Measuring Temporary Mobility: Dimensions and Issues

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Abstract
In contrast with developing countries, the literature on temporary mobility in the developed world is fragmented and unsystematic. This paper endeavours to delineate, for the first time, a battery of measures and techniques that capture the multiple dimensions of temporary movement. Following a review of the problems in measuring population mobility the paper identifies nine dimensions of population movement, each of which describe a particular facet of the phenomenon. These are: (i) movement intensity (ii) duration of stay (iii) frequency of movement (iv) seasonality (v) periodicity (vi) movement distance (vii) spatial connectivity (viii) spatial circuits and (ix) spatial impact. Each dimension is defined and its significance in the study of temporary mobility explored. We then show how the nine dimensions can be used to capture three spatial perspectives on mobility: the national picture; individual destination zones; and movement patterns. Measures and their applications for each perspective are illustrated using data from the Australian Census of Population and Housing and the National Visitor Survey.

1. Introduction

Contemporary analysis of population mobility has primarily focussed on the processes and impacts associated with permanent migration – defined and measured as a change in place of usual residence between two periods of time. With reductions in the friction of distance and cost of travel, there has been a commensurate rise in the intensity of population movement, and an increase in the diversity of its forms. One aspect has been the rise in temporary mobility, defined here after Zelinsky (1971), as movements that involve one or more nights stay away from home, but lack any stated intention to make a permanent or lasting change of

usual residence. Temporary moves encompass a wide variety of purposes ranging from holiday travel to seasonal migration; from short business trips to long distance commuting; and from hospital stays to conference travel. They may last from a single overnight stop to an absence of several weeks or months, involve a solitary destination or multiple stops, and range in distance from local moves to international travel. They may be sporadic or regular in occurrence, and follow fixed patterns in space or be highly variable. The unifying feature is the absence of any intention to make a lasting change in usual residence. Thus we use the term 'temporary mobility' here in the widest sense to encompass both occasional, short distance trips to a single destination as well as more complex forms of circulation that involve regular sequences of travel through space and time.

Temporary mobility has attracted attention from a range of disciplines and spawned a variety of conceptual schemas. Circulation featured strongly in Zelinsky's (1971) mobility transition but others have proposed more detailed classifications. Rothman *et al.* (1975), for example, classified 'recurrent migrations', according to purpose of move while Smith (1989) focused on the time dimension. differentiating diurnal activities from those that involve one or more nights away from home, arguing that the latter involve more seasonal variability and impose quite different demands at the destination. More recent approaches have introduced a biographical approach. McHugh, Hogan & Happel (1995) propose a life course perspective that recognises the development of recurrent mobility and multilocale relationships from childhood through to old age. Despite their intuitive appeal, few attempts have been made to operationalise these conceptual schemas.

Empirical work on circular mobility had its genesis in the developing world (Chapman and Prothero 1983; Prothero and Chapman 1984), with a primary focus on labour migration in Africa (Taylor 1986) and rural-urban linkages in Southeast Asia and the Pacific (Bedford 1973). Much of this work was descriptive, utilising purposive surveys to focus on population movements in selected communities, but some statistical measures were proposed.

Interest in temporary mobility in developed countries is more recent, and has tended to focus on specific types of move, rather than particular places. Examples include seasonal migration of the elderly, long distance commuting, second home owners, and business travel (see eg Longino and Marshall 1990, Green *et al.* 1999, Hall & Müller 2004, Swarbrooke and Horner 2001). Attempts are now being made to identify links between different forms of mobility

(Hall and Williams 2002). Interest has also been shown in the spatial patterns of population movement (Gober and Mings 1982; Bell and Ward 1998; Bell and Brown forthcoming a) and in measuring their impacts at the local level (Smith 1989). To date, however, what is missing from this expanding literature is a clearly defined and commonly agreed set of metrics that capture the space-time dynamics of temporary mobility.

In practice, the task of assembling a comprehensive set of measures of temporary mobility is by no means straightforward. In section 2 we review the extant literature and summarise achievements to date. Section 3 details key measurement and data issues that hinder the research. In sections 4 and 5 we advance nine dimensions of temporary mobility that, we argue, capture the various dimensions of temporary mobility in space and time, and link these to three discrete spatial perspectives, each of which calls for a different mix of these dimensions and measures. Section 6 illustrates the proposals drawing on data from the Australian Census and National Visitor Surveys. We conclude with a summary of what has been learned to date, enumerate outstanding issues and identify avenues for further work.

2. Prior work

The need for quantitative measures of temporary mobility has been recognised by a number of workers. These efforts have been confined primarily to developing country contexts (Taylor and Bell 2005) and have focused largely on the frequency, timing and duration of the moves. Among the earliest examples is Mitchell's (1956) labour stabilisation index which endeavoured to capture the shift from circular movement to permanent residence, measured simply as years resided in town since age fifteen, divided by total years lived since age fifteen. Subsequently Alverson (1967) used longitudinal data to plot the total time spent in town as a function of the cumulative age of migrants for successive three year intervals to produce a stabilisation curve. Although this method provided a greater level of precision on the temporal aspects of circulation, it served to generalise key features in the data – namely frequency and spacing of movements.

Graph theory techniques have also been used to quantify circulation and include measures of the intensity of circulation (Young 1979) and the velocity of circulation (Standing 1982). The first of these compoared the number of return moves to total moves, while the second focused on duration of time away from usual residence. A limitation of both methods is that they

deliver a measure of circulation in the context of overall mobility, but lose key aspects of the underlying dynamics of the movement, especially the frequency, duration and timing of circulation.

More recently Taylor (1986), building on the idea of life lines originally developed by Hagerstrand (1963), suggested two indices that capture two of these dimensions - the frequency and duration of moves. The first index, termed the frequency of movement *f*, measures the number of cycles within a defined period, while the second index, *p*, measures the proportion of total time away from home. Frequency is effectively measured on an open-ended scale, ultimately constrained only by the value selected for *t* (time), whereas *p* must lie in the range $0 \geq p \geq 1$ where, as $p \rightarrow 1$, time away from home is maximised. Taylor used these indices to track the evolution of circular moves among mine workers in Botswana, but they also have application in comparing differing mobility regimes which is undertaken in Section 6.

Some analysis in developed countries has also focused on the spatial circuits of particular groups. For example Mings (1997) tracked the movements of snowbirds in Australia and more recently Hanson and Bell (2005) have traced the seasonal migration of harvest labour. Such studies have tended to be largely descriptive, however, mapping the patterns but without any attempt to quantify movement dynamics. However, a separate subset of the literature has focused at other spatial scales. In one early study, Gober and Mings (1984), examined the geography of households away from their usual residence 1980 US Census, and this approach was replicated and extended in Australia by Bell and Ward (1998) and subsequently by Bell and Brown (forthcoming a). In both cases the focus was on patterns of displacement between regions at the national level at a particular point in time. Other studies have focused on the effects of temporary migrants on particular localities, typically on the destination zones (Smith 1989; 1994). Thus it is evident that temporary mobility operates at a range of scales. Indeed, as Chapman and Prothero (1983) observe, to fully comprehend the complex nature of temporary mobility, the phenomenon must be studied at several scales: the micro (family, individual); the meso (community, region); and the macro (national).

From this concise review two key factors are clear. First, little attention has been given to providing quantitative summary indices of temporary mobility and most indices that have been proposed capure only part of the overall dynamics of the movement. Secondly, the

spatial circuits that absorbed early analysts represent only one perspective on temporary movement. Such moves invite a range of alternative perspectives at different levels of spatial scale. At the national level, the totality of such moves in combination generates an ephemeral, but ever-changing shift in the disctribution of the population while at the local level they exert a profound impact on the size and composition of the population in a way that also alters over time.

We argue that to capture these dynamics requires a battery of measures, each of which focus on a particular dimension of temporary population movement. Nine such dimensions are identified. However, these dimensions in turn need to be considered in the context of three alternative perspectives on temporary mobility, formed around different scales of analysis.

3. Issues in measuring temporary mobility

The task of assembling a comprehensive set of measures of temporary mobility is by no means straightforward. Even in the field of permanent migration, differences in the way migration is captured in statistical collections, together with the traditional problems arising from the division of space and the measurement of distance, have severely handicapped comparative analysis, and proposals for robust general measures are only now beginning to emerge (Bell et al. 2002, Rees et al. 2000). In the case of temporary mobility, these problems are compounded by the multidimensional nature of the phenomenon, most prominent among which are the latter's variable duration, repetitive nature and seasonal variation. Building on a recent analysis by Bell *et al.* (2002), we focus on four main sources of error. These derive from:

(a) definitional issues;
(b) measurement issues;
(c) temporal issues;
(d) spatial issues;

Definitional issues

Temporary mobility is perhaps most readily defined as the complement of permanent migration: that is, as any form of territorial movement that does not involve a lasting change of usual residence (Zelinsky 1971). Such a definition encompasses all forms of temporary mobility from diurnal activities such as commuting to moves occurring over a longer duration

such as seasonal agricultural workers. Smith (1989) advances reasons for separating daily activities from those that involve an overnight stay, however this still groups short term travel such as for conferences with complex circuits of longer duration away from home, such as those undertaken by travelling showmen and fruit pickers. In fact for the most mobile, the concept of usual residence is inherently blurred. For example, the notion of a single usual residence is scarcely meaningful to many Indigenous Australians whose life and livelihoods involve many multi-local relationships (Taylor and Bell 2004).

Data issues

Arising from these definitional issues are problems associated with data sources and measurement. Temporary mobility occupies such a broad spectrum, that it is not surprising there is a lack of high quality data that capture the myriad forms of temporary movement and the diversity of spatio-temporal behaviour. Some national censuses offer a partial insight into temporary mobility but only provide a snapshot of the phenomenon, albeit for the whole country simultaneously. Tourism surveys are more specifically tailored to capture the complexities of travel, but are limited by their sample size. There are also problems with data quality. By definition the most mobile members of the community are the most difficult to capture and many collections are confined to a subset of the population. Surveys of tourist accommodation occupancy, for example, commonly exclude private dwellings, while omnibus surveys are generally dwelling-based, and hence fail to capture mobility among those segments of the population living in group quarters, many of whom (eg military personnel) are known to be highly mobile. Overall, conventional sources almost certainly unerreport the prevalence of temporary mobility.

Temporal Issues

The time interval over which migration is recorded is fundamental to the study of permanent moves (Kitsul and Philipov 1981), but it also impacts on the measurement of temporary mobility. In survey work one issue is the selection of an appropriate reference period, which needs to be long enough to capture infrequent travellers while avoiding the problems of recall. Richardson and Seethaler (1999) have proposed a method for reconstructing travel frequencies that relies simply on data for the latest trip, whenever conducted, but most surveys continue to adopt some intermediate time frame, generally around 1-3 months, as the reference period. While fixed periods readily capture data on frequency of travel, surveys provide no simple way of identifying regularities in the pattern of mobility over space and

time, such as weekly commuting (Green et al. 1999). Moreover, to qualify as regular behaviour suggests some minimum level of repetition, requiring a lengthy observation period. A related problem is that the reference period fundamentally determines the apparent prevalence of termporary moves within the community. As the period lengthens, the proportion of respondents reporting a move will rise, but not in a linear manner. These issues become especially problematic in the case of travel that involves extended cycles, such as seasonal migration.

Spatial issues

Measurement of distance also need to be considered. Common practice is to compute Euclidean distance between [population] weighted centroids for inter-zonal moves (Bell and Brown forthcoming a) or to use a proportion of the zone's radius for intra-zonal moves (Rogerson 1990). Neither reflects the true distances travelled by migrants and both are affected by size and shape of the zone together with population distribution within the zone. Furthermore the notion of temporary mobility infers return travel raising the question of whether distance should incorporate measurements of the outward- and inward-bound journeys thus providing a measure of distance for the whole trip. For analyses based on regional data, attention is also needed to the way space is divided - the Modifiable Areal Unit Problem (MAUP) (Openshaw 1983, Wrigley *et al.* 1996), because the relationships and conclusions evident at one spatial scale may not hold for different levels of disaggregation.

4. Dimensions of temporary population movement

In order to provide a common set of metrics that capture the complex space-time dynamics of temporary mobility, it is necessary to fully understand the key dimensions associated with this form of population movement. Once this has been achieved, measures pertinent to each of these dimensions can be advanced. Drawing on the early ethnographic studies of temporary mobility in developing countries, descriptive studies in developed countries and recent work on cross-national comparisons of permanent migration, we identify nine key dimensions of temporary mobility. These are: (i) movement intensity (ii) duration of stay (iii) frequency of movement (iv) periodicity (v) seasonality (vi) movement distance (vii) spatial connectivity (viii) spatial impact and (ix) spatial circuits. The first five direct attention to the temporal dynamics of temporal mobility, while the remaining four focus on the spatial aspects of the

phenomenon. The following discussion describes of each of these dimensions and, where appropriate, draws attention to measurement considerations.

Movement intensity

Movement intensities aim to capture the overall level, or incidence, of temporary population movements. While ostensibly simple, measurement of such intensities in practice is not entirely straightforward. One important choice is whether to focus on the number of *movers*, or the number of *moves*. Measured over a short interval the two figures will be similar but, as the reference period increases in length, the number of moves will increase more or less monotonically, whereas the count of movers will rise at a steadily declining rate. The difference represents the effect of repeat travel among chronic movers (Long and Bortlein 1990). Both types of data provide useful insights into the extent of temporary mobility. The aggregate number of moves describes the overall level of activity within the system, which is crucial for capacity planning. Data on movers, by contrast, allow the computation of intensities (rates) which show the proportion of the population who engage in temporary mobility. The length of the observation interval therefore assumes particular importnce in comparing populations. Intensities can also be computed at a point in time; for example in terms of the proportion of the population away from home on Census night, or the aggregate number of visitors in an area at time t.

Duration of stay

Temporary moves, by definition, are of limited duration, and the length of trips is therefore a key dimension. Perhaps the simplest approach and most commonly reported in the tourism literature is the average trip duration, computed simply by dividing total visitor nights by total overnight trips. In practice the mean is a poor measure of travel behaviour, since the duration of overnight travel is highly skewed towards shorter durations. In this situation, the median represents a more reliable summary measure.

Frequency of movement

Temporary mobility is repetitive in nature. Over the course of a year, individuals make a variety of trips for a range of purposes involving stays of one or more nights away from home. As with data on duration, frequency might be measured in relation to trips or visits (one trip can involve many visits), but the former seems more intuitive and useful. The length of the reference period over which travel behaviour is measured again becomes an issue

because short periods will inevitably constrain the number of moves that can be captured. This is important because movement frequencies, like proportions moving, cannot simply be 'factored up' to reflect behaviour over a longer period.

Periodicity

Much overnight travel simply represent a response to occasional need or opportunity and appears to follow no discernible pattern. There are many types of movement, however, that display much more regular sequences in space and time and it is these that are generally referred to under the rubric 'circulation' (Chapman and Prothero 1983). Examples of this form of travel include long distance weekly commuting (Green *et al.* 1999) to seasonal migration of the elderly (Mings 1997). What underpin these forms of movement are repetitive patterns of spatial behaviour that display regularities both in the timing of the moves and in their spatial structure. Quantifying this dimension is complicated, because periodicity in this context encompasses three distinct elements: frequency, timing and duration.

Seasonality

While periodicity recognises regularity in frequency and duration, it does not fully capture the way different types of temporary move vary over longer intervals. These variations are better considered under the heading of seasonality. There is now growing recognition that seasonality is of interest as a phenomenon in its own right, rather than as noise in the data, and more focused attempts are being made to develop appropriate quantitative measures (Lundtorp 2001, Koenig and Bischoff 2003). An important decision to make in the study of seasonality is whether simple summary statistics that measure the degree of variation across time periods, generally within a single year are required, or more complex indicators that measure the persistence of the seasonal pattern from year to year.

Movement distance

Population movement is by definition a spatial activity, and one fundamental parameter is the distance moved. Temporary moves involve longer distances than permanent migration (Bell and Brown forthcoming a) which can be related to the reasons for moving. Permanent migration distances are constrained by the predominance of local housing adjustment as a driver of relocation, and the substantial disruption caused by longer distance migration. Temporary moves, on the other hand, provide an ideal means of occasional access to more remote resources, whether for production or consumption-related purposes. However, as

discussed in relation to spatial issues above, measurement of this dimension is complex raising questions of the appropriateness of using standard measurement techniques.

Spatial connectivity

The magnitude of flows between regions in a system varies widely. Part of this variation is a product of distance and population size, but it also reflects the strength of functional linkages between regions (Bell *et al.* 2002). The extent and patterns of connectivity can provide valuable insights into the roles each region plays within the system as a whole and the relations among them. Such links are of long-standing interest to geographers and a variety of terms are used to refer to the phenomenon, including spatial concentration, spatial inequality and spatial focusing.

Spatial impact

Perhaps the single most significant role of both temporary and permanent migration is as an instrument of population redistribution and the resulting effects this has on settlement patterns. We consider this dimension of mobility under the heading of spatial impact. The extent of the asymmetry in the flows between regions determines the extent of redistribution but it is the magnitude of the net movement relative to the host population that determines the aggregate impact.

Spatial circuits

While distance, connectivity and impact capture important dimensions of the displacement that occurs through temporary movements, measures are also needed that encompass the spatial patterns involved in complex circuits involving multiple stops. These are by no means easily derived. One approach is to simply sum the number of discrete stops on a circuit. Tourism geographers have also developed classifications of circuits based on the way localities are connected (Lue 1993), while others have suggested that patterns of circulation among indigenous people might best be described by defining a migration region, demarcated as the outer boundary of activities (Memmott et al. 1991).

5. Spatial Focus

To fully comprehend temporary mobility, the phenomenon must be studied from several perspectives. Chapman and Prothero (1983) advanced three possibilities: family/individual;

community/region; and the national. However, in light of recent studies in developed countries discussed above, we argue for an alternative approach based around: the national level; destination zones; and spatial patterns.

At the national level, analysis is concerned primarily with providing an overall summary of mobility within the system and should seek to provide internationally comparative statistics. At the level of destination zones, what is required are measures of the impact of temporary populations in relation to service demand. For spatial patterns, the interest is in terms of the way sequences and circuits link places and spaces through time. While a case might also be made to examine areas of origin, these seem of less direct interest either for analysis or policy, except in conjunction with areas of destination.

Not all the dimensions listed above are relevant to each of these spatial perspectives (Table 1). At the national level, following the lead of Bell *et al.* (2002) in regard to permanent migration, the most important dimensions are intensity, distance, connectivity and impact. The result is a set of quantifiable measures of how much movement there is in the system, the average distance travelled, whether those movements occur between few or many regions and the effect on population redistribution. However, the temporal dynamics of the movement are also significant and a national perspective should examine the overall frequency of temporary movement among the population, and the average durations of stay.

Table 1: Relationship between temporary mobility dimensions and spatial perspectives

Spatial perspective	Intensity	Duration	Frequency	Seasonality	Periodicity	Distance	Connectivity	Circuits	Impact
National level	■	■	■			■	■		■
Destination zone		■	■	■			■		■
Spatial pattern				■	■		■	■	

For destination zones, the major imperative is to capture the demands imposed by temporary movers. These are variously described in the literature, but one term increasingly used is the 'service population'. For example the Australian Bureau of Statistics defines a service population as "those persons in a particular geographical area who demand goods or services… People in a service population may be permanent or temporary residents." (ABS 2004, p1). Service populations are reflected to some degree in measures of spatial impact, but these typically refer to a particular point in time which may not be representative of other points in the year. Seasonality, the extent of temporal variability in population, therefore needs to be measured. However, frequency of visits and duration of stay also influence the nature of demand in destination zones: frequent visitors are more likely to develop local connections, while those staying for longer periods will utilise a greater range of services. Connectivity may also be of interest, in terms of identifying whether visitors are drawn from a few sources, or from more widely scattered origins.

Spatial patterns direct interest to the way sequences of moves link places and spaces through time. The key dimensions of this perspective, therefore, posses a spatial component, namely: periodicity, connectivity and circuits. However, patterns can change over time so a temporal dimension, seasonality, is also required.

6. Measures of temporary mobility

We now consider each of these spatial perspectives in turn and illustrate their application by means of selected examples, drawing on data from two Australian sources: the Census of Population and Housing and the National Visitor Survey (NVS).

The national perspective

According to the Australian Census of Population and Housing, a total of 832,263 people were away from home on the night of 7th August 2001 (Table 2). This represented 4.4 per cent of the resident population, but the figure rises to just short of 5 per cent if attention is confined to those aged 15 and over, to facilitate comparison with data from the NVS. The Census is scheduled to minimise absenteeism and the snapshot provided by the Census may therefore not be representative of other times of year. However, the higher movement intensity suggested by the NVS data is a product of the different time frame adopted, rather than the date of the Census. Over the four week reference period used in the NVS, more than a quarter

of respondents reported making at least one overnight trip away from home. The NVS data also report the number of trips made during the period and, because of the continuous sample design, this can be factored up to provide a count of trips over a full year. A trip can involve a single destination or multiple stops (identified in the NVS as visits). The total number of visits is therefore equal to or greater than the number of trips. Coupling these counts with the number of nights in each location generates an aggregate count of visitor nights that is numerically impressive (Table 2). The NVS therefore assembles a range of data on temporary moves which, while not intrinsically meaningful as indicators of intensity, do, in combination, provide the basis to measure other critical dimensions of temporary mobility.

Table 2: Measures of intensity of temporary movement, Australia, 2001

Measure	Source	Reference period	Count	Rate[1]
Persons away from home (total)[2]	Census	Point in time	832,263	4.43
Persons away from home (aged 15+)	Census	Point in time	737,720	4.97
Persons making an overnight trip (15+)	NVS	Four week period	4,315,000	27.76
Total overnight trips (aged 15+)	NVS	Four week period	5,771,000	na
Total overnight trips (aged 15+)	NVS	Full year	74,585,000	na
Total visits (aged 15+)	NVS	Full year	87,555,000	na
Total visitor nights (aged 15+)	NVS	Full year	289,644,000	na

Source: ABS 2001 Census (unpublished data), BTR (2002)
Notes: (1) percent of population (2) excludes overseas visitors

A range of measures have been proposed to capture connectivity (Plane and Mulligan 1997; Rogers and Raymer 1998; Bell *et al.* 2002), which include the Coefficient of Variation (CV) and GINI coefficient among others. We focus on the first of these measures. For a single region the CV is calculated simply as the standard deviation of a set of interzonal flows, divided by the mean, which can then be weighted by for each region by its share of system wide migration (Rogers and Raymer 1998). To calculate the CV for a system, the indices are summed across all regions. A low CV score indicates that there is a low level of focussing – the zone/system is well connected. A high CV score shows that there is a high degree of focussing, or little connectivity. This methodology was applied to outflows and inflows of temporary migrants captured in the 2001 census using the 58 Statistical Divisions of Australia as the regional scale of analysis (Table 3). Results for permanent migration are provided for comparison. The analysis shows that at the aggregate scale, there is less spatial focussing for temporary flows. This is due to the greater connectivity (a lower CV value) evident in the outflows. The implication is that temporary outflows are connected more evenly to other

regions (implying less spatial focussing) than temporary inflows, the latter emanating from a more limited range of origins (implying more spatial focussing).

Table 3: Coefficients of variation for flows of temporary and permanent moves, Statistical Divisions of Australia 2001

	Out flows	In flows	Aggregate
Temporary mobility	1.978	2.292	4.270
Permanent migration 2000-2001	2.382	2.353	4.734

(Source: ABS Census 2001 (unpublished data)

The most significant role of migration is as an instrument of population redistribution and the resulting effects this has on human settlement patterns. Bell *et al.* (2002) propose the Migration Effectiveness Index (MEI) and Aggregate Net Migration Probability (ANMP) as the most appropriate measures. The MEI measures the degree of (a)symmetry between inflows and outflows within a system by comparing net flows to gross flows (Equation 1). The ANMP is used to supplement the MEI by providing a quantitative measure of the overall effect of migration on the settlement pattern. It should be noted that these two measures, together with Crude Migration Intensity, are related, ANMP = 100(CMI·MEI), indicating the interdependence of migration dynamics and spatial outcomes (Bell 2002).

$$MEI = 100\sum_{j} | N_j | / \sum_{j} T_j \qquad (1)$$

where:

N_j = net migration in area j

T_j = sum of the inflows to and outflows from j

The MEI possesses bounds which range between 0 and 100, where a score closer to 0 indicates more symmetry and so less population redistribution. It is evident that there is greater disequilibrium in the flows at the State/Territory level compared to Statistical Divisions (SD) (Table 4). For every 100 people that cross a State/Territory border, there is a net redistribution of 34 poeople, whereas the figure drops to 27 at the level of Statistical Divisions. However, the greater symmetry of flows for SDs, are offset by a higher level of intensity which in turn produces a higher ANMP than for the States/Territories. Thus

temporary mover flows at the Statistyical Division level exert a proportionally greater overall impact. Table 4 also sets out results for a system that divides Australia into 630 zones. In this case the MEI is similar to that for Statistical Divisions, but the higher levels of intensity generates a larger impact. These results underscore the influence of zone design on migration measures: effectiveness falls as the number of zones increases, but this can be offset by higher levels of intensity. For meaningful comparative analysis, similar levels of spatial disaggregation are needed for all study areas.

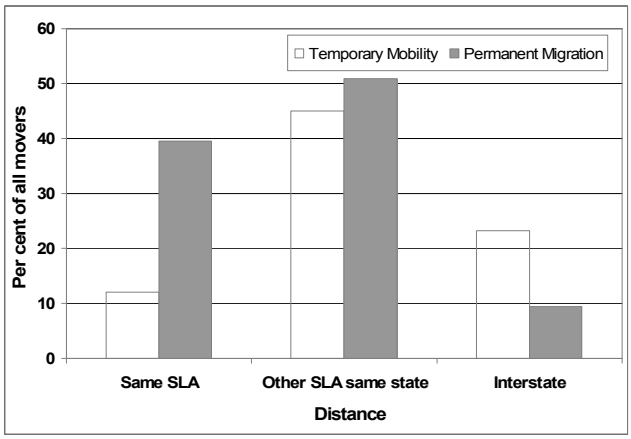
Table 4: Movement intensity, effectiveness and redistribution, temporary (2001) at selected regional scales, Australia

Indicator	8 States and Territories	58 Statistical Divisions	630 zones
Population at risk	18,769,249	18,769,249	18,769,249
Gross flows	240,712	458,293	617,180
Net redistribution	82,015	127,675	172,973
Migration intensity (%)	1.3	2.4	3.3
Migration Effectiveness Index	34.1	27.9	28.0
Net migration Probability	0.4	0.7	0.9

(Source: ABS Census 2001 (unpublished data)

Measures of distance are equally sensitive to the level of spatial disaggregation and are highly dependent on the size of the country considered, for national comparisons, and also zone size within that country. Accordingly, unless zones are analogous comparative analysis may be facile (Bell *et al.* 2002). Figure 1 presents data from the 2001 Australian Census comparing temporary moves on the night of the census with permanent moves occurring over the previous year. Short distance moves, those occurring within the same Statistical Local Area (SLA), comprise a much greater proportion of the total for permanent migration than temporary mobility, accounting for 39.6% and 12.1% respectively. In fact all moves occurring within the same State account for 90.5% of recorded permanent migrations between 2000 and 2001. In contrast, longer distance (interstate) moves are more common among temporary movers (23.3%) than permanent migrants (9.6%). It is clear that there is less friction of distance for those moving temporarily compared to those making a permanent migration.

Figure 1: Comparison of distance moved for temporary mobility (2001) and permanent migration (2000-01), Australia

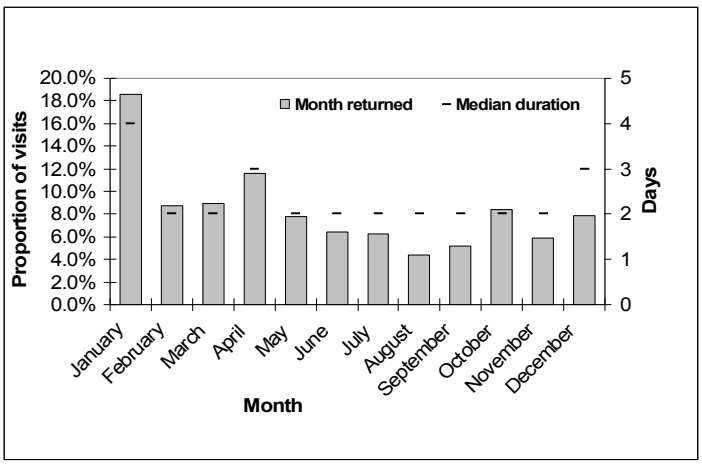


(Source: ABS Census 2001 (unpublished data))

Destination zones

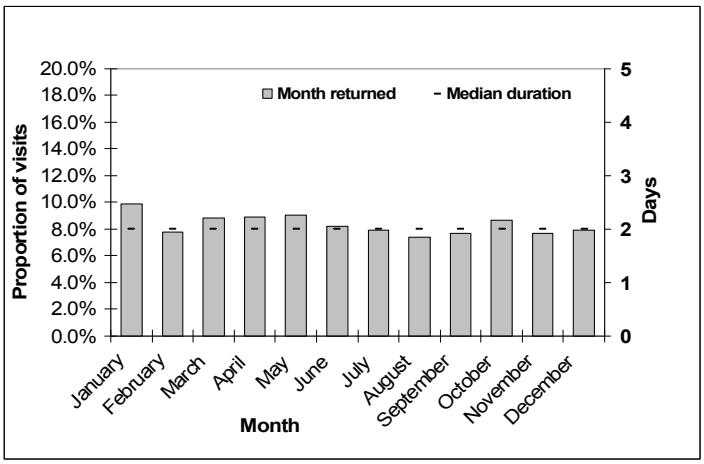
Seasonality and duration of stay were identified as key dimensions in the analysis of temporary mobility focussed on destination zones. The starting point for investigation must be a seasonal plot and this is presented for two tourism areas, as they are known in the NVS – South Coast NSW and Sydney. These two areas display visibly different levels of seasonality (Figure 2 and Figure 3). The South Coast of New South Wales experiences peaks during key vacation periods, most noticeable of which is in January, the main tourist season for this area, though secondary peaks are evident during Easter and Christmas. During these periods the median duration of stay also increases reaching a peak of four days in January, with a median duration of three days in April and October compared with two days for the remainder of the year. In contrast Sydney displays no discernable peak in either timing of visits or their duration. It is arguable there is a small peak over the Christmas and New Year period in December and January, however this has little effect on the median duration of stay. The seasonal plots imply that Sydney is an attractive destination zone, both for business and pleasure, throughout the year whereas the South Coast of NSW is more attractive in the warmer months for seaside vacationing.

Figure 2: Seasonal plot and median duration of stay for South Coast NSW, 1998-2001



Source: BTR National Visitor Survey 2002 (unpublished data)

Figure 3: Seasonal plot and median duration of stay for Sydney, 1998-2001



Source: BTR National Visitor Survey 2002 (unpublished data)

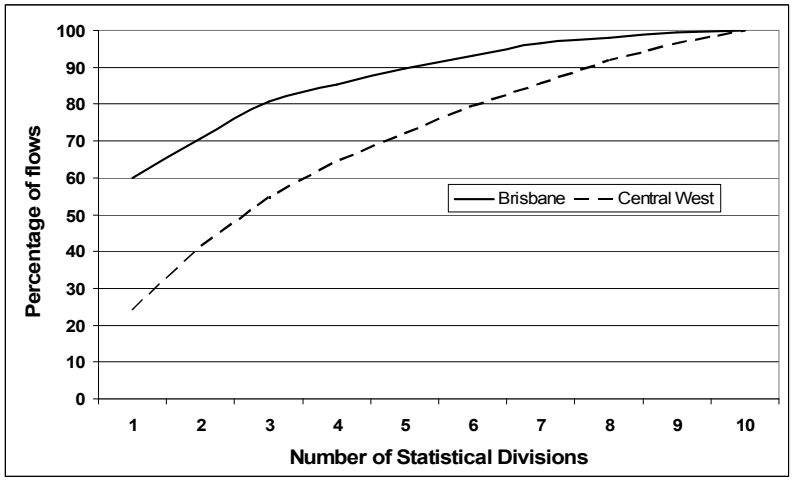
The seasonal plot, though useful, does not quantify seasonality. To achieve this, the Coefficient of Variation and GINI coefficient can be used. Interpretation of CV scores is similar to that used for connectivity: the higher the score the higher the level of focussing on travel in particular months, hence greater seasonality. Low CV scores indicate less focussing and so less seasonality. The greater level of seasonality for South Coast NSW, evident in the seasonal plot, is also borne out in the CV score with the results being 0.435 and 0.085 for South Coast NSW and Sydney respectively. These results are further supported by GINI

index scores, which although are more complex to compute are less affected by extreme values. Results close to 1 indicate more seasonality, while results close to 0 indicate less seasonality. GINI scores for South Coast NSW and Sydney were 0.16 and 0.03 respectively, again supporting the view of greater seasonality of trips to the coastal area.

Measuring connections between origin and destination zones at this perspective demands information on specific flows. Measures such as the Coefficient of Variation and GINI coefficient, although useful at the national level, cannot be used here. Instead attention needs to be turned to the primary and secondary flows to the destination zone, which can be derived from a migration matrix. To elucidate this example, the 11 Statistical Divisions in Queensland are considered. Coefficient of Variation scores ranged from 1.46 for Central West to 1.68 for Moreton revealing that the former is most connected and the latter least connected. However, these scores do not reveal the sources of these flows.

Analysis of the flows of migrants to these two Statistical Divisions reveals that nearly two thirds of all inflows to Moreton are from the neighbouring SD of Brisbane and a further 20% are comprised of flows from Wide Bay Burnett and Darling Downs (Figure 4). In short, 80% of temporary movers to Moreton are drawn from three Statistical Divisions. In contrast, the primary origin of flows to Central West, also from Brisbane, only comprise 25% of the total. Important secondary and tertiary flows are evident from Moreton, Wide Bay Burnett and Fitzroy, accounting for a further 37%. Thus four zones supply only 62% of temporary movers to Central West, underlining the greater level of connectivity of this Statistical Division.

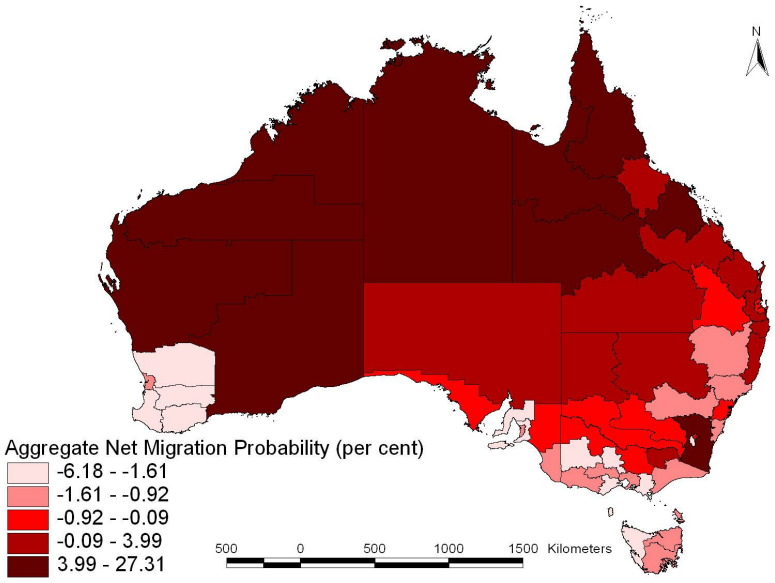
Figure 4: Lorenz curves of connectivity for Brisbane and Central West Statistical Divisions, Australia 2001



(Source: ABS Census 2001 (unpublished data))

The spatial impact on individual destination zones is illustrated in Figure 6 by mapping the net migration rate for temporary movements for individual Statistical Divisions of Australia. The results demonstrate wide variation in the impact of temporary moves. There is also a distinctive spatial pattern, with some of the largest gains in regions remote from the coast and the major population centres. As Bell and Ward (2000) have shown this pattern stands in stark contrast to the redistribution emanating from permanent migration, most of which involves movements away from the inland towards the coast.

Figure 5: Net temporary movement (2001), quintiles, Statistical Divisions of Australia



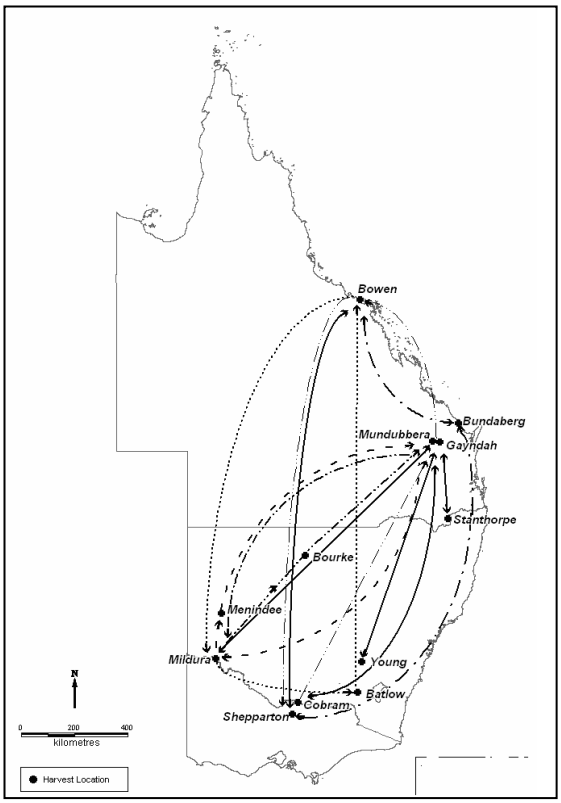
(Source: ABS Census unpublished data)

Spatial Patterns

Despite the longstanding recognition of circulation as an element of mobility in the developing world, remarkably little attention appears to have been given to quantifying the spatial and temporal patterns involved. In practice, such circuits are complex and difficult to capture, as Figure 6 shows. One approach which focuses not on the spatial patterning per se, but on the periodicity of the circular moves is the work of Taylor (1986), mentioned earlier,

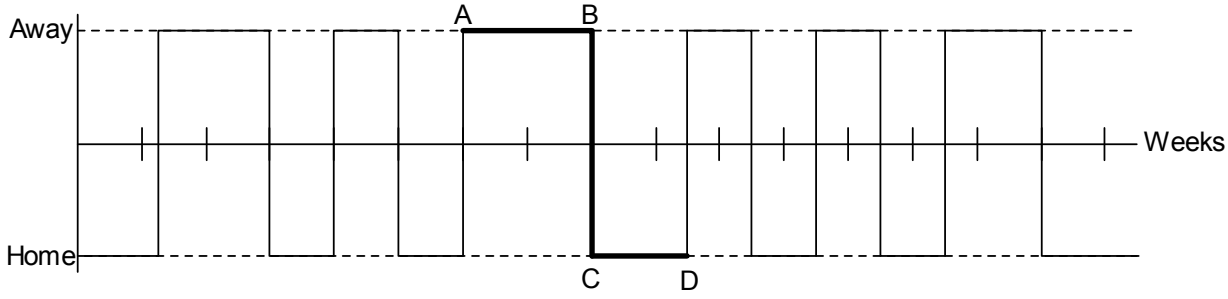
which measuures key elements in the cycle of movement, as illustrtaed in the hypothetical lifeline in Figure 7. Plotting Taylor's two indices, *f* (described by the sequence A-B-C-D in Figure 7) and *p* (proportion of time away), on an x-y scatter graph provides the basis of a comparative tool. Pairing these two dimensions in this way captures the essential structure of cyclic movements.

Figure 6: Major Harvest Trails centred on Gayndah, Mundubbera and Bowen



Source: Hanson and Bell (forthcoming)

Figure 7: Life-line of hypothetical circulator



Source: modified after Taylor 1986 Figure 1.

Empirical data on time sequences of circulation are scant, but some information is available for long distance commuting among miners (Gillies et al. 1997), and Figure 8 combines this with hypothetical data for a number of other well recognised forms of circular mobility. The underlying data are set out in Table 5. The examples display a pattern that is widely scattered across the two axes and clearly differentiates the varying forms of cyclic movement. The lower left quadrant captures temporal behaviour that involves relatively long cycles, of which only a small proportion is spent away from home, such as annual holidays. Moving to the right along the x-axis reduces the length of the cycle and hence raises the frequency of movement. This distinguishes the business woman who makes a 3 day trip once a month, from her peripatetic partner who works interstate one day each week. Located higher on the graph, the weekend-home-owner in this example makes use of his asset throughout the summer months placing him midway along the scale of completed circuits. This movement generates an aggregate period away from home very similar to the illustrative seasonal migrant who, in this case, moves north for three months each year. The upper right quadrant reveals forms of circulation that involve relatively short cycles of which a high proportion is spent away from home, the classic example being weekly commuters, who live near work from Monday to Friday, travelling 'home' only at weekends. Also plotted are the coordinates for fly-in-fly-out (FIFO) workers in the mining sector on three distinctive roster systems. Roster 1, now the most common in Queensland, involves two weeks on and one week off, generating 16 complete cycles per year with two-thirds of the time away from home. Roster 2 is a more intensive schedule of 4 weeks on for one week off reducing the number of cycles to 9.6 but raising time away to 80 per cent. Roster 3, more characteristic of mine management, involves a quite different structure based around short, symmetric cycles.

Figure 8: Frequency and duration away from home for selected types of circular mobility

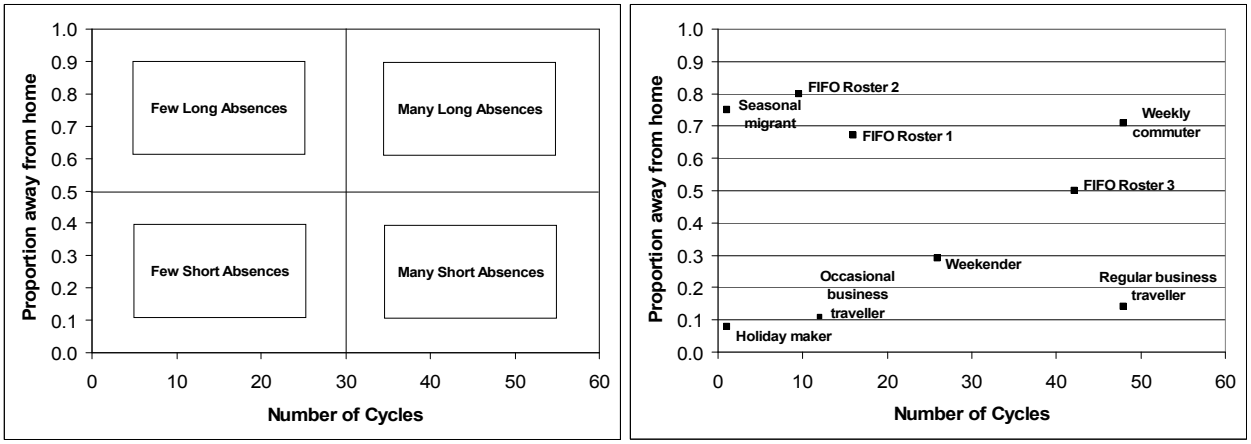


Table 5: Cyclic characteristics of hypothetical forms of circular mobility

Type of circulation	Number of cycles per year	Length of cycle	Time home	Time away	Duration of cyclic pattern	Proportion of cycle away from home
Seasonal migrant	1	One year	9 months	3 months	Full year	0.75
Weekender	26	1 week	5 days	2 days	Six months	0.29
Weekly commuter	48	1 week	2 days	5 days	Working year	0.71
Holiday maker	1	One year	48 weeks	4 weeks	Full year	0.08
FIFO Roster 1	16	3 weeks	1 week	2 week	Working year	0.67
FIFO Roster 2	9.6	5 weeks	1 week	4 weeks	Working year	0.80
FIFO Roster 3	42.1	8 days	4 days	4 days	Working year	0.50
Regular business traveller	48	7 days	6 days	1 day	Working year	0.14
Occasional business traveller	12	4 weeks	25 days	3 days	Working year	0.11

7. Conclusions

Understanding of mobility behaviour depends, to a significant degree, on access to appropriate, reliable data. Scholars concerned with permanent migration, and those who focus on patterns of daily travel have been well served in this regard, with a range of robust statistical sources. Data on temporary mobility are much less extensive, and this, together with the complexity of the issue, has significantly inhibited progress in understanding. While knowledge of some specific forms of mobility behaviour has clearly advanced, what has been lacking is any sense of the overall spatial and temporal structure of temporary population movements, within which these can be situated.

There are a number of reasons to call for a more systematic approach to measuring non-permanent forms of population movement (Bell *et al.* 2002). Development of a set of robust statistical tools should encourage and equip researchers to adopt a rigorous approach to measuring the phenomenon. Use of a standard set of measures also facilitates comparative analysis. Data describing a particular form of movement take on greater meaning when placed in a comparative framework. Commonalities and differences between various forms of mobility also become more readily apparent, which aids classification and theorisation. At a fundamental level, it also seems inherently sensible to establish a common framework against which to interpret an ostensibly diverse array of phenomena that share so many key features in common. Indeed, one clear benefit of a standard metric would be to promote greater coherence, if not integration, among a remarkably fragmented literature (Bell 2001).

This paper has taken some first steps to address this deficiency. Nine key dimensions of temporary mobility have been identified that capture the complex space-time dynamic of this phenomenon. Furthermore an argument to include a spatial perspective in the analysis has been advanced. From this it has been shown that there are overlaps not only between dimensions, but also that some dimensions prove useful for more than one spatial perspective. Importantly the discussion has shown that although a dimension may be relevant to more than one perspective, often different measures are required to capture the significant aspects of that dimension.

Several measurement issues have been identified that remain to be resolved. Most pressing, perhaps, though probably least tractable, is to determine the proportions moving over varying periods of time, and the associated movement frequencies, an issue that depends on the link between moves and movers. Notwithstanding Koenig and Bischoff's (2003) useful contribution, measures of seasonality also merit further creative scrutiny. A parsimonious measure that differentiates the diversity of cyclic travel patterns would also be a valuable addition.

Ultimately, though, it is constraints on data that will present the real hurdle to be overcome. While data on migration events are relatively simple to collect, temporary mobility needs tightly defined space-time sequences that capture the multiplicity of temporary movements. If this can be achieved, it offers great potential for quantitative, comparative studies of this complex phenomenon.

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