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Analysis of economic networks

Geographical information systems as a visualization tool

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This paper offers a simple methodology for the analysis of socio-economic networks, aimed at improving the understanding of wider industrialization processes and the potential of lower-ranked enterprises to advance to higher levels of development. It emphasizes the role of GIS as a visualization tool, the human ability to interpret complex network patterns and the GIS advantage of quick spatial investigation. The methodology involves a breakdown of the overall pattern into sub-patterns performed in a number of stages, each consisting of several steps. Each stage is based on a newly selected factor(s), after the application of the former factor(s) has been completed. After the most visible patterns have been removed, the investigation proceeds to the analysis of the residual patterns. The potential of the proposed methodology is demonstrated by its application to the analysis of sales and purchasing linkages of Arab industrial plants in Israel. The network is expanded into the following main patterns: links to metropolitan core, links to adjacent Jewish towns, intra-settlements links and interregional links. © **1998 Elsevier Science Ltd. All rights reserved**

Keywords: Israeli Arab industry, GIS based methodology, network pattern, network visualization, sales and purchasing linkages

Numerous applications of geographic information systems (GIS) have already been developed, among them decision support in planning and development, environmental impact assessment, and real-time analysis of spatially distributed data (Maguire *et al*., 1991). However, the use of GIS as a research tool, especially for socioeconomic issues, is less evident (O'Callaghan and Garner, 1991; Goodchild *et al*., 1993). The potential of GIS as a powerful tool for geographic, particularly socioeconomic, research has been raised on a number of occasions, yet it has largely remained a theoretical possibility, very little being offered in the way of application (Martin, 1991). This paper suggests a GIS application in the analysis of spatial patterns of economic linkages. The potential of the proposed methodology is demonstrated by analysing the purchasing and sales linkages of Arab industrial enterprises in Israel.

The development of ties among enterprises, reflected in the establishment of a complex

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network of industrial links, is a major part of the industrialization process and has been discussed from a number of theoretical approaches. The key focus in these approaches is the analysis of the degree to which firms are embedded in different markets, through relationships with competitors, suppliers, regional and national business organizations, and public decision-making spheres (Best, 1990; Harrison, 1992; Markusen, 1994).

A major argument in the literature concerning networks and industrialization processes is that different economic structures are associated with specific industrial network patterns. The contemporary industrial district literature, though largely biased towards advanced industrial production, gives an overwhelming importance to the presence of networks within the district (Best, 1990; Pyke and Sengenberger, 1992). These networks, based on sale, purchasing and information links, are especially important because the small firm lacks the resources and the economies of scale and scope that are normally available to large enterprises, and are necessary to influence their economic and political environment. Therefore, cooperation with other small and medium-sized enterprises is necessary to facilitate strategic action and to remove the fear of taking risks. This cooperation may be made up, for example, by family relations, ethnicity and religion, or by both formal and informal collective agreements and market relations with other firms. If a district is founded on cooperation and trust, the entrepreneur knows that it is in the interest of other firms that his expertise and capability remain part of the collective resource inventory (Pyke and Sengenberger, 1992; Digiovanna, 1996). Other examples of networks and linkages within districts are those consisting of subcontracting and sub-supplier arrangements. Patterns of networks may also be linked to the ethnic factor; minority members may enjoy economic opportunities that are unavailable to them in the larger economy (Waldinger *et al.*, 1990). Intra-ethnic markets might become a solid foundation in which open networks are smoothly developed, while inter-ethnic networks are blocked by prejudices, cultural differences, and so on (Miles, 1989; Ratti, 1992; Lewin-Epstein and Semyonov, 1993).

This study is concerned with one major aspect of industrial networks—the spatial pattern of sales linkages. This pattern is investigated under the assumption that it is significant for understanding the association between the network pattern and structural aspects of Arab industry in Israel. This is done by offering a simple methodology for the understanding of inter-firm networks, aimed at recognizing the structure of wider industrialization processes. When working with a network, the focus of observation is an industrial link which is a complex unit. The qualitative features of the network are primarily defined by the spatial characteristics of the link (its location and direction), while attributes of the link (such as sales volume) mainly define its quantitative features. In order to handle the properties of the network as a spatial pattern, the approach to the elementary stage of data investigation must be broadened. The methodology proposed below is based on the ability of GIS to query and analyse spatial and attributive data simultaneously, and to visualize the results. The methodology simulates the standard process of cross-tabulation and analysis of residuals. In this context the observations in the cell are now *network links*, and instead of cells' means, variance, and so on, we consider the characteristics of the network sub-pattern formed by the links that correspond with the cell. We consider this approach a suitable and valuable tool for hypothesis formulation at the initial stages of data analysis.

The paper begins by discussing the role of GIS as a (visualization) tool in socioeconomic research and proposing a new methodology. This is followed by a short description

of Arab industry in Israel and a discussion of the way the data used in the demonstration were recorded and handled. The core of the paper demonstrates a practical application of the methodology for the analysis of sales linkages of Arab industrial plants in Israel. The contribution of the proposed methodology and the added insights it provides are discussed in the concluding section.

GIS as a visualization tool for spatial data

The basic querying ability of any GIS software makes it possible to display geographical objects selected according to their non-spatial attributes, or alternatively, to analyse the non-spatial attributes of geographical objects selected on a map. The approaches to the analysis of attributive information, as well as the methods of spatial presentation of non-spatial query results, depend greatly on the nature of the spatial objects, particularly their dimensions. Three basic types of geometrical features—points, lines and polygons—differ with respect to the approaches to the analysis and visualization of related attributive information. The presentation of attributive information related to points and polygons has already established standard forms based on maps of symbols and choropleth maps. Various possibilities for presenting point and polygon data by thematic maps are included in commercial GIS packages (the thematic maps of MapInfo, for example). Combined with standard methods for the statistical investigation of attributive information (i.e. the description of sample distributions of separate variables, cross-tabulations, etc.), thematic maps serve as a useful tool for preliminary data investigation and hypothesis formulation. These options, however, are of limited use when working with data whose spatial components are presented by line features. For example, the graphical presentation of a network of industrial linkages employs a set of directed lines between sources and destinations. Even for a relatively small set of linkages, the result is a dense and complicated network that is visually awkward and difficult to interpret. The problem may thus be termed 'the discovery and interpretation of complex network data', involving the identification of the spatial patterns characterizing the network phenomenon under investigation.

To overcome the difficulties of data-processing strategies, and the fundamental problem of hypothesis formulation when interpreting data, this paper offers a methodology for investigating socioeconomic networks based largely on simple visualization and interpretation (see, for example, Kraak *et al*., 1995 on visualization as decision support). Essentially, the data dealt with comprise a *network*. Such a network corresponds to a matrix, the dimensions of which are equal to the number of the interacting objects—the individual industrial plants in the case study. It should be emphasized that we do not want to offer any *a priori* hypothesis regarding the network structure and therefore do not rely on spatial indices constructed in order to reveal specific phenomena.

The methodology presented here involves a breakdown of the overall network into sub-patterns in a manner similar to the conventionally used methods of cross-tabulation and analysis of residuals. The breakdown is performed in a number of stages, each consisting of several steps, as shown in *Figure 1*. Each stage is based on a newly selected factor(s), after the application of the former factor(s) has been completed. Once the most visible patterns have been removed, the investigation proceeds to the following stage, where the analysis is performed on the residual patterns. Each stage comprises several steps:

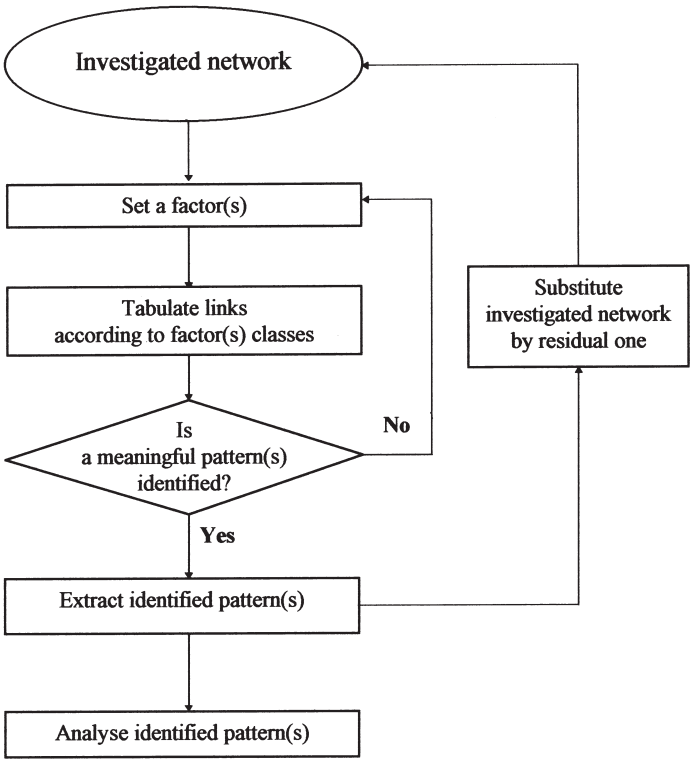

Figure 1 A methodology for the spatial analysis of economic networks

(1) Exploration of a number of intuitively important variables by which network links can be categorized, and presentation of the results in the form of a table of patterns (its counterpart would be repeating the one- or two-dimensional tabulation of non-spatial data according to different factors). As a result, factor(s) that produce a visually meaningful pattern(s) in a number of table cells is (are) selected.
(2) Extraction of the meaningful sub-patterns and the residual network.
(3) Statistical analysis of the extracted pattern.

If the proposed stage-by-stage analysis should reach a dead end, where the residual network is still complicated and a clear pattern(s) is hard to uncover, the analysis can be restarted at an earlier stage with new factors and a different path followed. This procedure has the advantage of exploring and selecting one or more possible forms of explanation which otherwise would not be accessible.

The following sections focus on a practical way in which the proposed methodological approach can be applied, the analysis concentrating on the sales and purchasing linkages of industrial plants located in Arab settlements in Israel. The analysis is performed within the framework of a simple ArcCAD application, with MapInfo GIS used for final presentation of the maps.

The construction of GIS for Arab industry in Israel

Arab industry

The Arab population of the State of Israel (not including the Palestinian Arabs living in the Gaza strip and the West Bank) constitutes a minority accounting for about 19 per cent of the total population and divided into four ethnic groups: Moslem, Christian, Druze and Bedouin. A total of 130 Arab settlements are clustered mainly in the Galilee mountains in the north and the Little Triangle in the centre, and, to a much lesser extent, in the Beer Sheva basin in the south (*Figure 2*). Until the late 1960s, the economic development of the Arab sector was characterized by a limited rate of industrialization, primarily due to the delay in establishing urban functions and an appropriate infrastructure (Bar-Gal and Soffer, 1976; Schnell, 1994). Infrastructure developments, improvements in educational levels and the increased professional experience of Arab workers, including those employed in Jewish-owned firms, led to a significant growth in the number of Arab-owned enterprises during the 1970s, and especially since the beginning of the 1980s (Meyer-Brodnitz and Czamanski, 1986; Schnell *et al*., 1995). By the early 1990s, the number of industrial workers employed in Arab settlements had grown to about 12,000 (Atrash, 1992) and the number of plants in these settlements had reached 900 (Schnell *et al*., 1995).

During the last decade, there has been a high concentration of workers (80 per cent of the labour force) in the textile and clothing industries, food processing, construction-related materials (including cement blocks, concrete, marble tiles and plates and floor tiles) and woodworking enterprises. These industries are characterized by low salaries and low contributions per employee to the gross domestic product (Central Bureau of Statistics, 1994). The reliance on relatively labour-intensive industries displaying low output per worker is a clear indication that Arab-owned plants cannot be counted among the more advanced enterprises in Israeli industry. Although the share of the Arab sector in Israeli manufacturing has increased steadily since 1970, this growth has not been fast enough to bring it level with the share of the Arab sector in the population and the labour force, and it has remained peripheral to overall industrial production (Gradus *et al*., 1993; Schnell *et al*., 1995).

In the Arab sector in Israel, as in other developed and developing economies, enterprises of different sizes and production characteristics coexist. Small household production and informal subcontracting activities (the latter especially in the textiles and clothing industries), which constitute 43 per cent of the enterprises in this sector, exist side by side with an increasing number of small and medium-sized workshops and factories (around 56 per cent), as well as a very small number of recently developed large-scale enterprises (about 1 per cent).

In 1992, the average number of employees per plant was about 15, a high percentage of whom were women employed primarily in sewing shops (Schnell *et al*., 1995). The formal training of the labour force is limited; most of it is done on the shop floor. The most common type of ownership is individual or family, with several brothers owning and managing a plant, and the family and its savings are the most common source of initial capital investment. In addition, a significant proportion of plants (60–80 per cent in most industrial branches) are situated in residential areas, especially on the ground floor of the owner's home or in rented residential buildings (Sofer *et al*., 1996). Only a

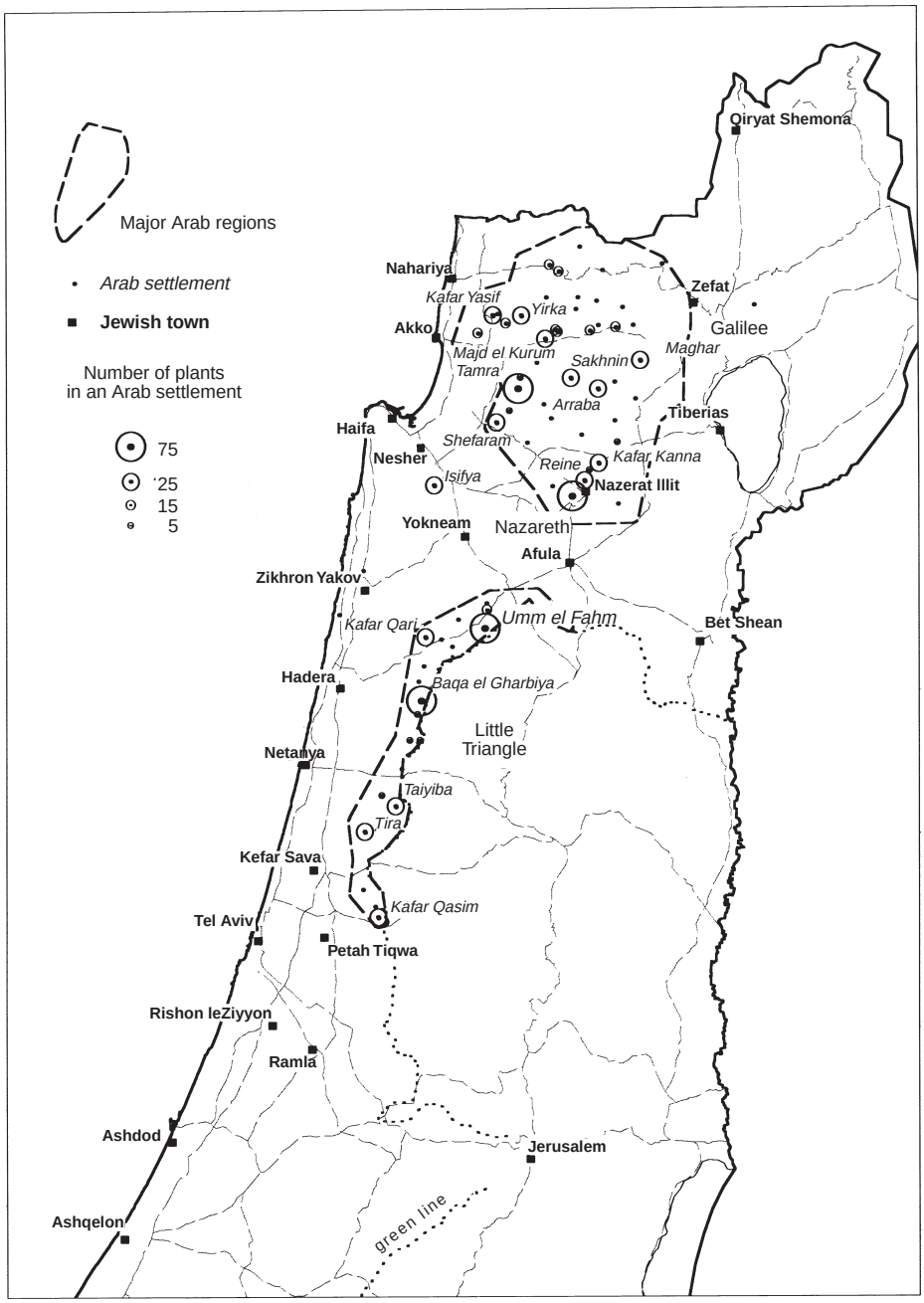

Figure 2 Arab settlements in Israel

small percentage are located in industrial areas, which have yet to be established in most settlements.

Organization of sample data

A sample of Arab settlements and enterprises was surveyed in 1992 for a thorough study of Arab industry and industrial entrepreneurship in Israel (Schnell *et al*., 1995). An enterprise was defined as any plant acting as a production unit employing at least three workers. Of the 900 enterprises operating in 1992, the managers and owners of 514 plants distributed in 35 settlements (constituting about 50 per cent of the larger settlements in the mountainous Galilee and the Little Triangle) were interviewed. The survey was comprehensive, examining, among other parameters, sources of inputs, output destinations, and related characteristics.

The GIS for Arab industry in Israel is based on the layers of standard geographic information and four data-derived layers. Layer one, termed 'plants', is composed of points representing the plants under study. Geometrically, the points coincide with the settlements in which they are situated. Layer two, termed 'purchasing links', is a collection of directed lines, each of which connects the location of a supplier with the location of a plant, so that any input purchased by a plant from any other settlement can be charted. Some purchasing links are geometrically identical; these links coincide when several plants located in one settlement purchase supplies from the same source. Nevertheless, they can be identified according to their non-spatial attributes. Layer three, termed 'sales links', presents sales connections in a similar fashion to the second layer, while layer four shows the mobility of the labour force as lines between the industrial workers' settlements of residence and settlements of employment.

When designing a GIS, linkages are established between: (1) plant characteristics and points representing the plants at layer one; (2) lines connecting plants and settlements at layer two and the sample data describing purchasing links, namely, the materials and volume purchased; (3) data on sales links and sales volumes and the lines at layer three; and (4) data on labour force mobility, namely, numbers and type of function—managerial, office work, production, marketing—and the lines at layer four. In order to illustrate the use of the methodology, the following application concentrates only on the industrial plants and their sales and purchasing links.

Application of the methodology

This section demonstrates how the proposed methodology can be applied, using the example of the industrial purchasing and sales linkages of Arab plants in Israel. The analysis in each stage is presented, along with possible conclusions that may be drawn from it.

The analysis begins with sales links. The initial map of sales links shows a pattern that is too complicated for simple visual interpretation (*Figure 3*). The successive stages, shown in *Figure 4* (see also a summary of the results in *Figure 9*), are the decomposition of the initial map (initial stage) by the construction of sub-patterns, which are explained below.

The investigation of the sales network began by examining a number of factors that could influence the network pattern: the geographical location of the plant, the distance of the plant settlement from metropolitan areas, the year of foundation, and so on. The

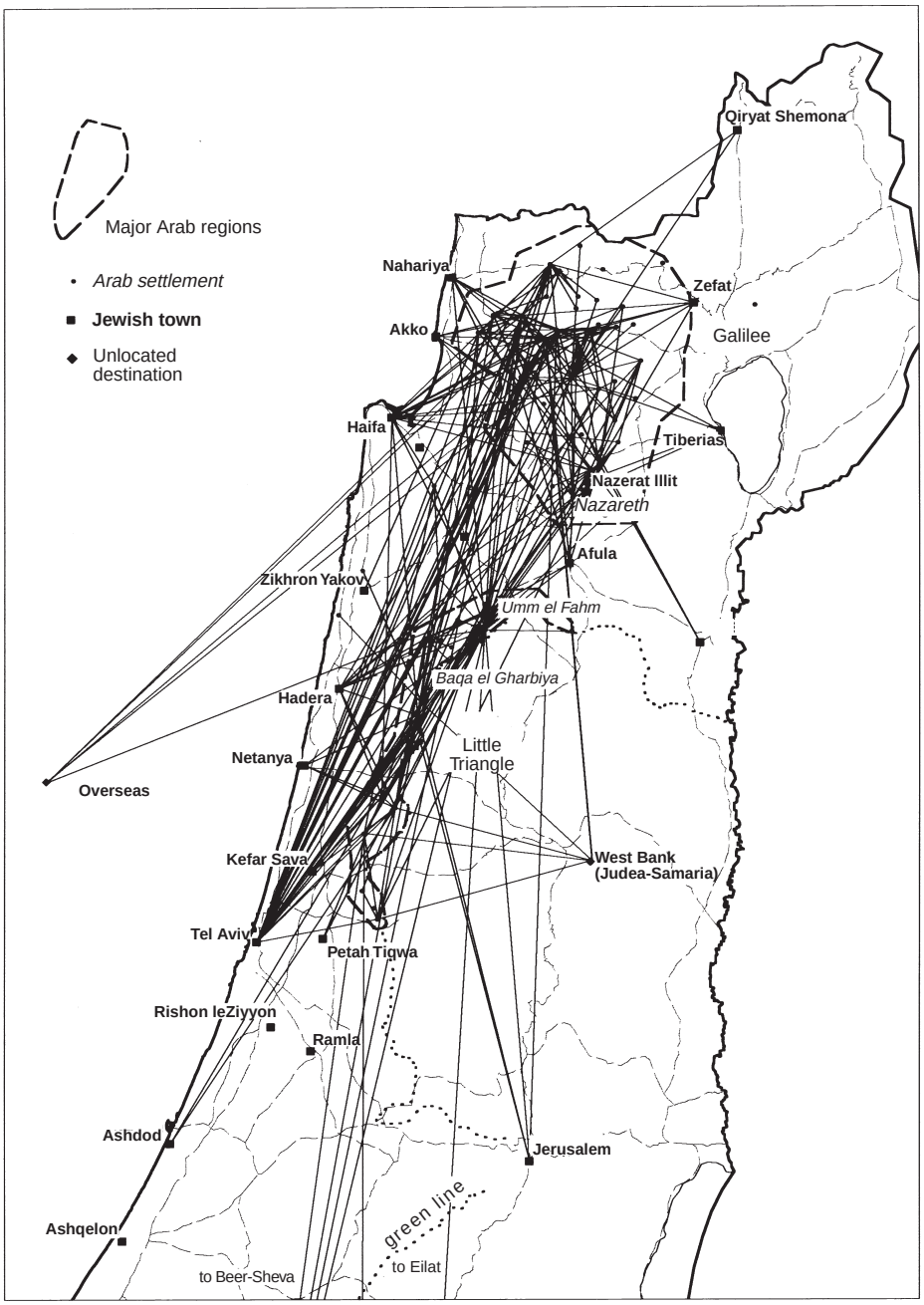

Figure 3 Sales linkages of Arab plants

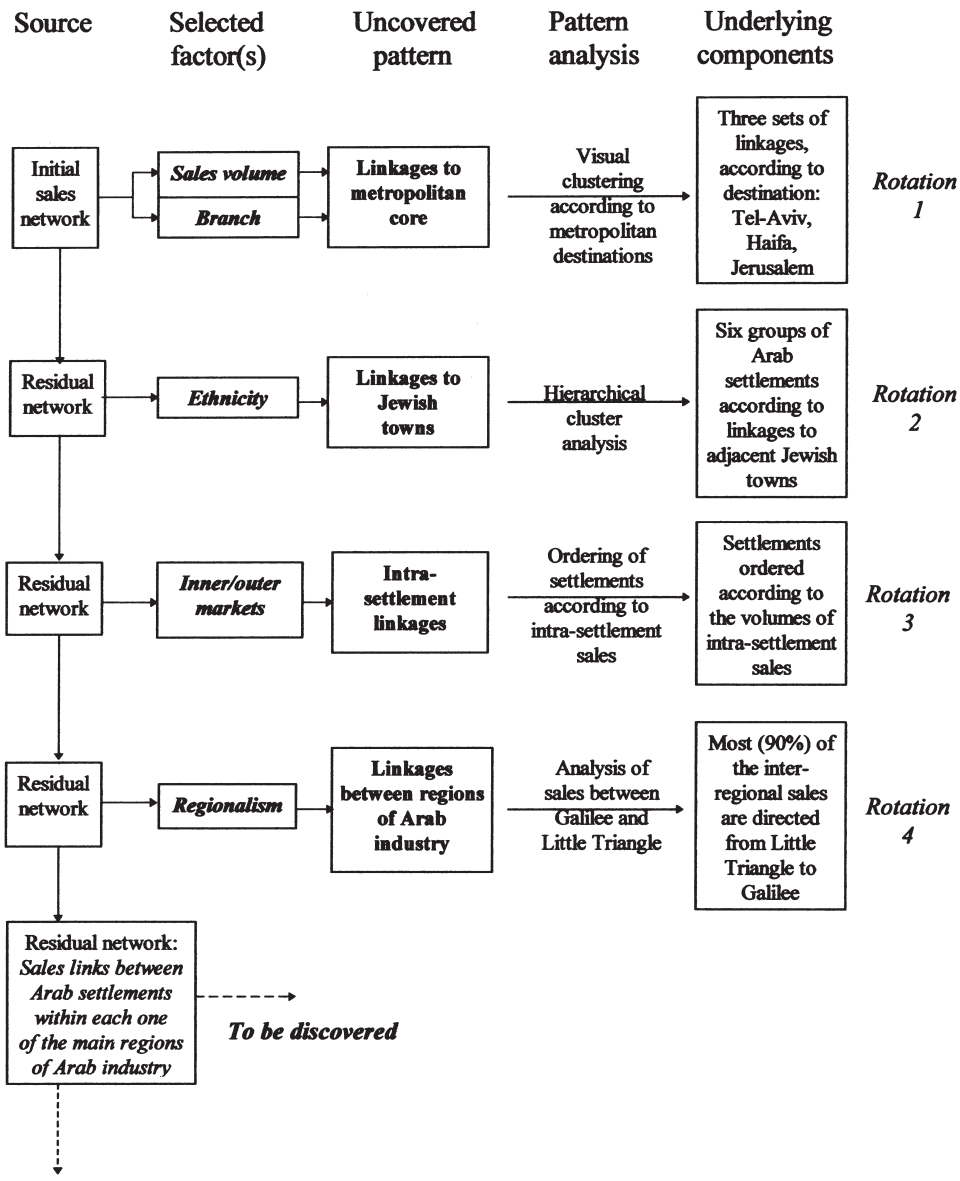

Figure 4 Successive stages of Arab plants sales network decomposition

first pair of factors selected comprises industrial branch (textiles and clothing, food, woodworking, construction materials) and volume of sales (*Figure 5*). In order to cross-tabulate the links, the plants were divided into three groups according to annual sales volume: (1) below NIS 0.4 million, (2) NIS 0.4–2 million and (3) above NIS 2 million.

On the maps of sales patterns, the links have a width at the destination that is proportional to the total value sold. This is repeated in *Figures 5, 7* and *9*. In the black-and-white maps included in this paper it is impossible to distinguish between Arab and Jewish destinations, though this task has been performed.

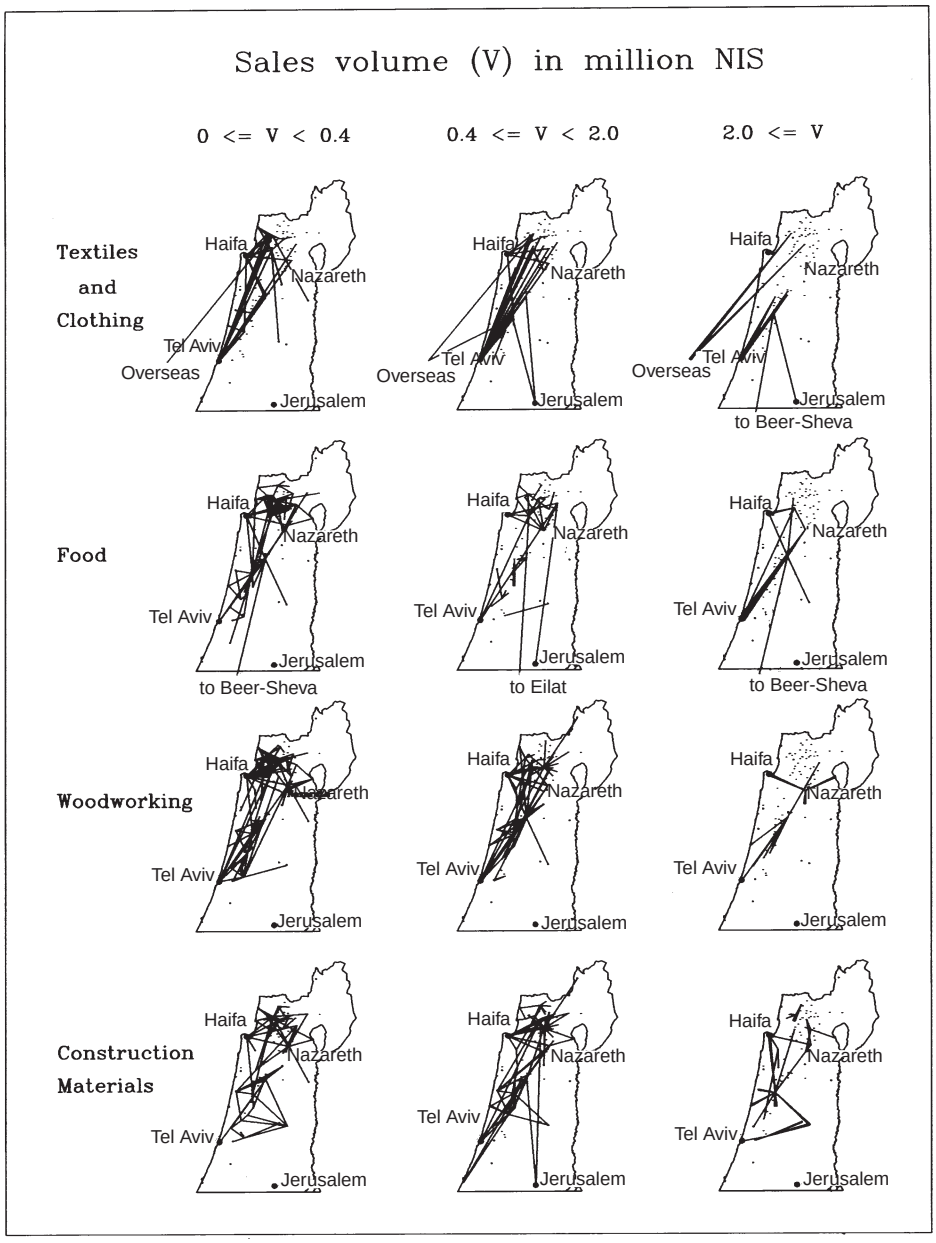

Figure 5 Cross-tabulation of plant sales linkages by branches and sales volume

The analysis of all the patterns shown in *Figure 5* yielded sub-patterns characterized by sales to the Jewish-dominated metropolitan areas of Tel-Aviv and Haifa, as well as to overseas destinations for the textiles and clothing branch. The combined rate of sales to the two metropolitan cores, to Jerusalem and to overseas destinations accounts for 88.9 per cent of the total volume of textiles sales. No significant change in the spatial

pattern of linkages for this specific branch occurs with an increase in sales volume. Two other conclusions can be drawn from this analysis. First, an increase in the size of the industrial operation, as expressed by the volume of sales, is accompanied by an increase in the percentage of exported output. Secondly, as the size of the industrial operation increases, Haifa drastically diminishes in importance as a destination, leaving Tel-Aviv and overseas as the two principal destinations. It should be noted that most Arab-owned textile and clothing plants operate as sub-contractors for large Jewish-owned companies in the metropolitan areas of Tel-Aviv and Haifa, a factor that obviously affects the overall spatial pattern of sales.

In contrast to textiles and clothing, the construction materials branch is spatially typified by short-distance links: links with nearby settlements are stronger than links with either Arab or Jewish settlements outside the adjacent regions. At all levels of plant size there are sales to both Arab and Jewish settlements. Medium-sized plants (with a sales volume of NIS 0.4–2 million) manage to penetrate Jewish markets further away than small-sized plants. The larger plants in the construction materials branch are typified by links with both the metropolitan areas of Haifa and Tel-Aviv, and with Arab settlements outside the region. This pattern is somewhat similar to that identified for the textiles and clothing branch, although much less pronounced.

Halfway between textiles and construction materials are the woodworking and food branches. For both, the smaller and medium-sized plants do not display a clear sales pattern, while in the case of the larger plants there appears to be a pronounced trend towards sales to Jewish metropolitan areas. As for the food industry, factories with a large sales volume have high-intensity links with the Tel-Aviv metropolitan area, while for the woodworking industry the stronger links are with the Haifa metropolitan area.

The most pronounced aspect that emerges from a visual inspection is the existence of a sub-pattern of sales defined by Jewish customers located in the metropolitan areas (27 per cent of total sales). This pattern is characteristic of both the textiles and clothing enterprises and the largest plants in the food and woodworking branches (*Figure 5*).

Up to this point we have performed one stage of the proposed methodology and extracted the sub-pattern of Jewish metropolitan markets. In seeking possible further components of Arab industrial activities, we must explore the residual network by excluding the sales destinations of Tel-Aviv, overseas, Haifa and Jerusalem.

The residuals of the textiles and clothing branch are insignificant and we turn now to the residuals of the food, woodworking and construction materials branches. By examining various factors and pairs of factors once again, we observe a clear visual trend of sales to non-metropolitan Jewish towns. This pattern emerges when two factors are invoked. The first is a two-class factor termed here ‘ethnicity of the customer’. The second is ‘sales volume’, divided according to the same three classes employed above. Twenty-one Jewish towns, comprising together about one-third of all towns in Israel, purchase about 19 per cent of the total production of the three major industrial branches of Arab industry. The hypothesis that can be formulated on the basis of the visual analysis of the 2×3 table of the patterns (not presented here) is that most Arab plants sell part of their production to adjacent Jewish towns. This hypothesis may be verified and the structure of this component of the sales network could then be studied by analysing the clustering of the Arab plants according to location of Jewish customers (*Figure 6*).

Such a classification is an example of further statistical analysis of the patterns obtained thus far. In this analysis we work at the settlement level, merging the sales of food,

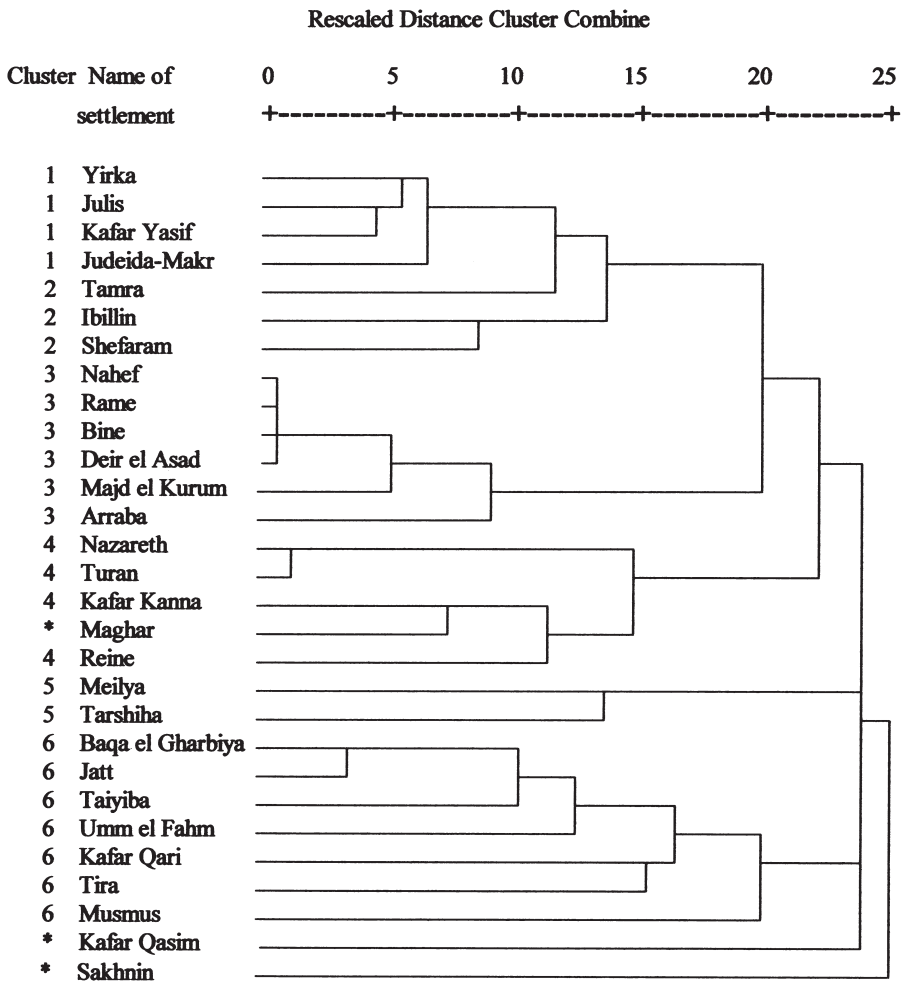

Figure 6 Regions with similar sales pattern to adjacent Jewish towns

* Unclassified settlements. Kafar Qasim and Sakhnin do not belong to any wider cluster; according to the structure of sales Maghar belongs to cluster 4, but it is spatially separated from the other settlements of this cluster.

woodworking and construction materials plants located in each settlement. Each settlement is then characterized by a vector demonstrating the industrial linkages of the plants to Jewish customers. The number of components of this vector is equal to the number of destination settlements (i.e. 21). Each component represents the flow of sales of all plants in a given settlement to a given destination. In order to elicit the clustering, we proceed with the SPSS/PC statistical package clustering procedure with ϕ^2 index as a measure of proximity between vectors of sales to Jewish destinations (Norcliffe, 1977). The classification dendogram is shown in *Figure 6*. A level of five clusters was chosen, with one further subdivided. The clusters, constructed according to the structure of sales to the Jewish destinations, identify six compact regions of Arab settlements (*Figure 7*),

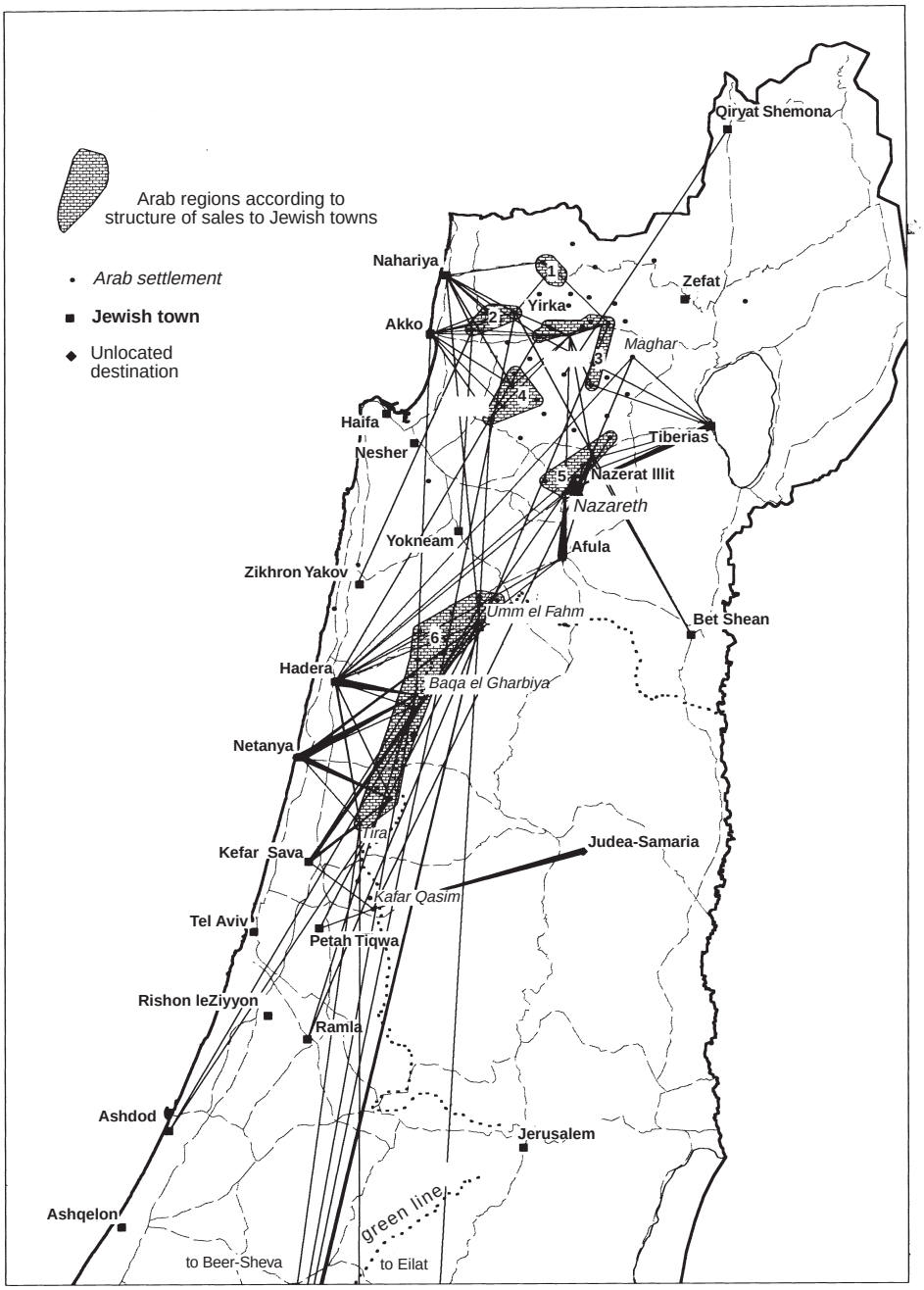

Figure 7 Arab settlements clustered according to sales to Jewish towns

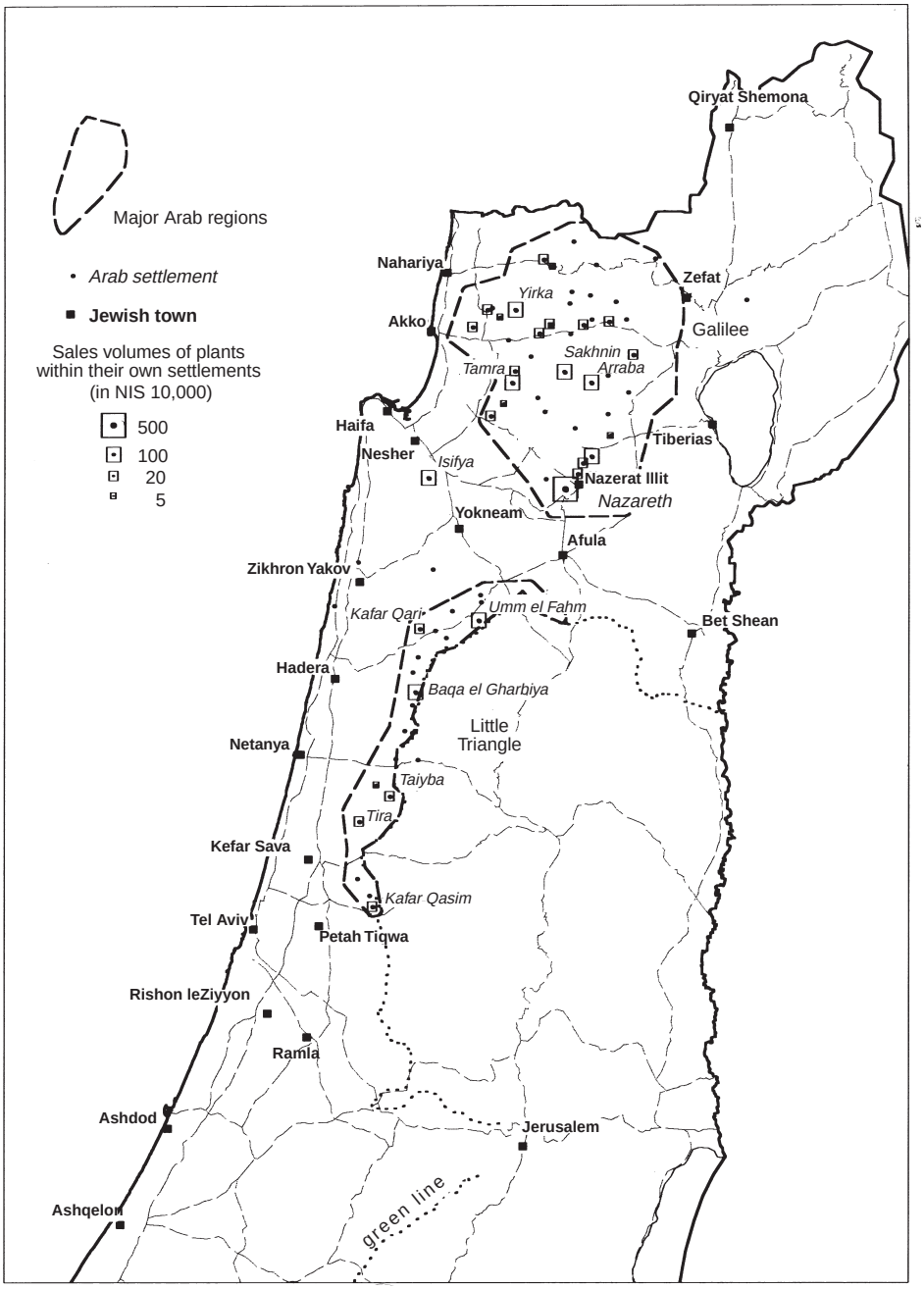

Figure 8 Intra-settlement sales

with only one exception of Maghar. For example, the plants in the region consisting of Yirka, Kafar Yasif, Judeida–Makr and Julis sell most of their products to the adjacent Jewish towns of Akko and Nahariya, while plants located in the settlements of the Little Triangle sell most of their products to Hadera, Netanya, Kefar Sava, Petah Tiqwa and Ashdod.

Further stages of the methodology, presented earlier in *Figure 4*, could be performed in the same manner. For the present paper, the linkages among the Arab settlements and within the settlements themselves were selected. Although the latter is the simplest component of the sales network, accounting for about 25 per cent of total sales (*Figure 8*), it is still quite significant. The residual network consists of the sales links between Arab settlements. At this stage we extracted from this network the pattern of sales links between the Galilee and the Little Triangle regions (3 per cent of the sales), as shown in *Figure 9e*. The residual network presents the sales to the other Arab settlements within the region of the plant (26 per cent of the sales) as shown in *Figure 9f*. Although this pattern still appears complex, a further analysis is beyond the scope of this paper.

The map of purchasing links *Figure 10a* appears much easier to decipher when compared with that of sales links. We begin by again employing the same factors used for the decomposition of the sales network. As with sales links, purchasing links of Arab-owned plants located in Arab settlements are dominated by links with the major metropolitan areas of Haifa and Tel-Aviv *Figure 10b*, representing 49 per cent of all purchasing links. Visually, it would seem that there is no clear regional specialization, most plants purchasing their inputs from metropolitan areas. The second component is also similar to that of the sales network *Figure 10c*; it consists of links with other Jewish towns and accounts for about 28 per cent of all links. In the same manner as for the sales network, an attempt was made to cluster the settlements according to the location of suppliers. The result here, however, does not reveal any significant spatial clustering.

The most significant component of the residual network is that consisting of links with the Arab town of Nazareth. It comprises 88 purchasing links, about 7 per cent of the total number of links *Figure 10d*, and is largely similar to the pattern of purchasing links with Jewish towns, each of which supplies about 30 customers on average. Clearly, in respect to the purchases by Arab-owned plants from other Arab settlements, Nazareth has far greater significance than any other settlement and emerges as the core of industrial inputs outside the Jewish sector. A network of links with other Arab settlements can be divided into the sub-network of links with settlements that supply eight or more plants *Figure 10e*—about 14 per cent—and the residual pattern concerning links with settlements that supply two or one plant *Figure 10f*—about 2 per cent of the links. All these links are affected mainly by the purchasing requirements of the food industry (Schnell *et al*., 1995).

Conclusions

The proposed methodology for the analysis of socioeconomic network patterns comprises three components: (1) GIS application as a tool for repeated examination of the influence of factors and mapping of results; (2) the human ability to recognize socioeconomic network patterns and their different degrees of similarity and dissimilarity; and (3) the formalization of identified patterns and their statistical analysis and confirmation.

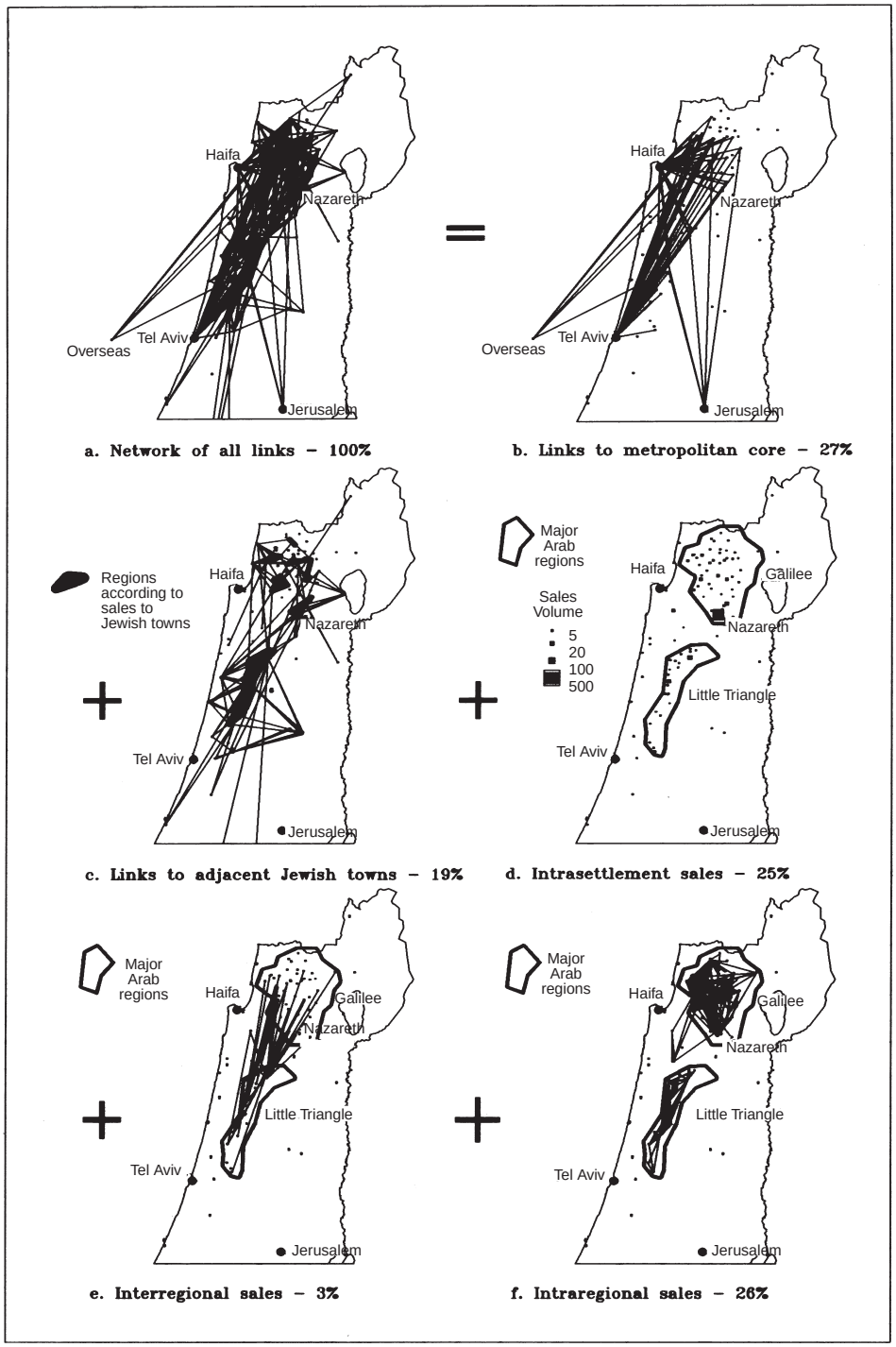

Figure 9 Decomposition of sales links of Arab plants

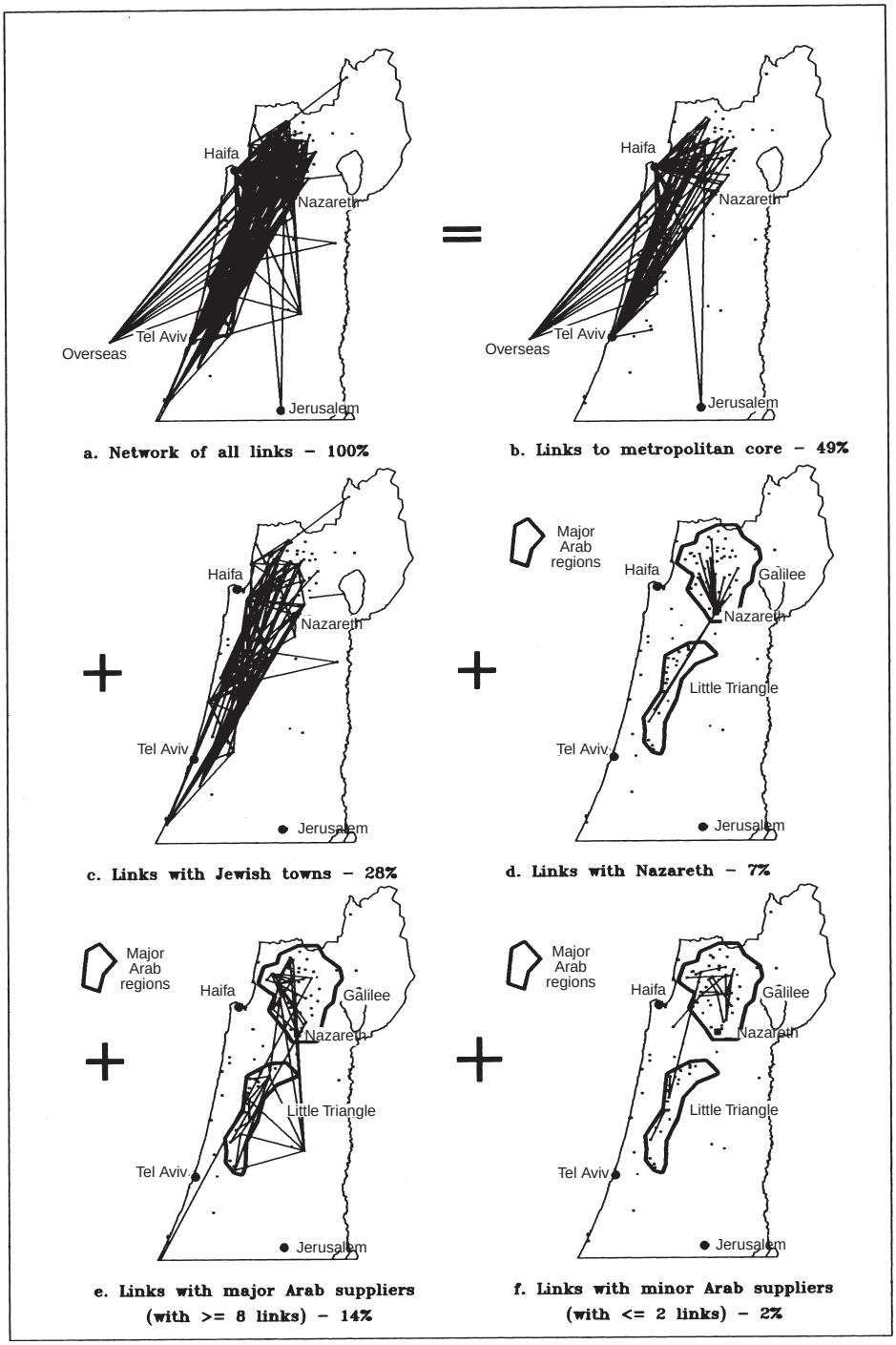

Figure 10 Decomposition of purchasing links of Arab plants

Separating the network into a number of simple sub-patterns seems to be a rational way to reveal the factors shaping its structure. The process of separation may be regarded as analogous to the standard statistical processing of ordinal/nominal data. First, the overall network is expanded by the factors that are at the focus of a researcher's interest, a procedure similar to a repeated cross-tabulation. Secondly, a visual analysis is executed in order to uncover any common significant trends for different 'cells', a procedure similar to the comparison of cell distribution. Although this step obviously depends entirely on a researcher's preferences, it appears to be the most natural way to reduce the high-dimensional network data to some understandable number of components without losing much information, at a stage when no hypothesis has yet been formulated. Finally, the trend uncovered by the patterns is subtracted and the residual pattern is subjected to analysis in the same way, a procedure analogous to residual analysis. The revealed patterns can then be further analysed. Since they are all complex objects, the possibilities for analysis are much wider than those available for non-spatial data.

In the case study of Arab industry in Israel, it was demonstrated how the overall pattern of the sales network was separated into five simpler sub-patterns (the percentage share is shown in *Figure 9*), each of which could be further elaborated: (1) sales to the dominant metropolitan core areas, especially Tel-Aviv; (2) sales to adjacent Jewish towns; (3) intra-settlement sales; (4) sales among two major regions of Arab industry; and (5) residual sales among Arab settlements within the region. Each of these sets of linkages may be subdivided into lower degrees of hierarchies. For example, sales to the metropolitan cores or Jewish towns may be expanded and analysed further by major branches or destinations. The network of purchasing links is simpler and could be presented as the sum of a major component and three secondary components (the percentage share is shown in *Figure 10*): first, purchases from the core metropolitan areas; and then the secondary components, purchases from adjacent Jewish towns, purchases from the leading Arab town of Nazareth, and purchases, with two different degrees of intensity, from other Arab settlements.

Our example deals with the major patterns of sales and purchasing networks making up a part of the industrialization processes of an ethnic minority that is a major element of the industrial periphery of Israel. From those networks we may learn that there are different ways and different levels of participating in the economy, especially for firms located in the periphery. Networks have different sub-networks, some representing local and regional industrial links which may reflect the emergence of specific Arab industrial districts. Some represent links at the regional and national levels, which may suggest a better incorporation into the national economy and less dependence on the local economy.

One may go further and argue that one of the possible conclusions from this research indicates that studying the development path of an Arab-owned plant could focus on the differentiation in the degree of plant participation in local, intra-ethnic and intra-regional markets. Once the sub-networks are revealed, the important issue of plant growth and development can be raised by examining the intensity of its participation in each of the networks. A detailed investigation of Arab industrialization in Israel would require the further analysis of plants' involvement in sales to metropolitan areas, medium-sized and small Jewish towns, and Arab settlements in adjacent and distant regions. Suffice it to say that in general, at the current stage of industrial development in Arab settlements in Israel, industrial expansion and growth are associated with increasing integration into Jewish markets, both smaller adjacent towns and the metropolitan cores.

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