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What happens to toll road ramp-up profile when there is an initial toll-free period, and the broader implications for demand forecasting

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Abstract

When a new transport facility opens, it takes some time for demand to grow and stabilise, as travellers adjust their trip patterns. This 'ramp-up' period is especially important for toll roads because it has significant financial implications for long-term profitability; and can provide an early indicator of likely forecast-versus-actual traffic levels. But there is little 'science' in ramp-up. Traditionally, forecast ramp-up profiles for new toll roads have been based on observed profiles for earlier toll roads in the some city or comparable cities. However there is a new and growing trend to have an initial 'toll-free' period as a 'soft opening' for new toll roads. This means that the 'traditional' ramp-up profile may no longer be valid. This paper examines the ramp-up behaviour of several recent toll roads in Australia that have all had an initial one month toll free period (including Sydney WestLink M7 and Melbourne EastLink). It then compares the observed profile with the 'traditional' profile; and discusses the findings and lessons for toll roads and demand forecasting in general.

1. Introduction

When a new transport facility or service opens, travel patterns do not reconfigure immediately; instead there is an adjustment period over which demand gradually rises to meet the long-term growth trend. A similar pattern of gradual take-up is observed for many consumer products (for instance, as expressed in product life cycle theory). In the case of transport demand, this initial adjustment process is known as 'ramp-up'. Ramp-up is observed for all kinds of new transport options but is especially important for toll road because it has significant financial implications for long-term profitability; and can provide an early indicator of likely forecast-versus-actual traffic levels.

Traditionally, motorists using a new toll road in Australia and other countries were required to pay the toll from Day 1. But in recent years in Australia this has changed, with most of the toll roads opened over the last five years offering an initial toll-free period of around one month as a 'soft opening'. This has included WestLink M7 and Lane Cove Tunnel in Sydney; EastLink in Melbourne; and Clem7 tunnel in Brisbane. The rationale has been explained by toll road operators as being "to allow as many motorists as possible to experience first-hand the motorway and the benefits it provides" (ConnectEast 2008). However there are also other factors likely to have influenced the decision to offer an initial toll-free period, including:

- construction completion ahead of schedule, providing a period when revenue was not expected anyway; and
- an opportunity to trial and get the bugs out of the electronic toll collection system, traffic management, and other systems under full opeational conditions.

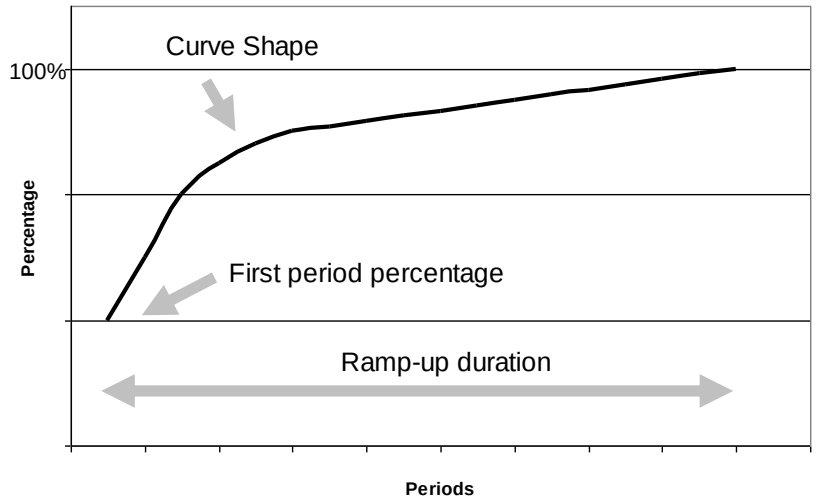
For several of these toll roads (particularly Sydney WestLink M7 and Melbourne EastLink), sufficient time has now elapsed since opening to enable a ramp-up profile to be constructed, and for the observed profile to be compared with the 'traditional' ramp-up profile for toll roads with no initial toll-free period. This paper is a first step towards understanding the ramp-up behaviour associated with an initial toll-free period. In particular, it examines the following research questions: whether the inclusion of an initial toll-free period materially affects ramp-up; what has the effect been; whether the 'traditional' ramp-up profile used for demand forecasting is still valid; and what are the findings and lessons for toll roads and demand forecasting in general.

2. Ramp-up

First some background on ramp-up. Immediately after the opening of a new transport facility or service, there is an adjustment period during which overall travel patterns rebalance as travellers become accustomed to the new travel opportunity. During this period, actual demand is generally less than expected under equilibrium conditions, but over time the difference reduces and eventually disappears. This process is called *ramp-up*. It is consistently observed in the early stages of operation of a new transport facility or service, and has become a routine part of the demand forecasting process, especially for toll roads.

Figure 1 shows a typical ramp-up profile for demand for a new transport facility, such as a toll road. Note that ramp-up is normally measured in terms of the ratio of actual demand to forecast equilibrium demand (percentage). This means that when forecasting demand for the initial adjustment period, the standard approach is to first develop a forecast under equilibrium assumptions (for instance from a traffic network model) and then adjust it down by multiplying by the assumed ramp-up percentage. Note that there may also be underlying changes in travel demand, for instance due to expansion of the overall travel market or price elasticity factors, but this is a separate issue and in the early stages of a new facility, observed demand will reflect both ramp-up and underlying behavioural and market factors.

Figure 1: Typical Ramp-up Profile



As shown in Figure 1, the key parameters of ramp-up are:

- the first period percentage (relative to the predicted equilibrium demand)
- the duration of the ramp-up periods in months or years
- the shape of the ramp-up curve (for instance, straight-line, convex or S-shaped)

Although standard ramp-up profiles are well-established in demand forecasting (as described below), there is little "science" behind ramp-up in terms of a comprehensive understanding of the underlying behavioural process; how they combined to produce the observed ramp-up profile; and how they can be influenced. In particular, the reasons and processes behind ramp-up are not well-understood but are likely to include factors such as:

- inherent inertia in human behaviour;
- a need to see the value-for-money proposition before changing travel habits. For instance, before a toll road opens the benefits can be talked about in terms of saved travel time or number of traffic signals avoided, but for many motorists these benefits are hypothetical and are not fully perceived until the road actually opens;
- initial or ongoing reluctance to pay for something that may have been perceived as previously being free and/or a general opposition to the concept of toll roads; and
- delay in obtaining an electronic tag (for fully electronic free-flow tolling).

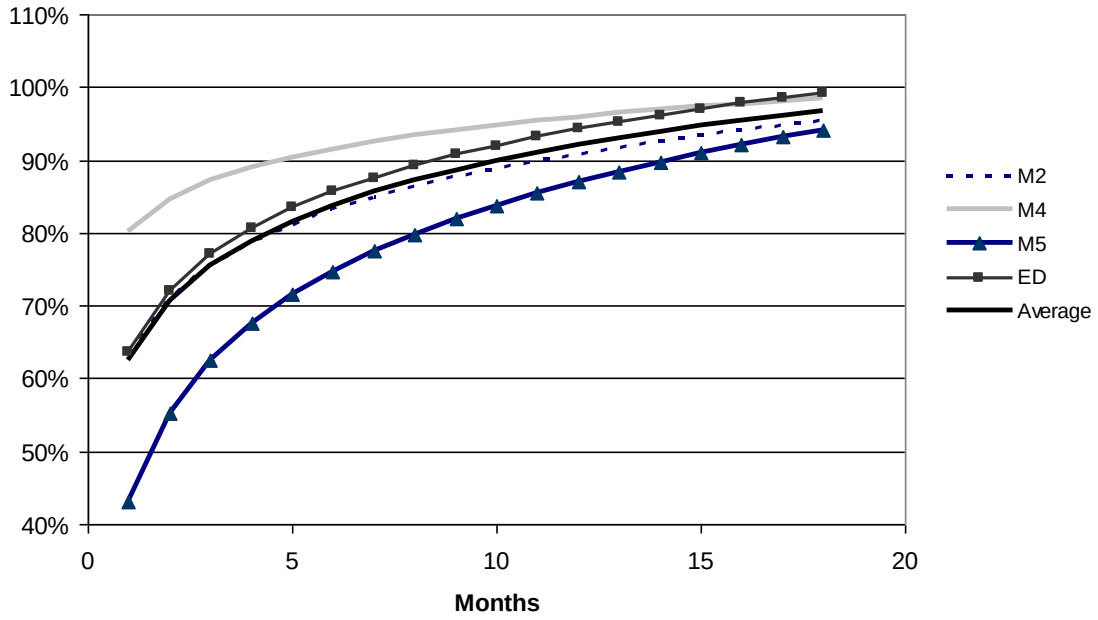
Instead of being based on a theoretical understanding or model of the underlying processes, ramp-up profiles used for demand forecasting are generally empirical. They are based on the observed ramp-up profiles for similar transport facilities in the same city or in comparable cities.

3. Observed ramp-up profiles

3.1 Toll roads

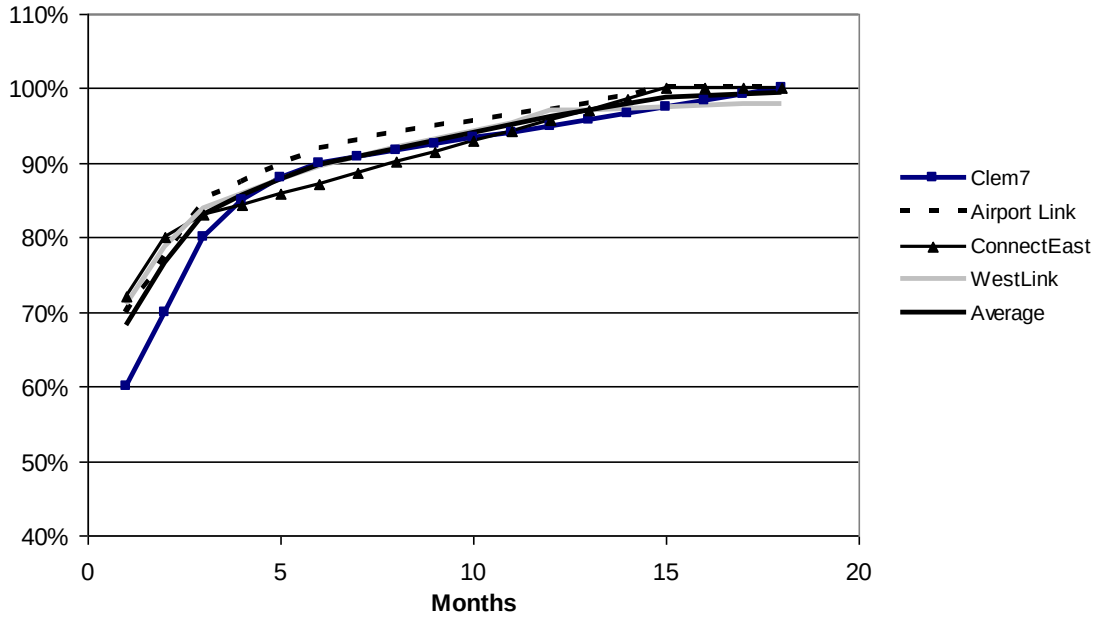
Over the last 20 years there have been around a dozen major toll roads built in Australia or currently under construction. Figure 2 shows actual ramp-up profiles for several toll roads in Sydney (RCM 2006b). The toll was applied from Day 1 of operation of these toll roads.

Figure 2: Observed ramp-up profiles for recent Australian toll roads



The “average” of these observed profiles is ramp-up that starts at around 65% in Month 1; is convex in shape; and is close to 100% after 18 months. Figure 3 shows the assumed ramp-up profile used for forecasting traffic for four of the most recent Australian toll roads to have been built or in-construction, namely WestLink M7 in Sydney, EastLink in Melbourne, and Clem7 and Airport Link in Brisbane. These profiles are derived from traffic forecast information contained in the Product Disclosure Statement for the roads (ConnectEast 2004; RCM 2006a,b; BrisConnections 2008) or information supplied to the Australian Stock Exchange (Transurban 2005). All relate to a situation in which the toll is applied from Day 1 of operation of the toll road. Note that the ramp-up profiles used for forecasting demand for WestLink, EastLink, Clem7 and Airport Link are based on the observed profiles for all earlier toll roads in Sydney and Melbourne, so to some extent are themselves influenced by observed profiles for Sydney M2, M4, M5 and Eastern Distributor shown in Figure 2.

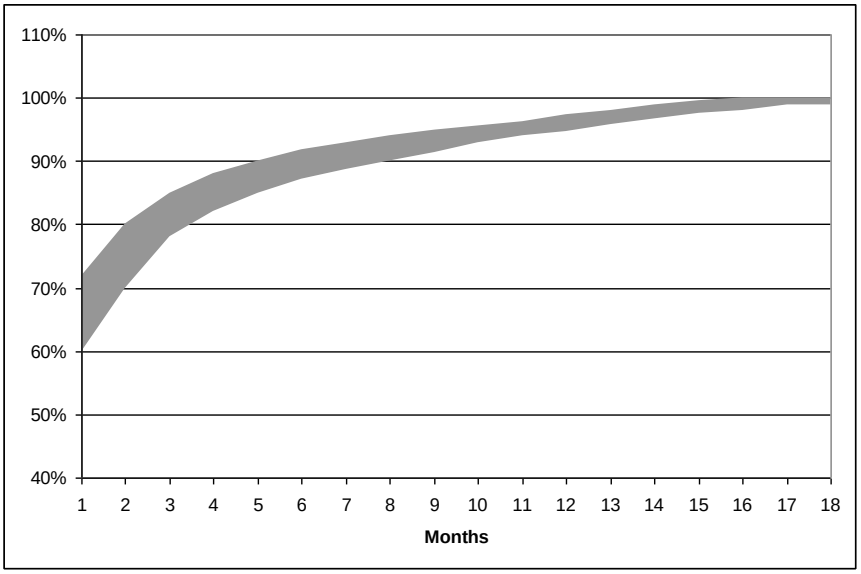
Figure 3: Forecast ramp-up profiles used for recent Australian toll roads



The actual and assumed ramp-up profiles shown in Figures 2 and 3 share a similar shape and define an envelope that characterises the “traditional” ramp-up profile of Australian toll roads during the era when toll charges when applied from Day 1. As shown in Figure 4, the key features of this “traditional” ramp-up profile are

- steep initial ramp-up with a convex profile;
- traffic start at around 60-75% of forecast steady-state patronage in Month 1;
- rising to around 90% by Month 6 and 95% by the end of the first year of operation; and
- ramp-up is complete by around 18 months after opening.

Figure 3: "Traditional" ramp-up profile for Australian toll roads



3.2 Transit Ramp-up

Although there has been less attention to transit ramp-up in the literature, transit systems also experience a ramp-up period, which can be compared with toll road profiles. Douglas (2003) reviewed ramp-up profiles for a sample of 13 rail and LRT start-up projects in Australia, NZ, Europe and Asia. The length and shape of the profile varied significantly but overall, the analysis concluded that reasonable rule-of-thumb factors are:

- 79% of forecast (steady state) patronage for year 1;
- 95% of forecast patronage for the second year; and
- steady state patronage is achieved from year 3 onwards.

The length of the ramp-up period may be longer than for toll roads, but overall, the shape and parameters for transit ramp-up are quite similar to standard ramp-up profiles for toll roads.

4. The effect of an initial toll-free period

As noted above, there has been a change in the opening strategy for toll roads in Australia. Prior to 2005, tolls were generally imposed from Day 1, but more recently, an initial toll-free period of around one month has become the norm. Since 2005 there have been two toll road start-ups in Australia (WestLink M7 and EastLink), which have included an initial non-toll period; provide regular publicly available reports of traffic statistics; and have been open for a sufficient length of time to enable an analysis of the actual ramp-up profile. In addition, there is sufficient published information about the Lane Cove Tunnel to enable a broad assessment of its ramp-up behaviour. This provides three case studies for examining the effect of an initial toll-free period and comparison against the "traditional" ramp-up profile.

4.1 WestLink M7

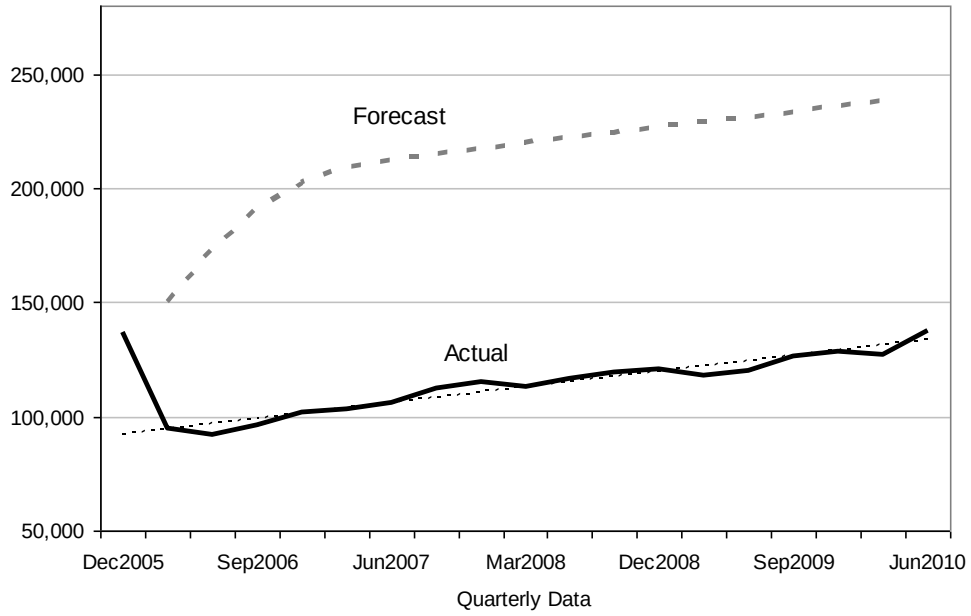
WestLink M7 is on the western outskirts of Sydney and is operated by Transurban. It opened in December 2005 with an initial one month toll free period from 16 December 2005 until 15 January 2006. Figure 5 shows the actual trend in average daily traffic for the first four years of operation (quarterly data). The chart also shows the Proponent's pre-opening traffic forecast which was presented to shareholders in 2004 (Transurban 2004). The data is derived from analysis of Transurban Australian Stock Market (ASX) reports and presentations to shareholders.

The main features of the WestLink M7 start-up and ramp-up behaviour are

- average daily traffic dropped by around 30% after the end of the toll-free period;
- almost five years after opening, traffic has now reached levels experienced during the toll-free period; and
- there is little evidence of the "traditional" ramp-up profile. After applying the toll, the trend in actual traffic volume was much more gradual and linear than the traditional profile.

It is also notable that compared to the pre-opening forecast (Transurban 2004), actual traffic during the toll-free period was approximately equal to forecast traffic for Year 1 and current traffic is around half of forecast levels.

Figure 5: WestLink M7 Traffic Data

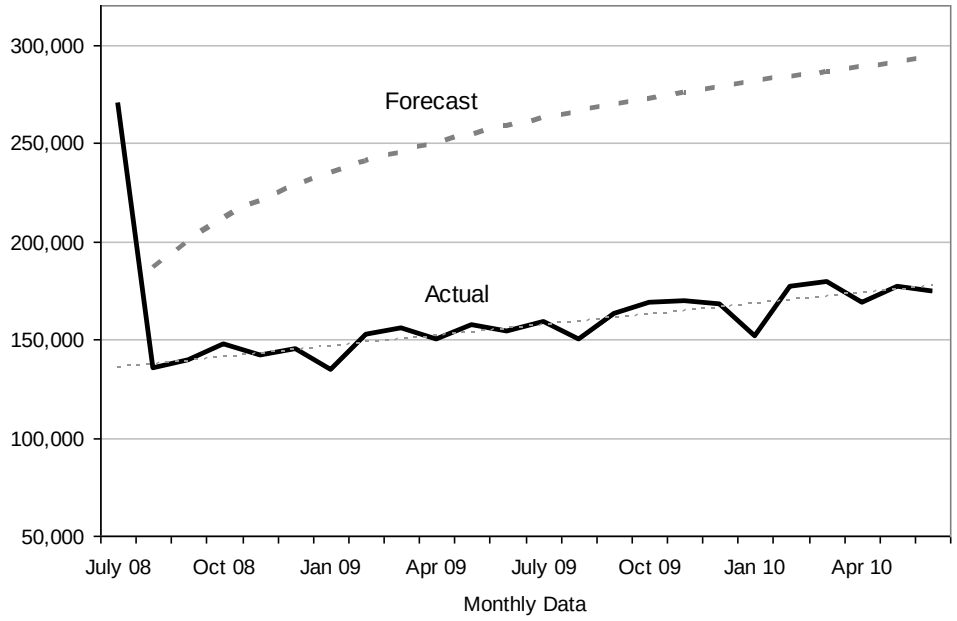


4.2 EastLink

EastLink is on the eastern outskirts of Melbourne and is operated by ConnectEast. It opened on 29 June 2008 with an initial 4-week toll free period. Figure 6 shows the trend in average daily traffic for the 18 months of operation (monthly data) and also shows the Proponent's pre-opening traffic forecast. The data is derived from analysis of ConnectEast ASX reports and the ConnectEast Product Disclosure Statement for investors (ConnectEast 2004).

Note that care should be taken in comparing Figures 5 and 6. They have the same vertical range but have a different range and scale for the time axis; EastLink data is monthly over 18 months while WestLink M7 is quarterly over 4 years.

Figure 6: EastLink Traffic Data



The main features of the EastLink start-up and ramp-up behaviour are

- average daily traffic dropped by 50% after the end of the toll-free period;
- actual traffic during the toll-free period was approximately equal to forecast traffic for Year 2; and
- traffic levels on EastLink have been growing rapidly (around 15% in the first year) but despite this rapid growth, there is little evidence of a “traditional” convex ramp-up profile. Instead the actual profile has fluctuated around straight-line growth, resulting in a longer and more gradual ramp up than the “traditional” profile.

In addition, available week-by-week data suggests some very tentative insights into demand trends during the toll-free period. It appears that traffic peaked in the first 1-2 weeks of the toll-free period and then settled back to a slightly lower level before dropping by 50% when the toll was applied. This indicates structure within the toll-free period as well as the overall structure of the ramp-up.

4.3 Lane Cove Tunnel

Lane Cove Tunnel (LCT) is on Sydney’s inner north shore. It opened in March 2007 with an initial one month toll free period. LCT is operated by the private company Connector Motorways and does not issue regular traffic statistics. However information available from public statements and newspaper articles indicates the following traffic trend during the ramp-up period:

- average daily traffic was around 75,000 trips per day during the toll-free period and this dropped to around 50,000 after the toll was applied (35% drop); and
- traffic levels over the first two years of operation fluctuated around 60,000 trips per day.

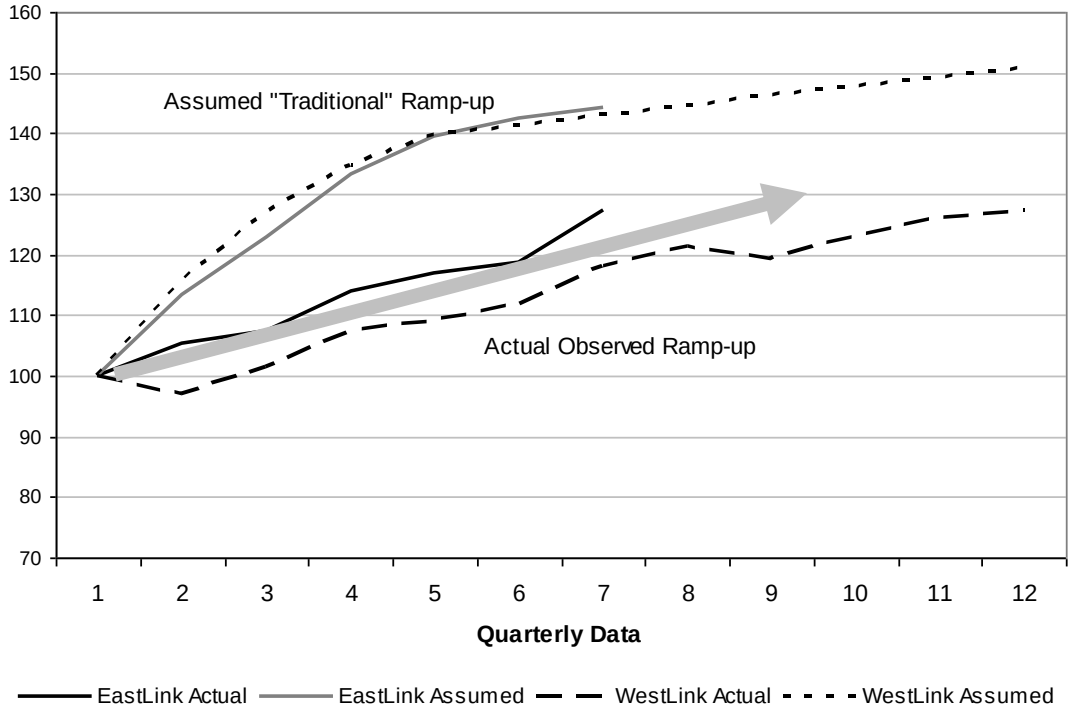
Again, there is evidence of a high level of curiosity during the toll-free period which does not translate into regular users in the short term, and little evidence of a steep ramp-up.

4.4 Overview of case studies

The conclusions to be drawn from the case studies come with several caveats. Firstly it is difficult to disentangle the ramp-up profile from other processes happening in parallel, such as underlying market growth and the effect of external factors such as volatile oil prices and the Global Financial Crisis. Secondly it must be recognised that two case studies and some broad information about the Lane Cove Tunnel is a meagre sample and more research needs to be done when data becomes available. However despite these caveats, there are several tentative conclusions that can be drawn about the effect of a toll-free period on ramp-up:

- traffic is likely to peak in the first 1-2 weeks of the toll-free period and then settle back to a slightly lower level for the remainder of the toll-free period. This behaviour has also been observed during the toll-free period of the Clem 7 tunnel in Brisbane (RCM ASX Releases) and is consistent with a large pent-up curiosity about the road that is satisfied quickly before usage patterns settle down;
- up to 30-50% of users during the toll-free period may be freeloaders or drivers who don't normally take that route but are curious about the road. These categories don't translate into regular users when the toll is applied, so a large drop in use follows the toll-free period; and
- ramp-up is likely to be longer and more gradual than the "traditional" convex profile and closer to a straight-line growth. Figure 7 shows the ramp-up used by the Proponents for forecasting demand for WestLink M7 and EastLink (on the assumption of tolling from Day 1) and the actual observed ramp-up after the toll was applied. The data has been converted to a common scale and starting point to reduce the effect of confounding factors such as optimism bias in the forecasts. Figure 7 highlights the effect of an initial toll-free period on changing the shape of the ramp-up curve. It is possible to speculate on the reasons for this change. Firstly, one of the effects of the toll-free period is to allow potential users to "test drive" the road, assess the value-for money proposition, and adjust their travel patterns before the toll is applied. This can happen more quickly and comprehensively during a toll-free period. The toll-free period also provides an opportunity for prospective regular users to get an electronic tag in the knowledge that the toll road provides them with value-for-money; and may accelerate the process of rebalancing the overall trip and traffic pattern. Together these factors pre-empt much of the early period of rapid change that occurs when a toll is applied from Day 1 and smooth out the following ramp-up.

Figure 6: Comparison of assumed and actual ramp-up for



5. Broader implications for demand forecasting

Forecasting of traffic on new toll roads and major public transport projects has come under considerable scrutiny in recent years, especially in relation to "optimism bias" which is reckoned to inflate toll road forecasts typically by around 20% (Bain et al 2002, 2003, 2004, 2005; Flyvbjerg 2005). However this is independent of the effect of ramp-up, so if the assumed ramp-up profile is not appropriate then there will be compounding errors. This situation will apply to forecasting demand for all kinds of transport facilities and services where ramp-up is expected.

Although more research is required for confirmation, the results of analysis of the case studies suggests the following findings and recommendations for demand forecasting:

- if there is an initial period when tolls (or charges/fares) are not applied then this will affect the subsequent ramp-up after toll collection begins. The "traditional" convex ramp-up profile is probably no longer a valid assumption, and a longer, slower, straighter ramp-up may be more appropriate (as shown in Figure 7). Other studies looking at worldwide experience of toll road forecasting have also shown that with or without a toll-free period, "Actual ramping-up, however, is often far less aggressive than is assumed, and can take many years." (Bain 2005)
- the observed ramp-up behavioural also means that with a toll-free period, it is invalid to take observed demand for an early period after charging commences and use it to project future demand by running up the "traditional" convex ramp-up curve. This will tend to over-estimate demand in the first 1-2 years of operation.
- a more speculative conclusion is that traffic levels during the toll-free period can be used as an early indicator of likely traffic immediately after tolls are applied. The way that the travel market responds to the toll road and toll-free period will depend very much on local

conditions, but a possible “rule-of-thumb” is that demand immediately after charging commences is likely to be around 50% of demand during the toll-free period (pessimistic) or up to 70% of demand during the toll-free period (optimistic). Although not specifically a ramp-up issue, the experience of the toll-free period also provides forecasters with an opportunity to recalibrate demand models based on revealed preference and update forecasts for subsequent tolled periods.

Whether or not there is an initial toll-free period can depend on many factors (such as timing of construction completion) that are not known with any certainty when demand forecasts are being produced. However if a toll-free period is a possibility that is contemplated, then sufficient evidence is accumulating to allow two different sets of forecasts to be prepared with assumptions appropriate to whether or not there is an initial toll-free period.

6. Conclusions

For many major new transport investments, offering an initial “toll free” period has become an established normal thing to do. The experience of toll roads in Australia that have had a toll-free period is that this substantially changes the demand profile in the start-up periods. Typically, demand peaks early in the toll-free period then settles down at a high but reduced level for the remainder of the toll-free period. When tolls are collected, demand drops back significantly (perhaps 30-50%) and then grows faster than general traffic on the network during the early years with a ramp-up profile that is longer and slower than the “traditional” convex ramp-up curve and is closer to straight-line growth. Although these conclusions have been developed by looking at toll roads, it is likely that they will also apply to major new transit investments.

This observed change in ramp-up also means that continuing to use the “traditional” convex profile will tend to over-estimate the speed of ramp-up in the first 1-2 years of operation. This will tend to compound with other errors in the demand forecasting such as ‘optimism bias”. If an initial charge-free period is planned, then updated assumptions about demand response and ramp-up behaviour should be applied to demand forecasting, rather than continuing to use the “traditional” ramp-up profile.

This paper does not resolve the lack of “science” behind the way that ramp-up is used in demand forecasting. However the change in ramp-up profile resulting from an initial toll-free period is a strong indicator that start-up pricing policy can influence longer-term ramp-up behaviour; and the need for further research to develop a more comprehensive understanding of the underlying behavioural processes.

References

ConnectEast (2004) *ConnectEast Mitcham-Frankston Project: Product Disclosure Statement*

ConnectEast (2008) *ConnectEast Annual Report*

Baeza, M.A. and Vassallo, J.M. (2008) Traffic Uncertainty in Toll Motorway Concessions in Spain: An analysis of the Ramp-up Period". *TRANSyT Working Paper* 2008-01-EN. Universidad Politécnica de Madrid, Spain.

Bain R and Wilkins M (2002), The Credit Implications of Traffic Risk in Start-Up Toll Facilities, August 2002, Standard & Poor's, London

Bain R and Plantagie JW (2003), Traffic Forecasting Risk: Study Update 2003, November 2003, Standard & Poor's, London

Bain R and Plantagie, JW (2004) Traffic Forecasting Risk: Study Update 2004, October 2004, Standard & Poor's, London.

Bain, R. and Polakovic, L (2005a) Traffic Forecasting Risk Study Update 2005: Through Ramp-up and Beyond. *Standard & Poor's RatingsDirect* August 2005

Bain, R. (2005b), Traffic Forecasting Risk: Through Ramp-Up and Beyond, Proceedings of the European Transport Conference, 3-5 October 2005, Strasbourg

BrisConnections (2008) *BrisConnections Airport Link Project: Product Disclosure Statement*

Douglas, N (2003) *Patronage Ramp-Up Factors for New Rail Services*. Unpublished report available from www.douglaseconomics.co.nz

Chatterjee, A and Kanj-Rae Ma (2009) Time taken for residents to adopt a new public transport service: examining heterogeneity through duration modelling. *Transportation* 36, 1-25.

Flyvbjerg, B (2005a) Measuring inaccuracy in travel demand forecasting: methodological considerations regarding ramp up and sampling. *Transportation Research* A 39, 522-530.

Flyvbjerg, B., Holm, M.K.S. and Buhl, S.L. (2005b) How (in)accurate are demand forecasts in public works projects? The case of transportation. *Journal of the American Planning Association*, 71(2)

RCM (2006a) *RiverCity Motorway: Product Disclosure Statement*

RCM (2006b) *RiverCity Motorway: Analyst Briefing Pack* September 2006

Transurban (2004) *Delivering Returns: Annual Results*. Transurban ASX Release, August 2004.

Transurban (2005) *Westlink M7 and M2 Site Tour Presentation*. Transurban ASX Release, August 2004.