Oil vulnerability in Melbourne

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Abstract

Peak Oil and Climate Change present serious challenges to governments and planners. The sprawling auto based city, which is the model upon which Australian cities have grown is particularly unsuited to a situation of decreasing oil availability and a need to reduce carbon emissions. The aim of this study is to investigate and expose possible variations in the spatial distribution of oil vulnerability in Melbourne. This study assesses vehicle ownership and usage characteristics by local government area (LGA), using data collected by the Victorian Department of Transport's *Victorian Integrated Survey of Travel and Activity* (VISTA) analysis. An *Oil Vulnerability Index* has been created and its application suggests that the fast growing outer suburbs of Melbourne are particularly vulnerable to oil price rises. Outer Suburban LGAs were found to have lower average incomes and travel by car more frequently and for longer distances. Future petrol price increases are likely to place stress on household expenditure, mobility and even the long-term viability of some suburbs.

1. Introduction

The dramatic increase in the price of crude oil between 2004 and 2008 has raised concerns over the world's oil supplies. An increasing number of prominent experts argue that the world has failed to find oil in sufficient quantities to balance with consumption (Skrewbowski, 2008; Campbell, 2005; Simmons, 2005; Hartmann, 2004; Shah, 2004; Leggett, 2005; Strahan, 2007; Klare, 2004; Deffeyes, 2005; Heinberg, 2006). Oil discovery peaked in 1964. Since then, we have been generally finding less oil each year and this has now reached a point in which we use approximately four barrels of oil for every one discovered (Exxon Mobil, 2002). With new demand from the emerging economies of India and China, and a global failure to match this growing demand with new discoveries, the world is likely to experience a spiralling of oil prices and this will have a major impact on the transport sector. In 2008 the CSIRO (2008) released the *Fuel for Thought* report that forecast petrol prices for 2018 at between $2 and $8 a litre.

Cities, such as Melbourne, that have developed sprawling, low density urban form across its post WWII footprint, face adaptation pressures if they are to avoid significant transport disadvantage and subsequent social exclusion issues. Dealing with the threats of Peak Oil and Climate Change requires long-term preparations. In 2004 the United States Department of Energy commissioned a team of risk management experts to address the threat posed by Peak Oil (Hirsch et al, 2005). They found 20 years of intense forward planning is required to negate the economic and social impact of reduced oil supply. Planners and governments need to begin taking action now in order to make accessibility less dependent on the private automobile and the availability of cheap oil.

2. Method

We obtained data from the Victorian Department of Transport's Victorian Integrated Survey of Travel and Activity (VISTA) 2007 (Department of Transport, 2009) study. The VISTA study

collected data on vehicle ownership such as vehicle make, model, age, cylinders and whether the vehicle costs are covered by a private individual or a company. VISTA also collected data on vehicle usage such as average trip distance and number of trips made. This allowed the authors to generate average Vehicle Kilometres Travelled (VKT). The VISTA data also provided modal splits for weekday travel. The figures for walking, cycling and public transport were combined to create a percentage for Non-Auto Travel. All of the VISTA data is aggregated at the level of the Local Government Area (LGA) and so we have used LGAs as the base spatial unit for our analysis.

Data was also obtained from the Green Vehicle Guide, a Federal Government website that provides consumers with information about the fuel economy of vehicles. By matching the make, model and year of production data from VISTA, we were able to obtain the fuel economy characteristics of the Melbourne vehicle fleet and generate an average vehicle fuel economy figure for each LGA. The Green Vehicle Guide does not provide fuel economy data for pre-1986 vehicles and so these vehicles were excluded from the average figure creating a slight bias towards lower fuel economy figures. In all but one case, the pre-1986 vehicles made up less than 10% of the vehicle fleet. Combining the Average Fuel Economy and VKT figures enabled the generation of an Average Weekly Fuel Use figure.

Average Taxable Income figures were obtained from the Australian Bureau of Statistics (ABS) *National Regional Profile* (ABS, 2008). Therefore from these four sources we were able to generate a data set of the following statistics aggregated by LGA:

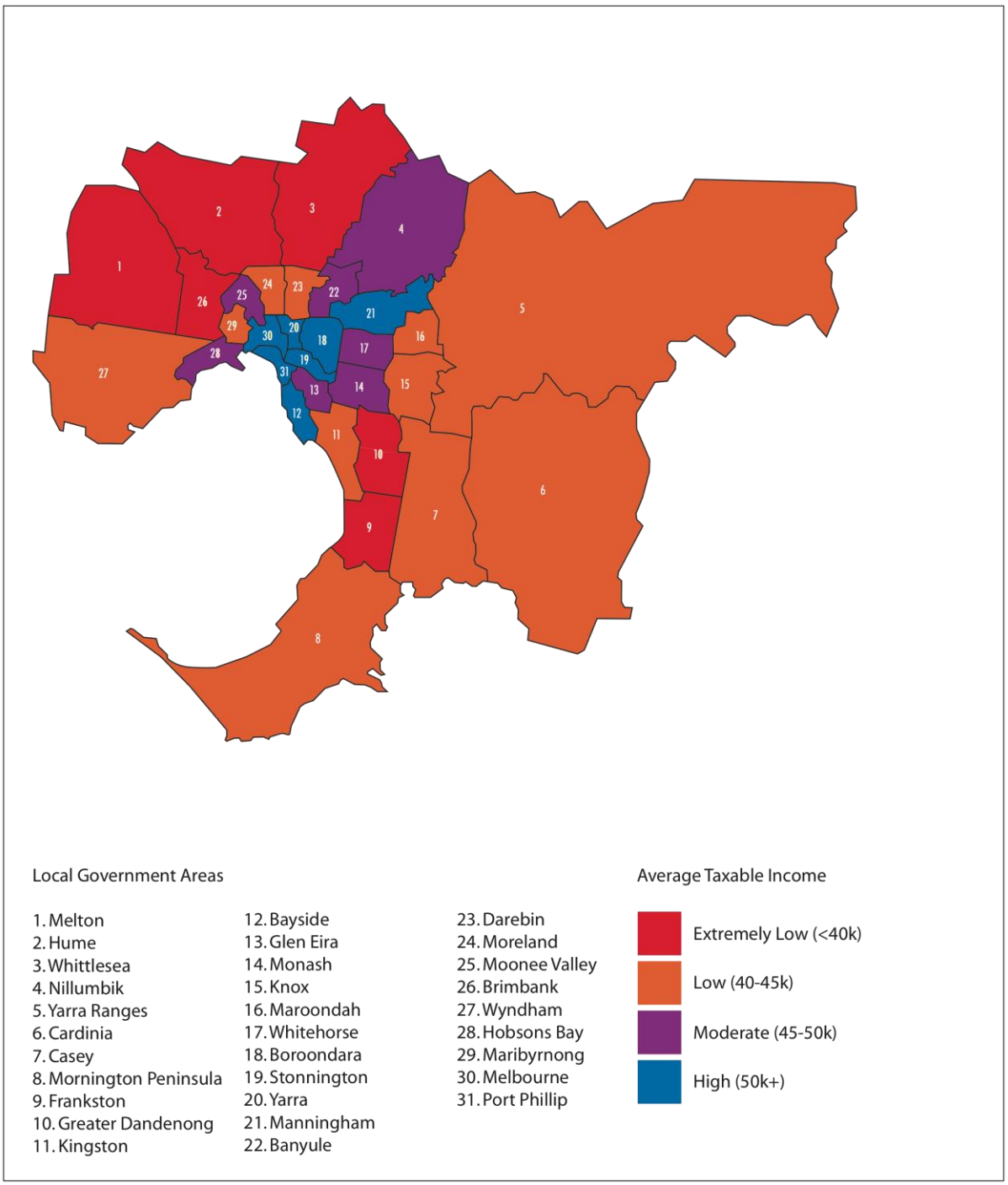
- Average Weekly VKT
- Average Vehicle Fuel Economy
- Average Weekly Fuel Use
- Weekday Modal Splits (all travel)
- Average Personal Net Taxable Income.

3. Melbourne’s Profile – The Data

3.1 Income Distribution

Melbourne is a city with a high degree of spatially based economic inequality. The spatial income inequality, combined with the difference in car usage patterns result in wide variation in Melbourne's exposure to higher oil prices. The Average Annual Taxable Income for residents of the poorest LGA, the City of Greater Dandenong, is just 46.45% of the highest, the City of Stonnington. Figure 1 shows a map of metropolitan Melbourne with the LGAs grouped by income, the pattern of increasing wealth with increasing proximity to the CBD is stark. The wealthiest councils are located in a band stretching from the CBD through the inner south-east and inner eastern suburbs.

Figure 1: Average Taxable Income per person (ABS, 2008), The four bands have been developed for use in the Oil Vulnerability Index



3.2 Vehicle Use and Expenditure

Figure 2: Weekly Kilometres Travelled (Department of Transport, 2009).

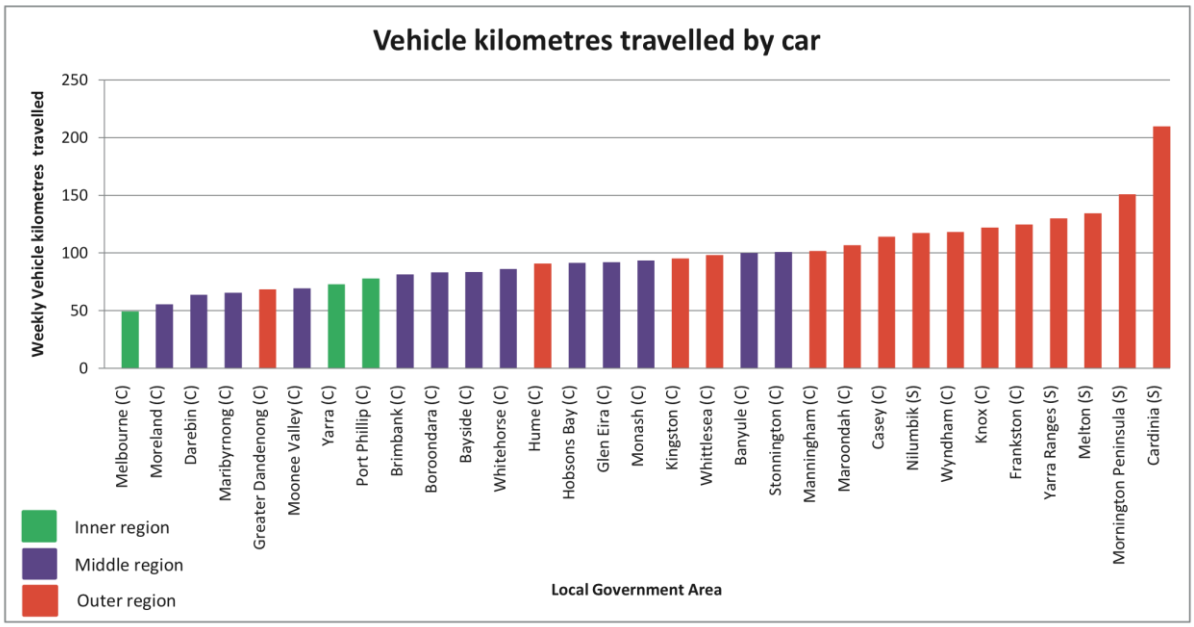


Figure 3: Average fuel economy of the vehicles fleet by LGA (Department of Transport, 2009), (Department of Infrastructure, Transport, Regional Development and Local Government, 2009), (ABS, 2009)

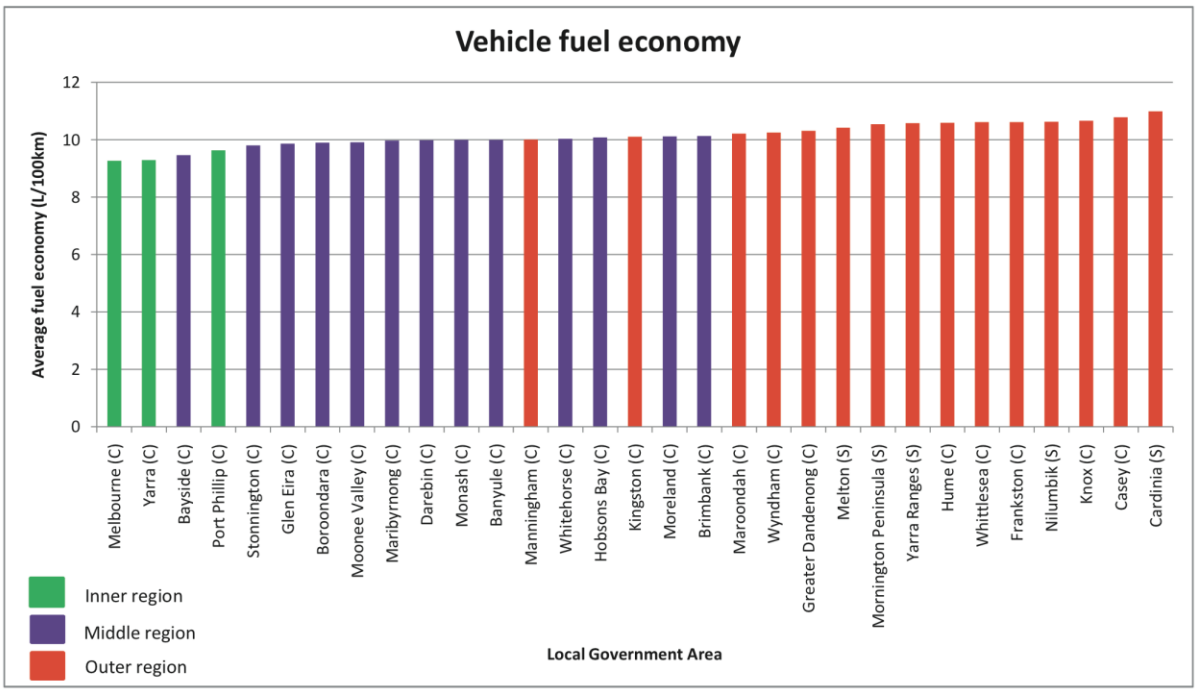


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Figure 4: Fuel usage in Melbourne. The average fuel use figures was determined by multiplying the average VKT by the average fuel economy figure for each LGA (Department of Transport, 2009), (Department of Infrastructure, Transport, Regional Development and Local Government, 2009)

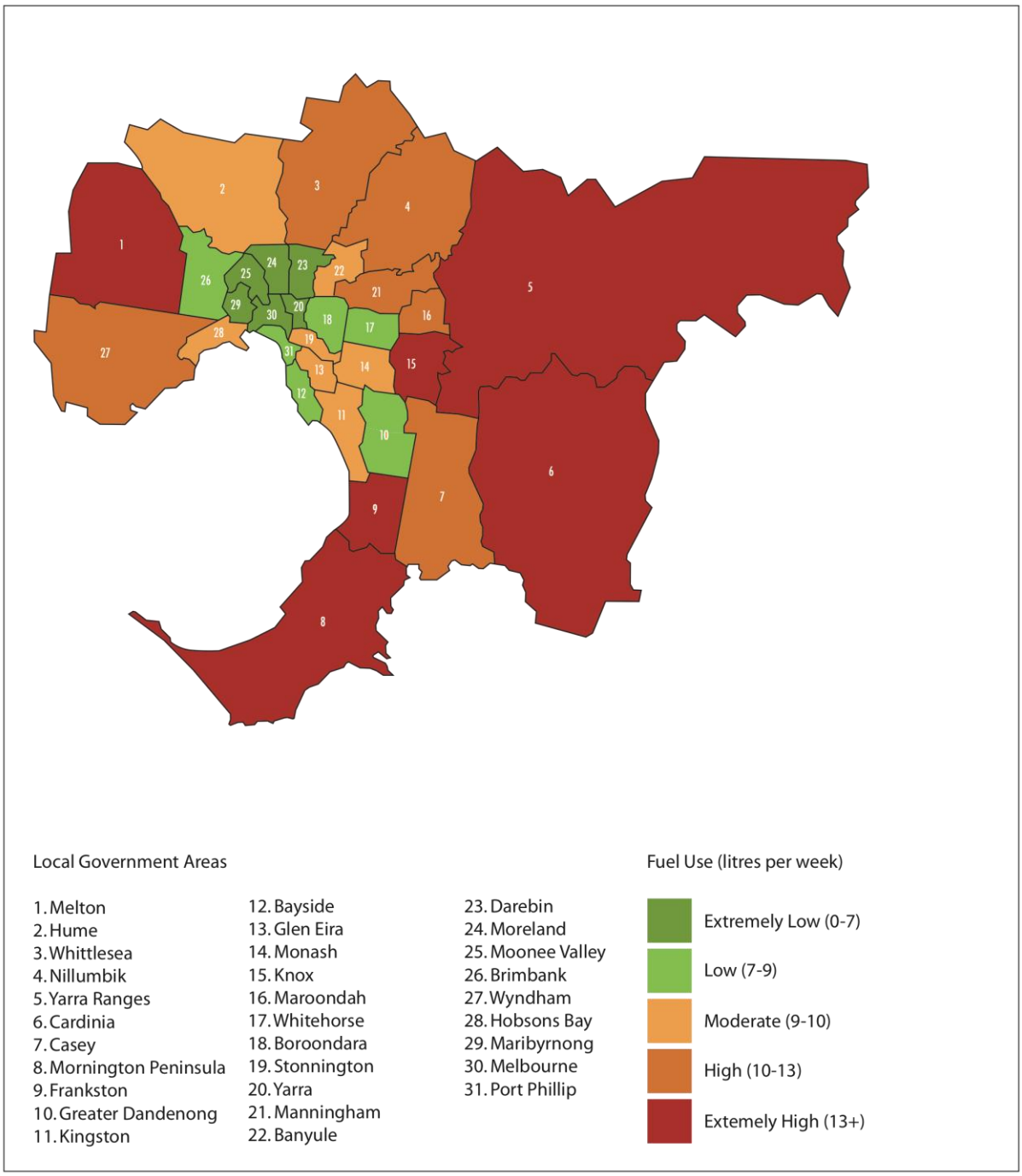
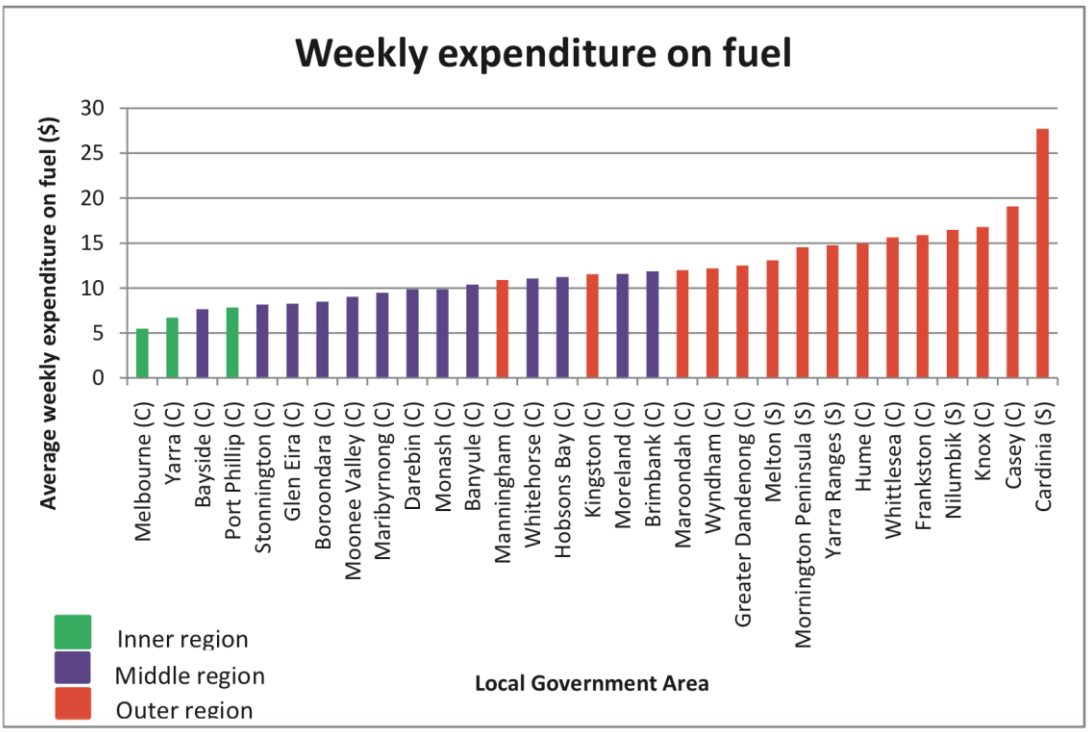
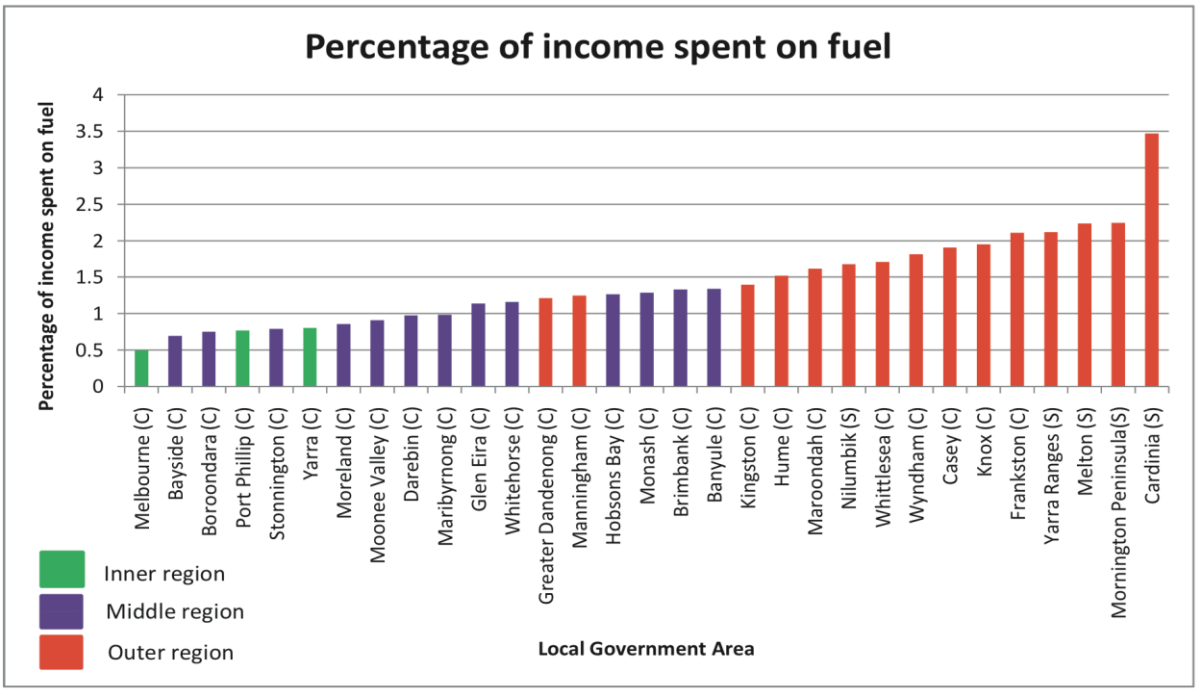


Figure 5: Current average individual weekly expenditure on fuel per person at $1.20/Litre (Department of Transport, 2009), (Department of Infrastructure, Transport, Regional Development and Local Government, 2009), (ABS, 2009)



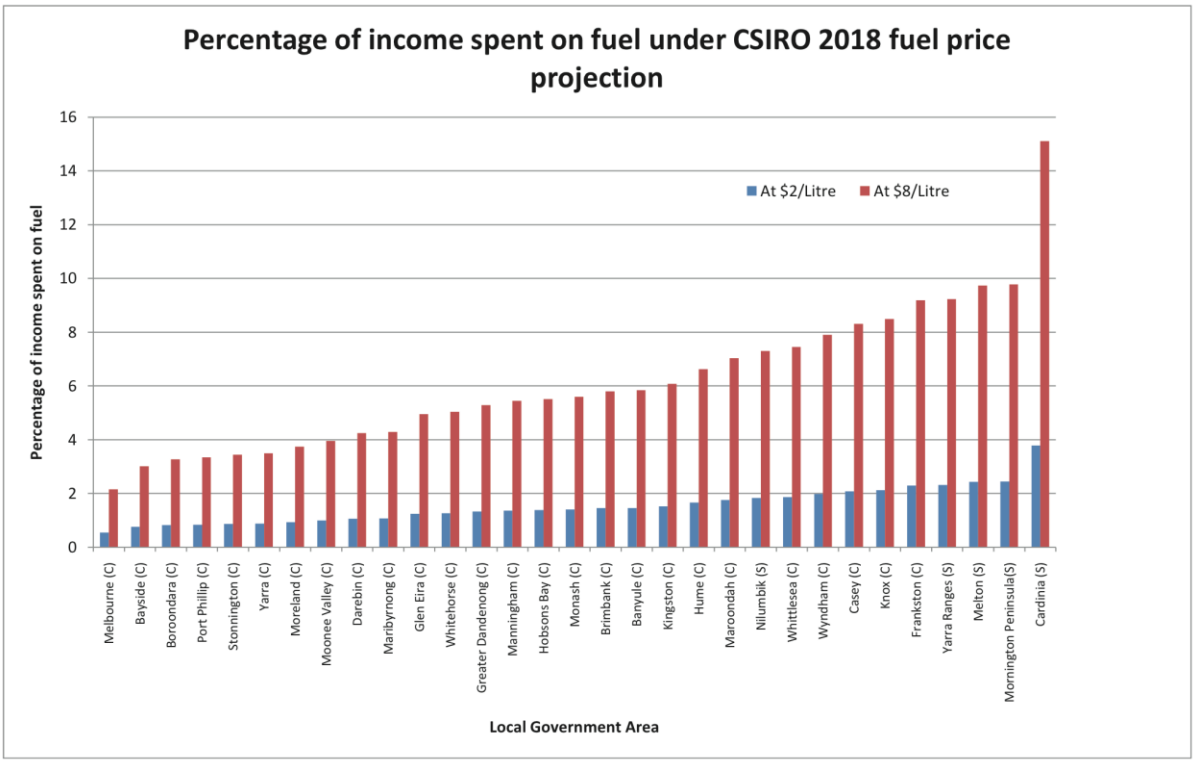
Figures 4 and 5, above, both show higher fuel expenditure among LGAs located on Melbourne's fringe. This is due to higher car use, as represented by modal split data (see figure 8 below), and greater trip distances (see figure 2 above). Interestingly very little spatial relationship exists for vehicle fuel efficiency (see figure 3)

Figure 6: Fuel spending as a proportion of average weekly income (Department of Transport, 2009), (Department of Infrastructure, Transport, regional Development and Local Government, 2009), (ABS, 2009)



Despite the strong sentiment in the community and media, fuel comprises a very small proportion of expenditure, as a percentage of income. The difference between LGAs can be stark however, with Cardinia Shire Council residents spending seven times the proportion of income on fuel as their City of Melbourne counterparts.

Figure 7: The proportion of average income spent on fuel (ABS, 2008), (Department of Transport, 2009), (Department of Infrastructure, Transport, Regional Development and Local Government, 2009). The fuel prices are derived from the projections in the CSIRO (2008) Fuel for Thought Report. The incomes are adjusted by the trend in incomes from 2000-2009 (ABS, 2009).

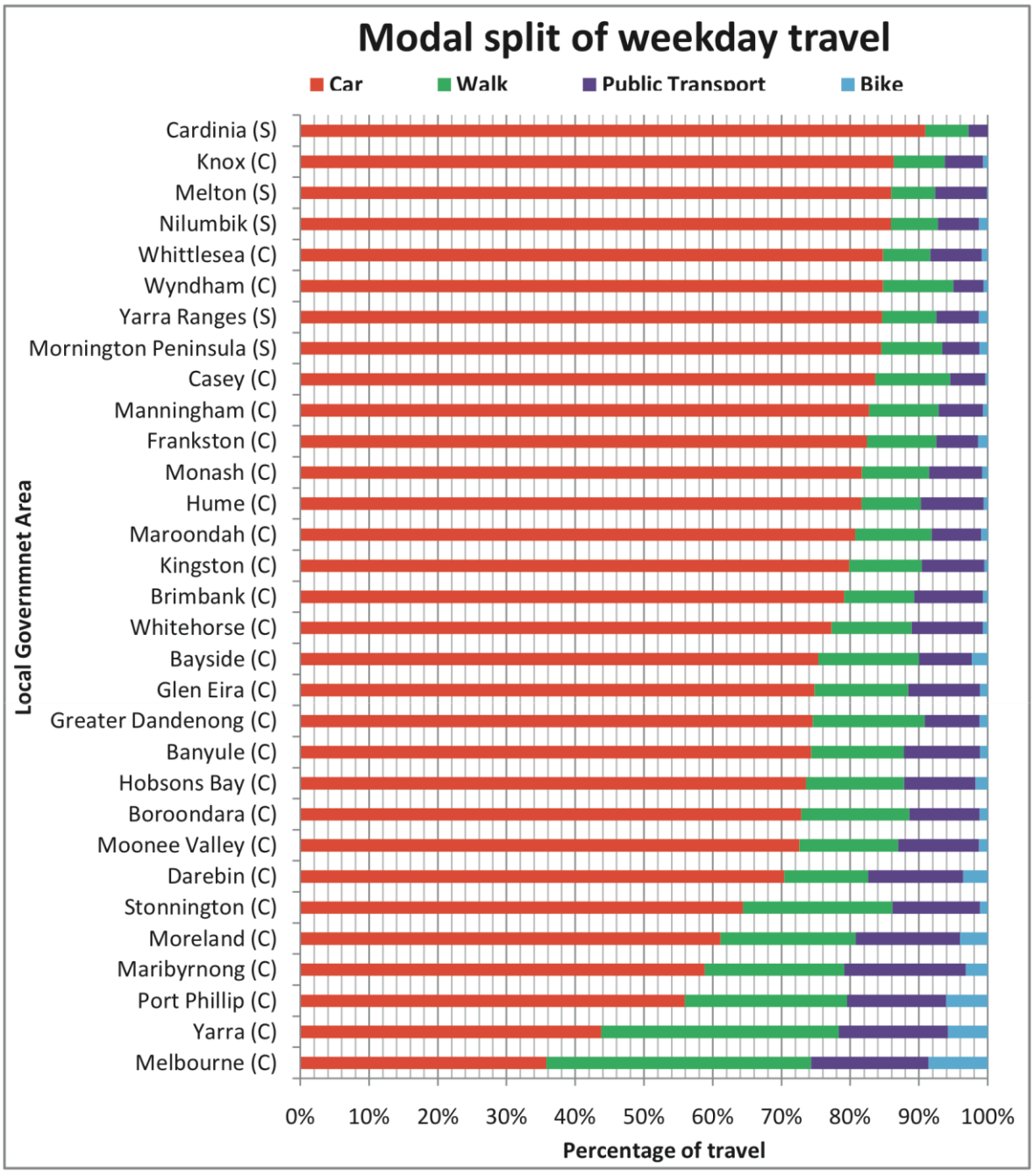


Under the CSIRO (2008) fuel price projections for 2018, the proportion of income spent on fuel (see figure 6) is still quite small at the low projection price of $2 per litre. At CSIROs upper projection of $8 per litre, individuals in the Shire of Mornington Peninsula and the Shire of Melton would be spending almost 10% of their income on fuel. In the Shire of Cardinia, 15% of income will be spent on fuel. The VISTA survey aggregated the VKT figure by LGA. These figures have been divided by the total population (which includes children and non-car owners) in order to derive the average fuel use figure for each LGA. Therefore the true cost of fuel for drivers will be higher than reported here. In most cases fuel is not the major cost of owning a car (NRMA, 2009) therefore the overall cost of car ownership may become an untenable financial burden for some outer suburban residents.

3.3 Modal Split

Figure 8 below illustrates the mode of transport for weekday travel by LGA. It includes travel for all purposes rather than journey to work only and this therefore captures the 75% of trips that are for non-commuting purposes. Car use shows significant variability across Melbourne, with Cardinia reporting just over 90% of all travel by car, with the City of Melbourne showing the lowest at 36%. The inner city LGAs recorded a significantly greater proportion of their trips by public transport, walking and cycling.

Figure 8: The Modal Split for Weekday Travel – all purposes (Department of Transport, 2009)



4.0 Oil Vulnerability Index

A key aim of this report was to assess the spatial distribution of oil vulnerability within Melbourne. To achieve this, an Oil Vulnerability Index has been developed for Melbourne that can be applied at the local government level. This builds on the aforementioned work of Dodson and Sipe (2006 & 2008). The VAMPIRE index combines four variables; the proportion of journeys to work made by car, the proportion of households with two or more cars, the median household weekly income and the proportion of dwellings that are under a mortgage (Dodson & Sipe, 2008). Their data is aggregated at the level of Census Collection District (CCD) - approximately 200 houses in each CCD.

The Oil Vulnerability Index developed for this paper uses average weekly fuel use, average personal income and modal split of sustainable transport. Sustainable transport includes the

percentage of weekday travel using public transport, cycling or walking. The income indicator used in the Oil Vulnerability Index is broadly similar to that used in the VAMPIRE Index. Our index differs from Dodson and Sipe (2006 & 2008) in that it includes all purpose weekday travel rather than journey to work only. The fuel use indicator in the Oil Vulnerability Index replaces the proportion of households owning more than two cars in the VAMPIRE Index. Fuel usage (which is based on average VKTs and average fuel economy) gives an indication of how far people are travelling - something not present in the VAMPIRE model. The fuel use indicator gauges the amount of money individuals are spending on fuel for transport, as well as rough indications of the accessibility of services and employment. For these reasons, the fuel use indicator, made possible by the newly released VISTA data (Department of Transport, 2009), is potentially a more accurate indicator of oil dependence than the proportion of houses with more than two cars. However VAMPIRE's use of the proportion of houses with two or more cars does give an indication of the long-term investment in cars that a household has made. Moreover the spatial units used by Dodson & Sipe (2006 & 2008), the CCD, provide a greater level of geographic precision than the use of LGAs.

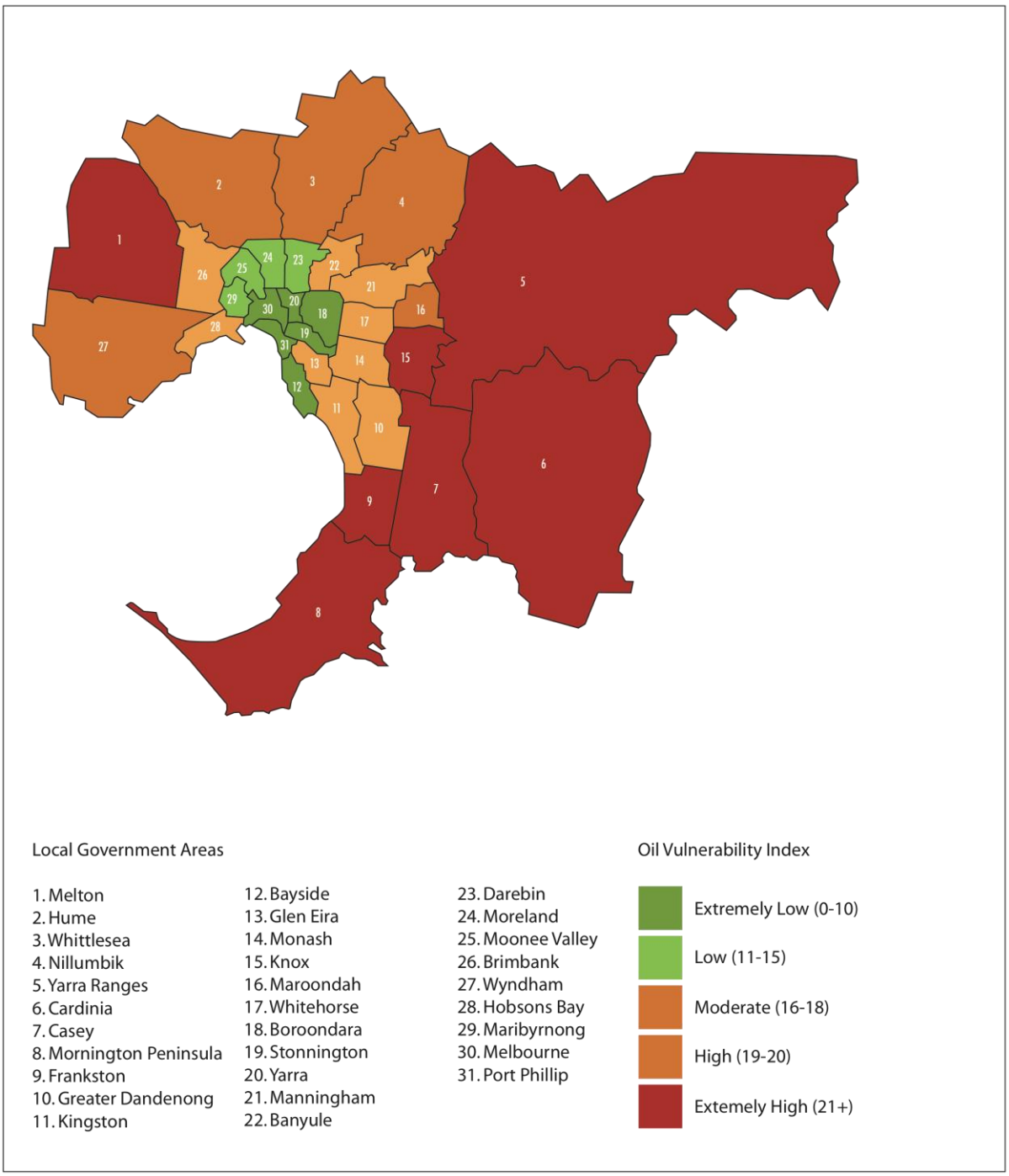
The Oil Vulnerability Index is derived from a combination of three variables; average taxable income, fuel use and the percentage of non-automobile weekly travel. For each of the three variables, the range from the minimum to the maximum value was determined. This range was split into 10% brackets and a rating from 0 – 10 assigned for each 10% bracket. The maximum score of 10 was assigned to the lowest average income and non-automobile travel modal split and the highest fuel use. Each LGA was assigned a score from 0 – 10 corresponding to their value for each variable. The three variables were added together (without weighting), to give a total oil vulnerability rating of 0 – 30.

4.1 The Oil Vulnerability Index of Melbourne – Local Government Areas

Figure 9: Results of Oil Vulnerability Index (see figure 10 or scale), (Department of Transport, 2009), (Department of Infrastructure, Transport, Regional Development and Local Government, 2009), (ABS, 2008).

Local Government Area	Oil Vulnerability Index Score
Melbourne	4
Stonnington	7
Port Phillip	8
Yarra	8
Bayside	9
Boroondara	10
Moreland	12
Maribyrnong	13
Darebin	14
Moonee Valley	14
Glen Eira	15
Banyule	15
Hobsons Bay	15
Whitehorse	16
Manningham	17
Monash	17
Greater Dandenong	18
Brimbank	18
Kingston	18
Maroondah	19
Hume	19
Whittlesea	20
Wyndham	20
Nilumbik	20
Knox	21
Casey	21
Frankston	21
Yarra Ranges	21
Mornington Peninsula	22
Melton	23
Cardinia	28

Figure 10: The Oil Vulnerability Index. (Department of Transport, 2009), (Department of Infrastructure, Transport, Regional Development and Local Government, 2009), (ABS, 2009)



5.0 Discussion

There is a clear pattern in the distribution of vulnerability, as measured by income and car use. Vulnerability increases with distance from the CBD. The least vulnerable councils are the central suburbs and the wealthy inner east and bayside suburbs. A pattern that emerges from the results, as shown in Figure 10, is that the outer north and west are slightly less vulnerable than the outer east (the five outer eastern LGAs average an Index score of 22.6 as opposed to the five northern and western LGAs that average 20.4). This difference in these scores is due to the outer north and west having lower VKT than the outer east and south.

The sustainable transport indicator (the modal split for non-auto travel) is an attempt to gauge a useful level of existing resilience to oil price increases within localities. It is not the ideal indicator as it measures current usage for non-auto based transport rather than the actual availability of these modes of transport. Nevertheless, even in areas with good access to public transport, a significant shift from car use to public transport may overwhelm current capacity. Litman (2009) has shown that even a 5% shift from current car commuters to public transport would create a 50% increase in public transport demand. At peak times, the Melbourne system would be unable to absorb this increase in patronage. In such a situation, the bicycle may prove to be a vehicle with significant additional capacity, able to absorb a considerable proportion of the short trips that are currently made by car. A more accurate gauge of transport resilience to oil price rises would be an indicator based upon supply rather than demand for public transport and cycling. To the best of our knowledge there is currently no public transport supply index aggregated to the level of LGA. Currie et al (2009) are currently working on the creation of a public transport supply index aggregated to the level of CCD. If future VISTA surveys are aggregated to this level this would be a useful indicator for the availability of public transport. Ideally if this could be matched with data that measured the amount of services and employment within the local pedestrian and cycle catchment, this would create a strong indicator for the ability of people to reduce auto dependency.

The findings presented above support the work of a growing body of research concerning transport disadvantage and social exclusion. A key characteristic of this work is the distinction made between mobility and accessibility. Mobility, the key concern of traffic engineers during the twentieth century, aims to facilitate travel quantity (speed, volume and distance) largely through the enabling of the free flow of traffic and road building. Accessibility, rather than focusing on transport per se focuses on the destinations and making them as accessible to people as possible. Adams (2005) has termed our current society as ‘hypermobile’ and believes this obsession with mobility has had a detrimental impact on community cohesion.

Hypermobility seeks to provide access to services by moving people to services, rather than the other way around. In areas where mobility options are not diverse, reduced availability of the dominant mode (for example, the car due to increasing fuel prices) leads to greater risk that social isolation will occur. The work of Currie et al (2009) is an ongoing research project studying the patterns of transport disadvantage within Melbourne. They have identified specific, ‘needs gaps’ within the public transport network as well as investigating the phenomenon of ‘forced car ownership’ where, due to the lack of other transport alternatives, low-income families are forced to own a car as they ‘need’ the accessibility it provides. The study shows that amongst low income earners in the outer suburbs, it is more common for a household to have two or more cars than to have zero cars. In these two plus car households there is generally little to no access to public transport as an alternative. An analysis of ‘zero car ownership’ showed that they tended to live in areas within walking distance of activity centres. Overall the findings of Currie et al (2009) “suggest a strong link between the quality of public transport supply and the share of low income households facing financial burden associated with car use. In addition, walk accessibility and inaccessibility is an equally strong driver of car use” (p. 102). This supports key findings of this report and specifically the spatial pattern of oil vulnerability, in which the outer suburbs are more heavily dependent on automobile travel and have lower levels of income. By integrating new data on vehicle use and projections of petrol price increases, it has been shown that a significant proportion of household expenditure will need to be dedicated to petrol in outer suburbs, should mobility patterns remain unchanged and petrol prices rise within CSIRO projections.

The Victorian Government’s Victorian Transport Plan (2008) aims to set out a blueprint for Victoria’s transport investment directions to 2020 and beyond. It is quite probable that the life span of the Victorian Transport Plan will extend into the period of peak and possibly post

peak oil. Therefore it would be prudent for the government to begin investing in projects that help build resilience to oil price rises. Our analysis has shown that the urban fringe is heavily dependent on automobile travel and therefore the most oil vulnerable outer suburbs. Whilst there are some rail extensions planned and upgrades to regional rail many of the major projects are still road based infrastructure; $6 billion for the Metropolitan Ring Road, $2.5 billion for a new road tunnel under the Maribyrnong River and $750 million for Peninsula Link. Given the well documented links between road construction and urban sprawl (Newman & Kenworthy, 1999), these projects will increase rather than diminish oil dependence and therefore vulnerability to higher petrol prices.

The major proposed public transport project in the Victorian Transport Plan, a $4.5 billion Melbourne Metro (costed at $8 billion in the Eddington Report), largely focuses on improving services in the already relatively wealthy and transport rich inner suburbs rather than easing transport disadvantage in the outer suburbs. If a sharp and continued rise in the price of oil were to occur, the lack of preparation made by government would suggest that there would be a serious decrease in social and economic well-being in the outer suburbs. The considerable exposure to high fuel prices on Melbourne's margins, as illustrated in figure 10 above warrants renewed consideration of transport investment in middle and outer ring areas.

6.0 Conclusion

This study of the data from the VISTA survey and the ABS has developed an Oil Vulnerability Index for Melbourne's LGAs. This Index has found a clear correlation between fuel use and location. Fuel use increases with distance from the CBD and this pattern mirrors the patterns of income and public transport supply, both of which decrease with distance from the CBD. The findings support the work of Currie et al (2009) in suggesting there are residents in parts of outer suburban Melbourne for whom driving is the only mobility option. The residents of these LGAs, who are already driving more than other people in Melbourne, are also more likely to be economically disadvantaged than their inner city counterparts. This suggests that Melbourne's outer suburbs, which are currently experiencing heavy population growth (ABS, 2009a), are extremely vulnerable to oil price increases. Should CSIROs (2008) prediction of dramatically higher petrol prices by 2018 prove correct, all of Melbourne's LGAs are likely to be significantly impacted upon – but outer suburbs will clearly be the worst affected. This analysis suggests that priorities for government action should include a focus on improving public transport services to the outer suburbs, encouraging compact land use and supporting active transport modes by upgrading bicycle infrastructure (both on road and end of trip) and encouraging pedestrian friendly development.

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