THE ECONOMIC VALUE OF BUS SERVICES TO THE VICTORIAN ECONOMY AND THE BENEFITS OF EXPANSION IN THOSE SERVICES

A report for the
BUS ASSOCIATION VICTORIA INC.

Prepared by
National Institute of Economic and Industry Research

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Executive summary: The economic value of bus services

E.1 The study objective

The study objective is to:

- build a data base suitable for analysing the contribution of bus services to the Victorian economy;
- use the data base to interrogate how the economy responds to the availability of bus services;
- develop a model framework to enable an overall assessment of the value of bus services to the economy;
- identify the economic contribution bus services make to the Victorian economy, that is, the contribution to employment, gross product and other indicators;
- use the model to explore:
  - the increase in the contribution bus services would make to the Victorian economy if bus services frequency was enhanced, or more precisely doubled;
  - assess the benefits from greater social inclusion from the extension of bus services; and
- compare the benefits of increased benefits from bus frequency increases to the benefits obtained from other rail and road public transport infrastructure investments.

Bus trips are undertaken for many reasons including education, shopping, entertainment, socialisation, and access to services, such as health, etc. This study focuses on one bus trip purpose, namely a trip to gain access to a place of employment. Employment trips form a relatively small part of total bus trips on any given work day. Bus boardings for employment purposes would constitute approximately 26 per cent of total bus boardings, or around 31.2 million annually in Melbourne. Total employment bus trips in Victoria per average work day are estimated at 70,000 of which 65,000 are in Melbourne. Total daily boardings for a complete work trip are 130,000 with the 31.2 million annual work trips consistent with an average work year of 240 days in Melbourne.

The monetary value is given in this study in terms of cvm prices which represent the price base for the 2018-19 fiscal year. Industry employment is the employment opportunities within the boundaries of a region. Resident employment is the number of the employed population who live in a region.

The most important aspect to keep in mind when reading this report is that it is probably the first time bus services have been evaluated with the methodology applied in this study, which positions bus services within a dynamic growing economy. Therefore the general expectation should be for conclusions that are different in scale and scope from the conclusions reached by traditional methodologies.

The methodology applied has been enabled by the highly disaggregated regional database employed for the analysis of 14,073 regions. Outside the rural areas, this has enabled the selection of regions which in the main correspond to a bus stop catchment, with the individual bus stop catchments linked to industrial activity within that catchment. Further the empirical rules developed for how the economy responds to bus services are securely anchored in the actual data of the regions, not in assumptions adopted from other studies or indeed from the modal choice decision-making frameworks that are often imposed in other studies. As a result there is no limit on the dynamic responses that can be induced by the availability of bus services.

E.2 The theoretical framework of the analysis

The theoretical framework for this study is the role of agglomeration economics in regional economic development. Agglomeration economics revolves around the role of industry clusters and the economic benefits of having high concentrations of industry activity in a regional area, defined in terms of with low travel times between the individual entities. The industry concentrations apply within individual industries and extend to groups of allied industries, whether as customers for goods and services, input suppliers or indeed any other related industries, in particular, so-called knowledge creation industries. The economic benefits to each enterprise forming the cluster may include:

(a) lower input costs from reduced communication and logistic costs;

(b) higher productivity from returns to scale and scope, both for individual entities and for the cluster as a whole;

(c) high productivity from the concentration of highly skilled workers attracted to live within commuting range of the cluster because the higher productivity will allow higher relative wage rates as well as a diverse range of employment opportunities;

(d) high long-run productivity growth from higher innovation capacity due to:

  (i) high availability of so-called knowledge-based workers essential for sustained innovation;

  (ii) the greater the industry concentration the more likely that both public (universities) and private (research organisations) will be available to support innovation in the application of codified and tacit knowledge.

On the basis of success breeds success, regions which pass certain thresholds of scale and scope of industry concentration will experience a virtuous cycle of growth by which past growth attracts new enterprises and a skilled workforce to maintain growth and development.

These dynamics are captured in the empirical model framework used for this study. However, there is perhaps a more important driver that is at the centre of the analysis. This deals with the role of labour market catchments.

Research in agglomeration economics generally focuses on calculating the benefits from regional industry concentration at a point in time. The empirical rules developed in this study are not inconsistent with the empirical findings of other studies. That is, the elasticity of productivity with respect to industry scale of between 0.06 and 0.08 derived herein is fully consistent with findings made from other jurisdictions (which typically use effective economic density as their measure of economic concentration).

This study, however, takes a step further back and seeks to identify the factors that brought existing concentrations into existence. The analysis of time series data identifies the key role of labour market catchments, or more correctly, the scale of the available labour force that can reach a given region whether from the local region or from other regions within commuting distance.

Given land use constraints, the concentration of industries in a region is largely determined by the relative scale and scope of the labour force catchment for the region and the growth over time of its labour force catchment, as determined by the working age population resident in the catchment areas and their incentive to enter the workforce. The catchment area is in turn determined by travel times, given that there are upper limits to acceptable travel times for journeys to work and also for journeys between workplaces, as producing entities interact within their local catchments.

The most important determinant of catchment scale is motor vehicle travel times. However, as populations and employment concentration increase in a given metropolitan area, congestion reduces travel speeds and car-parking costs rise, increasing demand for public transport. Once congestion costs and related motor vehicle costs pass certain thresholds, further regional growth will require the availability of public transport, that is, rail, buses and trams.

The focus of this study is on quantifying labour force catchments by micro-scale employment regions and so determining the role of public transport in general and bus services in particular in influencing catchment scale. The study then investigates the role of catchment scale in driving outcomes for industry concentrations.

The clear conclusion from the study, and what is perhaps a unique contribution of the study, is that it identifies that the role of public passenger transport investment in particular is critically strategic in explaining Victorian economic development. Put simply, and as is demonstrated by a counterfactual example given in chapter 3 of the report, without public-sector infrastructure passenger investment the distribution of economic activity within Victoria would be much more decentralised at the cost of lower per capita Victorian employment and even lower the capita real incomes (and productivity).

It's public passenger transport infrastructure including bus services which makes the dense industry concentrations of economic activity in the central Melbourne regions possible and it's the dense industry concentrations of economic activity in the central Melbourne regions that makes it possible for Victoria to extract large benefits from agglomeration economics. It's also public passenger transport infrastructure including bus services that allows the population of Victoria to be concentrated in Melbourne and its adjacent regions to the extent necessary so as to support the dense industrial concentrations of economic activity in Central Melbourne. It is this dynamic which is at the centre of the quantified conclusions of this study in relation to the economic benefits of bus services and what makes the study results unique in terms of scale and scope compared to more traditional studies. To illustrate: Melbourne would not have its CBD without the extensive public transport network on which it relies and on which its productivity depends.

Over the last one hundred years with the end result being final outcome as at 2020 is the cumulative outcome of thousands of marginal increments to the public transport capital stock. Logic demands that evaluations of the marginal increments to the 2020 public transport capital stock incorporate the actual dynamics that have operated in the past one hundred years. He study is unique in seeking to pursue an approach along these general lines.

The approach taken in this study is the antithesis of the consumer-producer surplus approach to transport infrastructure evaluation. It is firmly focused on the role of public transport infrastructure in driving regional economic development and quantifying the virtuous cycle created by a given transport infrastructure investment, that can magnify the initial response to an investment multiple times over a two to three decade period.

E.3 The regional dimension

Two types of regional configuration for Victoria are used in this study based on Australian Bureau of Statistics' geographical definitions. The first is the division of the state into 462 SA2 regions and the second the SA2 regions into 14,073 SA1 regions. Catchment analysis is carried out at the SA1 level since, in the metropolitan area and in provincial towns, the catchment of the typical SA1 reasonably corresponds to the catchment of a bus stop as defined by walking distance. In 2020 there were, on average, 171 occupied dwellings per SA1. SA1 boundaries are drawn to minimise variation around this average, and in 2020 the standard deviation of the number of occupied dwellings per SA1 was 115.

E.4 The study data base

A not insignificant amount of resources for this project went in constructing a time series database for the SA2 and SA1 regions. In order to provide the project with the necessary data inputs, time series estimates of industry employment (i.e. employment by place of work) for each of the 19 1-digit Australian Bureau of Statistics (ABS) ANZSIC industries were prepared. This involved estimating employment at workplaces in each SA1 from 2001 to 2020, a task which has not been attempted before in Victoria to the best our knowledge. Time series data for many other variables, such as employment by place of residence, population structure, household income from work, unemployment, participation rates, etc. also had to be developed for the 14,073 regions. However, this was a relatively easy task, since Census benchmark estimates were available for these series.

E.5 The calculation of catchment values

Each SA1 has a catchment, or area lying within acceptable commuting distance. From the point of view of employers in the SA1, this is the area from which they can draw labour and, from the point of view of residents in the SA1, the area where they can seek work. Catchment boundaries reflect available transport, which in this study comprise motor vehicles and public transport. The calculation of catchment values, such as the number of potential employees within the catchment, requires the estimation of travel times between each pair of SA1s by motor vehicle and by public transport, a major undertaking. Public transport includes buses, trams and trains. From some SA1s the public transport catchment is defined by all-bus journeys but in many of them catchment boundaries are determined by multi-modal travel.

Once all travel times had been calculated the labour force catchments were estimated. The catchment calculations for motor vehicles and public transport were then combined, taking into account the share of public transport in work travel in both origin and destination SA1s.

Figures E.1(a) and E.1(b) show the public transport network in Victoria and Greater Melbourne respectively. Figure E.1(a) indicates that the public transport network, not surprisingly, is confined to regional centres. Figure E.1(b) indicates that, for most outer Melbourne SA1s and for the majority of Melbourne, the bus network is the sole provider of public transport services. The potential importance of the bus network can be seen from the fact that seventy one per cent of SA1s have a bus stop, compared to only 15 per cent which have another public transport stop (rail and trams).

Figure E.2(a) shows the resulting estimated labour force catchment sizes for Victorian SA1s, while Figure E.2(b) shows the catchment sizes for Greater Melbourne SA1s.

In country SA1s, coloured red, the catchment labour force is between zero and 235,000. For the SA1s on the outer metropolitan periphery the within-catchment labour force is generally between 0.64 and 1.67 million, rising to between 1.67 and 2.7 million in the inner Metropolitan regions.

Figure E.1(a): Public transport network access within 400m – Victoria

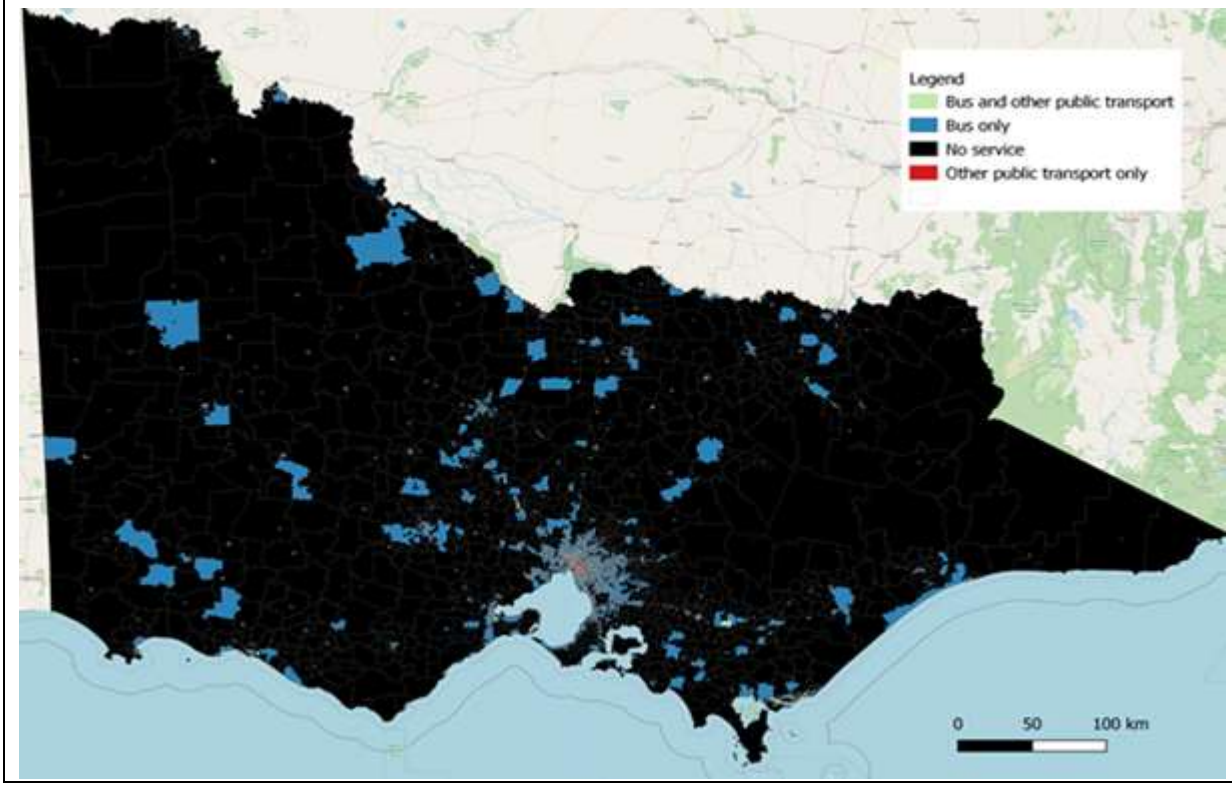


Figure E.1(b): Public transport network access within 400m – Greater Melbourne

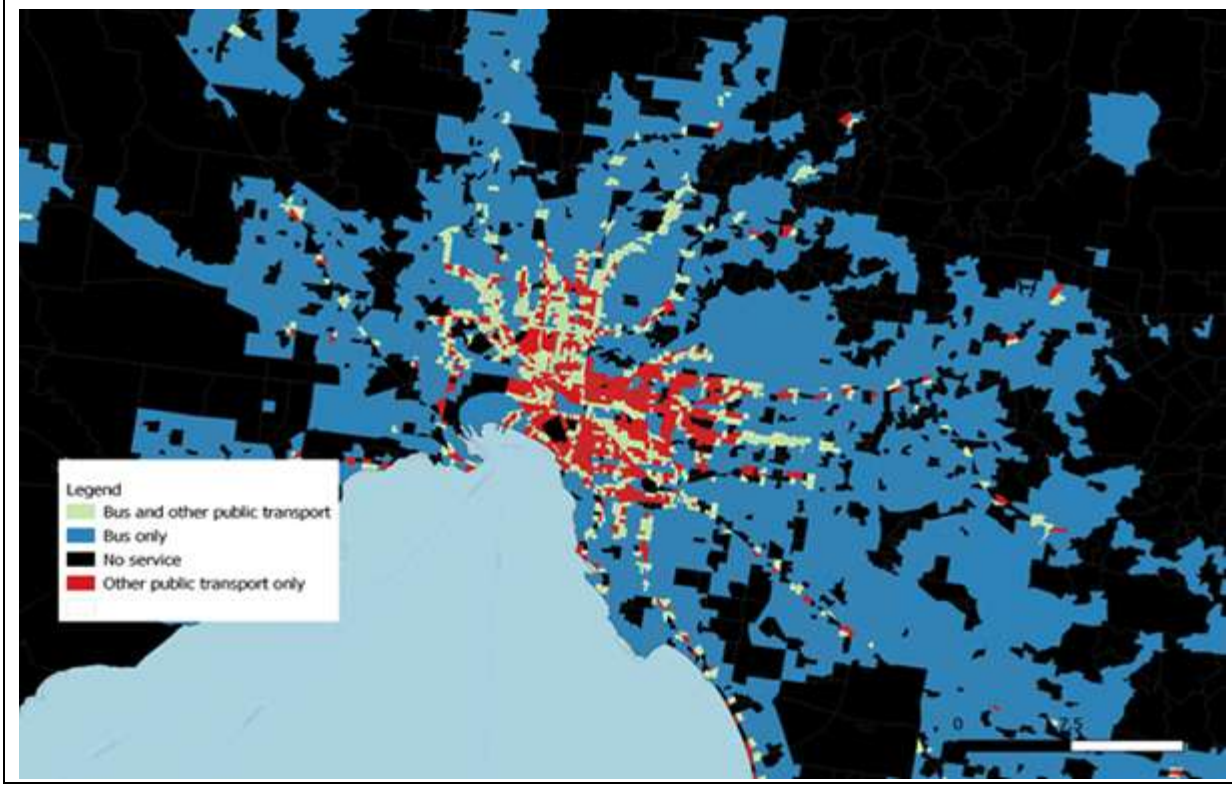


Figure E.2(a): Labour force SA1 catchment, 2020 – Greater Melbourne ('000)

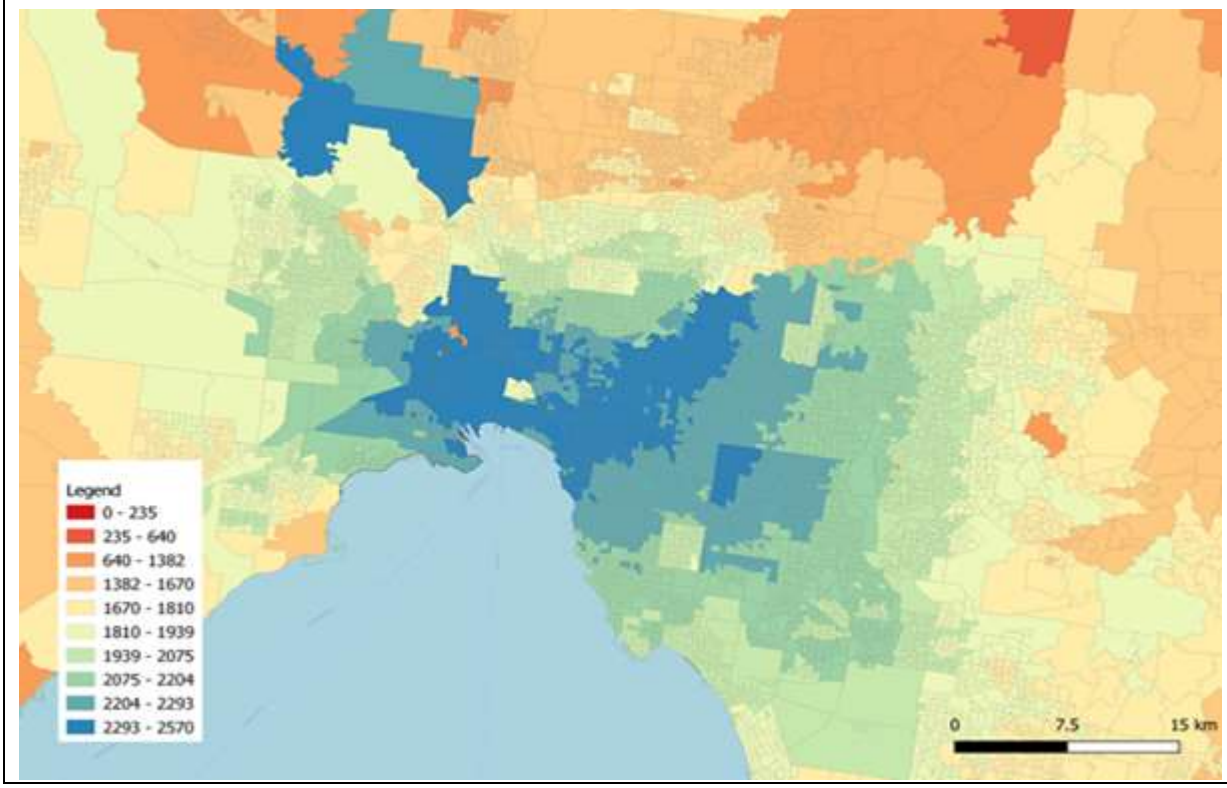
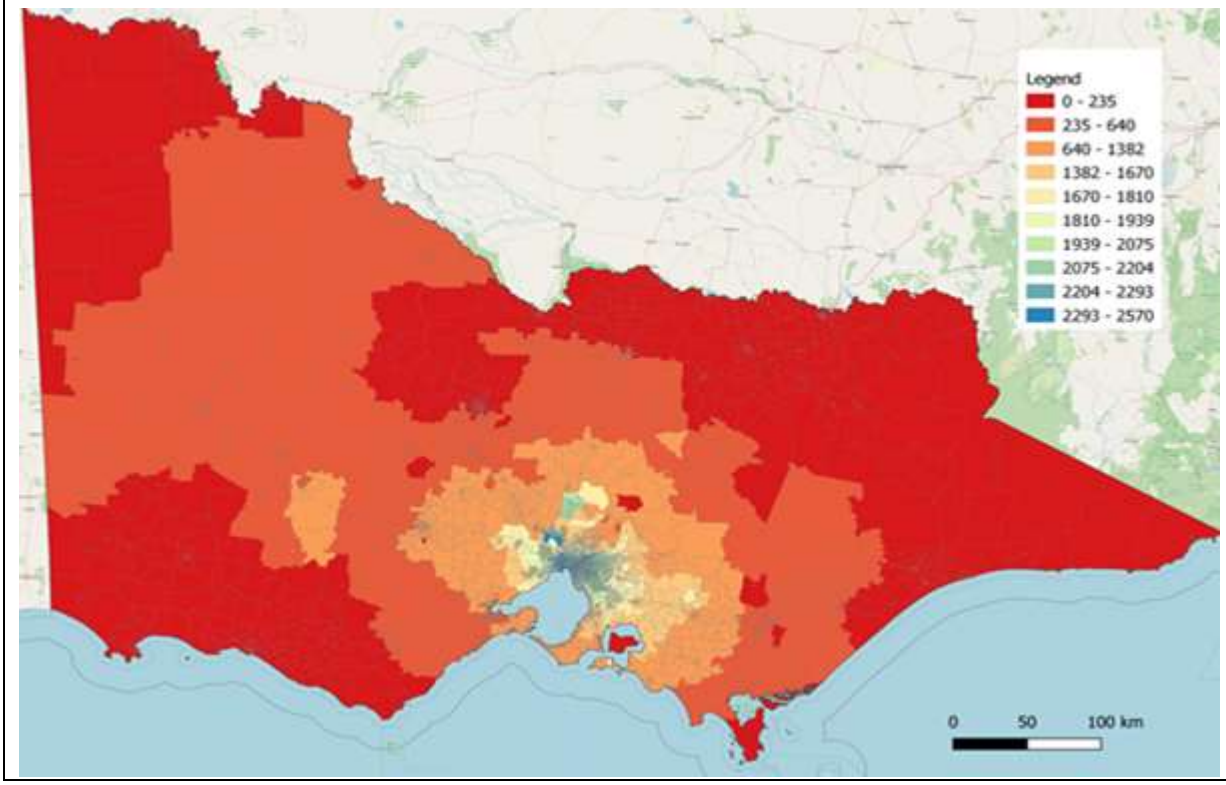


Figure E.2(b): Labour force SA1 catchment, 2020 – Victoria ('000)



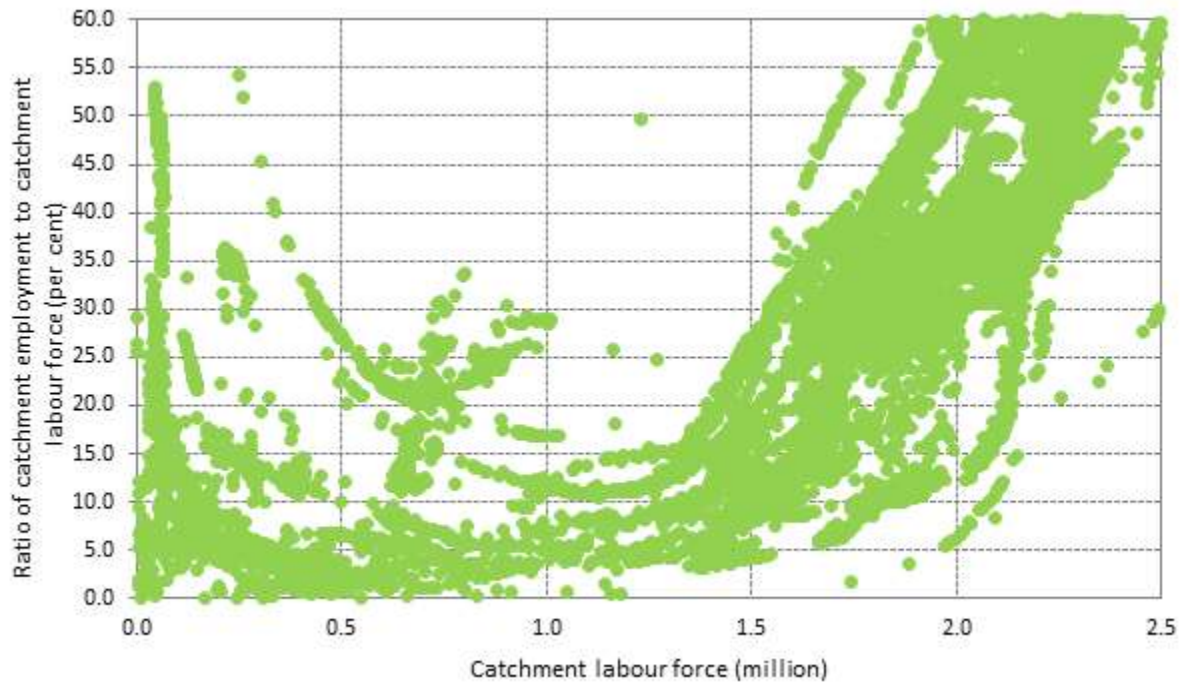
E.6 The importance of catchment scale to industry concentration

The data analysis in this report clearly shows the importance of catchment scale to industry concentrations for all of the 17 non-agriculture and non-mining ANZSIC 1-digit industries. This can be seen from Figure E.3. The figure shows the ratio of catchment industry employment to catchment labour force plotted against catchment labour force scale. This ratio is designated the industry concentration ratio. After a catchment labour force scale of 1.5 million, the industry concentration ratio increases sharply for further increase in catchment scale. As this report indicates, after 1.5 million the elasticity of industry employment with respect to catchment labour force catchment size is between 2 and 3.

The dots along the y axis with negligible labour force catchment represent non-metropolitan regions with mines or labour intensive agriculture activity. Agriculture and mining are not sensitive to labour force catchment scales. The dots between 10 and 35 y axis and 0.5 and 1.0 x axis generally represent nonmetropolitan centres more than 150 kilometres from Melbourne.

Figure E.3 is the most important empirical relationship underpinning the study results. It shows that outside special case nonmetropolitan regions, industry concentration (per cent of labour force) is highly elastic with respect to catchment labour force scale. A lower scale implies lower employment per labour force catchment and therefore lower overall Victorian employment per capita of working age population and, because of the operation of agglomeration economics, even lower household work income per capita of working age population (and lower productivity).

Figure E.3: Industry employment – Total



E.7 The positive feedback loops: From increases in catchment labour force scale to increases in employment and economic activity

Catchment scale can be increased by improving the quality of transport services, for example by increasing the frequency of bus services. Several feedback loops then interact to magnify the impact of the change in catchment scale on employment and economic activity. The initial impact will revolve around employment and productivity gains from more efficient organisation of the labour market, with skill shortages being wholly or partly eliminated and a better matching of skills available with skills required. This effect will be enhanced by including individuals who have withdrawn from the workforce, because of a lack transport options, as well as the existing unemployed. This effect will then be magnified by flow-on changes. Over the medium-term capacity expansion investments will be undertaken by local enterprises that were previously constrained by adverse expectations of their labour force catchment over the investment horizon, say the next decade. However, the main driver of capacity installed and employment growth is likely to be enterprises which relocate investment to the region, because the improved catchment enhances its competitiveness compared to where the enterprise is currently operating. In practice, relative expected population growth would be also taken into account. This relocation may come from other SA1s in Victoria, outside Victoria or from overseas. This initial industrial expansion will expand employment which, by itself, will increase catchment labour force scale from two factors:

(i) the increased employment availability will induce persons who have withdrawn from the work force to re-enter the workforce or to participate in it for the first time, increasing the participation rate; and

(ii) working age residents will be attracted to the catchment to exploit changed employment opportunities.

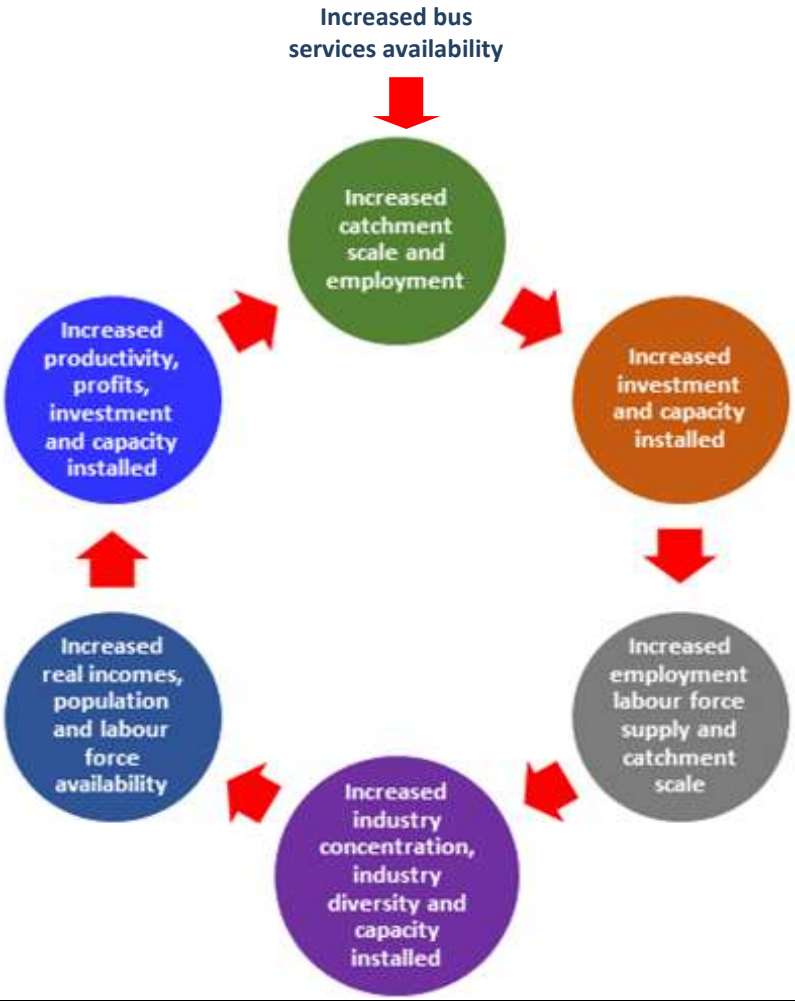
The catchment increases from population growth will be reinforced by the positive feedback loop, running from increasing industry concentration to productivity increases to real income increases to households, further increasing the attractiveness of the region for migration.

The increased industry concentration of the region will attract additional investment and capacity expansion simply because of the opportunity to exploit the productivity benefits of operating in a more highly concentrated industry environment.

Finally, there is the feedback loop from initial increases in productivity that will increase enterprise net cash flows, allowing elevated investment levels for enterprises and hence further capacity expansion employment growth and population increases.

The operation of the positive feedback loops are outlined in Figure E.4.

Figure E.4: The virtuous cycle of the economic response to increased bus services availability



E.8 The economic benefit from increasing the frequency of bus services

To demonstrate the benefits of increased bus services, a doubling of route bus frequencies was assessed. The first step in assessing the impact this might have on the Victorian economy was to estimate, for each SA1, how many residents of SA1s which were previously beyond reasonable commuting time will be added to the labour force within the catchment centred on that SA1.

A Review of the literature led to the conclusion that given Melbourne's structure of public transport services that a "mean" region elasticity of net additional employment related bus trips with respect to bus frequency would be 0.35.

At the individual regional level the increase in effective catchments and hence the response to a doubling of services will depend on three main factors.

(i) There will be no response in SA1s that lack a bus stop. As can be seen from Figure 5.1(b) this is the case for much of country Victoria, and from Figure 5.1(a) some of the fringe areas of Greater Melbourne.

(ii) For SA1s with a bus stop the increase in effective catchment will be high if service improvements significantly improve the competitiveness of bus services vis a vis private motoring. This is likely to be in the mid-range of service frequencies. Doubling frequency is likely to have little effect in areas already well-served by public transport. At the other end of the range, doubling frequency from two to four services a day to may not have a large effect on capturing usage and may not be seen by employers as an effectively expanding catchment.

(iii) The increase in effective catchment will be high if services are improved in SA1s where there is high unemployment and/or low labour force participation.

From these indicators the 0.35 elasticity is adopted as a "mean" value with the actual elasticity for a region obtained by multiplying the 0.35 by the weighted average of the demand indicators (i) to (iii) above relative to the overall average for all regions.

Applying the resulting elasticity to the bus employment trips as per 2020 for a region gave an estimate of the potential increase in employment trips by bus. The potential increase in employment trips was set equal to the increase in the labour force for each region. It was a straight forward calculation to convert the increase in local labour force to increases in a region's labour force catchment using the adjusted travel time matrices as outlined in Chapter 2 in the body of the Report.

Across all SA1s the average direct increase in catchment scale is 0.9 per cent. This represents a 42 per cent increase in the average catchment scale from the initial contribution bus services made to the total catchment scale as at 2019-20. The increases in Greater Melbourne SA1s ranging up to at 1.8 per cent. On a weighted industry employment basis the overall increase is 1.1 per cent in terms of the increased potential labour force availability to a region. It is the flow on effect from this initial perturbation to catchment scale that generate the results outlined below. What the actual increase in employment is will depend on how the model equations for employment respond to the increase in catchment scale.

In terms of the aggregate macroeconomic outcomes on a Victoria-wide basis that flow from the changes in Figure 5.6, after approximately one and a half decades the increase in employment is estimated at 81,550. This can be decomposed into the increases for the three stages. For stage one the increase is 28,319 or a multiplier of 0.40 on the 70,000 part or whole bus employment trips as at 2019-20. The stage two increase from the stage one increase is 31,454, or a multiplier of 1.1 on the stage one results and represents the increase in employment from industry concentration and agglomeration effects. The third stage increase is 21,777 and represents the impact on employment from enhanced labour force availability from increases in the participation rate due to the first two stages increase in employment. The total multiplier from the direct stage one employment increase is 2.9 or 81,550 divided by 28,319. For stage one the initial increase in employment bus trips is 25,400 in stage one and a total increase of 30,000 by stage three.

Overall, total employment increases by 2.4 per cent over 2020 levels and Victorian GSP by $\$_{cvm}$12.1 billion. Labour productivity increases by 0.6 per cent, giving a gross state product increase of 3.0 per cent. The productivity increase represents a $740 annual increase gross product per employed person in Victoria.

Household income from work on a Victoria-wide basis increases by $\$_{cvm}$6.9 billion, or an average of $2,500 per Victorian occupied dwelling or household.

The savings in social security income support measures is $\$_{cvm}$1.2 billion from the reduction in unemployment and the increase in the workforce participation rate.

Figure E.6(a) indicates the change in industry employment by SA1 for Greater Melbourne, while Figure E.6(b) shows the outcome for Victoria as a whole. For Greater Melbourne, excluding the fringe SA1s, the increase in industry employment for the overwhelming majority of SA1s can range up to at least 3.5 per cent. On the Melbourne fringe, that is, within the Metropolitan Statistical Division and in non-metropolitan SA1s, industry employment is likely to fall as enterprises relocate activity to exploit the improved competitiveness of catchments closer to the Melbourne centre. Bus service quality may well improve in these regions, but the quality gap with other regions may well decline as they would more often than not start from a low base.

Only 342, or 2.4 per cent, of the 14,073 SA1s experience an increase in the number unemployed. In part this is due to the out-migration of working age population from those SA1s that experience a decline in unemployment. It however reflects the decline in the participation rate in those SA1s experiencing a decline in employment. Overall, the not in labour force component of the Victorian working age population increases by 48,370 with unemployment declining by 33,830. This is a significant finding.

A measure of the extent of the distribution of the benefits of enhanced bus services would be the number of SA1s that experience an increase in the labour force from a combination of increased working age population and increases in the participation rate. Of the 14,073 SA1s 9,828, or 70 per cent, experience an increase in the labour force.

Figure E.7 shows the change in resident unemployed. For many Greater Melbourne SA1s the fall in the level of unemployed in absolute numbers, is between 1 and 2 for a typical population of less than 200.

The accessed benefits are assumed to be realised over an approximate one and a half decade period.

Stanley et. al. (forthcoming) undertook an allied study to this study by applying a sophisticated modal choice model that had been developed for Sydney which takes into account all transport options in household decision making. Among other issues one aspect that was addressed was the investigation the impact of doubling of bus frequency in Sydney. The conclusion was that over a ten year period to 2033 doubling of bus frequency would lead to an employment trip increase of just under 20,000. This estimate would equal the bus trip component of the stage one employment increase for this study as stage two and stage three flow-on impacts are excluded from the Stanley et. al. study. The stage one Victorian increase of 28,318 would mostly include the employment bus trips, but would also include a relative small increase in non-bus trips for employment. For Melbourne the stage one increase in employment bus trips is estimated at 24,000. Once the Melbourne results are adjusted for, the higher trip elasticities applied in Melbourne relative to Sydney, because of the different structure of the passenger transport system, the two results are similar.

Figure E.5(a): Per cent direct change in catchment scale – Bus services frequency enhancement, 2020 – Greater Melbourne

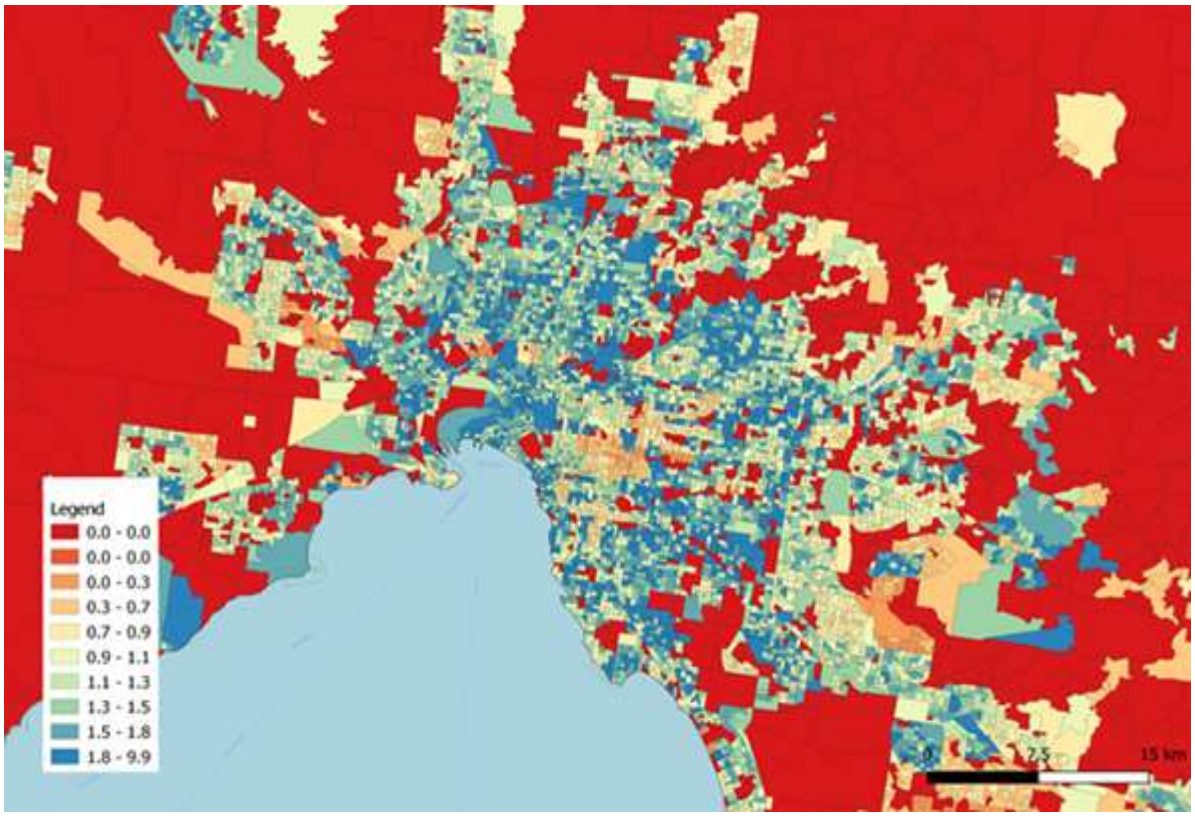


Figure E.5(b): Per cent direct change in catchment scale – Bus services frequency enhancement, 2020 – Victoria

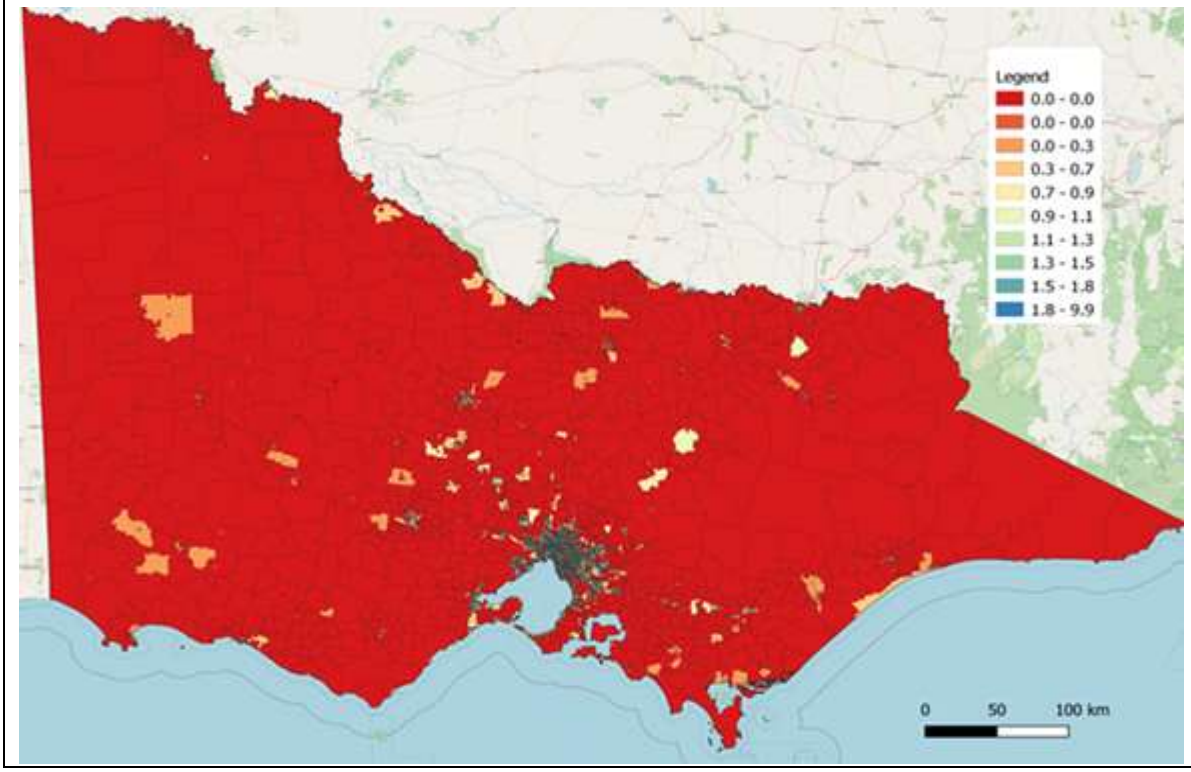


Figure E.6(a): Impact of bus services frequency increase, 2020 – Total industry employment – Greater Melbourne (per cent change from baseline)

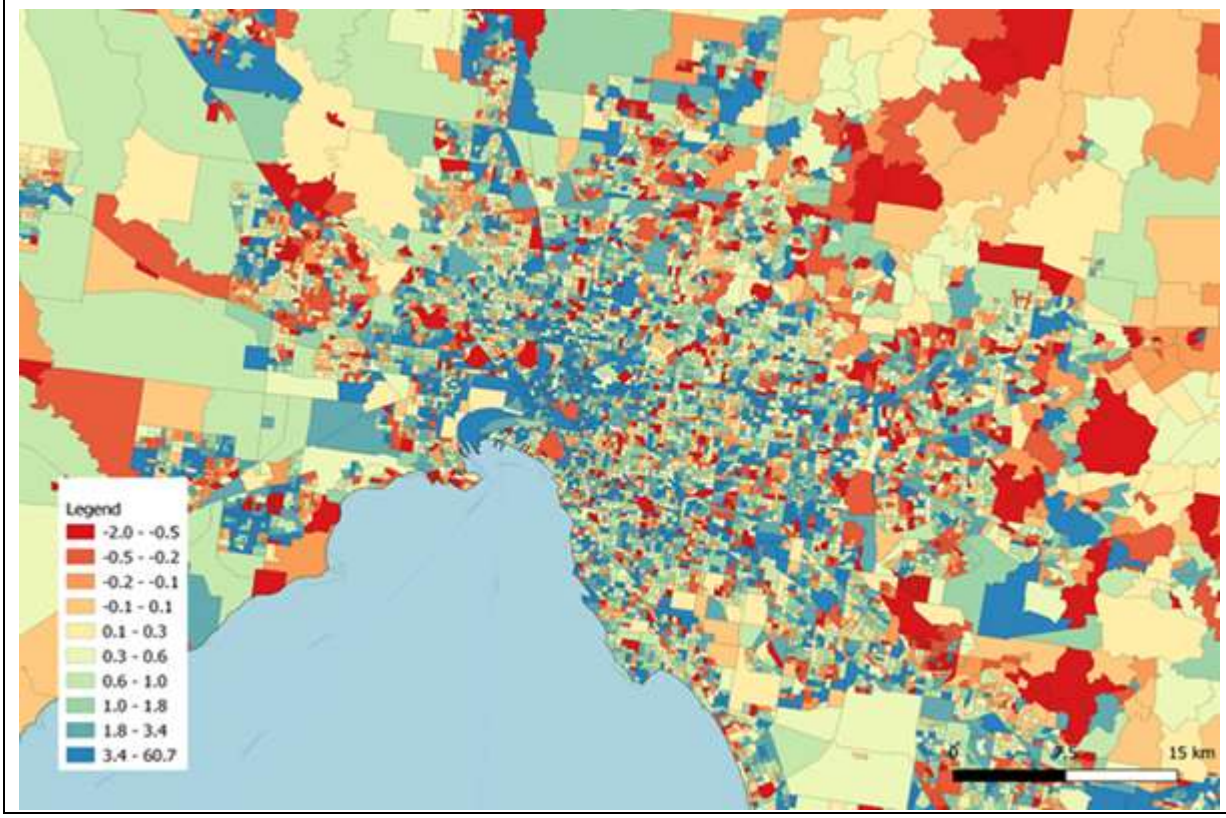


Figure E.6(b): Impact of bus services frequency increase, 2020 – Total industry employment – Victoria (per cent change from baseline)

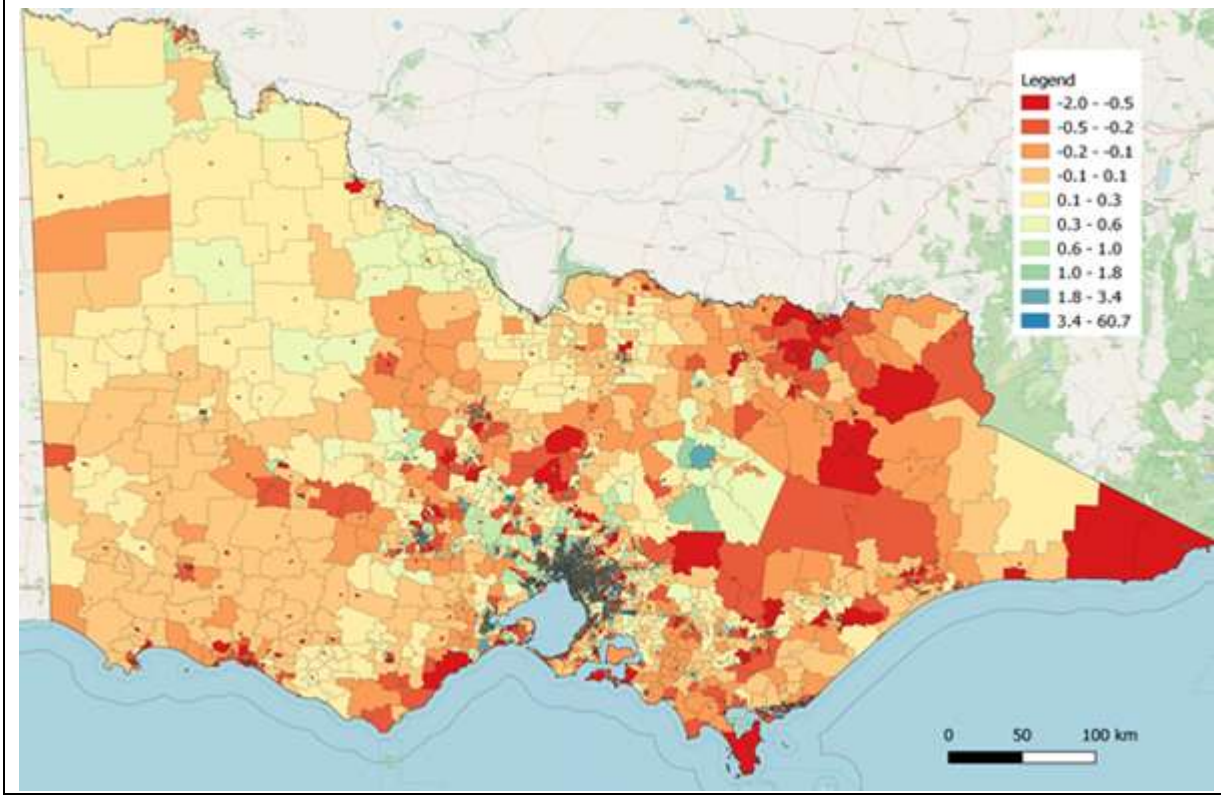
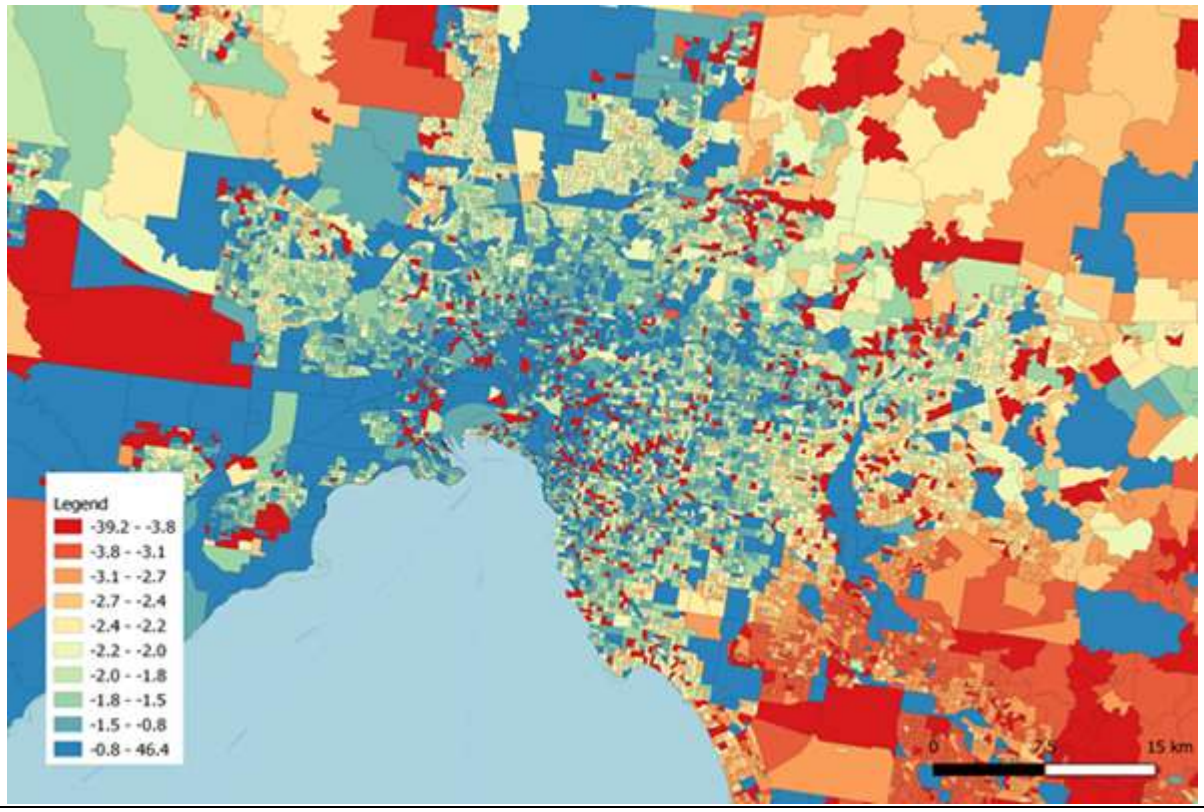


Figure E.7: Impact of bus services frequency increase, 2020 – Total residents unemployed (number) – Greater Melbourne (change from baseline)



E.9 The value of bus services to the Victorian economy

In the body of the report the calculation of the current value of bus services to the Victorian economy was carried out first in order to setup the framework and comparable benchmarks for the bus frequency enhancement case. The benefit of Bus services is evaluated by the hypothetical removal of bus services from the Victorian economy.

Bus services are assessed to contribute $\$_{cvm}$34.4 billion a year to the Victorian economy. This amounts to 8.6 per cent of the 2020 Victorian economy's gross state product (GSP), and can be interpreted as the amount by which GSP would fall if bus services were withdrawn, allowing approximately fifteen years for complete adjustment. The contribution to total employment is 235,000. This represents 6.5 per cent of the 2020 fiscal year employment, or an employment multiplier of 3.4, given that bus services delivered an estimated 70,000 persons to work places per work-day in 2020.

The very detailed tables and maps for this case are in the body of the report. For the purposes here all that needs to be noted is that the structure of the absolute outcomes is similar to the enhanced bus frequency case except at a higher scale by a factor in the range of 1.3 to 1.4.

As the report makes clear, the state-wide increase in employment flowing from improved bus services is accompanied by a redistribution of employment into areas with good bus services and hence involves a relative decline in economic activity and employment in non-metropolitan regions. However, for most non-metropolitan regions, unemployment falls despite employment loss because the working age population declines faster than the level of employment.

Many of the people who gain employment as a result of increased bus services are not in themselves bus travellers. Indeed, if those SA1s are excluded which experience a decrease in employment (that is, where there are few or no bus users), the percentage non-bus commuters in the total employment increase would be over 80 per cent. This reflects the strong flow-on or multiplier benefits of bus services.

The availability of bus services saves $\$_{cvm}3.7$ billion in social security income support measures for households that would be otherwise unemployed or not in the workforce.

E.10 The declining returns from increasing bus frequencies

Superficially doubling bus frequency should have a similar impact as the assessment of the value of bus services, just a change in sign. However, this cannot be the case since the stakeholders in bus services represent a defined group of disadvantaged households in terms of motor vehicle access and access to major employment nodes. Each improvement in bus frequency will reduce the potential stakeholder group that can be reached by the next round of bus frequency improvement. Overall, the total increase in Victorian employment for the bus frequency case compared to the Victorian change in employment for the value of bus services case is 35 per cent. This is to be expected since every 1 per cent in bus frequency from current levels would encounter steadily declining percentage increases in employment formation.

It could well be the case that to achieve the employment increase reported here for the enhanced bus frequency case more may have to be done to improve the attractiveness of a bus trip beyond simply increasing frequency. Such measures would include route reform to reduce travel times between start and ending of a route and expansion of bus priority lanes on congested roads.

E.11 The social inclusion economic benefit of bus services

The benefits from bus services extends beyond agglomeration economics and catchment scale impacts. These benefits arise from the fact that bus services play a key role in integrating disadvantaged households with the broader economy and community. By reducing social isolation of these households economic well-being is increased, reducing costs of health, mental health, as well as increasing the benefits from greater community involvement as well as participation in education and training which by itself will raise long-term productivity.

Collaborators on this study were John Stanley and Janet Stanley (2021) who have pioneered the development of estimates of the social inclusion benefits of public transport trips in general and bus trips in particular. They indicate that a value pf $\$_{cvm}22.75$ per trip should be adopted for the social inclusion benefits. This is an average for all trips. However employment trips are likely to generate greater benefits compared to other trips simply arising from the greater economic well-being enhancement. Accordingly, this study adopts the health and economic well-being values from their analysis for BusVic of an employment trip, or $\$_{cvm}35$.

This value would apply to those individuals with the greatest risk of social exclusion, which will not be uniform across individuals. Accordingly this study adopts a measure of regional disadvantage to adjust the trip benefit on the basis that the more disadvantaged a region the greater the probability of an individual resident in the region undertaking a bus trip that will generate a significant social inclusion benefit.

Figure E .8(a) and Figure E.8(b) show the quintile rating for each of the 14,073 regions on the basis of four indicators of disadvantage, namely, the number of low income households, the number of the working age population unemployed or not in the workforce, the number of population aged up to 17, and the number of the population 65 and over. Each indicator is divided into quintiles with the 5th quintile being the most disadvantaged and each region in the quintile is given the quintile number. The four indicators are then summed to give the results in Figure E.8(a) and Figure E.8(b). The maximum score for the most disadvantaged regions will be 20 and 4 for the least disadvantaged regions. Regions with a score of 20 receive the full $\$_{cvm}35$ per additional trip, with regions with a score of less than 20 receiving a pro rata benefit. Regions with a score of 8 or less are disregarded as the benefit of a bus trip from these regions is likely to be small. From the two figures, the regions with the greatest disadvantage are the Eastern outer and fringe Melbourne regions, middle Northern and Western Melbourne regions, and nonmetropolitan regional centres within 150 km and 200 km from Melbourne.

Using this methodology the total social inclusion benefit from the bus service enhance frequency case sums to $\$_{cvm}0.297$ billion, from 60,000 employment trips by two additional daily bus trips for 240 days a year. The average benefit per trip is, therefore, $\$_{cvm}20.6$ or 58 per cent of the maximum $\$_{cvm}35$ due to the discounting for a region's risk of social exclusion if appropriate.

The distribution of the social inclusion benefit across the Victorian SA1s is given in Figure E.9(a) and Figure E.9(b) in $ cvm million. Comparing the two sets of Figures, namely the Figure E.8 set and the Figure E.9 set, indicates the expected positive correlation between the two sets; that is, a positive relation between the disadvantage rating of a region and the benefit from social inclusion from the enhancement of the quality of bus services.

If the household income gain from bus service frequency enhancement is added to the social inclusion benefit for a region, the correlation coefficient between the combined income variable and the disadvantage rating for all SA1s is 0.2. This is a poor result but not surprising given the number of SA1s with no access to bus services. However, if the analysis is restricted to SA1s where bus services are the only public transport available then the correlation coefficient is 0.65, indicating that the bus enhanced frequency will be effective in increasing social inclusion for the existing bus network. Further, the gap between the 0.20 and 0.65 correlation coefficients indicates that bus network extension would be an important consideration in terms of long-term increases in social inclusion. However, the feasibility of network extension in terms of available catchment scale is unknown.

In terms of the total bus services industry total contribution to social inclusion the total is approximately $\$_{cvm}0.9$ billion from this study. This aggregate benefit scale is broadly consistent with findings by John Stanley and David Hensher (2011) a decade ago, that Melbourne's route bus services delivered total social inclusion benefits, from all trip purposes (though not just employment), of $0.9 billion in 2020 prices).

Figure E.8(a): Disadvantage quintile rating – Greater Melbourne

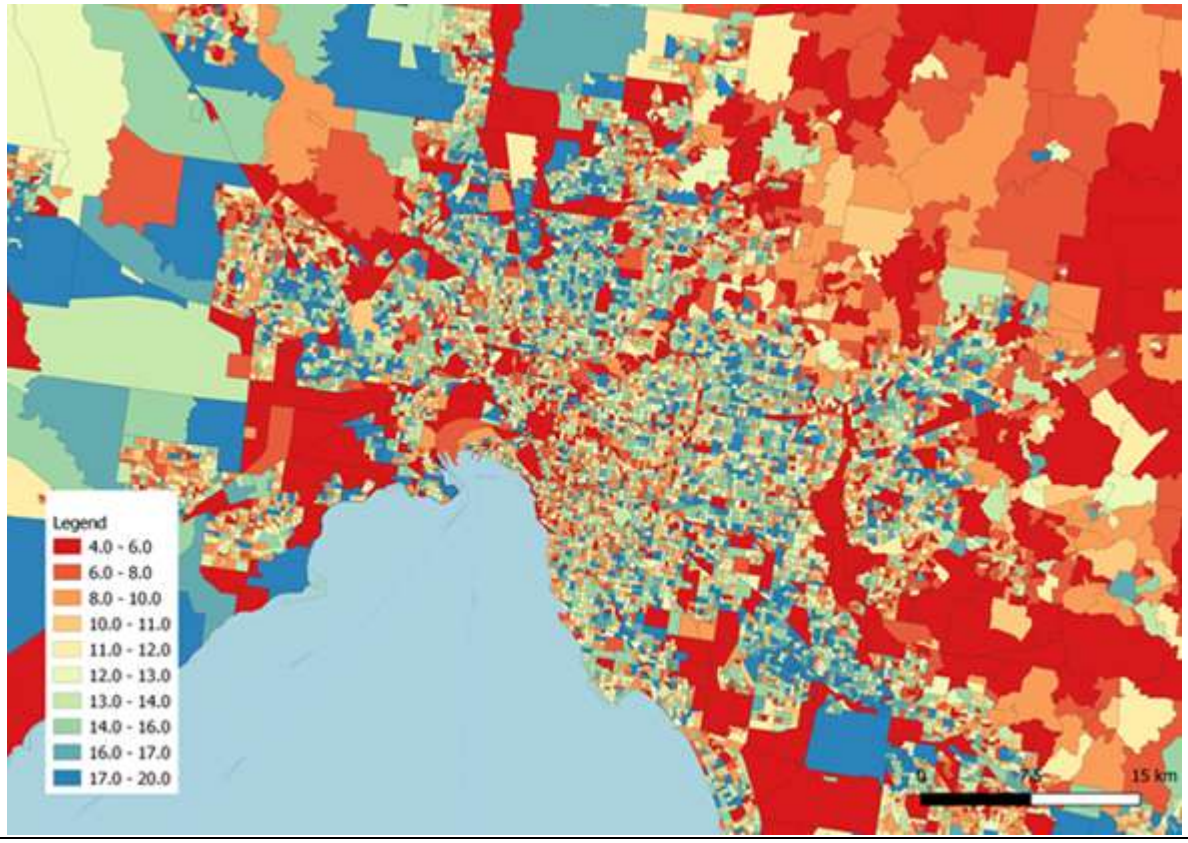


Figure E.8(b): Disadvantage quintile rating – Victoria

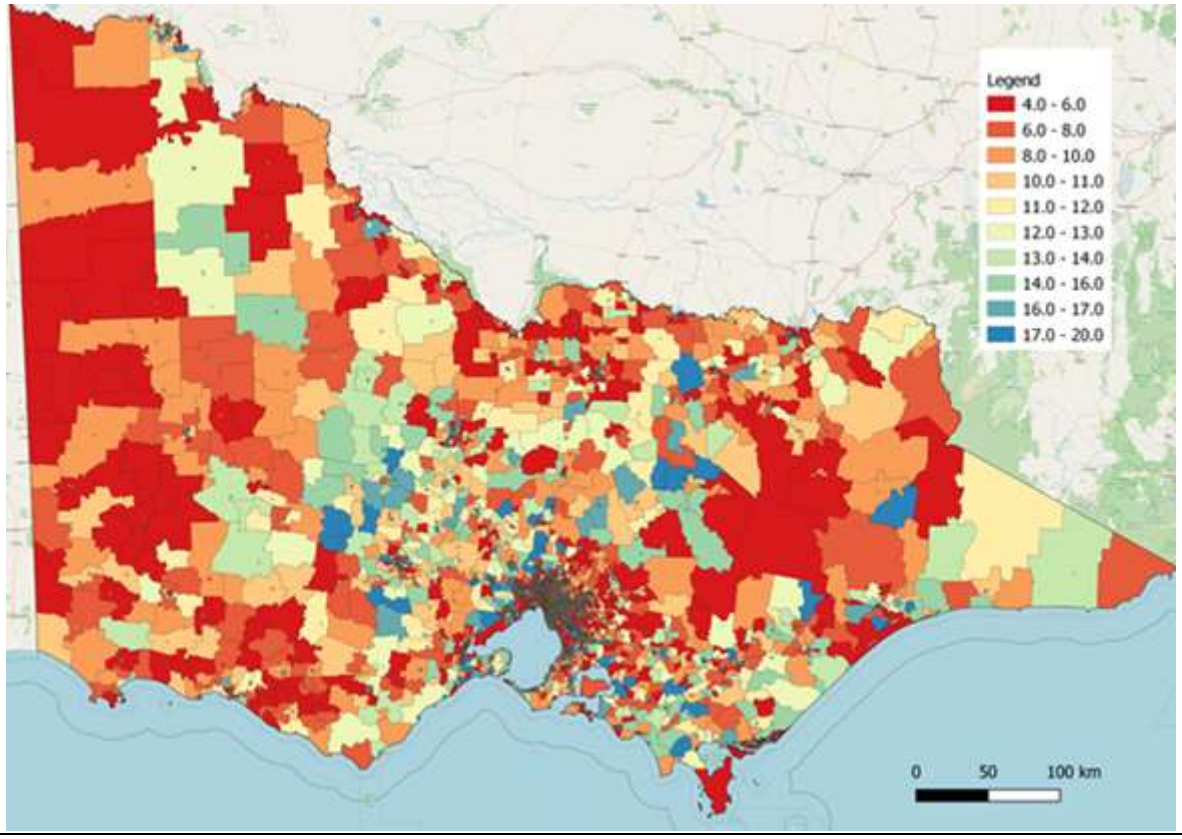


Figure E.9(a): Social inclusion benefit from bus frequency enhancement – Greater Melbourne ($ cvm million)

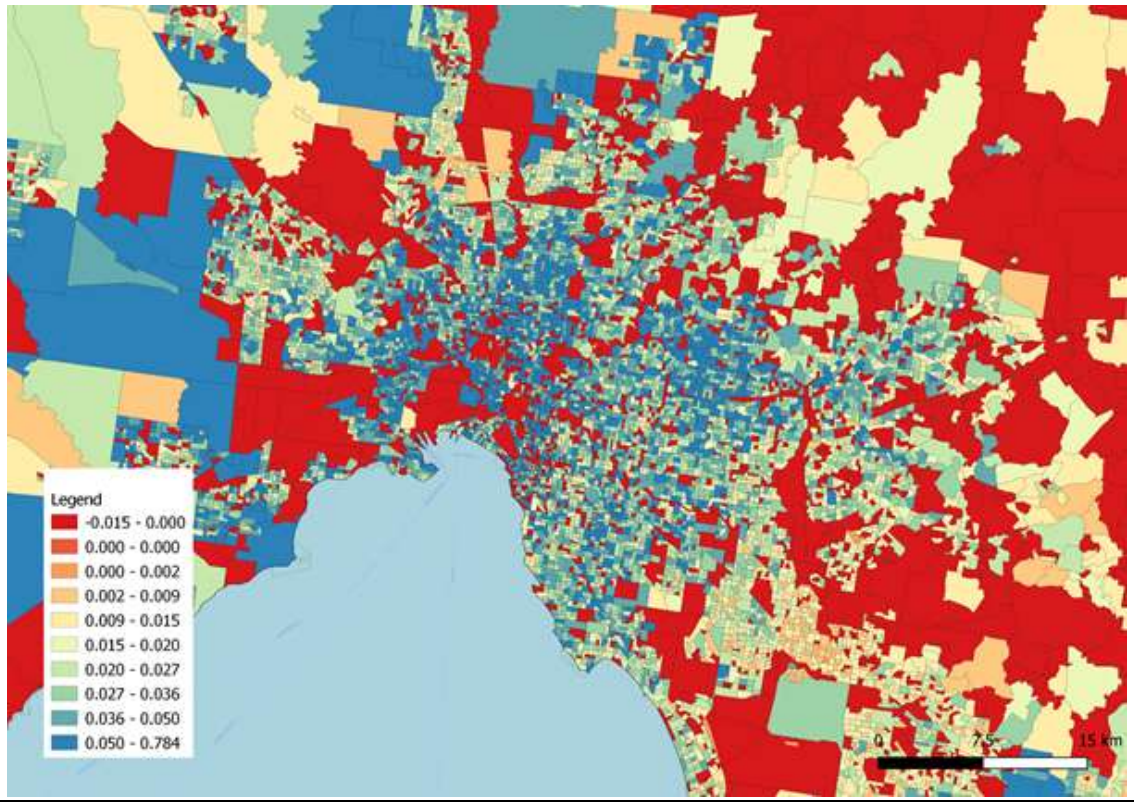
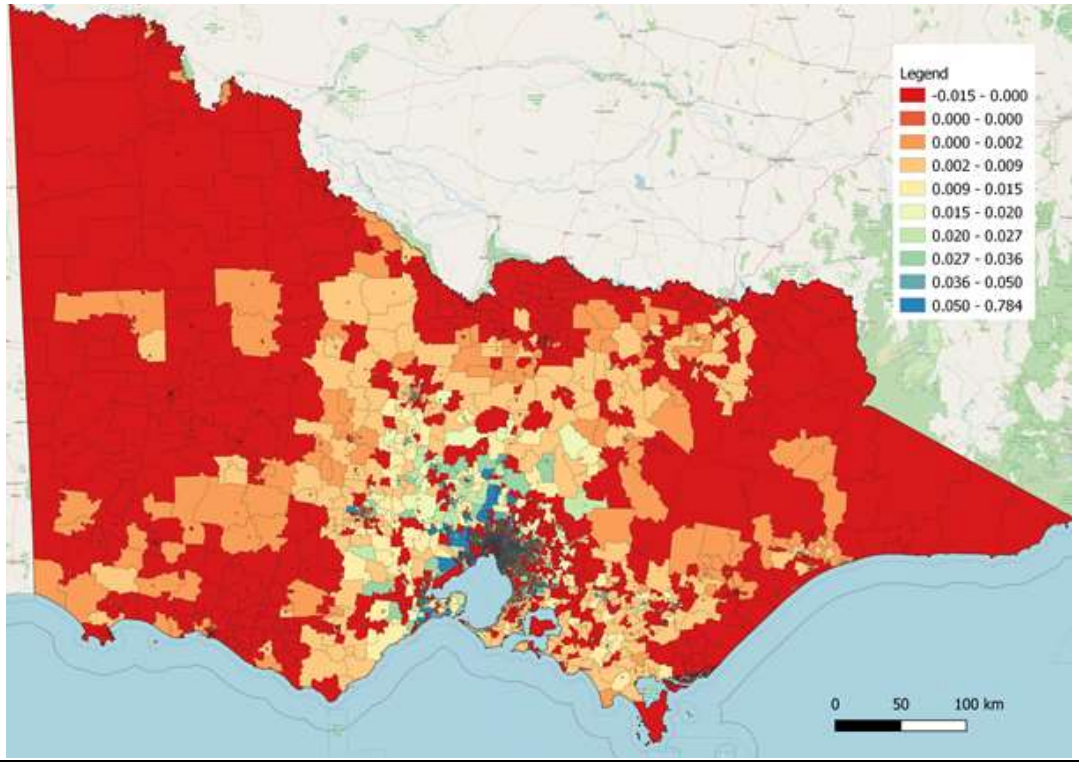


Figure E.9(b): Social inclusion benefit from bus frequency enhancement – Victoria ($ cvm million)



E.12 The benefit cost ratio for bus service quality enhancement compared to other public transport infrastructure investments

As required by the study objectives, results for the bus service frequency enhancement case were compared with the results for other public transport infrastructure investments. As projects had to be selected with a similar methodology as applied in this report, this restricted the selection to evaluations undertaken by NIEIR. The four projects selected are listed in table E .1. The results of the previous studies, where required, were adjusted to be compatible with the methodology adopted in this study of bus services. Two studies have been completed, namely the EastLink and Geelong Road upgrade projects while the Parramatta light rail project is under construction. The fast regional Rail project is a proposed project. Cost of the bus service enhanced frequency case is estimated at an undiscounted $\$_{cvm}$20.2 billion over 30 years. The social inclusion benefit of enhanced bus services is only a little less than the annual cost of the service quality improvement.

The investment in a project is treated as a "cost", in that, in a fully employed economy and/or an economy constrained in terms of acceptable public-sector deficits, the financing of the transport infrastructure project would require forgone expenditures in other areas that would involve direct additional welfare benefits, such as expenditures on health and education. This will not always be true but it is more likely to be true than not true.

In terms of benefit cost ratios, using a 4 per cent discount rate, the bus service enhanced frequency case performs well. However, it is important to keep things in perspective. Project benefit-cost ratios should only be validly compared if the projects either benefit the same stakeholder group or represent a similar type of public transport infrastructure applied in different catchment corridors. What can be said about the high benefit-cost ratio for bus services is that they are extremely effective in producing good economic outcomes for its core stakeholder group (disadvantage households, defined as households with low employment ratios, low incomes or households which because of mobility constraints cannot secure employment in general or in the higher productivity inner metropolitan employment nodes). Outside this group, the benefit from enhanced or new bus services is more limited in terms of additional value, at least from the employment perspective. That is, the bus trip substitution rate would be near 100 per cent. The bus trip substitution ratio refers to that share of employment bus trips that would not have been if bus services had not been available (see Appendix E.A at the end of this Executive summary). By definition those outside the disadvantaged group would in the main have alternatives to bus services for employment purposes.

In contrast major trunk public transport road infrastructure investments impact on a wide range of stakeholders, including businesses and households that are already employed but will benefit from lower travel times and congestion costs. Conversely the disadvantaged households in the catchment corridors for these types of investment will not significantly benefit directly. Thus, bus service investments are complimentary with other public transport infrastructure investments, not competitive. In this context bus service investments should be considered from the perspective of:

(i) an instrument to improve the effectiveness of any other public transport infrastructure investment, by maximising the reach of the investment to households within its transport corridor, where the findings of this study indicate substantial benefits can be delivered at relatively low cost; and

(ii) a stand-alone instrument to reduce the inequality of employment opportunity throughout Victoria.

The results Table E.1 do highlight an advantage of bus services over other types of projects. General bus service quality improvement will impact on all their stakeholders across Victoria covered by the existing network. Other projects are restricted to the stakeholders in the transport corridor of the project.

Table E.1 Benefit-cost ratios: Selected projects

	Gross State Product – annual peak ($\$_{cvm}$ billion)	Total investment ($\$_{cvm}$ billion)	Total discounted benefit 30 years – 4% discount rate ($\$_{cvm}$ billion)	Total discounted cost 30 years – 4% discount rate ($\$_{cvm}$ billion)	Benefit-cost ratio (per cent)
Bus frequency enhancement	9.2	20.2	81.2	11.7	7.0
Fast regional rail project – Victoria - proposed	33.1	71.4	225.3	57.9	3.9
Parramatta light rail project – version one	0.36	2.86	2.8	2.60	1.1
Parramatta light rail project – version two	0.63	2.96	4.9	2.66	1.8
EastLink	3.0	3.7	31.0	3.4	9.0
Geelong road upgrade	0.51	0.52	3.9	0.28	14.1

E.13 The bus services paradox: Why so important economically yet so unimportant in terms of the journey to work transport effort

The results of this study would seem implausible to those who note that the bus service contribution to the total employment trip effort in the Victorian economy is approximately 2 per cent. The obvious point to make here is that bus services are significantly more important in delivering employment to the Victorian economy in the most concentrated employment nodes, which are also the nodes with the highest productivity. Therefore, as shown here, bus services economic contribution will be substantially greater than their journey to work contribution. However, over the long term, bus services may be a victim of their initial success. This is because most disadvantaged households that will benefit from access to enhanced bus services are households which simply do not have the economic resources to access the required number of motor vehicles to give all household members employment opportunities. What are the implications of bus services creating the initial employment openings however, for the longer term demand for bus services?

For any region household motor vehicle ownership per capita of persons over 17 is a strong function of the household employment ratio and average household income. Once the additional employment opportunity is achieved, from for example of enhanced bus frequencies and/or bus service network extension, the incentive to purchase a motor vehicle from the increased household income will be strong as it will significantly further widen the labour market catchment (other than for inner Metropolitan employment) for the household member concerned and, therefore, the opportunity for higher paid employment. In the extreme, once all lags have worked themselves out, bus patronage may well have returned to the levels prevailing before any improvement was made to bus service provision. This effect will be particularly strong in non-metropolitan regions.

Although included in the model for this study, this mechanism is not included in the results presented in this report because, on the grounds of conservatism, model results were truncated before this mechanism could take effect. If the mechanism had been allowed to take effect, the employment "multiplier" from bus services frequency enhancement would be approaching 4.0 or above, or approximately 44 per cent greater for the enhanced bus frequency case than the results reported in this study on a Victoria wide average basis. The increment in bus trips would decline back towards the original levels prevailing before the bus service enhancements were introduced. The social inclusion benefits, however, will remain, with the exception of the physical health benefits, as a long-term job opportunity will have been secured irrespective of the ultimate transport mode of the journey to work activity.

This mechanism explains the bus service paradox. The bus service network left in place will however come back into its own in the longer term when the industry concentration benefits that the initial bus service enhancement created have the effect of increasing congestion costs and therefore an eventual partial recovery in bus service patronage. Also, carbon pricing and other motor vehicle restrictions that will be associated with emission reduction policies will assist in this regard. In any case the resolution of the paradox is just another mechanism which indicates that bus service quality enhancements are considerably more important to economic development in Victoria than what the macro indicators for the industry would suggest. This mechanism has been operating since the introduction of the motor-vehicle early in the previous century. From a technical perspective some may well argue, without too great an exaggeration, that the public passenger transport system is in fact one of the "prime enablers" of all subsequent economic development in Victoria.

E.14 Conclusion

One conclusion from the results is that a general strategy for bus services, and indeed public transport in general, should be developed on a corridor by corridor basis so as to maximise the benefit to the state as a whole. This implies that in some SA1s there may be no change in bus frequency, in some SA1s frequency may double and in some SA1s frequency may need to triple or quadruple. Part of this process would be to select changes that maximise the benefits to interconnected groups of regions and minimise negative spill over effects on relative competitiveness, giving emphasis to the benefits for disadvantaged groups. A key factor here is to focus on the non-bus transport infrastructure in fringe Melbourne SA1s to complement the improvement in the quality of bus services. As evidence in relation to this, the correlation coefficient between the benefit to a region from the bus service enhanced frequency case and regional inequality status was 0.65; adequate, but better outcomes in terms of driving the correlation coefficient towards one, could have been achieved with detailed targeting.

At the macroeconomic level, a working rule of thumb would be to regard public transport infrastructure, in the long-run, as a as a fixed input into the economic development process, which by itself will largely determine overall outcomes. That is, unless public transport infrastructure expands at least in proportion to the desired economic growth trajectory, the actual growth outcomes will fall recognisably short of the desired outcomes, irrespective of the contribution of other drivers such as business capital stock. The role of bus service is to ensure that the contribution of public transport infrastructure to economic development is maximised.

Finally there is a strong dynamic underlying the results as at least partly captured in the model equations. The improvement in bus service frequency will lead to increased education and training participation by the not in workforce population. This in turn will lead to an increase in productivity within the 15 year horizon of the analysis of this study. This underlying dynamic will be at least partly captured in the productivity increases noted above.