TRAVEL DEMAND ANALYSIS WITH RECENT FUEL PRICE RISE IN PERTH

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Main Roads Western Australia

June 2008
1.0 Fuel Price in Perth

First oil crisis in the world occurred in 1973 due to world politics and war, which had both micro and macro economic impacts in the world. Subsequently in 1979 the second oil crisis occurred in the wake of the Iranian Revolution. Since then world fuel price was stable until mid 2005. The price of standard crude oil was under US$25 per barrel in September 2003, but by August 11, 2005 it had risen to over US$60 per barrel, and further risen at a record price of US$139.89 per barrel (in market price) on June 16, 2008. People suspect this price increase is due to the Iraq War commenced in March 20, 2003. The world fuel price increase had direct impact on retail fuel price in Perth. Monthly average retail price of unleaded petrol (most of the cars use) was about $0.90 per litre between January 2001 and January 2004 in Perth according to the Fuelwatch under the Department of Consumer and Employment Protection (DOCEP). The average price from January 2004 to July 2006 was increased to $1.10 per litre and the price keeps on increasing. Actual daily price of unleaded petrol since January 2001 in Perth metro is shown in Figure 1.

![Daily price of Unleaded Petrol in Perth Metro](source: Fuelwatch)

Figure 1: Daily price of unleaded petrol in Perth

Pre mid 2005 the daily prices fluctuate within a reasonable range, however after mid 2005 the price increases almost exponentially. It is also evident that the price falls since July 2006, but still higher than pre 2005 price. Transport literatures report that increase in fuel price would lead to decrease in demand for fuel and transport use. In other words transport demand elasticity with respect to fuel price is negative in value. Literatures show that the fuel price elasticity varies with a wide range of -0.02 to -0.66 in the short run and more in long run (see Appendix – A). The question is how this price rise affects travel demand in Perth?
2.0 Traffic Volume Analysis

Traffic volume data for the entire Perth metropolitan area is required to measure the impact of fuel price on travel demand. Total daily traffic volume in entire Perth can only match with daily fuel price. However, daily traffic volume data for entire Perth metro are not available. Next alternative is to collect daily traffic volumes from a number of selected road links for the period of interest. Unfortunately, traffic count data from permanent locations in Perth metro managed by MAIN ROADS Western Australia are not available for the recent time. The continuous traffic count data available from Asset and Network Information (ANI) branch are for 2001 at the time of the preparation of the report. The SCATS data are available at all traffic lights in Perth metro on real time basis. Therefore, SCATS data are the only source which can be used to measure the impact of fuel price increase. Downloading SCATS data from all traffic lights is not also practical from the resource point of view. Hence, data are collected from a number of sites applying screen line.

Two screen lines are selected in Perth metro network, one in north of the river and another in the south. Approximate location of the screen lines are shown in Figure 2.

Figure 2: Locations of screen lines in Perth metro network.
More specific intersections on screen lines are provided in Table 1.

Table 1: Intersections on the screen lines

<table>
<thead>
<tr>
<th>North screen line</th>
<th>South screen line</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whitfords Av and Dampier Av</td>
<td>Cockburn Rd and Rockingham Rd</td>
</tr>
<tr>
<td>Whitfords Av and Marmion Av</td>
<td>Rockingham Rd and Carrington St</td>
</tr>
<tr>
<td>Whitfords Av and Gibson Av</td>
<td>Rockingham Rd and Phonix Rd</td>
</tr>
<tr>
<td>Whitfords Av and Freeway on ramp</td>
<td>Phonix St and Stock Rd</td>
</tr>
<tr>
<td>Whitfords Av and Freeway off ramp</td>
<td>Phonix St and Sudlow Rd</td>
</tr>
<tr>
<td>Whitfords Av and Kingsley Dr</td>
<td>Phonix St and North Lake Rd</td>
</tr>
<tr>
<td>Whitfords Av and Trappers Dr</td>
<td>North Lake Rd and Berrigan Dr</td>
</tr>
<tr>
<td>Whitfords Av and Wanneroo Rd</td>
<td>Berrigan Dr and Freeway On/Off ramp</td>
</tr>
</tbody>
</table>

Total daily traffic data are collected from SCATS for all intersections (both south and north) for the period between July 1, 2005 and June 2, 2008. Daily variation of traffic for north and south screen lines are shown in Figure 3.

Figure 3: Daily traffic volumes for a) south screen line and b) north screen line.

In both the cases the daily variations are similar which ensures the consistency of data. During late December through January for 2006, 2007, and 2008 total traffic drop which is due to holiday season. There are also slight drops in Aprils, which is also for Ester holidays. The SCATS data are not stored for more than one year because of the huge storage space requirement. For this time series analysis total of north and south screenlines data are used.

3.0 Data Smoothing

Both data sets are time series containing seasonal and daily variation components. A time series usually have four components, they are trend, cyclical, seasonal, and irregular components. In order to develop any relationship between time series data and any other data series or other time series, it is appropriate to decompose the components and subtract seasonal component and irregular component (if possible). Most of the published economic data are seasonally adjusted because seasonal variation is typically not of primary interest (Makridakis et al. 1998). Once seasonal component is subtracted, the time series leaves with
trend and cyclical component. The combined trend and cyclical components provide the
direction of change the data series. However, depending on nature of fluctuation of data
series, different data series need different approaches to smooth for eliminating seasonal
component.

By observing fuel price data series (Figure 1), it is evident that both additive trend and
multiplicative seasonality components are present. On the other hand traffic data show the
additive seasonality with no trend components. To discuss about the relationship between
traffic volume and fuel price the data sets are needed to be smoothen. As the natures of the
variation of two sets of data are different, the methods of smoothing are different for them.

Total traffic volume (combined north and south screenlines) data have additive seasonal
component, therefore either moving average technique or exponential smoothing would be
appropriate to smooth the data set. Again moving average could have different numbers of
order. As a rule, a large number of order in the moving average increases the likelihood that
randomness will be eliminated (Makridakis et al. 1998). On the other hand this approach
may smooth the genuine bumps or cycles that are of interest. Three orders of moving
averages, such as 3-point moving average (3-MA), 5-MA and 7-MA are applied on traffic
data. Smoothing data series are shown in Figure 4.

![Smoothing Traffic Data Series](image)

Figure 4: Smoothing traffic data

It is evident that the traffic volumes vary daily and have a weekly pattern. In this case 7-
point moving average (white line) provides the best data series without seasonal component.
This data series shows the actual movement (trend and cyclical components) over time.

Similarly, fuel price data are also made smooth using moving average technique. Since the
fuel price data have multiplicative seasonal component a “ratio-to-moving average”
technique is appropriate to smooth the data. The ratio-to-moving average is just one step
further to the simple moving average. A ratio between moving average and actual data would
provide the seasonal component. Deducting seasonal component from the actual data leaves
the trend component, which is of interest. The smoothed data series are shown in Figure 5. Note that fuel price data are shown in Figure 5 for the same period of traffic data. There is a noticeable difference between traffic data smoothing and fuel price data smoothing. In Figure 5, it is shows that there is no much difference among actual, 3-MA, 5-MA, 7-MA, and trend. All are more or less coinciding each other. Since there is no significant difference (visual method) between actual data and smoothing average, the study would use the actual data series for further analysis.

![Smoothing Fuel Price Data Series](image)

Figure 5: Smoothing fuel price data

To establish the relationship a 7-MA of traffic volume and actual fuel price data would be used. Since the traffic volumes are seasonally adjusted and obtained only the trend component of the time series comparing data on calendar year basis would be sufficient.

### 4.0 Relationship between fuel price and traffic volume

To establish the relationship between traffic volume and fuel price a regression model was developed to observe the influence of corresponding fuel price and its lag variables to the traffic volume. Up to 14 lag variables of fuel price were used to develop a relationship with seasonally adjusted traffic volume, however the model did not provide a good model fit. Therefore, simple average comparison method was used to establish the relationship between these two variables.

Seasonally adjusted daily traffic volume and actual fuel price along with linear trend lines for those are shown in Figure 6. Daily traffic volumes in 2005 through 2008 show an increasing trend with linear trend line equation of \( y = 9.56x + 427209 \). The slope of the trend line is positive 9.56.
The fuel prices for the same period are shown an increasing trend as well. Daily variation of fuel price from July 2005 to May 2008 along with trend is shown in the Figure 6. The trend line equation was $y = 0.0182x + 116.43$. Though from 2005 till mid 2007 price changes its directions, since mid 2007 the price increases more rapidly.

Figure 6: Trends of traffic volume and fuel price for the period between 2005 and 2008.

The 7-MA traffic volume data contain the trend and cyclical components of time series, therefore to establish the relationships between fuel price and traffic volume data need to compare for the same cyclical periods. Entire time series has been divided into three time periods, i.e. July-June for 2005-06, 2006-07, and 2007-08 periods. The variations for both traffic volumes and fuel prices along with average for above mentioned three periods are shown in Figure 7. Average fuel prices and traffic for years 2006-07 and 2007-08 had increased from 2005-06. There is a visual relationship, with the slight increase in average fuel price from 2005-06 to 2006-07 the traffic volume had also increased for the same period, whereas with the higher increase in price from 2006-07 to 2007-08 the traffic increases but with a decreasing rate than previous period. This may show an impact of fuel price increase in travel behaviour.
The averages for both traffic volume and fuel price have slightly increased over the period. Estimation of fuel price elasticity would give better insight of the travel behaviour with respect to fuel price. Price arc elasticity of travel demand can be expressed as in equation (1).

\[ e = \frac{\ln(V_2) - \ln(V_1)}{\ln(P_2) - \ln(P_1)} \]  

Where, \( e \) is arc elasticity of travel demand with respect to fuel price  
\( V_1 \) is traffic volume at fuel price level \( P_1 \)  
\( V_2 \) is traffic volume at fuel price level \( P_2 \)

In order to calculate the elasticity average price level and traffic volume for 2005-06, 2006-07, and 2007-08 are used. Daily average traffic volumes and petrol prices for three periods are shown in Table 2.

Table 2: Average traffic and fuel price

<table>
<thead>
<tr>
<th></th>
<th>2005-06</th>
<th>2006-07</th>
<th>2007-08</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily average traffic (no.)</td>
<td>428,426</td>
<td>434,000</td>
<td>434,606</td>
</tr>
<tr>
<td>Daily average petrol price (¢/litre)</td>
<td>122.3</td>
<td>122.8</td>
<td>133.7</td>
</tr>
<tr>
<td>Fuel price elasticity (e)</td>
<td>3.3</td>
<td>0.016</td>
<td></td>
</tr>
</tbody>
</table>

These average daily traffic volumes and petrol prices are applied in equation (1) to estimate elasticities, which are shown in Table 2. The values do not follow price elasticity principle. Price elasticity of travel demand is supposed to be negative. In this case the data show that with the increasing price of fuel the traffic did not reduce (refer Table 2). This situation may happen due to several reasons. Some of them can be identified as:

- Increased traffic volume could be due to  
  - population increase
Next section will investigate the probable reasons for increasing travel demand even if fuel price has increased and try to estimate elasticity with the adjusted traffic volumes.

**Population Increase:**

The ABS population data and two Census (1996 and 2001) data show that population in Perth has increased by 1.5% and driving age population has increased by 1.13%. If we assume that the increased traffic volume in 2006, 2007, and 2008 (refer Table 2) was entirely due to the increase in driving age population then we can adjust the traffic volume with the population increase. Population adjusted traffic volume with the reference to 2005 data is shown in Figure 8 with the linear trend line. The trend line for population adjusted traffic volume shows a decreasing trend with the slope of -4.025, whereas trend for the actual traffic volume was increasing with slope of 9.56.

![Population adjusted traffic volumes with trend line](image)

These population adjusted traffic data would be appropriate to use to determine the price elasticity of travel demand in Perth. The daily average traffic volume after population adjustment for the periods 2005-06, 2006-07 and 2007-08 are shown in Figure 9 with the average prices of fuel for the same periods.

- improved economic condition of the travellers
- increased public transport costs
- people shift to use smaller cars
The average values for traffic volumes and fuel prices which are used to estimate the price elasticities are shown in Table 3.

Table 3: Average traffic (population adjusted) and fuel price

<table>
<thead>
<tr>
<th></th>
<th>2005-06</th>
<th>2006-07</th>
<th>2007-08</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily average traffic (no.)</td>
<td>426,013</td>
<td>426,671</td>
<td>422,641</td>
</tr>
<tr>
<td>Daily average petrol price (¢/litre)</td>
<td>122.3</td>
<td>122.8</td>
<td>133.7</td>
</tr>
<tr>
<td>Fuel price elasticity (e)</td>
<td>0.39</td>
<td>-0.11</td>
<td></td>
</tr>
</tbody>
</table>

The arc price elasticities with the population adjusted traffic are shown in Table 3, which are positive for first change period and negative for the next. However, if 2005-06 and 2007-08 values are used to calculate elasticity the values would be -0.09. The value of elasticity can be defined as 1% increase in fuel price would drop maximum of 0.09% of travel demand in Perth. In other words, if the fuel price doubled from $1.22 per litre to $2.44 per litre the travel demand in Perth would reduced by a maximum of 9%. Although recent articles in the newspapers reports a higher impact of fuel price on travel behaviour (Appendix-C). This analysis considers the traffic volume increased entirely due to population increase, therefore elasticity of -0.09 is the extreme point. The true price elasticity of travel demand in Perth may vary between 0 and -0.09.

The average traffic volume with and without population adjusted corresponding to the average fuel price are shown in Figure 10.
It is clear from Figure 10 that actual traffic volume increases in the latter periods are mainly due to population increase. People may not responsive with small increase in fuel price however they are more responsive with bigger increase in price. The amounts of price change from 2005-06 to 2006-07 are fairly small compared to the change from 2006-07 to 2007-08 values. There could be other reasons of increasing traffic volumes. Therefore, if traffic volumes for the other factors can be eliminated then we could calculate accurate fuel price elasticity.

Economic Condition:

Good employment situation in Perth helps people to cope with fuel price increase. Recently Western Australia (WA) experiencing economic booming and lowest ever un-employment rate. People have sufficient money to fulfil extra cost of fuel. Alternatively, if we assume people have same income, then they must have shifted household expenditure from other items to travel expense. Unfortunately current household expenditure data for Perth or WA are not available from ABS or from any other sources. Full time employment trend in Perth and WA is shown in Figure 11. Monthly employment is increasing substantially. As we can see in Figure 10, monthly full time employment has increased with an increased rate since September 2004. This improved economical condition of the people in Perth in general may have some impact on travel behaviour. People are less likely to give up of using cars due to the increasing fuel price.
Public Transport Cost:

Even after increasing fuel price in Perth the public transport may not be attractive due to increase in public transport fares along with other reasons. The trends of transport related Consumer Price Indices (CPI) in Perth are shown in Figure 12.

**Figure 11: Full time employment in Perth and WA**

**Figure 12: Transport related CPI trend in Perth.**

The CPI for *automotive fuel* has an exponential increasing trend since 2000, which is expected. The CPI for *urban transport fares* has also increasing trend. On the other hand CPI for *motor vehicles* has declined since 1995. This declining motor vehicle price may attract people to own one or more cars. Again since economic situation of Perth population is getting better, people may want to own cars and use them.
Shift to Use Smaller Cars:

Another probable reason of travelling more with private cars is using smaller or fuel economy cars where increased fuel price have lesser impact. People in Perth may use increased number of smaller and fuel economy cars than before which could help them to cope with increased fuel price. Unfortunately category wise car sales data are not available to justify the increased use of fuel economy cars. The West Australian (issues May 10, 2006 and June 10, 2006) reported that people in WA are more interested to buy smaller cars than big cars due to the rise of petrol price (see Appendix – B). The monthly sale of new car in WA is shown in Figure 13.

![New Car Sale (WA)](source: ABS 8314.0.55.001)

Figure 13: New car sales in WA.

Passenger cars sales in WA increases despite operating cost increases. We can assume that many of the passenger cars are smaller cars or fuel economy cars. But at the same time it is evident that sales of SUV (Sports Utility Vehicle) has also increased. People may shift to buy smaller or fuel economy cars, however their interest to buy big cars like SUV has also increased. Although SUV does not necessarily consume more fuel, this can be a fuel economy car as well.

5.0 Conclusion

The fuel price elasticity of travel demand in Perth may vary between 0 and -0.09. This value is well with in the previously estimated elasticities in Australia and Wester Australia. The factors may influence the elasticity value in Perth includes (not limited to), i) available disposable incomes are absorbed by transportation, and ii) peoples’ values toward driving may be adjusted from land use development patterns. If it is possible to separate all influencing factors on travel demand other than fuel price then the elasticity would reflect true elasticity of fuel price. However, in reality it is hard, if not impossible, to separate each influencing factors on travel demand.

Not withstanding the difficulties of measuring elasticities, it would appear from the above analysis that there is a relationship between fuel price and travel demand in Perth in the short run.
## Appendix – A

### Previously estimated fuel price elasticities

<table>
<thead>
<tr>
<th>Context</th>
<th>Short term Elasticity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summary of 11 studies</td>
<td>-0.02</td>
</tr>
<tr>
<td>Australia, Donnelly 1984</td>
<td>-0.02</td>
</tr>
<tr>
<td>USA, Oum et al. 1990</td>
<td>-0.04</td>
</tr>
<tr>
<td>Australia, Donnelly 1984</td>
<td>-0.07</td>
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<td>WA</td>
<td>-0.10</td>
</tr>
<tr>
<td>Australia</td>
<td>-0.10</td>
</tr>
<tr>
<td>Australia</td>
<td>-0.10</td>
</tr>
<tr>
<td>Greene 1992</td>
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</tr>
<tr>
<td>UK, Oum et al. 1990</td>
<td>-0.10</td>
</tr>
<tr>
<td>Australia</td>
<td>-0.12</td>
</tr>
<tr>
<td>Australia, ARRB</td>
<td>-0.12</td>
</tr>
<tr>
<td>11 region of OECD, 1997</td>
<td>-0.12</td>
</tr>
<tr>
<td>Australia, Donnelly 1982</td>
<td>-0.12</td>
</tr>
<tr>
<td>Aust, UK, USA</td>
<td>-0.14</td>
</tr>
<tr>
<td>WA</td>
<td>-0.16</td>
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<td>Australia, Hensher &amp; Young 1990</td>
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<td>WA, Donnelly 1982</td>
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<td>WA</td>
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<td>Aust, UK, USA</td>
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<td>Greene 1992</td>
<td>-0.50</td>
</tr>
<tr>
<td>BTCE, 1991</td>
<td>-0.66</td>
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News paper reports:
(The West Australian Wednesday, May 10, 2006)
WA car sales surge

Sharif Siddique, MAIN ROADS Western Australia
Fuel price rise in Perth_version_June08.doc
Petrol costs could stop 30pc driving

SHANE WRIGHT
ECONOMICS EDITOR

Up to 30 per cent of motorists will leave their car in the garage if petrol prices hit a Labor government, then judging by the way he's behaving, the PM throws his hands up in surrender:

"eggs-temperly resists."

And yet just six months into the job, the PM throws his hands up in surrender.

Global oil prices slipped back yesterday to $US130.81 after reaching $US135.50 on Thursday. In Asian traded moved up a little to just over the $US131 a barrel mark.

Committee chief economist Craig James said the retail term oil had surpassed its peak price reached before the advent of cars - in 1884.

He said although prices might eventually come down, long term, there was no return to the days of cheap oil.

Prime Minister Kevin Rudd yesterday stood by his refusal to cut excise on fuel, saying the government was honouring its pre-election commitments in areas such as a petrol price commissioner.

He said oil prices were not something an Australian government could control.

Expenditure Leader Brendan Nelson said even if oil prices fluctuate, a cut in the excise as heh has proposed would provide relief to motorists.

"What Mr Rudd is trying to do is to deflect attention away from the fact that he does have control over one element of the price of fuel and this is the excise. We believe in the coalition in lower taxes, we believe that the excise is a tax," he said.

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THE UNIVERSITY OF WESTERN AUSTRALIA
Business School

"She Gets Australian 24/6/2008"

Sharif Siddique, MAIN ROADS Western Australia
Fuel price rise in Perth_version_June08.doc
City commuter slug

High fuel costs drain family budgets

By CARMELIE BANDER

In Perth workers are packing up nearly $10 a week to drive into the city and double that for a trip driving from Mandurah. The average price of a litre of unleaded petrol in the metropolis was $1.35 at the pump yesterday. Figures from Transport and Main Roads show many workers spend up to 10 per cent of their weekly wage on transport, based on the WA average weekly wage of $1375.60. Main Road commuters pay $130.11 a week, compared with $134.64 in 2007. The increase was 3.3 per cent, an increase of more than $90 a month.

While the Main Road train line has reduced commuters' time, those using the Kwinana way, Mandurah residents who drive to Perth spend $136.32 a week on transport.

Fremantle residents who drive to work in Perth pay $99.31 a week, while Mandurah commuters cough up $100.19. The main roads are at a price point that is more than double the national average. The average price of petrol is more than $11.70 a litre in 2009 to $14.20 a litre this month, plus the operating costs such as insurance, repairs and repayments.

Figures are based on a mid-range-sized car, such as a Toyota Camry 2.4 litre, and include a 50-kilometre parking fee.

The commuter slug costs are:

- Petrol prices are tipped to reach $1.70 a litre by the end of the year, andruing next year.
- Unprotected fuel is predicted to rise by at least 10 per cent and oil sales to increase until 2014.
- Fuel costs and wages are not in line and a lot of small families are being sold to prepare for serious financial stress.

State governments could reg

THE WEEKLY COST OF COMMUTING

POWELL DAVIES, MAIN ROADS Western Australia

Fuel price rise in Perth_version_June08.doc

The Sunday Times (May 25, 2008)
Easier road

Europeans pay highest prices

By CARMELLE SANDER

As Australians curse record fuel prices, European motorists have more cause to go bailiwick at the bowser — with fuel edging close to $3 a litre in some countries.

Motors in France, Britain, and May take on more than a litre for unleaded fuel, while those in Norway and the Netherlands pay more than $2.50.

But petrol remains cheaper in the US and South-East Asia because of lower taxes and government subsidies.

Driven in the UK, Malaysia, and Thailand pay about $1.00 by their petrol.

WA Motor Trade Association chief executive Peter Fitzpatrick said most Europeans suffered because of higher fuel taxes.

Several countries subsidise the cost of fuel, making transport of people and goods significantly cheaper.

Countries with subsidised fuel include Iran, Saudi Arabia, Egypt, Russia, Malaysia, Kuwait, China, Taiwan, South Korea, Brazil, and Nigeria.

In Indonesia there are calls for petrol to be subsidised — with cheap fuel limited to public transport and motorcycles.

"Three in oil-producing countries enjoy the lowest fuel prices, with Saudi Arabia, Iran and Kuwait paying just a few cents a litre," Mr Fitzpatrick said.

"Because these countries have so much oil they don't charge a tax on it," he said.

The usage and pricing of petrol around the world is influenced by other factors such as crude oil prices, processing and distribution costs, local demand, the strength of local currencies, and surtaxes.

RAC vehicle policy manager Mike Upton said the biggest factor affecting international petrol prices was crude oil and refined products from Singapore.

Under Australia's import policy, Singapore is used as the price benchmark for West petrol because of its proximity and availability.