DISCUSSION PAPER SERIES

IZA DP No. 443

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## A Reconnaissance Study Using Travel-to-Work Data

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February 2002

Forschungsinstitut
zur Zukunft der Arbeit
Institute for the Study
of Labor

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Discussion Paper No. 443
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IZA Discussion Paper No. 443
February 2002

# ABSTRACT

# Identifying Functional Labour Market Areas in New Zealand: A Reconnaissance Study Using Travel-to-Work Data *

To date, analysis of the spatial dimension of New Zealand labour markets has been limited to administrative, rather than appropriately-defined functional, geographic units. This paper presents a preliminary classification of New Zealand into local labour market areas using area unit travel-to-work data from the 1991 Census of Population and Dwellings and drawing on the regionalisation method of Coombes et al. (1986). After assessing the robustness of the preferred set of local labour market areas, the paper provides some illustrative labour market statistics for these zones. Migration between labour market areas is most likely to be accompanied by changes in job, whereas moves within a labour market are largely assumed to be non-work motivated. As a result, this study provides a more appropriate spatial unit of analysis than any administrative classification for studying migration at a subnational level.

JEL Classification: J61, R12, R23

Keywords: Geographic labour mobility, regional migration, regional labour markets

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* This paper was commissioned by the New Zealand Department of Labour and previously released by them as Occasional Paper 2001/6. A preliminary version of this paper was presented at the 2001 Population Association of New Zealand Conference. The authors would like to thank Professor Michael Coombes for his assistance. The paper also incorporates comments gratefully received from Dr Martin Perry, Associate Professor Philip Morrison, Professor Richard Bedford, Peter Salter and Professor José Manuel Casado-Díaz. The opinions expressed herein are those of the authors and do not necessarily reflect those of the New Zealand Department of Labour. Full results and maps are available online at: http://www.mera.co.nz/projects/NZLLMA/index.htm

## 1. Introduction

> "New Zealand has never been formally divided into local labour market areas the way Britain has, and has therefore not had the benefit of the wide-ranging comparative analysis which these areas are now receiving."
>
> Morrison (1989)

As is maintained by elementary economics texts, labour markets take on some spatial context. Typically, they are implicitly assumed to incorporate distinct geographical areas, so that the market for workers in a particular region is as well defined as the market for a certain type of good. Nevertheless, as observed by Morrison, previous studies of local labour markets in New Zealand have been restricted to a range of often arbitrarily-defined administrative regions. From a theoretical perspective, it would be preferable to use areas that reflect actual functional relationships between workers and jobs. One logical approach that involves such an interpretation of labour markets is to use commuting patterns to identify the borders of labour catchment areas. The aim of this study is to produce a reasonable set of so-called travel-to-work areas for New Zealand. To achieve this, data on residence and workplace location are drawn from the 1991 Census of Population and Dwellings at the area unit level.[1]

As observed by Newell (2001) in his recent review paper on the subject, one potential benefit of work towards delimiting functional labour markets is that it will provide a useful guide for research on migration within New Zealand. By its very nature, migration is linked to the spatial unit of analysis. Different definitions of distance between origin and destination areas have been found to have very significant effects on the measure of migration. Moreover, as noted by Green (1994) and Lichter and De Jong (1990), among others, reasons for migrating tend to vary by distance moved, with economic factors much more important in long-distance movements.

In their review of regional labour market adjustment in New Zealand, Maré and Choy (2001) explored the importance of the choice of spatial dimension for the study of internal migration in this country. Using census data, they found that over the 1991-1996 period, 39.5% of the identifiable population in New Zealand moved

[1] These are non-administrative units used by Statistics New Zealand that can be aggregated to define territorial authorities and regional councils. Although area units within urban areas typically have a population of 3,000-5,000, across the country both the population and size of area units vary widely.

between area units. In contrast, only 21.2% of people were found to have moved between territorial local authority zones and 10.4% between regional council zones. Maré and Choy also noted the problem of including "border-hoppers" in these measures of migration, *i.e.* people who move only a short distance but who cross an administrative boundary. They proposed defining "long moves" as those beyond a distance of 20 km.[2] These are the migration flows that are most likely to be labour market-related and, between 1991 and 1996, they were found to represent 15.2% of the New Zealand population.

By defining local labour market areas in New Zealand, this study will present some estimate of the average distance of moves within which migration can be assumed to be non-work related. As such, it will provide an indication of the appropriate distance threshold that should be used when studying migration at a subnational level. More importantly, the paper will suggest whether this distance varies much across the country.[3] If this is the case, there may be reason for studies of migration to utilise regions that are constructed from area units as indicated by this research or, failing this, administrative units that match the relevant boundaries as closely as possible.

To the extent that functional labour markets represent "self-contained" employment areas, another potential reason for disaggregating New Zealand on the basis of travel-to-work patterns is to evaluate the effectiveness of regional economic development programmes. As observed by Coombes and Openshaw (1982) in Great Britain, travel-to-work areas should closely resemble local labour market areas "so that the assistance to industry in any area is likely to benefit the unemployed of that area and not provide jobs that are largely filled by residents of neighbouring [travel-to-work areas] with lower unemployment rates" (p. 142).

Maré and Choy (2001) observed that "differences in regional size, population density, and the way in which internal migration is recorded in different countries make exact comparisons unlikely" (p. 30). Choosing to define functional labour markets according to an international approach is therefore appealing because it may allow the first valid comparisons of subnational migration rates across countries.

[2] Maré and Choy observed that, using Geographical Information System tools, it is also possible to explore migration patterns using spatial units that are defined by road distance or travel time, as well as Euclidean distance.

Variation in attributes of local labour market areas such as unemployment rates and income levels would also be quantifiable on a consistent basis for each nation. This indicates the benefit of adopting a regionalisation technique for New Zealand that has been used widely overseas.

A loose indication of how closely local labour markets in New Zealand resemble those in other countries can be obtained from a comparison of average commuting times. The 1999 Time Use Survey estimated that paid workers spend an average of 22 minutes travelling to work each day in New Zealand. In the same year, British workers spent an average of 25 minutes travelling to work, according to the Labour Force Survey. The most recent available estimates for the United States are from the 1995 Nationwide Personal Transportation Survey, which indicated that the average journey-to-work time in that country was 20.7 minutes. Although crude, this evidence does suggest that at the national level, local labour markets, as defined by travel-to-work areas, are of a similar *average* geographical size. Nevertheless, there are still likely to be considerable differences between countries in the *distribution* of labour market sizes.

Several other reasons for delimiting functional labour markets have been suggested. For example, these areas may serve as the basis for comparing the reactions of different geographical labour markets to external shocks or for examining changes in the extent and composition of labour markets over time.[4] Local labour market areas could also be used to construct labour market accounts, along the lines of Owen and Green (1989) in the United Kingdom. These accounts provide a means of relating local changes in employment to local changes in the size of the labour force by disaggregating the net change in jobs into the underlying gross flows.

This paper is structured as follows. The following section gives a brief overview of previous work that has addressed the issue of defining functional labour markets, including an outline of the approach that has been taken to determine travel-to-work areas in Great Britain. Section 3 outlines the algorithm that is used to group area units to form a set of local labour market areas for New Zealand. A description of the census data that are used in this study is given in Section 4, along with a discussion of

[3] One hypothesis is that heavily populated urban areas tend to have larger labour market catchment zones, perhaps due to the nature of their employment structure or transport infrastructure.

the results of the regionalisation process. This is followed by an examination of the robustness of the classification. Some basic descriptive statistics for the local labour market areas are then presented in Section 5, while the paper concludes with some recommendations for future work in this area.

## 2. A review of previous studies

Over the past five decades, a copious amount of research has been undertaken around the world with the aim of identifying local labour market areas. These studies have utilised a variety of different methods and have invariably employed different terminology. Coombes (1996) identified three broad approaches to regionalisation. The first, and longest standing, is reliant on manual methods and typically involves designating city centres before assigning remaining areas to these foci. Notably, this is the method used by the United States Office of Management and Budget since 1949 to define official Metropolitan Areas.[5] Under current standards, Metropolitan Statistical Areas are centred on cities of 50,000 or more inhabitants and incorporate surrounding counties that meet specified requirements of commuting to the central counties and other indicators of metropolitan character, such as population density. Highly-populated Metropolitan Statistical Areas may be classified as Consolidated Metropolitan Statistical Areas provided that component areas, known as Primary Metropolitan Statistical Areas, can be identified within the entire zone that meet specified criteria. By 1999, there were 258 Metropolitan Statistical Areas and 18 Consolidated Metropolitan Statistical Areas comprising 73 Primary Metropolitan Statistical Areas.[6]

An alternative approach that is more grounded in statistical methods is to employ numerical taxonomy principles. These are typically based on a single procedure that seeks to maximise a statistical criterion representing the objectives set for the

[4] Local labour market areas are the outcomes of relative demand and supply factors and are, hence, endogenous. It has been noted that by rendering these areas fixed and then measuring demand and supply, such endogeneity is ignored.

[5] See, for example, Dahmann and Fitzsimmons (1995).

[6] The United States Bureau of Labour Statistics also defines labour market areas, which are used for a variety of purposes, including reporting local area unemployment statistics. Major labour market areas are based on metropolitan statistical areas and primary metropolitan areas. Outside of metropolitan areas, small labour market areas are defined by aggregating counties on the basis of commuting. Labour market areas are non-overlapping and geographically exhaustive.

definitions and include cluster analyses and regionalisation-specific algorithms. A well-known example of the latter is the intrazonal interaction maximisation, or INTRAMAX, procedure developed by Masser and Brown (1975). This groups together, in a series of steps, origins and destinations between which relatively large flows exist. Masser (1976) noted that the INTRAMAX procedure "maximises the proportion of interaction that takes place within the aggregations of basic data units… at each stage of the grouping process. In this way the greatest possible amount of precision is retained in connection with those non-trivial flows between contiguous units and the proportion of cross boundary movements is minimised in the process of aggregation" (p. 41). Fischer (1980) provided a summary of the various purely statistical approaches to regionalisation, which can be classified as either hierarchic, like the INTRAMAX procedure, or non-hierarchic.[7] He referred to methods that are defined by the interaction of labour *etc.* as functional regionalisations, in contrast to homogeneous regionalisations, which aim to match inherent attributes of regions, such as their employment structure.[8]

The third general approach to the regionalisation problem that was described by Coombes (1996) is a hybrid of the other two alternatives, in the sense that it is based on a traditional understanding of cities as foci for hinterlands, while relying on multiple-step statistical methods and criteria in order to ensure that the final boundaries meet predefined objectives and can be "optimised" in relation to these objectives. The majority of research on the issue of delineating functional labour markets in this manner has originated from the United Kingdom, although regionalisation exercises have also been undertaken for a number of other European countries. Some of the key studies are discussed later.

An earlier review by Coombes (1992) concluded that the third approach provided the most flexible and reliable form of local labour market area definition. A drawback of using purely statistical techniques is that, apart from a few operational decisions,

[7] Hierarchic methods can be graphically represented by dendrograms, which are tree diagrams consisting of upside-down U-shaped nodes, the heights of which are proportional to the level of similarity between the groups they connect. An example of a hierarchic regionalisation was provided by Slater (1976) for Japan, although he used migration, rather than commuting, data.

[8] With respect to homogeneous regionalisations, Fischer claimed that they should fulfil at least one of two principles: internal homogeneity, whereby individual regions should be as homogeneous in the attribute space as possible, and external separation, whereby different regions should be as much apart in the attribute space as possible. The author further made the distinction between regionalisations and regional typifications, which differ essentially because the former requires all basic statistical units within a region to be contiguous.

they are largely deterministic and are often unable to produce meaningful results when applied to a variety of local labour market types. Meanwhile, Summers (1993) observed a growing awareness among researchers of the limitations of the concept of metropolitan areas for analysis in the United States, insofar as it "does not embrace communities that are clearly large, clearly growing, and clearly attached" (p. 6). In addition, the metropolitan area system is not designed to deal with rural areas and, thus, excludes a large proportion of the area of the United States. Taken together, these observations suggest that in selecting an approach to regionalisation, attention should be restricted to those methods that are based on an *a priori* model of the structure of local labour market areas, while still incorporating statistical criteria that are designed to group similar areas.

Unemployment rates have been reported for local areas in the United Kingdom since 1953. As noted earlier, for statistical reasons it is crucial that these areas constitute local labour markets. Initially motivated by the introduction of the American concept of metropolitan areas, authors have argued that journey-to-work behaviour is the most appropriate indicator of local labour market area dimensions since the late 1950s.[9] However, as noted by Ball (1980), it was acknowledged that the spatial definition of local labour market areas in this manner was, in anything but the simplest economic context, "fraught with the problems associated with simplifying a complex situation and imposing an artificial set of boundaries on an indeterminate and enormously variable set of individual workplace-residence relationships" (p. 126). From 1970, the then Department of Employment began defining and delimiting so-called travel-to-work areas based on a method proposed in work completed by Smart (1974). This drew on census journey-to-work interaction data, subject to the local knowledge of employment office managers.

Smart's basic approach was to initially calculate for each local authority area both the proportion of the resident employed population who were working locally and the proportion of the day employed population who were locally resident. These statistics may be described as measures of supply-side self-containment and demand-side self-containment, respectively. An arbitrary level of 75% self-containment with respect to both statistics was selected as the determinant of independent local labour market

[9] See, for example, Gerard (1958) and Vance (1960).

status.[10] Areas that fail to meet this criterion were associated according to travel-to-work links with all contiguous areas. This process was achieved by first ranking all areas in inverse order of lowest self-containment measure. Within this order, areas were paired with other bordering precincts according to the highest value of a simple "link" formula, which took account of journey-to-work interactions. This procedure continued until a geographically-exhaustive set of local labour market areas that met the 75% self-containment criterion was derived.[11]

Ball (1980) outlined a number of weaknesses in Smart's approach. Some of these were related to assumptions implicit in the approach itself. The method was seen as subsuming structural characteristics of local labour market areas, while ignoring the relative importance of areas as net recipients or contributors of jobs. There was also doubt about the imposition of a contiguity assumption and the need to select an arbitrary self-containment criterion. In addition, Ball questioned the accuracy of the census statistics and the appropriateness of using administrative units of varying shape and size as the basic unit of information.

Coombes and Openshaw (1982) also criticised Smart's method of defining travel-to-work areas. They noted that his algorithm was essentially arbitrary, insofar as "there is no theoretical basis for it, it has properties of neither a statistical classification nor a natural one" (p. 142). In particular, the authors observed that the travel-to-work areas form only one of innumerable possible different aggregations that achieve the goal of 75% self-containment. Smart's approach might be justified, Coombes and Openshaw continued, if it produced travel-to-work areas that were both consistently-defined across the country and reasonably representative of local labour market areas. However, evidence was presented to suggest that, in fact, it achieved neither of these goals.

Many of the above issues were taken account of in the 1984 revision of travel-to-work areas in Britain and in a later paper Coombes *et al*. (1986) described the approach to determining local labour market areas that they had designed specifically

[10] Smart justified this figure "as lying exactly half-way between perfect self-containment and a level of 50% which seems a reasonable minimum for thinking of an area in labour market terms at all" (p. 261).

[11] Crampton (1999) believed that the insistence on an exhaustive allocation of all land areas, including non-urban zones, was a potential weakness of travel-to-work areas (and, hence, labour market areas in the United States).

for this purpose.[12] They noted that any regionalisation method should ensure that, in approximate order of importance, travel-to-work areas: are sufficiently self-contained in terms of commuting flows; have statistical viability in terms of stated definitional requirements of travel-to-work area size and self-containment; are geographically reasonable across the whole country; have been consistently defined from the same procedure; achieve the maximum level of detail (*i.e.* feature as many travel-to-work areas as possible); are based on a method derived from labour market theory.

While drawing on a traditional operational research approach, Coombes *et al*. acknowledged the importance of developing a method that would produce appropriate zones, given Britain's local geography. As a result, the authors noted that their algorithm fell more within the tradition of the methods used for defining metropolitan areas in the United States "than of procedures which can automatically generate areas which have, for example, homogeneous levels of unemployment as the objective to be optimised" (p. 946). A consequence of this is that the resulting travel-to-work areas may exhibit considerable internal variation, in terms of various important economic and social variables.

As observed by Crampton (1999), elsewhere in Europe, empirical research on local labour market operation has been handicapped by the rather varied nature of the commuting statistics that are available. Austrian data were used by Baumann *et al*. (1983), who stressed the importance of tackling two related problems: the scale problem (*i.e.* choice of appropriate number of labour markets) and the aggregation problem (*i.e.* choice of appropriate regionalisation for these labour markets). In a later paper (Baumann *et al*. (1988)), the authors addressed the issue of how to operationalise non-disjoint (*i.e.* overlapping) spatial labour markets and argued that parameters of a labour supply model should be determined jointly with the regionalisation exercise.

Felsenstein (1994) studied the role that large high-technology firms play in determining the spatial extent of labour markets in Israel, through the widespread practice of paying the commuting costs of employees. The author found that this policy had helped to bring about a surprisingly extensive spatial labour market for low-skill labour, strengthened by the low *residential* mobility of Israeli labour.

[12] The 1984 revision utilised travel-to-work data from the 1981 Census. A similar revision was undertaken following the 1991 Census, with Northern Ireland included for the first time.

Felsenstein noted that "in non-rigorous terms the spatial labour market area of the firm is that area bounded by a "critical" isoline identifying the distance beyond which labour is likely to change place of residence when changing place of employment" (p. 868). Nonetheless, he emphasised that local labour market areas are much more than simply travel-to-work areas, reflecting other dimensions of local economic activity. As such, they can overlap with other local markets, such as housing markets and catchment areas for retail trade.

A recent paper by Casado-Díaz (2000) described the results of a regionalisation exercise carried out in Spain. Due to the fact that data are missing for some regions, the study focused on the region of Valencia only. Casado-Díaz followed the general approach of Coombes *et al*. (1986), with some minor modifications. These principally concerned the relationship between the labour market foci and the rest of the zones. Casado-Díaz also found that trial regionalisations using the trade-off parameters of the British study, as well as those used in Italy,[13] did not produce satisfactory maps of local labour market areas from a geographic perspective. Instead, after experimenting with a variety of parameter values, the author chose those that resulted in a number of labour market areas that was similar to the number of *comarcas* into which the regional government divides Valencia for statistical and other purposes.[14]

## 3. Method

In light of the evaluation of overseas regionalisation methods that was presented in the previous section, it was decided to basically follow the algorithm developed by Coombes *et al*. (1986) for New Zealand.[15] This method has the advantage of allocating every part of the country to a local labour market area, thereby producing an exhaustive geographical classification for use in future studies of New Zealand regions.[16] The algorithm also incorporates logical criteria relating to labour market

[13] Coombes (1992) provided a summary of the approach taken in Italy.

[14] Despite this, most borders of local labour market areas did not match those of the *comarcas* exactly.

[15] Only 10% of census respondents are asked about their travel-to-work behaviour in the United Kingdom, whereas every individual is included in New Zealand. Accordingly, the population constraints referred to in this paper are ten times the size of the actual values used when producing travel-to-work areas for Britain.

[16] Conversely, the fact that the algorithm assumes the existence of non-overlapping labour markets may be viewed as a weakness, as it therefore ignores the competition between labour catchments that occurs in reality.

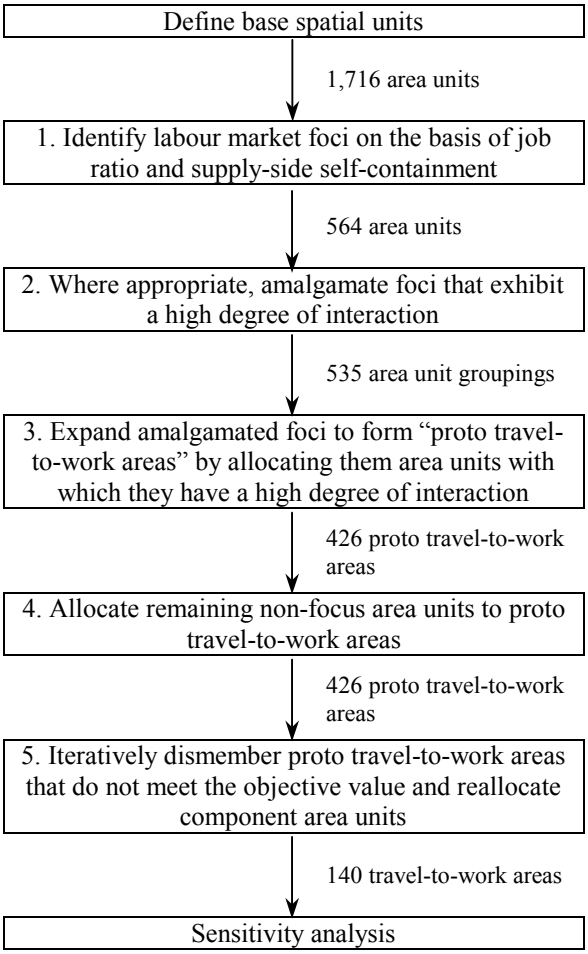


**Figure 1**
Structure of the regionalisation method used with number of zones arising under the preferred option

foci and their environs, while still being relatively easy to execute.[17] Another benefit of this methodology was noted by Casado-Díaz (2000), who chose to apply it to Valencia "because of its wide use in both administrative and research purposes and because it has also been successfully applied in other parts of Europe such as Italy" (p. 844). Unlike Casado-Díaz (2000), however, no simplifications of the original algorithm were required for computing reasons in this study. The algorithm that was implemented with New Zealand travel-to-work data is summarised below, with a basic overview given in Figure 1.

[17] The major advances in computing power that have occurred since the time the algorithm was developed, combined with the smaller number of base area units in New Zealand (1,716, compared with 10,102 that were used by Coombes *et al*. in Britain), meant that results were able to be rapidly replicated using different parameters.

The first step involves the identification of likely local labour market area foci by selecting areas that feature in the highest 20% on either of two measures: job ratio and supply-side self-containment.[18] Letting $T_{ij}$ denote the number of commuting trips from area $i$ to area $j$, these are defined thus:[19]

$$\text{Job ratio of area } i = \frac{\sum_{j=1}^{n} T_{ji}}{\sum_{j=1}^{n} T_{ij}}; \tag{1}$$

$$\text{Supply-side self-containment of area } i = \frac{T_{ii}}{\sum_{j=1}^{n} T_{ij}}. \tag{2}$$

The relationships between the group of potential foci are then considered. To prevent the arbitrary nature of the base area units from affecting the results, particularly in large urban areas, adjacent potential foci that are strongly linked should be amalgamated. Therefore, following Coombes *et al*., all foci are ranked by their level of commuting inflows and each is considered in turn. If some focus $j$ has a high proportion of travel-to-work flows between it and other foci, it must be merged. In practice, this means that either supply-side or demand-side self-containment must be less than 0.5 and there must be other foci $i$, from which at least 10% of trips are to $j$ and to which at least 1% of trips from $j$ are destined. Among the foci $i$, focus $j$ is merged with the one that generates the highest value of the following "weighted" interaction index, provided that this exceeds 0.002:[20]

[18] As noted by Coombes *et al*., these two criteria "represent the two extremes of candidacy for being the focus of a local labour market area: the job ratio identifies zones which are centres of in-commuting, while the self-containment measure finds zones that have very few out-commuters" (p. 949).

[19] Similarly, the demand-side self-containment of area $i = \frac{T_{ii}}{\sum_{j=1}^{n} T_{ji}}$.

[20] That is, $I$ is calculated by taking into account *all* journey-to-work flows for a given focus, but the candidates for amalgamation are restricted to other foci only. Should two or more foci produce the same value of $I$, the focus with the highest total level of commuting flows with $j$, $T_{ij} + T_{ji}$, is selected. In his original method, Smart (1974) had termed the corresponding criterion to (3) a "gravity formula", however Coombes and Openshaw (1982) claimed that "it is nothing of the sort, since no measure of distance… is either implicit or explicit" (p. 142).

$$I = \frac{T_{ij}^2}{\sum_{k=1}^{n} T_{ik} \sum_{k=1}^{n} T_{kj}} + \frac{T_{ji}^2}{\sum_{k=1}^{n} T_{jk} \sum_{k=1}^{n} T_{ki}}. \quad (3)$$

The new combined zone now replaces both *i* and *j*. It is considered as a focus in its own right in the last step before the algorithm proceeds to the next highest ranked focus. This process continues until it has produced a set of foci that fail to meet the two criteria for amalgamation that were specified above.

The next step is to examine the relationships between *all* areas, both the potential foci (or groups of foci) and the non-foci, and to form what Coombes *et al*. termed "proto travel-to-work areas". The required population and self-containment constraints are introduced gradually at this stage to allow the creation of as many feasible travel-to-work areas as possible. All foci are ranked according to the following function, where $\alpha$ denotes the size constraint, $\beta$ denotes the self-containment constraint and constants $c_1$, $c_2$ and $c_3$ allow for the desired trade-off:

$$F = \min\left(1, \frac{c_1 \sum_{k=1}^{n} T_{jk}}{\alpha}, \frac{c_2 \sum_{k=1}^{n} T_{jk} + c_3}{\alpha}\right) \times \min\left(1, \frac{T_{ji}}{\beta \max\left(\sum_{k=1}^{n} T_{kj}, \sum_{k=1}^{n} T_{jk}\right)}\right). \quad (4)$$

*F* represents the final objective function for the travel-to-work areas. All foci *j* that fail to meet an initial minimum value with respect to this, $F = a$, are, in turn, combined with those areas that rank highest according to *I*, only now *all* zones from which at least 10% of trips are to *j* are considered, except those foci that feature $F > a$. Once again, the algorithm will repeat this process with any combined focus, merging it with other areas until it satisfies the constraint $F > a$.

Figure 2, which is reproduced from Coombes *et al*. (1986), displays the effect of the constraints that are featured in Equation (4).[21] In forming proto travel-to-work areas, all foci that fall below the curve $F = a$ are allocated other zones, until they meet

[21] The original figure and accompanying text in Coombes *et al*. were somewhat misleading, as they referred to a "linear spline" between the horizontal and vertical segments of the $F = a$ curve, whereas it follows from Equation (4) that this is, in fact, an arc, albeit one with a gradient that is almost constant.

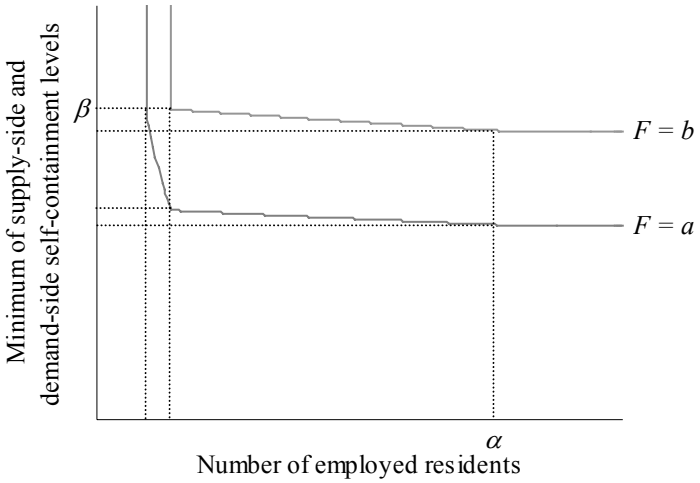


**Figure 2**
The effect of different minimum values for the objective function

this constraint. Following the suggestions of Coombes *et al*., $a = 0.625$, $b = 0.9267$, $c_1 = 5.2954$ and $c_2 = 0.08885$. Section 4 will discuss the values of $\alpha$ and $\beta$ (and the resulting value of $c_3$) that were chosen for this study.

In the next step, all unallocated areas are ranked according to their number of employed residents before, in turn, being absorbed into the proto travel-to-work area that features the highest value of *I*. Zones that are found to have no commuting flows with any proto travel-to-work area are subjected to a second repetition of this process. At the conclusion of this, the only unallocated areas are those with no flows to or from the rest of the country.

The fact that some proto travel-to-work areas may not satisfy the population and self-containment criteria is addressed in the final stage. In addition, the minimum value associated with *F* is raised to its final level, *b*. This ensures that every travel-to-work area produced by this algorithm lies above the $F = b$ curve in Figure 2. Proto travel-to-work areas are ranked in reverse order according to their value of *F* and, in turn, each with a value less than *b* is dismembered and has its constituent zones reallocated according to the procedure in the last step.[22]

Coombes *et al*. noted that only 0.5% of the base area units in Britain were allocated to local labour market areas to which they were not adjacent, despite the absence of an automated non-contiguity constraint in their algorithm. Nevertheless, at

[22] After any such dismemberment, the value of *F* is recalculated for each remaining proto travel-to-work area and the present step starts again. Those proto travel-to-work areas that fail this step lie between $F = a$ and $F = b$ in Figure 2.

the conclusion of his regionalisation of Valencia, Casado-Díaz saw fit to resolve all non-contiguities in the travel-to-work areas, "without implying any relaxation of the criteria" (p. 845). It is, however, arguably misleading to exclude non-contiguous components of local labour market areas that have satisfied the algorithm. The allocation of such zones, particularly those surrounding urban centres, may reflect actual journey-to-work patterns. In addition, the large size and arbitrary shape of many rural area units in New Zealand may distort the underlying commuting behaviour of workers that live in intermediate locations.[23]

## 4. Results of a regionalisation of New Zealand

This study drew on journey-to-work data from the 1991 New Zealand Census of Population and Dwellings at the area unit level. In essence, this involved information on the number of people working in each of New Zealand's 1,716 area units, by their area unit of usual residence.[24] 1991 data were preferred for this preliminary classification as they were readily available and predated the introduction of increased confidentiality protection by Statistics New Zealand, which placed restrictions on the release of local statistics.[25] Usual residence indicates the address respondents have lived at, or intend to live at, for at least three months, while workplace refers to a respondent's main job. For those with no fixed workplace, this may be the address of a depot, headquarters or reporting point.

In the application of their algorithm to Great Britain, Coombes *et al*. (1986) determined that all final local labour market areas must exceed a minimum labour force level of $\alpha$ = 20,000 and a minimum self-containment rate of 70%. However, the permitted trade-off between these two constraints, depicted here in Figure 2, was such that a zone with only 3,500 labour force participants was accepted if the self-containment rate was $\beta$ = 75%. The decision by Coombes *et al*. to select these particular objective values would seem to be open to an earlier criticism by Coombes and Openshaw (1982) themselves, wherein they described Smart's (1974) justification

[23] Non-contiguities in the New Zealand regionalisation will be discussed in the next section.

[24] In practice, 1,635 area units were used, with offshore islands and inlets *etc*. excluded.

[25] In particular, the Small Domain Release Policy dictates that disaggregated statistics can be released only if the unrounded population concerned is 100 or more *and* the average cell count in the table being released is 4 or more. This policy has recently been reviewed, although details of the revised policy were unavailable at the time of writing.

of a 75% level of self-containment as being "rather vague" (p. 143). However, sensitivity analysis had found no one constraint to be more justified than the other. Choosing a multiple criteria approach with the inclusion of a "trade-off" therefore largely avoided the problems caused by the use of a single threshold.[26] Nonetheless, the choice of $\alpha$ and $\beta$ is crucial to the results of the algorithm. A self-containment rate of $\beta$ = 75% was considered to be an appropriate minimum requirement for local labour market areas in New Zealand and likely to ensure that the final classification reflects discrete and tightly-defined communities. However, it was not clear what population constraint should be employed for this country.

The 1981 travel-to-work data used in Britain were drawn from the pool of all labour force participants, which, as was observed by Casado-Díaz (2000), meant that local labour market areas implicitly assumed that unemployed individuals exhibited "behaviour similar to the employed population belonging to the same socio-demographic group" (p. 848).[27] In contrast, the New Zealand Census of Population and Dwelling, like the Spanish Census of Population, asks only *employed* people about their daily travel patterns. Following the approach of Casado-Díaz, the obvious first trial is then to use the value of $\alpha$ suggested by Coombes *et al*. multiplied by the proportion of labour force participants who were employed in New Zealand at the time of the 1991 Census. This value was 88.5%, implying a target local labour market area size of approximately $\alpha$ = 17,700. When this parameter value was used in the algorithm outlined in the previous section (and $c_3$ adjusted accordingly), 56 local labour market areas were produced, collectively covering the country.[28]

This result is consistent with the findings of previous overseas studies that have followed the same basic method. Coombes *et al*. reported 322 local labour market areas in Britain in their 1984 revision of travel-to-work areas, while Casado-Díaz uncovered 27 local labour market areas in Valencia when he used the same algorithm and corresponding parameter values. In addition, a similar approach resulted in a demarcation of France into 365 travel-to-work areas, drawing on journey-to-work data

[26] In addition, the inclusion of a 75% self-containment threshold preserved consistency with Smart's (1974) method, which had been used to define travel-to-work areas previously.

[27] Only the 1981-based work attempted to estimate unemployed people's "likely" commuting patterns in this way, not the earlier or more recent British analyses.

[28] The values of $a$, $b$, $c_1$ and $c_2$, which also govern the positions of the curves in Figure 2, should not change in response to a change in $\beta$.

from the 1982 General Population Census.[29] In light of these findings, the existence of 56 local labour markets in New Zealand is expected, given both the country's population and its geographical size.[30] This classification implies an average total population of 59,000 and an average area of 4,600 km$^2$ among local labour market areas. While these areas may be relevant and useful for analyses that focus on aggregate relationships, they do not accurately reflect underlying commuting patterns across New Zealand. In particular, many small, but highly self-contained, rural centres are subsumed within large regional groupings. It is possible that New Zealand's low average population density requires that a lower population constraint be used in the regionalisation algorithm.[31]

After experimenting with a variety of other values for $\alpha$, a minimum employed population of 2,000 was eventually determined to provide the best representation of employment zones in New Zealand.[32] This resulted in a total of 140 local labour market areas across the country, as depicted in Figures 3 and 4.[33] In general, main urban areas are found to be associated with extensive labour markets. In particular, Christchurch is found to draw labour from a vast catchment area. The Auckland metropolitan area is divided into two local labour market areas, with Manukau appearing as a major source of jobs in the South Auckland region. In contrast, rural areas are typified by a large number of small labour markets centred on minor service centres.

As noted in the previous section, the algorithm did not require local labour market areas to be contiguous entities. Nevertheless, there were only 14 cases of area units being attached to non-adjacent local labour market areas, representing 0.9% of all area units that were allocated. In most cases, these were due to the presence of

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[29] Coombes (1992) provided a summary of the methods that have been employed in European countries.

[30] The relationship was found to be roughly $N = \frac{P}{195{,}000} + \frac{A}{6{,}500}$, where $N$ denotes the number of local labour market areas, $P$ the total population and $A$ the land area in km$^2$.

[31] Casado-Díaz noted that the base units used in Britain were reasonably homogeneous, in contrast to those in Valencia, however he chose to adapt the algorithm to a Spanish scenario by relaxing the self-containment, rather than population, threshold.

[32] This implied that $c_3 = 1822.3$.

[33] Two area units failed to be associated with any local labour market area by the algorithm, due to the fact that they had no commuting flows to or from the rest of the country. Consequently, these zones were manually allocated to the most "sensible" local labour market area.

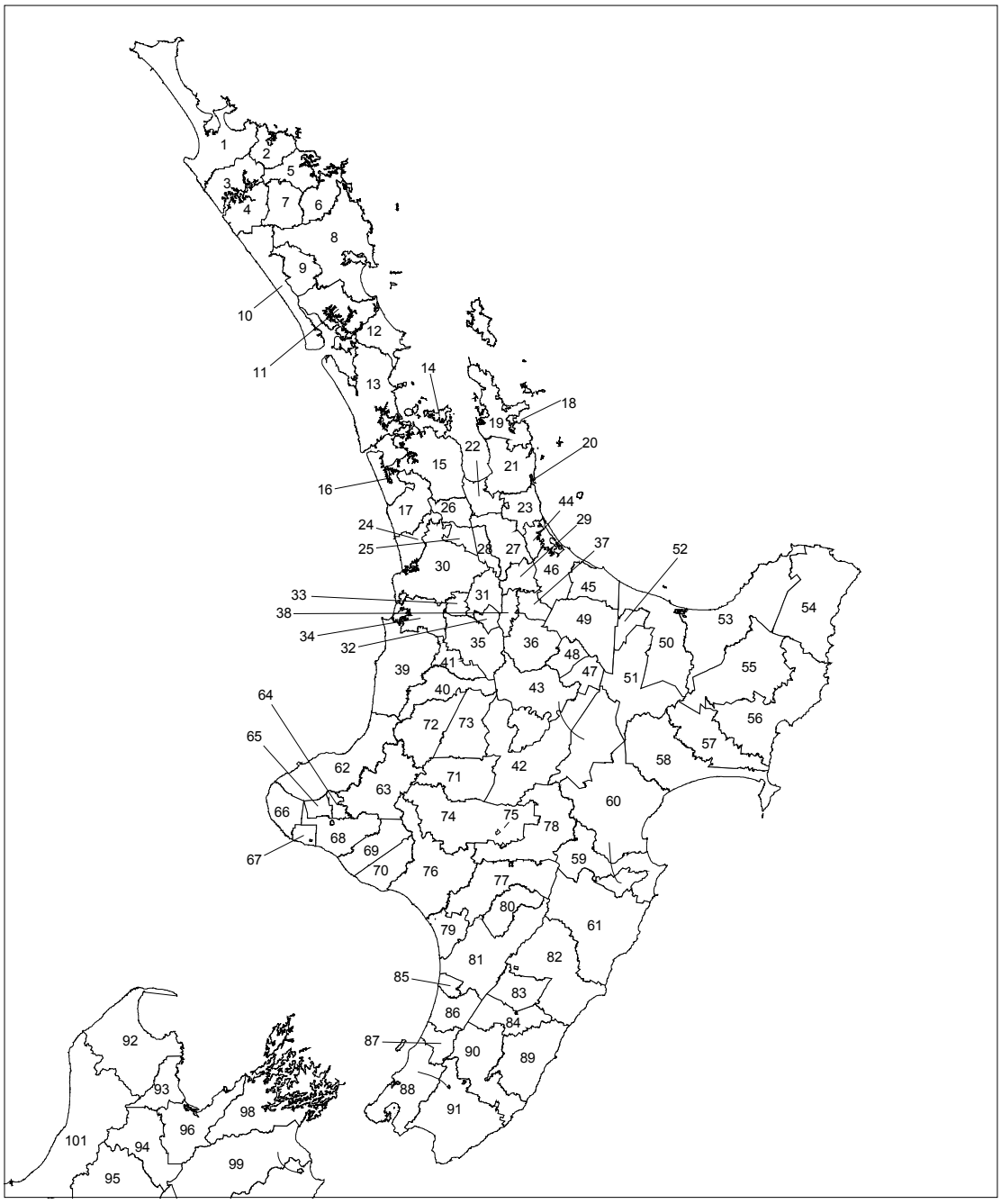


**Figure 3**
Local labour market areas in the North Island
(Labels refer to local labour market areas listed in Table 2)

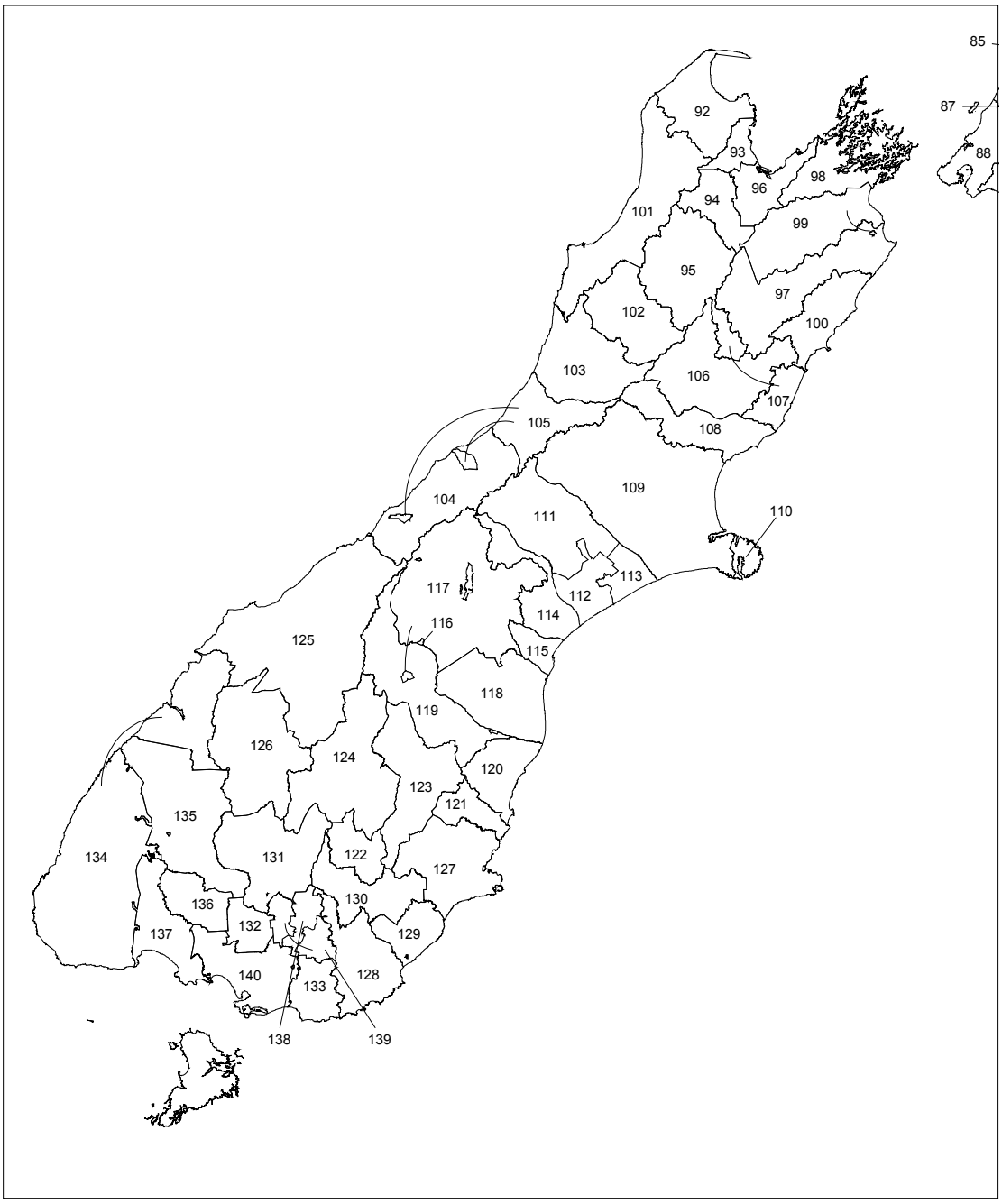


**Figure 4**
Local labour market areas in the South Island
(Labels refer to local labour market areas listed in Table 2)

abnormally-shaped area units, which disrupted the apparent underlying pattern of commuting. This clearly explains, for example, Seddon's detachment from Blenheim and the separation of Featherston from the Wellington Local Labour Market Area. However, other non-contiguities would appear to reflect the existence of genuine "satellite" communities: for example, the association of Poukawa with Napier, rather than the closer Hastings. In theory, one could examine the validity of non-contiguous labour market zones by following the process described in Stage 6 of the method prescribed by Coombes *et al*. This would involve reallocating area units to other local labour market areas in order to resolve any non-contiguities and then assessing whether the global sum of values of $F$ increases.

These results indicate that the uniform 20 km rule advocated by Maré and Choy (2001) for identifying work-related migration may be inappropriate. The travel-to-work areas for the main urban areas are found to have radii of approximately 50 km, centred on the cities' central business districts. Meanwhile, partly due to the base spatial units that were used, travel-to-work areas in other regions are found to vary widely in geographical size, with some as large as, or larger than, the cities and others cons iderably smaller. It is important to note that these areas reflect actual commuting patterns in 1991, not what travel distances *could* reasonably be expected of workers. To a large extent, the extensiveness of urban labour markets is likely to reflect their superior transport infrastructures and greater provision of public transport subsidies.

The boundaries of the local labour market areas also differ considerably from those of New Zealand's 73 territorial local authorities. However, in many cases, district council zones are straight aggregations of local labour market areas, reflecting the fact that local government boundaries are required to follow water catchment boundaries as closely as possible under the terms of the Local Government Act 1974. A handful of local labour market areas correspond exactly to territorial local authorities. These are the Whangārei, Ōpōtiki, New Plymouth, Wanganui, Central Hawke's Bay, Grey, Kaikoura and Waimate Districts. On the other hand, there are numerous cases of local labour market areas crossing territorial authority boundaries and even regional council boundaries. In particular, the labour catchment areas of all of New Zealand's 15 cities are found to extend well beyond their council limits. Even Dunedin City, which at 3,350 $km^2$ is the country's largest, is linked with part of the Waitaki District (although, admittedly, an outlying portion of the City is actually found to associate more strongly with Palmerston). The Christchurch Local Labour

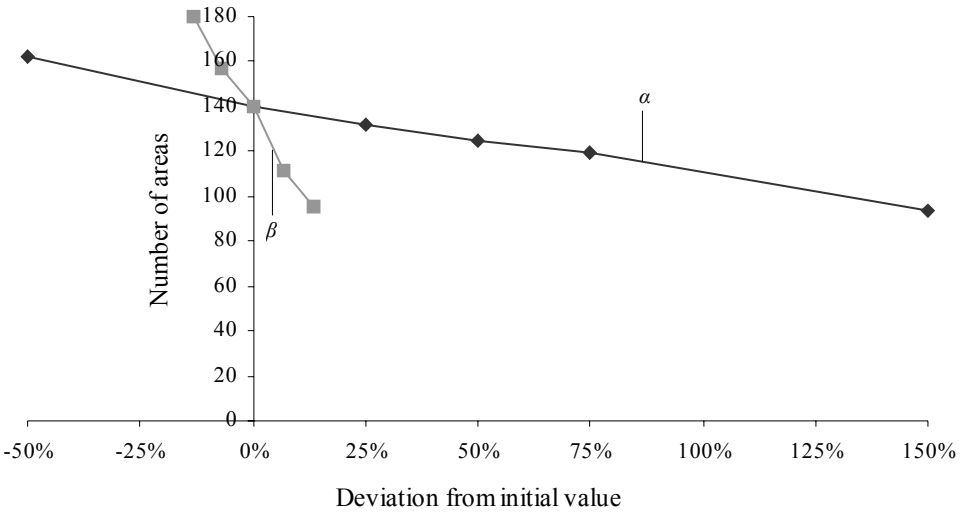


**Figure 5**
Testing the effect of changes to the population and self-containment thresholds

Market Area subsumes all of the Waimakariri and Selwyn Districts, while Wellington's hinterland includes Porirua, Upper Hutt and Lower Hutt Cities.

## 5. Testing the robustness of the local labour market areas

The areas depicted in Figures 3 and 4 are the product of a number of assumptions about what constitutes a labour market. In particular, as noted earlier, the number and layout of the zones is dependent on the minimum employment level, $\alpha$, and self-containment rate, $\beta$, that were imposed. It is important to determine how sensitive the classification is to changes in these parameters. Figure 5 illustrates the effect on the number of local labour market areas of changing $\alpha$ and $\beta$, in turn, from their initial values of 2,000 and 75%, respectively.[34]

It is clear that the results of the regionalisation are most sensitive to the self-containment criterion that is chosen. This is not surprising, given the relatively narrow range of reasonable self-containment values. A 5 percentage point increase in $\beta$ reduces the number of local labour market areas by 29, whereas a corresponding reduction only increases the number of areas by 17. This is consistent with the notion

[34] A wider range of positive deviations was tested for the employment constraint as it was considered more likely that a *higher* value of this would be preferred. As mentioned earlier, when $\alpha$ increases by 785% to 17,696, 56 local labour market areas result.

**Table 1**
Summary travel-to-work statistics for the local labour market areas and area units

| Variable | Local labour market areas | | Area units | |
|---|---|---|---|---|
| | Mean | Standard deviation | Mean | Standard deviation |
| Supply-side self-containment | 87.0% | 7.9% | 30.9% | 24.8% |
| Demand-side self-containment | 89.4% | 6.3% | 46.2% | 26.8% |
| Employed population | 9,131 | 28,157 | 782 | 537 |
| Number of jobs | 9,131 | 28,225 | 781 | 1,991 |

Note: The first two columns refer to means and standard deviations across the 140 travel-to-work areas, while the last two columns refer to corresponding values for the 1,635 area units that collectively comprise the travel-to-work areas.

that the self-containment rate is more likely to be a binding constraint on the formation of labour market areas as it approaches 100% (at which point there would be only one labour market in New Zealand). Although the number of zones is less sensitive to variation in $\alpha$, this is potentially a greater influence on the final classification, due to the many plausible minimum employment levels that are available.

The Coombes *et al*. procedure is a non-hierarchic method. One consequence of this is that the local labour market areas resulting from increases in the self-containment or population thresholds are not necessarily simple aggregations of those depicted in Figures 3 and 4. In a small number of cases, area units switch between labour markets when the criteria are changed. For example, the Hutt Valley is found to constitute a separate labour market from Wellington after the employment constraint is *increased* to the level implied by Coombes *et al*.

Table 1 summarises the principal travel-to-work statistics used in the regionalisation algorithm. The average values of both supply and demand-side self-containment for the travel-to-work areas are found to be well above the minimum value of 70%, indicating a low incidence of individuals working outside their local labour market area. The relative variation in these values *between* labour market areas is lower than the average variation *within* them, as approximated by the distribution of the two statistics across area units. This is consistent with the concept of a local labour market grouping locations with job-ratios both greater and less than one.[35] On average, local labour market areas are found to have just over 9,000 employed

[35] That is, each local labour market area consists of industrial or commercial area units that contribute mainly jobs and residential area units that contribute mainly workers. This variation is not observed in the travel-to-work area level statistics reported in Table 1.

residents, which is, naturally, equal to the mean number of jobs. There is considerable variation in the numbers of workers and jobs between zones, however, more interestingly, workers and jobs are distributed approximately equally across the zones, further suggesting that there is little commuting between zones.

## 6. Describing the local labour market areas

Much of the motivation for defining travel-to-work areas in Great Britain is derived from their use in the selection of regions that are eligible to receive a portion of the large amount of industry assistance that is available through the government's regional policy. A consequence of this is that the results of the regionalisations are subjected to a political evaluation, with some changes made before the final travel-to-work areas are published. In a number of cases, local groups have successfully appealed against the removal of their area from the travel-to-work zones that are entitled to development funding. Coombes *et al*. (1986) noted that all alterations that were made to the 1984 regionalisation took place within the specified statistical constraints. Had this not been ensured, it was claimed that the "resulting flood of *ad hoc* modifications would destroy any claim to consistency and objectivity in terms of the initial design criteria" (p. 946). Nonetheless, in contrast to Britain, this regionalisation of New Zealand is intended strictly for research purposes. An advantage of this is that all local labour market areas that are generated by the algorithm are consistently defined, meaning that they offer a valuable insight into the characteristics of labour markets and their dispersion across the country.

Table 2 presents a summary of the 140 local labour market areas, in terms of a selection of illustrative attributes from the 1991 Census.[36] Considerable variation in both the labour force and geographic size is observed across the areas. These values imply an active population density that ranges from 0.1 $km^{-2}$ in Te Anau to 243.5 $km^{-2}$ in Waiouru. As is clear from Figures 3 and 4, the vastness of some rural area units is the primary reason for the existence of the largest local labour market areas. This factor may reduce the reliability of the assumption that intra-area moves are not

[36] There are, of course, numerous other variables of interest, which should be investigated in future work. Full details of the relationship between 1991 area units and the local labour market areas presented here are available at the website listed at the beginning of this paper or from the authors on request. In addition, information about classifications that provide a smaller number of New Zealand labour markets may be obtained, such as that featuring $\alpha = 17{,}700$ described earlier.

**Table 2**
Selected statistics for the local labour market areas, 1991

| *n* | Label | *R* | Labour force | *A* (km$^2$) | *u* | Manu-facturing | Māori |
|---|---|---|---|---|---|---|---|
| 1 | Kaitaia | 1 | 5,595 | 2,417 | 17% | 8% | 38% |
| 2 | Mangapa-Matauri Bay | 1 | 948 | 639 | 20% | 5% | 44% |
| 3 | Hokianga North | 1 | 756 | 832 | 27% | 2% | 65% |
| 4 | Hokianga South | 1 | 1,113 | 782 | 27% | 3% | 56% |
| 5 | Kerikeri | 1 | 4,179 | 680 | 8% | 6% | 15% |
| 6 | Moerewa | 1 | 2,583 | 702 | 18% | 30% | 52% |
| 7 | Kaikohe | 1 | 2,799 | 772 | 17% | 6% | 56% |
| 8 | Whangārei | 1 | 26,781 | 2,729 | 14% | 15% | 21% |
| 9 | Maungaru | 1 | 852 | 716 | 8% | 1% | 9% |
| 10 | Dargaville | 1 | 3,390 | 1,236 | 12% | 15% | 23% |
| 11 | Rehia-Oneriri | 1 | 2,925 | 1,156 | 11% | 15% | 16% |
| 12 | Warkworth | 2 | 4,848 | 675 | 9% | 16% | 9% |
| 13 | Central Auckland | 2 | 273,603 | 2,601 | 9% | 15% | 8% |
| 14 | Waiheke Island | 2 | 1,911 | 92 | 19% | 8% | 9% |
| 15 | Southern Auckland | 2 | 163,083 | 1,838 | 12% | 28% | 16% |
| 16 | Glenbrook | 2 | 5,103 | 476 | 8% | 48% | 12% |
| 17 | Pukekohe | 2 | 9,858 | 927 | 8% | 14% | 19% |
| 18 | Whitianga | 3 | 912 | 25 | 15% | 16% | 8% |
| 19 | Te Rerenga | 3 | 1,731 | 1,127 | 14% | 7% | 17% |
| 20 | Whangamatā | 3 | 1,047 | 6 | 17% | 8% | 10% |
| 21 | Thames | 3 | 7,896 | 1,719 | 11% | 20% | 14% |
| 22 | Hauraki Plains | 3 | 1,326 | 503 | 6% | 4% | 8% |
| 23 | Waihi | 3 | 4,029 | 52 | 17% | 14% | 12% |
| 24 | Te Akau | 3 | 468 | 526 | 8% | 5% | 21% |
| 25 | Whitikahu | 3 | 1,029 | 304 | 6% | 4% | 11% |
| 26 | Waerenga | 3 | 1,281 | 463 | 6% | 18% | 13% |
| 27 | Ngarua | 3 | 5,640 | 966 | 6% | 21% | 8% |
| 28 | Morrinsville | 3 | 3,786 | 329 | 8% | 21% | 10% |
| 29 | Matamata | 3 | 4,560 | 458 | 8% | 16% | 12% |
| 30 | Hamilton | 3 | 63,525 | 2,093 | 12% | 15% | 18% |
| 31 | Cambridge | 3 | 7,506 | 611 | 8% | 15% | 9% |
| 32 | Rotongata | 3 | 414 | 211 | 7% | 0% | 14% |
| 33 | Te Awamutu | 3 | 6,141 | 226 | 10% | 11% | 17% |
| 34 | Ngutunui | 3 | 891 | 736 | 10% | 3% | 28% |
| 35 | Maihīhi | 3 | 3,264 | 1,262 | 8% | 7% | 22% |
| 36 | Tokoroa | 3 | 9,987 | 1,139 | 14% | 33% | 30% |
| 37 | Tāpapa | 3 | 534 | 368 | 4% | 12% | 14% |
| 38 | Arapuni | 3 | 1,410 | 313 | 8% | 15% | 13% |
| 39 | Marokopa | 3 | 1,392 | 2,036 | 9% | 1% | 31% |
| 40 | Mokauiti | 3 | 666 | 1,012 | 10% | 1% | 27% |
| 41 | Te Kuiti | 3 | 2,322 | 483 | 12% | 16% | 38% |
| 42 | Turangi | 3 | 2,538 | 2,989 | 17% | 3% | 51% |
| 43 | Taupō | 3 | 9,696 | 3,345 | 10% | 15% | 21% |
| 44 | Katikati | 4 | 2,238 | 256 | 11% | 8% | 10% |
| 45 | Te Puke | 4 | 5,853 | 813 | 12% | 17% | 22% |
| 46 | Tauranga | 4 | 33,522 | 974 | 12% | 17% | 13% |
| 47 | Golden Springs | 3 | 945 | 504 | 6% | 16% | 19% |
| 48 | Ngakuru | 3 | 780 | 445 | 5% | 1% | 10% |
| 49 | Rotorua | 4 | 26,031 | 1,665 | 13% | 12% | 32% |
| 50 | Whakatāne | 4 | 10,845 | 2,057 | 13% | 12% | 32% |
| 51 | Matahina-Minginui | 4 | 1,365 | 2,041 | 17% | 2% | 68% |
| 52 | Kawerau | 4 | 4,140 | 365 | 17% | 58% | 53% |
| 53 | Ōpōtiki | 4 | 3,066 | 3,084 | 19% | 7% | 50% |
| 54 | East Cape | 5 | 1,467 | 2,814 | 24% | 2% | 84% |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 55 | Tarndale-Rakauroa | 5 | 1,059 | 2,647 | 12% | 0% | 46% |
| 56 | Gisborne | 5 | 15,552 | 2,887 | 12% | 16% | 35% |
| 57 | Ruakituri-Morere | 6 | 552 | 1,576 | 12% | 7% | 40% |
| 58 | Wairoa | 6 | 3,354 | 2,542 | 14% | 21% | 54% |
| 59 | Hastings | 6 | 26,517 | 1,609 | 11% | 26% | 22% |
| 60 | Napier | 6 | 25,140 | 3,710 | 12% | 17% | 14% |
| 61 | Central Hawke's Bay | 6 | 5,934 | 3,317 | 8% | 19% | 17% |
| 62 | New Plymouth | 7 | 30,402 | 2,208 | 11% | 19% | 11% |
| 63 | Douglas | 7 | 609 | 1,741 | 5% | 1% | 4% |
| 64 | Toko | 7 | 714 | 187 | 4% | 5% | 3% |
| 65 | Stratford | 7 | 3,921 | 241 | 13% | 21% | 10% |
| 66 | Kahui | 7 | 2,322 | 644 | 10% | 4% | 17% |
| 67 | Kapuni | 7 | 933 | 214 | 5% | 8% | 10% |
| 68 | Hāwera | 7 | 7,269 | 1,042 | 10% | 21% | 15% |
| 69 | Whenuakura | 7 | 981 | 898 | 13% | 5% | 28% |
| 70 | Makakaho | 7 | 939 | 768 | 11% | 24% | 20% |
| 71 | Raurimu | 8 | 444 | 1,365 | 10% | 5% | 24% |
| 72 | Otangiwai-Heao | 8 | 729 | 1,347 | 10% | 1% | 25% |
| 73 | Taumarunui | 8 | 3,402 | 1,305 | 13% | 17% | 36% |
| 74 | Tangiwai | 8 | 1,677 | 2,703 | 12% | 14% | 36% |
| 75 | Waiouru | 8 | 1,461 | 6 | 3% | 1% | 34% |
| 76 | Wanganui | 8 | 18,537 | 2,372 | 13% | 18% | 17% |
| 77 | Pohonui-Porewa | 8 | 1,446 | 1,829 | 7% | 3% | 17% |
| 78 | Taihape | 8 | 1,251 | 2,020 | 9% | 6% | 33% |
| 79 | Marton | 8 | 3,516 | 622 | 9% | 18% | 16% |
| 80 | Kiwitea | 8 | 825 | 783 | 6% | 2% | 10% |
| 81 | Palmerston North | 8 | 46,722 | 2,286 | 11% | 16% | 10% |
| 82 | Dannevirke | 8 | 5,256 | 2,603 | 8% | 21% | 17% |
| 83 | Mangatainoka | 8 | 2,139 | 770 | 6% | 26% | 12% |
| 84 | Nireaha-Tiraumea | 8 | 909 | 916 | 6% | 2% | 10% |
| 85 | Foxton | 8 | 1,920 | 197 | 15% | 28% | 21% |
| 86 | Levin | 8 | 9,573 | 763 | 11% | 20% | 16% |
| 87 | Ōtaki | 9 | 2,718 | 456 | 10% | 26% | 20% |
| 88 | Wellington | 9 | 180,054 | 1,654 | 9% | 12% | 10% |
| 89 | Whareama | 9 | 834 | 1,730 | 8% | 2% | 9% |
| 90 | Masterton | 9 | 12,777 | 1,816 | 12% | 17% | 13% |
| 91 | Kahutara | 9 | 2,073 | 2,447 | 8% | 9% | 12% |
| 92 | Golden Bay | 10 | 1,857 | 2,671 | 11% | 13% | 5% |
| 93 | Motueka | 10 | 4,983 | 730 | 6% | 12% | 7% |
| 94 | Golden Downs | 10 | 525 | 1,500 | 13% | 7% | 7% |
| 95 | Lake Rotoroa | 10 | 552 | 3,716 | 6% | 1% | 4% |
| 96 | Nelson | 10 | 25,329 | 1,547 | 9% | 18% | 4% |
| 97 | Ward | 10 | 459 | 4,432 | 5% | 3% | 4% |
| 98 | Picton | 10 | 2,718 | 34 | 10% | 23% | 18% |
| 99 | Blenheim | 10 | 13,053 | 6,010 | 9% | 18% | 7% |
| 100 | Kaikoura | 10 | 1,383 | 2,042 | 9% | 10% | 11% |
| 101 | Westport | 11 | 3,477 | 5,019 | 13% | 13% | 6% |
| 102 | Inangahua | 11 | 855 | 2,922 | 11% | 8% | 6% |
| 103 | Greymouth | 11 | 5,925 | 3,515 | 12% | 15% | 5% |
| 104 | Whataroa | 11 | 405 | 3,893 | 4% | 10% | 7% |
| 105 | Hokitika | 11 | 3,177 | 2,574 | 7% | 15% | 9% |
| 106 | Āmuri | 12 | 1,218 | 4,202 | 4% | 2% | 5% |
| 107 | Parnassus | 12 | 702 | 1,528 | 6% | 3% | 4% |
| 108 | Hurunui | 12 | 1,236 | 2,463 | 6% | 2% | 5% |
| 109 | Christchurch | 12 | 162,816 | 10,278 | 10% | 19% | 5% |
| 110 | Okain's Bay | 12 | 765 | 437 | 8% | 6% | 5% |
| 111 | Mt Somers | 12 | 1,743 | 4,003 | 4% | 3% | 3% |
| 112 | Hinds | 12 | 1,809 | 1,306 | 4% | 1% | 2% |
| 113 | Ashburton | 12 | 8,013 | 868 | 7% | 22% | 4% |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 114 | Orari | 12 | 4,281 | 2,029 | 10% | 25% | 5% |
| 115 | Timaru | 12 | 14,277 | 704 | 11% | 25% | 4% |
| 116 | Twizel | 12 | 603 | 17 | 11% | 3% | 11% |
| 117 | Mackenzie | 12 | 1,392 | 7,457 | 6% | 1% | 3% |
| 118 | Waihao | 12 | 3,216 | 3,573 | 8% | 6% | 2% |
| 119 | Aviemore | 12 | 747 | 4,246 | 4% | 5% | 4% |
| 120 | Oamaru | 13 | 7,857 | 1,816 | 10% | 28% | 3% |
| 121 | Waihemo | 13 | 741 | 1,047 | 9% | 4% | 3% |
| 122 | Teviot | 13 | 930 | 1,310 | 1% | 10% | 5% |
| 123 | Maniototo | 13 | 1,008 | 3,542 | 8% | 5% | 5% |
| 124 | Alexandra | 13 | 5,121 | 5,089 | 8% | 5% | 5% |
| 125 | Wanaka | 13 | 1,437 | 9,954 | 7% | 6% | 5% |
| 126 | Queenstown | 13 | 4,251 | 4,779 | 6% | 3% | 4% |
| 127 | Dunedin | 13 | 50,715 | 3,326 | 12% | 16% | 4% |
| 128 | Clutha | 13 | 2,562 | 2,708 | 8% | 34% | 6% |
| 129 | Balclutha | 13 | 4,395 | 1,362 | 9% | 13% | 6% |
| 130 | Tuapeka | 13 | 1,632 | 2,325 | 5% | 15% | 8% |
| 131 | Waikaia | 14 | 1,155 | 3,892 | 4% | 2% | 4% |
| 132 | Hokonui | 14 | 2,154 | 979 | 6% | 8% | 5% |
| 133 | Toetoes | 14 | 1,062 | 1,340 | 3% | 1% | 4% |
| 134 | Te Anau | 14 | 1,140 | 11,234 | 3% | 2% | 5% |
| 135 | Mararoa River | 14 | 849 | 5,176 | 2% | 5% | 4% |
| 136 | Wairio | 14 | 840 | 1,454 | 8% | 1% | 15% |
| 137 | Te Waewae | 14 | 1,131 | 2,294 | 9% | 11% | 10% |
| 138 | Chatton | 14 | 924 | 678 | 3% | 2% | 2% |
| 139 | Gore | 14 | 6,360 | 1,052 | 9% | 28% | 9% |
| 140 | Invercargill | 14 | 31,347 | 4,366 | 10% | 27% | 10% |
| Mean | | | 11,173 | 1,909 | 10% | 12% | 17% |
| Standard deviation | | | 34,014 | 1,892 | 5% | 10% | 15% |

Notes: *n* denotes the number of the local labour market area, *A* the land area and *u* the unemployment rate. *R* denotes the 1991 local government region, as follows: Northland (1), Auckland (2), Waikato (3), Bay of Plenty (4), Gisborne (5), Taranaki (7), Hawke's Bay (6), Manawatu-Wanganui (8), Wellington (9), Nelson-Marlborough (10), West Coast (11), Canterbury (12), Otago (13), Southland (14).
Manufacturing refers to the proportion of jobs that are in manufacturing and Māori the proportion of usual residents who are Māori.

work-related in these cases.

The Government has recently expressed an intention to direct fiscal policy towards the promotion of employment in certain isolated and disadvantaged regions of New Zealand. Table 2 provides an example of a simple method for identifying local labour markets that may be at risk of adverse shocks to employment. The proportion of jobs in each local labour market area that are in manufacturing was chosen as an indication of a source of demand for labour that may be vulnerable to a decline in employment in the future. Similarly, the proportion of Māori in the usually resident population represents a component of the labour *supply* that tends to have a low level of human capital and also a low level of mobility.[37] A combination of high values for both of these variables therefore indicates a local labour market that may be

[37] See, for example, the discussion in Papps (2000).

particularly susceptible to high unemployment rates. Moerewa, Tokoroa and Kawerau are seen to be examples of such areas.

1991 marked the trough of a major recession in New Zealand, with a national unemployment rate of 10.1%.[38] Table 2 reveals that there was also enormous variation in unemployment across the country, with rates ranging from 1% in Teviot to 27% in both North and South Hokianga. The "vulnerable" areas identified above are all found to feature among the local labour markets with the highest unemployment rates in 1991. In general, the areas with the highest proportions of unemployed workers tended to lie in the Northland and Gisborne regions.

## 7. Conclusion

This study has demonstrated a method for defining local labour market areas in New Zealand, using travel-to-work data from the 1991 Census. By adapting a method developed by Coombes *et al*. (1986) for Great Britain and selecting parameters that seem appropriate to a New Zealand context, 140 areas were produced, collectively covering the entire country.[39] Considerable variation was observed among these zones for a range of labour market characteristics.

It would be instructive to replicate the procedure described in this paper using 2001 Census data. This would provide an indication of whether the travel-to-work areas observed in 1991 are still valid today. Moreover, in theory, data from all censi since 1976 could be used to examine the stability of these areas over time. This would be best achieved by creating a synthesis of meshblocks and area units that is consistent over time.

Another potential objective of future research may be to develop a method for identifying differences in geographic mobility between demographic and employment groups. There is a long-standing literature in economics that is concerned with the nature and implications of individuals' abilities or inclinations to shift regions in response to labour market conditions. Topel (1986) outlined a model in which workers face incentives to migrate to markets offering the greatest present value of

[38] Whether this has any effect on the classification of local labour market areas is unclear and should be tested by future work.

[39] Although the algorithm did not incorporate a contiguity constraint, these areas were still found to represent believable spatial units.

future earnings, so that costly migration arbitrages geographic wage differentials. An implication of this is that the "wage and unemployment consequences of within-area changes in labour demand fall on those with the strongest area attachments, that is, those who are least mobile in response to current and expected area wage differentials" (p. S142).[40]

Although differences in rates of internal migration across subgroups of New Zealand's population have been reasonably well documented, variation in commuting patterns is a related dimension of labour market mobility that has received little attention for its role in this respect.[41] If it were possible to determine systematic differences in the size of local labour market areas across age, gender, ethnicity, industry and skill groups, an indication of the latter type of variation in geographical mobility across of these groups could be obtained. The approach taken by this study therefore gives a framework that could be repeated for separate labour force groups.[42]

Statistics New Zealand's current confidentiality protection policies mean that use of their secure "Datalab" facility is the ideal way to extend the approach of this study to subsets of the total employed population. This would allow use of unrounded data at the area unit, or even meshblock, level. However, a more practical option in the short term is to draw on customised tabulations from the Census master-files, albeit at the cost of a much lower level of precision. Another approach is to study the degree of self-containment for each group within the aggregate labour market areas defined in this study. Less mobile groups would be characterised by a higher degree of reliance on the local labour market area of residence for employment. Any study of differences in regional travel-to-work patterns across demographic or employment groups might also draw on the 1999 Time Use Survey, which provided estimates of time spent travelling per day for the purpose of labour market activity.

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[40] In a New Zealand context, the efficiency wage model of Papps (2000) suggested that wages are "more sensitive to local labour market conditions the less geographically mobile workers are or the less elastic their labour supply" (p. iii), although this hypothesis was not tested directly. More recently, Morrison and Berezovsky (2001) found evidence that workers in provincial labour markets are more likely to be classified as unemployed during times of poor employment growth than their counterparts in metropolitan areas.

[41] Overseas, Coombes *et al*. (1988) attempted to define separate local labour markets by occupation within one region of Britain, while Casado-Díaz (2000a) considered gender, occupation and industry in Spain.

[42] It is unclear whether high commuting propensities are positively or negatively related to migration propensities.

Finally, New Zealand travel-to-work data offer some potential benefits when compared to the equivalent United Kingdom data, as well as some challenges for researchers. As noted earlier, the British Census provides commuting information for only 10% of respondents, whereas every employed person is included in the New Zealand Census. This access to a population of workers may permit some improvements to the regionalisation algorithm that is used here.[43] In addition, New Zealand has a much lower population density than the United Kingdom, resulting in differences in the nature of rural communities and the administrative units into which they are classified. In light of this, future work may explore the appropriateness of the constraints used in the study in a New Zealand context.

This aim of this paper was to present the first classification of New Zealand into local labour market areas using travel-to-work relationships: in this case, those from the 1991 Census at the area unit level. As a spatial framework for the study of sub-national migration, the preliminary results documented here are likely to be largely robust to variation in the regionalisation method used. An immediate challenge is therefore to apply the areas thus identified to the study of local labour markets in New Zealand.

As has been confirmed by the experiences of other countries, the nature of the regionalisation problem is such that there will never be a definitive classification of local labour market areas in New Zealand. The continually evolving nature of labour markets, combined with the fact that that each regionalisation is designed for a specific purpose, means that a range of plausible methods for analysing spatial units exists. However, by addressing the issues raised above, it may be possible to reach a consensus. Only then will the analytical benefits referred to by Morrison in the quotation that opened this paper be able to be realised.

[43] A recently-commenced doctoral thesis aims to apply Geographical Information Systems techniques to the delimitation of local labour markets in New Zealand (see de Vries and Morrison (2000)). This intends to involve the development of a regionalisation model specifically for this country.

## References


Ball, R.M. (1980). The use and definition of travel-to-work areas in Great Britain: Some problems. *Regional Studies*, 14, 125-139.

Baumann, J.H., Fischer, M.M. and Schubert, U. (1983). A multiregional labour supply model for Austria: The effects of different regionalisations in multiregional labour market modelling. *Papers of the Regional Science Association*, 52, 53-83.

Baumann, J.H., Fischer, M.M. and Schubert, U. (1988). A choice-theoretical labour market model: Empirical tests at the mesolevel. *Environment and Planning*, A20, 1085-1102.

Casado-Díaz, J.M. (2000). Local labour market areas in Spain: A case study. *Regional Studies*, 34, 843-856.

Casado-Díaz, J.M. (2000a). *Trabajo y territorio: Los mercados laborales locales de la Comunidad Valenciana*. Alicante: Publicaciones de la Universidad de Alicante.

Crampton, G.R. (1999). Urban labour markets. In Cheshire, P.C. and Mills, E.S. (Eds). *Handbook of Regional and Urban Economics, Volume 3*. Amsterdam: Elsevier Science.

Coombes, M.G. (1992). *Study on employment zones*. Document E/LOC/20. Luxembourg: Eurostat.

Coombes, M.G. (1996). *Defining boundaries from synthetic data*. Paper at First International Conference on GeoComputation, University of Leeds.

Coombes, M.G., Green, A.E. and Openshaw, S. (1986). An efficient algorithm to generate official statistical reporting areas: The case of the 1984 travel-to-work areas revision in Britain. *Journal of the Operational Research Society*, 37, 943-953.

Coombes, M.G., Green, A.E. and Owen, D.W. (1988). Substantive issues in the definition of "localities": Evidence from sub-group local labour market areas in the West Midlands. *Regional Studies*, 22, 303-318.

Coombes, M.G. and Openshaw, S. (1982). The use and definition of travel-to-work areas in Great Britain: Some comments. *Regional Studies*, 16, 141-149.

Dahmann, D.C. and Fitzsimmons, J.D. (Eds) (1995). *Metropolitan and nonmetropolitan areas: New approaches to geographical definition*. Bureau of the Census Working Paper 12, Washington: Bureau of the Census.

de Vries, H. and Morrison, P.S. (2000). *The identification of local labour markets in New Zealand*. Ph.D. thesis proposal, Victoria University of Wellington (mimeo.).

Felsenstein, D. (1994). Large high-technology firms and the spatial extension of metropolitan labour markets: Some evidence from Israel. *Urban Studies*, 31, 867-893.

Fischer, M.M. (1980). Regional taxonomy: A comparison of some hierarchic and non-hierarchic strategies. *Regional Science and Urban Economics*, 10, 503-537.

Gerard, R. (1958). Commuting and the labour market area. *Journal of Regional Science*, 1, 124-130.

Green, A.E. (1994). The role of migration in labour market adjustment: The British experience in the 1980s. *Environment and Planning*, A26, 1563-1577.

Lichter, D.T. and De Jong, G.F. (1990). The United States. In Nam, C.B., Serow, W.J. and Sly, D.F. (Eds). *International handbook on internal migration*. Westport: Greenwood Press.

Maré, D.C. and Choy, W. (2001). *Regional labour market adjustment and the movements of people: A review*. Treasury Working Paper 01/08. Wellington: The Treasury.

Masser, I. (1976). The design of spatial systems for internal migration analysis. *Regional Studies*, 10, 39-52.

Masser, I. and Brown, P.J.B. (1975). Hierarchical aggregation procedures for interaction data. *Environmental and Planning*, A7, 509-523.

Morrison, P.S. (1989). *Labour adjustment in metropolitan regions*. Wellington: Victoria University of Wellington Press.

Morrison, P.S. and Berezovsky, O. (2001). Labour market risk and the regions: Evidence from gross labour flows. In Martin, R. and Morrison, P.S. (Eds). *Geographies of labour market inequality*. London: TSO Publishing (forthcoming).

Newell, J.O. (2001). *Scoping regional migration and its interaction with labour markets in New Zealand*. Department of Labour Occasional Paper 2001/2. Wellington: Department of Labour.

Owen, D.W. and Green, A.E. (1989). Labour market accounts for travel-to-work areas 1981-1984. *Regional Studies*, 23, 69-72.

Papps, K.L. (2000). *Wage determination in local labour markets: Theory and evidence for the wage curve in New Zealand*. Master of Commerce and Administration thesis, Victoria University of Wellington.

Slater, P.B. (1976). A hierarchical regionalisation of Japanese prefectures using 1972 interprefectural migration flows. *Regional Studies*, 10, 123-132.

Smart, M.W. (1974). Labour market areas: Uses and definition. *Progress in Planning*, 2, 238-353.

Summers, A.A. (1993). Urban America and urban Western Europe: Are they different? In Summers, A.A., Cheshire, P.C. and Senn, L. (Eds). *Urban change in the United States and Western Europe: Comparative analysis and policy*. Washington: Urban Institute Press.

Topel, R.H. (1986). Local labour markets. *Journal of Political Economy*, 94, S111-S143.

Vance, J.E. (1960). Labour shed, employment field and dynamic analysis in urban geography. *Economic Geography*, 36, 189-220.

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