



Determining optimal prices for road use

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Abstract:

The Government is considering options for reforming the way roads are managed in New Zealand. Some options involve roads being owned and managed by publicly owned regional roading companies with the power to set prices and charge users directly. Such companies would be natural monopolies and may not have the incentives to set prices in full conformity with optimal pricing principles. If road prices differ from efficient levels some potential gains of road reform will not be realised. Regulatory or structural interventions might be justified if this divergence is substantial.

This paper sets out a framework for determining optimal prices for road use which can in turn be used as a baseline for assessing the road companies' pricing policies.

Road prices in total should cover all economic costs. This includes long run marginal costs which include a normal rate of return on capital invested in roads. However prices should not exceed this level. The requirement to earn a financial return on the capital invested in roads raises issues about the valuation of existing infrastructure. The paper argues that this is largely a sunk cost.

Prices based on long run marginal cost will be higher in corridors and areas where significant investment is required in the near future than areas where existing capacity is adequate and traffic growth is low.

Network pricing theory was investigated and the paper explains why its implications for road pricing were found to be relatively insignificant.

The paper argues that ultimately, fully disaggregated pricing, where a separate price applies for using each road link, in addition to a small access charge, will result in the clearest use and investment signals to road providers and road users. In the short to medium term achievement of fully disaggregated pricing will be constrained by technology limitations, public acceptance, and cost.

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Note: The discussion and proposed principles for determining optimal prices for road use presented in this paper are solely the views of the author. They do not reflect the view of the Government or government officials, nor should they be taken as an indication of possible future Government or road company policy.

Introduction

The New Zealand Government is considering options for reforming the way roads are managed. Some of the options being considered would involve roads being owned and managed by central and local government owned companies with the power to set prices and charge users directly. It has been suggested that Government need not concern itself with determining optimal prices or pricing principles for these companies because they will have the correct incentives to do this themselves once they have been set up.

This paper contends that road providers operating on commercial principles will not have the right incentives to set efficient prices (prices that maximize net national welfare) for road use. Much of the road network exhibits high fixed costs and relatively low marginal costs. In such situations often efficient pricing, that is pricing at marginal cost, will not cover average costs. In economic theory this is referred to as a natural monopoly. Therefore it is possible that optimal prices from the point of view of a commercial road provider will not be the same as optimal prices from the point of view of a Government wishing to maximise net welfare. Unconstrained monopolies set prices higher and investment lower than the efficient levels that prevail when companies face competition. If road prices differ from efficient levels some of the potential gains of road reform will not be realised.

New Zealand has to date taken a light-handed approach to the regulation of utility industries. A similar approach for roads might involve requiring road providers to publish all information on their costs and the derivation of their prices in order to demonstrate that they were conforming to efficient pricing principles. This paper sets out a possible set of principles that the Government could specify for determining prices for road use so that road providers would know what is expected and so that the Government's regulatory agency has a baseline for assessing road providers' pricing policies. More heavy-handed regulatory constraints on road providers' behavior, or structural interventions, might be justified if it is found that road providers are not setting prices in conformity with the efficient pricing principles.

There are a number of potential costs if prices do not reflect efficient pricing principles. If prices are too low people will travel too much, causing unnecessary congestion and environmental costs and urban sprawl. Also road providers might spend too much on extra road capacity in response to this demand, crowding out investment in other more productive parts of the economy. Conversely, if road prices are too high and investment too low some worthwhile travel will be suppressed and costs to businesses will be high.

Uniform nation-wide charges such as the existing New Zealand Road User Charges system, fuel tax and annual vehicle licensing fees are not efficient mechanisms from the point of view of optimal pricing. The most efficient pricing mechanisms for this purpose are those that can be targeted to areas and even specific road segments where demand for additional investment is high. The discussion in this paper assumes that such mechanisms will eventually become cost-effective.

The terms *road prices* and *optimal pricing* have been used to refer to all charges for all road use, not just to peak period congestion pricing.

This paper sets out eight proposed principles for determining optimal prices for road use. An explanation and discussion follow each principle.

Principle 1

Prices for road use should be set at a level that recovers all economic costs including a financial return on capital invested in roads.

Existing prices, based on pay-as-you-go pricing rules, do not cover all economic costs. Economic costs include an on-going financial return on the capital invested in roads. Efficient prices for road use should be based on marginal cost pricing and should incorporate a financial rate of return reflecting the opportunity cost of the funds invested in new capital projects, (marginal cost pricing theory is addressed in principle 4). This would ensure that road use is priced on the same basis as if such services were provided by the private sector. This would make consumer choices neutral between traveling by road or another efficiently priced mode, or purchasing some other good or service altogether. Where other transport modes are inefficiently priced they would receive a competitive advantage as road prices became more efficient. Requiring an appropriate return on equity would also help to ensure that, in future, money is not invested in roads when it could have been used more productively elsewhere in the economy.

Another way of looking at the required financial return is that it is the required profit after paying operating and maintenance costs and charging depreciation but before paying interest on loans. At the end of the year this profit is available for paying interest to debt providers, paying dividends to equity providers, or retaining to make new capital investments.

Including a required financial return in road prices might also improve the viability of a greater range of possible options for introducing more contestable road provision and management arrangements. (ACIL 1994) Such an outcome could be expected to help improve services and reduce prices paid by road users with less emphasis needing to be placed on regulatory measures.

Principle 2

Prices for road use should not exceed economic costs

Another way of stating this principle is to say that road providers should not be allowed to earn levels of profit that exceed a normal financial return on investment.

In many situations, for many road users, road use demand is relatively inelastic (i.e. unresponsive to variations in price). This means that even if prices for road use were increased substantially these users would pay the higher prices and continue to use the roads. The inelasticity of road demand suggests that there is a big gap between willingness to pay and costs of road provision in many cases. When this is the case, road providers have considerable opportunity to increase revenue by raising prices above current levels. Hence there is potential for substantial monopoly profits and wealth transfer from road users to road owners if price setting is left unconstrained. This would show up as reductions in the value of properties and businesses that are dependent on transport.

Governments generally consider it inappropriate for companies to earn monopoly profits. In New Zealand the Government uses the Commerce Act and industry specific regulation to constrain anti-competitive behavior and increase competition. Where competition is impractical, such as in the case of Government owned companies with natural monopolies, profits are controlled. Examples of such companies include Transpower (the national wholesale electricity transmission network operator), and the Airways Corporation (the operator of New Zealand's air traffic control services and navigation systems). This control occurs through the companies' Statements of Corporate Intent. The Government, as owner, lets it be known that it does not want the companies to earn monopoly profits and the companies propose mechanisms in their Statements of Corporate Intent to show how they will satisfy this requirement.

For example, the Airways Corporation operates an Economic Value Added (EVA) Reserve in its financial statements (Airways Corporation 1996). EVA measures the extent to which a business is performing above or below expectation. A positive EVA means the business is earning profits that are higher than a normal rate of return on the capital invested in the business. The EVA for a particular period is calculated by subtracting, from revenue, the company's operating expenses and a charge on operating capital. The charge on operating capital is the cost of an appropriate return to the providers of capital. It is calculated by multiplying the average capital employed by the cost of capital. The cost of capital is the required financial return on investment appropriate to a particular business. The EVA for each period is added to the closing EVA Reserve from the previous period to obtain the new EVA Reserve.

The Airways Corporation does not aim for a zero EVA in each reporting period. Rather it aims for the EVA Reserve to average zero over a period of time. If the EVA Reserve becomes positive the company reduces prices to its customers. If it is negative, and there is no prospect of revenue growth from increased business volume, prices are increased.

Prices for road use should be set in the same way as the Airways Corporation's, to achieve, over time, an appropriate rate of return on the capital invested

Principle 3

The required financial return on investment should not be obtained by applying a pro-rata surcharge uniformly across all prices for road use.

The required financial return on investment is not an amount that should be earned uniformly at all times. It needs to be earned some time over the life of the investment but this timing is flexible. Private toll road operators illustrate this point. They know that revenue will be maximised by keeping prices relatively lower when demand is still low and at times of day when demand is low. They might make very small profits or even losses in early years but they will expect to make up for this with large profits in later years to enable them to reach their required return, on average, over the life of the investment.

All revenue, over and above operating, maintenance, and depreciation costs, that can be earned from existing prices or from efficient pricing based on short run marginal cost pricing when this is higher, is a contribution to the required financial return. This includes any revenue from congestion pricing or peak period pricing. A common mistake is to believe that a financial return must be earned in addition to congestion prices.

Uniform nation-wide charges such as Road User Charges, petrol tax and Annual Vehicle Licensing Fees are not efficient mechanisms for earning the required financial return on capital. The most efficient pricing mechanisms for this purpose are those that can be targeted to areas where demand for additional investment is high. The required financial return should wherever practical be earned from the asset to which it relates and not be recovered in a uniform fashion across all network users.

Earning the required financial return flexibly by, for example, peak period surcharges in the case of capacity improvements and heavy vehicle surcharges in the case of pavement strengthening is consistent with efficient pricing principles. When the investment is extra capacity to relieve congestion the financial return and perhaps even some of the depreciation should be predominately recovered at periods of peak demand and later in the life of the investment when traffic growth has caused the road to become congested again. This ensures that the extra capacity is primarily paid for by the peak period users who caused it to be needed, and that the next increment of capacity is not provided until those users are collectively paying an amount that reflects the full economic costs of providing such capacity. This is both an efficient and equitable pricing regime with users facing the full cost of their decision of when and where to travel.

Economists have a more formal definition of this principle. Sometimes mistakenly called Ramsey Pricing (Kranton 1990), this principle states that the optimal way to earn

the required financial return and cover other long run costs is to apply different mark-ups to the short run marginal costs for each time, location, and vehicle type combination, such that the percentage mark-up of price over marginal cost is inversely proportional to the own-price elasticity of demand for each combination.

Demand is more elastic for travel at uncongested times than it is at congested times. Some long distance freight and private motorist leisure travel demand also appears to be more elastic. Charging a uniform surcharge in such situations is likely to suppress some travel. This might be inefficient if these trips would have occurred at a price that covered their short run costs.

In practice it is impossible to determine elasticities for every situation. The best that can be done is to charge different percentage mark-ups, somewhat subjectively determined for broad groups.

Principle 4

Prices for road use should be based on a balance between short run marginal costs and long run marginal costs.

Prices for road use should reflect marginal costs. Marginal cost is defined as the change in the total social cost of travel on existing roads, including costs of road maintenance and costs incurred by all users, brought about by adding one vehicle of a particular type and weight at a particular place and time (Small et al 1989).

Short run marginal cost includes costs of road maintenance and costs incurred by all users, brought about by adding one vehicle. It is based on the assumption that capacity is fixed. Long run marginal cost includes all predicted future costs including both maintenance and the economic cost of investment in additional capacity or strength that is required to accommodate traffic growth. Future (long run) costs are likely to be considerably higher for roads in parts of the network where demand is growing and capacity is inadequate than in other areas with slow growth and existing spare capacity.

Existing roads in slow growth areas may never become congested. If this is the case their long run costs will be determined by the costs of on-going routine maintenance and periodic pavement rehabilitation. The long run costs of unsealed roads in such situations may be determined by a combination of grading and re-graveling costs.

Prices should take account of both short run marginal costs and long run marginal costs. When there is little growth in traffic, and existing roads have adequate strength and spare capacity, short run and long run costs will be similar and this poses few problems. However in situations where investment in additional capacity or strength will be required to meet projected future traffic demand, long run marginal costs can be significantly higher than short run marginal costs. This raises a potential dilemma as to whether prices should track short run or long run costs.

The *traditional* economic approach is to base prices on short run marginal costs. The reason for this is to send appropriate price signals that will lead to the optimal usage of roads at all times throughout their lives. If an existing road is very strong or has much spare capacity the short run costs and hence the price will be low. The charging of a price above the short-run costs of use and operation, before the point at which the demand is large enough to exhaust the full capacity of the asset, when charged at long run cost would lead to a significant under-utilisation and there would be a loss of potential consumer surplus (Kirwan 1991). In other words pricing above short run costs might deter some usage that would have actually been economic.

One reason for pricing at long run marginal cost is to ensure that road users pay the full economic costs of investments in additional capacity or strength. Another reason is to influence users' own longer term investment decisions such as where to buy a house or locate a factory or plant a forest.

Setting prices for road use at long run cost will avoid misleading people about the full costs of providing such infrastructure. Other developments that rely on roads, such as residential subdivisions and shopping centres, will be built in more appropriate locations. If the price to use a road is based on short run marginal cost it is likely to be relatively low during long periods when the road has excess capacity which could result in excessive urban sprawl. The price will then rise sharply when capacity is exceeded. The price should rise to reflect the congestion costs that road users impose on each other. It will even need to exceed long run marginal cost for a time before more capacity is added if users are to cover the full economic costs of such investment. Once an increment of capacity has been added, prices based on short run marginal costs would drop again. The result would be a saw-tooth pattern of prices. Unless people learned to anticipate these periods of high prices, such fluctuations could cause economic costs as people and businesses found themselves unable to pay the high prices and had to sell properties and re-locate businesses or close down altogether.

To summarise this, when more capacity can only be added in large indivisible increments, both the long run and the short run approaches to pricing result in some economic costs or lost benefits. If prices are based on long run marginal costs, some efficient road use will be suppressed with a resulting loss of beneficial economic or social activity. If prices are based on short run marginal costs they are likely to exhibit large fluctuations, sending potentially misleading signals about where land use developments should take place for long term welfare maximisation, and resulting in dislocation and economic costs.

As a way of minimising these costs it is suggested that road prices should begin to rise earlier than when short run marginal costs begin to rise (i.e. some years before capacity is reached), and more gradually than short run marginal costs, so that users in the short term face prices that begin to reflect the long run costs to expand capacity. This is similar to what happens in other markets where new capacity is lumpy and expensive such as the electricity and newsprint markets. As suppliers perceive that demand is approaching the capacity of existing plant they begin to increase prices. Eventually prices exceed long run marginal cost and new capacity is built. The rise in prices often

occurs before capacity shortages are a reality but will not occur until there is some expectation that new investment is going to be required at some time in the near future. A competitive market automatically finds the correct balance between short run pricing to optimise current usage and long run pricing to signal the correct timing and scale of new investment. The balance varies depending on the level of demand. Notably a competitive market does not consistently price at long run marginal cost when increments of capacity are expensive and lumpy.

Principle 5

Prices for road use should be matched as closely as possible to costs of using each road segment.

Rapid advances in technology are bringing closer the time when it will be possible to monitor and charge directly for road use at reasonable cost and charge different prices for different parts of the road network. The most promising systems for thinly populated countries with extensive road networks like New Zealand appear to be systems that can share existing communications infrastructure rather than requiring extensive fixed investment in new dedicated infrastructure. Such systems might use satellite global positioning to enable vehicles to determine their location, and low earth orbital satellites or cellular telephone networks for communication between vehicles and billing companies. Two such systems have been demonstrated in New Zealand in the past year. The systems can be made attractive to road users by transmitting useful information into vehicles as well. In fact companies are already providing such services and it might be road owners who end up *coat tailing* on already established systems, expanding their usefulness and lowering costs. As the number and breadth of the uses to the road user increase, the proportion of the road using population subscribing will increase and prices will drop creating a virtuous circle of more subscribers and lower prices (Malick 1998).

In the meantime, until such technology arrives, it is necessary to use blunter pricing mechanisms. Some people consider that this does not matter because the road system is a network good and network pricing principles should apply. By this they mean that most costs cannot be attributed to particular users and therefore that uniform pricing should apply throughout the network. If competing road networks existed this might be valid.

However because the road network is a natural monopoly we have had to accept the requirement that prices should not exceed economic costs. This principle does not just apply to the network as a whole although that is an important minimum requirement. It is also important that the prices for any link do not exceed its economic costs. If a road provider were permitted to earn monopoly profits on some links it would be able to reduce prices below economic cost on another link where it faced competition. This could deter private sector provision of toll roads where they might otherwise be economically justified. Competition regulators dislike such anti-competitive practices

and in other industries in New Zealand, such as air traffic control, they have been requiring the elimination of such cross-subsidies.

Comparing roads with electricity distribution networks illustrates some other differences that reduce the justification for uniform pricing. In electricity distribution, network investment depends principally on the capacity required, which in turn depends on the maximum power loading of the end users (Ross 1992). This dependence is principally on the maximum rate of delivery of energy at a particular point in time rather than on the total volume delivered over a period of time. Cost is also dependent on the number of users connected to the system, particularly in lower loading density situations.

In road networks the investment depends on both the maximum capacity required and the total volume over a period of time. It is less directly dependent on the number of users (properties) connected to the system. Roads experience congestion when there is insufficient capacity but they also sustain pavement wear from each vehicle that passes. Power lines do not wear out from each electron that passes along them. Electricity networks do not care which route power takes to get to end users. With road networks the route that a particular vehicle takes does have cost implications. For example a heavy vehicle will impose greater costs on the road network if it travels on a low strength pavement than if it makes the same journey over an alternative slightly longer route which has been built with a high strength pavement.

Some economists recognise this and start with the base assumption that pavement segments should be priced differently depending on their strength (Small et al 1989). Using United States examples Small et al (1989) note that the Federal Highway Administration would have to calculate optimal durability and price for at least 160 combinations of functional class of road, type of pavement and interval of traffic volume. A truck traveling one hundred miles could easily use ten differently priced pavement segments. The authors observe that while such a scheme would not be impossible to manage with new technology it might be unattractive to road users and administrators.

A number of authors have noted that attributable costs are a relatively small proportion of total costs. Common variable and fixed costs make up a significant proportion of the total. The normal practice is to say that these are network costs and apportion them equally to all users on all roads. However although these costs cannot necessarily be attributed to particular users they can in many cases be associated with a particular road segment. This is increasingly the case under contract maintenance where each item of work is accounted for and billed separately. The overhead costs that cannot be attributed to a particular road are relatively few. These include costs such as the road provider's administration and contracting costs.

The question then becomes is it better to build the link specific non-attributable costs into the variable prices for each link or to recover them via a fixed network access charge. The former option means that the variable prices to use individual links will be higher than attributable variable costs but it ensures that only those who use a link are required to contribute towards its construction and upkeep. Also their contribution will

be in proportion to the number of times they use the link which also seems fair. The latter option results in cross-subsidies with some users contributing towards the common costs of links that they will never use. This could lead to significant distortions when large sums are spent increasing the capacity of some links while other links used by different road users require no such expenditure.

Small et al (1989) constructed a model based on United States data to investigate the likely welfare gains from different pricing schemes. They found that a charge that varied by vehicle type and axle weights but was uniform across all road types (similar to New Zealand's existing Road User Charges) yielded benefits that were within four percent of the net welfare improvement obtainable from a more detailed link by link pricing schedule. However this result hides some significant winners and losers.

Under current charges heavy vehicle operators are paying considerably more than their attributable costs when traveling on state highways, which generally have the strongest pavements in New Zealand. On the other hand the attributable costs of heavy vehicles using low strength rural roads for stock and fertilizer transport and forest harvesting are higher than current charges. State highway users are subsidizing these operations.

While the difference in net welfare of a uniform versus a link by link pricing scheme might not be great there is a fairness issue involved. Also the potential welfare gains might be greater in New Zealand because it is more reliant on external trade than the United States. Small et al (1989) also modeled a two step price schedule with one low price per esal-mile (equivalent standard axle load - mile) for freeways and another much higher price per esal-mile for travel on all other roads and found that the result was much closer to the net welfare of a link by link pricing scheme and with much lower cross subsidies.

This suggests that even in the short term it would be worthwhile investigating slightly more differentiated pricing mechanisms than the current uniform charges. In New Zealand it is possible that a good proportion of the welfare gains of a fully differentiated link by link pricing scheme could be achieved with separate price schedules for state highways and local roads, some peak period pricing on particularly congested urban arterials, link specific tolls where large sums are being spent on upgrading inter-city highways, and possibly special levies on log trucks for upgrading low strength forest access roads.

In the long term, as the cost of technology falls, it will be possible to achieve further welfare gains by moving further towards individual link by link prices that match, as closely as possible, the costs of using each link.

Principle 6

For the purposes of setting prices for road use the existing road network should be treated as a sunk cost

This principle means that prices for road use should not be increased to earn a financial return on historic or depreciated replacement cost valuations of past road investments

While it is clear how a financial return requirement on *new* investment improves resource allocation, it is not obvious how this would occur in the case of existing road infrastructure. Most of the investment that has gone into existing roads is a sunk cost. It cannot be recovered and re-deployed where it will earn a better return. Roads cannot be sold. Imposing a financial rate of return requirement on past investment in existing roads would only achieve an unearned transfer of wealth to road owners.

Nevertheless there is a case for requiring a return on an appropriate valuation of the existing investment in roads. This case is based on maintaining the existing balance of competition with other modes, and is discussed under the next principle.

Principle 7

The appropriate valuation method for the existing road network is an economic valuation based on existing prices.

An economic valuation of a business, is the price that someone would pay to obtain the future income stream from that business, or the amount that its assets could be sold for, whichever is higher. Strictly defined, an economic valuation is determined by calculating the discounted value of the future net cash flow that a business is expected to generate. Other valuation approaches such as depreciated replacement cost and even optimised depreciated replacement cost have been proposed but most have the disadvantage of being focused on past investment costs, and consequently of giving inappropriately high valuations for efficient pricing in most cases. These valuation methods might be appropriate for other purposes, e.g. future management performance monitoring, but not as a basis for setting prices for use of the existing road network.

The principle proposed above includes the constraint that the economic valuation for existing roads should be based on a continuation of existing road use prices. Existing prices for road use generate sufficient revenue to fund maintenance and new investment on a pay-as-you-go basis. If we change over to an approach of capitalising new investments, the portion of revenue that currently funds new investment can be considered as the appropriate financial return on the existing asset. This assumes that maintenance funding is sufficient to maintain the condition of the existing assets so that depreciation is zero. The discounted value of the portion of revenue that currently funds new investment is the economic valuation of the existing road network.

If the valuation of past investment was set at nil, prices for road use would initially reduce by the amount that is currently spent on capital investment and this would upset the competitive balance between the modes, towards roads. This would be just as inappropriate as an increase in prices.

If the valuation for the existing road network were set higher than the economic valuation as defined above, prices for using existing roads would need to increase. This would upset the competitive balance in favour of other modes such as air, coastal shipping, and particularly rail, and give windfall profits to these other modes. It would also suppress some efficient road use.

When the Government sold New Zealand Rail, in 1993, prospective purchasers would have given little attention to the book value of the business. They would have been much more interested in the discounted value of the future free cash-flow, and, as a back-up, the net realisable value of the assets they were acquiring, both of which were far lower than the past investment costs. They determined future cash flow by estimating future costs and prices. The prices they could charge were determined by the competition from roads and coastal shipping. In order to maintain the balance of competition with rail and other modes the existing road network should be valued on a similar basis.

The exception to this principle is when existing prices are less than short run marginal costs (primarily roads in congested areas and low strength rural local roads). In these cases prices should be set at short run marginal cost where practical. This will increase the economic valuation of the roads that are experiencing congestion because congestion is not a direct cost on the road owner. Future additional revenue from congestion pricing could be anticipated and built into the economic valuation.

If some uneconomic road links are currently being maintained, the cost of their upkeep should be left out of the valuation calculation and a nil value assigned. It should be assumed that a way will be found to reduce maintenance costs and increase prices on these links until they cover their costs, rather than continuing to fund them from revenue earned on other roads.

Where some roads can be closed and the land or structures used for other purposes without detracting from the value of adjacent land, these roads should also be valued at their value in the alternative use. This is not necessarily additional to the valuation based on net cash flow. The valuation for each link should be whichever is the higher. This might result in some roads on high value land being closed and used for other more valuable purposes.

It is important for the valuation to be forward looking. Prices for road use, and financial returns, and hence valuations, are likely to be higher in areas where demand is increasing and additional capital investment is required. In areas of low growth and adequate existing capacity, the valuation might be low and prices might only change in response to maintenance cost changes.

Note that this approach does not assume a long-term continuation of existing levels of road charges. It takes existing road charges as the least distortionary starting point, and then allows for adjustments from that base as new investment is added and existing assets are depreciated. The economic valuation would increase as prices were increased to short run costs, and then further as roads were upgraded onto new road formations.

and the full costs of these new investments were added to the valuation. As old road formations were bypassed and became obsolete they would be removed from the economic valuation. However, the valuation would not get as high as an optimised depreciated replacement cost valuation because there will be a significant proportion of existing roads which would never need to be replaced with new upgraded roads.

An objection to having different approaches for valuing and pricing new and existing infrastructure is that road users will all use the lower priced existing route. This overlooks that congestion pricing will have raised the price on the existing route to the long run marginal cost or higher by the time the new investment is made. If the new investment is made for reasons other than easing congestion then the price differential provides a good incentive to really question the demand for the new investment.

Principle 8

Spur roads should pay their way.

There is a commonly held view that the existing road network should be retained in its entirety and at the existing standard. Some of the potential gains of road reform will be missed if this view prevails.

Concerns have been expressed that road reform could result in the closing of many lowly trafficked roads. This is unlikely under the pricing principles described in this paper. Certainly the price to use some roads might increase and the standard of maintenance on some roads might need to reduce but spur roads are unlikely to be closed no matter how few properties they serve. This is because there is a large store of willingness-to-pay in the properties served by spur roads. As the roads are the only access for shipping out the produce from these properties the owners will be willing to pay considerably more than current uniform prices to use these roads if that is necessary to pay for their on-going maintenance.

On the spur roads in question maintenance is likely to be all that needs to be paid for. The roads currently cost more to maintain than they generate in revenue through uniform charges so under the valuation method proposed they have nil value and the financial return component of prices will also be nil. Being low volume roads they are unlikely to need expanding or upgrading in the foreseeable future so long run costs will be the same as short run costs. The only costs associated with these roads are the costs of routine and periodic maintenance - grading and re-graveling and culvert cleaning. Figures obtained from Transfund New Zealand indicate that on-going maintenance costs on many unsealed low volume roads are as low as \$200 - \$500 per kilometre per year for roads carrying up to 50 vehicles per day. Prices for using most spur roads would need to be increased to cover such costs. If link-based prices to cover these costs are higher than the users' willingness-to-pay then the frequency of maintenance would need to be reduced until prices and willingness-to-pay are matched. The situations where road providers will not be able to find some level of maintenance that the users of the road are willing to pay are likely to be rare.

Removing cross-subsidies for maintenance of low volume rural roads might have some environmental benefits in addition to avoiding the costs on road users elsewhere who have to fund the subsidies. Salmon (1996) observed that subsidised road maintenance enables barely viable sheep and beef farms to survive on difficult sites where they continue to cause significant degradation of soil and water resources which the farmers cannot afford to mitigate.

Furthermore the subsidies become built into property values. The tendency of farmers to pay too much for land relative to its productive potential drives debt and over-exploitation. The subsidies lead to investment decisions based on incorrect information and net welfare is reduced. The artificially inflated land value is a barrier to acquisition by more sustainable land users such as forestry investors.

The news is not all bad for road users on low volume rural roads. Most trips use a series of roads links. For example a trip into the nearest town might use a spur road, a rural collector, and possibly a state highway. The total cost of such longer trips might not differ much from the cost based on existing uniform prices.

With networks spur lines are sometimes operated at a loss if they feed valuable business into the core part of the network where marginal costs are low relative to the prices that can be charged. This will not be possible if principles two and five are followed because the price for each segment will be related to its costs and the price will not exceed economic costs. There will not be any links where the road provider can earn a margin over cost.

It has been suggested that some roads might have an option value. For example there might be roads in distant parts of the country that people in the main cities are prepared to contribute towards on the off-chance that they might want to use them one day. There is evidence that this proposition might have some validity (A survey in 1997 by the Roothing Advisory Group). However, measuring any such value would be extremely difficult, and levying it fairly on those people who are willing to make such a contribution but not on other people would also be difficult. The simplest solution is to let people pay their option value in a lump sum when they actually use the roads in question. In other words instead of many non-users making small contributions every year the road should be paid for by higher charges on actual users when they decide to exercise their option.

Low volume links that have alternative routes are a different matter from spur roads. There may well be some pairs of links which are close substitutes and which are both under-utilised. The disbenefits of closing one link of the pair might be small compared with costs of continuing to maintain it. If attributable costs are 25 percent or less of total costs on rural roads (Martin 1997) then link based prices to use the remaining link might be expected to reduce by about 40 percent.

Conclusions

This paper has argued that, because of strong natural monopoly characteristics, road providers operating on commercial principles might not have the right incentives to set efficient prices (prices that maximize net national welfare) for road use. If road prices differ from efficient levels some of the potential gains of road reform will not be realised.

A possible set of principles has been described that the Government could specify for determining prices for road use so that future commercial road providers would know what is expected and so that the Government's regulatory agency has a baseline for assessing such road providers' pricing policies.

The pricing principles suggested in this paper are:

- Prices for road use should be set at a level that covers all economic costs including a financial return on capital invested in roads.
- Prices for road use should not exceed economic costs.
- The required financial return on investment should not be obtained by applying a pro-rata surcharge uniformly across all prices for road use.
- Prices for road use should be based on a balance between short run marginal costs and long run marginal costs.
- Prices for road use should be matched as closely as possible to costs of using each road segment.
- For the purposes of setting prices for road use the existing road network should be treated as a sunk cost.
- The appropriate valuation method for the existing road network is an economic valuation based on existing prices.
- Spur roads should pay their way.

If prices for road use are lower than the levels given by these principles people will travel too much causing unnecessary congestion and environmental costs and urban sprawl. Also road providers might spend too much on extra road capacity in response to this demand, crowding out investment in other more productive parts of the economy. Conversely, if road prices are higher than efficient levels, and investment too low, some worthwhile travel will be suppressed and costs to businesses will be high.

It is unlikely to be practical to adopt these principles completely. However, they provide a direction in which to move as technology and political acceptability allow.

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