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Opportunities for managing peak train travel demand: a Melbourne pilot study

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Abstract

Melbourne, like many large cities around the world, experiences significant peak congestion on its public transport network. Demand for services in peak times is a key driver of investment in new rolling stock and infrastructure. A way of delaying these significant investments is to better utilize current available resources in non-peak times, by spreading out peak demand over a wider time period.

This study used an online survey methodology to investigate the propensity of peak period train passengers commuting for work on Melbourne's Pakenham line to shift out of peak travel times to access a better price, service frequency, stopping pattern and train conditions. The main methodology was two Discrete Choice Model exercises (one morning-peak and one afternoon-peak) which systematically varied time of travel, price and service attributes to model customer behaviour under various scenarios.

The results support the view that demand can be influenced by price and service attributes, and support the development of detailed business cases for reducing peak demand. Implications are discussed, as well as the challenges in converting these customer behaviour predictions into workable timetables, and in accurately costing the benefits of delays in investments in new rolling stock and infrastructure.

1. Introduction

In December 2008 the Victorian Government's Department of Transport announced significant investment in public transport through The Victorian Transport Plan, including a number of projects for the metropolitan rail network. Demand management is a critical aspect in deriving the largest benefit from these new projects as well as making the most of existing capacity before new rolling stock is delivered and projects completed. This is particularly important during the peak period, which is a key driver of the need for new investment in public transport. In March 2009 Metlink undertook research to provide an evidence base about the capacity to manage peak demand using price or other levers, and the results from this research are shared below to assist other cities considering similar initiatives. Metlink worked with Nature Pty Ltd, an independent research contractor and the Department of Transport on this research project.

The paper presents the results of this research by firstly outlining recent substantial patronage growth on Melbourne's metropolitan train network, which created the requirement to consider initiatives such as demand management. Existing price-based demand management initiatives are also highlighted. The methodology is presented, followed by a summary of results from a questionnaire and discrete choice model. Finally the challenges of implementing demand management initiatives during peak periods are discussed and conclusions are presented.

2. Background

In the four years from 2005 to 2009, the number of passenger trips (patronage) on Melbourne's trains grew by 43%, and by more than 81% in the ten years from 1998–99 to 2008–09 (Department of Transport, 2009). With 53% of metropolitan train passenger trips occurring in the morning and afternoon peaks on an average weekday (2008-09) (Department of Transport, 2010), this unprecedented patronage growth has caused crowding on many services, especially during these peak times. While patronage growth has slowed in recent months, patronage levels on Melbourne's metropolitan train network continue at these record highs.

In response to growing demand for train travel, new and extended services were added to the Pakenham/Cranbourne line as part of timetable changes in: October 2006, September 2007, April 2008, November 2008, and July 2009. Furthermore, in 2008 the Early Bird ticket was introduced to Melbourne's metropolitan rail network, which provides free travel to passengers arriving at their destination before 7am on a weekday. In an evaluation of the initiative, Currie (2010a) suggested that the Early Bird ticket has reduced the scale of increased overloading. Due to demand growth during the period, there was no net reduction in overloading. Currie (2010a) also highlighted that the Early Bird initiative was most influential between 7-8am, and can still be helpful in the more critical 8-9am period.

Melbourne is currently introducing a new smartcard ticketing system (known as myki). Smartcard ticketing systems allow for passengers to be automatically charged a different amount depending on the time they interact with the system, which means that far more complex time-based pricing can be implemented more easily than with other less automated systems. As such, myki provides far greater potential to manage peak demand through variable pricing.

To date Melbourne patronage has grown at record rates, and patronage levels have remained high despite the impact of the global financial crisis. There has been some success in managing travel demand using price, as demonstrated by the Early Bird ticket and there will be further opportunities for variable pricing with the introduction of myki. The research outlined below was a pilot study intended to provide insights about opportunities for managing demand between 7-9.30am, including the critical period between 8-9am highlighted by Currie (2010a) as well as the afternoon peak (4-7pm). The research also provided as one of its outputs a Decision Support Tool, which is an Excel-based model that provides an estimated demand profile for any policy option that utilises the factors included in the model.

In addition to this study and Currie's (2010a) analysis of Melbourne's Early Bird ticket, price-based demand management initiatives have been evaluated in other cities. Currie's (2010a) summary of previous research from both the UK and US into the use of ticketing discounts to shift demand from peak periods finds that 'previous research suggests that shifting demand from the peak is possible as long as peak/off-peak fare differentials are high'. Currie (2010a) also reports that this previous research provides evidence that free off-peak travel is more effective than fare discounts, and reducing pre-a.m. peak tickets is more effective than post-peak tickets.

In the study reported below, willingness-to-pay for travel during peak periods is approximated through a discrete choice model. Previous research in Australia (Douglas and Karpouzis, 2006) used a rating valuation model to convert changes in passenger ratings of various service attributes into ratings of onboard rail time. Onboard rail time was converted into on-train time minutes which supported an analysis of willingness-to-pay. This technique can be used to evaluate the passenger benefits of timetable change.

3. Methodology

The study primarily used discrete choice modelling (or stated preference methodology) to investigate customer trade-offs between CBD arrival time, price, whether an express train service is available, crowding conditions and service frequency. Choice modelling is an experimental technique which involves placing a survey respondent in a series of hypothetical yet realistic scenarios, and having them choose which of a number of alternatives they would choose. To reach their choice, the respondent is forced to make a trade-off between the various elements of the alternatives. An example of a choice task from this research is provided in figure 2. A base case is first established which reflects current conditions, then analysis of respondent choices provides information about likely customer behaviour change under varied conditions. In addition to the choice task, respondents were asked a module of direct questions about their likely behaviour in response to a variable pricing strategy.

The study was conducted during March 2009 on the Pakenham line, amongst customers aged over 18 years. To qualify for the study respondents needed to travel to the city for work, and return, at least once per week. The Pakenham line is part of the suburban rail network in Melbourne running from the CBD to about 60km south-east of Melbourne. It is one of the more crowded corridors on the network, and passes through suburbs with quite different socio-economic characteristics.

Respondents were recruited face-to-face from their ‘main’ station, between 6.30am-9am. Stations targeted in the study included inner-stations (Toorak and Hawksburn), zone 1 and zone 2 overlap-stations (Oakleigh and Huntingdale) and outer-stations (Narre Warren and Berwick). As an incentive to provide their email address to enable them to complete this study, all invited participants were provided with an instant “scratchie” ticket (regardless of whether they participated or not). Potential participants who provided their email addresses were then sent a link to a survey to be completed online, which included both a module of direct questions and the choice task. The opportunity to win free travel for one year (yearly Metcard) was offered as an incentive for completing the online questionnaire. A total of 1,750 scratchie tickets were distributed. With a total of 942 respondents completing the survey, this represents a 54% completion rate for those invited to participate.

The inner-stations surveyed are entirely in Zone 1 (thus offering travel to the city on a single zone ticket). Both stations are in suburbs that are considered to be relatively affluent parts of the inner east of Melbourne. Overlap-stations are in both zone 1 and 2, and are the furthest stations from the CBD that allow travel on a Zone 1 ticket. These are in middle-class suburbs of Melbourne. Outer-stations were considerably more than 60 minutes train travel from the CBD and require a zone Zone 1 + 2 ticket for travel to and from the city (thus incurring a higher cost). The catchment area for these stations includes several growth areas with new housing estates. The following table (table 1) summarises the number of boardings and percentage of total boardings at each station.

TABLE 1 Estimated Average Weekday Boardings at Surveyed Stations, 2008-09

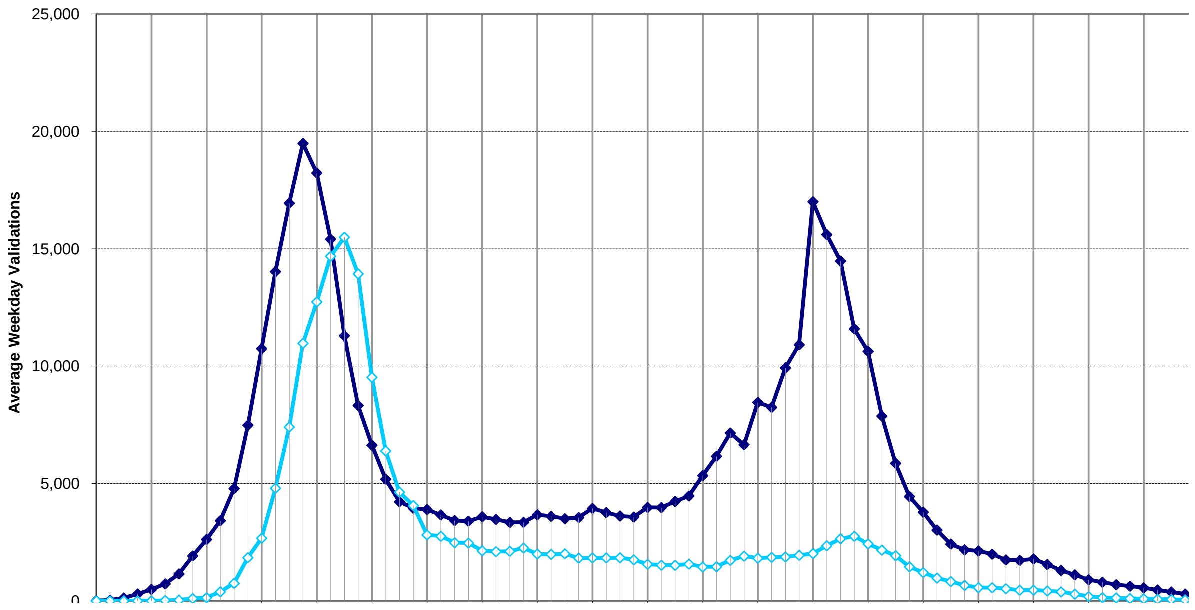
Estimated Average Weekday Boardings, 2008-09		
Station	**Boardings**	**Percentage of Line Total**
Toorak	1,822	2.5%
Berwick	2,482	3.4%
Hawksburn	1,433	2.0%
Oakleigh	6,820	9.3%
Huntingdale	4,267	5.8%
Narre Warren	3,021	4.1%
Berwick	2,482	3.4%

Department of Transport (2010a)

The sample included 942 respondents: 259 from inner-stations; 346 from overlap-stations; and 337 from outer-stations. It is important to note that the sample size was robust, and was more than sufficient given the size of the survey design.

Attributes tested by the choice modelling exercise included CBD arrival time, price, whether an express train service was available, crowding conditions and service frequency. Morning and afternoon timebands were structured in the following manner based on an analysis of exit ticket validations in the morning-peak and entry validations in the afternoon-peak (see figure 1). This was the most up-to-date data available when developing the research design.

FIGURE 1 Average Weekday Entry and Exit Ticket Validations, Melbourne Metropolitan Train, 2006-07



Department of Transport (2009)

Morning timebands:

- <7.00am
- 7.00-7.30am
- 7.30-7.45am - Peak
- 7.45-9.00am – High-peak
- 9.00-9.15am - Peak
- 9.15-9.30am
- >9.30am

Afternoon timebands:

- <4.00pm
- 4.00-4.30pm
- 4.30-4.45pm - Peak
- 4.45-5.45pm – High-peak
- 5.45-6.00pm - Peak
- 6.00-7.00pm
- >7.00pm

Choice models allow in their design for either all possible combinations of elements to be included as possible scenarios, or for the deliberate exclusion of particular combinations based on what is and what is not a realistic and feasible option for the future. As such, the design of the current study excluded price discounts during the “high-peak” periods (as this would not make sense in terms of desired policy outcomes). For the same reason, price increases were not included for “off-peak” periods (e.g. before 7am). The range of prices tested varied by timeband, as shown in tables 2 and 3 below. The availability of express train services was simply a choice between available and unavailable, and conditions on the train included three settings: seats available; standing but not cramped; and cramped. Finally, frequency was tested at 5, 10 or 15 minute intervals. The design was a “fractional factorial” design of 100 blocks of 8 scenarios, optimized at both the block and overall level. This culminated in 800 unique choice scenarios to which each respondent was randomly allocated a block of 8.

TABLE 2. Discrete choice model - Price discounts and increments by timeband, Morning-peak

	- 100%	- 80%	- 70%	- 60%	- 50%	- 40%	- 30%	- 20%	- 10%	No Change	+10%	+20%
<7.00am	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	×	×
7.00-7.30am	×	×	×	✓	✓	✓	✓	✓	✓	✓	✓	✓
7.30-7.45am - Peak	×	×	×	×	×	✓	✓	✓	✓	✓	✓	✓
7.45-9.00am – High-peak	×	×	×	×	×	×	×	×	×	✓	✓	✓
9.00-9.15am - Peak	×	×	×	×	×	✓	✓	✓	✓	✓	✓	✓
9.15-9.30am	×	×	×	✓	✓	✓	✓	✓	✓	✓	✓	✓
>9.30am	×	✓		✓	✓	✓	✓	✓	✓	✓	×	×

TABLE 3. Discrete choice model - Price discounts and increments by timeband, Afternoon-peak

	-100%	-80%	-70%	-60%	-50%	-40%	-30%	-20%	-10%	No Change	+10%	+20%
<4.00pm	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✗
4.00-4.30pm	✗	✗	✗	✓	✓	✓	✓	✓	✓	✓	✓	✓
4.30-4.45pm - Peak	✗	✗	✗	✗	✗	✓	✓	✓	✓	✓	✓	✓
4.45-5.45pm – High-peak	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✓	✓
5.45-6.00pm - Peak	✗	✗	✗	✗	✗	✓	✓	✓	✓	✓	✓	✓
6.00-7.00pm	✗	✗	✗	✓	✓	✓	✓	✓	✓	✓	✓	✓
>7.00pm	✗	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✗

Each respondent was presented with eight choice tasks for each model (that is, eight for the morning-peak and eight for the afternoon-peak model), each presenting a different set of competing choices. Respondents were able to opt out of the choices provided and select 'I would travel by another method of transport'. This provided the ability to measure under what conditions customers would abandon the train network in favour of travelling by another mode or not travelling at all. To help respondents understand the dollar savings of percentage discounts or increments, a reference table was provided with each choice task showing the price of the ticket they currently purchase and the value of each discount and increment. An example of a choice task is provided below in figure 2.

FIGURE 2. Example of choice task

The table below is different again from those you have just seen. Again, please contrast the features of the time periods, and indicate in which time period you would generally choose to **arrive** at Melbourne Central station.

Scenario 3 of 8.

Based on this scenario, please indicate in which time period you would generally choose to arrive at Melbourne Central station.

Time your train arrives at Melbourne Central station in the morning	Price of train ticket, relative to current price	Is there an express train available leaving from Narrewarren?	The expected conditions on the train	The frequency of trains during the time period	Select:
Before 7.00am	Decrease by 80%	Express not available	Standing but not cramped	Every 10 minutes	○
7.00am to 7.30am	Decrease by 40%	Express Available	Seats available	Every 10 minutes	○
7.30am to 7.45am	Decrease by 40%	Express Available	Standing but not cramped	Every 5 minutes	◉
7.45am to 9.00am	Increase by 20%	Express not available	Standing but not cramped	Every 5 minutes	○
9.00am to 9.15am	Increase by 20%	Express not available	Seats available	Every 5 minutes	○
9.15am to 9.30am	Increase by 10%	Express Available	Standing but not cramped	Every 5 minutes	○
After 9.30am	Same Price	Express not available	Cramped	Every 5 minutes	○
I would travel by another method of transport					○

Type of ticket: Weekly Zone 1 & 2	
	Price
Increase by 20%	$59.52
Increase by 10%	$54.56
Current Price	$49.60
Decrease by 20%	$39.68
Decrease by 40%	$29.76
Decrease by 60%	$19.84
Decrease by 80%	$9.92
Decrease by 100%	$0.00

PREVIOUS NEXT

Progress

4. Results – Direct Questions

Based on answers to the direct question module, 50% of train commuters travelling on the Pakenham line in the morning-peak would consider a discount to travel earlier, with the main reasons for not travelling earlier in the morning being 'no flexibility in work arrangements' and 'a discount is not enough to make me catch an earlier train'.

A lower proportion (20%) indicated that they would consider travelling later in the morning-peak to access a discount. The main barrier to travelling later in the morning-peak was 'no flexibility in work arrangements', listed by 58% of respondents who would not consider travelling later for a discount. A stronger preference for travelling before the morning-peak than after the morning peak was also reported in a study undertaken in London (Currie, 2010a).

Of those respondents who indicated they would consider travelling earlier in the morning-peak for a discount, approximately one-third (35%) would change their evening travel time. This suggests many commuters taking advantage of the discount would work longer hours or remain for a longer period in the city engaged in other activities. Conversely, the majority (79%) of commuters who caught a later train in the morning would change their afternoon travel time. While the proportion of respondents considering this choice is smaller, providing incentives to travel later in the morning may lead to a shift in demand for both the morning and afternoon-peaks, thus assisting in managing the demand at both ends of the working day.

When asked about the afternoon-peak, a similar proportion of commuters indicated they would consider a discount to travel earlier (34%) and later (38%) to access cheaper fares.

Table 4 summarises respondents' propensity to consider changing their travel time to access a discounted ticket price. Of the four options, travelling earlier in the morning-peak appears to represent the largest opportunity for managing peak demand using price.

TABLE 4. Propensity to consider changing travel time for a discount, percentage of respondents

	Per cent of respondents who would consider **earlier** travel for a discount	Per cent of respondents who would consider **later** travel for a discount
Morning-peak	50	20
Afternoon-peak	34	38

On average, commuters who indicated they were willing to change their travel for a discount would change their time of travel by a maximum of 30 minutes. At least 70% of respondents willing to change their travel could do so by 30 minutes or less. This is a relatively short period, given the high-peak period in this study was defined as one hour 15 minutes in the morning-peak and one hour in the evening-peak. This means that there will inevitably be a relatively high proportion of high-peak period travellers who will be difficult to shift out of this period because they will be travelling 30 minutes or more from a "shoulder" period where a discount may be offered. This finding echoes results from research undertaken in the UK where passengers who had flexibility to shift their travel time could most commonly do so by 30 mins (Currie, 2010a).

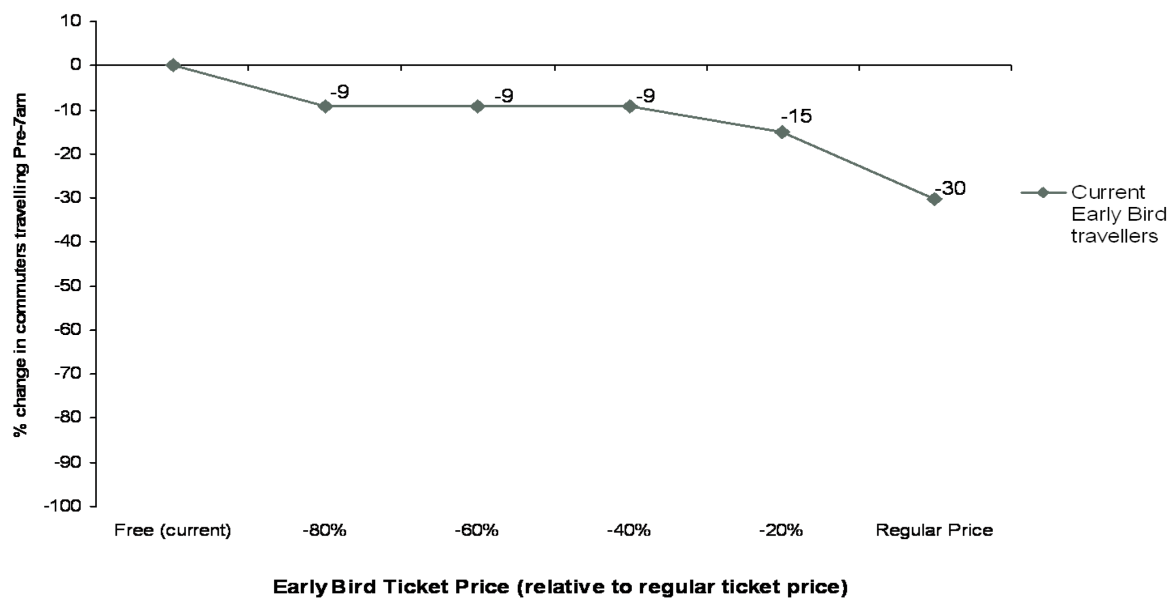
A combination of people's unwillingness to shift by more than 30 minutes and inflexible working arrangements appear to be significant barriers to the success of demand management, highlighting the need for policy makers to continue working with employers to encourage flexible working hours.

5. Results – Discrete Choice Model

The primary output from the discrete choice modeling exercise is a decision support tool, an Excel model where the value of the attributes tested by the study can be varied to understand the impacts of different policy parameters. A range of scenarios can be tested using the model. Below the key insights are summarized and discussed.

The discrete choice model outputs could be tested against revealed preferences from the Early Bird initiative. Results from the discrete choice model suggested around 30% of early bird users would switch back if 100% discount completely removed (see figure 3 below). By comparison, revealed preference surveying suggested 23% overall (and 24% of Caulfield group) are travelling at that time to access the full discount (Department of Transport, 2008). While the sample of passengers travelling before 7am in this research was low, it was encouraging to note the consistency in results between the revealed and stated preference studies.

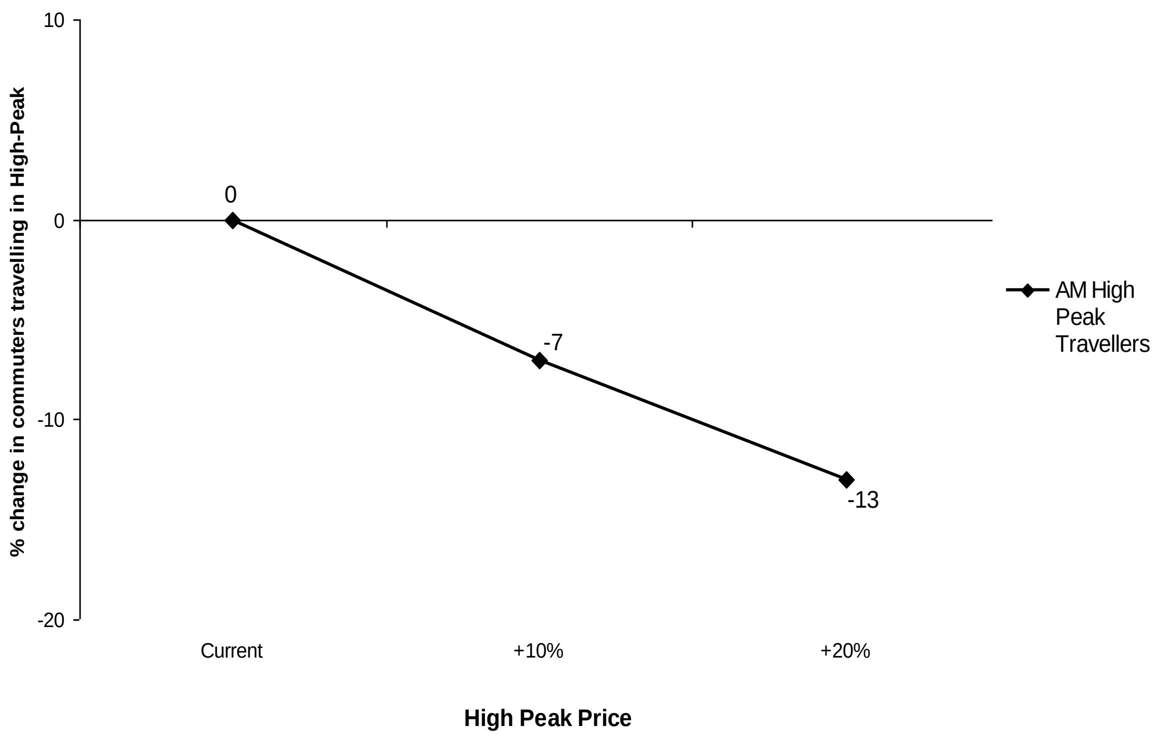
FIGURE 3 Impact of price decrease on commuters traveling before 7am



The model shows that a 10% price increase during the high-peak, 7.45-9.00am, would shift 7% of passengers out of the high-peak. A 20% price increase would result in a 13% decrease in high-peak travel. This equates to a price elasticity of approximately -0.65 (see figure 4). Similar results are also achieved in the afternoon-peak, with a price increase of 10% moving 8% of passengers and a price increase of 20% moving 13% of passengers.

These elasticity figures may on the surface appear to be high relative to the findings of other public transport studies. It should be noted, however, that these elasticities represent time-based shift in travel, rather than cross-mode travel. It would be expected that the barriers to shifting travel behaviour by less than an hour to access a discount (but remaining on the same mode) would be lower than for shifting modes altogether. This may explain the relatively high elasticities found here and elsewhere in this study.

FIGURE 4 Impact of morning-peak price increase on demand for peak travel



The choice model also allows for an examination of the timebands to which customers move in response to the pricing signals. Consistent with the findings from the direct questions, passengers tend to move to the closest timebands where the discounts are available, thus minimising changes to their travel routines. Most passengers who indicated they would change their travel time to avoid price increases would travel during the shoulder-peak; either 7.30-7.45am or 9.00-9.15am (see table 5). Based on a 10% discount, 86% of passengers who would change their travel time would travel during the shoulder-peak. Similarly, 77% passengers switching out of the high-peak for a 20% discount would travel during the shoulder-peak. For both a 10% and 20% discount, 4% of switching passengers would travel using a different mode or not travel at all. A similar trend is observed in the afternoon peak, however, 10% of switching passengers would travel using a different mode or not at all at both the 10% and 20% discount levels (see table 6). This is considerably higher than the 4% "opt out" rate in the morning-peak and may reflect that passengers feel there are more options available to them in returning home at the end of a work day (such as lifts with colleagues / friends) than are available in the morning.

TABLE 5 Demand changes by morning-peak timeband, 10% price increase and 20% price increase

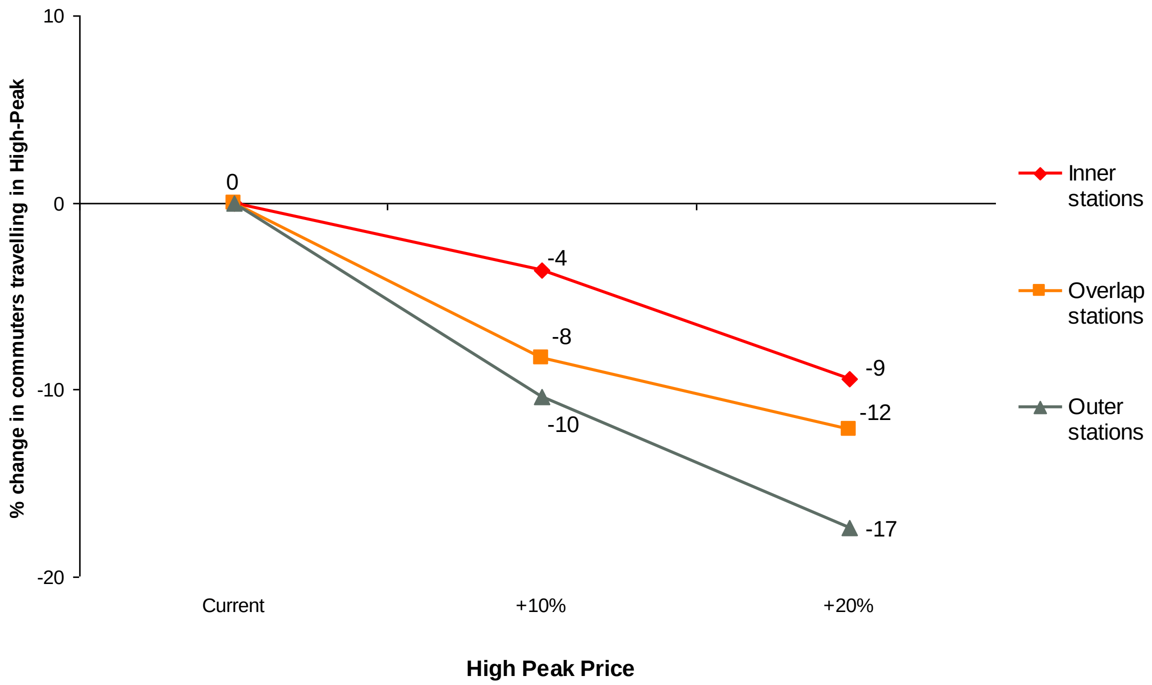
Time	Timeband	Price +10%	Price +20%
<7.00am	Off-peak	9%	11%
7.00-7.30am	Shoulder	-	3%
7.30-7.45am	Shoulder-peak	47%	46%
7.45-9.00am	**High-peak**		
9.00-9.15am	Shoulder-peak	39%	31%
9.15-9.30am	Shoulder	2%	5%
>9.30am	Off-peak	-	-
Opt Out		4%	4%
Percentage of high-peak travelers switching		**7%**	**13%**

TABLE 6 Demand changes by afternoon peak timeband, 10% price increase and 20% price increase

Time	Timeband	Price +10%	Price +20%
<4.00pm	Off-peak	6%	3%
4.00-4.30pm	Shoulder	-	1%
4.30-4.45pm	Shoulder-peak	48%	49%
4.45-5.45pm	**High-peak**		
5.45-6.00pm	Shoulder-peak	26%	31%
6.00-7.00pm	Shoulder	10%	6%
>7.00pm	Off-peak	-	5%
Opt Out		10%	10%
Percentage of high-peak travelers switching		**8%**	**13%**

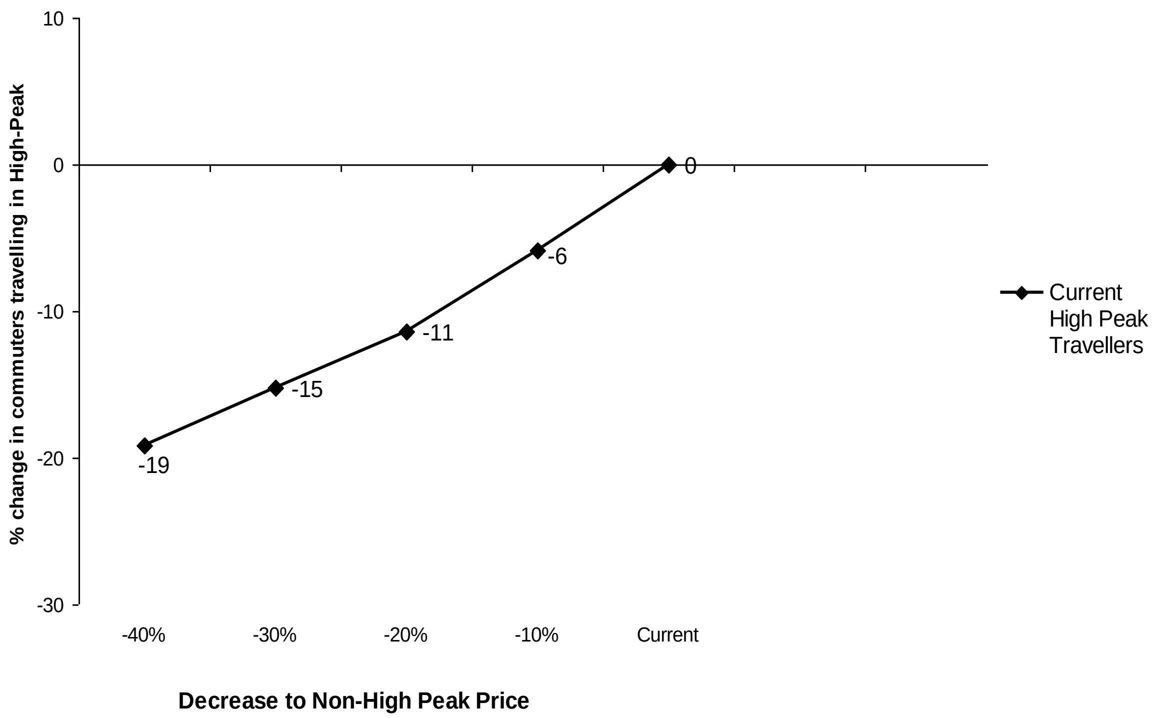
Importantly, the impact of price discounts varies by station grouping; whether a passenger travels from inner, overlap or outer-stations. As illustrated by figure 5 below, passengers traveling from outer-stations are the most sensitive to price increases. While the percentage of switching passengers from outer-stations choosing to travel by a different mode or not at all is low in the morning-peak, a high percentage would opt out in the afternoon peak (20% of the shifters at 10% price increase and 16% of the shifters at 20% at price increase). Interestingly, passengers traveling from overlap-stations are the least sensitive to this particular pricing scenario. The high sensitivity to price of the outer-stations was a consistent finding across many scenarios tested using the model. This may reflect that these passengers pay a higher price for travel (and thus, a per cent discount represents a greater dollar value) and / or that these suburbs may have a higher proportion of first home buyers and families suffering a degree of "mortgage stress" which may lead to greater price sensitivity in travel choices.

FIGURE 5 Impact of morning-peak price increase on demand for peak travel, by station type



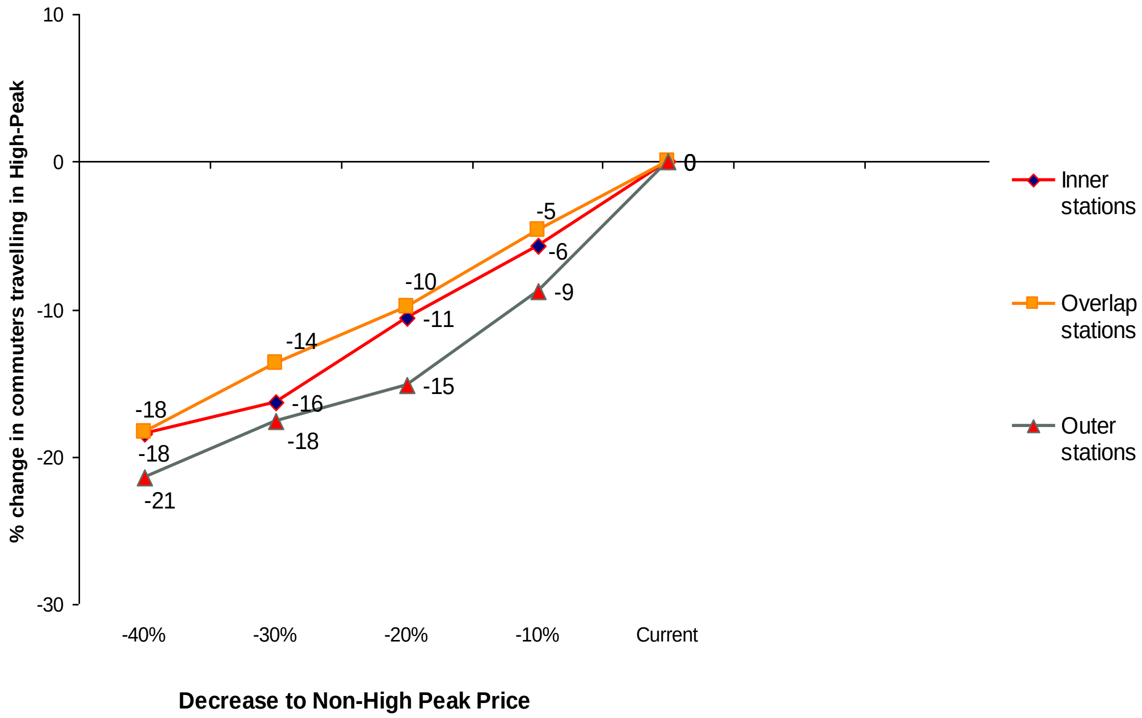
Price decreases during non-high-peak timebands have a similar impact on shifting peak demand as price increases during the peak. Figure 6 below shows that reducing non-high-peak prices by 10% would shift 6% of passengers out of the high-peak. A decrease of 40% would move 19% of passengers out of the high-peak. Results for the afternoon peak show a similar pattern of travel behaviour, with a 10% decrease in non-high-peak prices shifting 7% of passengers out of the afternoon peak. Again similar to the results from the scenarios with price increases in the high-peak, most passengers who indicated they would change their travel time in response to a price decrease in the non-high-peak also indicated they would travel in the timebands adjacent to the peak; 7.30-7.45am and 9.00–9.15am in the morning-peak and 4.30-4.45pm and 5.45-6.00pm in the afternoon peak. At the 10% discount level, 98% of switching passengers in the morning-peak and 84% of switching passengers in the afternoon peak would travel at these times.

FIGURE 6 Impact of morning non-high-peak price decrease on demand for peak travel



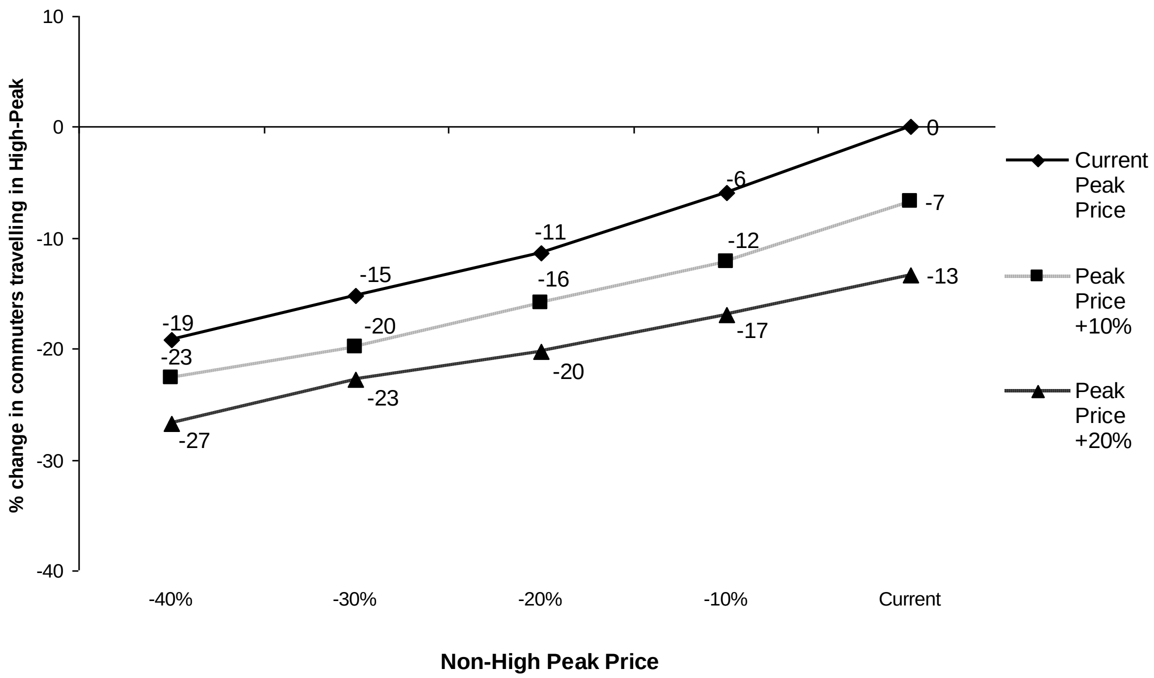
Consistent with earlier findings, during the morning and afternoon peaks, passengers traveling from outer-stations are most sensitive to price decreases in the non-high-peak, with 9% of passengers switching for a 10% discount during both the morning and afternoon peaks. There appears to be little difference in switching patterns between passengers from inner and overlap-stations during the morning-peak, as shown in figure 7 below. During the afternoon-peak, passengers from inner-stations showed the least sensitivity to price when compared with overlap and outer-station passengers.

FIGURE 7 Impact of morning-non-peak price decrease on demand for peak travel, by station type



It is possible to examine the impacts of using both price increases and decreases to shape demand. Figure 8 shows the impact of decreasing non-high-peak prices combined with high-peak price increases: essentially combining the pricing scenarios described above. As already described, a 10% price decrease in the non-high-peak would shift 6% of passengers out of the high-peak. When this discount is combined with a 10% price increase in the high-peak, the effect is doubled to 12%, and almost tripled if high-peak prices increased by 20%. Similar results would be achieved using the same pricing structure in the afternoon-peak.

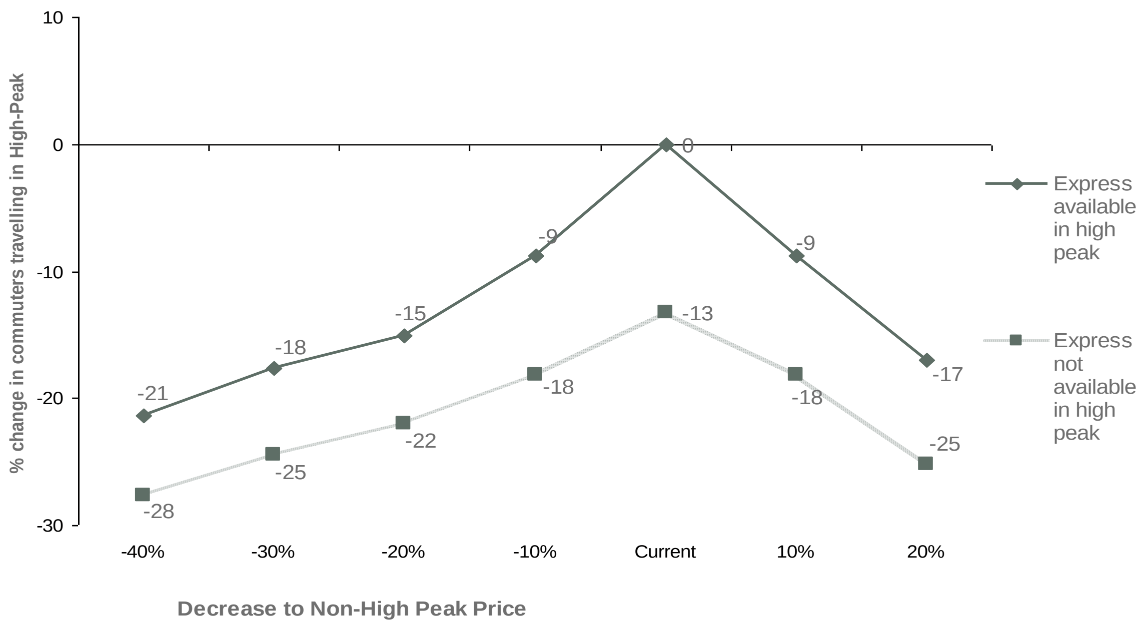
FIGURE 8 Impact of high-peak price increases and non-high-peak decreases, Morning-peak



The impact of other attributes such as service frequency, train conditions and stopping patterns can also be combined with price to model the impact on the demand for peak travel.

Of all the attributes tested, availability of express and price had the greatest potential to reduce peak demand by improving the relative service levels offered in ‘shoulder’ and ‘off-peak’ timebands. An examination of passengers traveling from outer-stations, who are most sensitive to both price and availability of express train services points to the potential for using these attributes to shape peak demand. Figure 9 below shows the impact of price changes in the non-high-peak and high-peak, combined with availability of express services in the high-peak for outer-stations. Simply removing express train services from the high-peak period moves 13% of passengers out of this timeslot. Increasing high-peak prices or decreasing non-high-peak prices by 10% could both shift 9% of passengers out of the high-peak. The impact of either pricing regime is doubled to 18% by also removing express services from the high-peak.

FIGURE 9 Impact of non-high-peak price decreases, high-peak price increases and availability of express services during the morning-peak, Outer-stations



Based on results from the model, service frequency does not appear to greatly influence passengers' choices about their time of travel. In the morning-peak, doubling shoulder-peak service frequency to a five minute headway would remove 2% of passengers from the high-peak. Doubling shoulder-peak service frequency in the afternoon peak would result in a 4% decrease in high-peak demand.

While service frequency did not resonate with customers, the availability of seats had a greater impact on peak demand especially during the afternoon peak. As shown in figure 10, during the morning-peak a 10% discount on non-high-peak prices would move 6% of passengers out of the high-peak. When customers are provided with scenarios which increase frequency to five minutes and guarantee them access to a seat, the impact of this pricing initiative increased to 10%. Under this scenario, passengers traveling in the morning and afternoon peaks display different behaviours. During the afternoon-peak a 10% discount would shift 7% of passengers out of the high-peak. If seats are available, 22% of high-peak travelers would travel at a different time. This is summarized in figure 11 below.

FIGURE 10 Impact of non-high-peak price decreases, increased service frequency and availability of seats during the morning-peak

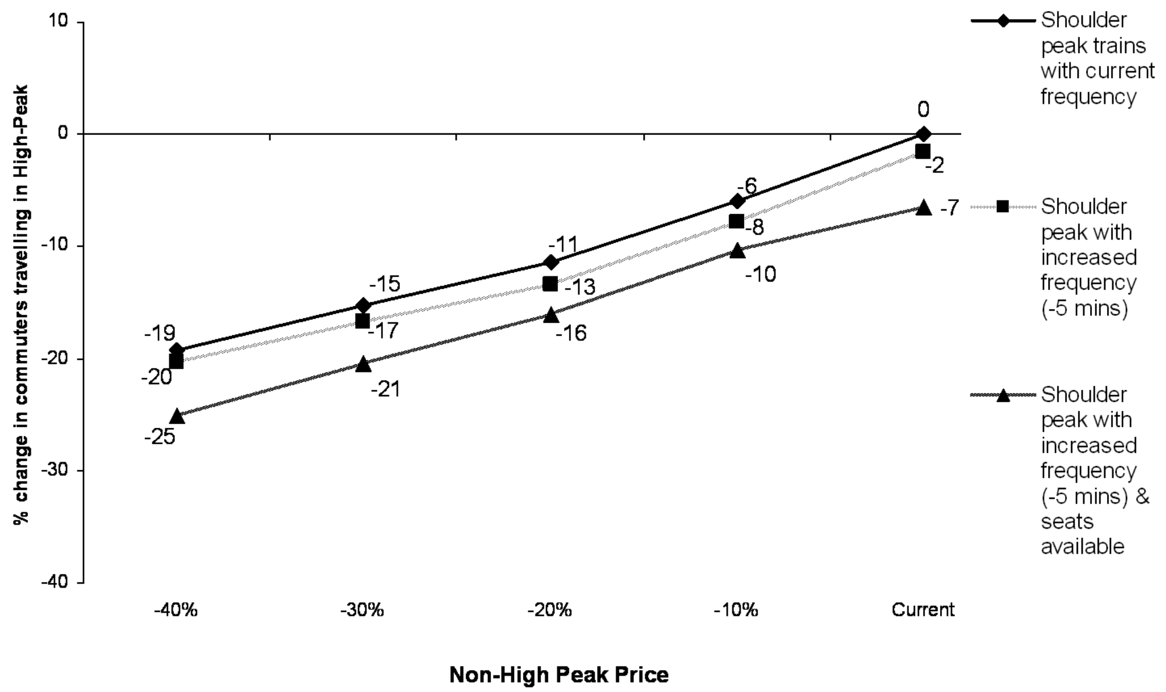
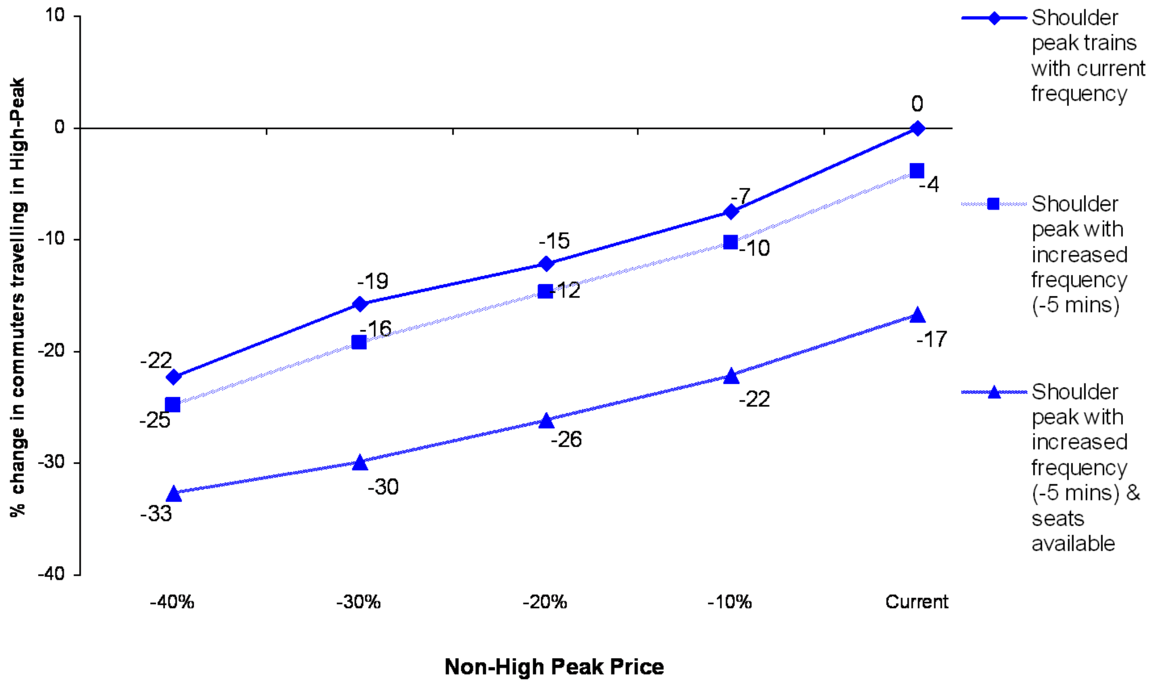


FIGURE 11 Impact of non-high-peak price decreases, increased service frequency and the availability of seats during the afternoon-peak



6. Challenges of Implementation

Currie (2010b) highlights key circumstances underpinning the success of initiatives seeking to shift passengers out of peak periods to assist with managing peak overloading. These include availability of pre-peak services with unused capacity; commuter willingness to retime trips; flexible ticketing systems and gated exits; and regulatory/economic structures to realize benefits from reduced overloading. On Melbourne's metropolitan train network, the introduction of myki presents an opportunity to encourage passengers to shift out of peak periods. Customer willingness to shift and capacity are discussed below. Economic/regulatory structures are not discussed in this paper.

The research suggests that customers are somewhat limited by inflexible working hours, but that there is some ability to shift the travel times of passengers through price changes by time of travel. There would obviously be potentially greater benefit from demand management strategies based on price, if employers could be persuaded to offer greater flexibility in the working arrangements of their employees.

This research suggests that customers are generally only willing to change their travel time by up to 30 minutes, and will generally shift by the smallest time increment possible that allows access to a better price. This creates challenges for the implementation of pricing strategies, because a poorly thought through initiative risks creating excess demand in shoulder-peak periods that may not have the capacity to cope with such an influx of customers. The research provides an initial indication of what the increased demand might be for particular timebands under certain circumstances, but there will need to be close consultation with the train operator in developing any proposals in the future. Funneling too much demand into timebands that are relatively heavily patronised and may not have much scope for increased services will be counter-productive to the overall goals of such a strategy. That said, the research points to the potential of sophisticated strategies including cascading price discounts or increments, along with packages of benefits such as express services and seating availability to shape demand in a manner which can be met through real world timetables.

A further challenge in developing robust business cases for such a variable pricing and service delivery approach is in costing the benefits. If a particular scenario is predicted to shift 10,000 commuters from "high-peak" periods to other timebands, the costs associated with such a policy can relatively easily be estimated by looking at the number of patrons receiving a discount based on their time of travel, and the operational costs of any additional services required to meet this demand. But how can the benefits be derived? 5,000 commuters represents 6 train loads of customers, which at $30m per train represents a cost saving of $180m (figures include an approximate cost for additional stabling and depot facilities). However this is really deferring expenditure (for how long?) and may increase the demand for additional rolling stock at other times with greater induced demand (some of which may come from other modes). Delays in infrastructure expenditure as a result of better demand management is similarly difficult to precisely cost in a way that can be used in a business case. This is an area requiring additional thought and discussion.

7. Conclusion

According to the discrete choice model developed from surveying customers commuting for work on the Pakenham line in Melbourne, price increases and decreases and express services have been shown to have the greatest potential to assist in managing demand for peak travel in both the morning and afternoon peaks. In addition to these service attributes, seating availability could play a role in managing the demand for afternoon peak travel.

While this research highlights the potential for managing peak demand, further research is required to understand whether the flexibility suggested by Pakenham line customers commuting for work is mirrored on other train lines. It could be hypothesised that different train lines, with different lengths, stopping patterns, travel times, load profiles and customer profiles, could be expected to have very different responses to the same scenarios. In addition, other modes such as tram where peak demand also creates challenges are likely to have different customer responses. This is important given that there may be a wish to preserve the current multi-modal nature of Melbourne's ticketing system by offering the same discounts to tram and bus users, although the Early bird ticket (train only) has set some sort of precedent in this area.

With the immanent availability of a smartcard ticketing system across the public transport network, this study is timely in providing information about the possibilities for demand management. The next step is to translate these findings (and the results of any other future studies) into business cases that show the total impact on the network of any proposed initiative.

A demand management strategy based around price and/or service elements has the potential to assist in shaping demand in a way that can defer major investment in rolling stock and infrastructure; however, the potential would be considerably improved if there was greater flexibility exhibited by passengers. As such, continued effort is required to encourage employers to provide more flexible working arrangements for staff that would allow for greater uptake of any future initiatives provided by the public transport network in Melbourne.

8. References

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