**WORLD CONFERENCE ON TRANSPORT 2010**

# ENHANCING RAIL CAPACITY USING FREE FARE INCENTIVES TO SHIFT DEMAND PEAKS

Graham Currie[1]

[1]Corresponding Author

Tel: +61 3 9905 5574
Email: graham.currie@eng.monash.edu.au

Institute of Transport Studies
Department of Civil Engineering
Monash University
Building 60, CLAYTON VIC 3800
AUSTRALIA

## ABSTRACT

Major cities worldwide rely on rail to handle large volumes of commuter demand in the morning and evening peaks to efficiently address congestion and environmental concerns. However overcrowding of rail services has now become an endemic problem which acts to reduce attractiveness and constrain growth in rail commuting. New rolling stock and rail lines can address capacity concerns but are costly and can take considerable time to implement. There is a need to find a cheap and quick way to address rail overcrowding.

This paper explores the short and medium term outcomes of a new policy measure aimed at managing peak overloading of rail services implemented in Melbourne Australia from March, 2008. The aim of the program was to encourage peak rail passengers to shift travel to trains travelling before the morning peak by offering a free ticket called the ‘early bird’ ticket which is valid for travellers arriving in the CBD before 7:00a.m.

The program costs about $6M/€ 3.9M p.a. in lost fare revenues (2008) and around 8-9,000 passengers use the free early bird tickets each weekday. Ticket usage is increasing at a rate of 1.7% p.a. while overall rail usage has been relatively stable over the last year. In 2008 a survey found that 23% of free early bird ticket users had shifted their time of travel out of the peak, the equivalent of 2,000 to 2,600 passengers each peak.

Previous research in London developed the ‘Medium Term Growth Effect’ hypothesis which suggests that take-up of pre-a.m. peak travel will take time because passengers need to adjust life styles to enable early commuter travel. Analysis of early bird usage was consistent with this hypothesis since the proportion of all ridership using early bird is increasing by about 1.7% p.a..

Another hypothesis from previous research is the ‘Winter Dark Morning Effect’ which suggests that passengers will be less inclined to time shift commuter trips to before the peak in dark winter months. While there are some trends consistent with this theory in the analysis there was not much variation in the share of early bird users (around + and – 5% per month) and no overall link between darker winter months and lower usage was found. This may partly be due to the relatively lighter (and milder) winter mornings in Melbourne compared to Northern American and European cities. London for example has far colder and darker winter mornings due to its higher latitude. Hence winter effects may be larger in that context.

After the early bird was introduced an increase in rail loadings of 41% occurred for trains arriving in the city before 7:00a.m. The shift of peak demand has reduced the financial pressure of having to buy and operate new peak trains. Estimates place these savings at between 2.5 and 5.0 trains in 2008 to a high of 8.05 trains in 2038. Financial analysis suggests the savings in peak trains would substantively cover most or more than cover the financial costs of providing free fares before 7:00a.m. Wider economic benefits would likely also apply making the program economically beneficial even under a low impact scenario.

The paper concludes by suggesting key factors for success in applying a similar program in other railways as well as identifying areas for future research.

# 1 INTRODUCTION

Most major cities worldwide rely on rail to handle large volumes of commuter demand in the morning and evening peaks. While these systems provide congestion, efficiency and environmental benefits compared to auto travel, overcrowding of rail services has now become an endemic problem which constrains growth in rail commuting and deteriorates the attractiveness of rail to commuters. For example the New York subway, long considered overcrowded, has experienced over 50% ridership growth over the last decade at a quarter of all stations (Center for an Urban Future, 2009). Options to address capacity problems are limited since almost all the subway lines above 100% loading are also at maximum track capacity (Neuman, 2007). In the UK the share of a.m. peak rail services into London which are beyond capacity has increased from 3.7% to 4.8% between 2002 and 2006 (Office of the Rail Regulator, 2008). In Sydney, Australia, the share of trains above their 135% load factor standard increased from 6% in January 2004 to 16% in July 2008 (Independent Pricing and Regulatory Tribunal, 2008). In Melbourne the number of trains breaching peak contract loading standards increased by 500% between 2005 and 2007 (Eddington, 2008).

There are substantive challenges with conventional solutions to rail overcrowding in these contexts. If track capacity is available to run more trains then new trains require significant investment (e.g. up to $Aust 20M/ € 13M each to purchase) and require a procurement period of up to 5 years. Where there is no additional track capacity to run new trains building new lines is a common option for increasing capacity but this involves significant land purchase and/or tunnelling costing many $/€ billions and can take decades to implement. Since almost all authorities are facing difficult financial pressures, there is a significant need for cheaper and quicker solutions.

This paper explores the short and medium term outcomes of a new policy measure aimed at managing peak overloading of rail services implemented in Melbourne Australia from March, 2008. The aim of the program was to encourage peak rail passengers to shift travel to trains travelling before the morning peak using a free fare ticket called the 'early bird' ticket which is valid for travellers arriving in the CBD before 7:00a.m. This paper expands on earlier research examining the short term impacts of the program (Currie, 2010) by examining medium and longer term impacts of the program on peak travel behaviour.

The next section of the paper presents a short literature review concerning the use of fare policy measures as a means to manage peak travel demand. This includes the identification of some research questions raised by previous research which are explored in the paper. An outline of the Melbourne early bird ticket program is then presented followed by a review of research undertaken to explore the usage of the ticket and its impact on travel. An analysis is then undertaken exploring trends in ticket usage and seasonal effects. This also examines the programs impact on peak loading. An assessment then follows examining the value for money aspects of the program as a means of managing peak rail overloading. The paper concludes with a short summary of key findings, a discussion of what findings imply for rail authorities considering such a program plus some suggestions for future research related to this topic.

# 2 RESEARCH BACKGROUND

The use of fare discounts to shift peak period demand is not new however free fare discounts are rare. Discounted season tickets called 'early bird' tickets have been offered by the First Transpennine Express for trains arriving in Manchester before 7:30 (National Rail Enquiries, 2009). Another 'early bird' ticket has been offered on the overloaded London, Tilbury and Southend Railway for arrivals before 7:00a.m. (Kearns, 2000). In both cases these are discounted rather than free tickets. Inter-peak to peak fare differentiation is reasonably common around the world although its implementation to reduce peak loadings is rare (Fearnley, 2003).

Research examining the impacts of fare policies on peak loadings was undertaken by the UK's Strategic Rail Authority largely in response to the overloading challenges in the UK (Whelan and

Johnson, 2004). This explored increasing peak fares as well as reductions in off peak fares (free fares were not examined). The research found that increasing peak fare 10% reduces peak loading from 130% to 126% while increasing peak fare 30% reduces peak loading from 130% to 119%, only a small change from the 10% increase. Overall the research suggests that discounting off peak fares of 10%-30% only generates small reductions in peak load factors. The report recommended a combined strategy of increased peak fares and reduced off peak fares which would have a larger effect on ridership shifts and also act to balance operator viability. The research concluded that "more substantial reductions to train overcrowding can be achieved by increasing fare differentials between peak and off-peak travel" (Whelan and Johnson, 2004). While these findings support the view that peak/off peak fare differentials should be high, increasing peak fares is likely to be unpopular with riders.

Research in London has confirmed the need for large peak/off peak fare differentials to achieve reductions in peak travel (Transport for London, 2004). Based on a neutral revenue assumption, modelling estimated that a 3% switch in travel (representing about a year's growth) could be achieved by introducing a 40% peak/off peak fare differential however a 100% differential would be needed in the outer zone 3 area. The report concluded that substantial fare changes are required to make even small changes in demand.

In general US research presents very similar conclusions regarding the impact of differential peak/off peak fares on peak loadings. In a rare example, free interpeak fares were offered on largely bus based systems in Denver and Trenton and achieved a reduction in the share of ridership in the peak from 50% to 30% and from 68% to 55% respectively (McCollom and Pratt, 2004). Substantially smaller impacts were found for discounted rather than free fares. This research also suggests peak/off peak fare differential is important in achieving demand shifts but also notes that having a large pool of peak passengers who are willing to shift the timing of trips is also important.

Focus groups in London targeted rail commuters who might have the flexibility to retime commuting trips to other time periods (Passenger Focus, 2006). This found a substantive share of users (41%) could consider retiming trips to arrive outside the peak. Interestingly of these the majority would prefer retiming travel to before the morning peak (only 6% suggested after the peak). This research suggested two likely effects on travel behaviour of those retiming trips to before the a.m. peak;

1. Winter Dark Morning Effect - The study found that seasonal factors might well affect behaviour, with passengers less willing to travel earlier in the dark winter months.

2. Medium Term Growth Effect – The study also suggests that there may be time lag effects whereby passengers have to adjust life activities to enable an earlier commute time. On this basis adjustments to pre-peak travel might be larger in the medium-long term than the short term.

Another UK rail user study has confirmed many of the above findings (Faber Maunsell, 2007). A train user survey established that 56% of passengers had more flexibility to travel earlier rather than later (39%). It also found that "a simple fare reduction for the shoulder of the peak would be insufficient to overcome the time displacement effect except for those travellers making longer journeys and paying higher fares". Longer distance passengers were found to have greater potential to overcome time displacement penalties while shorter distance travellers need very significant fare benefits to overcome time shifting effects. It also found that those on higher incomes would have greater flexibility to time shift than lower income travellers. This is related to their ability to use flexitime work opportunities which are generally less available to blue collar workers.

Overall there has been no previous research or practice concerning the likely impacts of free fare policies as a means to shift peak demand to reduce rail overcrowding. However research has focussed on peak-interpeak fare differentials with several sources suggesting that very large differentials are needed to impact peak travel. Since free fares are in theory the largest discount possible it can argued that this research supports the free 'early bird' ticket concept. Several UK sources have illustrated the considerable capacity for commuters to retime travel outside of the peak. Two studies have suggested shifting peak demand to pre- a.m. peak travel is likely to yield a greater market than shifting demand to after the a.m. peak. These studies also generally support the concept of higher. They also suggest that longer distance passengers (those paying higher fares) are more likely to time shift from the peak than shorter distance passengers.

It has also been hypothesised that there may be a 'winter dark morning effect' whereby time shifting to the pre-peak is less during darker winter months. A 'medium term growth effect' suggests that due to difficulties in reorganising the timing of life activities time shifting to pre-peak travel may take longer to develop. These hypothesised behaviours are examined in the following sections assessing the behavioural impacts of the early bird ticket program in Melbourne.

## 3 THE MELBOURNE 'EARLY BIRD' TICKET PROGRAM AND CONTEXT

Melbourne is a city of 3.6 million people with a public transport system consisting of trains, tram and buses; 13% of all motorised trips use public transport (Department of Treasury and Finance, 2007). There are some 450M annual boardings on Melbourne's public transport system in total and 201M on the metropolitan railway (Department of Transport, 2009). The rail system is radial to the CBD and includes 15 lines. Ticketing is based on magnetic strip technology and fares are integrated between all modes[1]. Transfers involve validation of tickets on each boarding. There are two fare zones, an outer and an inner zone concentric to the CBD.

Rail travel in Melbourne over the last few decades has been booming. In the 15 years between 1993/4 and 2007/8 rail boardings have doubled in Melbourne with a 43% increase in ridership over the last 5 years (Department of Transport, 2009). More recently rail patronage has levelled off (analysis of rail ticket validations between July-Nov 2008 and July-Nov 2009 show a 1.2% decline although small modest growth emerges from examining intervening months in addition to this period. However it is clear that booming ridership is no longer occurring in the last year).

Contemporary growth in rail patronage has had a significant impact on crowding on trains in the morning peak. Between 2001 and 2007, severe breeches of contract loading standards increased from 4 to 23 per average peak with most of these increases occurring in the last 3 years[2] (Eddington, 2008). Load breaches on trains are based on an average train loading standard of 800 passengers per train. Seated capacity ranges from 528-536 per set with crush loading at 1,532-1,584.

The 'early bird' ticket provides free travel to passengers completing their journey before 7:00a.m. Use of the scheme requires passengers to obtain a multi-trip early bird ticket allowing 10 trips. These tickets are free but require validation on each trip. In this way usage of the ticket can be monitored. If trains scheduled to arrive before 7:00a.m. actually arrive after this, due to service disruptions, station staff are told to let passengers through ticket barriers using these tickets.

The 'early bird' ticket was firstly introduced on a trial basis on two lines (Sydenham and Frankston) on 29th October 2007. Full details of the performance of the trial are not published however evidence suggested (Lahey, 2008) that 27% of the 1,500 passengers travelling on the trial lines before 7 a.m. had adjusted their travel to make use of the ticket (implying some 405 passengers). Clearly this was enough to encourage the government to make a full rollout of the program which proceeded to the full network on 31st March 2008.

The cost of the program, mainly lost revenue, was estimated at $Aust 12M over 2 years or around $Aust 6M p.a.(Department of Transport, 2009).

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[1] A smart card ticketing system called Myki was introduced in December 2009 but its introduction has not affected any of the travel examined in this paper.

[2] There were 38 average daily peak load breaches in May 2008, personal communication with the Victorian Department of Transport

## 4 EARLY BIRD TICKET USAGE BEHAVIOUR

Behavioural analysis of users of the early bird tickets is based on an analysis of ticket validation records and also from a survey of rail commuters making trips in the pre-a.m. peak and early a.m. peak. The survey took place in September 2008 (i.e. in the first year of full rollout of the program) and involved a random intercept of 901 rail users targeting travellers making trips which finish before 7:00a.m.. Interviews took place on platforms at selected stations between the start of services in the morning and 7:30 a.m. (Gaymer, 2008).

**Ticket Validation Trends**

Figure 1 shows the weekly take up rate of the early bird ticket over the period from first trial to end November 2009. These figures suggest that around 7,000 early bird validations a week (or 1,400 a weekday) were made during the trial however there is a slight trend to increasing validations over the trial period. The full roll out of the program in April 2007 saw the start of a ramp up period as ticket usage increased to a steady level at around July 2008. In 2008 for the period July-November average weekly usage was 43,037 per week or around 8,600 per weekday. There is a slight medium term trend to higher usage over time with average weekly usage of 43,764 per week (8,750 per weekday) for the equivalent period of July-November 2009, an increase of 1.7%.

**Time Shifting Behaviour of Ticket Users**

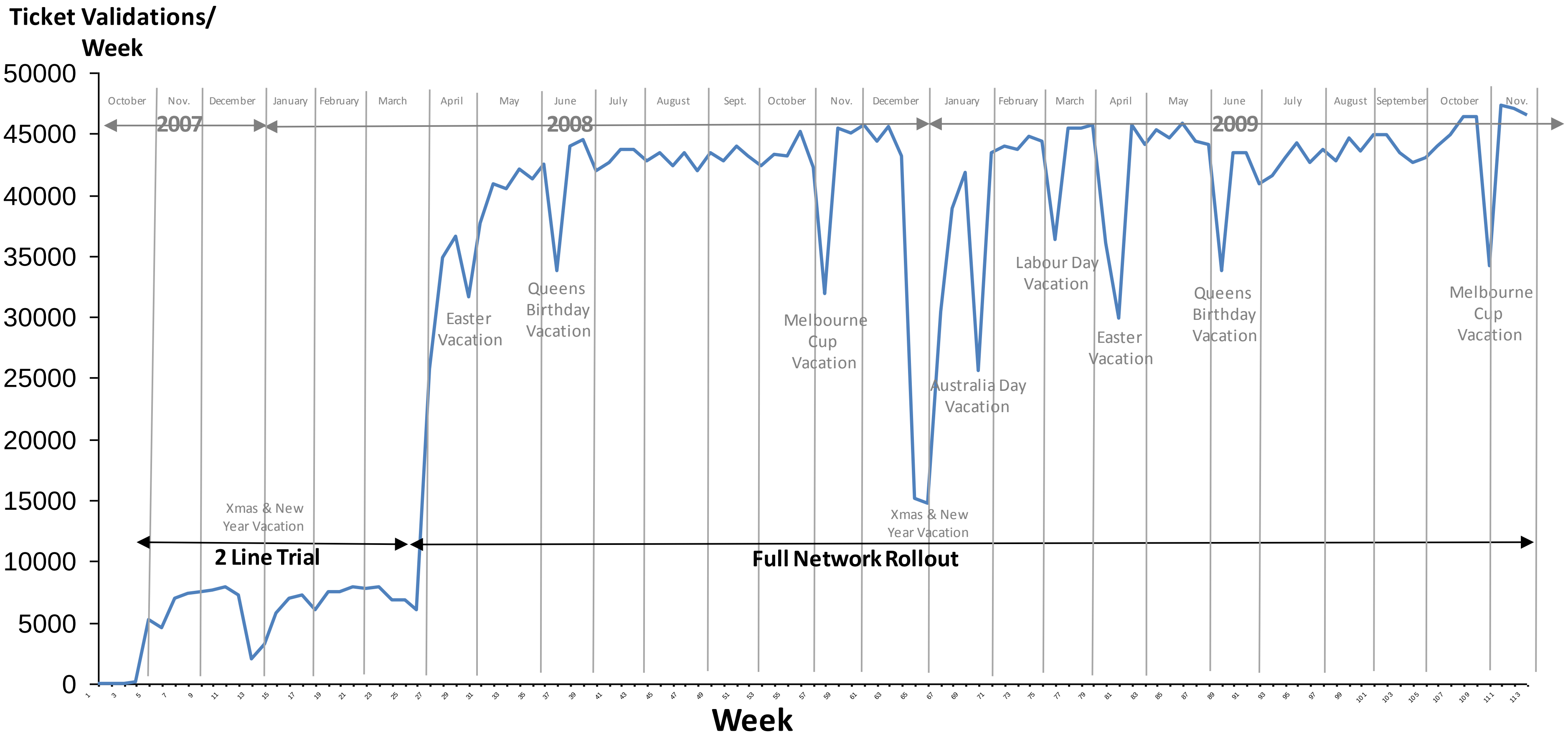
An intercept survey of rail users was undertaken to understand before and after travel impacts of the new ticket (Gaymer, 2008). The survey was undertaken 6 months after the ticket was introduced and users were asked to explain any changes in their travel that resulted. The ‘base case’ therefore represented travel before the ticket was introduced and the ‘option’ case, travel 6 months after introduction of the ticket. Before and after surveys of this kind are not perfect approaches to understand changes in behaviour since respondents often cannot recall previous behaviours. However the 6 month period enabled easier recall of previous (base case) general travel but also permitted some initial ramp up of demand and change in behaviour as a result of the ticket to occur. The survey contractor noted no cases where respondents did not remember previous travel behaviour prior to the ticket. A reasonably large sample was undertaken (901 interviews) to improve the robustness of the results with a sample frame designed to ensure a suitable coverage of inner and outer boarding stations based on known usage patterns.

The survey found that some 23% of early bird ticket users had shifted the timing of their trips from the peak to the pre-peak as a result of the ticket. The average time shift was -42 minutes with a range of between -5 mins and -120 mins.

The share of ticket users who had time shifted from the peak (23%) was less than found in the trial period on two routes (27% in Lahey, 2008). One possible reason for the difference is the longer distance travel undertaken on one of the two trial routes. The Frankston line is the longest rail line on the network. The intercept survey found strong evidence that uptake of the ticket was higher for longer distance travellers. Some 25% of early bird ticket users making the longer ‘zone 1-2 ticket’ trips made a time shift from the peak while only 14% of the shorter distance ‘zone 1’ ticket trips made a time shift from the peak. This evidence confirms the suggestion from previous research (Passenger Focus, 2006, Faber Maunsell, 2007) that longer distance (and higher fare passengers) are more likely to time shift as a result of fare discounts.

## 5 ANALYSIS

Three areas for analysis are considered. The first concerns an assessment of the short vs long term trends in use of the ticket to examine if the ‘Medium Term Growth Effect’ is occurring. The second concerns an analysis of seasonal variations in early bird ticket usage and its association with the time of dawn. This relates to the ‘Winter Dark Morning Effect’ which is again hypothesised from previous research. The final analysis examines the peak loading impacts of the early bird ticket program.




*Source: Analysis of Data from the Department of Transport, Victoria*

**Figure 1: Early Bird Ticket Validation History**

**Medium Term Growth Effect**

The hypothesis that there will be a delay in uptake of time shifting for commuters means that there should be higher uptake of 'early bird' tickets in the medium term compared to the short term. This requires an analysis of ticket usage trends however as Figure 1 demonstrates, ticket usage history is compounded by a 'ramp up' effect and a great deal of rail demand seasonality related largely to the timing of public holidays. Figures quoted above suggest a 1.7% growth in early bird validations (July-November, i.e. after ramp up) between 2008 and 2009. For the same period total rail validations (all tickets and all time periods) actually declined by 1.2% suggesting a higher medium term compared to short term uptake of the ticket. This would seem to confirm the 'Medium Term Growth Effect' hypothesis.

Figure 2 shows a more detailed analysis of monthly validations for the early bird, total rail travel and the share of early bird tickets. While there is much seasonality in the data set, it is clear that a year on year assessment (e.g. July to July) that an increase in usage of the ticket is occurring. In each case a simple linear regression trend is fitted which suggests a growth trend for both monthly early bird validations and total rail validations but overall the share of early bird validations is increasing. The share of variance explained by the regression is poor due to seasonality. Nevertheless the analysis suggests that the share of early bird validations is increasing by a rate equivalent to 0.06 of 1 percent share of tickets annually.

Overall each of the two sets of analyses undertaken confirm a medium term growth rate for both early bird ticket usage and the share of total rail users taking up the ticket. This is considered a reasonably robust conclusion from the data available at this time.

**Winter Dark Morning Effect**

This effect suggests that passengers will be less inclined to time shift commuter trips to before the peak on dark winter months. It was suggested by focus groups in London (Passenger Focus, 2006). Figure 2c shows the share of all rail trips using the early bird ticket by month. Shading illustrates the months where twilight (the time when it is officially light in the mornings) occurs after 6:30a.m (based on data from Geoscience Australia, 2010) [3]. In this case it is likely that an early bird passenger would spend at least some of their journey to work in the dark. At first glance this graph suggest that lower shares in early bird ticket usage occur during darker months however the pattern is by no means consistent. July 2008 and June 2009 have higher than trend shares and but represent mid-winter where mornings are darkest. In addition January 2009 has a below trend share of early bird tickets yet is mid-summer. The variation in share of early bird tickets by month is not large; between 1.62% and 1.82% i.e. a range of 0.2% or some 5% absolute variation in volume around the 2009 average. So if the 'Winter Dark Morning Effect' occurs it is unlikely to be a large effect.

Figure 3 shows an analysis of the monthly share of early bird tickets vs average monthly twilight time for the post ramp up period to the latest available month (November 2009). No clear relationship is apparent and indeed a simple regression analysis of the two variables suggest a very weak negative relationship i.e. that earlier twilight times generate lower not higher shares of early bird trips.

Overall this analysis does not support the 'Winter Dark Morning Effect' hypothesis. However two additional observations add some caution to this conclusion. Firstly the trend in Figure 2c is for a weak modest growth which might be confusing the analysis presented in Figure 3. Nevertheless it is clear that the 'Winter Dark Morning Effect' is weak since it varies monthly ticket volumes by only 5% from the average.

[3] Melbourne is located in the southern hemisphere and winter occurs mid year

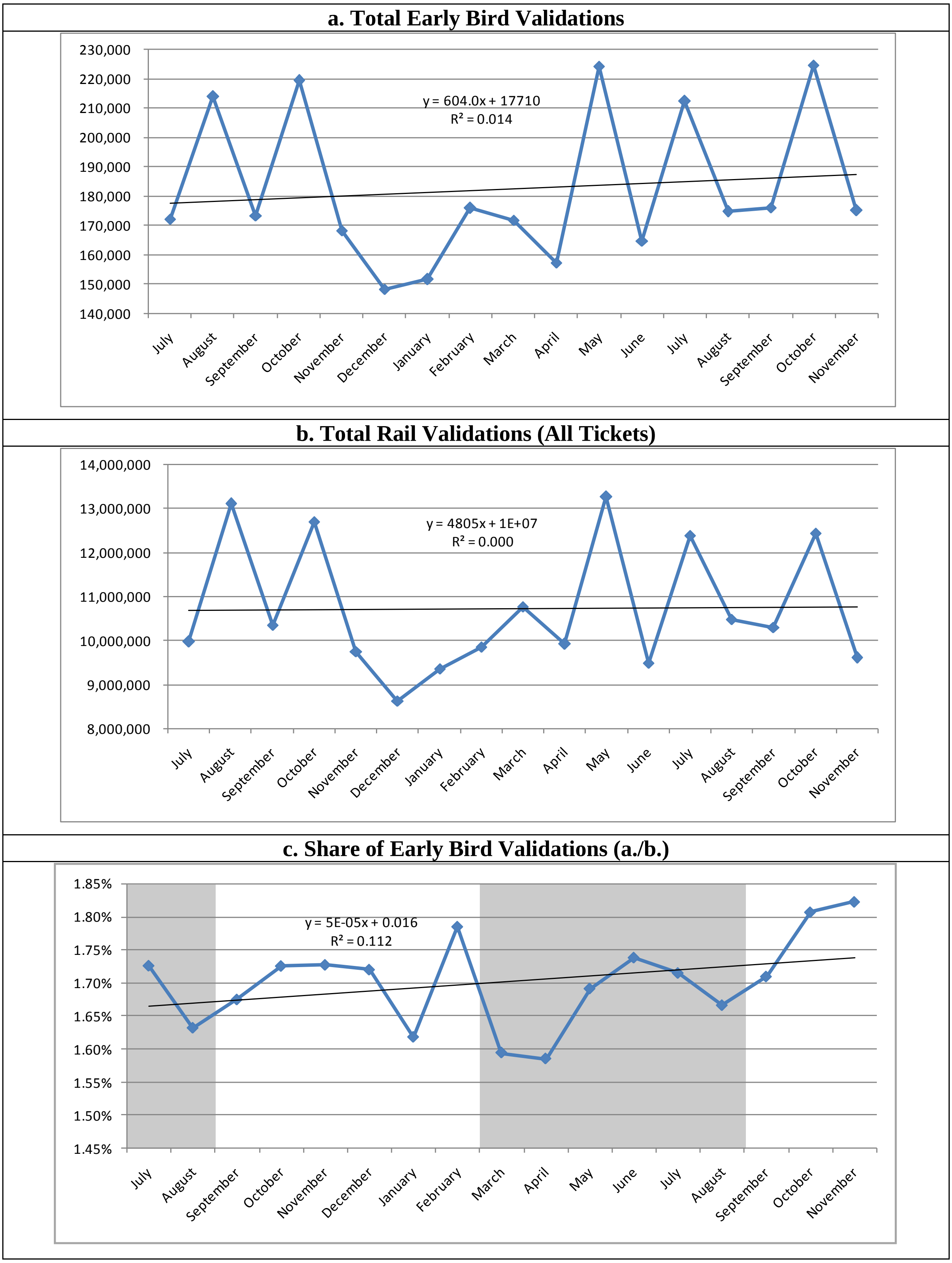



**Figure 2: Trends in Early Bird Monthly Validation History**

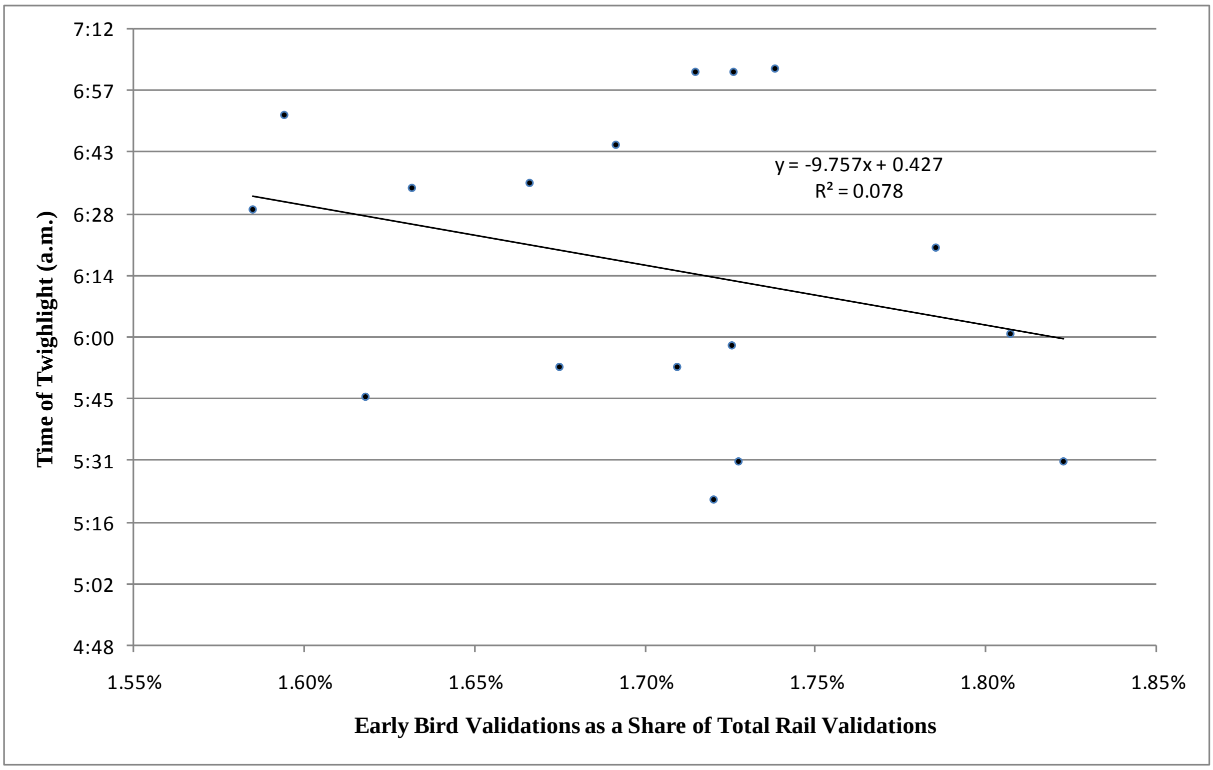



**Figure 3: Share of Early Bird Monthly Validations vs Twilight Time**

The second observation concerns the geographic location of Melbourne which lies at Latitude 37° 5`south of the equator. This is closer to the equator than northern American and European cities such as New York. As such the range of average monthly twilight times varies from 5:22 a.m. to 7:03 a.m. i.e. around 1 hour 41 minutes (Geoscience Australia, 2010). Northern and central European cities such as London have a much wider range of average monthly twilight times including much darker mornings. London average monthly twilight time varies from 4:19a.m. to 7:18a.m. i.e. almost 3 hours range or 70% larger than Melbourne (NMOC, 2010). The implication of this data is that darker mornings are less of an issue in Melbourne than they would be in cities like London or New York (which also experience harsher winter weather). This suggests that the null finding suggested for the 'Winter Dark Morning Effect' hypothesis might relate to the relatively moderate dark winter mornings in Melbourne. Harsher early mornings in Northern Europe and North America may present a more compelling environment for the 'Winter Dark Morning Effect' hypothesis.

## Peak Loading Impacts

Unfortunately only limited peak loading impact data is available and all is for the first year after implementation. Figure 4 illustrates the distribution of average train loadings on the network by rolling hour over the a.m. peak for October 2007 (before early bird) and for October 2008 (year after early bird and post 'ramp up'). These loadings are taken at the peak maximum loading point just as trains enter the city. Times indicated hence correspond to the times when early bird tickets are available i.e. a 7:01 time represents trains arriving in the city after eligible early bird tickets can be used (unless trains are arriving late compared to their schedule).

Train loads arriving in the city before 7:00a.m. have increased by 41% after early bird was introduced. This is higher, though fairly consistent with, the changes suggested by the 2008 intercept survey[5]. Figure 4 also shows many other changes in peak loadings which are unlikely to be related to the early bird ticket. Loads between 7:00-8:00 have increased by 56% i.e. more than any other time window.

[5] All the data indicates an increase in peak travel due to employment and population growth. This has occurred separately from the impacts of the early bird ticket and is not related to the tickets introduction.

The 7:30-8:30 loads have also increased but there are declines in those for the 8:00-9:00, 8:30-9:30 and 9:00 to 10:00 hours. While this could be associated with the early bird program it is by no means clear. The survey suggested that average time shifts for early bird users was 42 minutes. For the early bird ticket to reduce train loads after 8:00a.m. a time shift of at least 60 minutes would be needed. While the maximum time shift reported in the early bird user survey was 120mins it is clear this represented only a small share of those making time shifts.

It has been suggested that increases in train loads between 7-8a.m. could be a ‘cascade effect’ where travellers later in the peak (8-9a.m.) shift to early trains because more seats are available. The early bird ticket could have had an influence in creating these emptier trains but this is far from clear and the scale of the growth is well beyond any impact which the early bird ticket alone is having.

Overall these findings support the view that the early bird ticket has acted to increase ridership before 7:00 a.m. The evidence provides some support for the view that train loads during the peak have been reduced by the early bird program however the dominant shifts in behaviour seem to be towards earlier peak travel from later peak travel and early bird is unlikely to have been a major influence in this trend. It can be hypothesised that demand shifts may have occurred due to ‘cascading’ shifts in available capacity. While this seems plausible it is only a theory and requires further exploration to validate this effect.

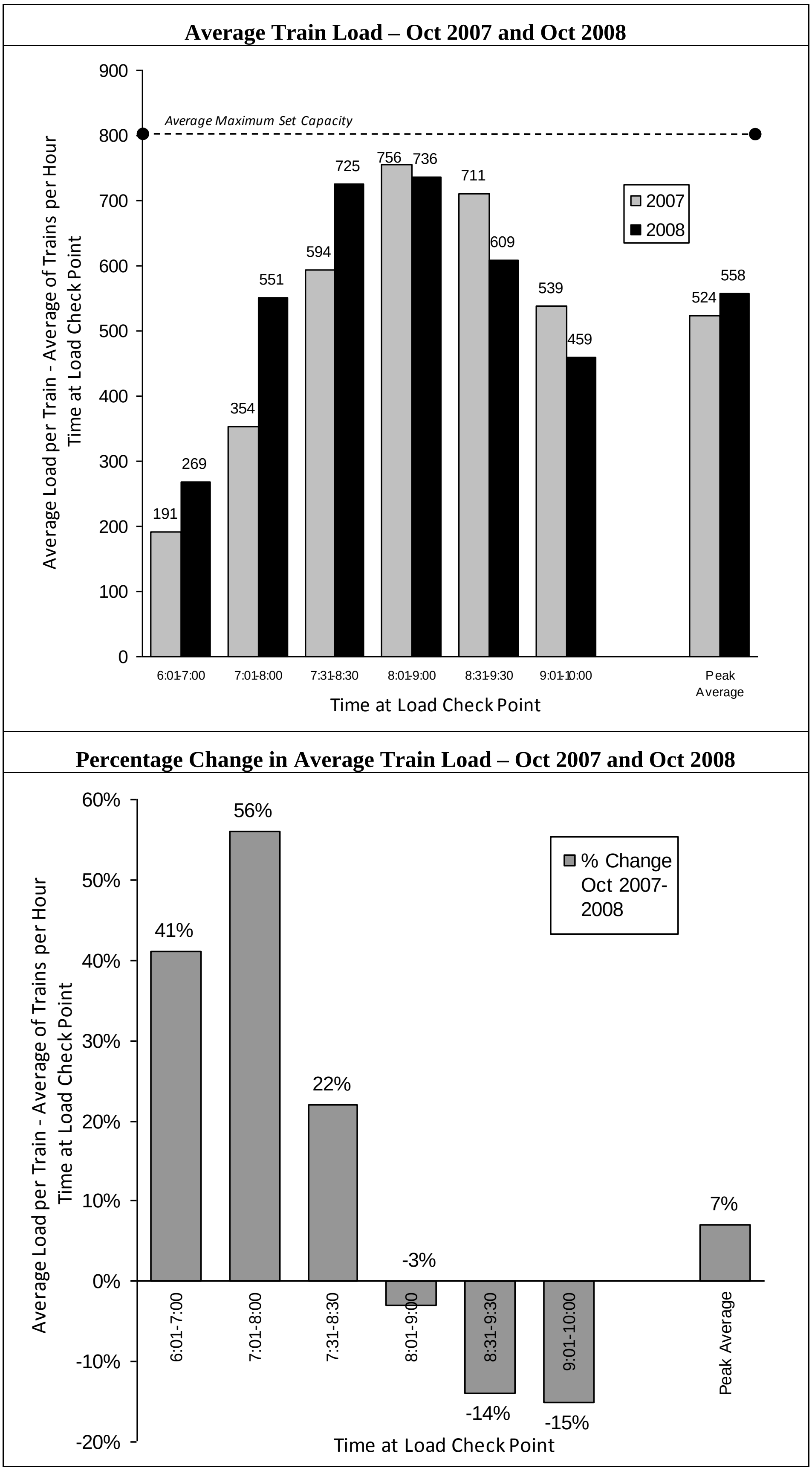



**Figure 4 : Change in Average Peak Train Loading – Before and After Early Bird (CBD Entrance Cordon)**

## 6 ASSESSMENT

So is the early bird ticket program worthwhile and did it achieve its aims? The central aim of the program was to relieve peak rail overcrowding. The intercept survey provides evidence that at least some time shifting of peak commuters is occurring. Some 23% of those using the ticket travelled an average of 42 minutes earlier than normal. The Department of Transport has estimated that this means that between 2,000 and 2,600 passengers shifted from peak trains to pre-peak trains (Gaymer, 2008). While in 2008 this represented only about 1.7% of all rail travellers (measured after ramp up) it is clear evidence of achievement of the schemes objectives at least to some extent.

This leaves the question of whether the program is worth the lost revenue resulting from providing free fares (estimated at $6M p.a. in 2008, (Department of Transport, 2009)). The regulating authority responsible for managing the program has suggested that the program ameliorates at least part of their need to buy new peak trains to cater for overloading problems. Table 1 shows various estimates of peak trains saved as a result of the commuter time shift resulting from the early bird program.

**Table 1: Estimates of Peak Demand and Peak Train Reductions from the early Bird Program**

| | Peak Demand Reduction | Peak Train Reduction | Basis of Estimate |
|---|---|---|---|
| **Short Term Impact (2008)** | | | |
| Low Demand – Overload Standard | 2,000 | 2.5 | • Low demand estimate made by Department of Transport (DoT) in 2008<br>• Peak train reduction based on applying average overloading standard per train of 800 |
| High Demand– Overload Standard | 2,600 | 3.3 | • High demand estimate made by DoT in 2008<br>• Peak train reduction based on applying average overloading standard per train of 800 |
| Low Demand- Average Load | 2,000 | 3.8 | • Low demand estimate made by DoT in 2008<br>• Peak train reduction based on applying average peak train load of 524 |
| High Demand- Average Load | 2,600 | 5.0 | • High demand estimate made by DoT in 2008<br>• Peak train reduction based on applying average peak train load of 524 |
| **Medium Term Impact (2014)** | | | |
| Low Demand plus Growth Trend – Overload Standard | 2,213 | 2.8 | • Starts from low demand estimate made by DoT in 2008<br>• Adopts growth trend of 1.7% growth in tickets p.a.<br>• Peak train reduction based on applying average overloading standard per train of 800 |
| High Demand plus Growth Trend – Average Load | 2,877 | 5.5 | • Starts from high demand estimate made by DoT in 2008<br>• Adopts growth trend of 1.7% growth in tickets p.a.<br>• Peak train reduction based on applying average peak train load of 524 |

The lowest short term estimate of peak trains saved is 2.5 (using overloading standards) while the highest is 5.0 (applying average loading standards). However there is clear evidence of growth in early bird ticket usage. Assuming the share of time shifting passengers remains constant (which is far from clear) then a low estimate of peak trains saved in 2014 would be 2.8 and a high 5.5. Fleet savings of this scale are considerable however increased ticket usage will increase the scale of the revenue loss from free fares. Table 2 presents a financial analysis of the program with low and high peak train impacts for a no growth and an average growth scenario for the share of early bird tickets.

**TABLE 2: Financial Assessment of the Free Before 7 Program**

| | Net Present Value (Discount rate 6%, 30 years, Australian Dollars) | | Notes |
|---|---|---|---|
| | Range of Benefits | | |
| | **Low Peak Impact** (2,000 pax initially time shift from peak – Overloading standard applied to estimate peak train savings) | **High Peak Impact** (2,500 pax initially time shift from peak – Average load standard applied to estimate peak train savings) | |
| **NO EARLY BIRD TICKET GROWTH** | | | |
| **Program Cost** | | | |
| Foregone Fare Revenue | $89M | $89M | • $A6M/€ 3.9M p.a. in foregone revenue |
| **Program Benefits** | | | |
| Reduced Annual Operating Costs | -$37M | -$74M | • $A1M/€ 0.6M p.a. reduced operating cost per peak train saved. Low is 2.5 trains high is 4.8 |
| Capital cost Savings | -$50M | -$100M | • $A20M/€ 13M saving per peak train saved |
| Sub-Total | -87M | -$174M | |
| **Performance** | | | |
| ***Net Present Value*** | ***-$2M*** | ***+85M*** | |
| ***Benefit Cost Ratio*** | ***.98*** | ***1.96*** | |
| **AVERAGE EARLY BIRD TICKET GROWTH** | | | |
| **Program Cost** | | | |
| Foregone Fare Revenue | $107M | $107M | • $A6M/€ 3.9M p.a. in foregone revenue in 2008 increasing by 1.7% p.a. over 30 years |
| **Program Benefits** | | | |
| Reduced Annual Operating Costs | -$46M | -$88M | • $A1M/€ 0.6M p.a. reduced operating cost per peak train saved. Low is 2.5 trains at year 1 increasing to a high 4.4 trains in year 30. High scenario is 5.0 trains in year 1 increasing to 8.05 trains in year 30 |
| Capital cost Savings | -$66M | -$127M | • $A20M/€ 13M saving per peak train saved. Marginal savings in capital are applied each year as saved trains increase |
| Sub-Total | -111M | -$214M | |
| **Performance** | | | |
| ***Net Present Value*** | ***+$4M*** | ***+107M*** | |
| ***Benefit Cost Ratio*** | ***1.04*** | ***2.0*** | |

Technical Notes:
- 6% discount rate assumed over an evaluation period of 30 years
- Analysis uses Australian dollars

Overall this analysis suggests that savings in peak train capital and operating costs broadly cover lost free fare revenues in financial terms. Without growth in early bird ticket the lowest estimate of peak train savings suggests the cost of lost revenue is almost covered (98%) by savings in peak train costs. The higher estimate of impacts on peak trains increases savings considerably; a 1.96 BCR is achieved in financial terms. The growth in early bird ticket scenario doesn't change this picture much. Although foregone revenues increase (from $6M/€ 3.9M p.a. in year 1 to $10M/€ 6.4M in year 30, in real 2008 terms) increases in peak train savings keep pace with this. Overall growth in early bird usage slightly improves the net financial benefit but not much. The low peak impact scenario has a BCR of 1.04 while the high 2.0. Since a range of wider economic (rather than financial) benefits might also apply as a result of reducing peak travel (e.g. peak road user travel time benefits) it seems reasonable to assume an economic assessment of the program would be positive even for a low peak demand impact scenario.

## 7 CONCLUSIONS

This paper explores the short and medium term outcomes of a new policy measure aimed at managing peak overloading of rail services implemented in Melbourne Australia from March, 2008. The aim of the program was to encourage peak rail passengers to shift travel to trains travelling before the morning peak using a free fare ticket called the 'early bird' ticket which is valid for travellers arriving in the CBD before 7:00a.m.

The program costs about $6M/€ 3.9M p.a. in lost fare revenues (2008) and around 8-9,000 passengers use the free early bird tickets each weekday. Ticket usage is increasing at a rate of 1.7% p.a. while overall rail usage has been relatively stable over the last year. In 2008 a survey found that 23% of free early bird ticket users had shifted their time of travel out of the peak or around 2,000 to 2,600 passengers each peak.

Previous research in London developed the 'Medium Term Growth Effect' hypothesis which suggests that take up of pre-a.m. peak travel will take time because passengers need to adjust life styles to enable early commuter travel (Passenger Focus, 2006). Analysis results are consistent with this hypothesis since early bird ticket use as a proportion of all ridership is increasing by about 1.7% p.a..

Another hypothesis from previous research is the 'Winter Dark Morning Effect' which suggests that passengers will be less inclined to time shift commuter trips to before the peak on dark winter months. While there are some trends consistent with this theory in practice there was not much variation in the share of early bird users (around + and – 5% per month) and no negative link between darker winter months and lower usage was found. This may partly be due to the relatively lighter (and milder) winter mornings in Melbourne compared to Northern American and European cities. London for example has far colder and darker winter mornings due to its higher latitude. Hence winter effects may be larger in this context.

After early bird was introduced an increase in train loads of 41% occurred for trains arriving in the city before 7:00a.m. It has been suggested that the shift of peak demand has reduced the financial burden of having to buy and operate new peak trains to address overloading. Estimates place these savings at between 2.5 and 5.0 trains in 2008 to a high of 8.05 trains in 2038. Financial analysis suggests the savings in peak trains would substantively cover most or more than cover the financial costs of providing free fares before 7:00a.m. Wider economic benefits would also likely apply making the program economically beneficial even under a low impact scenario.

So overall what does the assessment tell authorities considering options to address rail overloading in other geographies?

Firstly the results of the program appear positive. It has achieved its aim of reducing overloading however loading evidence suggests it is relieving congestion rather solving the problem (data in Figure 4 shows that overloading has increased overall in 2008 as a result of demand growth despite early bird). Certainly the scheme is cheaper than the conventional approach of buying new rolling stock and/or in increasing line capacity with new tunnels or lines. It is also relatively quick to implement.

Secondly what circumstances are required to achieve success? The following is informed by results of the research and also from discussions with major rail operators regarding the potential for wider implementation of the concept:

- Pre-Peak Services with Capacity– Rail operators are going to need to have available pre-peak services as well as services with pre-peak capacity. This may seem an obvious requirement but many North American systems have limited pre-peak services and hence little scope for spreading peaks unless the additional pre-peak operations are added.
- Rail Commuters Willing to Retime Trips – Clearly peak spreading will not occur without passengers who are willing to re-time trips. The available evidence on this is limited but suggests there is considerable scope for retiming. Both London and Melbourne had markets willing to retime journeys however it would be wise to check the potential for this in other markets. In

theory a higher share of free fares users who retime trips means a more effective program so identifying measures to increase the share of trip retiming would also be worthwhile.

- Ticketing Systems able to Manage Early Bird – Railway systems without flexible ticketing systems or without gated exits will find it difficult to validate free early rail travellers or to set up a free ticketing system.
- Regulatory/Economic Structures to Realise Benefits from Reduced Overloading – Not all railway systems will be able to benefit from savings in new rolling stock purchases. In discussing deferred rolling stock savings with some rail operators it quickly became apparent that many contexts provide little incentive for rail operators to be interested in the issue. Some governance arrangements have capital funded by separate authorities than operating costs e.g. Federal vs State arrangements in the United States. In this context a rail operator has no incentive to claim savings in rolling stock since it might risk future capital funding. Also a scheme such as early bird in this context would require intergovernmental trade-offs between the direct costs of the scheme (on reduced farebox revenue at a State level) with reduced capital expenditure (at the Federal level). Similar concerns can occur with privatised or franchised operations. Where farebox is a major part of operator income in a franchise, special arrangements would be needed between regulators and private agencies in developing an early bird scheme. This might be difficult to engineer during a contract term since the impacts of the scheme would need careful monitoring for all parties to agree on cost and revenue trade-offs. It appears that regulatory structures which do not allow flexibility to trial peak spreading measures such as the early bird scheme can act to stifle innovation of this kind.

From a research perspective there are many unanswered questions which could better inform assessment of the existing scheme and the potential for future applications. A major question concerns the share of early bird ticket users who have shifted from the peak. At this stage this has only been measured in 2008. A second intercept survey is warranted to determine whether this share is increasing. The exact impacts of the scheme on overloading is also a key area to target research since there are a wide range of theorised scheme impacts and they will have substantive impacts on the viability of the scheme and its future potential for adoption in other contexts. A more in depth understanding of the constraints and influences on time shifting behaviour might also inform the development of measures to encourage greater up-take of time shifting.

There is also room to further develop the early bird concept. Raising the early bird threshold to 7:30 a.m. rather than 7:00 a.m. would tap into a far greater potential commuter market and increase the scope for shorter time shifting from the busiest and more crowded times during the a.m. peak. There is a need to understand the implications of changing parameters such as these including a discounted rather than a free scheme. A radical option might even be to offer nominal payments to passengers for earlier travel. This would be possible with smart card systems and would be a perfectly valid option as long as benefits to peak travel are available and can be captured.

Overall the Melbourne early bird program provides encouraging support for the concept of using fare schemes as a means to achieve peak spreading. It remains to be seen if generally conservative rail operators and regulators can more widely adopt such innovations to address the endemic and growing overcrowding problems being faced in many world cities.

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## 9 ACKNOWLEDGEMENTS

The author would like to thank Dr Simon Gaymer, Effie Robotis, Linus Baltutis, David Arblaster and Matthew Raisbec of the Department of Transport for assistance in compiling data. Also Alexa delbosc of Monash University for assistance in review drafts of this paper. The author would also like to thank the Victorian Department of Transport for providing access to data used in this research and also the papers reviewers for useful points made. This research is an independent view from the author and does not necessarily represent the views of other parties. Any omission or errors are the responsibility of the author.