



### **Context**

Data on transport movements, travel demand and traffic flows has been the basis of traffic and transport planning for many decades. This information has been used extensively, but has not always been husbanded well. The steady reduction in the roles of central government has led to a progressive reduction in staff and skill sets within government, and one of the casualties of this process has been the corporate memory and the policy and advisory leverage from such data.

In earlier days, transport surveys were carried out no more frequently but the access to the data was good - if one knew it existed at all. Sometimes political exigencies led to reduced or even zero marketing for long periods of such data held within government. nevertheless even under such circumstances solid rates of return for the community were realised from its availability, albeit curtailed (Wigan and Groenhout, 1990).

The 1990's have seen more and more key government functions segmented, and major sections - if not all - regarded as no longer being a core function of government and being outsourced. These policies have generally been developed and executed as part of a broader agenda, where competition policy and underlying theories of corporate and executive government were espoused. A common characteristic of such environments is a progressive quarantining of information and restrictions on its access and availability. This has been a side effect of policies generally directed at the opposite outcome, one where Freedom of Information Acts and the opening up of government information for purchase by the community has been set up to improve access.

For a variety of reasons this has not worked particularly well, and the developing pricing, quality, availability and usage restrictions have generally proved to be too onerous for all but major users. The progressively greater involvement of the private sector in collection and marketing of such data has further muddied the waters of ownership, use, provenance, access and availability. Assertions of copyright and licensing control by major public sector players such as the Australian Bureau of Statistics have coincidentally legitimised many of these trends within Australia at least (Peterson and Wigan, 1995), however these trends are not out of step with moves in UK (Rhind, 1992) and elsewhere. The net effect of such trends is progressively declining ability of ordinary citizens to obtain or access much of the data that has such importance to them in a widening range of areas of their lives.

No individual information Community Service Obligation (CSO) has yet been recognised as a necessary countervailing measure to permit informed consultation and interactions with what is rapidly becoming a more sophisticated community than the public sector staff that remain in these areas. The US has a different tradition, but similar pricing pressures are widely evident, especially for publicly held spatial data.

While these and other problems (Wigan, 1985) have been building in the transport data area, a new technology of great importance to transport and traffic planning has been emerging. Spatial data systems have a central role in land information, and the potential

for huge economies of scale to the community can be realistically realised by improving their quality, extending their coverage - and ensuring their availability in a consistent manner across the whole community. This is a classical role of government, as the setting up of such a substantial resource takes years and huge sums of money - yet the gains are realised across the communities involved as cost reductions, quality improvements, enhanced response times and better public decision making.

The fairly recent emergence and rise in the usage of GIS-T (Geographical Information Systems for Transport) tools has still some way to go before it is a standard tool in public and private sector planning and analysis. The agenda is essentially still owned by the large scale GIS tools such as ESRI's ARCInfo. These tools are designed to manipulate spatial data mainly to build a spatial database from disparate and not necessarily very good quality data, and manipulate it until the results are a sound basis for working with. GIS-T is aimed at making use of these spatial data bases to do the planning and analysis tasks already done in transportation and planning, but with far less efficiency in traditional transportation planning packages.

GIS-T systems have special data structures to handle the complexities of transport networks, and matrices of origin-destination movements. These are the basic building blocks of transport planning. The first major gain for transport planners is that using a GIS-T allows totally accurate complex networks to be built in a few minutes, and to allow zone sizes for analysis also to be changed, adjusted and modified in a similar period of time.

The critical issue for this massive gain in response time and flexibility is a good quality digital road network, a prime public sector product from the GIS and spatial data systems profession.

In Australia, the Victorian State Government recognised very early on that a single public body charged with putting together the digital road, property boundary and topological databases for the entire State would ensure that all of the potential benefits of having a single high quality common spatial database for all agencies (and the public) could be realised. The Office of Geographic Data Coordination (OGDC) was set up to manage this major task, and bring together the many different building blocks required and fill the gaps in an authoritative manner. This quickly reached an advanced stage, and the resulting digital road network is now in daily use by public health and other services in a State emergency services response centre.

The benefits of consolidating this effort included building on the spatial data held by Melbourne Water, VicRoads and other public bodies who had built up partial spatial data bases as a result of their own internal searches for productivity and efficiency - and who, well before the advent of the OGDC, had gained significant benefits enough to justify this building effort internally through reduced costs.

One of the formal tasks required for OGDC was to develop principles for pricing their products when they were completed. In view of the importance of the digital road network as a foundation for enhanced and more responsive transportation planning in

particular, the digital road network proposals developed are considered here. Similar principles can also be applied to the topological and property boundary (cadastral) data bases

### **Pricing principles for transport data**

An earlier approach taken for transportation data as a whole (Wigan and Groenhout, 1990) was a cost avoidance or cost reduction approach. This method looks at the actual demands and requests made for data, investigates the outcomes of the availability of the information, traces the direct benefits from specific cases, and then determines the range of probable outcomes from similar requests.

The different types of benefits in this previous evaluation were:

#### **Cost reduction**

- Direct replacement of fresh full scale data collection
- Replacement of admitted pure guesswork by the consultants concerned
- Reductions in cost due to pruning the number of realistic alternatives to be assessed.

The other forms of outcome benefits considered were:

- Providing the precise information required to secure significant benefit streams for facilities
- Providing a form of risk management insurance in large scale projects

In each case a probability distribution of likely outcome benefits was constructed, and combined with a probability that these benefits would be realised in a specific case. The entire system was then run through a simulation system to obtain a most probable distribution of outcome BCRs (Benefit Cost Ratios) for the information resource.

This approach is appropriate to evaluating existing resources where there is a history of a range of realised requirements, both large and small. It cannot be used if the principles are to be determined prior to such a history being developed

This meant that any proposed digital road network pricing principles could not rely on market and revealed preference information as there was none to use.

The potential clients for this new data source needed (and still require) education in the effective deployment and leveraging from this asset. This reduced the likelihood that Stated Preference choice models would yet be very useful, as the market and the service and other attributes were poorly appreciated (eg. Wardman, 1998) and would therefore be simulating an unknown and unaware market. The choices to be assessed were too abstract and weakly connected to the current appreciation of the potential gains, and many of the markets and key attribute utilities have yet to be identified at all

However, such Stated Preference approaches are likely to be of rapidly increasing value to those developing and selling data for transport-related markets as the awareness of the cost-effectiveness and enhanced response time and presentation performance of GIS-T becomes understood, and will provide a rapid method of designing and pricing marketable packages of spatial transport data to different markets.

Revealed Preference models must also realistically await the emergence of a diverse set of participants in the data marketplace, which must have reached a stage of development where there are multiple niche and main game players if the full range of attributes associated with the data are to be captured effectively. Transport and spatial data are only two of the many new emergent data markets: many more will arise as Intelligent Transport Systems develop.

One of the crucial steps in a demand based pricing approach is to determine the price elasticities of the different products. Data on its own is only rarely a "product". To become one it must have additional attributes such as quality, timeliness, currency, documentation, licences terms for its usage etc. Each of these attributes will alter the nature of the 'product' supplied, and it is here that market oriented approaches seek to determine the most effective sets of attribute bundles. The tradeoffs between these attributes will define the utility (or 'value' of measured in dollars) of these different aspects of the data product. the overall demand elasticities will determine the takeup of the products so defined, and guide the marketing effort.

This approach is market oriented, and is quite at variance with the approach generally taken with data in Australia in the transport field, where the price has often been set on the basis of the cost of collection of the data, due to the lack of depth of the markets and the prevalence of interagency data trading at a zero price which reduces the sensitivity of the holding body to the prices asked from others outside the charmed circle.

The spread of cost centres and business units within government in Australia has not yet altered this approach substantially, although this is changing fairly rapidly as the process continues. Cost based pricing policies are particularly difficult and slippery to use where data is concerned. Issues of capitalisation and return on investment run into problems of joint costs where the data was originally collected to further internal government programs or add to their efficiency.

### **Costs and transport data**

Considerable resources are required to set up, execute, manage and analyse a large scale transport survey. The costs of setting up a digital road network, a cadastral or detailed topological data base are orders can be a magnitude higher - and the ongoing maintenance costs are also substantial.

This has the immediate effect of inclining public sector bodies towards a cost recovery approach, or to set prices on what the market will bear. In 1995 the Victorian Department of Treasury and Finance commissioned a study to determine the principles on which digital spatial database pricing should be based (Wigan et al., 1996). In accord

with the approach of seeking to obtain the best community outcome for the new unified digital road network and the other products, this brief specifically precluded the use of monopoly pricing strategies

Whatever the pricing principles set, the heavy weight of development costs that could potentially be attributed to the SDRN (State Digital Road Network) had to be addressed. Before considering the different pricing principles available in more detail, the implications of the cost side of the equation will be considered. Admittedly the SDRN is a special case, but the issues are easily recognisable across many other areas of information in transport.

The most basic issues are for a body about to integrate the various components into a useable product of broad application and utility:

- Who owns the data?
- What did it cost them to build it?
- What would it cost them to transfer it?
- What value should be applied to it?

These are all cost elements, not demand elements. However a prevailing attitude of many newly corporatising or privatising public sector areas is to seek monopoly rents from information within their grasp (Perritt, 1995). As long as the framing of the issue remains "secure revenue from somewhere", then cost-based pricing schemes will dominate the debate in such situations.

This approach does not usually survive the initial phases of privatisation, as, with some very high profile exceptions, the sovereign domain and implied unique rights to ownership of the information sources cannot easily be sustained once the market has stabilised and the organisation has been floated off.

The OGDC specifically precluded monopoly pricing from their otherwise-unrestrained range of alternative for pricing principles.

The determination of the cost base is still a major issue when floating off public enterprises, and so the issues are still current and of great practical importance. One such issue is the valuation of a body of data - such as the digital road network - which has taken a great deal of investment to create. It is a common starting point that the cost must be recovered from sales, and a Treasury-specified rate of return (currently 8% in Victoria) be achieved on this investment the transfer of the asset to any newly corporatised data management unit. Thus a great deal rests on the definition of the data asset involved.

The development of a digital road network and other geospatial datasets (cadastral, topological and such transport-related linear databases as road condition, accident and maintenance systems) has been fully cost justified on the internal productivity gains within the initially commissioning organisations. The cost recovery has therefore been largely obtained before the SDRN program began, and the marginal cost of transfer of

the data could be argued to be the appropriate transfer cost. The argument that the public agency has monopoly control of many of these assets should not be allowed to disguise this. This initial monopoly is often temporary, as other alternatives arise if the public sector over-prices their initial data products. In the spatial data area this can lead to substantial community disbenefits as the cumulative benefits of a common data set are lost.

Again, even when the data transfer is regarded as being worth what it cost to build, the actual utility of this data set will very rapidly decline if the information is not maintained as up to date. In practical terms the omission of a maintenance process can see such data sets rendered near-worthless for all but a few applications within a very short time: for road systems this can be as short as a year in some areas.

This issue points to a valuation of the data as being equal to the maintenance cost, as it would otherwise be worthless very quickly. This is a limiting case argument, just as the case for total cost recovery is in the other direction. These two examples show just how far apart the cost bases for digital road data could be defined justifiably and defensibly - and makes a very big difference to the prices that would be set on the cost recovery-based approach implied by this argument.

At one end of the scale, where the maintenance cost is taken as the full worth of the data set, then the marginal cost of transfer can be argued to be the appropriate pricing strategy. In realistic cases the need to extend the area covered and improve the range of linked data to the digital road system will demand an R&D component which will cause a shift from a pure marginal cost basis.

### **Pricing digital road data**

A US audience might find some of these problems unusual, as it has been observed in Europe:

"The United States passed through this stage some years ago, and summarised the European position as a wide concern that the problems with data pricing were causing widespread practical problems, and a general feeling that the United States had made the right decision on data pricing. Why do other countries, on their own admission, lag behind in GIS? The principal culprit is cost reimbursement on GIS data" (Dodson, 1995).

Australia is increasingly moving towards European models of spatial data pricing, a more developed one than general transportation data pricing, and from a general historical marginal cost of supply stance.

The arguments for different forms of transport data often hinge on the perception of the cost and the market tolerance for pricing. It is rarely appreciated that the charge for a data set is made up of a range of different components, not all easily reconciled to dollar

terms. The fee charged would appear to be the price, but the assertion of copyright, derived use - and even controls over the number of applications of the data - are all terms that have been imposed on the sale of such information.

Such conditions could massively reduce the utility of a transport data set to an end user, and make it unworkable for them to use it for fear of their own added value being demanded back at no fee as a result of the licence terms for using and enhancing a public data set. This places at risk the possibility of any return on the many corrections, adjustments and extensions that may be made by any purchaser - and this comprises expensive new intellectual property.

**Table 1: Packages of digital road network product variations**

Category	Aspects			
Content	Area covered	Number of items	Number of attributes	Number of layers
Quality	Coverage and completeness	Currency	Spatial precision	Data structure
Maintenance	Frequency	Quality Assurance	Incremental updating v complete reload of the database	
Formats	Physical (eg. CD-ROM, 8mm tape)	Logical (ie. in client's GIS-T software format)	Access (ie. via Internet to full product, or only limited aspects)	
License	Restrictions on usage	Ownership of additions/corrections	Quantity of user access terms (ie. per seat, per application etc.)	Terms of distribution of value-added products
Royalty	Per unit pricing	Per product pricing	Onward sales of client produced value-added products	
Service level	Supply speed	Customisation	Installation assistance	Response to errors etc.

Such licence conditions can, for example, make it very difficult to supply results incorporating the enhanced digital road network (for example) to members of the public - who originally paid for the assembly of the information in the first place.

There are a wide range of product packages that can be created, each of which will realise a different utility and perceived value to different market segments (Table 1).

Such practical arguments can easily confuse the issue of choosing an appropriate economic model for pricing transport data sales. There are other factors which can dominate, depending on the economic pricing principle chosen. These include the degree of monopoly over the information source, Community Service Obligations (CSO). The relative importance of the factors summarised in Table 2 will vary



substantially depending on the choice made between monopoly, marginal, market costing or other pricing principle

**Table 2: Factors modifying transport data set pricing**

Area	Significant factors			
Cost	Capitalised investment	Updating and maintenance	Costs of operation and distribution	Transfer costs and CSO inputs
Demand	Monopolies in supply	Stratified markets and elasticities	Market competition	License constraints
Supply	Quality of data	Value added by users	Co-opetition	Coverage

The various purely economic bases for pricing digital road networks have been reviewed (Wigan et al., 1996). Ramsey pricing approach was advocated for use by the Victorian public sector for sales of the digital road network. This approach relies upon the - often initially unknown - elasticities of demand for different products in the range, and can be very sensitive to the precise or relative values such elasticities (Tye, 1990).

Ramsey pricing is otherwise termed 'constrained social welfare maximisation' where social means the whole community including business operations. It aims to provide prices which maximise net total social benefit, and can cover externally-defined rates of return. Several different pricing policies can be covered in a compact form by considering the Ramsey number (see Table 3).

This makes it possible to build a straightforward model to explore the implications of different pricing policies, and to identify the relevance or otherwise of the special condition where Ramsey pricing can produce unstable results for specific combinations of parameter values (when the price elasticity is close to or equals the Ramsey number)

The different issues of costing, capitalisation of existing data brought in at the start of a corporatised enterprise, and the R&D, rate of return and other factors has been built into a spreadsheet which can handle multiple types of digital road network products using Ramsey pricing, producing different prices and at varying levels of price elasticities of demand for each product (Edgar et al., 1996).

There are major issues of estimation of price elasticities for different product packages that need to be resolved. The digital road network used by the Victorian Emergency Services system (the SDRN - State Digital Road Network) is the most time critical of all the product variants, and must be kept as closely up to date as possible. This level of service defines the highest price for this digital road network product, and for users where an annual update is enough a far lower price is appropriate. These are quite different products, along the axis of assured currency and quality of the road network information.

Table 3: Pricing regimes defined by Ramsey Number ( $\lambda$ )

Regime	Objective	Condition	Ramsey number
Monopoly pricing (Profit maximisation)	Maximises profit	MC = MR  Marginal Cost = Marginal Revenue	$\lambda = 1$
Marginal cost pricing (Social welfare maximisation)	Maximises net social benefit	P = MC  Profit = Marginal Cost	$\lambda = 0$
Average cost pricing (Full cost recovery)	Covers full cost. May also maximise net social benefit for the single-product enterprise	P = AC  Profit = Average Cost	$0 \leq \lambda \leq 1$
Ramsey pricing (Constrained social welfare maximisation)	Maximises net social benefit subject to the constraint that total cost be covered	$(P - MC)\eta = -\lambda$ MC ( $\eta$ = elasticity)	$0 \leq \lambda \leq 1$

A further practical issue is that for a major product such a State digital road network there should be a range of value added resellers. This is not simply a matter of commercial acumen: the need to gain the maximum community advantage from the use of a 'standard' - or at least common - geospatial reference source demands that a flexible and wide ranging resale, licensing and distribution policy be set up to ensure that the full gains are realised for all.

The full range of options, ranging from the State Digital Road Network (SDRN) through to a very frequently updated version for the use of emergency services dispatchers (ESN), an On-Line digital road network service and the 'value added reseller' channels were included in a pricing model (Fig 1). The stochastic variables were highlighted in this display, and the model is actuated by selecting parameters and values for the various elements, and determining the parameters for the uncertain price elasticities.

These gains arise in several ways: from the cumulative efficiencies of multiple agencies and companies building on a common, regularly updated reference digital road network, from the avoidance of private sector monopolies arising, and from the secondary markets for information based on the use of this state common reference. Education, for instance, is a time-delayed value added reseller (VAR) as the trained people move on to demand the same digital road data to which they have become accustomed to rely, once they are in the workforce. In all these cases there are strong arguments for a pricing regime that allows these different means of distribution and commitment to coexist. Ramsey pricing can offer such a coordinating and guiding strategy.

A digital road network pricing model spreadsheet (Edgar et al., 1996) has been set up to handle the various input costing parameters required to determine the Ramsey number

(see Fig. 1). Amongst these numbers are the price elasticities of the different products, as required for determining the Ramsey prices.

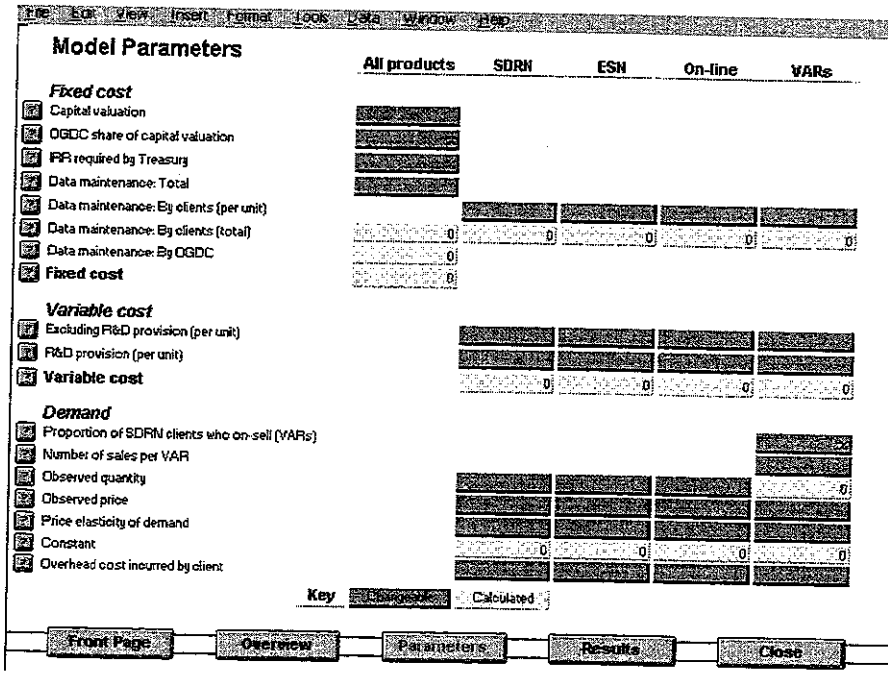


Figure 1. Front page of the digital road network pricing model

The system is set up to permit the user to estimate the results of uncertain values for these elasticities, which must either be guessed, or estimated from a stated preference survey and choice analysis model designed to elicit the price elasticities of different attribute bundles for the digital road network. The process adopted is to determine the Ramsey number from the input parameters, and determine the revenue and other outcomes.

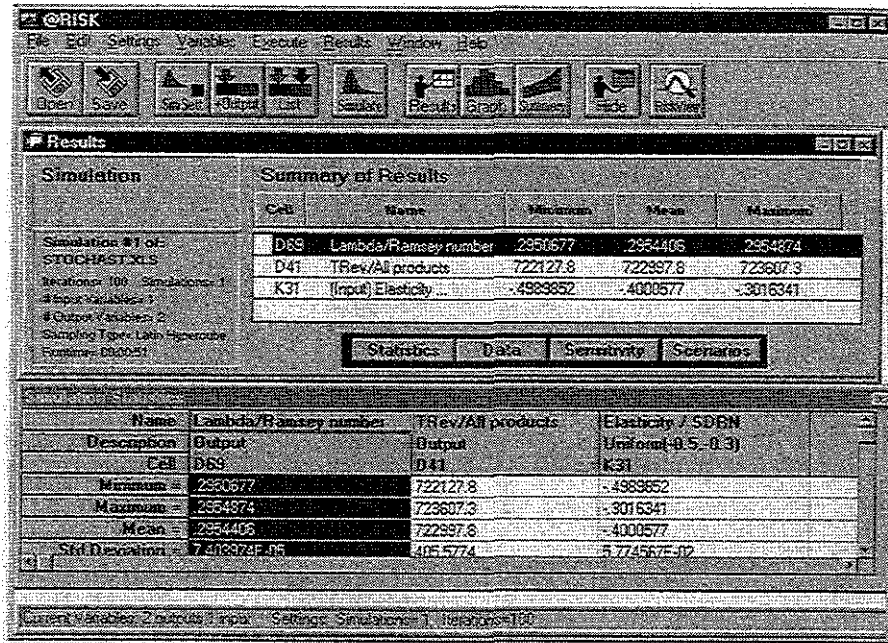


Figure 2. Simulation model for Ramsey pricing for the State Digital Road Network

A sample simulation add-in product (@Risk from Palisade Corporation (Palisade Corporation, 1997)) is used to generalise this process. A random variate is drawn from a user-specified probability distribution for each elasticity, and the whole non linear estimation of Ramsey number and resulting outcomes is repeated numerous times until a statistically reliable distribution function of the outcomes (in terms of sales, revenues etc) has been built up from these many runs

Technically this requires each randomly drawn set of elasticity values to be passed to the Excel Solver to determine the Ramsey number. The results are then accumulated to provide the resulting outcome probability distributions for sales and revenues from the digital road network. Fig 3 (Edgar et al , 1996) shows a typical result

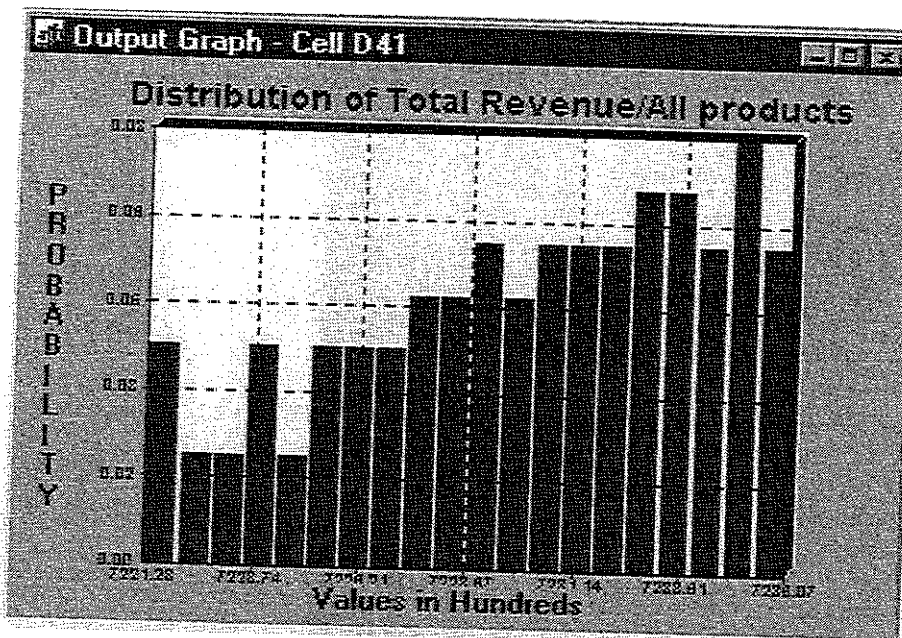


Figure 3: Probability distribution of a family of SDRN-based product revenues

This technique has proved to offer a useful benchtesting tool for pricing and product strategies for digital road networks, and can also be used to undertake more precise price setting when the market has shown the operational price elasticities of the different products

#### At what price, to whom?

The increasing concentration of public policy-related analysis into computer form has caused the information access to the community to decline quite sharply. In the case of digital road networks, the basis for consultation and informed community response to public sector initiatives is beginning to require access to the public sector digital data holdings. The community increasingly holds a larger reserve of technically competent analysts and commentators than those remaining within government, and the community cannot indefinitely afford to preclude the uncosted and highly informed input that can be generated by data mediated consultation processes.

This is the subject of further work in this program, but suffice to say that a CSO embodying an ability of individuals to obtain sufficient of the public sector digital data pertaining to issues immediately affecting them is becoming a significant issue. Further moves to integrate planning schemes, digital road information, transport and traffic data in electronic form has resulted in access costs aimed more at Local Government budgets, and out of reach of individuals and their access being therefore increasingly limited

While Ramsey pricing offers an appropriate basic approach to pricing previously public data, the pricing policies for transport and transport-related geospatial and behavioural data need to be set with provision for an appropriate CSO for such access if meaningful consultation is to be achieved with the community in future.

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