

Oil Vulnerability in the Australian City

Jago Dodson and Neil Sipe



Urban Research Program

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Introduction

‘One thing is clear: the era of easy oil is over...’

- Chevron Oil Ltd Advertisements (The Economist 2005, pp.6-7)

‘I’m afraid we’re not going to go back to the days of having petrol below a dollar a litre for quite some time, if at all.’

- John Howard, Prime Minister of Australia (2005)

Rising fuel costs are impacting on household budgets and this pressure is likely to continue. This paper seeks to raise scholarly and public awareness of the distributional effects of rising fuel costs on urban areas and to invite governments to begin to contemplate appropriate policy responses to ensure equitable social outcomes under conditions of energy uncertainty. The paper assesses the resilience or vulnerability of urban communities to increased fuel prices and how the socio-economic impacts will be spread across different localities. In particular, the paper seeks to assess how different socio-economic groups will be affected by rising fuel costs, at the neighbourhood level. We base our analysis on ABS Census variables that are combined to indicate potential household vulnerability to fuel price rises, based on existing levels of social disadvantage, household motor vehicle ownership and current dependence on motor vehicles for work trips. This information is used to generate a ‘vulnerability index for petroleum energy rises’ (VIPER). Maps generated with the VIPER demonstrate that high levels of oil vulnerability are present in Australian cities but that this vulnerability is unevenly distributed. Localities situated on middle and outer suburbs are most vulnerable to the socio-economic impact of oil price rises. New policies emphasising public transport services are needed to avoid, remedy or mitigate the impacts of oil price rises.

The Strategic Context

The rising price of oil

One of the most noted economic phenomena over the past eighteen months has been the strong and relatively rapid increase in the international price of oil. The global price of crude oil has risen from approximately \$30 per barrel in early-2004 to over \$60 in October (Figure 1). The past five months have seen the oil price remain above \$50 per barrel, a level that was seen as a key global ‘psychological barrier’ as recently as late-2004 (e.g. Agence Presse France 2004; Toronto Star 2004).

The rise in the international oil price has been reflected in Australian fuel prices and represented in recent consumer price index figures. The Australian Bureau of Statistics (ABS 2005) reports that the cost of ‘automotive fuel’ rose approximately 10 per cent during the year to June 2005, with an increase of 7.2 per cent during the June 2005 quarter. Thus for example, the monthly average cost of petrol for Sydney rose 40 per cent during the 21 months to September 2005 (Figure 2), a pattern that was replicated in other Australian capital cities.

While October prices have eased from September highs of above \$1.26/L, average Sydney prices fluctuated between \$1.20/L and \$1.26/L during the week to October 20 (Motormouth 2005). There are no indications of a strong decline in fuel prices in the short term.

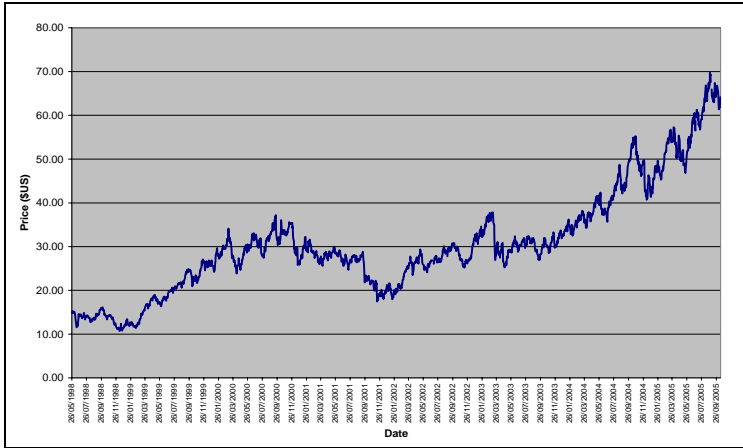


Figure 1: Price for NYMEX Sweet Light Crude (Daily Contract 1), 1998-2005.
Source: US Energy Information Agency (2005)

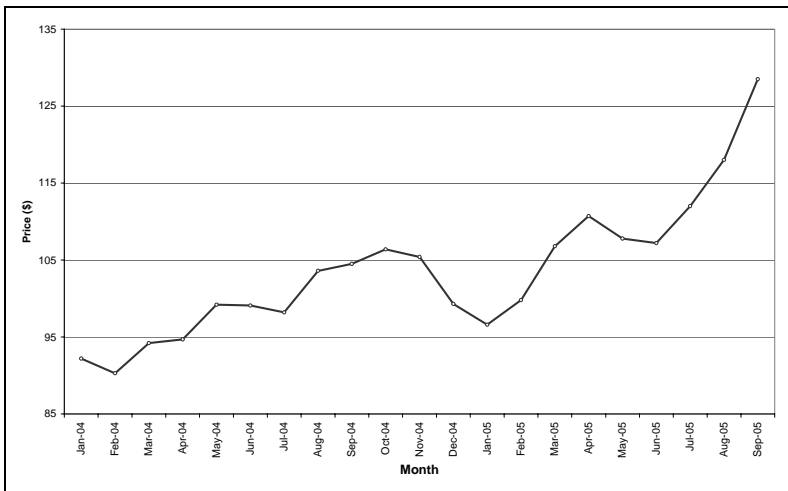


Figure 2: Monthly average fuel price for Sydney 2004-2005.
(Source: AC Neilson 2005)

Underlying pressures

There is a reasonable degree of consensus regarding the drivers of the recent international oil price increases. The twin pressures on the international oil price have been reported as including overall global economic growth, particularly new demand from China – and to some extent India – which has increased demand for oil. In addition to this strong growth in demand, recent meteorological events in the Gulf of Mexico have impacted on US petroleum production, constraining international supply.

The causes of the current high petrol prices in Australia have been the subject of much public debate between motorist lobby groups, oil companies, regulators and politicians. The NRMA has claimed that oil companies have been 'gouging' prices (Baker 2005), while the Australian Consumer and Competition Commission has argued that current prices merely reflect international patterns of supply and demand combined with international currency exchange rate fluctuations (ACCC 2005).

A number of political representatives have acknowledged the long term prospects for fuel prices. Australian Prime Minister John Howard, Treasurer Peter Costello and Australian Labor Party Leader Kim Beazley have each acknowledged that oil prices are likely to remain at their current level, although these observers are typically not specific about the underlying causes. In Queensland the government has instituted an inquiry into the causes of high petrol prices, but at the time of writing this inquiry had not yet reported. The Australian Senate has also commenced an inquiry into Australia's future oil supply and alternative transport fuels.

Peak Oil

The pressure on oil prices has drawn substantial attention to the longer-term outlook for petroleum production. A number of analyses suggest that global oil production will peak within the next twenty years (Deffeyes 2001; Campbell 2003). 'Peak oil' is the point where approximately half of all the world's oil supplies have been consumed (see Figure 3). Unfortunately the remaining reserves will be those that are harder to extract and refine. Increased production complexity implies increased production costs, which in turn implies higher fuel costs. One peak oil pessimist, Bahktiari (cited in Porter 2004) has argued that a production peak underlies recent oil price increases:

No one can restrain the price any more. For example, everyone thought that it would be OPEC who could manage demand. But that is now in the past. Now it is really peak oil that is behind the wheel of the car. Peak oil is driving the rise in price and demand is not the real question. We are entering a new era, but we are only at the very beginning of it.

A peak oil scenario has substantial implications for economies that are dependent on a continuing supply of cheap oil for economic activity and growth. Peak oil implies a growing gap between expanding fuel demand and gradually declining fuel supply. The impact of this growing shortfall between petroleum demand and supply is currently the subject of much controversy among industry analysts (Deffeyes and Huber 2005). Many commentators suggest that market forces will limit the price impact of peak oil by driving advances in technology and extraction techniques as well as through improvements in the efficiency of oil consumption (Huber and Mills 2004; Cable 2005).

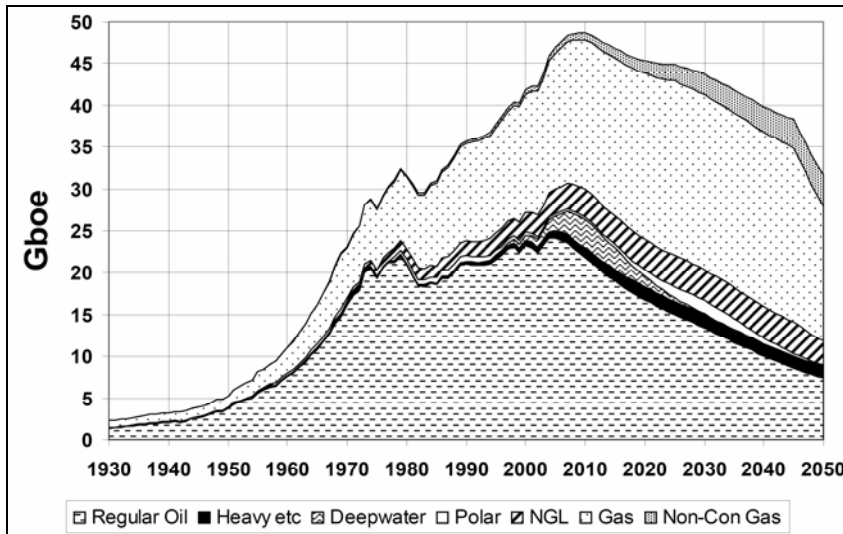


Figure 3: Association for the Study of Peak Oil (ASPO) predicted production scenarios for various oil/gas types, September 2005; Source: Campbell (2005a).

A group of more pessimistic analysts and commentators, such as members of the Association for the Study of Peak Oil and Gas (Campbell 2005b), argue that there are few alternative sources of energy that can provide the same energy return on energy invested (EROEI) ratio as petroleum and that few substitutes for oil are available. Proposed alternatives such as tar sands and oil shale are many times more energy intensive to produce than oil and generate substantial environmental effects (Deffeyes 2001). The production of hydrogen and ethanol each requires a much greater energy expense per unit generated than for an equivalent unit of petroleum energy. The EROEI for petroleum internationally is about 30, whereas the ratio for Australian ethanol is approximately 1.5 (Manildra Ltd, pers. comm.).

Some commentators have drawn attention to the potential adverse scenarios that peak oil portends for cities that are dependent on roads and private motor vehicles for urban mobility (Newman 1991). Some argue that peak oil will have much broader and deeper impact than simply increased fuel costs, extending into every aspect of urban economic and social life (Heinberg 2004; Kunstler 2005). So far most surmising about the urban impacts of peak oil has focused on the sustainability of US suburbia. Kunstler (2005) and to a milder degree Heinberg (2004) forecast highly dystopian visions of urban societies facing long-term energy shortages.

Newman and Kenworthy (1999) are the only Australian scholars to have considered the implications of peak oil for our cities to any substantive extent. Their view is that community-led pressure for upgrades of public transport offers the best solution to more expensive oil. However, peak oil scenarios have received some attention from Australian governments. The Western Australian state government has been most forward in contemplating peak oil, in part due to an active energy awareness lobby in that state. The Western Australian planning minister, Allannah McTiernan (2004) has publicly acknowledged the possibility and impact of peak oil and the Western Australian government has promoted policies to address oil dependence in that State. In response to parliamentary advocacy of the issue, the Queensland government is currently undertaking an inquiry into peak oil and its

possible impacts. This inquiry had not reported at the time of writing. Notably, ALP leader Kim Beazley alluded to peak oil in a recent speech in which he predicted a future of “falling production but higher demand” for petroleum (Beazley 2005). Recent statements about oil prices made by John Howard, Peter Costello and Mal Brough also appear to indicate an awareness of peak oil issues.

The current Australian Senate inquiry into future oil production also appears premised on at least an awareness of the currency of the concept of peak oil. This inquiry also has relatively broad terms of reference (Senate Rural and Regional Affairs and Transport Committee 2005) that include:

1. projections of oil production and demand in Australia and globally and the implications for availability and pricing of transport fuels in Australia;
2. potential of new sources of oil and alternative transport fuels to meet a significant share of Australia’s fuel demands, taking into account technological developments and environmental and economic costs;
3. flow-on economic and social impacts in Australia from continuing rises in the price of transport fuel and potential reductions in oil supply; and
4. options for reducing Australia’s transport fuel demands.

As we are not petroleum scholars, we remain agnostic on the likelihood of a peak oil scenario eventuating within the next twenty years. Irrespective of the likelihood of such a peak, it is clear however that we live in an era of ‘uneasy oil’ as the Chevron Oil Company has suggested. We need to start understanding what this unease will mean for our overwhelmingly urban economic and social systems. The importance of this task appears to be reflected in the Senate Inquiry terms of reference.

There has to date been almost no discussion in the scholarly urban policy literature about peak oil, with the exception of Newman (1991) and Campbell (2003). However, given the magnitude of the potential implications of a peak oil outcome we consider that it is relevant to begin contemplating what impact such a scenario might have for Australia’s cities. Such a process of thinking through potential peak oil impacts allows us to better understand our urban vulnerability and the risks associated with our dependence on a single finite geological resource. It also allows us to comprehend the risks of various courses of future action. To undertake such an assessment however it is necessary to understand the current structure and form of the Australian city and the way in which we depend on cheap oil for our transportation.

Transport in the Australian city

Australian cities are highly car dependent and thus oil dependent (Newman 1991). In most of our capital cities the private motor car is used for the vast majority of trips, including those for work and for other purposes (Newman and Kenworthy 1999; Mees 2000; Morris *et al.* 2002). Given this paper is concerned about the vulnerability of our cities to increasing fuel costs it is worth identifying some of the travel patterns that contribute to this vulnerability.

Travel patterns

Sydney, which maintains high quality data, serves as a good example of the increasing level of car dependence of Australia's cities. Approximately 15 million trips are undertaken each day in Sydney, 70 per cent of which are by car (DIPNR 2003). Sydney's annual total vehicle kilometres travelled (VKT) increased on average 2.3 per cent each year from 1991 onwards, rising to approximately 80 million kilometres in 2001 (DIPNR 2005). These patterns were geographically uneven – while per-person VKTs increased by approximately 23 per cent in outer- and south-west Sydney, inner- and east-Sydney saw a 10 per cent decline in per-person VKT. While precise data is not presently available, similar travel patterns are likely to be found in Brisbane and Melbourne. Thus for example, the South East Queensland Regional Plan anticipates an *annual* growth in that region's VKT of approximately 5.8 per cent, from approximately 42,000 VKT per day in 2001 to over 110,000 in 2026 (Office of Urban Management 2005, p.107).

Weak public transport

Australia's public transport systems are beset by operational and patronage problems. Many are operating below potential (Mees 2000). The major capital cities each have extensive metropolitan rail networks but the numbers of services running on them are far below system capacities. There is typically little integration between modes particularly between the rail and bus networks and the use of local buses as feeders to the higher capacity rail systems is underdeveloped (Mees 2000). Circumferential public transport links are almost non-existent meaning that travel between outer suburbs is very difficult and which means those living in such areas are highly dependent on cars for such cross-suburban trips.

The dispersed patterns of urbanisation found in Australian cities have also been noted as contributing to poor public transport services (Newman and Kenworthy 1999). Newman and Kenworthy (1999) argue that low population densities result in lower patronage for public transport and suggest that increasing residential densities is a means of achieving higher public transport use. Mees (2000) by comparison argues that high quality services operating as an integrated network is the key to generating public transport patronage. The optimal solution is probably a combination of both elements but there are indications that inadequate public transport is currently a barrier to the sustainability outcomes sought through higher densities (Horin 2004).

Inadequacies in the public transport systems are in part due to institutional factors that fragment and diminish overall responsibility for public transport planning (Mees 2000; Mees 2005). In the most successful international metropolitan jurisdictions unitary transit agencies are responsible for the planning and operation of public transport systems. Such responsibilities in the Australian metropolitan context are dispersed across multiple agencies across the public and private sectors. In Brisbane, operation of the rail and bus systems is split between state and local government and the private sector, with some state coordination. Sydney's public transport is split between the State Rail agency, Sydney Transit which operates buses in the central and eastern suburbs, and a multitude of loosely coordinated private operators throughout the western region.

Road dominance

While public transport systems have languished in recent years, governments have undertaken comparatively high levels of new investment in major road networks. In Sydney a number of tollways have been constructed that have encouraged the use of private motor vehicles for urban travel (Zeibots 2003). Melbourne in the 1990s constructed the CityLink tollway system and the Western Ring Road, while the largest current transport infrastructure project there is the \$2.5 billion outer eastern Scoresby Tollway. Brisbane's largest proposed transport project is the mooted \$5.3 billion TransApex suite of tunnels.

The behavioural signals these road projects appear to have given urban travellers has entrenched and exacerbated the high levels of car dependence in Australian cities. As road improvements encourage urban residents to use automobiles they draw patronage away from public transport, worsening congestion and decreasing the viability of the public transport systems (Zeibots 2003). In Sydney, the opening of the M5 East motorway reportedly caused a drastic 7.1 per cent fall in patronage on the adjacent rail line (Smith 2004). Such increases in the extent of automobile dependence among Australia's cities places them at greater risk from potential adverse social and economic outcomes arising from increasing oil prices. Urban residents at the lower end of the socio-economic spectrum with least financial capacity to absorb additional costs would likely be worst affected, particularly when geography is factored in.

Transport disadvantage

Transport disadvantage is a critical issue in Australia's cities. In addition to being highly car dependent, Australian cities are marked by strong spatial socio-economic differentiation. The combined effect of ongoing restructuring of housing and labour markets has been to create an urban geography in which higher income groups are largely concentrated within inner locations and the most highly disadvantaged households are situated in middle or outer suburban localities (Maher 1994; Murphy and Watson 1994; Wulff and Evans 1999; Wulff and Reynolds 2000; Yates 2002; Yates 2002). These divisions appear to have been exacerbated by the recent house price boom which has delivered inflationary gains to some households, typically the better off, while lower-socioeconomic status households have gained relatively less (Burke and Hayward 2000).

Service deficits

The interaction of the social geography of residential areas combined with the spatial and temporal coverage of public transport services can limit socio-economic opportunity. Access to transport services appears to be one of the key delineators of socio-economic status within Australian cities (Cheal 2003; Dodson 2004; Dodson *et al.* 2004). Cheal's (2003) study found that there are clear differences between inner and middle suburbs in Melbourne and those further out, in terms of the quality and availability of public transport services. 'Transit rich' inner areas had much higher quality public transport services compared to 'transit poor' outer suburban localities. Households in 'transit-rich' areas tended to have higher incomes than those in 'transit poor areas'. In Sydney the high socio-economic status households of north Sydney have been able to capture among the best

quality public transport services in the city, while lower socio-economic status groups in fringe areas receive much poorer services (Mees 2002).

Qualitative studies have demonstrated the impact on households' socio-economic opportunities arising from transport disadvantage. Johnson and Herath's (2004) study of the Goodna/Gailes area of Brisbane is instructive. Johnson and Herath (2004) found that the residents of this socio-economically disadvantaged suburb were not only poorly served by public transport and local pedestrian and cycling infrastructure but that the design and layout of adjacent freeway and rail networks were compounding disadvantage by impeding access to social, health and community services and, crucially, to employment. Johnson and Herath's approach is unique in the Australian context, but it is likely that other comparable areas within Australia's cities are experiencing similar problems (Dodson 2005).

There are multiple aspects of household wellbeing that are dependent upon transport systems but that are poorly understood at present. Research in the UK has demonstrated that access to employment, health services, education and recreation are all impeded by inadequate transport services (Social Exclusion Unit 2002; Social Exclusion Unit 2003). There is little research in the Australian context that depicts the impact of transport disadvantage or transport stress (see below) particularly at the local scale. – Dodson *et al's* (2004) attempt to investigate this problem, for example, focused on the methodological aspects of this issue rather than the empirical issues.

Locational Disadvantage

Much of what little Australian literature exists about transport disadvantage has focused on the impact of uneven access to transport on lower-income and disadvantaged households (Dodson *et al* 2004). Similar problems to those faced by the poor are also experienced by those on modest incomes, albeit in different ways. The links between labour markets, household income, housing markets and tenure structures become crucial for modest income groups, particularly those entering the housing market (Burnley *et al.* 1997).

Conventional understandings of the relationships between land markets and transportation systems in cities with strongly centralised housing markets have assumed a price-distance gradient whereby the price of land decreases as the distance from desirable residential and commercial locations increases (Burnley 1980). Households face a residential trade-off in their housing choices between their capacity to afford housing versus their distance from the relatively centralised employment and services found in the major Australian cities.

Improvements in transportation systems – overwhelmingly road-based – have over time flattened the land price-distance gradient thus reducing the relative costs of greater dispersion from urban cores, enabling households to access cheaper land, further from city centres and thus afford home-ownership (Manning 1984). Employment has also suburbanised, but as Neutze (1977) points out, has subsequently located away from public transport, thus necessitating car use for suburban work and other journeys.

Residential dispersion

With increasing distance from the centres of Australian cities, the dispersion of community and transport services has increased while public transport services remain underdeveloped. This activity dispersion has resulted in 'locational disadvantage' for households situated in fringe areas. In the early-1990s, a major study was undertaken into the issue of 'locational disadvantage' arising from household locational decisions to move to fringe areas (Maher *et al.* 1992; Maher 1994). Maher *et al.* (1992) argued that locationally disadvantaged areas are deficient in terms of the facilities and resources necessary to enable a 'satisfactory life' or which require residents to undertake long journeys to access such resources. The transport network, and transport services are among the 'resources' available to households, and thus transport can be seen as a key element of locational disadvantage.

The Australian Government's National Housing Strategy (1992, p.76) drew on Maher *et al.*'s study of locational disadvantage arguing:

People without private transport, especially where public transport is not readily available are likely to be disadvantaged. In particular older people, young people and members of a car-owning household who cannot use the car, are more likely to have problems and/or longer travel times to services and jobs.

Such findings were confirmed in Burnley *et al.*'s (1997) major study of relocation decisions to fringe areas in Sydney. Burnley (1997, p.1125) argued:

To the extent that people move to outer suburbia to obtain affordable housing, such pricing trends may be socially inequitable unless strong policies to relocate employment and to develop public transport are pursued in tandem.

Such conclusions support the view that transport systems play a critical role in shaping household socio-economic opportunity in Australian cities.

Transport and opportunity

Other studies have appeared to confirm the role of transport frictions in mediating household suburban opportunities. Dodson's (2004) study of spatial mismatch in Melbourne demonstrates the persistence of tracts of high unemployment in older middle-ring industrial suburbs within relative proximity to areas of employment growth. Dodson suggested that the persistence of such high unemployment within growing employment regions suggests that either skills mismatch is preventing the uptake of such opportunities or that the inadequacy of the outer-suburban public transport system is impeding employment access.

There has not been any recent substantial investigation of the issue of locational disadvantage in Australian cities and how this links to broader issues of transport access and household wellbeing. However, in the context of rising fuel costs there appears to be an emerging recognition among the development sector that the cost of transport is now impacting on many households' capacity to access affordable housing. Such increased costs have implications for the historical trend towards a flatter price-distance gradient, particularly for those developers whose investment planning was based on low oil prices. Figure 4

illustrates that distance from the core, measured through the price of fuel, is becoming a critical factor in the affordability of fringe-area housing.

Figure 4: A recent house, land and fuel package in Brisbane’s outer north; Source: Courier Mail, Homes Guide, 15 October 2005.

Transport stress

Transport costs are one of the largest items in household budgets (Table 1). Yet, an often ignored dimension of transport disadvantage in Australian cities is the transport cost burden – ‘transport stress’ (Dodson *et al.* 2004) – on households and the relative composition and spatial distribution of household transport costs within cities. The concept and measurement of transport stress is a corollary of the concept of ‘housing stress’ which is used by some Australian scholars to measure housing affordability (National Housing Strategy 1991; King 1994). Households are considered to be in housing stress if they are in the lowest two income quintiles and their housing costs exceed 30 per cent of income (National Housing Strategy 1991). Transport stress can be defined as the proportion of weekly household income that is expended on transport, whether by motor vehicle, public transport or other mode. There has been no detailed scholarly assessment of transport stress to consider what thresholds or indicators should be used to assess transport stress, but households suffering transport stress are arguably those whose income is 40 per cent of the metropolitan median and whose transport costs exceed 20 per cent of their income.

Household expenditure

Measuring the spatial distribution of household transport stress is not possible in Australia because there are no datasets available that include detailed local scale information on income, transport costs and urban location at the household level. State government travel surveys such as those operating in South East Queensland or Sydney include only demographic, travel and locational data. Federal government household expenditure survey (HES) operates at statistical sample size that cannot meaningfully be decomposed to the level of the individual suburb (Table 1). For example, the 2003-2004 HES used a sample size of only 579 households for all of Brisbane which makes meaningful local-scale assessments impossible, even if the data was able to be publicly released at such a level of disaggregation.

Transport costs on average make up around 15.2 per cent of household budgets (Table 1). There is however, relatively little variation in average household transport costs between the major capital cities, which vary by only 1.8 percentage points, compared to housing, which displays a four-point spread of average costs.

Table 1: Selected costs as a proportion of household income for Australia's major metropolitan areas, 2003-2004; Source: ABS Household Expenditure Survey, 2003-2004, ABS Cat. 6350.0.

Proportion of income:	Capital City						
	<i>Sydney</i>	<i>Melbourne</i>	<i>Brisbane</i>	<i>Adelaide</i>	<i>Perth</i>	<i>Canberra</i>	<i>Aust</i>
- Current housing costs (excl. mortgage principal)	18.0	14.4	17.7	14.6	15.6	14.0	16.2
- Food and non-alc. bvgs	17.3	17.5	16.8	16.7	16.5	16.7	17.1
- Transport	14.8	15.2	16.2	15.4	15.3	14.4	15.2
Sample size:	1199	1087	579	581	475	269	6957

Running costs for various motor vehicle types are available from private motorist associations. Thus in Melbourne, the average weekly running cost for a small car (1.8 L engine) in 2005 is approximately \$147.54 per week (RACV 2005). Matching such costs to household income by combination with other data involves such imputations that the validity of any conclusions is drastically diminished.

Car ownership

Car ownership can provide some basic indication of household transport stress, given what is known about vehicle running costs. Morris *et al* (2002) reported that in Melbourne in 1999 central and inner city areas had per-household car ownership rates of 1.13 and 1.43 respectively, compared to fringe area households which had on average 1.9 vehicles per household. Larger household sizes exacerbated these spatial differences in car ownership. Thus central city four-person households had on average 1.60 cars compared to outer-suburban four person-households, which had an average of 2.39 cars, equivalent, on average, to 0.79 of a car. Based on the running-cost information above, the difference in vehicle ownership and running costs between inner-city and fringe locality four-person households could be as much as \$117 (0.79 x \$147.54) per week, or around \$6084 per year, for a small car (RACV 2005). The actual costs are likely to be even higher. The RACV fuel costs are calculated for an average VKT of 15,000 per year, but given that outer-suburban households have higher VKT than inner city households, they are likely to therefore also have higher fuel costs associated with these longer annual travels. Again, Australia's divided urban geography is likely to be imposing high relative travel costs on outer-urban households.

Given that transport costs are typically the third largest household budget expenditure item after housing and food (Table 1), a simple calculation illustrates the potential cost-equivalent impact of higher fuel prices relative to mortgage costs. In Brisbane the median house price is presently \$310,000 (REIQ 2005). Assuming a 10 per cent deposit, the weekly cost of servicing a mortgage on this property value, at an interest rate of 6.75 per cent, is approximately \$444. A rise in interest rates of 0.5 percentage point to 7.0 per cent would

increase weekly repayments to approximately \$454 which is \$10 additional cost. Therefore for a household purchasing the median-priced house, a rise of \$10 in weekly transport costs is equivalent in budget impact to a mortgage interest rate rise of 0.25 per cent. It is not currently feasible to assess the number of households who may be facing petrol cost increases of this level or greater given the available data.

In the context of high household debt levels achieved during the recent inflationary housing boom, the added impact of fuel prices on household budgets could be highly deleterious. Further research is necessary to draw out these impacts in greater detail, in particular the relative elasticity of discretionary spending on leisure consumption compared with essential spending such as on housing, clothing and food.

Car ownership imposes high costs on households, through purchase, depreciation, insurance, registration, maintenance and operating costs. Given that public transport services in the fringe areas of Australia's major cities are almost universally of low quality (Mees 2000; Dodson 2003), the failure of this provision could be costing the relatively lower-income households who reside in such locations substantial proportions of their weekly incomes. For those in the peri-urban areas beyond the fringe where the dispersion of employment and activities is greater, the situation could be much worse. Unfortunately currently available data sets are inadequate to the task of illuminating these problems at a close spatial scale or at the household level. Further research is needed to more accurately comprehend the dynamics of this transport divide.

Choosing alternatives

Under conditions where demand for petrol outstrips supply resulting in ongoing price rises, the capacity of households to choose alternative means of travel will be a critical determinant of community wellbeing. It is worth briefly noting the demand elasticities for public transport relative to fuel prices (DEPTP). The Industry Commission suggested that the DEPTP was 0.07, suggesting that a 1.0 per cent fuel price increase will produce a 0.07 per cent increase in public transport use (Industry Commission 1993, pp.44-46). De Jong *et al* suggest the long run DEPTP is 0.26 (1998, p.38), while Taplin *et al* (1999, p.228) suggest that for Australia the DEPTP is 0.173.

The demand elasticity values suggest that only small shifts in public transport demand will occur as petrol prices rise although these assessments are based on data collected during 'cheap oil' periods, with little expectation of high future fuel costs. Historic demand elasticity figures may not be valid bases for assessments in circumstances where a long term expectation of sustained fuel cost increases is apparent. Some recent demand changes are therefore instructive. In Brisbane public transport recorded patronage growth of 14 per cent for July and August 2005 compared with the same months in 2004 (Lucas 2005) while petrol prices increased 20 per cent over the same period (Figure 2). This shift suggests that some urban residents with access to public transport will change to that mode.

Those with adequate spatial access to high quality public transport have the option of switching to this mode. For those who live in areas with no services, or infrequent or poorly connected services, public transport may not be a viable alternative. Clearly more research on this issue is essential as is the likely elasticity of demand for walking and cycling as a mode

of transport relative to increases in petrol prices. In particular, understanding the spatial distribution of locational demand elasticities will be essential.

There is currently very limited attention in Australian urban policy to the problems that will be faced by those households who have poor access to high quality public transport services under conditions of increasing fuel costs. Hence there is insufficient research available in Australia to provide a comprehensive picture of the impact of oil vulnerability on Australia's cities. There is a critical need for new research into the links between household wellbeing and transport access. It behoves urban scholars to assist governments and the public to comprehend how the potential impact of oil price rises will impact on urban communities. This study begins to contribute to this task by assessing at broad-scale the relative vulnerability of Australian urban areas to the adverse socio-economic impacts of increasing oil prices.

Assessing Australian Urban Oil Vulnerability: The VIPER

This study seeks to understand how the socio-economic impact of rising fuel costs will be distributed across Australia's highly differentiated urban geography. In particular we seek to highlight those areas that stand to suffer most from the interaction of increased petrol prices, urban transport systems and social geography. Our study is a preliminary intervention, however we consider it to be a highly relevant and timely contribution given the critical need for policy makers, political representatives and scholars to comprehend the impact that costlier fuel may have and to effectively plan to ameliorate eventual impacts.

Our analytical is straightforward. To assess the potential exposure of households to adverse outcomes arising from increased fuel costs we have created a basic locational measure of oil vulnerability that we term the 'vulnerability index for petrol expense rises' (VIPER). The VIPER enables a spatial representation of oil vulnerability at the local suburban scale, thus providing the average relative vulnerability for urban areas that can enable inter-locality comparisons.

Selection of indicator variables

VIPER is constructed from three indicator variables obtained from the 2001 ABS Census that are combined to provide a composite vulnerability index that can be mapped at the geographic level of the Collection District (CD)¹. The VIPER therefore assesses the average vulnerability of the households within the CD, rather than indicating the specific vulnerability of particular urban households. The variables used are:

- Socio-economic index for areas (SEIFA).
- Household motor vehicle ownership.
- Car-dependence for work journeys.

The rationale for the selection, use and weighting of these variables is set out below.

¹ Collector districts are smaller than suburbs and typically contain approximately 200 households.

First, household socio-economic status is a primary determinant of resilience or vulnerability to increased consumption costs, not only for fuel but also to goods whose prices are influenced by fuel costs. Higher socio-economic status households, as indicated by high SEIFA scores, typically have higher incomes than lower SEIFA households. These higher status households are thus arguably relatively more able to absorb increasing transport costs than lower socio-economic status households and are therefore less vulnerable to the affordability impacts of increasing fuel expenditure. Because a household's capacity to meet rising fuel costs from its existing income is a key dimension of its resilience to oil price increases, socio-economic status as measured by SEIFA is thus an important marker of oil vulnerability at the suburb level.

The second and third variables indicate the extent of current dependence on automobiles for urban travel. The proportion of households with two or more motor vehicles is a basic indicator of demand for motor vehicle travel. The use of such a variable as an indicator of oil vulnerability is based on the assumption that the greater the level of vehicle ownership for a given household, the higher that household's dependence on oil. A further assumption is that the higher the number of vehicles owned per household within a given CD, the higher the aggregate fuel costs for all households within that CD will be. Similarly, the proportional use of motor vehicles for work journeys serves as an indicator of the dependence on motor vehicles for urban travel of households within that CD. While the mode of journey to work is not an ideal indicator of travel preference, it in the context of Census data, it is sufficiently valid to use this mode-dependence indicator within the context of VIPER.

Combination of indicator variables

Because VIPER is a composite index, some form of weighting had to be devised to enable the combination and ranges of values for the VIPER variables. First each variable was sorted into relative value categories based on the 10th, 25th, 50th, 75th and 90th percentiles for each city. Census districts were assigned values of 5 to 0 depending on which percentile they were situated within. Hence a CD situated between the 10th and the 25th percentile received a value of 4 whereas a CD situated in the 75th percentile for that variable received a value of 2. These rankings are set out in Table 2:

Table 2: Value assignment relative to Census District percentile for VIPER variables

Percentile	<u>Value Assigned:</u>		
	<i>SEIFA</i>	<i>Car own ≥2</i>	<i>JTW by car</i>
100	0	5	5
90	1	4	4
75	2	3	3
50	3	2	2
25	4	1	1
10	5	0	0

Hence a CD within the 10th percentile for SEIFA, 50th percentile for car ownership and 75th percentile for JTW by private motor vehicle would receive a value of 5+3+4. However, our assessment is that the three variables we have selected are not of equal importance in determining household vulnerability. Thus we have split VIPER into two equal-weight indicator variable sets, of which the first comprises only SEIFA, while the second comprises

car ownership and JTW. This is achieved through doubling the index value for SEIFA, thus creating a 20-point scale. The proportions are displayed in Table 3:

Table 3: Variable weighting for VIPER

Indicator	SEIFA	Proportion of households with ≥ 2 cars	Proportion of work trips by private motor vehicle
Potential points:	10	5	5
Weighting (%):	50	25	25

A CD that scored the worst possible rating for each of the three variable counts could thus receive twenty points, while the best could receive zero. This range from zero to twenty provides a range of values that can be grouped and mapped for each CD for Australian metropolitan areas. Selection of CDs was based on the ABS definitions of urban centres (Australian Bureau of Statistics). Maps were shaded (using equal ranges) according to the following groups of VIPER scores (Table 4):

Table 4: Assignment of VIPER ratings to map shadings.

VIPER Value:	1-4	4-7	7-11	11-14	14-17/18
Shading					

Results of the VIPER

The results of the VIPER mapping for Brisbane, Sydney and Melbourne are presented in Figures 5 to 7. Each city displays clear spatial patterns that indicate a highly uneven distribution of potential vulnerability to oil price pressures. The following section discusses each of these cities in turn.

Brisbane

Brisbane's urban geography comprises a large core area from which four corridors of development extend north, west, south and east. The VIPER results for Brisbane demonstrate a wide variation in oil vulnerability levels between the city's localities (Figure 5). The central area has a relatively low vulnerability rating with most CDs in this area scoring lower than 7 on the VIPER. Areas immediately to the north and west, and south-east of the central area also fared relatively less well. The localities that are most vulnerable to oil price increases are generally concentrated along Brisbane's outer development corridors. Thus for example the area towards Ipswich in the southwest, Beenleigh in the southeast and Caboolture in the northern growth corridor all contain localities that are highly socio-economically vulnerable to oil price rises. Of these, the southeastern corridor displays the most concentrated vulnerability. The southwestern corridor also contains highly vulnerable areas although these are less concentrated than in the southeast. The eastern corridor contains only a few areas of high vulnerability but does include a number of modest-vulnerability areas. The north also has a mix of ranges, although moderate and high vulnerability areas predominate.

The areas of highest vulnerability are very similar to localities that typically appear in measures of socio-economic disadvantage, such as Logan, Beenleigh and the Ipswich corridor. This is unsurprising given that 50 per cent of VIPER is based on the SEIFA index.

What is important to note is that travel behaviour patterns appear not to be diminishing the distribution of socio-economic disadvantage. Indeed, low socio-economic status appears likely to be exacerbated by automobile dependence within Brisbane under conditions of rising fuel costs.

Sydney

Sydney's urban geography is structured around the Sydney Harbour, with development to the north and south extending west and then dividing into two growth corridors to the north west and south west. As is the case for Brisbane, Sydney's geography is strongly patterned in terms of oil vulnerability, as revealed by our analysis (Figure 6). Thus the broad area of northern Sydney from the northern beaches to the Parramatta river displays low to moderate socio-economic vulnerability to increased oil prices. A narrower band south of the harbour from the harbour mouth to Parramatta also displays low socio-economic vulnerability to the socio-economic impact rising fuel costs.

High oil vulnerability is concentrated in Sydney's west, particularly in a broad area of localities south-west of Parramatta which extends along both the north-west and south-west corridors. Of particular note are the areas in the to the immediate west of Liverpool, Cabramatta and Fairfield which contain a large cluster of highly vulnerable localities. Similar although not as extensive concentrations of high oil vulnerability are found in Mount Druitt, Habersham and Hassall Grove to the north west, while a small cluster of high vulnerability is present in Campbelltown.

The geography of oil vulnerability in Sydney is clearly marked and appears to mirror existing socio-spatial divisions. The most vulnerable areas are situated in Sydney's western suburbs, while the least vulnerable areas are in the northern and eastern suburbs, a geographic divide that has long been appreciated both by scholars and the public. Rising oil prices will clearly have different socio-economic impact across Sydney. It is worth noting the large number of areas in with VIPER index ratings of 7 to 11 (see discussion below). These areas are moderately vulnerable to oil price rises and are largely situated in the northern suburbs, and large areas of the south. Only the most central and eastern localities have relatively low vulnerability, although lower ratings are apparent along the rail line through central northern Sydney.

Melbourne

The results for VIPER in Melbourne also display comparable strong geographical differentiation to the other cities discussed in this paper (Figure 7). The areas that scored the lowest ratings for vulnerability are largely situated in close proximity to the Melbourne central business district, particularly the inner eastern suburbs. Lower vulnerability areas are also found in Melbourne's inner-north and particularly within the inner east, to a distance of approximately 15 kilometres from the CBD. Beyond these areas is a ring of moderate vulnerability localities, around 25 kilometres from the CBD in the east, reducing to 15 kilometres in the north.

The most vulnerable localities in Melbourne are those located on the urban fringe, but also within the ageing industrial areas, such as Sunshine and Altona in the west, Broadmeadows, Thomastown and Lalor in the north and greater Dandenong and Frankston in the south-

east. Such areas contain large concentrations of Melbourne's most vulnerable localities and are larger in area than most of those found in either Sydney or Brisbane. Clearly Melbourne's lower socio-economic status households in fringe areas face considerable challenges from escalating fuel costs.

Population Distribution of Oil Vulnerability

This study has focused primarily on the locational aspects of oil vulnerability. The analyses we have presented so far focus on mapping the spatial distribution of oil vulnerability. Such maps provide little indication of the population numbers affected by this problem. We have therefore enumerated the number of persons within each of the oil vulnerability index rating for each of Brisbane, Sydney and Melbourne (Figures 8 to 10). These figures assist to provide greater appreciation of the scale of potential impact in terms of the numbers of urban residents who will be affected by oil vulnerability and the relative degree of impact increased fuel costs will have for these groups. It should be noted that the figures cannot be used for inter-city comparisons – VIPER measures relative, not absolute, oil vulnerability meaning it can be used for comparative assessments of localities within, but not between cities.

Brisbane

Brisbane's population of 1,500,000 displays a 'normal' distribution of oil vulnerability with relatively few households at low or high risk, and with a large number of households in the moderate vulnerability categories (Figure 8). This distribution is skewed slightly towards moderate vulnerability levels with approximately 955,000 or just under 64 per cent of Brisbane's population situated in localities that scored a relative VIPER rating of between 4 and 10. Just over 23,000 persons were in the lowest vulnerability range of 1-3 (approximately 2 per cent), while approximately 522,000 persons rated in the moderate or high VIPER categories of 11 to 18, equating to just below 35 percent of the population. Just over 150,000 (or 10 per cent of) Brisbane's population was situated in the highest VIPER categories of 14 to 18. Clearly a substantial proportion of Brisbane's population is at moderate or high risk of socio-economic impacts arising from high or increasing fuel prices, as Figure 5 demonstrated, the majority of this population is situated in outer-suburban locations.

Sydney

In Sydney, the primary observation of note is the relative increase in population scale between Sydney and other cities, such as Brisbane – Sydney's population is more than double that of Brisbane. Again however, most of Sydney's population is situated within the moderate vulnerability localities under VIPER (Figure 9). Approximately 2.15 million people (62 per cent) are rated within the 4-10 category of oil vulnerability, with 584,000 (17 per cent) receiving a category 9 rating. Those within the least vulnerable VIPER categories of 1 to 3 numbered slightly less than 153,000, or approximately 4.4 per cent of the overall population. Just over 1.14 million were rated 11 (33 per cent) or higher on VIPER, suggesting a large number of people will be adversely or very adversely socio-economically

impacted by high or rising fuel costs. As is the case in Brisbane and Melbourne, the majority of this population is situated in the outer suburbs of Sydney, particularly in the outer northwest and southwest.

Melbourne

The pattern of distribution of relative oil vulnerability within Melbourne's population appears broadly similar to the patterns found in Brisbane and Sydney, albeit with some important differences (Figure 10). In Melbourne, approximately 46 per cent of the population (1.46 million people) is situated within localities that are rated at moderate vulnerability to oil prices increases on VIPER. While these are relative measures and thus not suitable for inter-city comparisons, a higher proportion of Melbourne's population falls within the higher VIPER categories when compared to Sydney or Brisbane. Thus slightly fewer than 53 per cent of Melbourne's population (1.82 million people) are in localities that received a VIPER oil vulnerability rating of 11 or higher. Just under 350,000 (11 per cent) of Melbourne's population are in very high vulnerability localities, according to VIPER. By comparison, only 1.5 per cent (fewer than 49,000 persons) of Melbourne's population is situated in low oil vulnerability localities. Melbourne's locational VIPER ratings are clearly skewed towards higher relative vulnerabilities than is the case with Brisbane or Sydney.

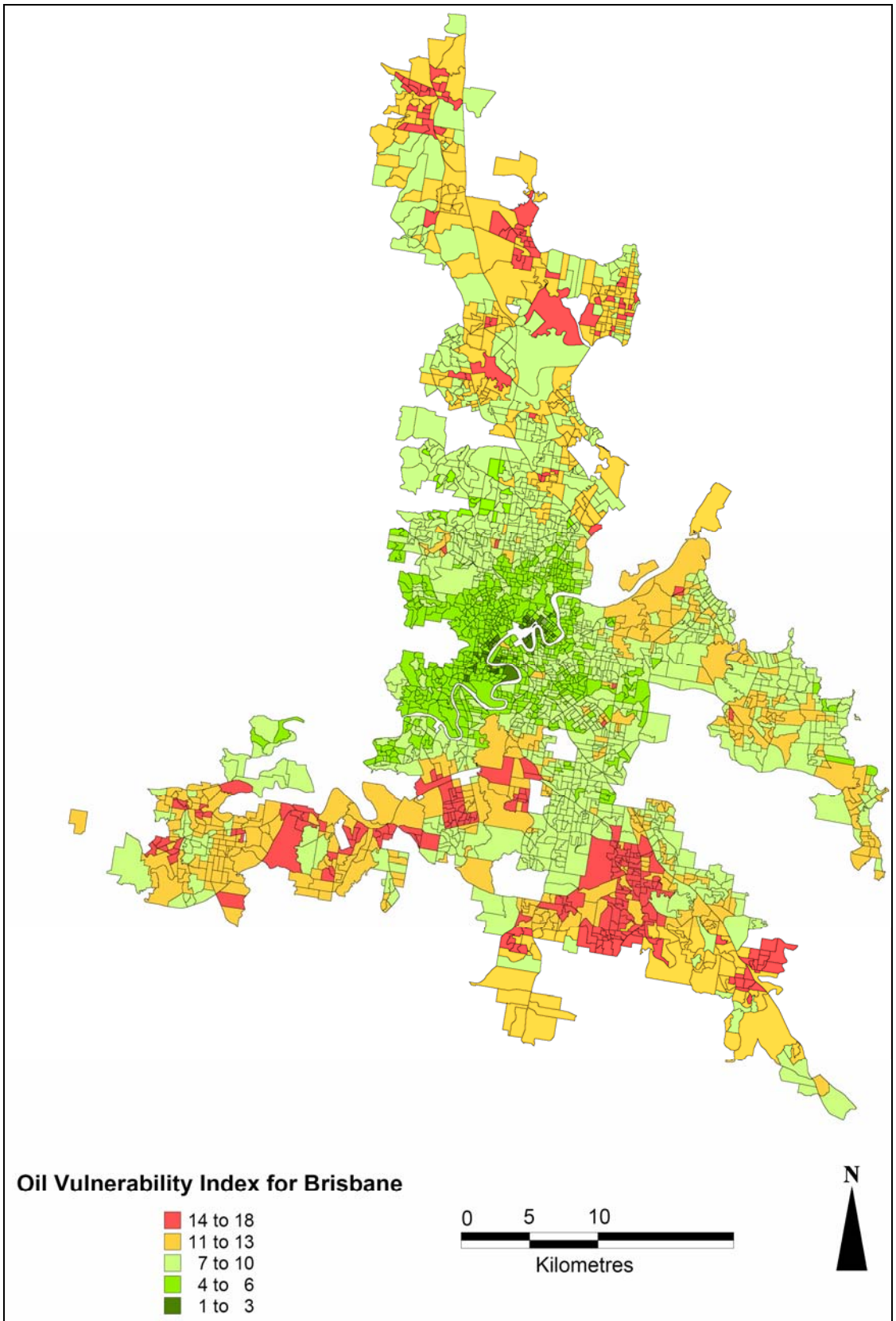


Figure 5: Oil vulnerability in Brisbane.

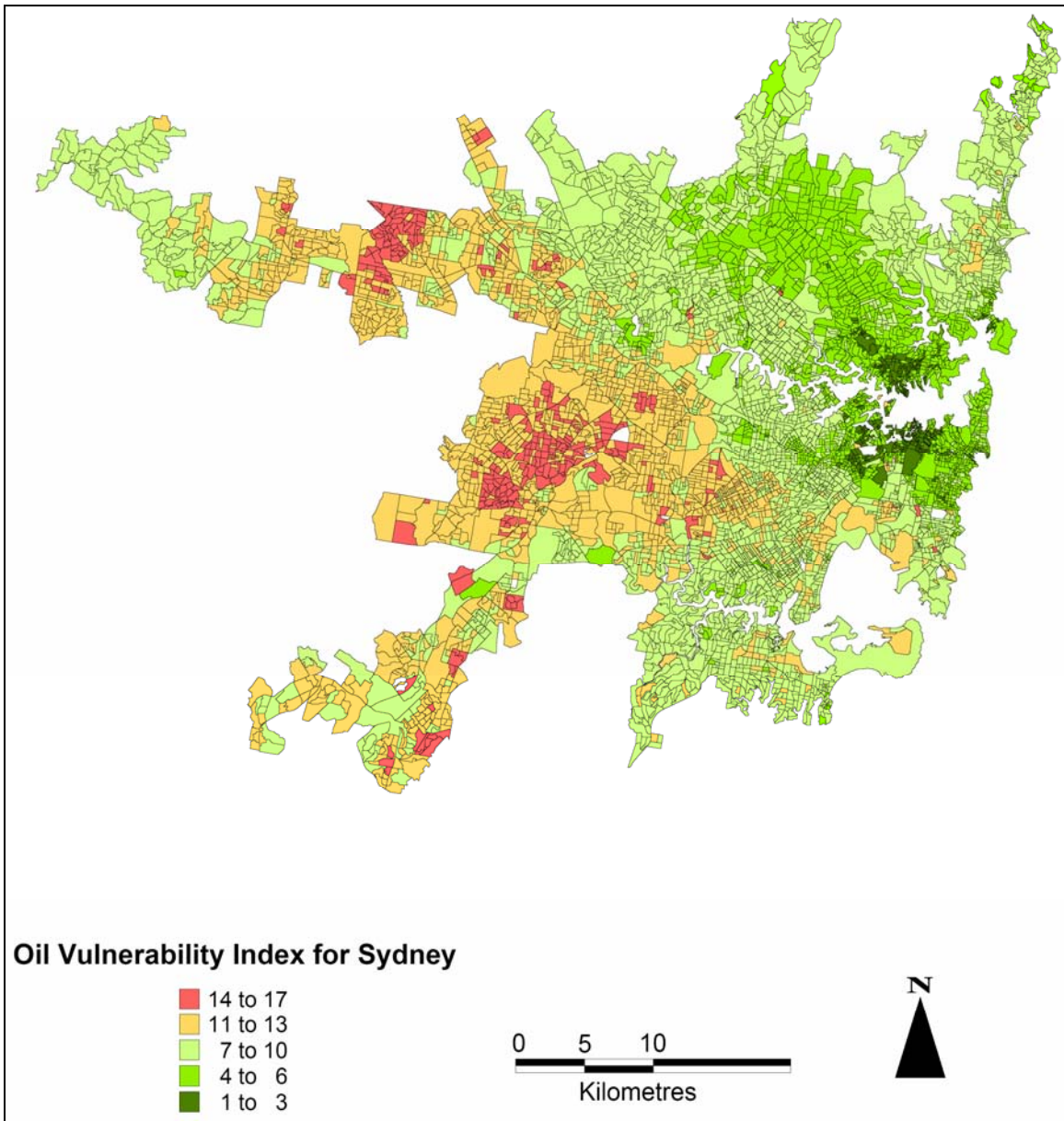


Figure 6: Oil vulnerability in Sydney.

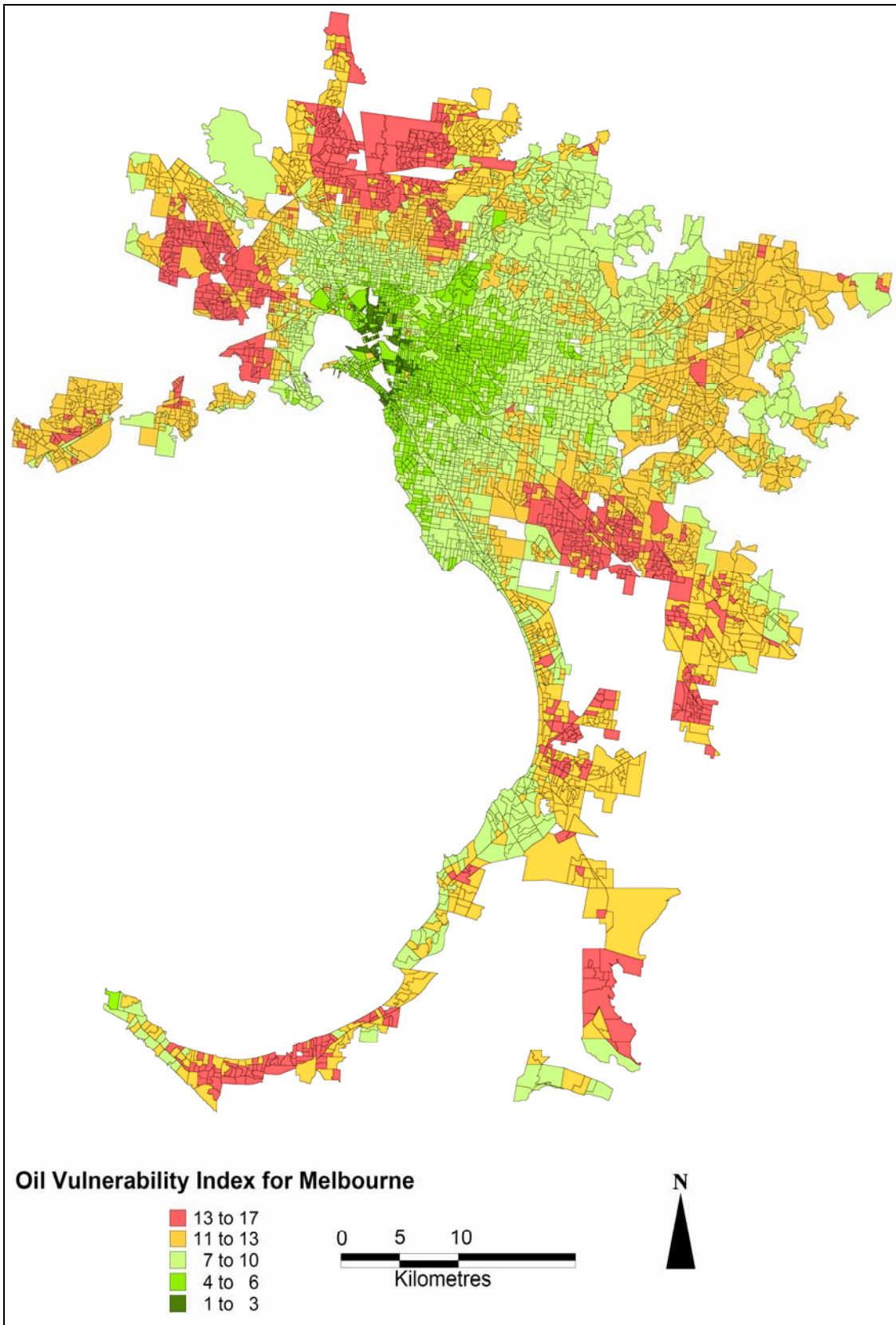


Figure 7: Oil vulnerability in Melbourne.

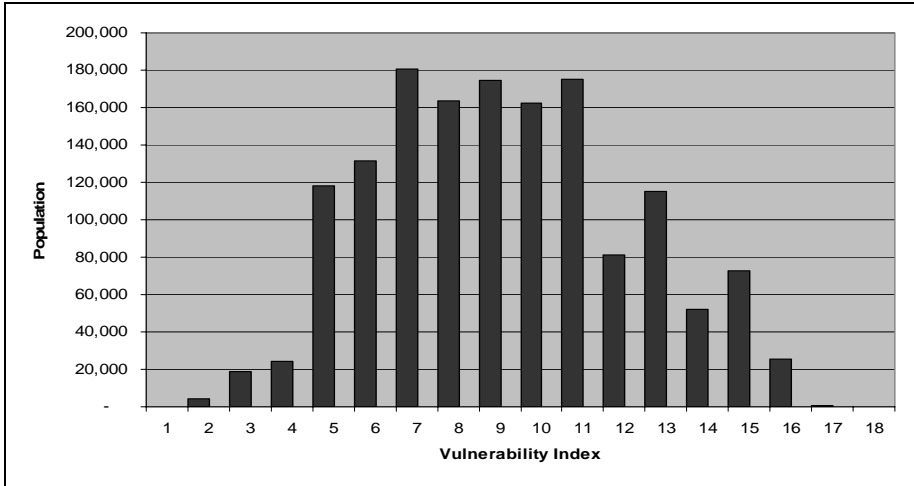


Figure 8: Distribution of oil vulnerability for total population of Brisbane.

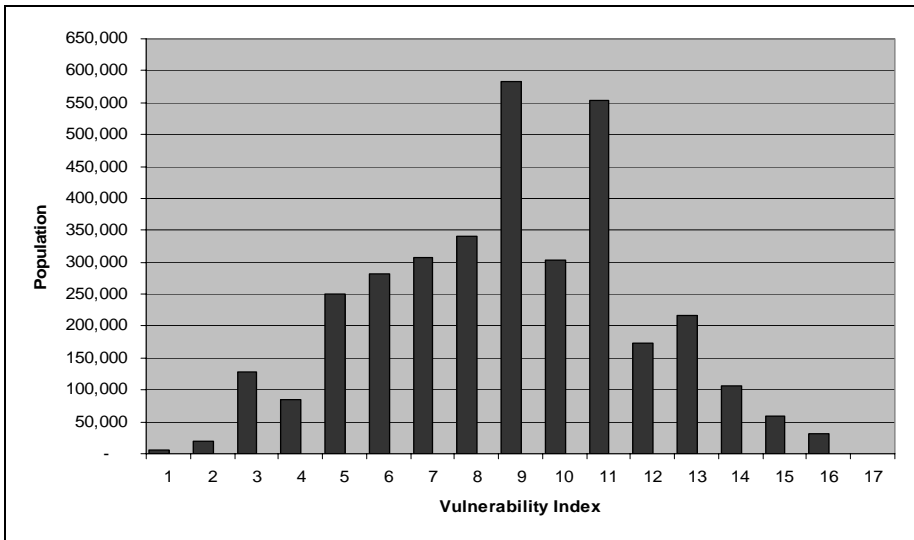


Figure 9: Distribution of oil vulnerability for total population of Sydney.

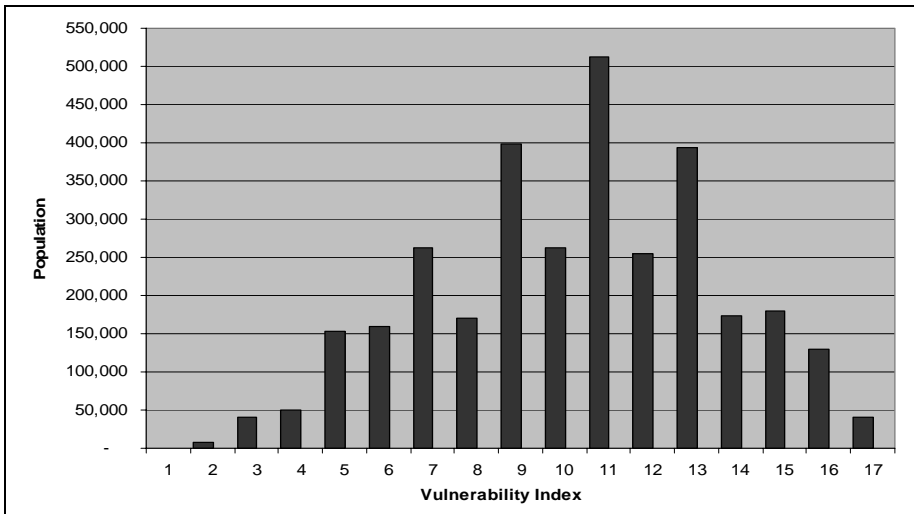


Figure 10: Distribution of oil vulnerability for total population of Melbourne.

Discussion

This paper began with a discussion about the likely impact of higher fuel prices on Australian cities and the distribution of these impacts. It is clear from the analysis that we have presented that the socio-economic impacts of rising fuel costs are likely to be unevenly distributed across Australian cities and across the populations of these cities. Within each of Brisbane, Sydney and Melbourne, it is invariably those households that are located in socio-economically disadvantaged outer-suburban locations that will be most vulnerable to current high and potential future rising petrol prices. By comparison those localities in central and inner areas will be relatively less socio-economically disadvantaged as a result of rising fuel given the geography of employment particularly for high-wage sectors, which is concentrated in the CBD of most Australian cities.

The reason why rising fuel costs will fall more greatly on lower socio-economic suburban groups in outer suburban areas are twofold. First, socio-economic vulnerability already places these households at greater risk of adverse impacts from any economic change, such as industrial restructuring, rising interest rates, increasing unemployment or workplace deregulation. Second, however, the specifically greater dependence on automobiles for urban travel is the critical factor that places these households at much greater risk from rising fuel prices. Australian urban scholars have for many years warned of the high levels of car dependence in Australian suburbs, particularly those developed after WWII (Neutze 1977; Morris 1981; Manning 1984; Newman and Kenworthy 1999; Mees 2000). This car dependence places the residents of these areas who rely on cheap petrol for their capacity to access employment and services highly vulnerable to increased fuel costs. This impact may be compounded by the relative lack of provision in such areas for alternative modes, such as public transport walking and cycling, and by the wide dispersion of employment and services that necessitates long journeys for work and other activities.

Limitations of the study

The study has a number of limitations that are worth noting although these do not diminish the value of the results. First, the selection of variables is limited to three Census statistics based on a presumed relationship between these variables. However we consider that the weighting of socio-economic and travel variables is broadly justified by the scholarly literature on this topic area which we discussed in the introductory sections of this paper. In favour of our methodology, there are effectively no alternative data sets that can respond to the questions we pose, at a spatial scale below the suburb level. Only Census data provides comprehensive information on household disadvantage and basic travel characteristics with a sample size that allows detailed mapping at the scale of the local CD.

If a better data set was available that could reveal information about household socio-economic status, vehicle and travel costs, and the access to and use of different travel modes, as well as the relative weighting of socio-economic and transport mode factors and which collated data for all Australia's major cities, a more sophisticated analysis of suburban oil vulnerability could be undertaken. No such dataset exists. VIPER is therefore the best currently available measure of the spatial distribution of oil vulnerability in Australian cities. Given the lack of prior attempts to investigate this issue and the currency of public concerns about rising fuel prices the expedient methodology is justified. However given the

importance of the topic we hope that our approach will stimulate scholarly debate about methodologies for investigating this crucial issue.

We have deliberately not attempted to assess the potential for modal switching between automobiles and public transport. It would be feasible to attempt a transport modelling analysis of transport disadvantage, such as that undertaken by Evans, Buchanan and Dodson (2005) or a 'public transport accessibility level' (PTAL) model of the type prepared by Wu and Hine (2003). Our colleagues at the Urban Research Program are currently developing a land-use and transport accessibility model of this sort for use by Local Governments in assessing the transport impacts of development proposals. Such enterprises involve intensive use of spatial data sets and scholarly labour which are not available to the present study, at the broad metropolitan scale.

We note also the critical importance of accounting for the temporal dimension of public transport services in terms of service frequency and periods of operation (Dodson *et al.* 2004) in the evaluation of adequacy of public transport access, as temporal factors can dramatically impact on the assessment of public transport quality. Again, accounting for such factors requires intensive use of analytical resources, even for just a single city (Buchanan *et al.* 2005). Adequate data to undertake such comprehensive spatial and temporal access assessments is typically not readily available. VIPER is thus the simplest, spatially most comprehensive and detailed, and most efficient assessment of oil vulnerability presently available in Australia.

Finally, VIPER is a measure of *potential* vulnerability. This means that it is not possible to definitively conclude that rising oil prices will impact on local areas in a specific defined way. The uncertainty over the future cost of fuel is matched by uncertainty about the nature of household response. However, on the balance of socio-economic resilience we anticipate that VIPER provides a strong and clear insight into the likely distribution of oil price rise impacts across the suburban social geography of the cities we have analysed.

Conclusions and policy directions

Most commentators anticipate that oil prices will remain high for the foreseeable future and may continue to rise over time. It is critical that governments attend to the way in which these impacts will be distributed across Australia's cities. Clearly outer-suburban areas, locations that contain low socio-economic status populations, and suburbs which have high levels of car dependence will be the most affected by such increases. Acknowledging this uneven distribution of impacts will be critical to policies that governments may pursue to adjust our urban systems to cope with costlier fuel.

Australia has a long history in constructing large items of urban transport infrastructure, including roads, bridges, tunnels, railways and busways. Each of the recent Brisbane, Sydney and Melbourne metropolitan plans contain commitments to major infrastructure projects, mostly roads. 'Big build' transport infrastructure is able to capture the imagination of policy makers and political representatives, and often the public – although Sydney's Cross-City Tunnel and Melbourne's Scoresby Tollway experiences suggest the public gleam is wearing off such enterprises.

Yet, it is the local and small scale infrastructure, combined with high quality public transport services, linked to local centres with good walking and cycling connections, that will ultimately determine the future outcomes for oil-vulnerable communities. The humble local suburban bus stop is likely to become a more important item of community infrastructure as fuel prices increase, than any cross-harbour, cross-river or cross-city road tunnel.

Understanding the relative social, spatial and scalar impacts of urban transport infrastructure provision will thus be a critical task in addressing any future fuel price increases. Again there is little evidence of government appreciation of this problem. Understanding how infrastructure can operate at different scales – from the local to the regional – will be a key element of attempts to address this issue. There may be substantial opportunity in the development of models of infrastructure financing and delivery that can assist to achieve the provision of a network of dispersed local forms of infrastructure such as bus stops and related facilities.

Large infrastructure projects will remain necessary even if fuel costs continue to increase. However the extent to which these projects cater to different travel modes will require substantial consideration that includes detailed and searching assessment of the long-term petroleum outlook. Urban planners have for many years advocated greater use of public transport in Australia's cities, but the bulk of infrastructure provision has been dedicated to facilitating increased automobile dependence. While recent Australian metropolitan plans have advocated greater emphasis on public transport, in effect these schemes remain focused on road capacity expansion. Switching the balance of new infrastructure provision towards public transport, walking and cycling would not only assist to achieve currently relevant planning objectives but would hedge our urban systems against potential impacts of rising fuel costs. Continuing the present model of road-driven urban transport policy may only make any eventual adjustment to accommodate higher fuel prices more painful, complex and fractious. The pain of such adjustment would invariably fall most heavily on the more disadvantaged members of our communities.

Our analysis suggests that it is outer-suburban locations where the most disadvantaged urban communities are located that will be hardest hit by rising fuel costs. There is currently substantial debate among metropolitan planners about the provision of services to outer-suburban locations, including new rail lines and high quality bus services. Governments so far have been less than forthcoming in providing these new services. Brisbane's new infrastructure plan allocates less than 19 per cent of its non-road budget to outer-suburban infrastructure. In Melbourne, the government has shied away from the few public transport commitments in its Melbourne 2030 metropolitan strategy including the long-promised rail extensions to Rowville and South Morang. Circumferential public transport in Australian cities is woefully poor especially in middle and outer suburbs; such services deserve substantial attention from transport policy makers to ensure cross-suburban access to employment and services. The neglect of the suburbs by Australian governments may prove a strategic miscalculation under conditions where fuel prices continue to rise. There is a strong need for governments at all levels to start taking outer-suburban transport seriously as a critical element of future social and economic sustainability.

The issue of relative levels of investment in different urban transport modes is inevitably linked to the institutional context in which decisions about urban transport are made. There is a growing body of critique within Australian urban planning literature which suggests that the common subordination of public transport agencies relative to road agencies leads to transport policy outcomes that favour road investment over alternative modes. While the present discussion does not afford a complete opportunity to contemplate the specific issues relating to institutional support for various transport nodes, we note that any consideration of the future impacts of rising fuel costs needs to be undertaken with an appreciation of the influence of differing institutional prerogatives and preferences. Depending on which transport agencies are charged with developing the strategic response to potential future oil prices increase substantial variations in eventual policy proposals may occur. We would question whether the current institutional framework for transport policy making is adequate to the task of appropriately conceptualising and responding to rising oil prices.

Speculating whether excess demand or some 'peak oil' scenario will continue to generate increases in the short- or medium-term fuel costs of urban travel remains as risky as the bets waged by futures traders hoping to second guess geology. But the future lasts a long time and adjusting to a future of uneasy oil will not be rapidly achieved. Even if energy markets were able to quickly adjust to much higher oil prices, our production and distribution systems are unlikely to be so responsive. Assessing present options and adjusting urban priorities now may avoid much greater problems for the long future ahead.

References

- Agence Presse France (2004). 50-dollar crude oil becomes reality, and some look higher. Agence Presse Frances. New York, 28 September.
- Australian Bureau of Statistics Statistical Geography Volume 3 Australian Standard Geographical Classification (ASGC) Urban Centres/Localities (Cat. no. 2909.9). Canberra, Australian Bureau of Statistics.
- Australian Bureau of Statistics (2005). Consumer Price Index June Quarter, 7 July 2005 (Cat. 6401.1). Canberra, Australian Government.
- Australian Competition and Consumer Commission (2005). Snapshot of Australian Petrol Prices. Media Release. Canberra, 30 September.
- Baker, J. (2005). Watchdog should monitor petrol prices: NRMA. Sydney Morning Herald. Sydney, 22 September.
- Beazley, K. (2005). Developing The Australian Fuel Industry - Labor's Blueprint Number Three, Speech to the Australian Institute of Company Directors. Melbourne, 29 October.
- Buchanan, N., R. Evans, *et al.* (2005). Transport Disadvantage and Social Status: A Gold Coast Pilot Study; URP Research Monograph 8. Brisbane, Urban Research Program, Griffith University.
- Burke, T. and D. Hayward (2000). Housing Past, Housing Futures: Melbourne Metropolitan Strategy Technical Report 4. Melbourne, Department of Infrastructure.
- Burnley, I. (1980). The Australian Urban System: Growth, change and differentiation. Melbourne, Longman Cheshire.
- Burnley, I., P. Murphy, *et al.* (1997). "Selecting Suburbia: Residential Relocation to Outer Sydney." Urban Studies **34**(7): 1109-1127.
- Cable, V. (2005). We have been here before: the price of oil will fall. The Guardian Unlimited. Manchester, 8 August.
- Campbell, C. (2003). The Peak of Oil: A geological and political turning point for the world. Making Urban Transport Sustainable. N. Low and B. Gleeson. Basingstoke, Palgrave Macmillan: 42-66.
- Campbell, C. (2005a) Newsletter No. 57 - September; Association for the Study of Peak Oil and Gas; http://www.peakoil.ie/downloads/newsletters/newsletter57_200509.pdf; Accessed 25 October, 2005.
- Campbell, C. (2005b). Oil Crisis. London, Multi-Science Publishing.
- Cheal, C. (2003). Transit Rich or Transit Poor: Is public transport policy in Melbourne exacerbating social disadvantage? Faculty of Architecture, Building and Planning. Melbourne, University of Melbourne.
- Chevron Oil Ltd (2005). Advertisement in The Economist magazine, 16 July, pp.6-7.
- de Jong, G. C., L. Biggiero, *et al.* (1998). Elasticity Handbook for Prototypical Contexts. TRACE Costs of private road travel and their effects on demand, including short and long term elasticities. Brussels, European Commission Directorate-General for Transport.
- Deffeyes, K. (2001). Hubbert's Peak: The Impending World Oil Shortage. New Jersey, Princeton University Press.
- Deffeyes, K. and P. Huber (2005). The End of Oil - Oil is Here to Stay. Time. **13 October**: <http://www.time.com/time/magazine/printout/0,8816,1122019,00.html>.
- DIPNR (2003). Regional Transport Indicators for Sydney. Sydney, Transport and Population Data Centre, NSW Government.
- DIPNR (2005). Car Travel in Sydney: Changes in the Last Decade. Sydney, Department of Infrastructure, Planning and Natural Resources.
- Dodson, J. (2003). Visions for 2030: Housing and Transport Planning in Labor's Metropolitan Strategy. Visions for Victoria: Proposals to achieve public sector renewal in Australia. D. Hayward and P. Ewer. Melbourne.
- Dodson, J. (2004). Is there a spatial mismatch between housing affordability and employment opportunity in Melbourne? Conference on the State of Australian Cities, Parramatta, Urban Frontiers Program, University of Western Sydney.
- Dodson, J. (2005). Is there a spatial mismatch between housing affordability and employment opportunity in Melbourne? Melbourne, Australian Housing and Urban Research Institute.

- Dodson, J., B. Gleeson, *et al.* (2004). *Transport Disadvantage and Social Status: A review of literature and methods*; Research Monograph 5. Brisbane, Griffith University Urban Research Program.
- Heinberg, R. (2004). Powerdown: Options and actions for a post-carbon world. Gabriola Island, New Society Books.
- Horin, A. (2004). Carr's Transport Strategy goes off the Rails. Sydney Morning Herald. Sydney, 27 November.
- Howard, J. (2005). Radio Interview with Tanya Nolan on ABC Radio 'World Today' Show, 26 September, 12:18 pm. Australia.
- Huber, P. and M. P. Mills (2004). The Bottomless Well: The Twilight of Fuel, the Virtue of Waste, and Why We Will Never Run Out of Energy. New York, Basic Books.
- Industry Commission (1993). *Public Transport; Draft Report, Vol. 2. Appendices*. Canberra, Australian Government.
- Johnson, L. and S. Herath (2004). *Big Roads, No Transport: A Report of the Goodna and Gailes Community Mapping for Transport Improvements Study*; Research Monograph 5. Brisbane, Urban Policy Program, Griffith University.
- King, A. (1994). *Towards Indicators of Housing Stress*,. Monograph Series No. 2. Canberra, Department of Housing and Regional Development,.
- Kunstler, J. H. (2005). The Long Emergency: Surviving the Converging Catastrophes of the Twenty-first Century. New York, Grove/Atlantic.
- Lucas, P. (2005). Translink provides relief as petrol prices remain high, Media Release. Brisbane, Minister of Transport.
- Maher, C. (1994). "Residential mobility, locational disadvantage and spatial inequality in Australian Cities." Urban Policy and Research 12(3): 185-191.
- Maher, C., J. Whitelaw, *et al.* (1992). *Mobility and Locational Disadvantage within Australian Cities*. Canberra, Department of Prime Minister and Cabinet Social Justice Research Program into Locational Disadvantage.
- Manning, I. (1984). Beyond Walking Distance: The gains from speed in Australian urban travel. Canberra, Australian National University Press.
- McTiernan, A. (2004). Speech to Sustainable Transport Coalition's 'Oil: Living with Less' Conference. Perth, WA., Minister of Transport and WA Government,.
- Mees, P. (2000). A Very Public Solution: Transport in the Dispersed City. Melbourne, Melbourne University Press.
- Mees, P. (2002). The road lobby goes post-modern: deconstructing the 'feminist car'. Institute of Australian Geographers, Australian National University, Canberra, 12 -16 July, 2002., Institute of Australian Geographers.
- Mees, P. (2005). "Privatization of Rail and Tram Services in Melbourne: What Went Wrong?" Transport Reviews 24(4): 433-449.
- Morris, J. (1981). *Urban Public Transport. Equity in the City*. P. N. Troy. Sydney, George Allen & Unwin.
- Morris, J., F. Wang, *et al.* (2002). Planning for Public Transport in the Future: Challenges of a Changing Metropolitan Melbourne. Australasian Transport Research Forum, Canberra, 2-4 October., Australian Bureau of Transport and Regional Economics.
- Motormouth (2005). Average Sydney Unleaded Petrol Prices for Past Week. Sydney, www.motormouth.com.au.
- Murphy, P. and S. Watson (1994). "Social Polarization and Australian Cities." International Journal of Urban and Regional Research 18(4): 573-590.
- National Housing Strategy (1991). *The Affordability of Australian Housing: NHS Issues Paper 2*. Canberra, National Housing Strategy.
- Neutze, M. (1977). Urban Development in Australia. Sydney, George Allen and Unwin.
- Newman, P. (1991). "Cities and Oil Dependence." Cities(August 1991): 170-173.
- Newman, P. and J. Kenworthy (1999). Sustainability and Cities: Overcoming Automobile Dependence. Washington, Island Press.
- Office of Urban Management (2005). *South East Queensland Regional Plan 2005-2006*. Brisbane, Office of Urban Management, Queensland Government.
- Porter, A. (2004). *The Man Who Foresaw High Oil Prices*, Al Jazeera.net.
- RACV (2005). *2005 RACV vehicle operating costs*. Melbourne, Royal Automobile Club of Victoria.

- Senate Rural and Regional Affairs and Transport Committee (2005). Inquiry into Australia's future oil supply and alternative transport fuels: Terms of reference; Australian Parliament House Website: http://www.aph.gov.au/Senate/committee/rrat_ctte/oil_supply/info.htm; Accessed on 13/12/2005.
- Smith, A. (2004). Motorway design must learn from past mistakes. Sydney Morning Herald. Sydney, 24 August.
- Social Exclusion Unit (2002). Making the Connections: Transport and Social Exclusion: Interim findings from the Social Exclusion Unit. London, UK Government Social Exclusion Unit.
- Social Exclusion Unit (2003). Making the Connections: Final Report on Transport and Social Exclusion. London, UK Government.
- Taplin, J. H. E., D. Hensher, *et al.* (1999). "Preserving the symmetry of estimated commuter travel elasticities." Transportation Research B, **33**(B): 215-232.
- Toronto Star (2004). Hard winter may push oil prices even higher. Toronto Star. Toronto, 28 September 8.
- Wulff, M. and S. Evans (1999). The Spatial Impacts of Commonwealth Rent Assistance on Australia's Low-Income Households. Australia's Housing Choices. M. Wulff and J. Yates. Queensland, University of Queensland Press and the Australian Housing and Urban Research Institute.
- Wulff, M. and M. Reynolds (2000). Social Polarisation and Housing Market Change: A Case Study of Melbourne, 1986 to 1996. Australian Population Association 10th Biennial Conference: Population and Globalisation: Australia in the 21st Century, 28 November to 1 December, 2000., Melbourne, Australia, Australian Population Association.
- Yates, J. (2002). Housing Implications of Spatial Social and Structural Change. Melbourne, Australian Housing and Urban Research Institute.
- Yates, J. (2002). "The Limits to Choice in the Private Rental Market." Just Policy **25**(March): 32-48.
- Zeibots, M. (2003). Before and after Sydney's M4 Motorway: Did it make the city more sustainable? National Conference on the State of Australian Cities, Parramatta, NSW, 1-3 December, Urban Frontiers Program, University of Western Sydney,.

