JOB ACCESSIBILITY AND UNEMPLOYMENT IN METROPOLITAN MELBOURNE : A SPATIAL ANALYSIS*

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ABSTRACT: *The 1970s witnessed an economic transition in Australia with cessation of the post war economic expansion being marked by the endemic recession and pressures for economic structural adjustment. With this change, unemployment has become a major social problem both in terms of its magnitude and in terms of its economic and psychological impact on individuals. Pressure is therefore mounting on our social institutions, governments, planners, and community organisations to develop strategies which may reduce unemployment, or at least ameliorate its undesirable effects. Before effective remedial programs can be devised, however, more information on the causes and effects of unemployment is required. This paper aims to shed light on one aspect of the potential causes and effects of unemployment by examining the relationship between transport availability, job accessibility and unemployment in Metropolitan Melbourne. Specifically, it examines the uneven spatial distribution of unemployment in Melbourne and sets out to establish the degree to which these variations are attributed to transport factors.*

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The views expressed in the paper are those of the authors and do not necessarily reflect those of the Bureau of Transport Economics or any other organisation.

INTRODUCTION

Australia has witnessed a major change in the employment situation over the last decade. After a prolonged period of subdued unemployment under conditions of post-war economic expansion, there has been a recent escalation of unemployment to a level which has not been experienced since the 1930s Great Depression. This development reflects distortions in the economy associated with a combination of changes occurring on both the national and global scales. At the national level, social, demographic and technological changes have generated pressures for economic structural adjustment. These pressures have been added to by developments on the international front such as the worldwide economic recession and shifts in international trading patterns which have changed Australia's position in the world economic order.

While there may be some debate over the precise nature of the changes responsible for the demise of full employment in Australia, there is abundant evidence of inequalities in their impact upon the Australian population. Variations in the incidence of unemployment occur among different groups according to age, sex, ethnic origin and educational background. In particular, youths (15 to 19 year olds), females, recent migrants and unskilled people have been especially vulnerable to unemployment (Sheehan 1980; Stricker and Sheehan 1981; Windschuttle 1979).

There is also a considerable variation in unemployment levels among different geographical areas. Figure 1 reveals that there is an uneven distribution of unemployment in the Melbourne metropolitan area. Relatively high levels of unemployment occur in inner suburbs such as St Kilda, Richmond, Collingwood and Fitzroy, and in some outer suburbs including Sunshine, Healesville, Frankston, Chelsea and Flinders. Burnley and Walker (1982) draw attention to a similar pattern in Sydney. These spatial variations in unemployment undoubtedly reflect the residential segregation of different social groups who vary in their vulnerability to unemployment - as Burnley and Walker observe in the case of Sydney. Yet, there is also a possibility that transport contributes to this pattern by making job opportunities less accessible for segments of the metropolitan population in particular localities.

This paper explores the relationship between transport and unemployment by examining spatial variations in unemployment in metropolitan Melbourne. After reviewing the evidence suggesting that such a relationship may exist, attention is focussed on trends in the location of employment and the journey to work patterns produced by these trends. This provides some insights into the way access to different types of jobs has changed in Melbourne. Variations in access to employment from individual LGAs are then measured using indexes which allow for the influence of transport as well as purely locational variables. Finally, the relationship between these indexes and unemployment levels is analysed with a view to identifying the impact of accessibility relative to social segregation.

EVIDENCE OF A LINK BETWEEN UNEMPLOYMENT AND TRANSPORT

In the context of the broader developments which have contributed to the present relatively high levels of unemployment in Australia, it is difficult to visualise transport as having more than a secondary effect on unemployment. Even so, the contraction of demand for labour in many economic activities has undoubtedly resulted in fewer job opportunities being available within commuting distance from many homes. Under these conditions, the influence of transport and locational factors on spatial

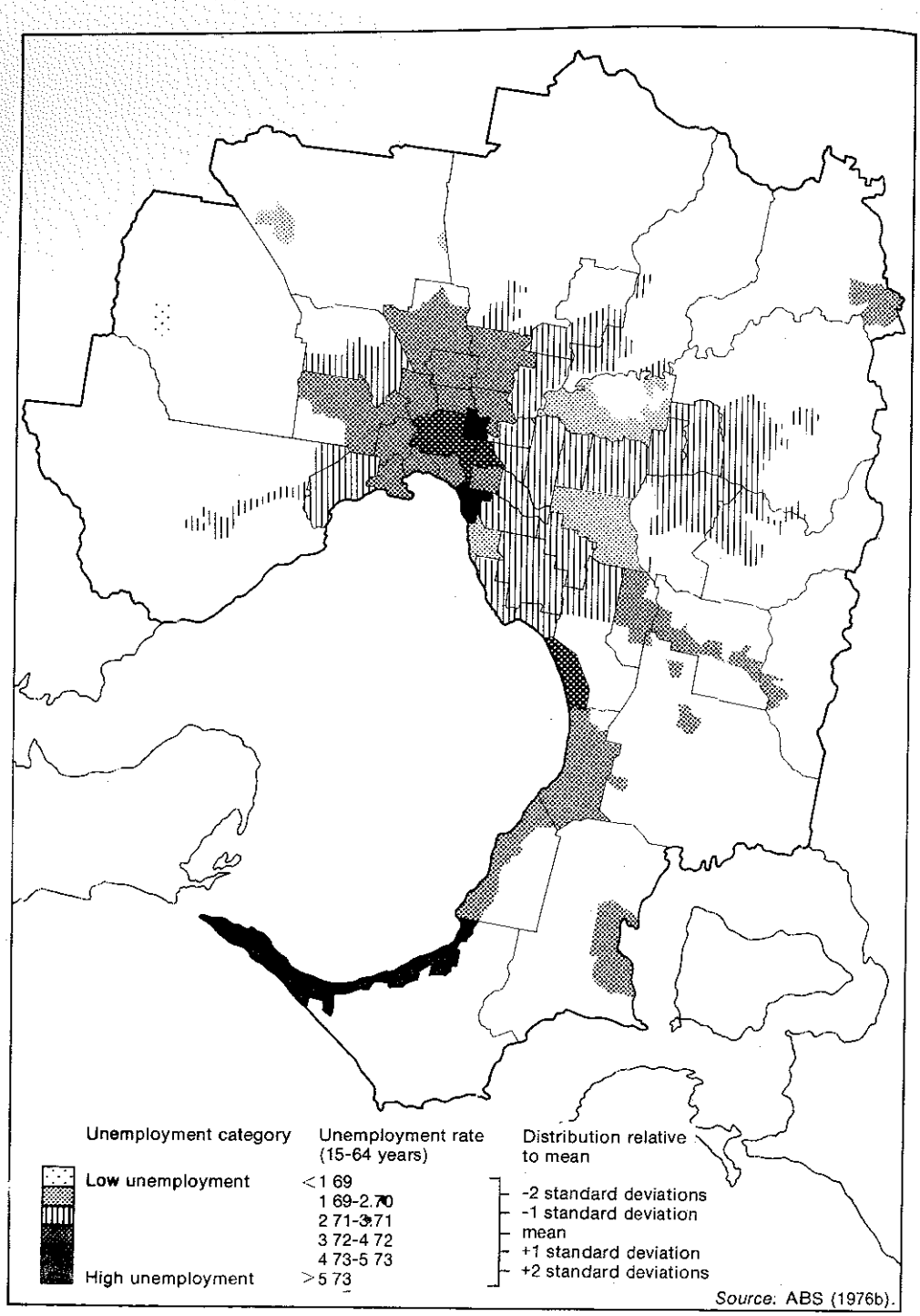
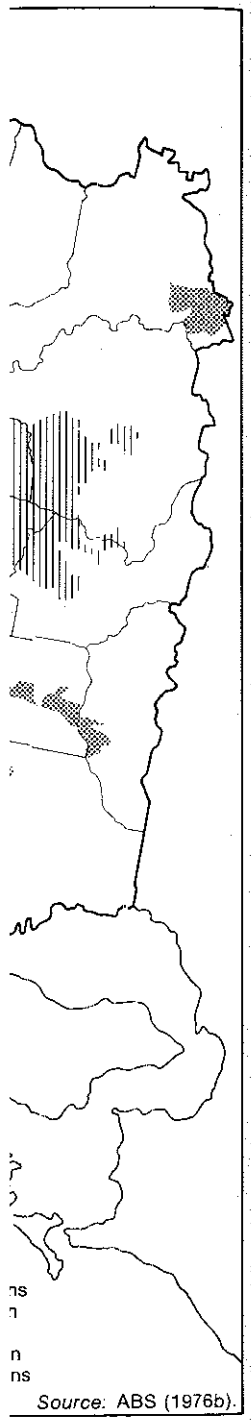


Figure 1 Unemployment rates, Melbourne



Source: ABS (1976b).

patterns of unemployment could conceivably be increased. However, to date there has been little research into the relationship between transport and unemployment, and that which has been caried out is inconclusive and, in some respects, contradictory.

A household survey conducted in Melbourne on behalf of the Victorian Employment Committee (1980) revealed that only 3.3 per cent of unemployed youths who left jobs did so because of travel problems, and all of those reporting such problems were females. Only 3.4 per cent of the same sample referred to distance as the main reason for certain jobs being regarded as unacceptable. But, on the other hand, 7.2 per cent claimed that transport considerations were given as the main reason for their job applications being rejected. Meanwhile, a higher proportion of unemployed people interviewed in an Adelaide study - 30 per cent - believed that transport problems affected their chances of finding work (Department of Social Security 1975, cited in Forster 1978).

While Australian studies at least imply that transport may affect unemployment levels, albeit marginally, one of the few studies directly considering the impact of transport found this variable to be relatively unimportant. A study of the effect of transport on the job search process in Greater Manchester, in the United Kingdom, concluded that the prospect of finding a job is influenced more by personal characteristics (age, skill, duration of unemployment) than by transport and location (Hedges and Hopkin 1981). In those cases where transport does interfere with the search for jobs, it is mainly the cost which creates problems. However, these findings may have limited relevance in the Melbourne situation because of differences between the two cities concerning the distances involved and the extensiveness of their respective public transport networks.

Another body of evidence points to a possible link between transport and unemployment on the basis of the tendency for groups who are vulnerable to unemployment to also be those who are transport disadvantaged. In this context, the transport disadvantaged section of the population includes those whose access to employment opportunities is restricted by their lack of transport resources. People who are dependent upon public transport because of low income, lack of access to a car or an inability to drive comprise this group. Generally, five major groups of people have been identified as being transport disadvantaged: the young (school children, and youths without a car), old, poor (resource poor and information-poor), housebound mothers and the disabled (Falcocchio and Cantilli 1974; Morris, 1981). Thus, youths, women who are housebound and many migrants (included in the information-poor) tend to be both vulnerable to unemployment and transport disadvantaged.

Morris (1981) found that lower proportions of women than men, of all ages, held a driver's licence and that, where several workers compete for household vehicles for work journeys, males are more likely than females to travel by car. Similarly, the Victorian Ministry of Transport survey (1981) reveals that 90 per cent of working men in Melbourne held a driver's licence, compared with only 70 per cent of working women. Journey to work data from the 1976 Census reveals that in Melbourne 50 per cent of work journeys among women were by car compared with 71 per cent for men, and correspondingly, a higher proportion of women than men travel to work by public transport (24 and 15 per cent respectively). These statistics suggest that women in general, and not only housewives, have comparatively poor access to private transport. Furthermore, several studies have referred to evidence suggesting that, for many women, transport problems are compounded by family responsibilities which limit the range of job opportunities available to them (Ferrier 1981; MSJ Keys-Young 1975; Faulkner 1978).

According to the Victorian Ministry of Transport (1981) data youths are even more dependent upon public transport for the journey to work than women. Fifty-four per cent of youths do not possess a driver's licence and only 46 per cent travel to work by car. A relatively high 36 per cent travel to work by public transport.

Women and youths are transport disadvantaged in the sense that they have relatively limited access to private transport. Their consequent dependence upon public transport is likely to exacerbate their vulnerable position in the labour market by limiting the areas in which they can search for work to those served by public transport. Information relating to the transport disadvantage of other vulnerable groups (migrants and unskilled workers) is less readily obtained. However Morris' (1981) classification of the 'information-poor' as transport disadvantaged includes, among others, recent migrants who have little knowledge of transport services owing mainly to the language barrier. Trends in the location of jobs revealed in the following section suggest that all these groups may be increasingly disadvantaged as jobs (especially those for unskilled workers in manufacturing) become more dispersed throughout the suburbs and less accessible by public transport.

TRENDS IN THE LOCATION OF EMPLOYMENT AND JOURNEYS TO WORK IN METROPOLITAN MELBOURNE

As a background to analysing the relationship between transport and unemployment in Melbourne, it is relevant to consider the location of employment generating activities. In particular, recent changes in the distribution of these activities are examined in conjunction with trends in residential location so that their impact on journey to work patterns can be identified.

Trends in Residential and Employment Location

Melbourne's post-war metropolitan expansion has been dominated by the suburbanisation of its population, with the proportion of the Melbourne Statistical Division (MSD) population resident in central LGAs[1] declining from 31 to 10 per cent between 1947 and 1976 (Gawler 1953; ABS 1976a). Suburban extensions of residential development were initially confined to radial public transport routes which converged on the Central Business District (CBD), but with rising car ownership levels in the 1960s this development was no longer so constrained (Johnston 1968). With the increased level of personal mobility produced by widespread car ownership, more and more people could choose their place of residence according to life-style preferences, epitomised by the detached suburban bungalow, rather than on the basis of proximity to work and public transport.

To a certain extent, the suburbanisation of Melbourne's population did not necessarily entail the classical trade-off between residential considerations and proximity to work (Kain 1961). While lagging behind

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1. The regional boundaries devised by Logan *et al* (1975) have been adopted for the purposes of this analysis (See Figure 2). According to this framework, the central region comprises the following LGAs: Melbourne, South Melbourne, Port Melbourne, Fitzroy, Collingwood, St Kilda, Richmond and Prahran.

the decentralisation of the population, jobs have also become more decentralised since the 1960s. Between 1961 and 1976 the central region's share of MSD employment has diminished substantially from 55 to 37 per cent, accompanied by rising employment shares at increasing distances from the CBD (Maher and O'Connor 1978, 1979; ABS 1976b). However, the suburbanisation of jobs has been selective. Suburban areas vary in the extent to which local job opportunities have been created, and some occupations have been affected more than others.

Not only has the distribution of employment in Melbourne become more suburban, but it also has become less concentrated. Between 1961 and 1971 the proportion of the MSD's total workforce employed in the 'top ten' LGAs (in terms of employment concentration) declined from 64 to 50 per cent. This percentage declined further to 40 per cent by 1976. Thus, rather than simply decentralising to a few suburbs, employment has become generally more dispersed.

Occupational profiles of the labour force working in the 'top ten' employment concentrations reveal that most of the newer suburban centres of employment (especially Broadmeadows, Preston, Sunshine, Oakleigh and Moorabbin) have a high proportion of craftsmen-labourers and, to a lesser extent, clerical workers. The proportion of the workforce in these LGAs in craftsman-labourer occupations ranged from 44 to 52 per cent in 1976, compared with averages of 32 and 31 per cent for the 'top ten' LGAs and the MSD respectively (ABS 1976b). This emphasis on craftsman-labourer employment reflects the importance of manufacturing as an element of employment growth in these areas. As Table 1 reveals, all five of the abovementioned LGAs are among the major concentrations of manufacturing employment in Melbourne, and relatively high percentages of their individual workforces are engaged in this sector.

TABLE 1 - LGAs EMPLOYING MORE THAN 10 000 WORKERS IN MANUFACTURING, 1976

LGA	Manufacturing jobs	
	Number	Per cent of total employment in LGA
Melbourne	28 315	13.2
Moorabbin	23 553	57.4
Sunshine	21 525	75.9
Oakleigh	20 534	58.0
Port Melbourne	17 654	75.8
Broadmeadows	15 799	67.2
Footscray	14 811	50.3
Brunswick	14 168	69.3
Preston	12 874	42.7
Richmond	12 041	54.1
Collingwood	11 615	64.3
Waverley	10 974	38.7

Source: ABS 1977a

An examination of the ten LGAs containing the largest concentrations of employment in the 1961, 1971 and 1976 Censuses provides an indication of the spatial and occupational biases in the decentralisation of jobs. Among the 'top ten' LGAs in 1961 there were only two outer suburban LGAs (Sunshine and Moorabbin) - at positions 7 and 9 respectively. Of the remaining eight LGAs, six were in the central region and two (Footscray and Brunswick) were adjacent to it. By 1971 Moorabbin was in third place and an adjacent outer suburban LGA, Oakleigh, was in fourth place. Sunshine retained its seventh place, while another outer suburban LGA, Preston, was in sixth place. Two more outer suburbs (Waverley and Broadmeadows) entered the 'top ten' by 1976, both displacing central region LGAs.

The decentralisation of industrial activity within the metropolitan area arose from a combination of conditions in the post-war period (Logan 1964; Rimmer 1969). Post-war industrial growth created a demand for space and this could not be met economically in congested inner areas. Trends in industrial technology favoured larger sites. These trends were reinforced by a suburbanisation of the workforce and, as this workforce increasingly used cars for the journey to work, more space was also required to accommodate these cars. But this shift in industrial employment towards the suburbs did not necessarily increase *overall* access to such employment, as many of the suburban industrial plants were not served by public transport (Rimmer 1969).

Sales work is the other major occupational category affected by the suburbanisation of workplaces. The factors behind the dispersal of retailing are similar to those involved in the decentralisation of manufacturing with a concomitant impact on access to jobs (Johnston and Rimmer 1968). Much retailing in all but the most specialised fields has been dispersed to integrated suburban centres incorporating a variety of retail outlets and where space permits the use of modern retailing techniques. These centres are frequently on totally new sites which have often been located mainly with local access by car in mind - access by public transport has been a secondary consideration.

Changes in the composition of employment in the central region *vis a vis* the remainder of the Melbourne metropolitan area between 1961 and 1976 reflect the trends in the manufacturing and retailing industry referred to above (Maher and O'Connor 1978; ABS 1976b). Over 32,000 jobs in the craftsman-labourer field were lost from the central region during this period, while there was a compensating increase of over 111,000 jobs elsewhere. Similarly, over 7,000 sales jobs disappeared from the central region, while an additional 28,000 jobs in this category emerged in the suburbs. In general, however, the suburbs gained in the employment of every occupational group. Meanwhile, the number of central region jobs decreased by nearly 19,000 overall and increases occurred only in the professional-technical and clerical fields. Thus, while the range of employment opportunities in the suburbs has diversified, the central region's labour force has become more specialised towards white-collar employment in the professional, technical and clerical fields.

Journey to Work Patterns

Several observers have drawn attention to the tendency for metropolitan areas to be divided into a series of local 'labour markets' (Bunting 1962) or 'labour sheds' (Vance 1960) within which people live and work. In Australia, Logan (1968) and Maher and O'Connor (1978) have identified similar patterns in metropolitan Sydney and Melbourne respectively. However, the orientation of labour sheds varies among different occupational groups, and these variations warrant attention when considering the impact of changes in Melbourne's spatial structure on access to jobs.

As noted above, many of the jobs in the new suburban employment concentrations are for blue-collar workers engaged in manufacturing, while employment in the central region has become increasingly for white-collar workers. Maher and O'Connor's (1978) analysis reveals that suburban employment centres tend to have commuting fields which are confined to the same geographical sector of the metropolis and oriented directionally away from the CBD. The Waverley-Oakleigh-Moorabbin, Broadmeadows-Preston and Sunshine-Footscray complexes all draw heavily upon adjacent suburbs towards the periphery. Conversely, white-collar workers employed at the centre are drawn from the whole of the metropolitan area, but noticeably to a lesser extent from the suburbs which supply workers to suburban industrial centres (BTE, in print). Meanwhile, sales jobs, which have also become more dispersed, have increasingly drawn upon more localised labour sheds.

The self-containment of individual labour sheds refers to the extent to which workers residing within a particular area are also employed within that area (Smart 1974). To the extent that this measure indicates the degree to which homes and workplaces are separated spatially, it provides a basis for detecting variations in the amount of travel involved in the journeys to work of different residential and occupational groups. Given the trends observed in the location of employment and the disposition of labour sheds, we may expect that self-containment - as defined above - will be higher among blue-collar and sales workers than among white-collar workers; and it will be much lower for white-collar workers in suburban areas than in the central area.

These expectations are borne out by the variations in self-containment recorded in Table 2 where the regional classification devised by Logan *et al* (1975) has been adopted as the framework for measuring intra-metropolitan variations in self-containment (Figure 2). Outside the central and western regions, self-containment is generally higher among blue-collar workers, while self-containment among white-collar workers is relatively low in regions beyond the central area. The Western and Westernport regions are exceptions to this generalisation.

TABLE 2 - SELF-CONTAINMENT OF OCCUPATION IN REGIONS, 1976

Occupational Groups	Percentage of workers living in each region and also employed within that region								
	Central	Western	North Western	Northern	Inner Eastern	Outer Eastern	Inner Southern	Western-port	All regions
Prof/Tech	73.8	60.7	37.0	49.3	31.8	32.9	35.9	57.1	44.9
Admin/Man	77.6	62.5	42.0	43.3	23.5	32.0	35.2	51.9	40.3
Clerical	89.8	44.9	32.4	35.4	28.5	32.6	31.1	47.6	40.9
Sales	79.3	67.5	47.3	56.3	45.2	48.9	52.8	63.8	56.3
Trans/Com	78.9	50.0	36.5	42.6	41.5	44.2	44.7	54.7	49.0
Crafts/Lab	74.3	69.3	54.9	51.8	41.2	50.7	61.1	54.4	57.9
Service	85.4	50.6	43.1	57.3	57.9	51.6	62.4	65.0	60.3
TOTAL	79.2	61.6	45.9	48.6	35.7	42.6	46.4	57.3	51.4

Source: ABS 1976b

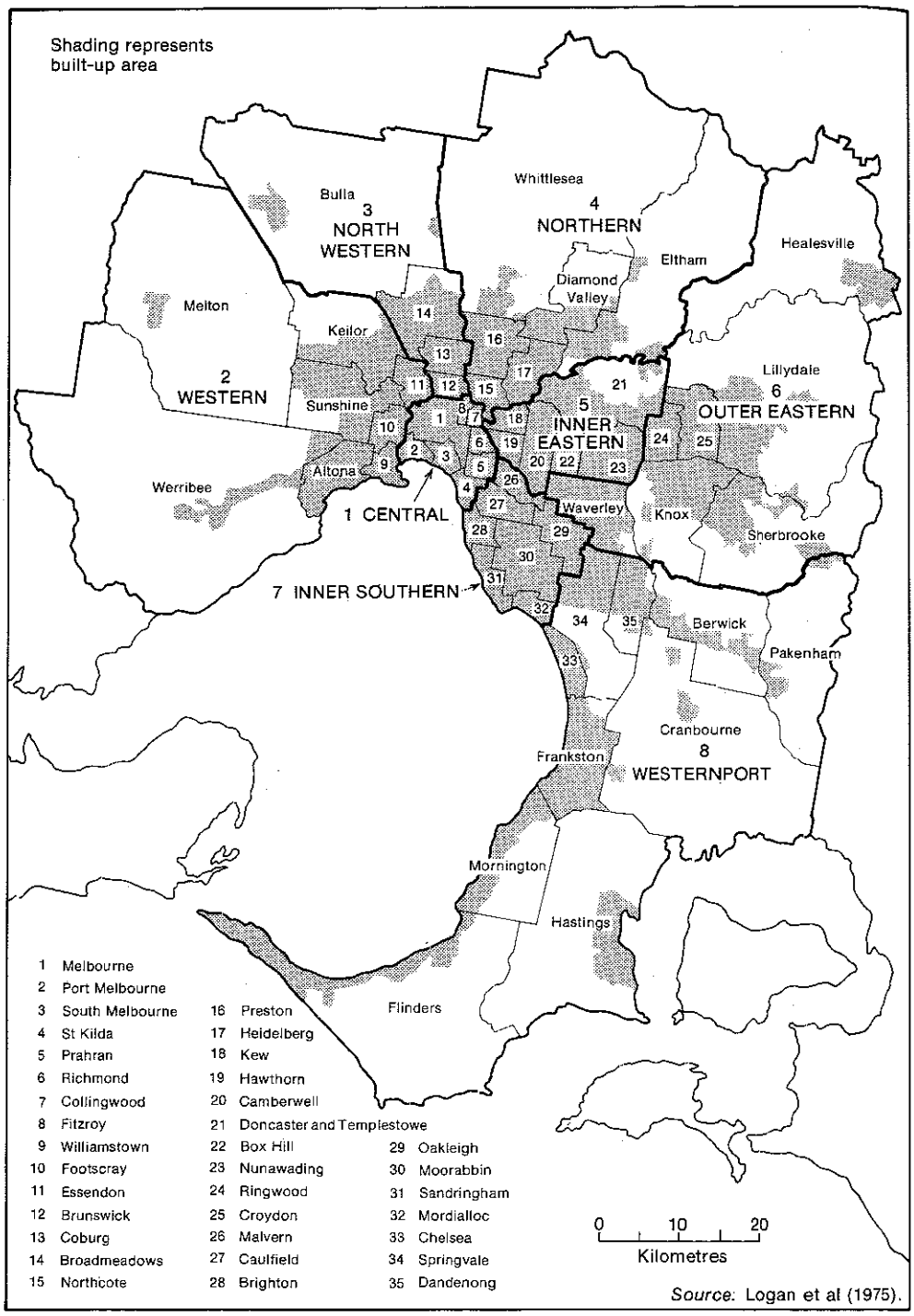
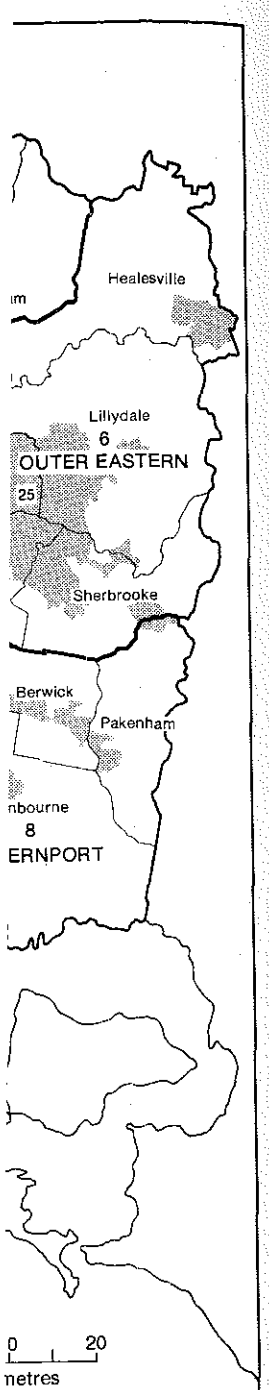


Figure 2 Sub-regional classification of the Melbourne metropolitan area



Source: Logan et al (1975).

metropolitan area

TRANSPORT AND UNEMPLOYMENT

Another, more precise way of measuring the distribution of work relative to residential locations for different occupational groups is to use a Gini Coefficient (Maher and O'Connor 1978). The Gini Coefficient quantifies the degree of equality in the distribution of a particular quantity among units of a population[1]. Table 3 records Gini Coefficients for each occupational group in 1961, 1971 and 1976. The trends revealed are consistent with earlier observations concerning the location of employment for different occupational groups. Sales workers, labourers and service employees exhibit very low coefficients, indicating decentralisation of work places in conjunction with the suburbanisation of the workforce. Clerical, administrative and professional workers have higher coefficients reflecting the greater concentration of these jobs, although these coefficients declined consistently since 1961, indicating a decline in the level of concentration. Coefficients for the decentralised occupations declined over 1961-71 but rose again over 1971-76, perhaps indicating some regrouping of these jobs in larger regional centres.

TABLE 3 - GINI COEFFICIENT MEASURES OF JOB CONCENTRATION RELATIVE TO LABOUR FORCE RESIDENTIAL DISTRIBUTION, BY OCCUPATION

Year	Prof/ tech	Admin/ man	Clerical	Sales	Trans/ comm	Crafts/ Labourer	Service	Total
1961	43.52	45.74	64.05	39.00	42.89	32.14	29.22	39.84
1971	39.72	41.52	52.70	31.74	36.44	26.60	25.54	33.55
1976	38.36	41.68	50.27	29.43	42.17	28.91	29.31	35.70

Sources: 1961 and 1971 figures, Maher and O'Connor 1978; 1976 figures, ABS 1976b.

From the analysis contained in this section, it appears that the recent suburbanisation of jobs in Melbourne has selectively benefitted blue-collar workers. This 'benefit', however, may be more apparent than real for two reasons. First, many jobs in the suburbs are in locations away from public transport routes and access to these jobs therefore depends upon car availability. Secondly, the radial orientation of transport systems in Melbourne inhibits commuting between suburbs in different sectors, and results in employment options for blue-collar and sales workers being restricted to the sector in which they live. While the access of these workers to some employment opportunities has probably improved, they are in a precarious situation because, in the event of retrenchment, their access to alternative employment may be more limited.

1. The possible range of values for the Gini Coefficient is 0 to 100. A value of 0 occurs when there is total equality in the distribution of jobs relative to workers by LGA, when each LGA has a share of MSD jobs commensurate with the proportion of the MSD workforce residing within it. A value of 100 indicates maximum inequality in the distribution of jobs compared with workers. If all jobs were concentrated in LGAs where there were no resident workers, then the Gini Coefficient would be 100.

VARIATIONS IN ACCESS TO JOBS

Accessibility generally refers to the opportunity individuals at a given location have to take part in a given activity or set of activities at other locations. Changes in employment location, therefore, have a bearing on variations in access to jobs at least to the extent that these variations are directly related to distances separating jobs from homes. However, a more comprehensive measure of accessibility must take into account the ease of movement between these two locations. Consequently, accessibility is commonly recognised as being a function not only of the location of individuals relative to relevant activities, but also of the characteristics of the transport system linking them to these activities (Jones 1981; Morris *et al* 1979; Vickerman 1974; Zakaria 1974).

There are a number of ways in which data representing these two dimensions can be integrated to form indices of accessibility (Jones 1971; Morris *et al*, 1979). Two alternative approaches appear to be applicable to the analysis of variations in access to jobs in Melbourne: the distance decay approach; and the cumulative opportunity approach.

In the distance decay approach a weighting factor is incorporated into the summation of opportunities so that the value of opportunities is discounted according to some function of the cost incurred in reaching them. Originally Hansen (1959) discounted opportunities by using a negative power function, while a negative exponential decay function has been commonly used more recently (see Dalvi and Martin 1976; Martin and Dalvi 1976; Pike *et al* 1976). The main advantage of this approach lies in its recognition that more remote employment opportunities are not as valuable to a worker as those which are closer and that all opportunities should therefore not make an equal contribution to the accessibility index.

The cumulative opportunity approach is based on the curve which can be plotted reflecting the inevitable increase in the proportion of total job opportunities which can be reached as the commuting distance from a given location is increased. This approach has been applied to the measurement of areal variations in employment opportunities by Breheny (1974) and has been elaborated in analyses carried out by Black (1977), Black and Conroy (1977) and Wachs and Kumagai (1973). In its simplest form, the cumulative opportunity index has the advantage of being intelligible to the layman (Briggs and Jones 1973; Morris *et al* 1979; Whitebread 1972). Units of measurement are immediately understood irrespective of whether they refer to the proportion of MSD jobs within a specified travel cost range or to the travel cost incurred in reaching a particular proportion of jobs. However, this approach is weakened by the necessity of making a somewhat arbitrary decision concerning the cut-off points for deriving index values.

Parallel analyses using each of these approaches have been carried out and reveal that they each produced similar results (BTE in print). Thus, the cumulative opportunity approach has been adopted in this paper by virtue of its simplicity.

To calculate accessibility indexes for individual LGAs data was required on the distribution of employment among LGAs and some measure of the difficulty or cost of travel between LGAs. Information on the distribution of employment was derived from the destination column of the 1976 Census journey to work matrix. Travel times for trips between LGAs by private and public transport were adopted as surrogates for travel costs (Briggs and Jones 1973; Dalvi and Martin 1976; Schneider and Beck 1974;

Sherman *et al* 1974; Wachs and Kumagai 1973; Wickstrom 1971). Private and public transport were considered separately because of this study's specific interest in the impact of transport availability on access to jobs, and ultimately on unemployment. Matrices indicating the average time reportedly spent by users of private and public transport in trips between LGAs were compiled using information obtained from the Victorian Ministry of Transport survey (1981). Figure 3 illustrates the derivation of indexes for LGA, i, and occupation, m, based on:

- the proportion of MSD jobs within a specified travel time, t, by public (Pub:$A_{im(t)}$) and private transport (Priv: $A_{im(t)}$); and

- the minimum time required to reach a given percentage, p, of MSD jobs by public (Pub: $T_{im(p)}$) and private transport (Priv: $T_{im(p)}$).

The $T_{im(p)}$ index has been excluded from the analysis reported in this paper because, relative to the other index, it contributes little to the statistical explanation of variations in unemployment. For the other index, one-hour was chosen as the critical time interval for access by public transport and thirty minutes for access by private transport.

Figures 4 and 5 represent variations in access to jobs (all occupations) throughout the Melbourne Metropolitan area by private and public transport respectively. For the purpose of describing general patterns it is sufficient to concentrate on LGAs at the extremes of each scale. Here the extremes have been defined as beyond one standard deviation above and below the weighted mean (weighted according to the numbers of workers resident in each LGA). As might be expected, LGAs towards the centre of the metropolitan area have high levels of accessibility. These include Melbourne, South Melbourne, St Kilda, Prahran, Richmond, Collingwood, Hawthorn, Fitzroy and Malvern. At the other extreme, a number of outlying areas have low private and public transport accessibility; Werribee, Melton, Healesville, Croydon, Lillydale, Pakenham, Bulla, Sherbrooke, Eltham and parts of the Mornington Peninsula south of Chelsea.

Disparities between public and private transport access to jobs from individual LGAs are proportional to the area encompassed by their respective accessibility profiles (ie, the shaded area in Figure 3). A disparity index (D_{im}) for workers in occupation, m, residing in LGA, i, was therefore produced by calculating this area. In the resulting index, the disparity is measured in terms of the average potential difference in the times required for travel by private and public transport from LGA,i, to all MSD jobs in the specified occupation. The magnitude of this index indicates the degree of inequality of access between private and public transport dependent groups.

Modal disparity indexes (all occupations) for each LGA are recorded in Table 4, where LGAs have been arranged in rank order and those with extreme values (in the first and fourth quartiles) have been isolated in separate columns. Notably, the same outer suburbs identified previously as having low access to jobs stand out as also having high disparity levels. Conversely, LGAs towards the city centre that were classified as having high access to jobs register low disparity levels. Indeed, as Figure 6 indicates, there is a strong apparent relationship between proximity to the CBD (horizontal axis) and the magnitude of the disparity (vertical axis). This relationship is a product of several factors generally related to Melbourne's urban spatial structure and the configuration of the transport system around which it has evolved.

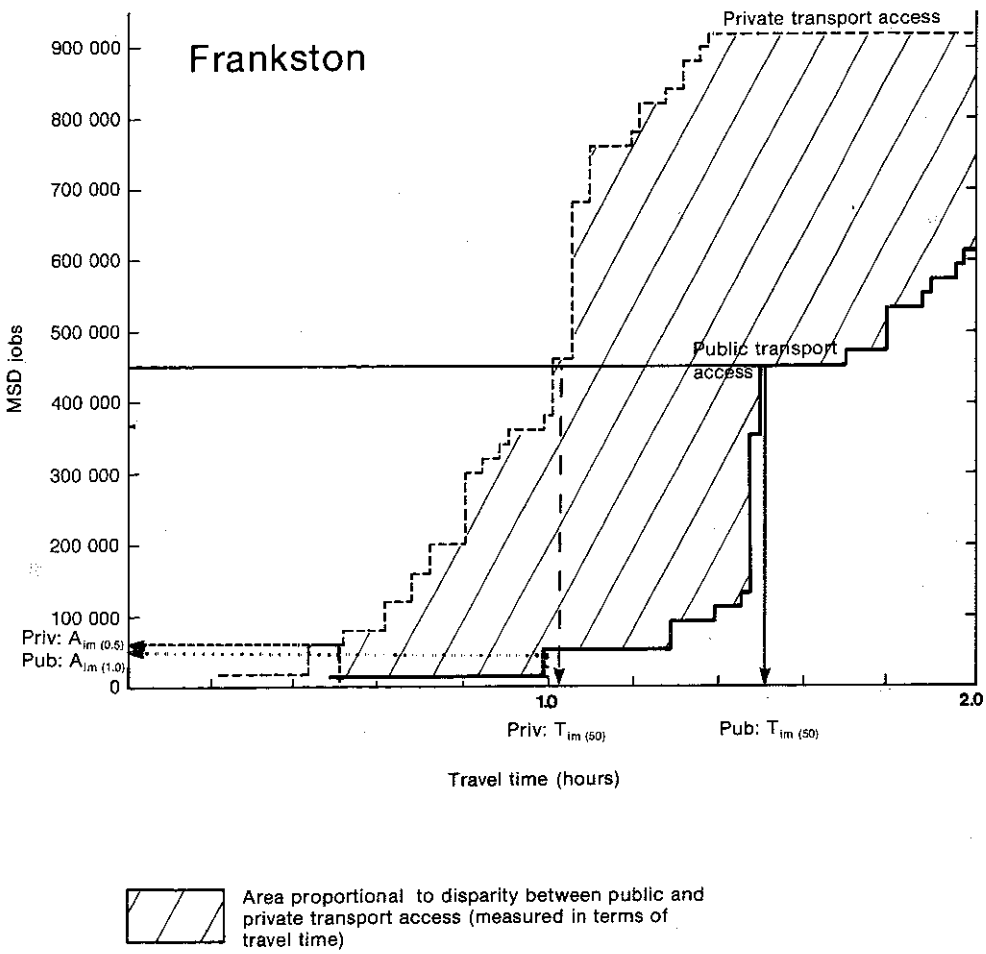
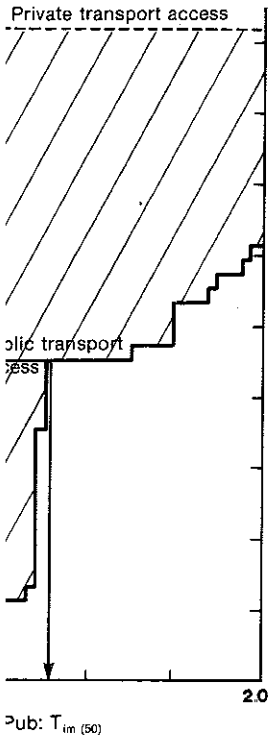


Figure 3. Travel time curve for Frankston indicating derivation of alternative indexes of job accessibility



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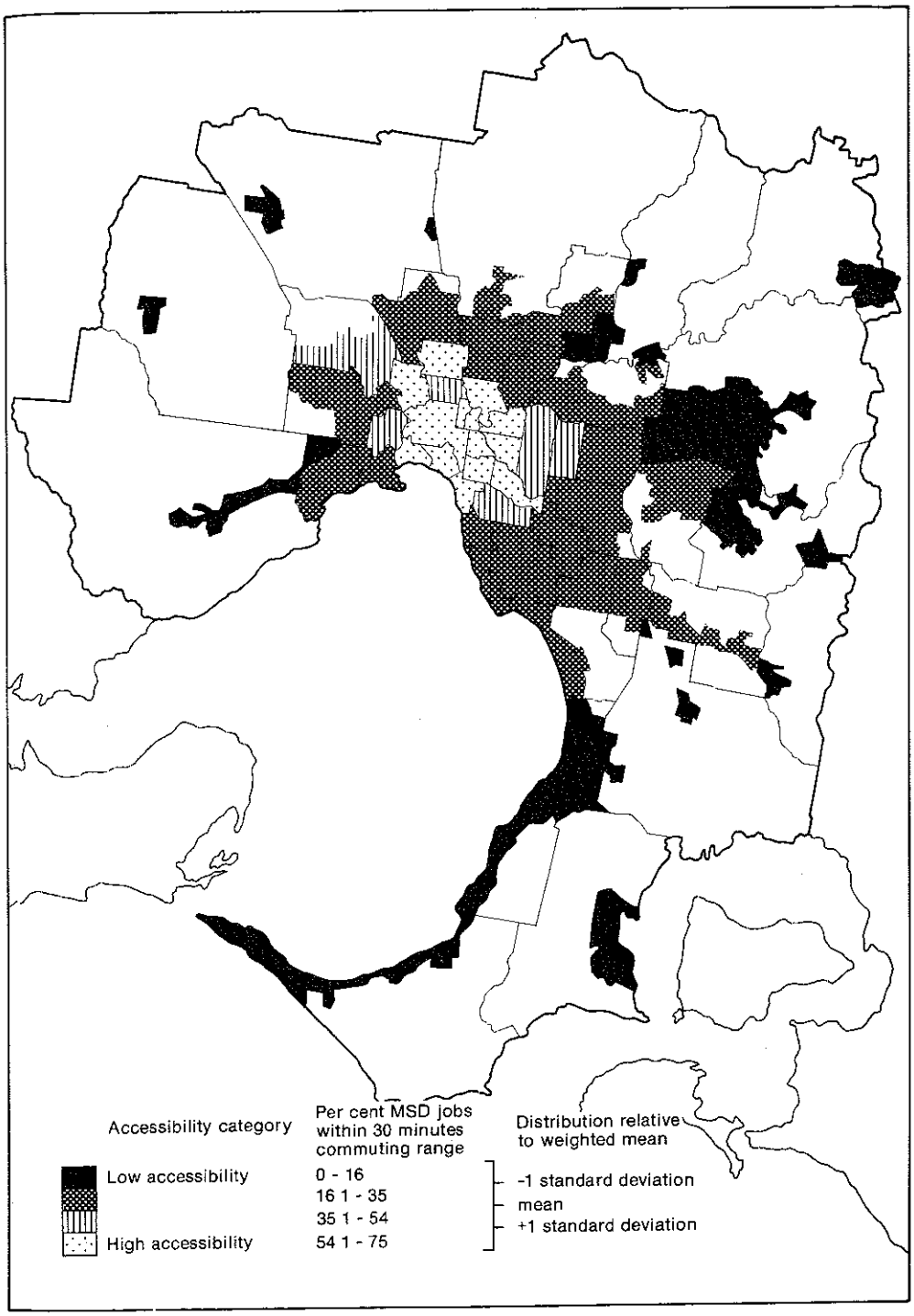

Figure 4 Variations in accessibility to employment in the Melbourne metropolitan area—private transport ($Aim_{0.5}$) index

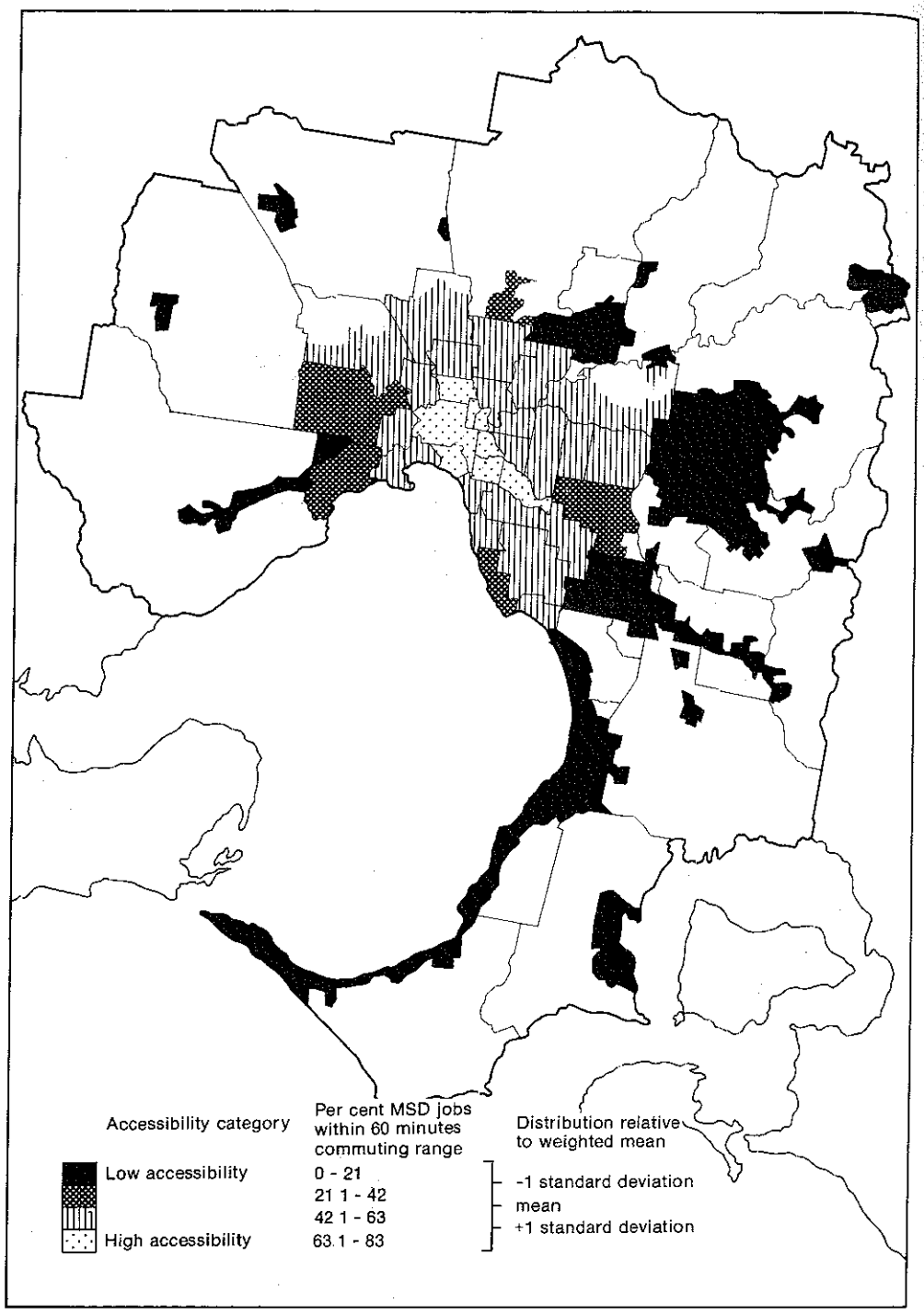

Figure 5 Variations in accessibility to employment in the Melbourne metropolitan area—public transport ($Aim_{1.0}$) index

TABLE 4 - DISPARITY INDEXES BY LGA IN THE MELBOURNE STATISTICAL DIVISION

(All Occupations)

Low disparity LGAs		Intermediate LGAs		High disparity LGAs	
Melbourne	0.19	Caulfield	0.45	Ringwood	0.70
Brunswick	0.31	Mordialloc	0.46	Sunshine	0.70
Sth Melbourne	0.32	Oakleigh	0.50	Bulla	0.73
Collingwood	0.34	Williamstown	0.50	Lilydale	0.77
Richmond	0.36	Preston	0.50	Melton	0.79
Footscray	0.37	Nunawading	0.51	Pakenham	0.81
Port Melbourne	0.39	Brighton	0.53	Frankston	0.85
Waverley	0.40	Knox	0.53	Eltham	0.89
Fitzroy	0.40	Kew	0.54	Berwick	0.91
Prahran	0.40	Box Hill	0.54	Cranbourne	0.95
Malvern	0.44	Sherbrooke	0.54	Healesville	1.11
St Kilda	0.44	Essendon	0.55	Hastings	1.11
Northcote	0.44	Heidelberg	0.55	Mornington	1.25
Moorabbin	0.44	Werribee	0.59	Flinders	1.55
Camberwell	0.44	Springvale	0.59		
Hawthorn	0.44	Chelsea	0.60		
		Broadmeadows	0.60		
		Whittlesea	0.61		
		Keilor	0.62		
		Coburg	0.62		
		Altona	0.62		
		Sandringham	0.63		
		Dandenong	0.64		
		Croydon	0.65		
		Doncaster & Templestowe	0.66		
		Diamond Valley	0.69		

Source: Derived from ABS 1976b and Victorian Ministry of Transport 1981.

With the denser network of public transport services in the older and more central LGAs, residents have better access to public transport. This is reflected in Figure 7 where an index of access to public transport routes in individual LGAs is plotted against their direct physical distance from the CBD. This index has been calculated by adding standardised scores (Z-scores) of access to train, bus and tram services. In each case access has been measured in terms of the percentage of households within 0.8 kilometres of service access points as revealed by the Melbourne Household survey (Victorian Ministry of Transport 1981). An opposite trend is evident in Figure 8 where car ownership levels are plotted against distance from the CBD. A similar increase in car ownership levels towards the periphery has been observed in Perth by Wildermuth (1982) Whether this higher car ownership towards the outer suburbs is an outcome of a lack of alternative transport, a reflection of socio-economic factors, or some combination of both remains to be determined.

In addition to the denser network of public transport services towards the centre, the disparity in access to jobs between public and private transport users is also diminished because central locations are physically closer to the remainder of the metropolitan area. Furthermore, central areas have direct public transport links with most parts of the metropolis, whereas areas towards the periphery only have direct links with

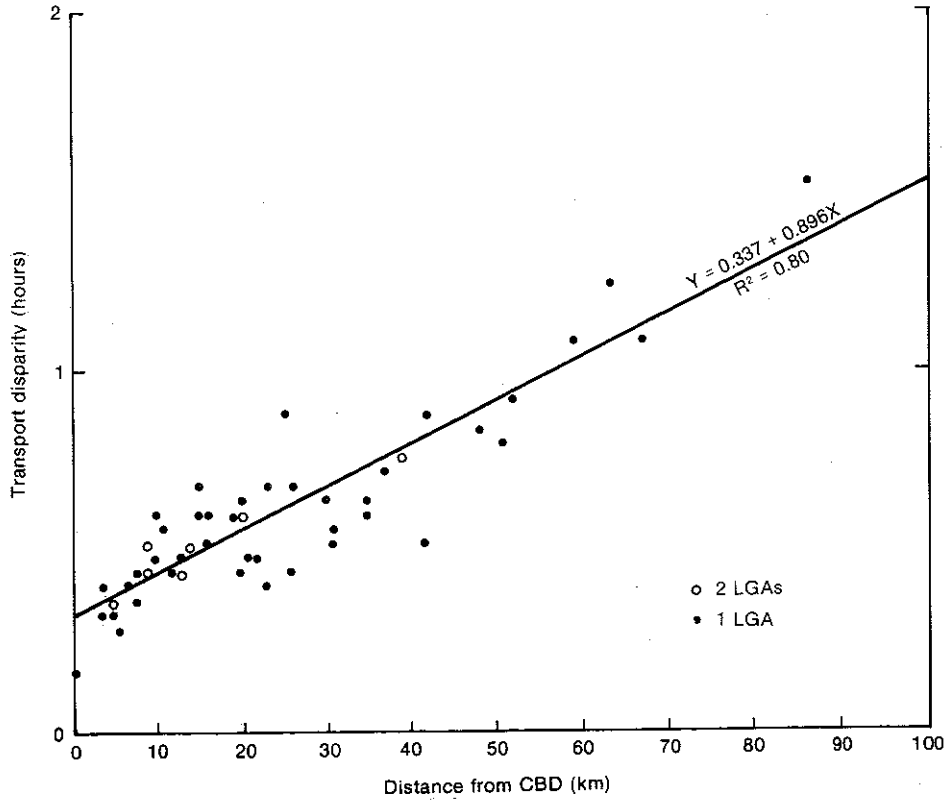

Figure 6 Disparity indexes with increasing distance from Melbourne CBD—all occupations *Source:* ABS (1976a)

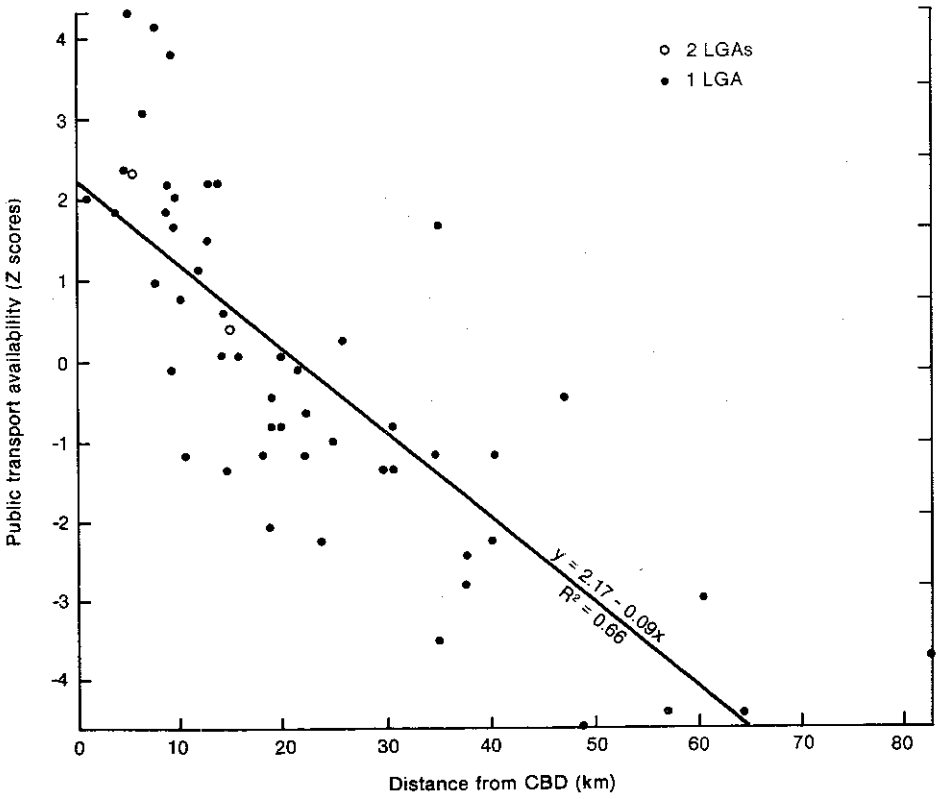

Figure 7 Public transport availability by distance from Melbourne CBD

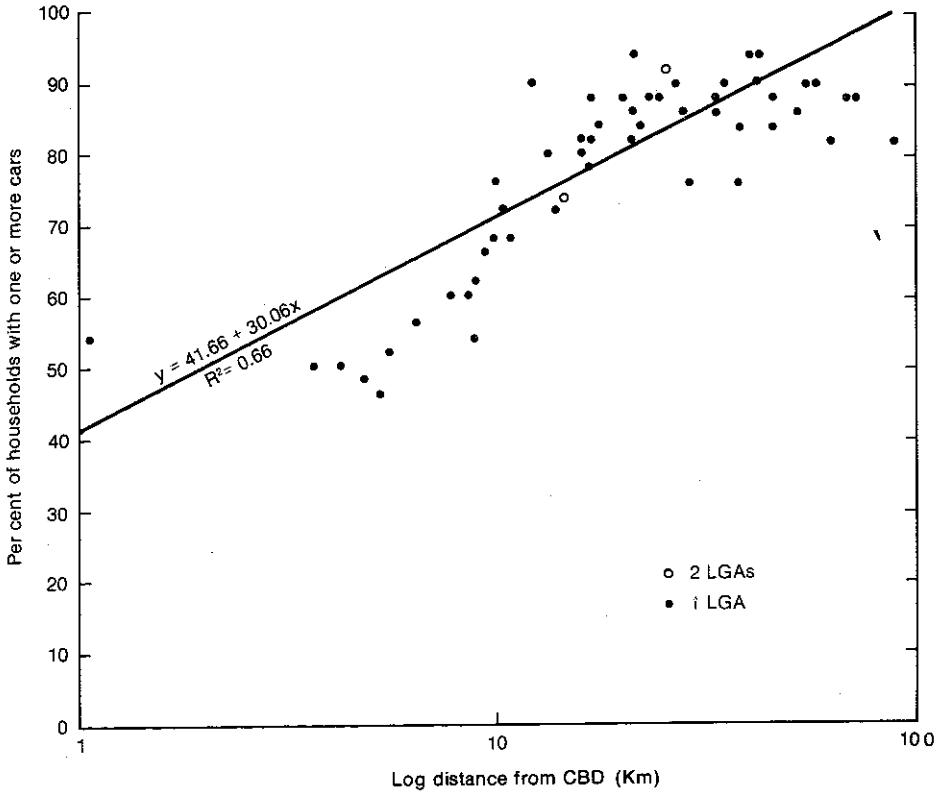

Figure 8 Car ownership levels versus distance from Melbourne CBD
Source: ABS (1976b)

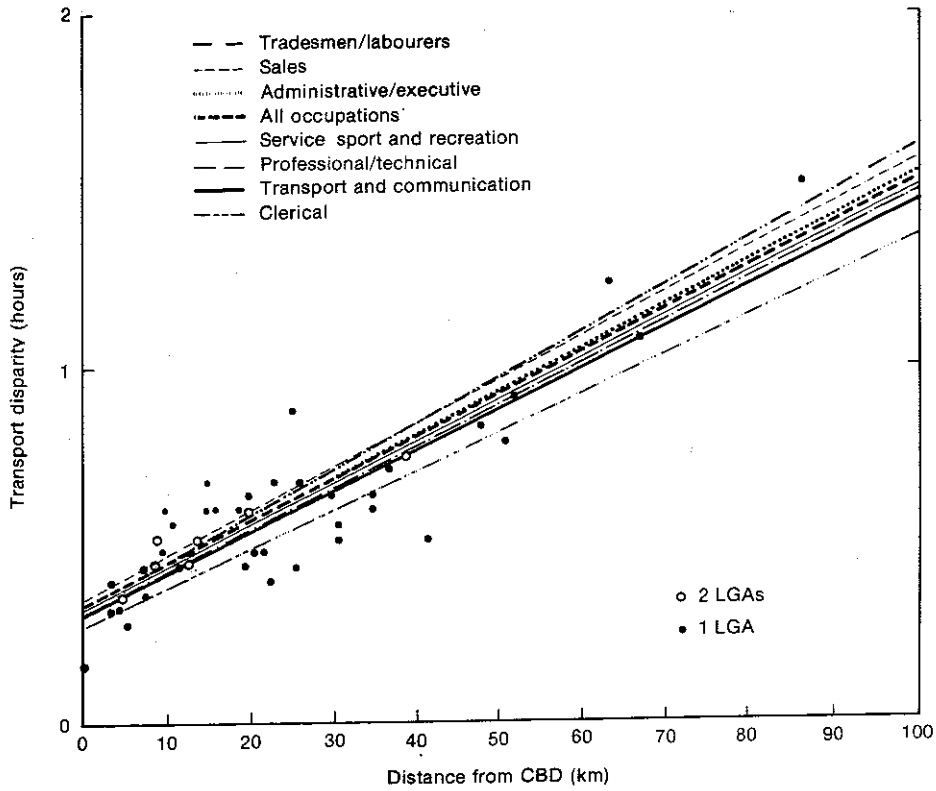

Figure 9 Disparity indexes with increasing distance from Melbourne CBD, by occupation
Source ABS (1976a)

other areas in the same corridor. These variations in accessibility are reflected in labour shed patterns referred to in the previous section.

Another factor which disadvantages suburban residents relying upon public transport for the journey to work is that, as mentioned previously, many suburban employment centres are located away from the main public transport routes. This shows up in Figure 9 where disparity indexes for jobs in different occupations are plotted against distance from the CBD. Trend lines for occupations which have recently shown a greater tendency to decentralise (labourers and sales workers) are steeper than those which have remained relatively concentrated (especially clerical workers).

RELATIONSHIPS BETWEEN ACCESSIBILITY AND UNEMPLOYMENT PATTERNS

In measuring the relationship between patterns of unemployment and accessibility, allowance had to be made for the confounding effect of the residential segregation process. As the incidence of unemployment is higher among some groups than others and spatial concentrations of these groups occur, variations in the social characteristics of residential populations may obscure the hypothesised relationship between accessibility and unemployment.

Census data reflecting the presence of vulnerable groups in individual LGAs was therefore included in the analysis. Taking into account earlier observations about the nature of groups having particularly high rates of unemployment, five variables were selected;

- the proportion of the labour force in the 15-19 age group (Age 15-19);
- the proportion of the labour force in the 20-24 age group (Age 20-24);
- the proportion of the population born in non-English speaking countries and resident in Australia less than 5 years (Migrants);
- the proportion of the population with no formal qualifications (No qualifications) - a surrogate measure for the proportion of unskilled workers;
- the proportion of the population not living in the same LGA in the previous year (Transience).

The last of these variables has been included on the basis of previously observed relationships between geographic mobility and unemployment in Melbourne (Brewer 1980) and Manchester (Hedges and Hopkins 1981).

There are a number of reasons why high population turnover might be associated with high levels of unemployment. Areas with a large amount of rental accommodation tend to have a mobile population. People living in rented houses and flats are mainly in the low income groups, and/or are relatively young (ABS 1980, p227), and hence vulnerable to unemployment. In addition to this, the availability of low cost rental housing attracts unemployed people to the area, thus making transience both a cause and effect of unemployment.

A stepwise regression technique was adopted so that the relative impacts of job accessibility and residential social segregation upon spatial patterns of unemployment could be evaluated. Variables included in the analysis are listed in Table 5. All three accessibility indexes described in the previous section were included as independent variables

along with the five social variables. Four separate regression analyses were carried out to enable the differing importance of independent variables with respect to four unemployment groups (adult females, junior females, adult males and junior males) to be assessed.

TABLE 5 - VARIABLES INCLUDED IN THE ANALYSES OF RELATIONSHIPS BETWEEN UNEMPLOYMENT AND SOCIAL SEGREGATION VERSUS ACCESSIBILITY

Dependent variable	Independent variables	
	Social segregation	Accessibility to jobs
Junior female unemployment	Recent migrants	Public: $A_{im}(1.0)^{(a)}$
	Unskilled workers	Private: $A_{im}(0.5)^{(a)}$
Adult female unemployment	Population aged 15-19	Private-Public transport
Junior male unemployment	Population aged 20-24	disparity
	Transience	
Adult male unemployment		

(a) Indexes transformed by subtracting from 100 to make the sign of expected relationships consistent with those for all other independent variables.

Results of the analysis are summarised in Table 6 where only those variables which explain variations at a statistically significant (0.05) level have been included. These results are discussed separately for each unemployment category.

Adult Female Unemployment

Residential segregation variables reflecting high concentrations of teenagers (Age 15-19) and recent migrants from non English speaking countries accounted for 37 per cent of the variation in adult female unemployment among LGAs. After these factors have been taken into account the disparity index explained an additional 12 per cent of the variation, and the accessibility index based on public transport explained another 3 per cent of the variation. Residential segregation variables are clearly more important than these indicators of accessibility in explaining patterns of adult female unemployment. However, the importance of public transport variables, relative to the private transport accessibility variable reinforces previous comments concerning the importance of public transport in determining access to jobs for adult females.

Junior Female Unemployment

The disparity index appears to be the most important variable explaining variations in junior female unemployment. Again, this is consistent with previous observations indicating that this group is heavily dependent upon public transport for travel to work. None of the residential segregation variables was found to contribute significantly to the distribution of junior female unemployment when considered in conjunction with accessibility variables.

TABLE 6 - MAJOR DEMOGRAPHIC AND ACCESSIBILITY VARIABLES EXPLAINING SPATIAL VARIATIONS IN UNEMPLOYMENT

Dependent variable	Independent variables	B coefficient	Standard error of B	F statistic (significance)	R^2
Adult female unemployment	Age 15-19	0.05	0.05	0.76 (0.00)	0.22
	Migrant	0.38	0.10	13.27 (0.00)	0.15
	Disparity	0.04	0.99×10^{-2}	14.34 (0.00)	0.12
	No qualifications	0.07	0.03	7.62 (0.01)	0.08
	Pub: A_{im} (1.0)	0.01	0.66×10^{-2}	4.16 (0.05)	0.03
					0.60
Junior female unemployment	Disparity	0.11	0.03	19.69 (0.00)	0.27
					0.27
Adult male unemployment	Migrant	0.54	0.12	25.86 (0.00)	0.31
	Disparity	0.05	0.01	18.46 (0.00)	0.16
	Priv: A_{im} (0.5)	-0.02	0.82×10^{-2}	6.11 (0.00)	0.09
	Transience	0.05	0.02	5.00 (0.03)	0.04
					0.60
Junior male unemployment	-	-	-	-	-

Source: Derived from ABS 1976a, ABS 1976b and Ministry of Transport Victoria 1981.

Adult Male Unemployment

The presence of recent migrants from non-English speaking countries predominates over all other factors in explaining variations in unemployment among adult males. 'Migrants' accounts for 31 per cent of the variation compared with 16 and 9 per cent accounted for by the disparity index and private transport access respectively. However, the relationship between adult male unemployment and accessibility variables is somewhat more complex than this analysis suggests.

The plot in Figure 10 represents the relationship between adult male unemployment (vertical axis) and private transport access to employment (horizontal axis). A simple bi-variate regression produces a counter-intuitive result with unemployment apparently increasing with increasing accessibility. However, the plot approximates a U-shaped distribution rather than the linear pattern assumed by the simple bi-variate approach. Indeed, when a quadratic function is fitted, a statistically significant (0.01 level) relationship is evident. Details of the quadratic regression are provided in Table 7.

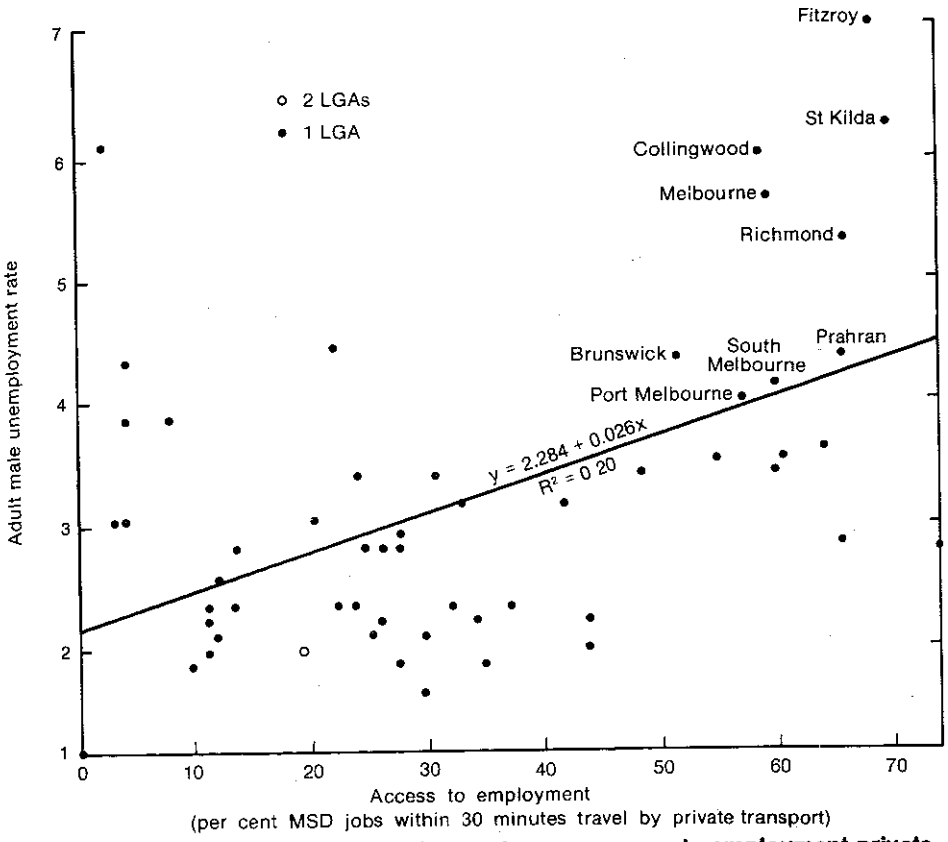

Figure 10 Adult male unemployment versus access to employment private transport ($Aim_{0.5}$)

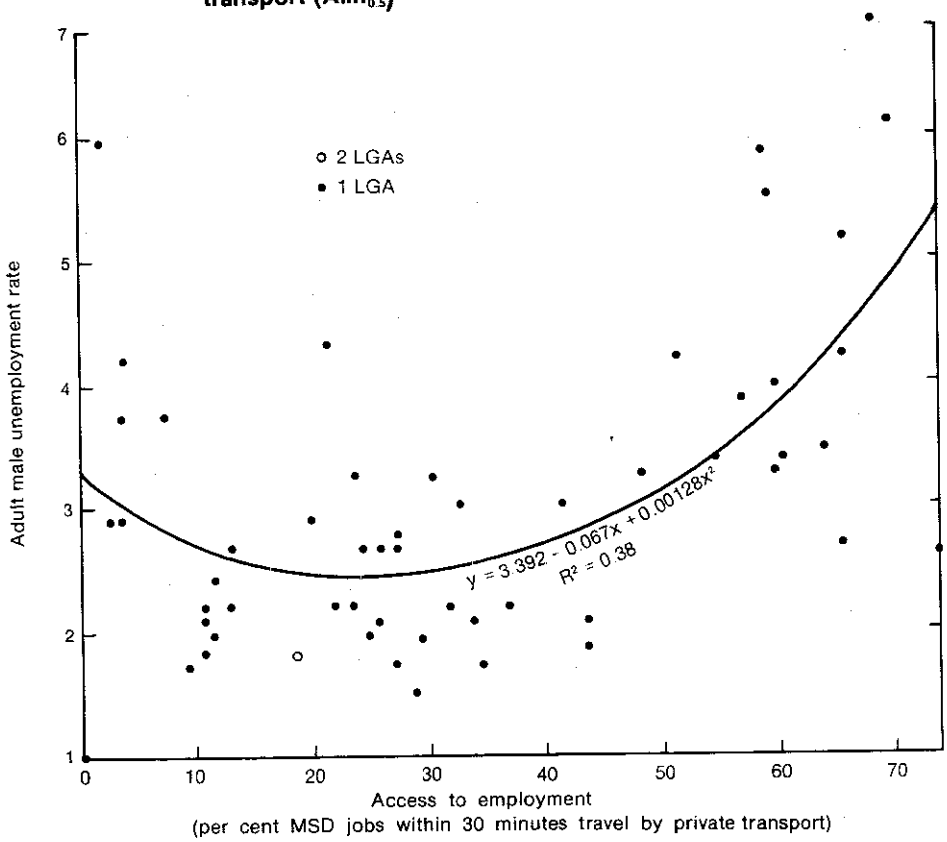

Figure 11 Quadratic function for adult male unemployment levels by private transport access ($Aim_{0.5}$)

TABLE 7 - QUADRATIC FUNCTIONS DESCRIBING THE RELATIONSHIP BETWEEN ADULT MALE UNEMPLOYMENT AND ACCESSIBILITY

Dependent Variable	Independent variable	B coefficient	Standard error of B	F statistic (significance)	R^2
Adult male unemployment	Priv: A_{im} (0.05	-0.07	0.03		
	$(\text{Priv: } A_{im})^2$ (0.5)	0.13×10^{-2}	0.03×10^{-2}	15.96 (0.000)	0.38
Adult male unemployment	Pub: A_{im} (1.0)	-0.08	0.02		
	$(\text{Pub: } A_{im})^2$ (1.0)	0.13×10^{-2}	0.03×10^{-2}	17.73 (0.000)	0.40

Source: Derived from ABS 1976b and Ministry of Transport Victoria, 1981.

Figure 11 demonstrates the fit of the quadratic function to the data previously plotted in Figure 10. This trend implies that beyond a certain threshold, transport and locational factors are related to unemployment in a manner consistent with the proposition that these factors exacerbate unemployment. Thus, based on the location of the minimum point in the curve, it appears that unemployment levels are mainly affected negatively by accessibility among those LGAs which have accessibility indexes less than about 26 (on the A_{im} scale).

Migrant presence is the other factor which intervenes to confound any simple relationship between accessibility and unemployment among the remaining LGAs. This is evident in the refined stepwise regression model described in Table 8 where squared values of disparity and accessibility indexes were included to allow for the quadratic pattern. LGAs which register high levels of adult male unemployment, despite their relatively high accessibility (see Figure 10) are all inner suburbs which also have relatively high concentrations of migrants. The proportion of the population in these LGAs who are recent migrants from non-English speaking countries ranges from 2.6 per cent (South Melbourne) to 5.8 per cent (Richmond) while the average for all nine LGAs is 4.4 per cent compared with 1.9 per cent for the MSD as a whole (ABS 1977).

As in the case of adult females, spatial variations in adult male unemployment are influenced by locational and transport factors, but this influence is secondary to certain social factors. Moreover, there is only a limited number of LGAs in respect to which there exists a positive relationship between lack of access to jobs and unemployment. These LGAs mainly include outer suburbs where extremely high disparity indexes imply that the disadvantage of those dependent upon public transport (*vis a vis* those with access to private transport) is most pronounced.

TABLE 8 - MAJOR DEMOGRAPHIC AND ACCESSIBILITY VARIABLES EXPLAINING SPATIAL VARIATIONS IN ADULT MALE UNEMPLOYMENT: SQUARED ACCESSIBILITY VARIABLES ADDED

Dependent variable	Independent variable	B coefficient	Standard error of B	F statistic (significance)	R^2
Adult male unemployment	Migrant	0.50	0.09	28.82 (0.00)	0.31
	$(\text{Disparity})^2$	0.11×10^{-2}	0.37×10^{-3}	9.25 (0.00)	0.22
	Transience	0.05	0.02	6.23 (0.00)	0.07
	$\left(\text{Priv: } A_{im}\ (0.5)\right)^2$	0.01×10^{-2}	0.03×10^{-2}	11.97 (0.03)	0.04
	Priv: A_{im} (0.5)	-0.13	0.03	14.31 (0.03)	0.04
					0.68

Source: Derived from ABS 1976a, ABS 1976b and Ministry of Transport Victoria 1981.

Junior Male Unemployment

Junior male unemployment rates proved to be the most difficult to describe using the variables included in this analysis. However, as in the case of adult males, junior male unemployment rates tend to produce non-linear distributions when they are plotted against accessibility indexes. Consequently, as is evident in the results recorded in Table 9, when squared accessibility predictors are included a more satisfactory model is produced in which the impact of public transport is highlighted.

TABLE 9 - MAJOR DEMOGRAPHIC AND ACCESSIBILITY VARIABLES EXPLAINING SPATIAL VARIATIONS IN JUNIOR MALE UNEMPLOYMENT : SQUARED ACCESSIBILITY VARIABLES ADDED

Dependent variable	Independent variable	B coefficient	Standard error of B	F statistic (significance)	R^2
Junior male unemployment	$(\text{Disparity})^2$	0.52×10^{-3}	0.26×10^{-3}	4.06 (0.05)	0.21
	Pub: A_{im} (1.0)	-0.27	0.13	4.42 (0.04)	0.06
					0.27

Source: Derived from ABS 1976b and Ministry of Tran ictoria

CONCLUSION

Notwithstanding the decentralisation of employment that has occurred in the Melbourne metropolitan area over the last decade, suburbs on the periphery continue to be markedly less accessible to employment than those closer to the centre. Furthermore, the pattern of metropolitan development has been such that those who rely upon public transport are disadvantaged in terms of their access to employment, and this disadvantage increases towards the periphery. Unemployment rates among all groups included in the analysis reflected these patterns of accessibility, although residential social segregation factors appear to be more influential in the case of adults.

Spatial variations in unemployment rates among juniors generally appear to be more a product of accessibility than of social factors. In particular, the disparity between accessibility achieved by public and private transport emerged as a key factor. Even so, the variables utilised in this analysis were unimpressive as a basis for describing patterns of junior unemployment when compared with the degree of explanation achieved for adults. This may be due to critical variables in youth unemployment being omitted, or because youth unemployment is so pervasive that any disadvantages arising from transport and locational factors have little impact on differentials between areas.

While the analysis described in this paper indicates that there is some evidence of a relationship between access to jobs and unemployment patterns, it provides few insights into why such a relationship exists. However, discussions with unemployed people and professionals involved with the unemployed in Frankston and St Kilda have provided the basis for some speculations concerning the nature of the link between transport and unemployment.

Apart from the impact that variations in transport availability among different socio-economic groups may have within areas, the following conditions related to transport may exacerbate unemployment problems experienced in some areas:

- The cost of transport may restrict the number and range of job opportunities that can be responded to and erode the incentive to find work;
- Transport may actually cause unemployment where disrupted journeys, arising from poor connections or unreliable services, lead to dismissals owing to the effect on worker punctuality;
- Alternatively, journeys to work which are made especially taxing because of poor connections and/or the distance involved may eventually lead to dismissals or resignations owing to the effect on motivation and effectiveness at work;
- For people who are dependent upon public transport, jobs with irregular hours may be unsuitable because of the lack of services outside peak periods;
- Transport considerations may also affect the chances of gaining employment because of employer discrimination. For punctuality reasons, many employers prefer local residents or applicants who own a car. Also, some employers may be reluctant to train people who have to travel long distances because they suspect that the trainee will resign as soon as a suitable job closer to home becomes available.

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TRANSPORT AND UNEMPLOYMENT

The reliance upon speculations to explain the relationships we have observed highlights the need for a more systematic and intensive social research effort aimed at identifying precisely how unemployment is affected by transport. It is hoped that this paper will provide a stimulus for such research.

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