, what type of ticket to purchase, or which service to use so as to avoid the perceived price penalties. This complaint about complexity is

echoed in the frequent criticism of rail ticket pricing in the UK (two thirds of the individual customers consulted recently as part of the Strategic Rail Authority's policy consultation on fare structures in the UK rail industry (SRA, 2003) said that fare complexity was a major problem). Some potential customers are apparently so concerned that they do not know how to secure the best deal, or avoid paying more than need to, that they avoid using the mode at all. Even though some of the behaviour may be misconstrued – it may be that the complexity of the fares is quoted, post hoc, as an excuse for not travelling by train, rather than being a real cause of the behaviour – it is clear that, for some people at least, the complexity of the fares makes the service less attractive than it otherwise would be. As in the case of the people who opt for simple telecommunication tariffs even when they could save money by doing otherwise, it seems that price complicity is adding a transaction cost (or disutility).

The apparent success of Virgin Trains' new ticket pricing policy is interesting in this context; customers have apparently welcomed the company's simplification of the fare structure by designating different services as peak or off peak and removing the former complication (which is still prevalent elsewhere in real pricing practice elsewhere in the UK) whereby the price of one leg of a journey depended on whether it was part of a return journey and, if so, when that return journey might be made.

The pricing of 'no frills' airline tickets is perhaps unique in the transport sector; the price of these tickets can change, without warning, at very short notice and the customer cannot be sure of the price until they purchase their ticket. Uncertainty of this sort might be thought inappropriate in the context of international travel and yet the public do not complain – indeed they seem happy with the thought that they are getting a good deal even if the price is not at its lowest. They seem to understand that the prices will be higher when the demand is high and that, unless they book well in advance and avoid the most popular services, they are unlikely to get the keenest prices. It appears that the negative connotations of uncertainty in prices is offset, or perhaps does not even apply, when the prices on offer are very attractive or when it is relatively easy, in this case via the internet, to access information about the current price of a given service.

The use of time-of-day pricing via off-peak fares is now the norm in the UK and is broadly accepted by passengers. However, the US experience of time-of-day pricing in the bus industry has been disappointing ; thirty-three US transit agencies introduced time of day pricing between 1970 and 1983 but, within a few years, only three of these had increased the differential, nineteen had allowed inflation to reduce the real value of the differential and eleven had been discontinued The main reasons for abandonment were, apparently (Cervero, 1984; Glazer et al, 2001), loss of revenue, fare disputes and failure to achieve the hoped-for shift in demand into the off-peak.

Thus far we have been drawing evidence from sectors other than private motoring but this sector does, of course, provide several examples worldwide of prices which vary over time and which some people might regard as unpredictable. Two interesting examples come from Singapore. The first is the road user charge levied electronically on vehicles using the central area (Keong, 2002). This charge varies by time of day and, with up to 12 separate charge bands between 0730 and 0930, is significantly more variable than that which applied during the previous, low-tech, area licensing scheme. Prior to its implementation there was a concern that this degree of variation would lead to confusion but, after a short

period during which people became accustomed to the fact that they would need to make sure their watches were showing the right time (!), the public response to the new system has been favourable. The public also seem to accept, perhaps even to welcome, the fact that the tariff rates and differentials are subject to periodic review in the light of changes in the pattern of congestion.

The other example from Singapore is the pricing of vehicle registration permits. The price of these permits, which effectively control the number of vehicles in use on Singapore's roads, reflects current supply and demand – the government determines the monthly supply (n) in the light of recent congestion data and people wanting a permit indicate the maximum they are prepared to pay – the actual price is then determined by the n^{th} highest bid. Thus a would-be car owner is faced with uncertainty as to whether he will get a permit at all and about the price he will have to pay. Despite these uncertainties the system has apparently been accepted by the Singaporeans as fair, logical and necessary. But one must of course wonder how it might be received in a country less used to strong government intervention in the citizens' day to day business.

The introduction of peak period surcharges on motorway tolls in France and the US provides some very interesting case studies. In 1996 the French motorway concessionaire, Cofiroute, introduced time-differentiated tolls on its motorways near Paris. The charge structure, which was designed to help spread the peak post-weekend flow of traffic back into Paris, included four different time bands between 1300 on Sundays and 1300 on Mondays. The system was not liked by the public who regarded it as unfair, ineffective and unnecessarily complicated. The accusation of complexity was made even though there were only four time bands. The scheme was withdrawn following public protests and a concern about behavioural responses on the feeder roads (excessive speeding by drivers seeking to get there before rate increases and cluttering up of toll plazas by drivers waiting for cheaper rate periods to begin).

The US experience of value pricing and HOT (High Occupancy Toll) lanes suggests that, if differential charges can yield more reliable journey times, the existence of time-varying charges is not a serious issue for individual motorists. Although there are several examples of peak period charges the two most interesting case studies are from California: the I-15 in San Diego and the SR91 in Orange County. The I-15 HOT lane was introduced in 1996 as two tidal toll lanes running alongside an existing toll-free highway. Since 1998 the tolls have been varied dynamically in the light of the expected level of congestion (being kept just high enough to dissuade sufficient users to ensure that the HOT lanes are kept congestion free). Current tolls are clearly posted so that people can make an informed choice before deciding to enter the lane and, although the toll might change again before the motorist has left the lane, the lower rate will be charged. Although the tariffs are variable (changing as often as every 6 minutes) and unpredictable from one day to the next, and although the aim of a congestion-free journey is not always achieved, the scheme has been welcomed by motorists and its success has led to it being extended to 4 lanes over 22 miles. The unpredictability of HOT lane charges (and the complexity of the underlying formula) have not attracted widespread opposition from private motorists since the scheme was launched. and it is suggested that the fact that the individual driver has a choice (to continue in the all-vehicle lane) has been an important factor in defusing criticism (Sullivan, 2001; Supernak et al, 2001; Wilbur Smith Associates, 2002; Eliasson and Lundberg, 2003 and Lindsey, 2003). The scheme organisers do, however, receive a lot of complaints

if the billing system makes a mistake or if the expected level of service in the HOT lane fails to be provided (e.g. if, due to a system failure, the price is set too low or if drivers have been charged and then see traffic flowing quite freely on the parallel freeway). Interestingly, there is evidence that drivers have come to associate high prices in the toll lanes with congestion on the parallel-running highway and that some drivers are choosing to use the toll lanes only when their price is *high*. Another interesting result is that, in contrast to private motorists, some businesses do not welcome the uncertainty of their monthly bill for HOT lane usage and express a preference for the previous system of fixed charge peak-period passes. This difference in attitude may reflect the fact that businesses cannot control their exposure to HOT lane charges as readily as individual motorists.

The SR91 HOT lanes opened in 1995 as a privately built and operational HOT lane facility comprising 4 lanes for transponder-equipped vehicles in the median of an existing 8 lane highway. The tolls vary according to a pre-published schedule which currently has up to 11 different charge bands on a single day. This level of complexity has been phased in as the operators, with experience, learned how to fine tune the demand and is apparently quite readily accepted by those who use the lanes. Any antipathy towards the complexity of the tariff schedule is apparently offset but the fact that the toll lanes offer a good level of service even during peak periods and that, ultimately, the motorist can choose whether or not to pay for that service (Sullivan, 2001).

2.2 Evidence from Behavioural Studies

There is a substantial body of literature and theory on the way in which people respond to complex information. Much of it is based on evidence derived from laboratory experiments which, typically, have used students as the experimental subjects. Taken individually, the relevance of these studies might be questionned but, taken together, they provide a powerful source of insight and, given that the resulting theories appear able to predict behaviour in real-world contexts and are consistent with the findings from our case studies, they are clearly of great relevance to the current investigation.

The key theories and concepts in the current context are :

- Risk Aversion and Ambiguity Avioidance;
- The related concepts of Bounded Rationality, Satisficing Behaviour, Simplifying Behaviour, and Reliance on Heuristics;
- The concept of transaction costs; and
- Prospect Theory.

Most people are risk averse (e.g. Ellsberg, 1961) and, other things being equal, will choose an option with a known price over one with an uncertain price. This result has been found over and over again in studies and experiments – including some in the context of road charges Train et al, 1989; Bonsall and Cho, 1999; Schade and Schlag, 2003; Harsman et al, 2000). Research has suggested that, where prices vary over time, people's behaviour is more than proportionately influenced by the upper end of a price distribution. A particular example of this form of risk aversion is apparent from research in the telecoms industry which suggests that some people avoid making calls whose price is uncertain but may be very high.

'Ambiguity Avoidance' refers to the frequently observed tendency whereby, faced with an option they do not understand, people will ofeten choose one that they do understand even though it may be sub-optimal (Ellsberg, 1961). Preferences and choices may thus be driven by understandability rather than by utility (Garbarino and Edell, 1997 ; Janiszewski and Lichtenstein, 1999; Menon and Raghubir, 2003).

It is well established that people have limited capacity to store and process information (most people can deal with no more than about 7 items of numeric or abstract data at any one time (Miller, 1956), that they use relatively simple rules to overcome these limitations and that, consequently, their decisions are only boundedly rational (Simon, 1955). Research suggests that the most prevalent coping strategy is to use a simplifying rule (a heuristic) to approximate the "true" value of the unknown factors. People generate expectations and heuristics by attempting to recognise patterns - they look for and apply relationships between variables - e.g. price and quality (Ofir, 2004) or distance and time (Kang et al, 2003) - which may be more imagined than real. The more obvious the apparent structure in the data the better able people are to handle complex information. In the absence of an apparent structure, people may seek advice from a trusted source (Grewal et al, 1998; OFGEM, 2001a,b; Cruickshank, 2000) or, if this is not available, may derive heuristics from experience or hearsay (Devetag, 1999), may fixate on aspects which cause them greatest concern - basing their decision soley on parameters of greatest importance to them (Tversky, 1972) or on extreme outcomes however unlikely they might be, or they may seek to avoid the problem by disengaging (avoiding the product or brand in question or simply paying whatever price is charged).

Heuristics are often used for solving problems that are regarded as routine or unimportant but are also employed when the individual is under pressure or finds the situation too complex to handle (Darke et al, 1995; Swait and Adamowicz, 2001). In such circumstances the decisions are likely to be based on an incomplete appreciation of information and to be influenced by extraneous factors such as the format in which information is presented (Diehl et al, 2003 and Ariely, 2000). This can lead to 'wrong' choices, anomalous and contradictory behaviour (Russo et al, 1998) – although decisions which fail to take into account all the dimensions of a complex problem need not lead to sub-optimal behaviour provided that the *relevant* dimensions are covered adequately.

The effort required to process complex information may be regarded as a transaction cost and, like other costs, tends to put people off. People tend to be cognitive misers (Garbarino and Edell, 1997; Bettman et al, 1998; Swait and Adamowicz, 2001) – they will not waste effort on thinking about something that they consider not to warrant it. This means that they will be looking for ways to economise on their mental effort. Even when the task is within their capability, people may *choose* not to allocate all their resources to it. (019, 021, 102). Thus people are more likely to rely on rough approximations or heuristics when they are in a hurry (Garbarino and Edell, 1997; Suri and Monroe, 2003) and even when not under time pressure, people tend to rely most heavily on the most easily accessed information (Menon and Raghubir, 2003). Increasing complexity makes people more likely to stick with the status quo (Swait and Adamowicz, 2001) and there is a large body of research showing that information overload leads to a decrease in the quality of decisions made (Ariely, 2000).

Prospect Theory (Kahneman and Tversky, 1984) suggests that people's evaluation of choice options depends crucially on whether they model the situation as a gain (will the transaction bring me benefit?) or a loss (will I lose out?). Laboratory evidence, backed up by field evidence, shows that responses to price signals depend crucially on whether the transaction is seen in a positive or a negative light. Thus we should expect the complexity of prices offered by, for example, low-cost airlines (where the dominant perception is that all the prices represent a bargain relative to those of the traditional airlines) to be viewed more favourably than an equivalent complexity of, for example, tax rates. We note that voluntary commercial transactions are, almost by definition, seen as gains whereas charges for 'public' services – particularly if the good in question was previously thought of as free and if the individual thinks he has no option but to continue consuming it – are likely to be viewed as a loss. This may reduce the relevance of experience from commercial transactions to the case of road charging.

Individuals differ in their responce to complexity. Evidence from the telecoms industry and elsewhere suggests that, although most people are happy to make do with approximate estimates of cost when the sums involved are trivial or manifestly represent a bargain, a minority of people find it disconcerting not to know the exact price before they commit themselves to a transaction whatever the sum involved. Similarly, in any given case, some people will resort to approximations while others will seek to calculate the exact price even if that calculation is difficult. A person's readiness to rely on approximations will reflect their income or socio-economic group, their mental and emotional state as well as their mental ability, education and experience (Nerhagen, 2000).

The attitudes and behavioural responses evidenced in the previous section are consistent with the general model of response to complex prices outlined in Figure 1. This model allows that each individual will respond differently depending on their perception of the importance of the uncertainty, their fundamental attitude to it, and the effort they envisage as being necessary to resolve it. In the case of uncertain charges, an individual's income is likely to affect their perception of the significance of a given level of uncertainty but the fundamental attitude to uncertainty is, arguably, a basic character trait – some people are happy to accept a large amount while others feel uncomfortable without a precise knowledge of the options available. The effort required to resolve a given uncertainty is situation-specific but will tend to reflect the individual's experience and intellectual capability.

People's ability to respond to price signals is constrained, not only by their circumstances and commitments, but by their access to the necessary information and by their ability and preparedness to access, understand and process that information (Lurie, 2004). Their ability to access, understand and process information is limited by their mental capacity and experience, and by situational factors such as the time available to complete the task, but it also reflects their personality and their engagement with the task.

3. CONCLUSIONS AND IMPLICATIONS FOR ROAD PRICING

3.1 Implications for the design and implementation of road charging

Although the clarity of the pricing signal is fundamental to the success of congestion charging, it is not realistic to expect drivers to be able, or willing, to calculate the precise charges that they would incur for each of the routes and departure times available to them.

Figure 1: A model of Response to Complex Prices

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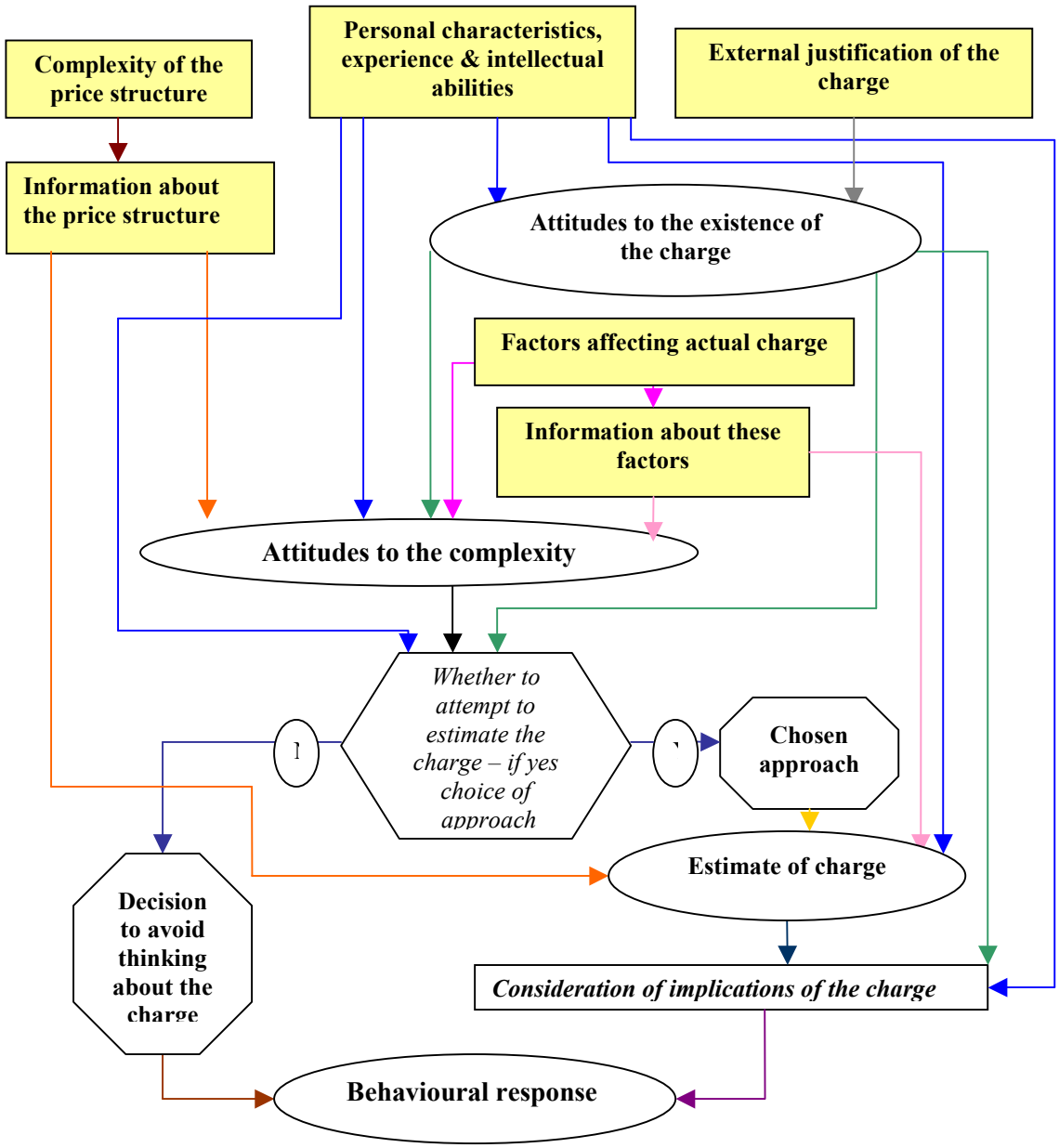

The best that can be hoped for is that, *if they understand the structure of the charges*, they will be in a position to predict whether one option would be cheaper or more expensive than another and, perhaps, to make a reasonable estimate of the likely cost. Their ability to understand the structure of the charges will depend on the strength of the logic that underlies it. We assume, in what follows, that the structure provides for higher charges on the busiest roads at the busiest times and that the logic is that this will help to reduce congestion.

A prime requirement is that the logic of the charge structure, and the necessity of a degree of complexity, is capable of being communicated and is seen to reflect the objectives of the scheme. The logic should be capable of being summed up in a relatively simple expression such as *"Charges will be highest when and where traffic is expected to be busiest"*. The

logic of such a charge structure would be reinforced by replacing fixed costs (such as the annual vehicle excise duty) by usage-based charges and by allowing rates to vary according to seasonal or incident-related demand and by imposing higher charges on larger vehicles. Communication of the underlying logic would be more difficult if it is intended that the charges should also seek to achieve environmental goals (e.g. by discouraging rat-running or the use of other environmentally sensitive roads).

Whatever the clarity of the underlying rationale, information about the price structure may need to be communicated in a variety of ways (e.g. in both summary and detailed formats) in order to meet the needs and abilities of different types of driver. Significant effort would be required, prior to launch, to explain the reasons for the scheme and the logic of the charging structure and the system should be trialled with no actual charging to help people become familiar with the charge structure. The development of information services (e.g. internet-based advice on the likely costs of particular journeys, advice on minimum charge routes or journey timings, in-car meters displaying the incidence of charges in real-time, and post-journey analysis of charges incurred) could play an enormous role in helping people to understand, predict and react to variable charges. Government has a role in facilitating this development while staying alert to the equity implications of the best advice being available only to those equipped with the latest technological aids.

The form in which information is presented (e.g. structure, content and amount) is likely to be crucial in determining the decisions strategies that people use, and hence the choices that they make. Map-based information about charges might be useful for some people but would be of little use to others. Colour coding would probably be more universally useful but it would be inequitable to rely exclusively on any one form of display or communication. Also, it is important to recognise that, even with the best-designed aids to understanding, it is inevitable that people's experience will be incomplete and distorted by misperceptions and selective recall.

Even though, given access to appropriate real-time information, people could find out about the latest charges before setting off on a journey, and might even be in a position to alter a journey after it has sbeen started, the lack of uptake of equivalent advice in thit seems unreasonable to expect ordinary motorists to do this and we conclude that, unless, a la HOT lane, notice can be given upstream of a diversion point, it is not realistic to try to use charges to influence traffic in anything approaching real time.

It is likely that, in the early stages of implementation, people will think quite carefully, perhaps even logically, about the likely cost of using different routes at different times but, unless the price differentials are significant, they will in time begin to take less care about optimising their behaviour. Thus, to maintain a given response, the strength of the price signal (e.g. the differences between the different rates) may need to be increased over time.

3.2 Implications for response

If road pricing induces strong task engagement people will make an effort to predict accurately; if not, they will resort to simple rules and heuristics (e.g. "try to avoid town centres and peak traffic") or may make no effort to adjust their behaviour in the light of the charges. Levels of engagement will undoubtedly vary from person to person and from situation

to situation but, in general, one should expect the level of engagement to diminish as familiarity increases.

Even though they might *wish* to choose routes and journey timings so as to minimise charges, some people will not be equipped to do so – either because they lack the analytical skills or because they do not have access to the requisite information. Such people will make estimates based on rough guesses, personal experience and the advice of friends and colleagues. The 'errors' in these estimates may be quite significant. Some of the error may be random but some may be systematic – for example, the common tendency of people estimate distance via time and so perceive journeys made in congested traffic to be longer (in distance) than those made in free-flowing traffic (Kang et al, 2003), may lead people to over-respond to distance-based charges. In general, however, the efficiency with which people respond to the intended price signals will be greater if they are supplied with good feedback and advice from trip-planning services.

Some people will respond to perceived complexity of charges by reducing their use of the roads about whose charges they are uncertain. Although this response might be welcomed in as much as it tends to reduce use of congested roads (assuming that these are the ones with, for example, the greatest peak/off-peak differential), this response would be imprecisely aligned to the intended price signal and the loss of individual welfare could cause the entire scheme to be viewed in a worse light than necessary.

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