Toll forecasts

Big numbers win prizes

Twenty-one ways to inflate toll road traffic and revenue forecasts. By **Robert Bain**.

A number of high profile investor-financed toll roads around the world are currently failing to meet expectations. This has less to do with the present economic climate and more to do with a market readiness to be seduced by hopelessly optimistic traffic and revenue projections; with lenders relying too heavily on elaborate transaction structuring for protection. The time is right for a paradigm shift with a renewed emphasis placed on understanding the demand fundamentals and less willingness to accept forecasts at face value – especially those that resemble statements of advocacy rather than unbiased predictions.

The evaluation criteria used to award many of today's toll road concessions focus on maximising income – or minimising expenditure – for promoters. These criteria establish the rules of the game. Bidders are incentivised to develop strategies that best respond to the criteria – framing their bids in a positive light and maximising their chances of winning the competition. Under such circumstances, traffic and revenue forecasts are bound to attract considerable attention.

Bidding strategy success and the ability to raise significant quantities of debt often rely on strong projections of demand; even beyond credibility in situations where the short-term benefits of winning overshadow any possible longer-term costs. This is true in cases where profits are front-loaded or where, for practical or reputational reasons, procuring agencies may be open to subsequent contractual renegotiation.

In short, the procurement process in general – and bid evaluation criteria specifically – reward high traffic and revenue forecasts, not accurate ones. This places asymmetric pressure on traffic advisers in terms of the outputs from their forecasting models. In this context, the following article summarises 21 ways in which toll road traffic and revenue projections can be inflated – tricks for investors to watch out for.

Flatter the asset

The representation of a toll road in a traffic model may be flattered in various ways. An incomplete treatment of the delays that drivers experience at toll collection stations or upon leaving the toll road (and re-joining a congested toll-free network) makes the toll road more attractive to potential users. So does exaggerating the capacity per lane. Traffic modellers commonly employ assumptions about how the capacity of a toll facility will increase in future years despite its geometry and configuration remaining unchanged! This is supposed to reflect the fact that driver behaviour adapts over time such that the "effective" capacity of a road will increase. Naturally, this improves the attractiveness of the asset. Evidence should be provided by traffic advisers to support such assumptions if they are to be incorporated in base case traffic models.

An alternative approach is to impair the competitive landscape. The competitive position of a toll road will appear to be strong in circumstances where the alternative facilities offer particularly poor levels of service to users. This can be achieved by degrading a competing route's capacity through the use of punitive speed/flow relationships or speed limits, or by over-emphasising delays (such as those experienced at signalised intersections). It can also be achieved by over-simplifying the competitive context – ignoring important rat-runs in an urban network or by neglecting the potential for competition from other roads or transportation modes in the future.

Cherry-pick your planning variables

The future-year socio-demographic and planning variables that are used by traffic models are commonly presented as ranges. Consistent selection of values from the upper ends of these ranges will place upward pressure on the traffic numbers. This is one of the reasons why all of a model's input assumptions should be tabulated on a

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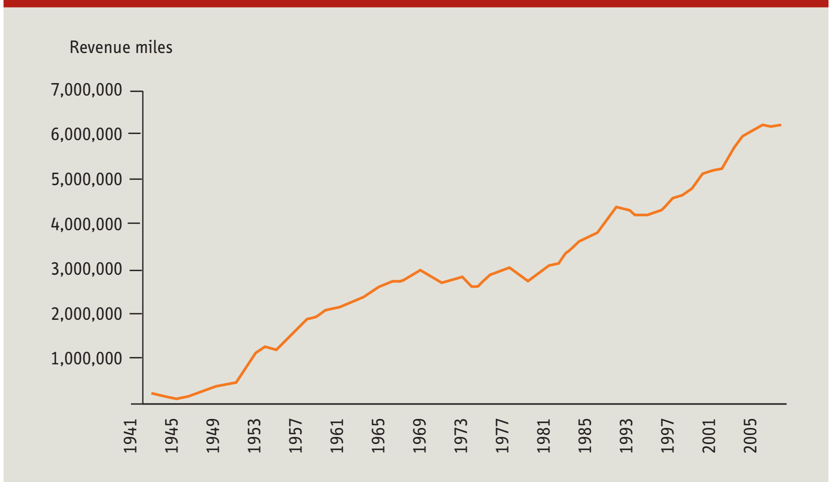
FIGURE 1 - TIME SERIES OF REVENUE MILES ON THE PENNSYLVANIA TURNPIKE



Source: www.paturnpike.com

Just because the model reports certain results does not mean that they have to be assumed to be credible.

single sheet and justified – with supporting evidence being provided by the traffic adviser.

A variation on this theme is the use of planning variables designed to achieve particular political objectives. A recent report reviewed talked of "planning targets". These seemingly independent and unbiased variables – such as projections of population – may be the basis upon which the state allocates funds to regional government. There are incentives for the producers of these planning forecasts to inflate their own projections, which in turn can be used to pump-up the traffic numbers. Understanding the source(s) of these "independent" socio-demographic and planning variables can help to mitigate this risk. Presenting alternative planning forecasts from different public and private sector sources also provides some comfort to investors.

Judiciously 'identify' the historical trend

With a time series of data – such as traffic or toll revenue – it is often possible to isolate different trends by carefully selecting the period to be analysed. Figure 1 shows the time series of revenue miles from the Pennsylvania Turnpike. From opening year (1941) to 2006 the compound annual growth rate was 5%. From 1952 to 2006 the rate was only 3%. However, in terms of supporting high traffic forecasts, from 1943 to 2006 the rate was a very useful 7%. These different growth rates are all derived from the same historical data set – just different parts of it.

Selectively apply or report growth factors

Traffic and revenue study reports commonly provide area-wide statistics in support of their forecasts. A report might state that, across the study area from 2010 to 2030, average population growth of 1.2% per annum is predicted. This appears reasonable – possibly even conservative. But what about the distribution of this growth? If the model is specified such that most of the population growth takes place in zones adjacent to or that feed the toll road, it would be no surprise to find high traffic growth rates resulting on the asset itself – usually considerably higher than 1.2% per annum!

The future will look exactly like the past

Some toll road forecasts are made against a backdrop of strong historical traffic growth trends. Why should such trends continue unabated for the next 25–30 years or beyond? And what about historical relationships – such as the elasticity between GDP growth and traffic growth? Why should this relationship remain constant throughout the forecasting horizon? These are for the traffic forecaster to justify – particularly if senior debt accretes or debt amortisation schedules are back-ended. In the absence of solid justification, base case forecasts should be adjusted accordingly to reflect the increasing uncertainty associated with long-range projections and sensitivity tests should be used to evaluate the impact of key relationships that could change in the future.

The future will look nothing like the past

A recent traffic and revenue study reviewed by the author demonstrated clearly that historical traffic growth across the study area had neither been strong nor consistent. Along some key corridors traffic volumes had been declining. Yet the future, according to the traffic forecasts, was one of strong, sustained growth. No explanation was provided for this dramatic disconnect between the past and the future. At best this hints of model-blindness. The traffic adviser has been engrossed in the mechanics of model building to the extent that they become blind to the credibility of the model outputs. Other symptoms of possible model blindness recently noted include low growth scenarios that resulted in traffic and revenue projections above the base case and severe downside sensitivity tests that had little impact on project revenues. Just because the model reports certain results does not mean that they have to be assumed to be credible.

Using seasonality to your advantage

Traffic surveys should be conducted on neutral days and during neutral months of the year. These are ones that are typical in terms of trip-making patterns and traffic conditions. This is not always possible, but failure to take proper account of factors such as seasonal variations can lead to erroneous modelling results. Figure 2 shows the impact of seasonality on roads in Cornwall – a popular tourist destination in the southwest of England – and compares traffic patterns there with the UK average.

Whereas the national trend demonstrates some seasonality, it is mild in comparison with that recorded in

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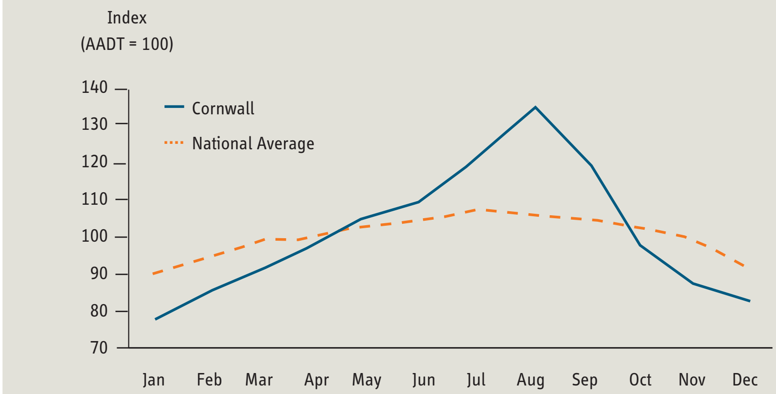
FIGURE 2 - EXAMPLE OF SEASONALITY



Note: AADT = Annual Average Daily Traffic

TABLE 1 - JOURNEY TIME SURVEY RESULTS

		All journey times in minutes			
Run 1	**Run 2**	**Run 3**	**Run 4**	**Run 5**	**Average**
17	11	14	6	12	12
17	11	14	n/a	12	13.5

TABLE 2 - EXPANSION FACTORS AND THEIR INFLUENCE

Expansion factors	Scenario A	Scenario B
AM peak hour as a fraction of weekday daily traffic	1/8	1/10
Weekday daily traffic as a fraction of annual traffic	1/250	1/275
Annual revenue	**$4.8m**	**$6.6m**

Cornwall. Traffic in Cornwall in August is 35% higher than the annual average. Figure 2 shows just how atypical certain months of the year can be. Days of the week can demonstrate similar variability. Compare market-day traffic with that from an average weekday. Without appropriate adjustment, surveys conducted on atypically busy days or during atypically busy months will overstate the amount of trip-making in an area and will lead to higher projections of traffic.

Remove inconvenient truths

This is best illustrated by example. Take a journey time survey involving five separate runs along a toll-free alternative to a proposed toll road. The run times are shown in Table 1.

The run time average is 12 minutes (top line). However, Run 4 was quicker than the others by some margin. If this is treated as an outlier – and is discarded – the average run time becomes 13.5 minutes (bottom line). This is useful as it degrades the attractiveness of the alternative facility and boosts the competitive standing of the toll road. The difference between 12 and 13.5 minutes may appear insignificant, but some demand estimation techniques are very sensitive to small changes in the characteristics of competing alternatives. These small changes can have a disproportionate impact on the percentage of traffic projected to use the toll road. Traffic advisers should report how stable their estimates of market capture are to small changes in the competitive landscape – but seldom do.

Design surveys to return the required results

Transport researchers acknowledge that it is possible to achieve specific results from some survey types through judicious design and administration. Similarly, it is possible to bias the results through poor design and administration. This is particularly true in the case of Stated Preference surveys, where respondents' choices between alternative travel options are influenced by factors such as how those options are portrayed, the range of attribute levels presented and the absence of any opt-out choice (forcing an outcome on respondents).

This is not to suggest that Stated Preference techniques are inherently flawed. Good practitioners are alert to these issues and should be able to minimise such influences. However, investors should look for some comfort in this regard – ensuring the use of experienced firms in this field – alert to the fact that it remains possible to affect survey output through the judicious contexting, selection and definition of the questions being asked to interviewees.

The magic of expansion/annualisation factors

Traffic models focus on critical times such as weekday AM peak periods – in part, for convenience. Expansion factors are then used to gross-up the results to annual estimates (toll revenue per year, for example). The smaller the modelled time period, the more emphasis is placed on expansion factors – and small changes to the factors can have a significant impact on the final revenue calculations. Say that a traffic model suggests that, during a weekday AM peak hour, 1,600 vehicles use a toll road paying an average of US$1.50. Two alternative sets of expansion factors are presented in Table 2 (Scenario A and B).

The expansion factors under Scenario A result in an annual revenue estimate of US$4.8m. Using the alternative – yet still plausible – factors under Scenario B, the revenue is US$6.6m (40% higher). This significant difference has nothing to do with the traffic model. It results from the use of different expansion factors. Traffic advisers should explain their choice of values used and should conduct and report the results from sensitivity tests if revenue projections appear to be particularly factor-dependent. Unlike the simple example presented here, the expansion process behind some forecasts can

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be complex. It is important that investors understand this process particularly well.

Assume that consumers act rationally

It is easy to underestimate the reluctance of some (sometimes many) drivers to paying tolls. Even in circumstances where the time savings appear attractive, it is possible to observe drivers sitting in heavily congested traffic conditions just to avoid paying a relatively modest charge. This may appear to defy logic – and be contrary to what a traffic models suggests – but it can be observed nevertheless. For this reason, investors should pay particular attention to any revealed preference data (from comparable facilities) presented in support of toll road projections – or the absence thereof.

Assume that consumers make the same choices

An urban toll bridge in San Juan, Puerto Rico illustrates this issue well. It caters mainly for commuter traffic heading for the capital's downtown business district. The tariff is US$1.50 (cars) and the traffic model over-estimated demand by 46% in the first year of operations. Subsequent analysis of travel patterns on the bridge revealed that commuters were not using the bridge in each direction, nor were they using it every day. Commuters were using the bridge selectively. They were more inclined to pay to hurry home than they were to pay to hurry to work – and this effect became more pronounced towards the end of the week.

The cost proposition in the traffic model was a one-off payment of US$1.50 (for x minutes of time saving). However, if commuters used the bridge twice a day, five days a week, the cost proposition was US$15/week. Although not captured by the model, this was the cost that drivers faced and responded to. Hence their selective use of the asset. Models that fail to capture such behaviour will produce inflated projections of traffic and revenue.

Hypothetical bias – A helping hand

Stated preference (SP) surveys are widely used in transport studies because they are one of the few techniques that can measure the market and non-market values associated with consumer products such as toll roads. The technique remains somewhat controversial. Investors cannot be certain of the accuracy of the SP value estimates since SP surveys are hypothetical in both the payment for and the provision of the service in question. Most research suggests that people overestimate the amount they would pay for a service when they do not have to back-up that choice with a real commitment (hard cash). This is called hypothetical bias and is well documented in both laboratory and field settings.

Researchers suggest that mean hypothetical values could be 2.5 to 3 times greater than actual cash payments would be. There are some limited contradictory findings that suggest that SP underestimates the amount that people would be willing to pay in real life. Notwithstanding, investors should be aware that there are professional concerns about SP and hypothetical bias – particularly when interviewees remain uncertain about their responses. The majority view is that, when present, hypothetical bias is likely to overstate (inflate) the consumer response. This is another reason why revealed preference data – hard evidence – should be provided alongside SP survey results whenever possible.

Grow your value of travel time savings

The value of travel time savings (VTTS) is a central concept in toll road demand studies. It is a large topic in itself. Here, we concentrate on just three aspects. The first is the concept of growth in the VTTS, as it is common for traffic consultants to use growth assumptions about the VTTS in toll road forecasting models. The underlying theory suggests that disposable income will grow – in real terms – in the future and hence the value attributed to time savings should also grow.

Forecasts of GDP are often used as a proxy for growth in disposable income, although the growth factor applied to VTTS may be higher (eg, 1.2x disposable income growth). Increasing the value of time savings boosts toll road usage in future years.

There may be arguments in support of such an approach – and these should be articulated – however, the impact of this growth is commonly material, and should be isolated and understood by funders who may feel that, in some situations, it has the scent of equity upside.

There is a second issue regarding time savings that is pertinent to mention here. It concerns small time savings. The conventional approach is to say that the driver who values a time saving of one hour at US$20 automatically values a saving of three minutes at US$1. This is known as the constant value approach and it has attracted a vocal body of critical opinion.

Researchers suggest that small amounts of saved time are inherently less useful than large amounts – particularly if you cannot do anything with the time saved – and that small time savings may go unnoticed (hence unvalued) by travellers. Assumptions about small time savings have a particular relevance in the context of short tolled sections of roads, bridges or tunnels. The recent revenue underperformance of some urban toll tunnels in Australia, for example, may in part be attributed to overestimating the price consumers are willing to pay to save relatively small amounts of travel time.

There is also the issue of VTTS in congested traffic conditions. Some traffic advisers maintain that the VTTS varies according to congestion levels and values over 1.5x the base value have been noted. Traffic advisers draw parallels with the value of waiting time in public transport models (which is typically higher than the value of trav-

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el time – reflecting the perception of time passing slowly while waiting). The impact is for more trips in the model to assign via the tolled facility and the effect – helpfully – compounds in the future as congestion intensifies across the network.

Overstating the toll road premium

Some traffic models incorporate the use of a toll road premium or bonus to capture the inherent attractiveness of toll roads. This suggests that if a toll road and its toll-free competitor are matched, taking account of the toll paid and the time saved, instead of traffic assigning on a 50:50 basis, proportionately more traffic will use the toll road. The premium is supposed to encapsulate those characteristics of the road not fully estimated in the model (softer attributes that are more difficult to quantify such as ride quality or perceived safety).

The impact of this premium is replicated in models that, alternatively, penalise links that compete with the toll road. The danger here lies in overestimating the premium – overstating the inherent attractiveness of the asset. This inflates revenues. Any toll road premium employed by traffic consultants should be made explicit and should be justified – to the extent of re-running the model in its absence to determine the contribution to revenues made by assumptions about the premium alone.

Overstating the yield

Yield refers to average revenue/vehicle. As most toll roads are dominated by private car use, the yield generally lies close to the car tariff. Because of the proportionately higher tariffs, the greater the contribution of trucks and buses to the traffic mix, the higher will be the yield. Overestimating the number of trucks using a toll road will disproportionately inflate aggregate revenues. This is a particular concern as truck usage of toll roads is notoriously challenging to predict and has often been overestimated. Yield calculations can also be overstated if unrealistic assumptions are made about the take-up of discount programmes. Similarly, unrealistic estimates of toll avoidance and/or exemptions will overstate yield. Investors need to understand not only what revenues are forecast, but the composition of these revenues and any (and all) assumptions underpinning them.

Reliance on speculative development

Future land use plans are a key traffic modelling input, but there may be questions about how committed some development proposals actually are. The reliance that can be placed on land use plans is a challenging issue in economies experiencing rapid growth – especially under less-regulated planning regimes – but it is also an issue in many developed countries. Purely speculative developments should be omitted from base case traffic forecasts. Similarly, developments expected to result from the building of new tolled facilities should be treated cautiously in terms of their contribution to traffic. Speculative and generated developments in toll road demand models simply serve to inflate the traffic and revenue projections.

The joy of induced demand

Building new highway infrastructure generates traffic, but the relationship is far from clear or consistent. Often, toll road traffic forecasters make an assumption about generated (induced) traffic and add this to their forecasts. An upwards adjustment of 10% is not uncommon – but it is seldom supported with evidence. Investors should identify if such an adjustment has been made to the traffic figures they are reviewing and then consider the evidence. In some circumstances the contribution from induced traffic has been removed from base case forecasts, reflecting the fact that considerable uncertainty surrounds this revenue contribution. As before, induced traffic helpfully serves to inflate project revenues.

Introduce your own toll discount

There is some evidence to suggest that, in terms oftoll road usage, drivers respond differently to different toll road payment media – particularly non-cash options. By using electronic toll collection (ETC) technologies, drivers do not have to pay the toll at the time/point of use. The charge is made to their credit card account and they are billed, in arrears, on a monthly basis. It is suggested that this encourages toll road usage above and beyond what would be expected from a cash-only operation.

To capture this effect, traffic modellers talk about a "perceived ETC discount" – the discount reflecting users' misperceptions of the price paid due to electronic tolling and the payment deferral. This is entirely separate from (and in addition to) any real discount enjoyed by ETC scheme patrons. In a recent study, the perceived ETC discount was set at 15% and tariffs were accordingly reduced to 0.85x their face value. Reducing the price encourages toll road use and inflates the traffic figures. Investors should look for evidence in support of perceived ETC discounts in traffic studies if they are to accept the use of artificially reduced tolls in base case projections.

Assume quick ramp-up

Ramp-up is the period upon the opening of a tolled facility when drivers experiment with new routes. It is a period often characterised by strong growth (from a low base) and it ends when trip-making patterns stabilise and evolve into more mature trends. It is notoriously difficult to predict in terms of its depth and duration.

Traffic consultants often assume a ramp-up profile based on instinct or weak evidence with questionable transferability. The use of instant or short ramp-up assumptions runs the danger of inflating early-year rev-

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enue forecasts. Ramp-up assumptions should be challenged to understand their underpinning rationale. It may be sensible to run sensitivity tests using alternative assumptions to ensure that the financing remains robust during the early years of project operations and throughout the remaining term of the concession.

Ignore physical capacity constraints

It may seem incredible that some forecasts have actually exceeded the physical capacity of their road (in terms of volume/lane/hour) but it has been noted – particularly when these forecasts result, not directly from traffic models, but from traffic model figures extrapolated into the future. Typically, no mention is made of widening or the costs (and disruption) involved in capacity expansion. Turning from volume/hour to volume/day, another phenomenon observed has been the fact that some forecasts of daily traffic (AADT) would required roads to operate at peak-hour congestion levels for over 12 (sometimes over 18) hours/day. These highly uncharacteristic flow profiles should certainly raise investor questions.

The recent development of managed lanes with dynamic pricing – particularly in the US – introduces concerns about how forecasts may exceed a highway's operational capacity. On some managed lanes, the tariff is adjusted based on the volume of traffic using the facility. As usage goes up, the toll goes up – with a view to constraining demand such that a certain level of service can be offered to drivers. Traffic forecasts recently reviewed from one project, however, were so high that they would have degraded the level of service to below that required contractually of the concessionaire.

High-occupancy vehicle (HOV) and HOV/toll (HOT) lanes – and other initiatives that fall under the "managed lane" concept – are relatively new and present particular methodological challenges to traffic modellers. They are commonly crudely or incompletely represented within the model – although this fact is seldom highlighted. Investors reviewing these more innovative tolling applications need to ensure that, in terms of modelling, traffic advisers explain clearly what has been achieved, how and – importantly – the limits of these achievements.

Commentary

The list of 21 ways in which toll road traffic and revenue forecasts can be inflated is not exhaustive. It is purely indicative. There are others – some of which are highly technical and would require forensic work to uncover (such as the careful positioning of centroid connectors). Other techniques are more general and rely upon clouding detail – such as obscuring daily traffic volumes (which people understand) by reporting vehicle kilometres/year (which no one can), or obscuring the relationship between traffic and revenue by simply reporting project revenues. This way, the recipient of the forecast has no idea how much traffic is supposed to be paying how much toll. The results cannot be sense-checked or compared with the findings from other studies.

Good traffic consultants know how to fine-tune their models. That is what model calibration is all about. In an environment where prizes are commonly awarded to the bidding team with the highest numbers, fine-tuning may be open to abuse. The purpose of the list is not to alarm investors. It simply demonstrates that it is perfectly possible to inflate the numbers for clients that want inflated numbers, and highlights some key issues to watch out for.

To knowingly inflate traffic and revenue projections is an act of deception – but it is not alone in that regard. Investors reviewing toll road studies should remain alert to two other potential acts of deceit. The first concerns sensitivity tests. Suspicions should arise when sensitivity tests have a limited adverse impact on project traffic or revenues. Under certain circumstances this is possible, but it is not the norm. Good explanations should be provided in support of such results.

The second act of deceit concerns the use of pseudoscience to infer a precision of foresight that is simply not supported by empirical evidence. Favoured ploys include the presentation of narrow confidence intervals around base case forecasts and the abuse of exceedance probabilities.

Traffic advisers sometimes talk in terms of P95 values – inferring that there is only a 5% probability of that particular number (traffic volume or revenue) not being achieved. However, these exceedance probabilities are unlike those associated with scientifically-measurable natural phenomena such as the measurement of wind to determine energy yield predictions for windfarm financings. At best, they result from consultants attempting to re-cast their traffic model in a simple probabilistic framework. At worst, they are simply guestimates.

Proper analysis of any traffic or toll revenue projections presented as probabilities requires a sound understanding of the probabilistic model construction, the probabilistic variables and their distributions and the correlations among the probabilistic variables. No comfort should ever be taken from P95 figures alone. If there really was as little uncertainty in the forecasts as some sensitivity tests, confidence intervals and P95s have suggested, traffic advisers could remove the legal disclaimers from their reports and could cancel their professional indemnity insurance. These trends have not been observed to date.

* Robert Bain runs his own consultancy providing technical support services to investors, insurers and infrastructure funds. This article is an abridged extract from his forthcoming book "Toll Road Traffic & Revenue Forecasts: An Interpreter's Guide". Further details are available from Rob at info@robbain.com.