The Value of Melbourne's
Route Bus Services

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1. Context

2010 has seen a growing level of concern in the Victorian community and media about the state of public transport. It is widely recognised that efforts to improve services must increase. The *Victorian Transport Plan (2010)* is the State Government's single most comprehensive statement of how it intends to respond to these concerns, with a small number of commitments being subsequently added to the Plan, especially during the November election Campaign. These additional commitments have been mainly around rail but have also included a commitment to a Bus Rapid Transit project in the Mernda corridor.

Implicit in all these improvement plans is that the public transport system is a valued community asset (service) and that enhancing this asset will deliver even better value for the community. However, this is all implicit, not having been quantified in any publicly available manner. While cost-benefit evaluations may be undertaken of specific upgrading proposals, as part of State Budget funding bid processes (including bids that might pass through Infrastructure Australia channels to the federal government), there has been no concerted attempt to value the existence of Melbourne's public transport network to date, to the author's knowledge.

The present article does not attempt to change that situation! What it does do, however, is attempt to place a value on Melbourne's route bus services. For many years buses have been perceived as the poor cousin of Melbourne's public transport system. However, with patronage numbers now reaching 100 million annually and patronage growth rates at historically high levels, supported by service upgrades, it is timely to consider the value that these services are providing to the Victorian community.

Section 2 of this paper sets out the approach that has been taken to valuing Melbourne's route bus services, based primarily on estimating the benefits to bus users and the external costs of personal travel in the city that are avoided because of the existence of bus services. Section 3 outlines the various parameter values that have been adopted to quantify the benefits of bus services and Section 4 applies these values to derive a system value. Section 5 presents the conclusions from the analysis and suggests areas for further investigation.

2. Approach

Clauses 8, 9 and 10 of the new Victorian Transport Integration Act 2010 set out objectives for the state's transport system, indicating that it should:

- ... provide a means by which persons can access social and economic opportunities to support individual and community wellbeing
- ... facilitate economic prosperity
- actively contribute to environmental sustainability.

The Act also sets out some objectives that relate to how these three outcome objectives are to be pursued (e.g. through an integrated approach to transport and land use). These high level outcome objectives provide signposts against which the value of Melbourne's bus services should be assessed.

The value of public transport in Melbourne (and other places) is essentially about two things:

1. the benefits the system creates for its users, which are largely involved with provision of access to economic and social opportunities and issues that arise therewith, as outlined in the Act (e.g. access to employment, promoting social inclusion); and also
2. how it can reduce the negative externalities that arise from the travel choices of city residents, particularly externalities from car use.

There is also growing interest in the role of public transport in promoting positive externalities of agglomeration, particularly as these arise from clustering of growth in cities (and in activity centres, primarily Central Activity Districts). Agglomeration benefits are particularly relevant for rail but Bus Rapid Transit is also a candidate for such potential benefits (e.g. in Brisbane, where new high density developments have been approved at a BRT station).

So far as Melbourne's route bus services are concerned, service benefits primarily relate to direct user benefits and savings of the external costs from car use that would arise if buses were not available. These externality benefits are mainly economic or environmental in origin.

External costs arise when the actions of one or more agents impact on the well-being of other people, with no compensation for those impacts. Common text book examples are the factory whose smoke pollutes neighbourhood air but they also include examples of Garrett Hardin's (1968) 'tragedy of the commons', where people acting in their own interests impose costs on others which they could avoid or reduce if joint decision-taking was possible – such that all could potentially be better-off. Transactions costs inhibit such joint action and frequently lead to arguments for government intervention, through regulatory or pricing solutions. Traffic congestion costs are the prime example of the urban transport 'tragedy of the commons' but road traffic accidents and greenhouse gas emissions (for example) are also relevant.

There are six major external costs that can be reduced by the operation of an effective urban bus (public transport) service. These are:

1. the costs of traffic congestion;
2. greenhouse gas emissions, which are implicated in climate change;
3. local pollution effects (air, noise, water, nature and landscape);
4. energy security;
5. safety and health; and
6. social exclusion.

It could also be argued that urban sprawl is less likely in cities with strong public transport networks, as demonstrated (for example), by Bento et al. (2005), and that reduced external costs of urban sprawl should also be counted as a benefit of public transport. While there has been some quantification of the savings in infrastructure costs from more compact urban settlement patterns, the quantification of this aspect of land use/transport interaction more generally is not sufficiently well developed for Melbourne to be included in the present paper. It is an area requiring further research.

If these are the external costs that public transport can reduce, how can the public transport contribution in this regard be assessed – or, in the context of the present paper, how can the value of Melbourne's bus services be assessed? The approach taken in this paper is to estimate what would happen to these costs if, overnight, Melbourne's route bus services ceased to exist. This is necessarily a hypothetical situation but it does provide a neat point of departure for defining the potential value of bus, through the user benefits that would be lost and the external costs that would arise in the (hypothetical) absence of bus.

3. Estimating the various benefits

3.1 Congestion

Cities are the heart of our national economy. BTRE (2007) estimated that road congestion cost $10 billion in Australia in 2005, projecting that this would double by 2020. This cost estimate was based on what economists call the 'deadweight loss' associated with congestion. $10 billion is almost 1% of Australia's GDP and about half of the costs involved arise as increased business costs. This is a significant negative effect on business and on the liveability of our cities, both of which affect economic competitiveness.

Aftabuzzaman et al. (2009) estimated how Melbourne's road use would change if its public transport system (hypothetically) ceased to operate. They estimated that about one-third of existing public transport users would switch to car, including seeking a lift. The remaining two-thirds were estimated to walk/cycle or not travel (we consider these assumptions in a little more detail later in this section). Their analysis considered public transport as a system but also disaggregated by mode. One analysis considered removal of the bus system alone, the authors suggesting that removal of the bus system would result in:

- vehicle travel times in the weekday morning peak (7.00-9.00am) increasing by 35,772 hours, or 11.3%;
- vehicle travel distances in the morning peak increasing by 617,072 kilometres, or 3.9%;
- average vehicle speeds in the morning peak declining from 41.64 kph to 39.17 kph, a decline of 6%.

To estimate annual congestion costs, these peak impacts need to be extended to daily impacts and then to annual cost impacts.

Delay costs are the major component of congestion costs. BTRE (2007) includes typical delay profiles for Australian capital cities by time of day. These profiles suggest that the morning peak two hours might account for about one-quarter of total daily travel time delays. The current analysis has adopted a more conservative approach, increasing morning peak (two hour) delays by a factor of 3 to estimate daily delays. On the assumption that congestion is minimal at weekends, 250 days a year has been assumed to convert daily delays to annual delays. The outcome is an estimated 26.8

million hours of annual travel delay on the road system attributable to (hypothetical) removal of the bus system, as illustrated in Table 1.[1]

Aftabuzzaman et al. (2009) undertook their research when Melbourne's bus use was 85 million boardings a year. In the short time since their analysis was undertaken, Melbourne's bus patronage has grown significantly to about 100 million boardings. Given the rising impact of added traffic volumes on marginal congestion costs, this additional traffic would add more than proportionately to congestion costs, particularly delay costs. For example, the 3.9% increase in vehicle kms associated with removal of the bus service was estimated by Aftabuzzaman et al. (2009) to increase road travel times by 11.3%.

For the current analysis, the 617072 morning peak additional road travel kms estimated by Aftabuzzaman et al. (2009) were increased by 100/85 to estimate additional morning vehicle travel because of growth in bus use since the time of their analysis, this then being scaled up to obtain an annual estimate.

Additional vehicle delays (in vehicle hours) were then estimated by increasing the morning peak delays by (100/85), to allow for the additional bus patronage growth since the Aftabuzzaman et al. (2009) analysis. This lifted the additional annual delay costs from 26.8 m vhrs to 31.6 m. These delay times could actually be increased further, given the estimate by Aftabuzzaman et al. (2009) that delay costs increase much faster than travel distances (by 11.3/3.9 for their bus estimates). This would considerably increase delay times. This further refinement would have increased delay times by a further 17.8m vhrs annually , a very significant increase. This adjustment was not undertaken in the interests of taking a conservative approach.

Table 1: Melbourne Annual Travel Distance and Delay Estimates With and Without the Route Bus Service

Item	Base Case = With Bus	No Bus	Differences
Aftabuzzaman et al. (2009)			
AM peak vehicle kms	13219371	13836443	+617072
AM peak vehicle hrs	317473	353245	+35772
This paper's adjustments:			
(1) Estimating annual figures			
Annual vehicle kms	9.91b	10.38b	+462.8m
Annual vehicle hrs	238.1m	264.9m	+26.8m
(2) Allowing for higher bus use/diversion to road use			
Annual vkms with inc. bus use	9.91b	10.46b	+544.5m
Annual vhrs with inc. bus use	238.1m	269.7m	+31.6m

[1] It might be argued that 190 days a year is a better base from which to extend from daily to annual congestion delays, removing all non-school days. This would reduce annual delays by 24%, as compared to use of 250 congested days a year. Conversely, however, if a factor of 4, rather than 3, had been used to scale from morning peak to daily delays, delays would have increased by an even larger proportion. The aggregate impact of using factors of 3 and 250 to convert morning peak delays to annual delays is considered reasonable (3*250= 750; 4*190 = 760).

Changes in Mode Usage

Before quantifying the benefits associated with such a change, it is important to explore in a little detail the basis for the changes in mode split adopted by Aftabazzaman et al. (2009), since the hypothetical removal of a public transport/bus system is just that – hypothetical. It means that analysts seeking to evaluate such a change must necessarily develop estimates of changing mode splits from other situations that have some similarities to this hypothetical situation. Aftabuzzaman et al. (2009) review a range of data in this regard, from changing mode splits during public transport strikes, to stated preference data and patronage changes following major increases in public transport service. Their analysis suggests:

- increased car use is the major response to a major cessation/disruption to public transport services, the scale of increase being quite variable but typically 40-60% of the lost public transport patronage;
- some of this increased car use (typically about half) is as car passenger trips, some of which involve ride sharing but others would require a chauffeur (i.e. requiring another person to act as a lift giver);
- walking and cycling (limited data) can be important;
- cancellation of trips accounts for about one in ten public transport trips..

Conversely, a small survey of the impacts of major outer suburban bus improvements, undertaken by Busvic, has suggested that about half the trips made by bus users in outer urban areas would either:

1. not be made or
2. be undertaken with the assistance of a lift-giver or
3. be undertaken by taxi

if there was no bus service available (Loader and Stanley 2009).

On the basis of the Aftabuzzaman et al. (2009) research and the BusVic analysis, the current research has assumed that, if Melbourne's route bus services ceased to exist:

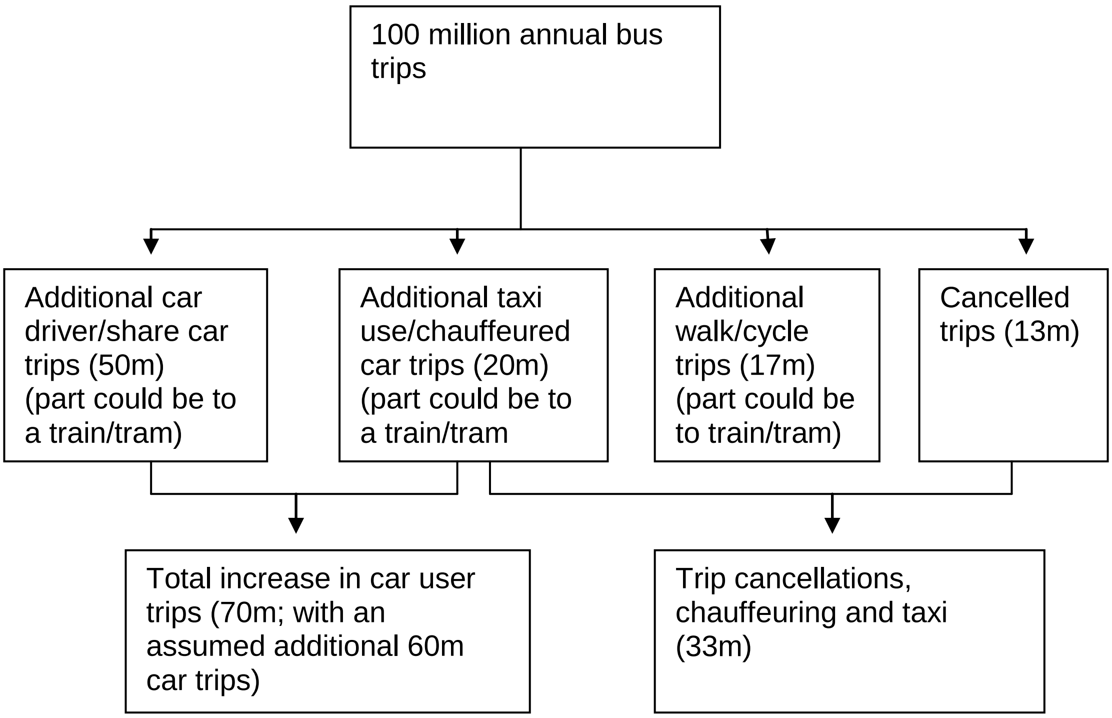
- 50% of bus users would switch to driving themselves or car sharing car (about 40 million additional car driver trips assumed);
- a further 20% would take a taxi or be chauffeured, adding another 20 million trips to car use, taking the total proportion switching to car to 70%. This is at the top end of the range reviewed by Aftabuzzaman et al. (2009). This assumption reflects the present author's belief that, because of (1) the lack of alternative public transport choices in many areas where buses operate and (2) relatively long trip lengths in these areas, car use will be the main alternative to bus. VISTA data suggests that the average trip length that includes a bus for at least part of the trip is 16.1 kms, of which the average bus component is 10.1 kms (Joshua Stewart, DOT, pers com). The chauffeuring proportion recognises the high use of buses by young people, who do not have the option of driving themselves;
- a further 13 million people who were making bus trips would now not travel (cancelling their trip). This takes the proportion in trip categories 1, 2 or 3 above to about one third, which is lower than suggested by BusVic surveys but seems to be broadly consistent with the work reported by Aftabuzzaman et al.

(2009). This data is used in the subsequent valuation of social inclusion benefits (Section 3.6 below);

- 17% would walk or cycle. It might be argued that this share could perhaps be higher. However, given the relatively longer average trip distances in areas where bus is the main form of public transport, it is thought to be a reasonable assumption. .

The travel switching assumptions that have been made are regarded as conservative and likely to underestimate the value of bus. The various proportions assumed for the current study are illustrated in Figure 1.

Figure 1: Assumed Changes in Modal Splits if Melbourne Had No Bus System



By way of sensibility testing these assumptions, Aftabuzzaman et al. (2009) estimate an additional 617012 morning peak kms of road (car) travel. Assuming conversion factors of 3 to convert this to daily kms and 250 to derive annual estimates suggests 463 million additional annual vehicle (car) kms (Table 1), which has been increased to 545 million additional vkms once allowance is made for recent growth in bus patronage (Table 1). If this additional vehicle travel represents car use for an additional 60 million vehicle trips, average car trip length of about 9 kms is implied for those who previously used bus. This is conservative compared to the 16.1 kms average trip length for a trip that currently involves a bus but consistent with an average 10.1 km bus trip length. This suggests that some of the additional car travel is associated with people driving to a train or tram, rather than for the full trip length. These assumptions are unlikely to over-value congestion benefits from the existence of bus.

Congestion Time Benefit Valuation

Table 1 suggests that the travel time delays avoided because of the existence of Melbourne's bus system amount to about 31.6 million hours annually. The time costs associated with these delays can be attributed as congestion time benefits to bus operation. Well over 90% of these benefits will accrue to car users who were car users before the hypothetical transfer of additional bus users to the road system, their car trips now becoming slower. In that event, the relevant congestion time benefits should be valued at time values that are applicable for car users. Hensher and Rose (2003) have estimated the value of travel time of car users at $20.53/hr for work trips and $9.96/hr for non-work trips. Adding 30% to bring their values to 2009-10, and assuming one quarter of trips are work trips and three quarters are non-work, gives a weighted time value of $16.40/hr.

Multiplying the additional hours (31.6m) by the average time cost for car users ($16.40/hr) gives an annual congestion time benefit of $518 million attributable to the existence of Melbourne's route bus services.

Congestion also increases vehicle operating costs, costs/km increasing as speed slows from an average of 41.64 kph to 39.17 kph. As noted in Section 3.1, this represents a 6% reduction in speed. Indicative data (e.g. BTRE 2007) suggests that vehicle fuel consumption increases broadly in proportion to the decline in speeds at about 30-40 kph (faster at slower speeds; slower at faster speeds) and that assumption has been used in the current analysis. Table 2 shows estimated car fuel use on this basis, both before and after the assumed removal of buses. It also shows estimated bus fuel use before removal. Total annual fuel use in the base (before) case is an estimated 1031mL, increasing to 1109mL in the absence of buses, an increase of 78mL.

At an assumed resource cost of $0.90/L, this additional fuel use implies increased fuel costs of $70 million because of the slower travel speeds, resulting from some bus users switching to car/taxi. This sum of $70m can be added as a further congestion externality benefit of bus, giving a total congestion externality benefit of $588 million.

It is useful to sensibility test this estimate of congestion costs. The additional annual road travel associated with this cost has been estimated at 544 million vkms. This gives an implied congestion cost of a little over a $1/km (about $1.08/km). This is at the high end of the congestion cost range and reflects peak cost levels. However, it will be recalled that the estimate of an additional 60 million annual cars on the road, and the associated 544 m vehicle kilometres, implied an average car trip length of about 9 kms. This compared to the current average trip length that includes a bus stage of 16.1 kms, suggesting that the additional vehicle kms associated with diversion of bus trips to car is underestimated. If the rate of underestimation was in proportion to the underestimation of relative trip length, the average congestion cost per vkm would fall to about 68c/km, which reflects mid range congestion levels. That is broadly acceptable as a sensibility test on the scale of estimated congestion benefits, particularly given that adding an extra 60 million trips a year by car to the road would have a relatively large increase in congestion levels[2].

[2] The marginal social cost curve for congestion costs is steeply sloping upwards in congested conditions, costs rising much faster than traffic volumes.

A second sensibility test is to compare the estimated congestion benefits with estimated total congestion costs for Melbourne. BTRE (2007) estimated Melbourne's congestion costs at $3.0b in 2005, increasing to $4.9 b in 2010, assessed on a 'deadweight loss' basis. The 'deadweight loss' estimate of congestion costs is less than total delay costs. If removal of the bus service reduced time and fuel costs by about $590 million, this would represent about 12% of deadweight losses. UK research has suggested that urban congestion costs (in the UK) can be cut by over 40 per cent if congestion pricing reduces urban traffic volumes by about 4 per cent.[3] Given that congestion costs **increase** more than proportionately to traffic volumes, a suggestion that Melbourne's road congestion costs might increase by about 12% of the bus service was removed seems quite reasonable.

3.2 Climate change and GHG emissions from land transport

Land transport is Australia's third largest source of greenhouse gas emissions (GHG) and the second fastest growing source (from 1990), with GHG from transport projected to be over 50% above 1990 levels by 2020 (DCC 2009). Road transport is the dominant contributor to transport emissions and accounts for well over 80% of sectoral emissions.

Valuation of GHG externalities is a contentious matter, with a wide range of possible prices per tonne available, depending on factors such as whether the valuation is done using damage costs or avoidance costs and the discount rate chosen to express future costs in present values. Maibach et al. (2007), for example, cite costs with central values of €70/tonne CO_2-e for Germany and Switzerland, with a range from €20-280. Parry (2009) cites figures from $US10-70/tonne.

For Victoria, the adoption of a State Government target of cutting GHG emissions by 20% on 2000 levels by 2020 makes the estimation of a marginal cost of carbon reduction a little simpler. An avoidance cost approach can be used in this case, to estimate the marginal costs of cutting GHG emissions at this rate. This rate of emission reduction is relatively modest as a state target, such that it can be expected to survive changes in state government against a 2020 time scale.

ClimateWorks Australia (2010) has estimated the costs of Australia cutting GHG emissions by 25% on 2000 levels by 2020, with the average cost of the last 35% of these reductions being $A61/tonne CO_2. This 35% range includes the marginal tonnage to achieve a 20% cut on 2000 levels, which falls at just over $A50/tonne CO2. A marginal cost of $50/t can thus be applied to the GHG emissions from the fuel used in the before and after cases under consideration. GHG costs of 11.1c/L for petrol and 13.4c/L for diesel were used for assessing costs, recognising that diesel has a higher GHG content than petrol. Table 2 shows estimated GHG benefits from bus of about $7.5 million annually.

[3] U.K. Department for Transport (2004), Table B3.

Table 2: Some key annual aggregates for benefit estimation

Item	Base case	No bus	Change
Car kms[1]	9.9b	10.5b	+544m
Bus kms	100m	0	-100m
Car fuel use[2]	991mL	1109mL	+118mL
Bus fuel use	40mL	0	-40mL
Total fuel use	1031mL	1109mL	+78mL
GHG costs car @11.1c/L[3]	$110.1m	$123.1m	+$13m
GHG costs bus @13.4c/L[3]	$5.5m	0	-$5.5m
Total GHG costs	$116.5m	$122m	+$7.5m
Car air pollution costs @3c/km	$297.4m	$332.6m[4]	+$35.2m
Bus air pollution costs @23c/km	$23m	0	-$23m
Total air pollution costs	$320m	$330m	+$12.2m
Car energy security costs @3c/L	$19.8m	$22.2m	+$2.4m
Bus energy security costs @3c/L	$0.8m	0	-$0.8m
Total energy security costs	$20.6m	$22.0m	+$1.6m

Notes: 1. From Table 1. 2. Assuming car =10L/100kms, increasing by 6% in the "no bus" case, with bus 40L/100kms in the base case. 3. Assuming $50/t for greenhouse gas emissions. 4. Adding 6% to increase emissions from increased fuel use, as a result of slower speeds. The GHG emission calculations already include this adjustment because they are directly calculated from the increased fuel use figures, rather than from kms of travel.

3.3 Local pollution

Under this generic heading we follow Parry (2009) and include only local air pollution, although additional items could be included (e.g. noise, surface water run-off, nature and landscape effects, all of which are included as relevant evaluation factors in the Australian Transport Council National Guidelines (ATC 2006)). These items have been excluded on the basis that they are expected to net out close to zero.

The main air pollutants are particulate matter, NO_x, SO_2 and VOC and the main costs consist of health costs, building/material damages and crop losses, together with costs for further damages for the ecosystem (biosphere, soil and water) (Maibach et al. 2007).

ATC (2006) values local pollution costs from passenger vehicles at 2.45c/km and bus pollution costs at 19.1c/km in 2005 prices. The bus costs are considerably higher because of the particulate emissions from diesel. These costs can be increased by about 22% to put them in 2009-10 values, to 3c/km for cars and 23c/km for bus. These costs are relevant to (1) increased air pollution from existing (or base) car traffic which is now using more fuel (and hence, emitting more pollutants), (2) the additional car use associated with diverting some bus users to road and (3) bus use in the base case.

Table 2 shows estimated air pollution costs in the before (base case) and after (no bus) cases. Car air pollution damage costs are projected to increase by about $35m and bus damage costs to decline by about $23m, if there was no route bus system in Melbourne. The net outcome is an annual benefit of about $12 m to bus.

3.4 Energy security

Maibach et al. (2007) point out that, at a time when there are concerns about peak oil and much oil supply comes from regions where there are questions of reliability, nations that have a relatively high dependence on imported oil face risks of security of supply at an acceptable price. Australia is currently about 54% self-sufficient in transport fuels but Rare Consulting Pty Ltd, in a study for the Bus Industry Confederation, has projected this will decline to less than 19% by 2030, increasing vulnerability to changing international oil supplies (Rare Consulting 2010).

Few studies have attempted to quantify the external costs of energy dependence. Maibach et al. (2007) summarise some studies which show a range of cost estimates, based on the US, ranging from about €0.03-0.11 a litre. They point out that there are three relevant cost implications of energy dependence:

- costs due to transfer of wealth (from oil consumers to oil producers, due to market power);
- potential GDP losses (reduction of the maximum output an economy is able to produce due to the increased economic scarcity of oil);
- macroeconomic adjustment costs (costs of adjusting to sudden, large price changes).

Costs in the first and third of these categories are where valuation efforts have been mainly focused. Parry (2009) uses a value of $US0.10/gallon in 2007 prices, or about 3c/L in 2009-10 Australian values, based on macro-economic disruption costs. Australian figures may arguably be lower, given the high US commitment to energy security, with its associated defence consequences. A cost of 2c/L has been assumed in this analysis, though without any particularly strong foundation. Applying a value of 2c/L gives a small net benefit for bus of $1.6m. With Australia's declining energy self-sufficiency, energy dependence is an area where Australian research efforts need to be increased.

3.5 Safety and health

Australia is making some progress in reducing its road toll and is in the better half of OECD countries for the number of people killed through travel, on an exposure basis. However, there are still about 1450 people killed on Australian roads and 30,000 serious injuries per annum. If this number of deaths was associated with terrorism or a pandemic, it would be seen as catastrophic. The high cost of road accidents, in itself, is a sound economic reason for supporting greater travel by public transport, being much safer than travel by car or truck.

Part of the cost of car accidents is covered by insurance and some additional parts can be considered as internal to the traveller. The relevant component for evaluating the value of Melbourne's route bus services is that part of accident costs which are external to the user that are saved because of the existence of the bus network. Using broadly similar values for the costs of a fatality as proposed by Hensher et al. (2009), Parry

(2009) uses a value of $US0.035/mile in 2007 prices, or about 2.3 c/km in Australian 2009-10 terms, as the externality component in car accident costs. Bus accident costs are very low, so the accident externality can be considered as a net benefit for bus. The increased car use as a result of the (hypothetical) cessation of Melbourne's bus network is estimated to generate annual accident benefits for bus of $15 million, on this basis.

The prevalence of obesity in Australia has more than doubled in the last 20 years: 52% of women, 67% of men, and 25% of children are overweight or obese. This has significant adverse health consequences. Environments that encourage walking, cycling and incidental exercise, such as walking to and from public transport, are considered as helping to reduce the incidence and economic costs of obesity and inactivity. DOT (2010) suggest default health benefit values of $A3.42/km of walking and $A1.71/km of cycling, in 2007 prices. These unit values are the least reliable of all benefit parameters considered for the present study. Their application would require further assumptions about trip lengths of mode switchers from bus to walk/cycle that are equally problematic. For these reasons, no attempt has been made to estimate the net benefit/cost impacts of such possible switches.

3.6 Social inclusion/exclusion

Social exclusion is a relatively new area of understanding that is extremely important in relation to the benefits of public transport in general and buses in particular. Part of the social exclusion benefit arises in the form of public transport (bus) user benefits and part as an externality benefit. The present study focuses on the user benefit component. The externality component, which includes benefits such as lower crime rates and health care costs from a more inclusive society, has not had sufficient research to enable reasonable quantification at this time. Further research is needed on the externality dimension, which will increase the value of public transport/bus services.

Australian research has produced substantial quantitative evidence that poor mobility can lead to increased risks of people being socially excluded (Stanley et al. (in press), Stanley and Stanley (2010))[4]. Research suggests that people in regional Australia and in outer suburbs are at most risk of transport-related social exclusion (Currie et al. 2007). Two noteworthy characteristics from the Australian research in Melbourne reflect the relatively greater transport disadvantage faced by people living in outer suburbs (Currie and Delbosc 2010).

1. People living in outer suburbs make about the same number of trips as those living in inner suburbs but travel almost twice as far in so doing (a function of relatively lower accessibility in outer areas).
2. Public transport service availability in outer Melbourne is less than one-third that in inner Melbourne.

Low levels of mobility increase risks of social exclusion and undermine capacity to contribute to society and the economy.

Research at the London School of Economics (Burchardt et al. 2002) has identified 4 risk factors for social exclusion, encompassing income, employment, political

[4] This research was undertaken as part of an Australian Research Council supported study, *Investigating Transport Disadvantage, Social Exclusion and Wellbeing in Metropolitan, Regional and Rural Victoria.*

engagement and participation (in selected activities). Australian research has added a fifth risk factor, social support (being able to get help when needed) (Stanley et al. in press). Table 3 shows the proportion of respondents in a recent Melbourne survey who exhibited various social exclusion risk factors.

Table 3: Social Exclusion Risk Factors for Melbourne Survey Respondents

Risk factors exhibited	% of respondents
0	45
1	35
2	13
3	5
4	1
5	0

The Australian research suggests that a person's risk of social exclusion is affected by: their level of social capital and sense of community, household income, trip making and elements of personality (extraversion). Increased risk of social exclusion negatively affects personal wellbeing (Stanley et al. in press; Stanley and Stanley 2010). A person is less likely to be at risk of social exclusion if they (Stanley et al. in press):

- have a strong sense of community;
- have contact with members of their close family more frequently than once a year (but can be less than monthly);
- have contact with members of their extended family;
- trust people in general (an element of social capital);
- have medium or better household incomes;
- are relatively mobile (make more trips); and
- are relatively extroverted.

On average, people make about 3.8 trips per day but, as the number of social exclusion risk factors increases, the number of trips tends to reduce. Because trips are closely associated with activities undertaken outside the home, fewer trips indicates fewer activities, which suggests greater risk of social exclusion. The difference between 3.8 and (say) 2.8 trips per day is substantial in terms of capacity to engage as members of a community. There is clear evidence of a significant link between mobility and risk of social exclusion: the lower a person's level of mobility (trip making), the higher their risk of social exclusion.

The Australian research establishes that people value highly the mobility contribution to reducing the risks of social exclusion. A value of about $19.30-$22.40 per trip (2008 values) is implied at an average household income level, by the research. This value is about 4 times the value that traditional economic evaluation ascribes to the value of new (or additional) trips that flow from transport improvements (what economists would call the generated traffic benefit, measured using the "rule-of-a-half").

In valuing Melbourne's bus services, average household incomes are of little interest. It is bus users' household incomes that will determine the value of additional trips and, conversely, the value forgone when trips are cancelled. Data from the Department of

Transport's Victorian Activity and Travel Survey 2007 shows that bus users have household income levels that are below the mean for Melbourne as a whole. Mean weekly household incomes of bus users was $1633 in 2007-08, some 9.5% below the Melbourne mean. For households that only travel by bus, mean incomes are lower still (at 20.8% below the Melbourne mean). Using the more conservative figure for bus users' mean household income (of 9.5% below the Melbourne mean), and starting with a mid-range value for an additional trip of $21, implies a weighted value for an additional trip by bus of $23.25.

It was noted above that research by Busvic has suggested that a significant proportion of trips made by bus users in outer urban areas would either:

- not be made or
- be undertaken with the assistance of a lift-giver or
- be undertaken by taxi

if there was no bus service available. For user benefit valuation purposes, these trips can all effectively be considered as 'new trips" and receive the value of $23.25/trip.

As shown in Figure 1, the present analysis assumes that one in three bus trips would be in one or other of these three categories if there was no bus service, suggesting 33 million trips would have value forgone of $23.25/trip if Melbourne's bus services ceased operation. $5/trip is assumed for the value forgone by the other 67 million bus users (as implied by the rule-of-a-half), who now travel by some other mode. The resulting values are very substantial: they suggest an annual user value of about $767 million for bus trips that are highly bus-dependent (i.e. are in one of the three trip categories noted in the dot points above) and about $335m for bus trips that have more readily alternative options. The total annual user value is thus estimated at a very substantial $1.1 billion.

4. System Net Benefits

Table 4 summarises the various benefit values derived above, to suggest that the total economic value of Melbourne's route bus services is over $1.7 billion annually. Two benefit categories dominate the benefit estimates: user social inclusion benefits and congestion benefits. In total, these two account for over $1.3 billion in annual value, with the social inclusion benefit being the largest single benefit (at $767m). This total benefit estimate is likely to be an under-estimate, particularly because of neglect of the externality benefits from reduced risks of social exclusion (e.g. lower crime rates and health costs).

The social inclusion benefit values for bus that have been included are driven by the value of a trip that has emerged from recent Australian research reported above. These values underpin the single most important benefit component of bus. The relevant unit trip values have been peer reviewed and the article in which the specific valuation work has been documented has been accepted for publication in the leading international transport economics journal, the *Journal of Transport Economics and Policy*. The research has thus been given a significant integrity tick by international leaders in the transport economics field.

Table 3: Indicative annual value of Melbourne's route bus services

Value of route bus services in *m*etro Melbourne	**$ pa**
Congestion time ($518m) and fuel ($70m) benefits	$588 M
GHG ($7.5m), local pollution ($12.2m), energy security ($1.6m)	$21 M
Accidents savings	$15M
Bus user benefits of social inclusion = 33 m trips @ $23.25 per trip	$767 M
User benefits for other bus users = 67 m trips @ $5 per trip	$335 M
Total value (externality + user benefits)	**$1.726 B**
Gross cost to budget	$486 M
Benefit Cost Ratio (BCR)	**~3.5**

It should be noted that there is an element of self-correction in the benefit valuation approach. In particular, the lower the proportion of bus trips to which the high social exclusion value of $23.25 applies, the higher the proportion of trips that are likely to require a car travel alternative if bus is not available. A corollary of this is that the high congestion benefits of bus would be further increased. In short, if the proportion of bus users in the three critical trip categories that trigger the high unit (social exclusion) value is lower, congestion benefits are likely to increase as an offset (as are benefits in the smaller categories such as other user benefits, air pollution, greenhouse gas emissions and accidents). As a consequence, the aggregate benefit measure reported in Table 4 is likely to be reasonably robust.

Table 4 also sets out the government funding contribution in 2009-10 to Melbourne's route bus services, at $486 million (Victorian Government, 2010). Comparing this funding commitment to the estimated benefits from bus suggests an overall economic benefit-cost ratio of about 3.5:1, which is a very solid result.

5. Conclusions

Externalities are pervasive in our cities and very much affect people movement. The existence of these externalities drives much of the public value from public transport services, which derives from reducing such externalities as traffic congestion, accident costs, air pollution and greenhouse gas emissions. So far as Melbourne's route bus services are concerned, the congestion benefit has been shown to be substantial, of a slightly larger order than the total funding support provided by the State Government.

Public transport is also an important means of supporting social inclusion. This is particularly so in the case of Melbourne's bus services, which typically operate in areas where there is no other public transport available. The paper has applied the latest research on benefit valuation to show that the largest single benefit resulting from the existence of Melbourne's bus route services is the contribution they make to supporting mobility, as a means of reducing risks of social exclusion. This is new evidence of the value of bus. The current research is to be extended in the immediate future, to assess non-metropolitan route bus services in similar terms. Research should also be undertaken on the value of flow-on externality benefits from reduced risks of social exclusion. These are benefits in areas such as reduced crime, improved health, etc. They are likely to be very substantial and would increase the net community value of route bus services.

Across the board, it has been estimated that Melbourne's route bus services produce about $3.50 in value to the Victorian community for each $1 of public money used to support service provision. This compares favourably with returns on investment in other transport areas, such as roads. It is also an underestimate of total community value from route bus services, because of the current inability to value the externality component of social exclusion benefits.

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