BusVic
Bus Association Victoria

The Economic Impact of Proposed New Bus Services in Metropolitan Melbourne

A report for
BUSVIC

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1. Project objective

The project objective is to evaluate additional bus services as listed in Table 1 in terms of their impact on economic indicators as well as to calculate an average cost-benefit ratio.

2. Additional bus routes and economic activity

There are a number of channels by which additional bus routes, or indeed additional train, tram and major automobile infrastructure, will impact on economic activity. The three key channels are:

1. expanding the scale of the labour market;
2. reducing the fixed cost of an automobile; and
3. reduction in congestion costs.

Expanding the scale of the workforce will impact on economic activity in two ways, namely:

1. increasing hours of work available per capita of the available workforce; and
2. increasing productivity or $ per hour paid to the available workforce that is employed.

Increasing the scale and scope of the labour market will increase productivity and resident hours of work because the more likely employers can achieve maximum productivity potential by being able to select the appropriately qualified and experienced workforce at competitive wage rates. Employers in regions with small catchments relative to Brisbane City will have limited choice in employee selection. In these regions, to attract suitable employees, employers will have to pay relatively high wages to employees who will, in all probability, have excessive journey to work travel times. This is likely to be in most instances an unsustainable arrangement which will limit the growth potential of establishments. Also, production can be expected to expand to the extent that current limitations, in terms of access to public transport and low car ownership, creates labour market bottlenecks leading to labour shortages in some areas.

Automobiles and in particular second automobiles which are purchased for journey to work purposes offer the household little additional consumer utility if suitable public transport options are available. The fixed cost savings are considerable, assumed here to average $5,700 per annum for a vehicle mid-way through its life. The avoidance of these costs will significantly increase household disposable income if suitable public transport options are available. For this study, automobile running costs are assumed equal to the substitute public transport costs.

Congestion increases automobile running costs and increases travel times, thereby reducing labour productivity. It is assumed in this report that each automobile kilometre that is avoided at peak hour by substitution for public transport reduced congestion costs by $0.15.

3. Methodology

The study is strictly empirical based. The estimation of the impact of the above factor is estimated by applying the equations developed from the Melbourne SA2 region to 2011 Census data bases. The equations are outlined in Appendix A.

As per Table 1, BusVic provided NIEIR with a list of Plan Melbourne bus service initiatives. For each initiative, NIEIR estimated the following:

- the number of additional trips per annum (both ways);
- passengers per trip hence; and
- additional passengers per annum.

The numbers of additional passengers so calculated were compared with data on bus route patronage posted on the PTV website and found to be of the same order.

For each route, additional trips were then distributed between origin-destination pairs using the 2011 ABS journey-to-work matrix. For this purpose trips were defined as complete trips, of which the bus journey might form but a part. Depending on the length of the proposed route, up to five origin zones were identified with up to five destination zones for each origin zone, again depending on route characteristics. Destination zones (or origin zones in the case of university oriented routes) were chosen to typify trip patterns, which in reality will be more dispersed. Thus, Melbourne was nominated as the representative destination zone for its immediately surrounding inner suburbs.

BusVic also estimated the recurrent cost of each initiative. Additional bus requirements were indicated, but the number of buses was not. The calculations as they stand therefore exclude capex. It would be possible to include capex by taking a stab at the number of buses required.

The bus service initiatives include two BRT routes. It was not clear whether these were substitutes for initiatives using public roads. Accordingly, they were not included in the analysis.

Three of the initiatives comprised regional reviews without any routes being indicated. Judging by nominated recurrent cost these might yield quite significant new routes. However, the assumption was made that the new bus kilometres resulting from these reviews would be local and limited. Recurrent cost was reduced to allow for the limited scope of these assumed service improvements.

This lead to the specification of likely trip numbers for SA2 *i* to SA2 $_j$. After vetting out BusVic (weekend) and education trips the daily one way journey to work trips were estimated. The row totals from this estimation are given in Table 2.

In terms of the direct impact of the routes total additional annual trips were estimated at 10.5 million. After deducting education, shopping and leisure trips the daily one-way journey to work trips was estimated at 8,725.

The derived matrix of the distribution of the 8,725 journey to work trips across the SA2 was used to estimate the impact of the trips on:

- industry productivity;
- resident additional hours of work; and
- foregone automobile fixed costs,

Using the equations developed in Appendix A. The congestion costs were estimated using the distances between the SA2s. The results are given in Table 2.

3.1 Cost-benefit

From Table 2, the total economic benefit is estimated at $210 million across all SAQ2s. The total cost from Table 1 is $35 million. However, this has to be reduced by 30 per cent to $25 million to allow for fare recovery by the government. The benefit cost ratio is, therefore, 210/25 or 8.4 to 1.

The additional net employment to the economy is placed at approximately 1,800, which underlines the $73 million increase in household income from employment. Thus, the net additional employment ratio per journey to work trip by bus is 1,800/8,725 or 0.21.

Table 1 Low Hanging Fruit service upgrades – Metropolitan Bus 2014			
Category	**Route(s)**	**Suggested change/detail**	**Estimated recurrent cost**
Access to tertiary education and employment clusters (Plan Melbourne initiatives)			
Surry Hills Station - Deakin Uni (Burwood Rd Campus)	New Service	Would operate an express shuttle between Surry Hill Station and Deakin Uni (Burwood Rd Campus) during study periods. The round trip distance is approximately 8km. A 10 minute headway over an 16 hour span on teaching days is proposed.	~$510k
Deakin Uni (Burwood Rd campus) – Holmesglen (Warragul Rd Campus)	New Service	Would operate an express shuttle between Deakin Uni (Burwood Rd Campus) and Holmesglen during study periods. The round trip distance is approximately 12.5km. A 10 minute headway over an 16 hour span on teaching days is proposed.	~$810k
Westall Station – Monash Uni	New Service	Would operate an express shuttle between Westall Station and Monash Uni (Wellington Rd Campus) during study periods. The round trip distance is approximately 9.3km. A 10 minute headway over an 16 hour span on teaching days is proposed	~$600k
Macleod Station - Latrobe Uni	New Service	Would operate an express shuttle between Macleod Station and Latrobe Uni during study periods. The round trip distance is approximately 8km. A 10 minute headway over an 16 hour span on teaching days is proposed.	~$510k
Reservoir Station to Latrobe Uni	New Service	Would operate an express shuttle between Reservoir Station and Latrobe Uni during study periods. The round trip distance is approximately 8.6km. A 10 minute headway over an 16 hour span on teaching days is proposed.	~$550k
Footscray Station - Victoria University Footscray Campus – Keilor East	406	The 406 currently operates a 20 minute peak service. Propose to increase the frequency to 10 on the 406 during study periods	~$1.3m (this is a long route at approximate 42km one way)
Keilor Park, Tullamarine and Airport West Industrial area services	New	This area provides employment for around 5,000-6,000 people and currently has very poor services. Ryan Brothers and Tullamarine Bus Lines have proposals ready that could be implemented using mostly existing resources.	~$93k

Table 1 Low Hanging Fruit service upgrades – Metropolitan Bus 2014 (continued)			
Category	**Route(s)**	**Suggested change/detail**	**Estimated recurrent cost**
20 Minute City: Mass Transit Options for Outer Melbourne			
Mernda/Laurimar Train link service to South Morang Station.	New Service	This service is design to provide a rapid transit service between Laurimar/Mernda and South Morang Station. The 562 is the nearest service to this at the moment. The suggested new service would run direct along Plenty Road and McDonalds Roads starting at Laurimar Town Centre.	~$3m
Wallan Town and Commuter Services	New services	There is presently only 1 service in Wallan which does not operate on weekends or public holidays. Wallan is a rapidly growing area with very limited public transport. The area would benefit for at least 4 new routes running to the train station via the town centre.	~$950k
Carrum Station – Berwick Station	New Service	A 20 minute service would link households in the either end of the south east corridor to employment opportunities along Thompsons Road.	~$6m
Keysborough – Noble Park train station via Parkmore SC	New Service	An express shuttle between Greens Road and Noble Park station.	~$850k
Sanctuary Lakes to Williams Landing	New Service	This area is well established and household surveys have indicated strong demand for a service to Williams landing.	~$560k
Dandenong-Dandenong South-Cranbourne East via Thompsons Road Rapid Transit	New service	Thompsons Road is desperately congested in the am and PM peaks with motorists travelling from the city of Casey to Dandenong and Monash for employment. A rapid transit service that linked Cranbourne to Dandenong South and Dandenong Station where it could hub with other rail and bus services would be a major benefit to the area.	~$4.8m
Mornington link1: Frankston to Rosebud	New service	This service would take advantage of Peninsula link and provide a regular limited stop service from Rosebud to Frankston. High capacity articulated buses with a load capacity of 120 people could be used.	~$3.6m
Mornington link2: Frankston to Mornington	New service	This service would take advantage of Peninsula link and provide a regular limited stop service from Rosebud to Frankston. High capacity articulated buses with a load capacity of 120 people could be used.	~$4.1m
Frankston/Mornington Peninsula	New Service	An LGA/Subregional wide review of services is required. Frankston are has a dysfunctional network and very poor service levels	~$2m
Mordialloc to Berwick via Dandenong South and Narre Warren South	New Service	Implement a new east west bus from Mordialloc to Berwick via Dandenong South to service industrial area.	<$2.3m
Hume/Whittlesea/ Darebin/Banyule	Sub regional review	An LGA/Subregional wide review of services is required. New growth areas under serviced.	~$1.5m
Melton/Toolern/ Rockbank service upgrades from low level local services to higher order commuter and intermodal services.	Sub regional review	An LGA/Subregional wide review of services is required. New growth areas under serviced.	~$1m

Table 1 Low Hanging Fruit service upgrades – Metropolitan Bus 2014 (continued)			
Category	**Route(s)**	**Suggested change/detail**	**Estimated recurrent cost**
Small But Effective: Timetable and route alignment improvements			
Public holiday service consistency – part 1	605 681 682 691	These routes run Sundays, but not all public holidays. Suggest upgrade these routes to run a normal Sunday timetable on public holidays.	<$50k
Public holiday service consistency – part 2	843 845 849 861	Improve the span and frequency for Sunday and public holiday services.	<$50k
Increase span of service extensions – minimal cost	845	Dandenong – Endeavour Hills	<$50k
Yarra Glen/Healesville	685	Upgrade service to minimum service span. Increase weekday frequency to 30 minutes.	
Frankston-Portsea	788	Summer months have significant increased demand and traffic congestion. The current timetable does not meet passenger demand and runs very late. Suggest operate a special summer only timetable with a (boosted) 30 minute headway and slower running times.	$160-$200k
Gowrie - Glenroy via Gowrie Park	536	Service all day Saturday and Sunday	Low
Roxburgh Park – Pascoe Vale via Meadow Heights, Broadmeadows, Glenroy	542	Service Broadmeadows to Pascoe Vale RS on Sundays.	~$70k
North East Reservoir – Northcote Plaza via High Street	552	Requires an extra school bus from Thornbury Darebin to assist the 552 route service	~$52k
Northcote – Regent via Northland	567	Adding a peak bus to assist late running and put in a 20 minute frequency.	Moving the frequency from 22 minutes to 25 minutes – no cost
Northland SC – Whittlesea via South Morang Station	562	Adjust weekday timetable with existing time in the run.	$0
Macleod – Coburg via La Trobe University	561	Adding a peak bus to assist in overcrowding between Latrobe University and Reservoir station.	~$125k
University Hill to Doreen	572	Extra bus on Lakes Bvd between in peaks. Only doing quick shuttles on Lakes Bvd and turn around at Red Oaks way	<$200k
Bundoora RMIT – Mill Park Lakes – Palisades via South Morang Station	573	Extra bus required on weekends.	~$166k
Epping North – Thomastown via Epping	575	Extra bus on a shuttle between Epping Station and Epping North in peaks.	~$126k
Thomastown – RMIT Bundoora via Betula Avenue, Plenty Road	570	Service all day Saturday and Sunday.	~$166k
Craigieburn	537	Upgrade to a 20 minute service on weekends.	~$100k

Table 2 Economic outcome of additional bus services					
SA2	Total daily one-way journey to work trips by residents	Additional household income from net increased household hours of work ($2011m)	Additional household income from reduction in fixed cost of motor vehicle ($2011m)	Additional household income from net increased labour productivity ($2011m)	Peak hour congestion costs ($2011m)
Brunswick	0	0.0	0.0	0.0	0.0
Brunswick East	0	0.0	0.0	0.0	0.0
Brunswick West	0	0.0	0.0	0.0	0.0
Coburg	0	0.0	0.0	0.0	0.0
Pascoe Vale South	0	0.0	0.0	0.0	0.0
Alphington - Fairfield	0	0.0	0.0	0.0	0.0
Northcote	57	0.5	0.2	0.1	0.2
Thornbury	17	0.0	0.0	0.0	0.0
Ascot Vale	0	0.0	0.0	0.0	0.0
Essendon - Aberfeldie	0	0.0	0.0	0.0	0.0
Flemington	0	0.0	0.0	0.0	0.0
Moonee Ponds	0	0.0	0.0	0.0	0.0
Carlton	0	0.0	0.0	0.0	0.0
Docklands	0	0.0	0.0	0.0	0.0
East Melbourne	0	0.0	0.0	0.0	0.0
Flemington Racecourse	0	0.0	0.0	0.0	0.0
Kensington	0	0.0	0.0	0.0	0.0
Melbourne	0	0.0	2.5	0.0	0.0
North Melbourne	0	0.0	0.0	0.0	0.0
Parkville	0	0.0	0.0	0.0	0.0
South Yarra - West	0	0.0	0.0	0.0	0.0
Southbank	0	0.0	0.0	0.0	0.0
West Melbourne	0	0.0	0.0	0.0	0.0
Albert Park	0	0.0	0.0	0.0	0.0
Elwood	0	0.0	0.0	0.0	0.0
Port Melbourne	0	0.0	0.0	0.0	0.0
Port Melbourne Industrial	0	0.0	0.0	0.0	0.0
South Melbourne	0	0.0	0.0	0.0	0.0
St Kilda	0	0.0	0.0	0.0	0.0
St Kilda East	0	0.0	0.0	0.0	0.0
Armadale	0	0.0	0.0	0.0	0.0
Prahran - Windsor	4	0.0	0.0	0.0	0.0
South Yarra - East	0	0.0	0.0	0.0	0.0
Toorak	0	0.0	0.0	0.0	0.0
Abbotsford	0	0.0	0.0	0.0	0.0
Carlton North - Princes Hill	0	0.0	0.0	0.0	0.0
Collingwood	0	0.0	0.0	0.0	0.0
Fitzroy	0	0.0	0.0	0.0	0.0
Fitzroy North	0	0.0	0.0	0.0	0.0
Richmond (Vic.)	0	0.0	0.0	0.0	0.0
Yarra - North	0	0.0	0.0	0.0	0.0
Ashburton (Vic.)	0	0.0	0.0	0.0	0.0

Table 2 Economic outcome of additional bus services (continued)					
SA2	Total daily one-way journey to work trips by residents	Additional household income from net increased household hours of work ($2011m)	Additional household income from reduction in fixed cost of motor vehicle ($2011m)	Additional household income from net increased labour productivity ($2011m)	Peak hour congestion costs ($2011m)
Balwyn	0	0.0	0.0	0.0	0.0
Balwyn North	0	0.0	0.0	0.0	0.0
Camberwell	0	0.0	0.0	0.0	0.0
Glen Iris - East	125	0.8	0.5	0.3	0.2
Hawthorn	0	0.0	0.0	0.0	0.0
Hawthorn East	0	0.0	0.0	0.0	0.0
Kew	0	0.0	0.0	0.0	0.0
Kew East	0	0.0	0.0	0.0	0.0
Surrey Hills (West) - Canterbury	125	1.0	0.5	0.3	0.2
Bulleen	0	0.0	0.0	0.0	0.0
Doncaster	0	0.0	0.0	0.0	0.0
Doncaster East	0	0.0	0.0	0.0	0.0
Templestowe	0	0.0	0.0	0.0	0.0
Templestowe Lower	0	0.0	0.0	0.0	0.0
Blackburn	0	0.0	0.0	0.0	0.0
Blackburn South	0	0.0	0.0	0.0	0.0
Box Hill	125	0.3	0.4	0.3	0.1
Box Hill North	0	0.0	0.0	0.0	0.0
Burwood	0	0.0	0.0	0.0	0.0
Burwood East	0	0.0	0.0	0.0	0.0
Surrey Hills (East) - Mont Albert	0	0.0	0.0	0.0	0.0
Beaumaris	0	0.0	0.0	0.0	0.0
Brighton (Vic.)	0	0.0	0.0	0.0	0.0
Brighton East	0	0.0	0.0	0.0	0.0
Cheltenham - Highett (West)	0	0.0	0.0	0.0	0.0
Hampton	0	0.0	0.0	0.0	0.0
Sandringham - Black Rock	0	0.0	0.0	0.0	0.0
Bentleigh - McKinnon	0	0.0	0.0	0.0	0.0
Bentleigh East	0	0.0	0.0	0.0	0.0
Carnegie	0	0.0	0.0	0.0	0.0
Caulfield - North	0	0.0	0.0	0.0	0.0
Caulfield - South	0	0.0	0.0	0.0	0.0
Elsternwick	0	0.0	0.0	0.0	0.0
Hughesdale	0	0.0	0.0	0.0	0.0
Murrumbeena	0	0.0	0.0	0.0	0.0
Ormond - Glen Huntly	0	0.0	0.0	0.0	0.0
Aspendale Gardens - Waterways	0	0.0	0.0	0.0	0.0
Braeside	209	0.0	0.0	0.0	0.5
Carrum - Patterson Lakes	84	0.0	0.7	0.0	0.0
Chelsea - Bonbeach	0	0.0	0.0	0.0	0.0

Table 2 Economic outcome of additional bus services (continued)					
SA2	Total daily one-way journey to work trips by residents	Additional household income from net increased household hours of work ($2011m)	Additional household income from reduction in fixed cost of motor vehicle ($2011m)	Additional household income from net increased labour productivity ($2011m)	Peak hour congestion costs ($2011m)
Chelsea Heights	0	0.0	0.0	0.0	0.0
Cheltenham - Highett (East)	0	0.0	0.0	0.0	0.0
Edithvale - Aspendale	0	0.0	0.0	0.0	0.0
Mentone	0	0.0	0.0	0.0	0.0
Moorabbin - Heatherton	13	0.0	0.1	0.0	0.1
Moorabbin Airport	0	0.0	0.0	0.0	0.0
Mordialloc - Parkdale	0	0.0	0.0	0.0	0.0
Malvern - Glen Iris	0	0.0	0.0	0.0	0.0
Malvern East	0	0.0	0.0	0.0	0.0
Bundoora - East	0	0.0	0.0	0.0	0.0
Greensborough	125	0.3	0.7	0.1	0.2
Heidelberg - Rosanna	0	0.0	0.0	0.0	0.0
Heidelberg West	0	0.0	0.0	0.0	0.0
Ivanhoe	0	0.0	0.0	0.0	0.0
Ivanhoe East - Eaglemont	0	0.0	0.0	0.0	0.0
Montmorency - Briar Hill	0	0.0	0.0	0.0	0.0
Viewbank - Yallambie	0	0.0	0.0	0.0	0.0
Watsonia	0	0.0	0.0	0.0	0.0
Kingsbury	0	0.0	0.0	0.0	0.0
Preston	142	0.7	0.5	0.4	0.3
Reservoir - East	4	0.0	0.0	0.0	0.0
Reservoir - West	125	0.5	0.6	0.1	0.3
Eltham	125	0.3	0.8	0.1	0.4
Hurstbridge	57	0.2	0.5	0.0	0.2
Kinglake	0	0.0	0.0	0.0	0.0
Panton Hill - St Andrews	0	0.0	0.0	0.0	0.0
Plenty - Yarrambat	42	0.4	0.4	0.1	0.2
Research - North Warrandyte	0	0.0	0.0	0.0	0.0
Wattle Glen - Diamond Creek	125	0.4	0.9	0.0	0.3
Bundoora - North	0	0.0	0.0	0.0	0.0
Bundoora - West	0	0.0	0.0	0.0	0.0
Epping	171	0.5	1.0	0.2	0.5
Lalor	4	0.0	0.0	0.0	0.0
Mill Park - North	4	0.0	0.0	0.0	0.0
Mill Park - South	0	0.0	0.0	0.0	0.0
South Morang	541	5.4	4.1	0.7	2.5
Thomastown	21	0.1	0.2	0.1	0.0
Wallan	68	0.9	0.8	0.1	0.6
Whittlesea	0	0.0	0.0	0.0	0.0
Airport West	0	0.0	0.0	0.0	0.0
Essendon Airport	17	0.0	0.0	0.0	0.0
Keilor	0	0.0	0.0	0.0	0.0

Table 2 Economic outcome of additional bus services (continued)					
SA2	Total daily one-way journey to work trips by residents	Additional household income from net increased household hours of work ($2011m)	Additional household income from reduction in fixed cost of motor vehicle ($2011m)	Additional household income from net increased labour productivity ($2011m)	Peak hour congestion costs ($2011m)
Keilor East	0	0.0	0.0	0.0	0.0
Niddrie - Essendon West	0	0.0	0.0	0.0	0.0
Strathmore	0	0.0	0.0	0.0	0.0
Gisborne	0	0.0	0.0	0.0	0.0
Macedon	0	0.0	0.0	0.0	0.0
Riddells Creek	0	0.0	0.0	0.0	0.0
Romsey	0	0.0	0.0	0.0	0.0
Coburg North	0	0.0	0.0	0.0	0.0
Fawkner	0	0.0	0.0	0.0	0.0
Glenroy - Hadfield	90	0.3	0.4	0.0	0.1
Pascoe Vale	0	0.0	0.0	0.0	0.0
Sunbury	0	0.0	0.0	0.0	0.0
Sunbury - South	42	0.3	0.3	0.0	0.2
Broadmeadows	0	0.0	0.0	0.0	0.0
Campbellfield - Coolaroo	0	0.0	0.0	0.0	0.0
Craigieburn - Mickleham	58	0.3	0.3	0.0	0.1
Gladstone Park - Westmeadows	0	0.0	0.0	0.0	0.0
Greenvale - Bulla	0	0.0	0.0	0.0	0.0
Meadow Heights	23	0.0	0.2	0.0	0.0
Melbourne Airport	0	0.0	0.0	0.0	0.0
Roxburgh Park - Somerton	0	0.0	0.0	0.0	0.0
Tullamarine	0	0.0	0.0	0.0	0.0
Bayswater	0	0.0	0.0	0.0	0.0
Boronia - The Basin	0	0.0	0.0	0.0	0.0
Ferntree Gully	0	0.0	0.0	0.0	0.0
Knoxfield - Scoresby	0	0.0	0.0	0.0	0.0
Lysterfield	0	0.0	0.0	0.0	0.0
Rowville - Central	0	0.0	0.0	0.0	0.0
Rowville - North	4	0.0	0.0	0.0	0.0
Rowville - South	0	0.0	0.0	0.0	0.0
Wantirna	0	0.0	0.0	0.0	0.0
Wantirna South	0	0.0	0.0	0.0	0.0
Donvale - Park Orchards	0	0.0	0.0	0.0	0.0
Warrandyte - Wonga Park	0	0.0	0.0	0.0	0.0
Bayswater North	0	0.0	0.0	0.0	0.0
Croydon	0	0.0	0.0	0.0	0.0
Croydon Hills - Warranwood	0	0.0	0.0	0.0	0.0
Ringwood	0	0.0	0.0	0.0	0.0
Ringwood East	125	0.5	0.6	0.1	0.4
Ringwood North	0	0.0	0.0	0.0	0.0
Forest Hill	0	0.0	0.0	0.0	0.0

Table 2 Economic outcome of additional bus services (continued)					
SA2	Total daily one-way journey to work trips by residents	Additional household income from net increased household hours of work ($2011m)	Additional household income from reduction in fixed cost of motor vehicle ($2011m)	Additional household income from net increased labour productivity ($2011m)	Peak hour congestion costs ($2011m)
Mitcham (Vic.)	0	0.0	0.0	0.0	0.0
Nunawading	0	0.0	0.0	0.0	0.0
Vermont	0	0.0	0.0	0.0	0.0
Vermont South	0	0.0	0.0	0.0	0.0
Belgrave - Selby	0	0.0	0.0	0.0	0.0
Chirnside Park	0	0.0	0.0	0.0	0.0
Healesville - Yarra Glen	157	2.1	2.8	0.5	0.7
Kilsyth	0	0.0	0.0	0.0	0.0
Lilydale - Coldstream	57	1.0	0.6	0.5	0.4
Monbulk - Silvan	0	0.0	0.0	0.0	0.0
Montrose	0	0.0	0.0	0.0	0.0
Mooroolbark	0	0.0	0.0	0.0	0.0
Mount Dandenong - Olinda	0	0.0	0.0	0.0	0.0
Mount Evelyn	0	0.0	0.0	0.0	0.0
Upwey - Tecoma	0	0.0	0.0	0.0	0.0
Wandin - Seville	0	0.0	0.0	0.0	0.0
Yarra Valley	0	0.0	0.0	0.0	0.0
Beaconsfield - Officer	0	0.0	0.0	0.0	0.0
Bunyip - Garfield	0	0.0	0.0	0.0	0.0
Emerald - Cockatoo	0	0.0	0.0	0.0	0.0
Koo Wee Rup	0	0.0	0.0	0.0	0.0
Pakenham - North	57	0.8	0.6	0.2	0.6
Pakenham - South	0	0.0	0.0	0.0	0.0
Berwick - North	125	1.3	1.2	0.4	0.7
Berwick - South	84	0.1	0.7	0.0	0.1
Doveton	0	0.0	0.0	0.0	0.0
Endeavour Hills	4	0.0	0.0	0.0	0.0
Hallam	0	0.0	0.0	0.0	0.0
Narre Warren	0	0.0	0.0	0.0	0.0
Narre Warren North	0	0.0	0.0	0.0	0.0
Cranbourne	125	1.3	1.0	0.4	0.8
Cranbourne East	0	0.0	0.0	0.0	0.0
Cranbourne North	334	2.9	2.5	0.3	1.6
Cranbourne South	0	0.0	0.0	0.0	0.0
Cranbourne West	626	3.9	2.9	0.3	2.4
Hampton Park - Lynbrook	251	0.7	1.5	0.1	0.6
Lynbrook - Lyndhurst	543	2.4	2.5	0.5	1.7
Narre Warren South	626	2.2	4.4	0.1	1.8
Pearcedale - Tooradin	0	0.0	0.0	0.0	0.0
Clarinda - Oakleigh South	0	0.0	0.0	0.0	0.0
Clayton South	0	0.0	0.0	0.0	0.0
Dandenong	125	0.8	0.6	2.8	0.4

Table 2 Economic outcome of additional bus services (continued)					
SA2	Total daily one-way journey to work trips by residents	Additional household income from net increased household hours of work ($2011m)	Additional household income from reduction in fixed cost of motor vehicle ($2011m)	Additional household income from net increased labour productivity ($2011m)	Peak hour congestion costs ($2011m)
Dandenong North	0	0.0	0.0	0.0	0.0
Dingley Village	0	0.0	0.0	0.0	0.0
Keysborough	585	3.3	3.5	1.4	2.4
Noble Park	0	0.0	0.0	0.0	0.0
Noble Park North	0	0.0	0.0	0.0	0.0
Springvale	0	0.0	0.0	0.0	0.0
Springvale South	0	0.0	0.0	0.0	0.0
Ashwood - Chadstone	0	0.0	0.0	0.0	0.0
Clayton	0	0.0	0.0	0.0	0.0
Glen Waverley - East	125	0.3	0.6	0.1	0.2
Glen Waverley - West	0	0.0	0.0	0.0	0.0
Mount Waverley - North	125	0.3	0.6	0.0	0.1
Mount Waverley - South	0	0.0	0.0	0.0	0.0
Mulgrave	0	0.0	0.0	0.0	0.0
Oakleigh - Huntingdale	57	0.4	0.2	0.2	0.1
Wheelers Hill	0	0.0	0.0	0.0	0.0
Ardeer - Albion	0	0.0	0.0	0.0	0.0
Cairnlea	0	0.0	0.0	0.0	0.0
Deer Park - Derrimut	0	0.0	0.0	0.0	0.0
Delahey	0	0.0	0.0	0.0	0.0
Keilor Downs	0	0.0	0.0	0.0	0.0
Kings Park (Vic.)	0	0.0	0.0	0.0	0.0
St Albans - North	0	0.0	0.0	0.0	0.0
St Albans - South	0	0.0	0.0	0.0	0.0
Sunshine	0	0.0	0.0	0.0	0.0
Sunshine North	0	0.0	0.0	0.0	0.0
Sunshine West	0	0.0	0.0	0.0	0.0
Sydenham	0	0.0	0.0	0.0	0.0
Taylors Lakes	0	0.0	0.0	0.0	0.0
Altona	0	0.0	0.0	0.0	0.0
Altona Meadows	213	0.8	1.1	0.1	0.8
Altona North	0	0.0	0.0	0.0	0.0
Newport	0	0.0	0.0	0.0	0.0
Seabrook	0	0.0	0.0	0.0	0.0
Williamstown	0	0.0	0.0	0.0	0.0
Braybrook	0	0.0	0.0	0.0	0.0
Footscray	81	0.2	0.2	0.2	0.1
Maribyrnong	0	0.0	0.0	0.0	0.0
Seddon - Kingsville	0	0.0	0.0	0.0	0.0
West Footscray - Tottenham	0	0.0	0.0	0.0	0.0
Yarraville	0	0.0	0.0	0.0	0.0
Bacchus Marsh	0	0.0	0.0	0.0	0.0

Table 2 Economic outcome of additional bus services (continued)					
SA2	Total daily one-way journey to work trips by residents	Additional household income from net increased household hours of work ($2011m)	Additional household income from reduction in fixed cost of motor vehicle ($2011m)	Additional household income from net increased labour productivity ($2011m)	Peak hour congestion costs ($2011m)
Caroline Springs	0	0.0	0.0	0.0	0.0
Hillside	0	0.0	0.0	0.0	0.0
Melton	0	0.0	0.0	0.0	0.0
Melton South	0	0.0	0.0	0.0	0.0
Melton West	42	0.3	0.4	0.0	0.2
Rockbank - Mount Cottrell	42	1.6	1.5	1.6	0.2
Taylors Hill	0	0.0	0.0	0.0	0.0
Hoppers Crossing - North	0	0.0	0.0	0.0	0.0
Hoppers Crossing - South	0	0.0	0.0	0.0	0.0
Laverton	0	0.0	0.0	0.0	0.0
Point Cook	0	0.0	0.0	0.0	0.0
Tarneit	0	0.0	0.0	0.0	0.0
Truganina	0	0.0	0.0	0.0	0.0
Werribee	0	0.0	0.0	0.0	0.0
Werribee - South	0	0.0	0.0	0.0	0.0
Wyndham Vale	0	0.0	0.0	0.0	0.0
Carrum Downs	334	8.2	3.1	3.6	2.2
Frankston	0	0.0	0.0	0.0	0.0
Frankston North	84	0.1	0.8	0.0	0.1
Frankston South	84	0.1	1.0	0.0	0.1
Langwarrin	46	0.1	0.9	0.0	0.1
Seaford (Vic.)	0	0.0	0.0	0.0	0.0
Skye - Sandhurst	0	0.0	0.0	0.0	0.0
Dromana	167	2.5	3.4	0.6	1.2
Flinders	0	0.0	0.0	0.0	0.0
Hastings - Somers	0	0.0	0.0	0.0	0.0
Mornington	418	6.5	5.7	2.7	2.2
Mount Eliza	221	2.5	2.6	0.5	0.8
Mount Martha	0	0.0	0.0	0.0	0.0
Point Nepean	0	0.0	0.0	0.0	0.0
Rosebud - McCrae	313	12.5	9.2	9.5	3.2
Somerville	0	0.0	0.0	0.0	0.0
Total	**8725**	**72.6**	**73.7**	**29.6**	**33.7**

Appendix A: The estimated equations

The route assessment is carried out using three equations estimated by using data from the 2011 Census. The data was for the SA2 regions for Melbourne and nearby regions. Subsequently, it would have been desirable to use pooled time series cross-section data from earlier Census. However, because of the region changes a considerable amount of work would be needed to obtain a consistent data base. This would have to be part of further research validating the results of this paper.

A.1 The resident hours equation

The estimated resident hours equation is:

$$\begin{aligned} ln(RHW_i / AW_i) \quad &= 1.862 \\ &+ 0.406 \times ln(CTIWH_i / CAW_i) \\ &\quad (4.5) \\ &+ 0.074 \times ln(ECTIWH_i / CTIWH_i) \\ &\quad (2.7) \\ &+ 0.419 \cdot ln(SMV_i / AW_i) \\ &\quad (7.9) \end{aligned} \qquad (1)$$

R2 = 0.22

Where:

RHW_i = Hours worked by residents per capita of available workforce for SA2 *i* in 2011.

AW_i = Available workforce for SA2 *i* in 2011.

$CTIWH_i$ = Hours of work available from industry in the labour market catchment for SA2 *i* in 2011 based on unconstrained travel times.

CAW_i = Available workforce in catchment for SA2 *i* in 2011.

$ECTIWH_i$ = Effective hours of work available from industry in the labour market catchment for SA2 *i* in 2011 based on actual travel patterns.

SMV_i = Stock of motor vehicles owned by residents of SA2 *i* in 2011.

ln Denotes natural logarithm.

The central coefficient from equation (1) is the 0.074 elasticity, or the elasticity of residential hours to changes in the effective labour market catchment to the unconstrained labour market catchment. Additional bus routes increase the effective labour market catchment.

Data limitations prevent, at this stage, the development of a fully specified model. Equation (1) is best thought of as a quasi reduced form equation capturing the combination of additional resident market access and employer supply expansion decisions.

A.2 Industry productivity

The estimated equation for industry productivity, or $per hour of work, is:

$$\begin{aligned} ln(DPH_i) \quad &= -1.959 + 1.110\ ln(ISP_i) \\ &\quad (7.5) \quad (15.9) \\ &+ 0.048\ .\ ln(ECTIWH_i) \\ &\quad (4.3) \\ &+ 0.155\ ODN \\ &\quad (15.3) \\ &- 0.175\ ODP \\ &\quad (17.0) \end{aligned} \qquad (2)$$

R2 = 0.81

Where:

DPH_i = Dollar per hour paid by industry located in SA2 *i* in 2011.

ISP_i = Industry structure in SA2 *i* weighted by productivity in 2011.

ODP = Positive outlier dummy variable taking the value 1 for outlier positive residuals.

ODN = Negative outlier dummy variable taking the value 1 for outlier negative residuals.

The key coefficient for the analysis from equation (2) is the value of the $ECTIWH_i$ coefficient, or 0.048. Additional bus routes increase the value of the $ECTIWH_i$ variable.

A.3 The stock of motor vehicle equation

The estimated stock of motor vehicles held by residents is given by:

$$\begin{aligned} ln(SMV_i / AW_i) \quad &= 0.046 \\ &\quad (0.8) \\ &- 0.081\ .\ ln(PTT_i / AT_i) \\ &\quad (8.0) \\ &+ 0.204\ .\ ln(DEPPC_i) \\ &\quad (7.0) \\ &+ 0.095\ .\ ODN \\ &\quad (5.8) \\ &- 0.220\ .\ ODP \\ &\quad (10.8) \end{aligned} \qquad (3)$$

R2 = 0.76

Where:

PTT_i = Total public transport trips to work by residents in SA2 *i*.

AT_i = Automobile trips to work by residents in SA2 *i*.

$DEPPC_i$ = Population aged under 18 per capita in SA2 *i* in 2011.

One interesting feature of this equation is the failure of per capita disposable income to be a significant factor in automobile ownership. The key parameter from equation (3), in terms of estimating the impact of additional bus routes, is the -0.081 elasticity, or how the stock of motor vehicle changes as the public transport trips to work increase relative to automobile trips.

A.4 Data measurement issues

Most of the data is taken directly from the Census data, including travel to work data by mode.

The *CTIWH* variable is based on an unconstrained travel time in minutes given the distance. For SA2s with an unconstrained travel time of less than 30 minutes the weight is 1. The weight then declines in a concave fashion for travel times up to 50 minutes. Zero weights then apply for travel times over 50 minutes. To calculate *CTIWH* for SA2 *i* the relevant hours of work from industry available in SA2 *j* is multiplied by the coefficient 1, 0, or between 0 and 1 obtained from the unconstrained travel times between SA2 *i* and SA2 *j*. The results are then summed for SA2 *i*.

The *ECTIWH* was obtained by the share of total public transport and automobile trips to work for residents in SA2 *i* travelling to SA2 *j* multiplied by the total hours of work available from industry in SA2 *j* and summing the results for all the SA2s.

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