Geography of Norwegian production and innovation: Measuring spatial concentration and regional diversification *

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ABSTRACT

The objective of this paper is to access the regularities in spatial arrangement of production as well as innovation in Norway. In this connection, we have gone through a brief review of existing locational theories and discussed some empirical evidence along with the methodological variety that exist in explaining agglomeration in Scandinavian countries. Further, we are looking deeper into this fact, whether or not innovation has the same geographical distribution as production in Norway. The study is based on register data from the Business Register of Statistics Norway and patent data from the Norwegian Patent Office for the period 1995-2003, encompassing all the 161 labor market regions of Norway. Varieties of multivariate statistics and spatial econometrics estimation procedures have been applied. The results confirm a strong core-peripheral structure in production as well as in innovation in Norway. Moreover, the study indicates strong existence of spatial autocorrelation between sectors and regions suggesting spillovers of externalities between Norwegian labor market regions.

INTRODUCTION

Agglomeration is a stylized fact of spatial arrangement of production and is well explained in various location theories. The New Economic Geography (NEG) initiated by Krugman (1991), explains the formation of a large variety of such economic agglomeration using general equilibrium framework explicitly through a micro founded mechanism, in the geographical space (Fujita and Thisse, 2002; Fujita, 2005). To date, NEG has been focusing on four areas of locational dependency (Fujita and Mori, 2005). They includes; the general equilibrium modeling of an entire spatial economy which sets apart this approach from that of traditional location theory and economic geography. The second is the role of increasing returns or indivisibilities at the level of individual producer or plant (which is essential for the economy not to degenerate into backyard capitalism). The third is the transport costs, which makes location matter. Finally, the locational movement of productive factors and consumers which is considered as a prerequisite for agglomeration. There areas are generally summed up in three classes of NEG models: core-periphery models, regional and urban system models, and international models. In all these version of the NEG the most popular modeling strategy is to focus on the spatial distribution of agglomerations while abstracting from the internal spatial structure of agglomeration. In the previous two types of models, namely, core-periphery, urban and regional system, factor mobility has been a key element in creating agglomeration.

With some decisive shift in our understanding of space economy, the present NEG is under serious refinement and extension. Two of the major extensions are heavily focusing in its monopolistic nature of explanation and further conglomeration to regional growth. It has been criticized that many of the present NEG models are static in the sense that they postulate; until the economy reaches to equilibrium, no further change occurs in it unless parameters are exogenously varied. In other words these models do not account for the possible impact of agglomeration on the rate of innovation and vise versa, which in turn is likely to influence further the geographical distribution of economic activities. At present, this acknowledgement is a plausible subject of investigation for both geographers and growth economist alike. Further, as both the new theories of growth and new economic geography share the same basic framework of monopolistic competition, there is a growing reorganization, that there exists a solid foundation for cross-fertilization between the two fields. The existing contributions that have recently explored the mutual influences between growth and location exploit this formal

* This paper is a preliminary material circulated to stimulate discussions and critical comments.

analogy includes Waltz (1996), Baldwin (1999), Martin and Ottaviano (1999), Baldwin et al.(2001), Yamamoto (2003).

In this paper we will look in to this matter in Norway. The objective is to access the regularities present in spatial arrangement of production as well as in innovation in Norway. Doing so, we would like answer; can spatial arrangement of production in Norway be explained in NEG framework? In this connection, we will go through a brief review of existing location theories and discuss some empirical evidence along with the methodological variety that exist in explaining agglomeration in Scandinavian countries. Further, we are looking deeper into this fact, whether or not innovation has the same geographical distribution as production in Norway. This empirical analysis is based on Business Register Data (BRD) and patent statistics from the Norwegian Patent Office (NPO) for the period 1995 to 2003. Norwegian labor market region (LMR) is used here as spatial unit of observation and the study confined to manufacturing sectors.

Rest of the paper is organized as follow. A brief discussion of the location theories and some Norwegian empirical examples are presented in next two sections. The section four sketches the estimation model and the main findings of the study. Finally discussion and some concluding remarks are provided in two subsequent sections.

FRONTIERS OF LOCATION THEORIES

In the following section we will produce a bird's eye view of the existing locational theories. Although these theories can be group in several ways, the choice here is random but to bring a variety. The first theory in this context could be the minisum location approach of Fermat early in the 17th century and an elaborate version by Weber and others in early 1900s. The theory postulates, plants locate in a continuous space by minimizing the weighted sum of Euclidean distances from that plant to a finite number of sites corresponding to the markets where the plant purchases its inputs and sells its outputs. In the postulation the weights represent the quantities of inputs and outputs bought and sold by the plant, multiplied by the appropriate freight rates (Weber, 1909). Subsequently, an alternative and more relevant line of research focuses on the explicit modeling of the transportation network. Using this framework, Isard (1956), Hakimi (1964), Witzgall (1964) have shown that the set of vertices of the network always contains an optimal solution to the minisum problem. This result has several interesting implications. First, it shows that the location of a facility on a network is of a discontinuous nature because the search for an optimal location may always be restricted to a finite set of points, and suggests some form of inertia in firms' locational behavior. Second, the locations to be considered are very distinctive in the sense that they are markets, or nodes, or both.

Since the 1960s, the more standard microeconomic approach of profit maximization has taken the place of the least transport cost approach. This has allowed to understand the influence of additional economic and geographic factors on firm location. For instance, Sakashita (1967) considers the case of freight rates that are constant or taper off with distance, a condition that characterizes all modern transport technologies. He demonstrates that, in the case of a segment connecting the market and the input source, the firm always chooses to set up at one of the two endpoints and never at an intermediate point. This result has been extended to the case of a network and of several in put and output markets (Louveaux et al, 1982). The fact that the location of a firm follows a discontinuous logic is the counterpart of the inertia observed in locational decisions. Thus, models of firms' location suggest a fundamental feature of the space-economy.

The minisum problem rationalizes the location choice of plants assuming away the crucial decision firms make in the real world on how many plants to run. In other words, in supplying (or sourcing from) a new market, a firm can choose between shipments from (or to) some pre-existent distant plant or sales from (or to) a new local plant. The choice is not trivial provided transportation is costly and there are increasing returns to scale at the plant level. Without transport costs, space is immaterial. Increasing returns lead the firm to concentrate its production in a few plants, whereas transport costs raise the issue of where to locate those plants. That increasing returns to scale generate such indivisibilities has been recognized by various scholars interested in the formation of human settlements. Indeed, the trade-off between increasing returns and transport costs may take quite different forms, thus making the argument applicable to a wide range of scenarios.

The insights presented so far consider the location decision made by a firm isolated from any competition with other firms. Few industries, however, feature such local monopolists. That perfect competition is essentially incompatible with spatial interdependence in the absence of first nature differences across sites has been very elegantly proven by Starrett (1978). Using a more general framework in which the transport sector is explicitly accounted for and allowing for variable land consumption by all agents, Starrett (1978) shows the following result without making any convexity assumption regarding preferences and technologies. According to author, in an economy with a finite number of locations and a finite number of consumers and firms, if space is homogeneous, transport is costly and preferences are locally non satiated, then there is no competitive equilibrium involving transportation. It mean, if economic activities are divisible, each activity can operate at an arbitrarily small level without any loss of productive efficiency. Thus, a competitive equilibrium exists and is such that each location operates as an autarchy. However, once economic activities are not perfectly divisible, they have an address and the transport of some goods between addresses becomes unavoidable. As simple as it may look, the logical implications of this Spatial Impossibility Theorem are nonetheless far reaching. In particular, it implies that understanding the spatial distribution of economic activities cannot escape some deviation from the set of assumptions that stand behind the theorem. This allows us to present the various theories of industry location as alternative settings. In particular, in the wake of Marshall, modern urban economics assumes that local externalities exist and are many. Other theories assume instead that space is heterogeneous. This is the case of land use models of von Thunen and neoclassical models of international trade. Finally, spatial competition theory and economic geography rest on imperfectly competitive markets.

According to Marshall, second nature may be explained by mutually reinforcing external effects. More generally, Marshallian externalities arise because of (i) mass-production (or, equivalently, increasing returns at the firm level as discussed below), (ii) the formation of a highly specialized labor force and the production of new ideas, both based on the accumulation of human capital and face-to-face communications, (iii) the availability of specialized input services, and (iv) the existence of modern infrastructures. Building on Weber (1909, ch. 5), Hoover (1936, ch. 6) has proposed what became the now standard classification of agglomeration economies: (a) localization economies, which are external to firms but internal to an industry; and (b) urbanization economies, which are external to industries and depend on the overall scale as well as scope of the economic activity in one location. Localization economies refer to Marshallian externalities of type (ii) and (iii), whereas urbanization economies cover the Marshallian externalities of types (ii), (iii) and (iv) since they typically depend on the presence of public infrastructures and on the size of the agglomeration. This classification has been used extensively in empirical studies as surveyed in Rosenthal and Strange (2004).While such a classification mainly stresses the supply side ofthe economic system, agglomeration economies also operate on the demand side e.g Haig (1926), Lampard(1958), and Stahl (1983).

The Spatial Impossibility Theorem tells us that the price mechanism does not work in a homogeneous spatial economy. Therefore, such result may not hold in the presence of spatial heterogeneity. One example is the model designed by von Thunen (1826) to explain the pattern of agricultural activities around pre-industrial cities. von Thunen considers a space represented by a plain on which land is homogeneous in all respects except for a marketplace (e.g. a town) where all economic transactions take place. In this framework the allocation of land to the different economic activities (e.g. crops) is shown to emerge as the equilibrium outcome of a perfectly competitive land market. In other words, the existence of a center is sufficient for a competitive land market to structure the use of space by different activities. Consider, for instance, the basic set-up in Fujita and Thisse (2002) in which land is the only factor of production, whereas transport costs are linear in distance. Then, if activities use similar amounts of land per unit of output, the goods facing higher transport costs are produced closer to the marketplace. Conversely, if goods face similar transport costs, activities that are relatively land intensive are located closer to the marketplace. Even though von Thunen also assumes both land and activities to be perfectly divisible, the key assumption that allows for an analysis within the competitive paradigm is that transactions among firms and households have to occur at a given marketplace. Such an exogenously located marketplace breaks the homogeneity of space, thus removing the locational indeterminacy highlighted by Starrett. The reason is that, as discussed in the foregoing example, the source of indeterminacy is that in a homogeneous space all that matters for the location of an activity is the location of other activities. Under this respect, Thunen's marketplace serves as an 'anchor' to otherwise undetermined locational choices.

Spatial homogeneity is also rules out in trade models based on the concept of comparative costs or comparative advantage: countries specialize in the production of the goods in which their opportunity cost, in terms of the implicit sacrifice of other foregone goods, is lowest. Even though it is mainly known as Ricardian theory, the credit for the classical model of comparative advantage should be equally shared by Mill (1821), Ricardo (1817), and Torrens (1815). Why then do comparative costs differ across countries? The answer is because space is heterogeneous in terms of technological alternatives. For classical trade economists it is thus localized knowledge, embodied in the skills of the local population that breaks spatial homogeneity.

The neoclassical theory of international trade, heralded by Heckscher (1918) and Ohlin (1933) departs from its classical antecedent by ruling out technological differences among countries. Spatial heterogeneity stems instead from the assumptions that natural resources, and more generally productive factors, are unevenly distributed across countries. Their international immobility generates different relative factor prices under autarchy and this determines the pattern of specialization once trade is liberalized: a country specializes in the production and exportation of the goods that are relatively intensive in its relatively abundant resources. When compared to location theory, one of the most distinctive features of both classical and neoclassical trade theories is that in the latter, countries are generally considered as being dimensionless. Such a simplifying assumption has long been considered as a handicap as recognized by Ohlin himself (1968). The reason being that changes in the transportability of commodities as well as in the mobility off actors *between and within* countries affect the location of economic activities, the distribution of labor and capital, the geography of demand and, therefore, the pattern of trade. Indeed, even though Ohlin's contribution is essentially identified with his spaceless factor proportions model (Ohlin, 1967), he explicitly discusses how the explicit consideration of space affects (and, sometimes, even reverses) some of the main conclusions of the neoclassical paradigm of trade theory (Ohlin, 1967). Unfortunately, the robustness of Ohlin's spatial insights is often undermined by the lack of a model dealing with both increasing returns and imperfect competition.

So far we have seen how the deadlock stressed by the Spatial Impossibility Theorem has been overcome by introducing either non-market interactions among agents or spatial in homogeneities. Both strategies allow one to perform meaningful analyses without departing from perfect competition. The last research strategy we discuss takes an alternative route by assuming instead that firms are not price-takers in their output markets. In the wake of Hotelling (1929), it is now generally accepted that competition for market areas is a force that would lead sellers to congregate (the so-called principle of minimum differentiation). However, the principle of minim um differentiation no longer holds once sellers are allowed to compete in prices. As established by d'Aspremont et al (1979), if the transport costs are quadratic, a unique price equilibrium exists for any location pair and the two firms wish to set up at the endpoints of the location. More generally, whether sellers cluster half way along the beach or separate depends on the degree of product differentiation as well as the level of transport costs: the less similar the products and the lower the transport costs, the more likely the clustering (de Palma et al, 1985). The reason is weaker price competition and a stronger market area effect. Finally, once the mobility of customers along the beach is allowed for, sufficiently differentiated products and/or sufficiently low transport costs lead to a spatial equilibrium in which both sellers and customers distribute themselves according to two bell-shaped curves that sustain each other (Papageorgiou and Thisse, 1985). The foregoing insights can be summarized as follows: Under imperfect competition, industry location can be explained in term of the search for prevailed access to customer and the desire to relax competitive pressures by the other firms.

The result according to which, under imperfect competition, the spatial distributions of customers and firms sustain each other highlights the possibility of the economic landscape being molded by feedback mechanisms. Papageorgiou and Thisse (1985, 20) describe such a possibility by these words: "*Households are attracted by places where the density of firms is high because opportunities there are more numerous ... Firms are attracted to places where the density of consumers is high because there the expected volume of business is large*." In the same spirit, research conducted in migration theory raises the following question: do people follow jobs or do jobs follow people? Since the seminal work of Muth (1971), it has been argued convincingly that this is an egg-and-chicken problem. The role of circular causation among the location decisions of different agents has been mainly stressed in terms of regional divergence. In particular, it has been argued for long that growth is localized, the reason being that technological and social innovations tend to be spatially clustered while their diffusion across places would be slow. For example, Hirschman (1958, 183) claimed that: "*we may take it for granted that economic progress does not appear everywhere at the same time and that once it has appeared powerful forces make for a spatial concentration of economic growth around the initial starting points.*" This echoed by Myrdal (1957) as well as by Kaldor (1970, 340) who stresses the role of transport costs in sustaining circular causation in a way that strongly reminds the results of spatial competition models: "*As communication between different regions becomes more intensified (with improvements in transport and marketing organization), the region that is initially more developed industrially may gain from the progressive opening of trade at the expense of the less developed region whose development will be inhibited by it.*"

METHODS REPERTOIRE AND MODELS OF SPATIAL AGGLOMERATION IN NORWAY

Like the theoretical complexity, methods to identify the spatial regularities in production system are also complex. Keeping in mind the limitation of this paper we will follow up with some of the Norwegian empirical studies. An elaborate survey of spatial regularities in Norwegian production system was first coved by a Reve and Jakobsen (1992) with 1988 data. Based on Porter's original study (1990) was intended to identified internationally competitive industries in Norway and then subjected them to further analysis. A national level of clustering was set and the regional clusters below the national level was excluded from this study. The first unit of observation in this study was an industry, defined as those firms that produce a group of tangible products defined by one of the 5-digit SITC codes (N=1,900). To this was added a number of service industries. For each industry, its international competitiveness was then defined as its share of total export between all the OECD countries (N=21), divided by the country's average OECD export share for all products and services on the list. When only dealing with goods, this is known as the revealed comparative advantage, or RCA index[1] (Balassa 1965; Porter 1990).

Since a number of services (particularly the shipping services) were included in this study, the index was called TRCA. A 'TRCA' index higher than 1.0 was then chosen as a sign of competitiveness. All industries with a total export among the 50 largest industry exports were included, as were all industries with significant direct investments abroad based on competitive advantages created at home. Industries with an RCA less than or equal to 2.0 and an import surplus were excluded. The resulting 200 or so competitive industries were then grouped in 16 industrial sectors according to usage of primary products and level in the value chain (upstream, manufacturing/support and consumer-oriented products and services). These again were grouped into five competitive industry groups: minerals and metals, pulp and paper, petroleum and chemicals, transport, and foods. Each of the 16 industrial sectors was then subjected to an analysis of actual and potential signs of strong and weak clustering and of dynamics leading to upgrading or downgrading, using a diversity of data sources.

Geographical clustering below the national level was hailed as potentially yielding a competitive advantage because of ease of knowledge flow and potential rivalry. It was, however, not systematically addressed. In fact, the low geographical concentration of firms within each industry was lamented. The purely Porterian approach may have greater appeal to policy makers than to analytical science because it identifies strong clusters on a national scale, which is an appropriate level of analysis for many policy discussions. On the other hand, the policy debate seemed to learn more in general than specific terms from this study. Its appeal also lies, of course, in the wide array of aspects touched upon, of which clustering is only one. The approach has set a standard, however, in using an RCA measure for probing performance. A sequel appeared nine years later (Reve and Jakobsen 2001). Here, the study led to a focus on three internationally strong clusters (seafood, energy, and maritime) with three infrastructural competence industries (ICT, finance, and trade) in support roles. Although the focus is still on national clusters, a certain degree of regional specialization is uncovered and also recommended for future growth policies. Here, a region may be anything between the 1,000 km long northern coast and the capital agglomeration of Oslo.

In the first systematic study of regional clusters in Norway, Isaksen (Isaksen and Spilling 1996; Isaksen 1997) keeps the geographic scope fixed to labor market regions (defined by commuting distance). He then says that a particular industry is clustered in a region if it is dominant there relative to the national average. Finally, the economic development from 1970 to 1990 is compared between clustered firms and each industry average. For clustering, this study uses a measure of concentration of workplaces, which is usually considered a measure of regional specialization. This localization quotient[2] (LQ) is defined as the share of jobs that one industrial sector has in a region in proportion to the sector's share of all the jobs in the country as a whole. With N = 39 industrial sectors (primary industries and the public sector were not included) and K = 103 labor market regions, the study suggested a localization quotient of 3.0 as a suitable criterion for defining a regional cluster. The data for 1990 then displayed 143 regional clusters, accounting for about 20 per cent of the total national employment covered by the study. Performance was then measured at the level of national industrial sectors in terms of the RCA index (relative to the OECD). Seven industrial sectors had an RCA index greater than 1.0 in 1990: Ships, petroleum refining, basic metals, pulp and paper, wood products, furniture, and food (i.e. fish). 90 of the 124 regional manufacturing clusters were found in these industrial sectors, a strong overrepresentation. The study concluded that Norway's export specialization industries tend to agglomerate locationally. Furthermore, the share of jobs in these sectors to be found in regional clusters grew significantly from 1970 to 1990. The study then went on to focus on local production systems, operationalized as regional clusters having at least 10 establishments in the dominant industrial sector, whose production chain can be vertically disintegrated in a meaningful way (thus excluding process industry, stone-cutting, wholesaling, restaurants, and hotels). 41 of the original 143 clusters

[1] $$RCA_{sn} = \left[E_{sn} \Big/ \sum_{s=1}^{S} E_{sn} \right] \Bigg/ \left[\sum_{n=1}^{N} E_{sn} \Big/ \sum_{s=1}^{S} \sum_{n=1}^{N} E_{sn} \right]$$
where E = export, s = Product number, and n = country number in OECD

[2] $$LQ_{rs} = \left[E_{rs} \Big/ \sum_{s} E_{rs} \right] \Bigg/ \left[\sum_{r} E_{rs} \Big/ \sum_{r} \sum_{s} E_{rs} \right]$$
Where E = employment, r = region and s = industrial sectors.

remained. This revealed a pattern where, in most sectors, the regional clusters had their distinct geographical location. In the nine manufacturing sectors represented (fish processing, textiles and clothing, wood products, furniture, printing and publishing, metal products, machinery, shipbuilding, and electronics and electrical equipment), most had substantial job losses from 1970 to 1990, but the regional clusters fared better than average, except for those located in the urban areas which did in fact have the greatest job concentration at the outset.

The geographic scope chosen and the primary focus on clustering within an industry can be grounded in a theory of rivalry and of joint access to common resources, notably the skills traded in the labor market, as the main linkages that may or may not be involved in creating competitiveness. This allows for relatively stable cluster definitions, even though improved commuting infrastructure and changes in acceptable limits to commuting time might change the underlying regional scope. Because clusters only include single industries, some densely populated areas with a broad industrial base do not qualify because they are too diverse. This is probably a disadvantage arising from the choice of a specialization measure. The attempt at introducing potential vertical production chain disintegration does not measure the number or strength of actual vertical links; it only serves to exclude a small number of industries from the analysis. The analysis was repeated for 1989 and 1999 (Nås 2000) with a methodology practically identical to the original one, which – as we recall – identified 41 clusters for 1990. The more recent study identified 49 such clusters (including producer services) for 1989 and 63 for 1999, with an overlap of 36. Whether the changes were primarily due to relative declines and growths or partly due to over-sensitivity of the methodological definitions, was not investigated.

An interesting alternative approach is followed in a study based on input/output data between sectors of the Norwegian economy (Hauknes 1998, 1999). The premise here is that it is the direct interaction between firms in a value chain rather than through a shared market of input factors (including labor) or competition in a product market that counts. To construct data for an input/output analysis between individual firms would be a gargantuan task but data for deliveries between sectors of the national economy are readily available. 149 industries (production sectors, roughly corresponding to a 3-digit NACE code) are divided across public and private institutional sectors to make up 161 institutional-production sectors used for the analysis. This process results in a data matrix with 161 x 161 elements minus the diagonal, and all elements need not contain data. The task then is to reduce the matrix to a reasonable number of clusters by maximizing the exchange within each cluster and minimizing the exchange between them. This is achieved through a three-step procedure. Firstly, by introducing a cut-off on the deliveries from one sector to another if it falls below a certain percentage of the total deliveries from the first sector, corresponding to a measure of link strength. The study tests various cutoff values and finally lands on 10 per cent. Secondly, by introducing another cut off for sectors representing only a very small percentage of the total intermediate deliveries. This corresponds to a question of sector significance and a 1 per mille level is chosen. Thirdly, trade sectors are considered artifacts of the industrial classification and are excluded; this helps reducing the number of clusters significantly and meaningfully. This approach identified six national clusters: Agro food, oil and gas, construction, transport, paper and graphics, and information intensive activities. The study then goes on to measure innovation performance, the rationale being that user/producer relations are strong carriers of innovative activity.

EMPIRICAL RESULTS ON SPATIAL PATTERNS OF INNOVATIVE ACTIVITIES

This analysis is based on data on industrial activities in Norway for the period 1995 to 2003; specifically patent statistics from the Norwegian Patent office (NPO) and the business register data (BRD) of Statistics Norway. Even with their shortcomings, elaborately discussed in Desrochers (2001, p.389), patent statistics have strong reasons for use here as an indicator of 'true' innovation (Ejermo, 2005, p.175). They are authentic and there is no suitable alternative to them. Furthermore, they are suitable for geographical aggregation and render the location of the innovators. The BRD contains an annual census of all business establishments in the country. We use its data in calculation of indices for the distribution pattern of production (such as size and sector – aggregated to regional level). In order to draw a compatible link between the technological classification of patents and the economic character of establishments (business sector), we have used the latest EU concordance scheme (see Schmoc, Laville, Patel, Frietsch, 2003). Compared to previous concordance schemes (e.g. Kronz, 1980; Evenson 1993; Verspagen et al., 1994; Johnson, 2002), this scheme has certain merits. It is well praised for its international compatibility, highest level of disaggregation, strong empirical basis of development, and easy applicability. Using this concordance scheme, we have combined the whole Norwegian manufacturing sector at the 3 digit NACE level and the total patents at the 4 digit IPC level into 44 industrial sectors plus one 'non-industrial' sector (details in annex 2).

We have aggregated the data spatially to 161 labor market regions (LMRs) as identified by NIBR (see Juvkam, 2002) based on daily commuting patterns. By definition, they are geographical areas with comparatively short internal traveling distances, the boundaries of which are determined by the distance from homes to workplaces incurring less than 30 minutes travel each way. As a result of differences in topography, communication infrastructures, and population density, LMRs vary greatly in population: the first decile is about 1,100 inhabitants and the ninth decile just above 50,000, with one region larger than 1 million inhabitants (detail in annex 1). Such a low level of spatial aggregation has certain merits (also identified by Paci and Usai, 1999). These LMR characteristics reflect the presence of substantial levels of daily commuting to and from a centre or between basic geographical units or at least the presence of an infrastructure and a centre/periphery relation facilitating such travel. This is particularly useful for our analysis of knowledge externalities as they are mostly locally bounded and linked to a local labor pool. To get the correct regional attribution in the empirical analysis, the patents are assigned on the basis of the innovators' personal residence and we use the location of each establishment rather than of the headquarter of the enterprise to which it belongs.

Figure 1 about here.

A set of four indices has been used in this study to capture, to what extent industrial activities are spatially concentrated or dispersed across various regions on Norway. These indices are substantially different from those used before but are based on similar principle. All of them are based on BRD employment records (E). To this end, we took into consideration employment records of all the existing establishments (at any point of time, at any region or at any sector, and without repetition) for all the manufacturing sectors in Norway for the period of 1995-2003 (for establishments with increment or decrement in employment, we chose the average value). These 46,713 establishments represent 16 per cent of the total workforce in the country of this period. Based on this information the Production Specialization (PS) is calculated as:

$$PS_{rs} = \left[E_{rs} \Big/ \sum_{s} E_{rs} \right] \Bigg/ \left[\sum_{r} E_{rs} \Big/ \sum_{r} \sum_{s} E_{rs} \right] \tag{1.1}$$

where *r* stands for region and *s* stands for sector. The explanation behind this index follows if a region has an employment share in any given sector greater than the national average, the region must be relatively specialized in the production of the output of that particular sector (McCann, 2001). Therefore, it represents the usual measure for Marshall Externalities. As a result, a positive sign of this index is interpreted as evidence of the fact that innovations are bound to arise within those sectors in which the production of LMR is specialized.

In order to capture the effect of presence of complimentary industries within each regional cluster, we used another index called localized production specialization (LPS). This is the modification to the science based specialization and diversity index used by Paci et al. (1999) and Feldman and Audretsch (1999) based on the Yale survey. This survey provides an assessment of relevance of basic scientific research. In the light of this assessment, the said authors had identified six groups of industries that share similar rankings for the importance of certain academic disciplines. The twist we bring here is substantive and spatial in nature. Following Isaksen (1997) and Nås (2000), we considered regional industrial cluster as the main criterion for grouping our industrial sectors. Taking in to account the PS index, we calculate 10 different 'techgroups' representation of regional clusters in Norway. A PS value higher than 3 was taken as a benchmark for identification of a regional cluster (see Isaksen and Spilling (1996) for a detailed account of the method). Our data indicate 118 such clusters in Norway. Furthermore, 76 out of these were found to belong to sectors that have a revealed comparative advantage (RCA) index higher than 1 in 2003. These 76 are grouped to into 10 groups on the basis of their regional character. To this end, sectors having at least 10 establishments in the dominant sector are designated as a regional cluster. These clusters are Agro-business, Textile and clothing, Wood products, Printing and publication, Non-metals and Chemicals, Metal Products, Machinery, Electronics and Electrical equipments, Equipments and Furniture (detail in annex 2). Following this, the LPS is calculated as follows:

$$LPS_{rs} = \left[E^{c}_{rs} \Big/ \sum_{s} E_{rs} \right] \Bigg/ \left[\sum_{r} E^{c}_{rs} \Big/ \sum_{r} \sum_{s} E_{rs} \right] \tag{1.2}$$

where c indexes the clusters in Norway and all others are same as above. For our empirical analysis, PS and LPS are standardized to be constrained between 1 and -1. A positive and significant sign of the coefficient of LPS is taken as a further signal of the importance of specialization (even though in near-by industries) and therefore of Marshall Externalities.

The production diversity index (PD) for the whole LMR is based on the reciprocal of the Gini coefficient and calculated as follows:

$$PD_r = \left[\frac{2}{(n-1)Q_n} \sum_{s=1}^{n-1} Q_s \right] \tag{1.3}$$

Here, Q_j is the cumulative sum of employees (E) up to sector *S* when sectors are listed in increasing order and others are same as above. The index is defined within the interval (0, 1) and it increases with variety. A point to note here is that in a recent study, Greunz (2004) used other measures to catch this parameter. She concludes that some of these measures give identical result but differ in strength so they should be used as indicators only. Given that the Gini coefficient is a measure of concentration, an increase of its reciprocal implies that diversification is higher, so a positive, significant sign of its coefficient is taken as evidence of the presence of diversity externalities.

Another interesting dimension of diversity at the LMR level is given by the degree of diversity within the cluster, as measured by its localized production diversity (LPD). The formula is, again, based on the reciprocal of the Gini coefficient with reference to employment within the sectors, which constitute the cluster c defined above.

$$LPD_{rs} = \left[\frac{2}{(n^c-1)Q_n^c} \sum_{s=1}^{n^c-1} Q_s^c \right] \tag{1.4}$$

where Q_j is the cumulative sum of employees (E) in cluster *c* up to sector *j* when sectors are listed in increasing order. This index allows for a further specification of the degree of diversity in LMRs similar to the tests for production specialization above. A positive significant sign will be read as a further evidence of the presence of diversity externalities.

Result

The aim of this section is to identify some broad empirical regularity in the geographical organization of production and innovation activities, particularly with reference to the relationship between spatial and sectoral patterns. Spatial patterns of innovation may be identified by the existence of specific and systematic relationships between the indicators reported above. To this end principal component analysis, multidimensional scaling and k-mean cluster analysis have been performed. For index of production specialization, the analysis identifies 12 factors that capture a substantial fraction (>80 %) of total variance (KMO measure = 0.68, Bartlett's test of sphericity = 1018.665, df = 946, p<0.001). After a careful observation of the correlation circle, squared cosines values and percentage contribution of each variable to different factors, the first two factors are used here for two dimensional presentation and interpretation. For PS, interpretation of the correlation circle justifies the first principal component (*x axis*) as the scalar representation of production specialization where as the second principal component (y *axis*) indicates spatial organization. For each of the 44 industrial sectors and for each LMR regions the values of the factor scores for the first two principal components have given in table 1 and 2 respectively. Further the regional factor scores are plotted in figure 2.

Table 1 about here.
Table 2 about here.
Figure 2 about here.

The figure clearly indicates a geographical peculiarity in production specialization of Norway. Considering a factor score of five and higher it can infer that a small no of region spread across space show high degree of regional specialization but a more clustered but less specialized regions out number them. Those specialized regions are identified as Oslo, Drammen, Kongsberg, Tønsberg, Larvik, Grenland, Kristiansand, Stavanger, Bergen, Trondheim and LMRs surrounding Oslo region (LMR No 1, 2, 3, 5, 19, 20, 25, 26, 27, 37, 44, 50 and 84) .

Further, to get an elaborate understanding of this geographical distribution and to circumvent the low variability of first two factors of production specialization, multidimensional scaling (MDS) has done with PS index. This is useful in the sense it identified the dissimilarities in regional specialization index and plots the variables in desire dimension. For easy graphical interpretation result of two-dimensional representation are given here in table 2 and figure 3 (Kruskal's stress (1) = 0.328). The two dimensional configuration plot in figure 2 indicates similar result of PCA. It again identifies the above said LMR regions are as the specialized region in Norway. They are scattered over the space and significantly different from other lagging regions in terms of their production specialization.

Figure 3 about here.

The same two analyses have been repeated with reference to LPS and LPD indices. For index of localized production specialization (LPS), the analysis identifies six factors that capture a substantial fraction (> 80 %) of total variance (KMO measure = 0.72, Bartlett's test of sphericity = 1018.665,df = 946, p< 0.001) . After a careful observation of the correlation circle, squared cosines values and percentage contribution of each variable to different factors, the first and the third factors are used here for two dimensional presentation and interpretation. They together represent 66 % to the total variance. In the graph, the first principal component (*x axis*) is indicating the regional distribution and the second principal component (y *axis*) is indicating the spatial concentration. The regional factor scores are plotted in figure 4. Unlike PS, the PCA result for LPS is much more complicated to analyze. To this end multidimensional scaling (MDS) has proved beneficial. For easy graphical interpretation result of two-dimensional representation are given here in table 2 and figure 5 (Kruskal's stress (1) = 0.255). It again identifies the above said LMR regions are the specialized region in Norway. They can be located at the center of the configuration plot and a clear demarcation is visible between specialized or we can say know industrialized regions and periphery. All the lagging regions remarkable different from specialized regions in term of specialization index and placed themselves in the outer sketch of the two dimensional space. A careful observation indicated a core and periphery structure and a short of centrifugal force in the plot.

Figure 4 about here.
Figure 5 about here.

For index of localized production diversity (LPS) the analysis identifies only four factors that capture a substantial fraction (> 80 %) of total variance (KMO measure = 0.832, Bartlett's test of sphericity = 1018.665, df = 946, p< 0.001). Taking in to account the squared cosines values and percentage contribution of each variable to different factors, the first two factors are used here for two dimensional presentation and interpretation. They together represent 71 % to the total variance. In the graph the first principal component (*x axis*) is a representing the regional distribution and the second principal component (y *axis*) is a representing the spatial concentration. For each LMR regions the value of the factor scores for the first two principal components have given in third column of the table 2 and the factor scores are plotted in figure 6. A factor score of five and higher is again taken to distribute regions into blocks. The figure clearly indicates two blocks in term of regional specialization. Where there is a small no of region spread across space show high degree of regional specialization but a more clustered peripheral or less specialized regions out number them. Further the multidimensional scaling (MDS) has done to supplement the PCA results. For easy graphical interpretation result of two-dimensional representation are given here in table 2 (third column) and figure 7 (Kruskal's stress (1) = 0.176). The two dimensional configuration plot in figure 7 is clear and more decisive to interpret. It again identifies the above said LMR regions are the specialized region in Norway. They can be located at the center of the configuration plot and a clear demarcation is visible between specialized or we can say know industrialized regions and periphery. All the lagging regions remarkable different from specialized regions in term of specialization index and placed themselves in the outer sketch of the two dimensional space.

Figure 6 about here.
Figure 7 about here.

In order to confirm the way we interpret regional production pattern as a core-periphery structure in Norway, k-mean cluster analysis has done. K-means clustering can best be described as a partitioning method. That is, the function k-means divides the observations in our data into k mutually exclusive clusters, and returns a vector of indices indicating to which of the k clusters it has assigned each observation. Unlike the hierarchical clustering methods, k-means does not create a tree structure to describe the groupings, but rather creates a single level of clusters. Another difference is that K-means clustering uses the actual observations of objects or individuals in our data, and not just their proximities. These differences often mean that k-means is more suitable for clustering large amounts of data like the present study. K-means treats each observation as an object having a location in space. It finds a partition in which objects within each cluster are as close to each other as possible, and as far from objects in other clusters as possible. Here we choose city block distance for our clustering. To get an idea of how well separated the resulting clusters are, a silhouette plot is presented in figure 8. The silhouette plot displays a measure of how close each point in one cluster is to points in the neighboring clusters. This measure ranges from +1, indicating points that are very distant from neighboring clusters, through 0, indicating points that are not distinctly in one cluster or another, to -1, indicating points that are probably assigned to the wrong cluster. The result is presented in table 2 and a matrix of all the silhouette plot are presented in figure 7. The highest mean silhouette value for PS, LPS and LPD index link to k =2. This indicates this is that two is the right number of cluster for data representation.

Figure 8 about here.

The silhouette plots at two cluster level confirm a core peripheral relation in production structure of Norway. In case of PS and LPD value a small portion of non positive silhouette value suggest a possibility of an intermediate zone. This intermediate zone could be because of spillover of externalities from center and indicates spatial autocorrelation in index value. Analysis of local spatial auto correlation can be carried out using the tools of the Moran scatter plot map, which can be used to visualize local spatial instability. The spatial lag: an indicator of contiguous adjacency of similar scores of any original value resulting in four different quadrants of the scatter plot that correspond to the four types of local spatial association between a location and its neighbors. Positive spatial autocorrelation occurs when high or low values of the random variable tend to cluster (agglomerate) in space. These values locate them self in HH and LL quadrants. Negative spatial autocorrelation occurs when geographical area tends to be surrounded by neighbors with very dissimilar values. The location in each quadrant can be mapped. This is done in this paper for regional patent share, production specialization and production diversity. This brings insights to production and innovation pattern in LMR regions of Norway.

Figure 9 about here.
Figure 10 about here.
Figure 11 about here.

Together the following generalization can be draw from this analysis. The Moran scatter map regional innovation share indicated a clear and strong core-peripheral structure in Norway. Clearly the costal regions in southern part of the country are more innovative than the northern elongated region. The eight most prominent cores are Oslo, Kristiansand, Stavanger, Haugesund, Bergen, Kristiansund, Trondheim and Tromsø. Trondheim is a prominent core surrounded by regions relatively low innovation capacity and productivity. It is also found southern Norway surrounding the Oslo region is more diverse in their production structure.

DISCUSSION

Two important insights came out from the above empirical observation. First, production in Norway shows a core-periphery pattern where manufacturing is concentrated in to few regions. Two, there is a strong similarities in spatial pattern of production and innovation. This similarity is true for both specialization and diversity exist in regional production pattern. Further regional innovation capacity show a strong spillover to nearby region. This spatial arrangement can be explained partially by the core-periphery model introduced by Krugman (1991). The model illustrates how the interaction among increasing returns at the level of firm, transport cost and factor mobility can cause spatial economic structure to emerge and change. It need to be note, according to this model the core-periphery pattern likely to occur (i) when the transport cost of the manufactures is low enough (ii) when varieties are sufficiently differentiated or (iii) when the expenditure on manufactures is large enough. This condition is particularly true in Norwegian case.

CONCLUSION

In the present context it is more appropriate to combines a Krugman type core-periphery model with a Grossman- Helpman-Romer type model of endogenous growth, with horizontally differentiated products. Specifically, the core-periphery model is put in a dynamic framework by adding a research and development sector that uses skilled workers to create new varieties for the modern sector, so that the number of varieties produced in the economy growth with time, while forward-looking behavior and migration are formalized in the same spirit as in Ottaviano, Tabuchi and Thisse(2002). The innovation activity in the R&D sector involves knowledge externalities among skilled workers, which occur more intensely in the same region than across the regions. Thus a more agglomeration of skilled workers in a region leads to a higher productivity of skilled workers in the R&D sector in that region. This leads to the possibility that the additional growth spurred by agglomeration may yield a Pareto-dominant outcome. That is, when the economy moves from dispersion to agglomeration, innovation proceeds at a faster pace. As a consequence, even those who stay put in the periphery are better off than under dispersion, provided that the growth effect triggered by the agglomeration is strong enough.

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Figure 2: Production specialization in LMR regions of Norway: Principal component analysis

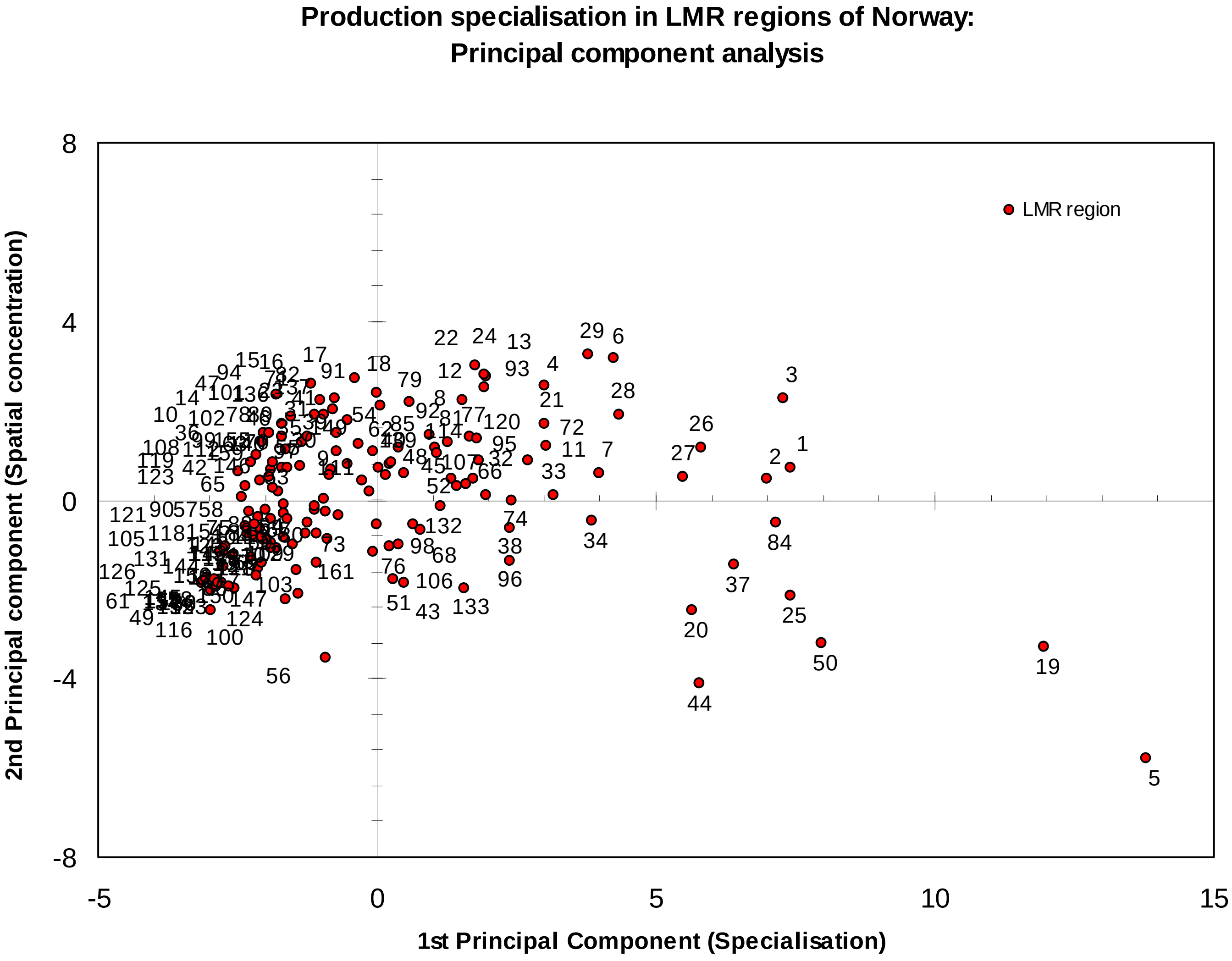


Figure 3: Production specialization of LMR regions in Norway: Multi dimension scaling- Two-dimensional representation (Kruskal's stress (1) = 0.328).

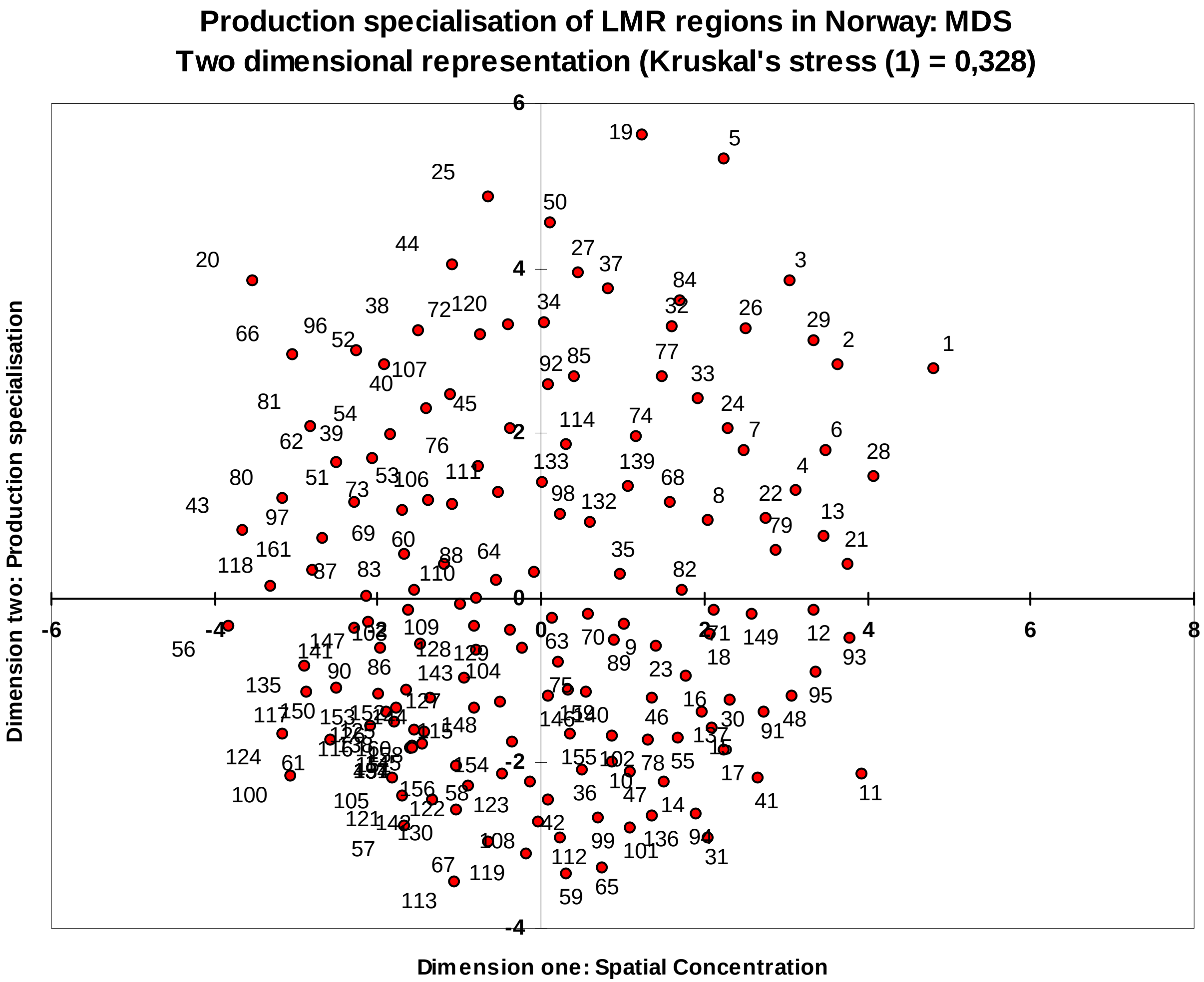


Figure 4: Localized production specialization in LMR regions of Norway: Principal component analysis

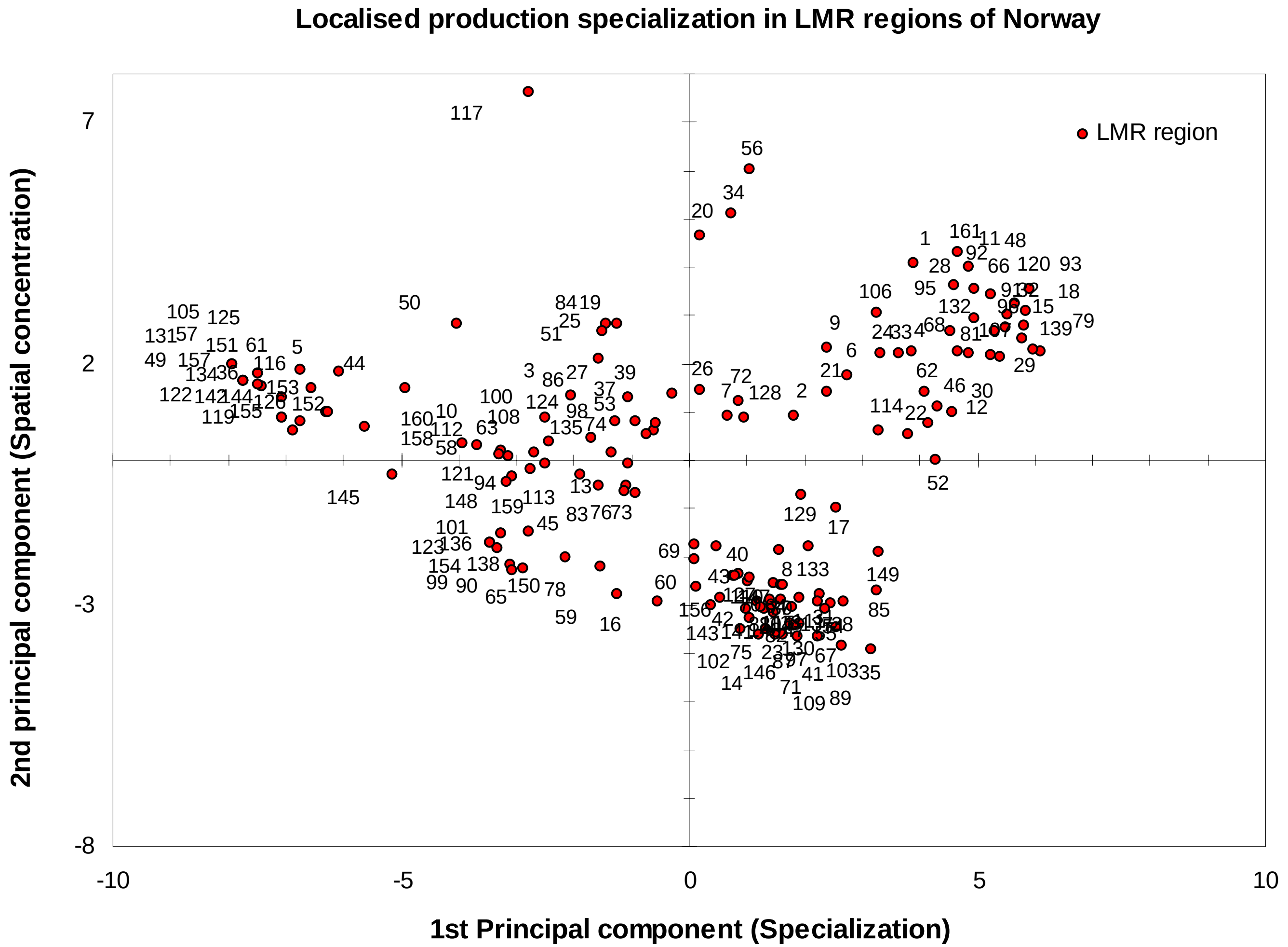


Figure 5: Localized production specialization of LMR regions in Norway: Multi dimension scaling – Two-dimensional representation (Kruskal's stress (1) = 0.255)

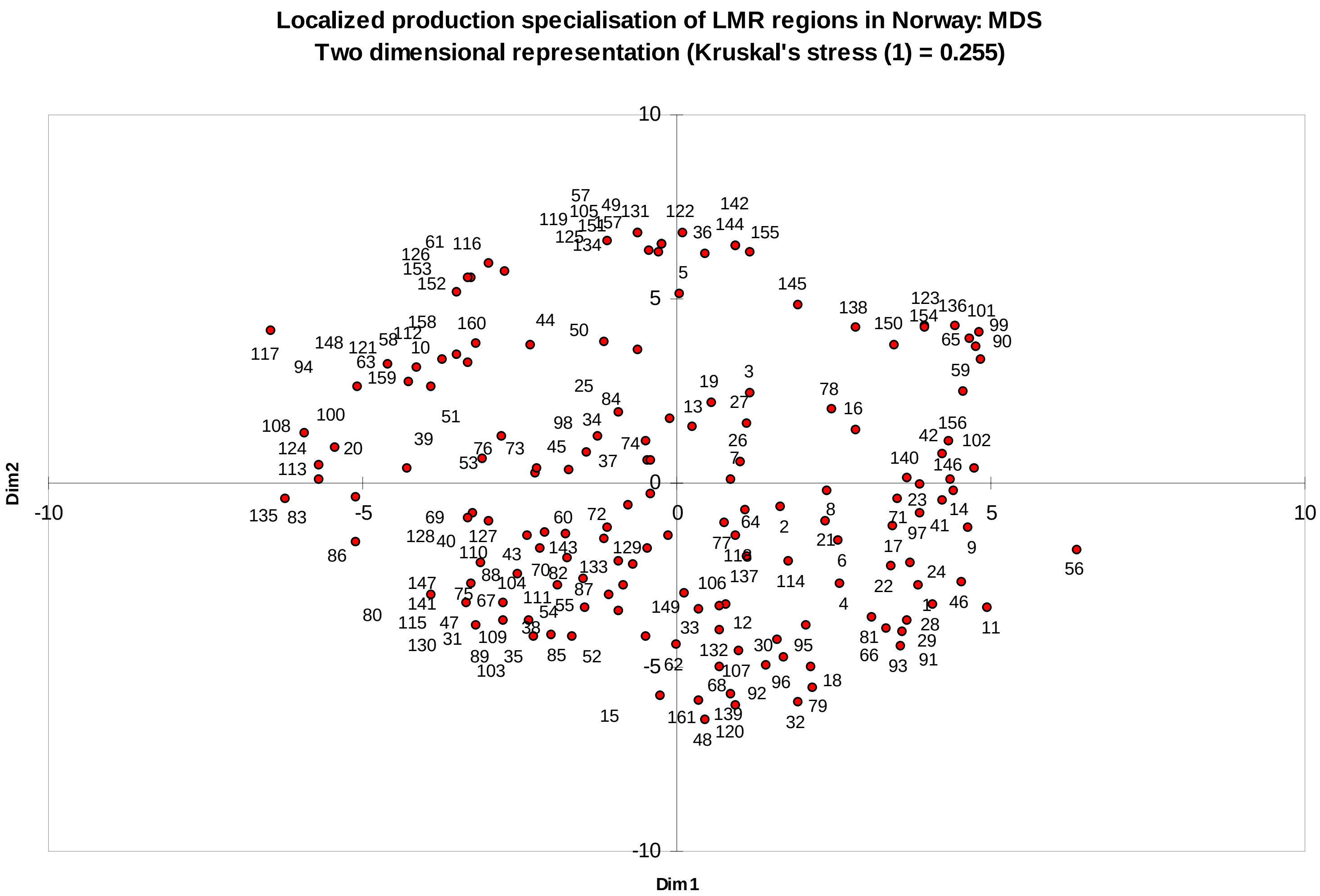


Figure 6: Localized production diversity in LMR regions of Norway: Principal component analysis

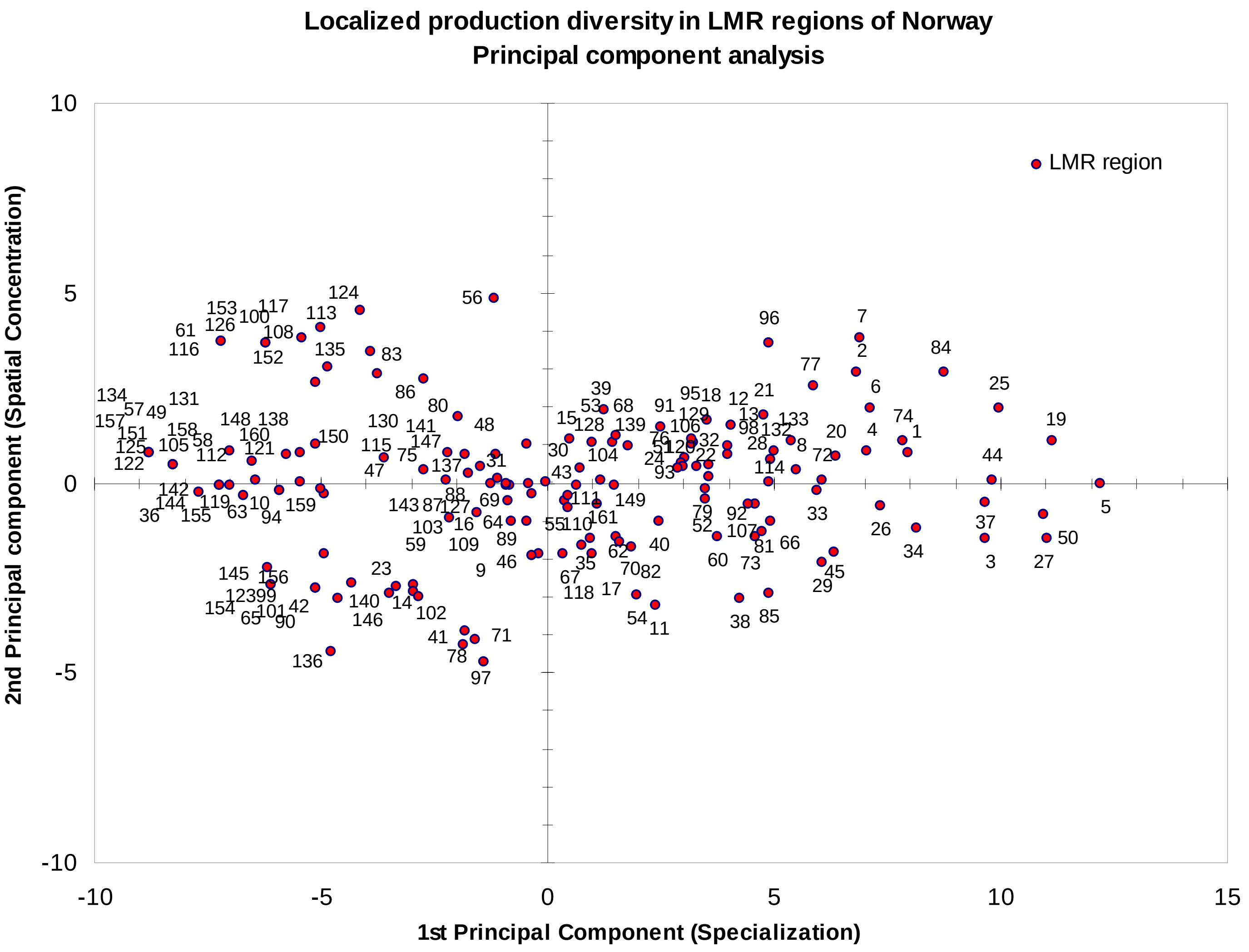


Figure 7: Localized production specialization of LMR regions in Norway: Multi dimension scaling – Two-dimensional representation (Kruskal's stress (1) = 0.176).

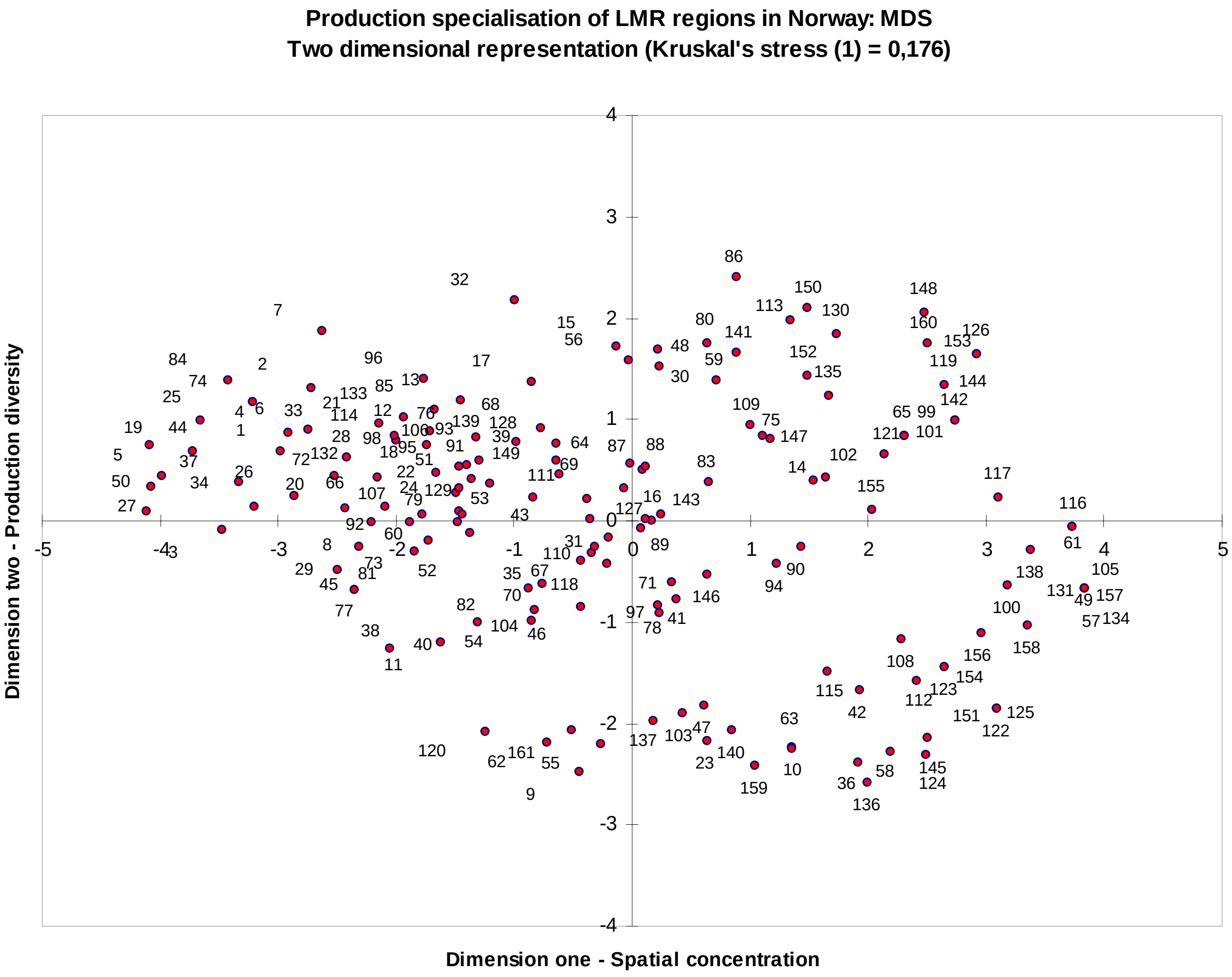
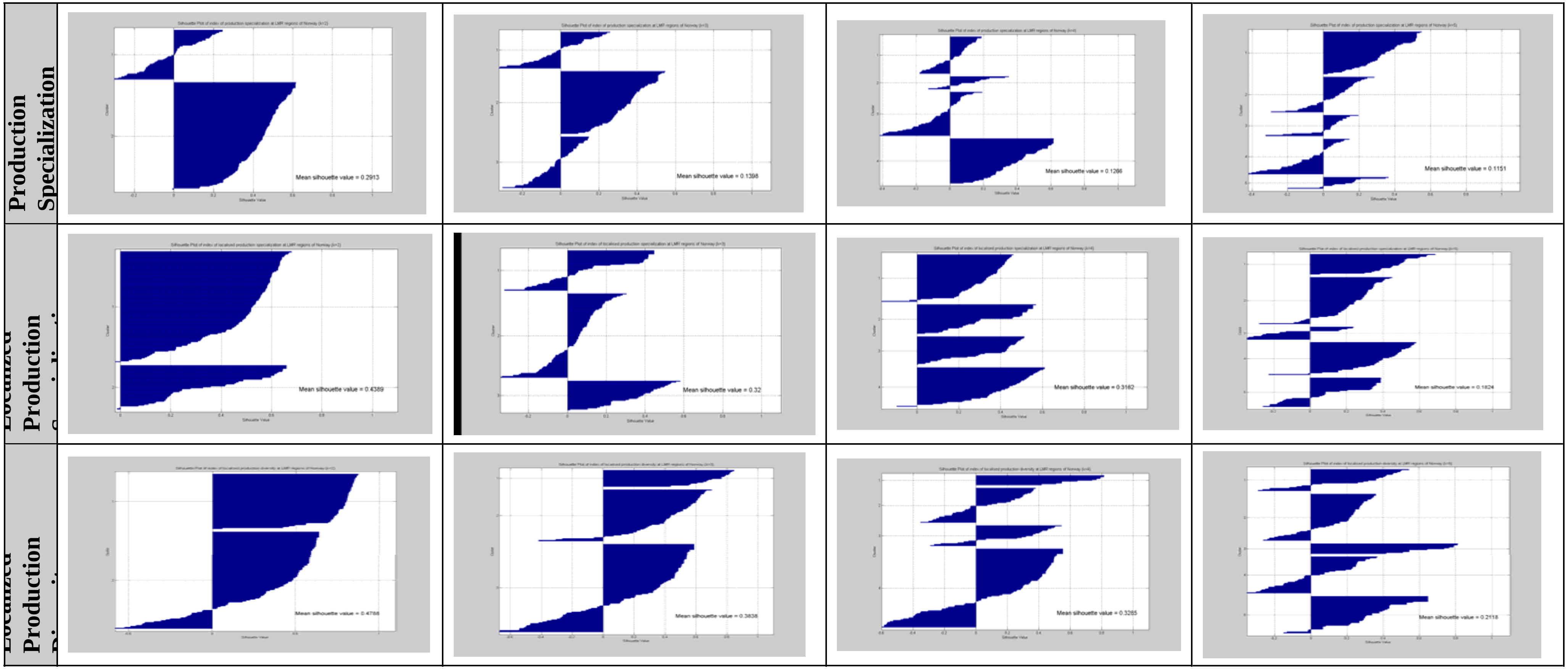


Figure 8: Silhouette Plots of production at LMR regions of Norway (k = 2, 3, 4, 5)



Mean silhouette value				
	k = 2	k = 3	k = 4	k = 5
Production specialisation	0.2913	0.1398	0.1266	0.1151
Localised production specialisation	0.4389	0.32	0.3162	0.1824
Localised production diversity	0.4788	0.3838	0.3284	0.2118

Table 1: Principal Component Analysis result for industrial sectors in Norway

	Production specialisation						**Localized production specialisation**						**Localised production diversity**					
			F1	F2	F1	F2			F1	F2	F1	F2			F1	F2	F1	F2
Eigenvalue					8,735	2,483					14,227	5,948					26,565	3,555
Variability (%)					20,313	5,775					33,873	14,161					63,249	8,464
Cumulative %					20,313	26,088					33,873	48,035					63,249	71,713
Sectors	Mean	Std.dev	Eigenvectors		Factor loadings		Mean	Std.dev	Eigenvectors		Factor loadings		Mean	Std.dev	Eigenvectors		Factor loadings	
FB	0,052	0,503	-0,118	-0,208	-0,350	-0,327	-0,996	0,040	0,010	-0,019	0,039	-0,047	-0,998	0,011	0,065	0,016	0,337	0,029
TP	-0,942	0,253	0,189	-0,211	0,559	-0,333	0,690	0,556	0,048	-0,105	0,179	-0,255	-0,998	0,011	0,065	0,016	0,337	0,029
TX	-0,387	0,641	0,062	-0,036	0,182	-0,056	-0,443	0,740	0,078	-0,101	0,295	-0,246	-0,149	0,528	0,129	-0,011	0,667	-0,020
WA	-0,492	0,652	0,095	0,250	0,280	0,394	-0,187	0,819	0,054	-0,078	0,205	-0,190	-0,149	0,528	0,129	-0,011	0,667	-0,020
LA	-0,769	0,535	0,114	0,030	0,337	0,048	-0,047	0,814	0,075	-0,127	0,282	-0,311	-0,149	0,528	0,129	-0,011	0,667	-0,020
WP	-0,115	0,587	0,056	0,416	0,166	0,655	-0,801	0,491	0,062	0,081	0,232	0,198	0,150	0,537	0,118	-0,153	0,607	-0,288
PR	-0,806	0,446	0,197	-0,026	0,583	-0,041	0,354	0,770	0,137	-0,091	0,518	-0,221	0,150	0,537	0,118	-0,153	0,607	-0,288
PP	-0,515	0,430	0,132	0,074	0,391	0,117	-1,000	0,000	0,000	0,000	0,000	0,000	-1,000	0,000	0,000	0,000	0,000	0,000
PTNF	-0,844	0,416	0,154	-0,105	0,454	-0,165	0,216	0,787	0,197	-0,162	0,744	-0,394	-0,560	0,288	0,168	-0,218	0,865	-0,411
BC	-0,794	0,476	0,124	0,052	0,368	0,083	0,167	0,783	0,190	-0,153	0,718	-0,374	-0,560	0,288	0,168	-0,218	0,865	-0,411
PACP	-0,981	0,180	0,076	-0,066	0,226	-0,104	0,221	0,787	0,197	-0,162	0,743	-0,395	-0,560	0,288	0,168	-0,218	0,865	-0,411
PV	-0,950	0,222	0,172	-0,143	0,507	-0,225	0,217	0,788	0,197	-0,163	0,743	-0,398	-0,560	0,288	0,168	-0,218	0,865	-0,411
PhR	-0,907	0,351	0,150	-0,073	0,442	-0,115	0,215	0,784	0,197	-0,162	0,741	-0,395	-0,560	0,288	0,168	-0,218	0,865	-0,411
SDT	-0,872	0,386	0,144	0,026	0,425	0,041	0,206	0,794	0,193	-0,154	0,730	-0,376	-0,560	0,288	0,168	-0,218	0,865	-0,411
OC	-0,913	0,324	0,200	0,006	0,591	0,010	0,219	0,787	0,197	-0,163	0,743	-0,397	-0,560	0,288	0,168	-0,218	0,865	-0,411
MMF	-1,000	0,000	0,000	0,000	0,000	0,000	-1,000	0,000	0,000	0,000	0,000	0,000	-1,000	0,000	0,000	0,000	0,000	0,000
RPL	-0,542	0,561	0,173	0,178	0,510	0,280	0,041	0,796	0,183	-0,103	0,691	-0,252	-0,560	0,288	0,168	-0,218	0,865	-0,411
NMMP	-0,383	0,565	0,119	0,212	0,351	0,334	-0,176	0,795	0,162	-0,082	0,610	-0,199	-0,560	0,288	0,168	-0,218	0,865	-0,411
BM	-0,644	0,603	0,120	0,162	0,355	0,255	0,151	0,797	0,133	-0,040	0,501	-0,096	0,038	0,613	0,119	-0,065	0,614	-0,122
FMP	-0,332	0,555	0,140	0,133	0,413	0,210	-0,593	0,694	0,095	0,065	0,357	0,160	0,038	0,613	0,119	-0,065	0,614	-0,122
EM	-0,727	0,494	0,188	-0,009	0,556	-0,014	0,336	0,750	0,198	-0,072	0,748	-0,176	-0,459	0,355	0,175	0,007	0,903	0,014
NSPM	-0,457	0,547	0,138	0,048	0,406	0,076	0,066	0,808	0,166	-0,008	0,626	-0,020	-0,459	0,355	0,175	0,007	0,903	0,014
AFM	-0,514	0,626	0,061	0,224	0,181	0,354	0,201	0,810	0,192	-0,031	0,722	-0,076	-0,459	0,355	0,175	0,007	0,903	0,014
MT	-0,807	0,474	0,190	0,116	0,561	0,184	0,351	0,752	0,199	-0,067	0,749	-0,163	-0,459	0,355	0,175	0,007	0,903	0,014
SPM	-0,583	0,538	0,163	-0,006	0,483	-0,010	0,263	0,765	0,188	-0,052	0,709	-0,126	-0,459	0,355	0,175	0,007	0,903	0,014
WeA	-0,959	0,234	0,093	-0,009	0,276	-0,013	0,358	0,749	0,200	-0,071	0,756	-0,172	-0,459	0,355	0,175	0,007	0,903	0,014
DA	-0,906	0,335	0,184	-0,013	0,543	-0,020	0,358	0,751	0,200	-0,068	0,754	-0,167	-0,459	0,355	0,175	0,007	0,903	0,014
OMC	-0,883	0,366	0,202	-0,057	0,596	-0,090	0,357	0,750	0,200	-0,070	0,753	-0,171	-0,459	0,355	0,175	0,007	0,903	0,014
EIMGT	-0,875	0,354	0,210	-0,146	0,620	-0,229	-0,547	0,661	0,162	0,299	0,612	0,730	-0,704	0,367	0,165	0,114	0,852	0,214
EID	-0,774	0,497	0,184	-0,081	0,543	-0,128	-0,618	0,599	0,156	0,248	0,587	0,605	-0,704	0,367	0,165	0,114	0,852	0,214
AB	-0,943	0,295	0,143	-0,066	0,422	-0,103	-0,517	0,676	0,168	0,307	0,633	0,748	-0,704	0,367	0,165	0,114	0,852	0,214
LEQ	-0,858	0,421	0,198	0,106	0,585	0,167	-0,545	0,661	0,160	0,303	0,603	0,739	-0,704	0,367	0,165	0,114	0,852	0,214
OEQ	-0,783	0,442	0,200	0,004	0,590	0,006	-0,602	0,631	0,149	0,284	0,563	0,693	-0,704	0,367	0,165	0,114	0,852	0,214
EIC	-0,825	0,451	0,179	0,059	0,529	0,093	-0,552	0,647	0,161	0,298	0,608	0,727	-0,704	0,367	0,165	0,114	0,852	0,214
ST	-0,923	0,314	0,174	-0,091	0,516	-0,144	-0,528	0,672	0,166	0,304	0,628	0,741	-0,704	0,367	0,165	0,114	0,852	0,214
AV	-0,871	0,389	0,174	0,068	0,513	0,107	-0,539	0,666	0,163	0,305	0,616	0,743	-0,704	0,367	0,165	0,114	0,852	0,214
MEQ	-0,721	0,477	0,188	-0,016	0,556	-0,025	0,027	0,861	0,089	-0,002	0,335	-0,004	-0,553	0,303	0,141	0,263	0,728	0,495
MI	-0,854	0,396	0,177	-0,224	0,523	-0,353	0,063	0,847	0,105	-0,016	0,397	-0,038	-0,553	0,303	0,141	0,263	0,728	0,495
IPC	-0,878	0,386	0,138	-0,227	0,406	-0,358	0,074	0,842	0,099	-0,017	0,372	-0,043	-0,553	0,303	0,141	0,263	0,728	0,495
OpI	-0,924	0,322	0,172	-0,143	0,509	-0,226	0,081	0,847	0,101	-0,012	0,380	-0,030	-0,553	0,303	0,141	0,263	0,728	0,495
WAT	-0,983	0,160	0,103	-0,199	0,303	-0,314	0,087	0,842	0,104	-0,009	0,393	-0,023	-0,553	0,303	0,141	0,263	0,728	0,495
MV	-0,701	0,551	0,139	0,125	0,412	0,197	0,330	0,744	0,197	-0,073	0,744	-0,177	-0,459	0,355	0,175	0,007	0,903	0,014
OTEQ	-0,515	0,538	0,057	-0,257	0,168	-0,405	-0,708	0,541	0,093	0,084	0,351	0,206	-0,553	0,303	0,141	0,263	0,728	0,495
FCG	-0,372	0,602	0,086	0,361	0,255	0,568	-0,801	0,491	0,062	0,081	0,232	0,198	-0,149	0,528	0,129	-0,011	0,667	-0,020

Table 2: PCA and MDS results for LMR regions of Norway

	Production specialisation				**Localized production specialisation**				**Localised production diversity**			
	Factor scores (PCA)		MDS representation		Factor scores (PCA)		MDS representation		Factor scores (PCA)		MDS representation	
Kruskal's stress (1)				0,328				0,255				0,176
LMR Name	F1	F2	Dim1	Dim2	F1	F2	Dim1	Dim2	F1	F2	Dim1	Dim2
Halden	7,421	0,702	4,807	2,771	3,900	4,090	3,842	-2,775	7,961	0,787	-2,973	0,678
Moss	7,009	0,487	3,643	2,828	1,818	0,933	1,662	-0,639	6,819	2,922	-2,711	1,306
Fredrikstad/Sarpsbo	7,271	2,290	3,066	3,836	-2,042	1,315	1,172	2,450	9,659	-1,466	-3,473	-0,094
Askim/Eidsberg	3,018	2,567	3,122	1,300	3,879	2,240	2,589	-2,748	7,054	0,855	-2,916	0,863
Oslo	13,804	-5,784	2,253	5,321	-6,085	1,812	0,060	5,119	12,193	-0,038	-3,983	0,448
Kongsvinger	4,258	3,182	3,506	1,779	2,751	1,757	2,570	-1,583	7,131	1,948	-2,746	0,890
Hamar	3,974	0,584	2,497	1,778	0,669	0,904	0,861	0,090	6,907	3,825	-2,629	1,869
Elverum	0,958	1,452	2,042	0,946	1,565	-1,880	2,401	-0,205	5,495	0,339	-2,209	-0,023
Trysil/Engerdal	-0,276	0,411	1,028	-0,327	2,380	2,328	4,643	-1,231	-0,203	-1,882	-0,450	-2,475
Stor-Elvdal/Rendaler	-2,034	1,492	0,871	-1,980	-3,134	0,063	-3,308	3,247	-5,913	-0,193	1,357	-2,240
Tynset	2,697	0,864	3,928	-2,142	4,841	4,014	4,959	-3,392	2,378	-3,209	-1,613	-1,208
Lillehammer	1,522	2,233	3,346	-0,148	4,167	0,754	0,803	-3,323	4,052	1,520	-1,713	0,883
Gjøvik	1,963	2,749	3,476	0,750	-1,048	-0,088	0,266	1,536	3,974	0,974	-1,449	1,189
Dovre	-1,628	1,135	1,520	-2,239	1,331	-3,503	4,415	-0,228	-2,963	-2,700	1,543	0,390
Skjåk/Lom	-0,939	1,917	2,108	-1,584	5,311	2,661	-0,248	-5,781	0,498	1,141	-0,131	1,715
Fron	-1,186	2,606	1,784	-0,941	-0,531	-2,947	2,865	1,427	-0,875	-0,496	0,170	0,007
Sel	-0,393	2,701	2,244	-1,839	2,560	-0,984	3,454	-1,194	0,984	-1,863	-0,848	1,373
Fagernes	0,063	2,115	2,077	-0,432	5,830	2,778	2,155	-5,012	3,536	1,634	-1,664	0,465
Drammen	11,975	-3,309	1,234	5,619	-1,426	2,830	0,569	2,165	11,120	1,091	-4,092	0,745
Kongsberg	5,653	-2,467	-3,531	3,844	0,184	4,661	-4,280	0,408	6,373	0,695	-2,428	0,120
Ringerike	2,993	1,709	3,773	0,408	2,396	1,408	2,384	-1,036	4,789	1,793	-2,136	0,961
Hallingdal	1,767	2,990	2,762	0,967	3,815	0,533	3,417	-2,276	3,561	0,148	-1,482	0,269
Nore og Uvdal	-1,108	1,898	1,406	-0,575	1,303	-3,067	3,878	-0,026	-2,955	-2,880	0,646	-2,180
Holmestrand	1,933	2,793	2,309	2,042	3,318	2,209	3,736	-2,187	3,284	0,442	-1,463	0,093
Tønsberg	7,428	-2,145	-0,649	4,852	-1,489	2,663	-0,921	1,895	9,945	1,986	-3,654	0,992
Larvik/Sandefjord	5,811	1,153	2,522	3,270	0,203	1,451	1,024	0,562	7,336	-0,620	-2,854	0,237
Grenland	5,506	0,494	0,466	3,951	-1,043	1,303	1,124	1,626	11,041	-1,464	-4,119	0,094
Notodden	4,334	1,900	4,090	1,479	4,599	3,606	4,083	-3,284	4,926	0,606	-1,994	0,785
Tinn	3,777	3,247	3,356	3,123	5,408	2,148	3,668	-3,751	6,045	-2,100	-2,311	-0,255
Seljord/Kviteseid	-0,524	0,778	2,326	-1,230	4,582	0,977	1,610	-4,264	0,732	0,370	0,240	1,517
Nissedal/Fyresdal	-0,716	1,474	2,051	-2,905	2,276	-2,800	-2,759	-3,721	-0,051	0,021	-0,191	-0,175
Vinje/Tokke	1,723	0,476	1,606	3,288	5,843	3,093	1,930	-5,966	3,543	0,481	-0,989	2,178
Risør	3,164	0,103	1,939	2,428	3,639	2,216	0,370	-3,435	5,942	-0,214	-2,415	0,629
Arendal	3,853	-0,452	0,042	3,325	0,720	5,097	-0,494	1,119	8,129	-1,213	-3,193	0,135
Evje/Bygland	-0,725	1,083	0,980	0,275	3,175	-3,936	-1,663	-4,155	0,962	-1,463	-0,436	-0,391
Valle/Bykle	-2,160	1,000	0,512	-2,087	-7,050	1,286	0,458	6,203	-7,690	-0,266	1,913	-2,384
Kristiansand	6,405	-1,459	0,821	3,739	-0,607	0,619	-0,450	0,618	9,663	-0,539	-3,327	0,380
Mandal	2,382	-0,614	-1,495	3,231	2,679	-2,920	-1,443	-3,374	4,248	-3,031	-2,047	-1,256
Farsund	-0,341	1,250	-2,067	1,694	-0,297	1,361	-3,091	0,667	1,233	1,899	-0,637	0,599
Flekkefjord	0,224	0,783	-1,408	2,303	0,476	-1,784	-2,983	-1,055	2,449	-1,004	-1,300	-1,005
Indre Vest-Agder	-0,534	1,777	2,657	-2,182	1,631	-3,600	4,247	-0,484	-1,842	-4,280	0,376	-0,776
Sirdal	-1,749	0,172	0,097	-2,446	0,535	-2,868	4,236	0,792	-4,332	-2,635	1,935	-1,668
Eigersund	0,494	-1,876	-3,660	0,808	0,759	-2,389	-1,769	-1,390	0,660	-0,087	-0,352	0,015
Stavanger/Sandnes	5,782	-4,098	-1,079	4,043	-4,922	1,468	-1,152	3,843	9,812	0,074	-3,720	0,692
Haugesund	1,593	0,353	-0,368	2,053	-1,570	-0,551	-1,427	0,845	6,333	-1,829	-2,494	-0,493
Hjelmeland	-1,326	1,309	1,360	-1,210	4,327	1,122	4,544	-2,711	-0,345	-1,904	-0,434	-0,855
Suldal	-1,708	1,702	1,100	-2,108	1,790	-3,047	-2,746	-3,258	-2,217	0,054	0,613	-1,818
Sauda	0,474	0,597	3,076	-1,188	5,652	3,227	0,468	-6,435	-0,444	1,027	0,228	1,687
Utsira	-3,139	-1,853	-1,592	-1,829	-7,739	1,620	-0,220	6,497	-8,793	0,773	3,834	-0,677
Bergen	7,976	-3,215	0,129	4,542	-4,026	2,821	-0,620	3,624	10,955	-0,837	-4,078	0,328
Stord	0,310	-1,776	-2,276	1,149	-1,557	2,093	-2,784	1,246	3,046	0,669	-1,353	0,408
Jondal/Kvam	1,330	0,457	-1,913	2,819	4,275	-0,005	-0,493	-4,155	3,479	-0,410	-1,374	-0,122
Kvinnherad	-0,945	0,022	-1,363	1,186	-0,590	0,768	-2,250	0,278	1,429	1,075	-0,839	0,227
Odda	0,170	0,546	-1,844	1,974	2,455	-2,961	-1,076	-3,055	1,954	-2,936	-0,847	-0,990
Voss	-0,819	0,663	1,675	-1,689	2,362	-3,075	-0,830	-2,789	0,365	-0,468	-0,259	-2,200
Austevoll	-0,916	-3,558	-3,812	-0,333	1,042	6,020	6,375	-1,825	-1,171	4,839	-0,029	1,577
Modalen	-2,180	-0,834	-1,669	-2,757	-7,910	1,996	-0,613	6,774	-8,793	0,773	3,834	-0,677
Fedje	-2,124	-0,378	-0,475	-2,141	-3,263	0,189	-3,723	3,351	-6,497	0,565	2,196	-2,289
Masfjorden/Gulen	-1,123	-0,213	0,309	-3,348	-1,235	-2,798	4,568	2,470	-2,154	-0,941	0,717	1,381
Flora	-1,256	-0,517	-1,166	0,395	0,102	-2,046	-0,768	-0,595	3,764	-1,431	-1,478	-0,013
Solund	-2,551	-1,991	-2,576	-1,734	-6,735	1,863	-2,976	5,963	-7,196	3,743	3,737	-0,057
Høyanger	0,030	0,713	-2,509	1,632	4,102	1,409	0,009	-4,379	1,517	-1,431	-0,714	-2,194
Vik	-1,704	0,698	0,146	-0,241	-2,684	0,144	-4,260	2,752	-5,910	-0,195	1,352	-2,246
Sogndal	-1,103	-0,147	-0,085	0,321	1,470	-2,549	1,095	-0,748	-0,353	-0,311	-0,011	0,562
Aurland	-1,880	0,677	0,758	-3,274	-3,111	-2,170	4,667	3,911	-5,129	-2,789	2,305	0,837
Lærdal/Årdal	1,975	0,096	-3,039	2,946	5,229	3,415	3,350	-3,959	4,910	-1,030	-2,091	0,131
Fjaler	-0,919	-0,246	-0,645	-2,949	1,902	-3,374	-1,890	-2,800	0,758	-1,656	-0,335	-0,312
Førde	0,663	-0,565	1,581	1,169	4,667	2,238	0,685	-5,016	1,505	1,261	-0,769	0,914
Vågsøy	-1,503	-1,023	-1,673	0,534	0,081	-1,752	-3,245	-0,832	-0,399	-0,033	-0,069	0,318
Eid/Gloppen	-1,375	0,761	0,589	-0,206	1,030	-2,530	-1,146	-1,509	1,595	-1,537	-0,751	-0,620
Stryn	-1,012	2,229	2,137	-0,159	1,500	-3,616	3,510	-0,454	-1,803	-3,919	0,339	-0,614
Molde	3,044	1,199	-0,742	3,191	0,854	1,203	-0,419	-0,288	6,067	0,070	-2,523	0,440
Kristiansund	-0,004	-0,550	-1,687	1,071	-1,070	-0,523	-1,710	0,350	4,585	-1,444	-1,723	-0,191
Ålesund	2,432	-0,013	1,181	1,957	-0,724	0,546	-0,405	0,605	7,837	1,105	-3,215	1,174
Vanylven	-1,981	-0,242	0,215	-0,772	1,061	-3,274	-2,522	-2,496	-1,755	0,254	1,176	0,807
Ulstein	0,224	-1,036	-0,756	1,598	-0,936	-0,673	-2,209	0,378	2,971	0,505	-1,324	0,817
Ørsta/Volda	1,671	1,427	1,498	2,674	1,584	-2,583	0,764	-1,066	5,861	2,537	-2,346	-0,685
Norddal/Stranda	-1,693	1,418	1,310	-1,728	-1,544	-2,227	2,467	1,984	-1,580	-4,147	0,221	-0,841
Rauma	0,581	2,169	2,879	0,577	6,105	2,258	2,175	-5,548	3,495	-0,139	-1,431	0,063

Table 2: PCA and MDS results for LMR regions of Norway

	Production specialisation				**Localized production specialisation**				**Localised production diversity**			
	Factor scores (PCA)		MDS representation		Factor scores (PCA)		MDS representation		Factor scores (PCA)		MDS representation	
Kruskal's stress (1)				0,328				0,255				0,176
LMR Name	F1	F2	Dim1	Dim2	F1	F2	Dim1	Dim2	F1	F2	Dim1	Dim2
Sandøy	-0,697	-0,344	-3,152	1,207	1,631	-2,600	-3,898	-3,044	-1,125	0,754	0,643	1,746
Sunndal	1,275	1,307	-2,827	2,086	4,848	2,192	3,106	-3,634	4,754	-1,270	-1,834	-0,297
Surnadal	-0,747	2,278	1,738	0,090	1,468	-3,156	-0,906	-2,133	1,857	-1,705	-0,876	-0,666
Smøla	-1,683	-0,289	-1,543	0,097	-1,121	-0,642	-5,098	-0,373	-2,717	2,721	0,649	0,378
Trondheim	7,141	-0,513	1,703	3,612	-1,246	2,810	-0,114	1,742	8,753	2,890	-3,424	1,384
Hemne/Snillfjord/Aure	0,408	1,152	0,410	2,679	3,252	-2,696	-0,912	-3,489	4,896	-2,921	-1,666	1,101
Hitra	-2,120	-1,537	-1,481	-0,567	-1,279	0,818	-5,089	-1,596	-1,975	1,749	0,886	2,402
Frøya	-1,675	-0,844	-2,129	0,019	1,772	-3,398	-0,697	-2,225	-0,816	-0,049	0,086	0,504
Ørland	-1,675	-0,122	-0,530	0,208	1,193	-2,934	-2,177	-1,779	-0,919	-0,054	0,121	0,538
Åfjord/Roan	-1,256	1,414	0,910	-0,511	2,664	-3,843	-2,268	-4,180	-0,473	-1,017	0,083	-0,074
Osen	-2,106	-0,633	-1,970	-0,616	-2,880	-2,234	4,850	3,353	-4,611	-3,070	1,434	-0,258
Oppdal/Rennebu	-0,009	2,376	2,731	-1,389	5,516	3,009	3,585	-4,062	2,504	1,472	-1,198	0,362
Orkdal	1,051	1,152	0,084	2,577	4,961	3,532	1,441	-4,939	4,584	-0,572	-1,879	-0,018
Røros	1,938	2,528	3,800	-0,484	5,780	2,500	3,582	-4,446	2,974	0,445	-1,292	0,588
Tydal	-1,800	2,361	1,907	-2,628	-2,750	-0,197	-5,081	2,599	-4,932	-0,274	1,224	-0,426
Steinkjer	1,828	0,896	3,372	-0,903	4,952	2,929	2,058	-3,886	3,203	1,059	-1,460	0,536
Namsos	2,400	-1,378	-2,258	2,994	5,504	2,759	1,710	-4,757	4,890	3,670	-1,767	1,397
Meråker	-0,864	0,537	-2,660	0,716	1,887	-3,670	3,885	-0,831	-1,402	-4,725	0,234	-0,910
Levanger/Verdal	0,773	-0,687	0,231	1,022	-0,941	0,805	-1,243	1,254	3,963	0,730	-1,741	0,742
Lierne	-2,239	0,837	0,717	-2,663	-3,063	-2,289	4,767	3,691	-5,129	-2,789	2,305	0,837
Røyrvik	-1,415	-2,106	-3,071	-2,166	-2,491	0,878	-5,922	1,364	-5,419	3,816	3,187	-0,637
Namsskogan	-1,924	1,479	1,097	-2,799	-3,310	-1,834	4,812	4,078	-5,129	-2,789	2,305	0,837
Grong/Høylandet	-2,056	1,293	0,881	-1,670	0,895	-3,497	4,756	0,410	-3,352	-2,716	1,647	0,426
Flatanger	-1,088	-1,420	-1,608	-0,154	2,563	-3,459	-1,997	-4,117	-1,554	-0,806	0,432	-1,905
Vikna/Nærøy	-1,880	-0,420	-0,217	-0,620	1,451	-2,995	-1,734	-2,055	1,158	0,071	-0,825	-0,878
Leka	-2,737	-1,147	-1,823	-2,195	-7,910	1,996	-0,613	6,774	-8,793	0,773	3,834	-0,677
Bodø	0,387	-1,018	-1,071	1,129	3,245	3,053	0,680	-3,364	3,193	0,994	-1,396	0,552
Narvik	1,427	0,293	-1,097	2,454	5,233	2,155	0,994	-4,554	4,448	-0,558	-1,780	0,064
Bindal	-2,357	0,323	-0,031	-2,722	-2,421	0,389	-5,442	0,972	-4,834	3,057	2,284	-1,167
Brønnøy	-1,262	-0,754	-0,980	-0,075	2,224	-3,675	-2,335	-3,740	-0,793	-0,994	1,004	0,950
Alstahaug	-1,667	-0,821	-0,796	0,004	0,873	-2,364	-2,384	-1,442	0,438	-0,661	-0,309	-0,251
Vefsn	-0,130	0,185	-0,513	1,276	1,913	-2,840	-1,491	-2,629	0,461	-0,320	-0,379	0,206
Hattfjelldal	-2,483	0,653	0,232	-2,909	-3,304	0,113	-3,507	3,489	-6,431	0,088	2,419	-1,585
Nesna	-1,608	-0,419	-1,067	-3,436	-1,900	-0,317	-5,697	0,103	-3,919	3,454	1,339	1,972
Rana	1,094	1,061	0,305	1,853	3,289	0,623	1,775	-2,135	4,889	0,028	-2,007	0,830
Lurøy	-2,314	-0,742	-0,812	-1,333	1,418	-2,889	-3,336	-3,278	-2,735	0,335	1,657	-1,490
Træna	-2,974	-2,462	-2,086	-1,556	-6,565	1,486	-2,731	5,725	-7,196	3,743	3,737	-0,057
Rødøy	-2,044	-1,404	-2,868	-1,132	-2,786	7,614	-6,454	4,133	-5,008	4,086	3,101	0,233
Meløy	-0,882	-0,899	-3,298	0,133	1,610	-2,911	0,952	-1,438	0,343	-1,866	-0,212	-0,422
Beiarn	-2,089	0,420	-0,186	-3,095	-6,856	0,611	-1,098	6,553	-7,019	-0,083	2,656	1,345
Fauske	1,792	1,376	-0,404	3,321	5,911	3,534	0,939	-6,024	2,867	0,374	-1,243	-2,081
Steigen	-2,802	-1,175	-1,700	-2,390	-3,079	-0,350	-4,141	3,133	-5,451	0,007	2,138	0,657
Hamarøy	-2,346	-0,589	-0,891	-2,279	-7,466	1,808	0,101	6,788	-8,274	0,492	3,099	-1,854
Tysfjord	-2,409	0,080	-0,128	-2,225	-3,465	-1,698	3,942	4,240	-6,110	-2,708	2,655	-1,445
Lødingen	-1,631	-2,247	-3,150	-1,644	-1,690	0,450	-5,677	0,481	-4,143	4,545	2,487	-2,317
Røst	-2,758	-1,479	-1,762	-1,334	-7,405	1,521	-0,444	6,310	-8,274	0,492	3,099	-1,854
Værøy	-2,987	-2,010	-1,899	-1,388	-6,287	0,994	-3,260	5,582	-6,215	3,661	2,925	1,650
Flakstad/Vestvågøy	-2,258	-1,300	-0,939	-0,973	0,791	-2,402	-2,082	-1,334	-0,898	-0,013	0,121	0,014
Vågan	-1,792	-1,077	-0,810	-0,343	0,956	0,858	-3,316	-0,957	0,981	1,066	-0,637	0,754
Sortland	-1,082	-0,769	-0,375	-0,391	1,936	-0,708	-0,123	-1,413	3,170	1,153	-1,464	0,324
Andøy	-1,879	-0,962	-1,039	-2,574	1,815	-3,437	-3,179	-3,879	-2,182	0,808	1,731	1,837
Moskenes	-3,139	-1,853	-1,592	-1,829	-7,739	1,620	-0,220	6,497	-8,793	0,773	3,834	-0,677
Harstad	1,137	-0,135	0,607	0,910	4,523	2,679	0,682	-4,021	5,011	0,833	-2,149	0,431
Tromsø	1,564	-1,986	0,016	1,398	2,088	-1,801	-0,466	-1,790	5,371	1,087	-1,927	1,021
Bjarkøy	-3,139	-1,853	-1,592	-1,829	-7,739	1,620	-0,220	6,497	-8,793	0,773	3,834	-0,677
Ibestad	-1,996	-0,862	-2,881	-0,835	-1,330	0,135	-6,223	-0,415	-3,754	2,847	1,666	1,227
Salangen	-1,548	1,845	1,372	-2,642	-3,253	-1,518	4,434	4,263	-4,756	-4,464	1,992	-2,581
Målselv	-0,788	2,034	1,990	-1,387	2,227	-2,950	1,117	-1,988	-1,083	0,101	0,182	-1,982
Torsken/Berg	-2,765	-1,876	-1,782	-1,502	-2,791	-1,479	2,848	4,208	-5,097	1,020	3,380	-0,295
Lenvik	0,257	0,840	1,070	1,340	5,968	2,274	0,870	-5,749	1,794	0,992	-0,977	0,768
Balsfjord/Storfjord	-1,603	0,717	0,564	-1,139	1,255	-3,059	3,663	0,116	-3,482	-2,902	0,843	-2,073
Lyngen	-1,881	-1,091	-2,289	-0,380	0,978	-3,102	-3,258	-2,756	-1,821	0,731	0,883	1,652
Kåfjord	-2,222	-0,807	-1,328	-2,457	-7,067	0,883	0,935	6,434	-7,228	-0,066	2,736	0,987
Skjervøy/Nordreisa	-2,051	-0,844	-0,793	-0,642	0,373	-3,008	-1,092	-1,202	-1,236	-0,027	0,245	0,059
Kvænangen	-2,719	-1,057	-1,341	-1,225	-7,067	0,883	0,934	6,434	-7,228	-0,066	2,736	0,987
Vardø	-3,054	-1,742	-1,459	-1,761	-5,149	-0,310	1,933	4,807	-6,176	-2,230	2,505	-2,144
Vadsø	-1,873	0,247	0,088	-1,198	1,208	-3,637	4,374	0,102	-2,833	-2,997	0,638	-0,535
Hammerfest	-1,431	-1,595	-2,118	-0,289	1,068	-2,425	-3,100	-2,188	-1,491	0,409	1,104	0,842
Kautokeino	-2,181	-0,551	-0,492	-1,252	-3,161	-0,439	-4,583	3,221	-5,768	0,743	2,475	2,050
Alta	-0,066	1,097	2,601	-0,190	3,284	-1,917	0,135	-3,006	1,489	-0,086	-0,620	0,449
Loppa	-2,150	-1,679	-2,511	-1,087	-2,132	-2,018	3,466	3,752	-3,598	0,658	1,487	2,096
Hasvik	-3,120	-1,835	-1,575	-1,803	-7,490	1,546	-0,290	6,278	-8,274	0,492	3,099	-1,854
Måsøy	-2,868	-1,964	-1,640	-1,112	-5,638	0,687	-3,502	5,164	-5,112	2,622	1,486	1,434
Nordkapp	-2,633	-1,935	-1,991	-1,178	-6,269	0,991	-3,326	5,584	-6,215	3,661	2,925	1,650
Porsanger	-2,277	-0,276	-0,353	-1,738	-3,457	-1,707	3,952	4,239	-6,110	-2,708	2,655	-1,445
Karasjok	-1,875	0,823	0,358	-1,659	-6,736	0,787	1,167	6,282	-6,709	-0,347	2,040	0,108
Lebesby	-2,578	-1,247	-1,031	-2,049	0,113	-2,647	4,334	1,118	-4,917	-1,876	2,965	-1,110
Gamvik	-3,109	-1,836	-1,560	-1,818	-7,739	1,620	-0,221	6,497	-8,793	0,773	3,834	-0,677
Berlevåg	-2,910	-1,770	-1,426	-1,638	-3,674	0,314	-3,196	3,796	-7,016	0,846	3,361	-1,027
Tana	-1,917	0,531	0,330	-1,120	-2,501	-0,065	-3,893	2,601	-5,010	-0,156	1,041	-2,425
Båtsfjord	-2,842	-1,862	-1,535	-1,608	-3,926	0,361	-2,333	3,732	-5,460	0,789	2,512	1,755
Sør-Varanger	-0,079	-1,152	-2,784	0,341	4,674	4,292	0,356	-5,908	1,087	-0,573	-0,515	-2,076

Annex 1: Region wise distribution of Patent in LMR regions of Norway (Page 1of 2)						
LMR Id	Name	No of patent awarded during 1998 to 2000	No of patent awarded during 2000 to 2003	Total no of Patents	Regional patentshare (percentage)	Change (percentage)
1	Halden	17	16	33	0,28	-5,88
2	Moss	37	40	77	0,65	8,11
3	Fredrikstad / Sarpsborg	125	112	237	2,00	-10,40
4	Askim / Eidsberg	13	11	24	0,20	-15,38
5	Oslo	2060	2077	4137	34,91	0,83
6	Kongsvinger	25	19	44	0,37	-24,00
7	Hamar	32	41	73	0,62	28,13
8	Elverum	7	12	19	0,16	71,43
9	Trysil / Engerdal	2	4	6	0,05	100,00
10	Stor-Elvdal / Rendalen	0	0	0	0,00	0,00
11	Tynset	4	2	6	0,05	-50,00
12	Lillehammer	39	28	67	0,57	-28,21
13	Gjøvik	69	35	104	0,88	-49,28
14	Dovre	0	5	5	0,04	500,00
15	Skjåk / Lom	0	1	1	0,01	100,00
16	Fron	6	7	13	0,11	16,67
17	Sel	1	2	3	0,03	100,00
18	Fagernes	5	3	8	0,07	-40,00
19	Drammen	157	139	296	2,50	-11,46
20	Kongsberg	67	66	133	1,12	-1,49
21	Ringerike	28	32	60	0,51	14,29
22	Hallingdal	12	14	26	0,22	16,67
23	Nore og Uvdal	0	0	0	0,00	0,00
24	Holmestrand	25	12	37	0,31	-52,00
25	Tønsberg	100	87	187	1,58	-13,00
26	Larvik/Sandefjord	92	83	175	1,48	-9,78
27	Grenland	266	230	496	4,19	-13,53
28	Notodden	32	20	52	0,44	-37,50
29	Tinn	4	2	6	0,05	-50,00
30	Seljord / Kviteseid	2	2	4	0,03	0,00
31	Nissedal / Fyresdal	0	0	0	0,00	0,00
32	Vinje / Tokke	3	1	4	0,03	-66,67
33	Risør	13	14	27	0,23	7,69
34	Arendal	111	124	235	1,98	11,71
35	Evje / Bygland	0	1	1	0,01	100,00
36	Valle / Bykle	0	0	0	0,00	0,00
37	Kristiansand	123	141	264	2,23	14,63
38	Mandal	33	20	53	0,45	-39,39
39	Farsund	8	11	19	0,16	37,50
40	Flekkefjord	16	8	24	0,20	-50,00
41	Indre Vest-Agder	0	2	2	0,02	0,00
42	Sirdal	13	16	29	0,24	23,08
43	Eigersund	13	14	27	0,23	7,69
44	Stavanger / Sandnes	691	661	1352	11,41	-4,34
45	Haugesund	87	132	219	1,85	51,72
46	Hjelmeland	0	2	2	0,02	200,00
47	Suldal	4	1	5	0,04	-75,00
48	Sauda	1	1	2	0,02	0,00
49	Utsira	0	0	0	0,00	0,00
50	Bergen	425	390	815	6,88	-8,24
51	Stord	12	19	31	0,26	58,33
52	Jondal/Kvam	12	4	16	0,14	-66,67
53	Kvinnherad	7	3	10	0,08	-57,14
54	Odda	9	5	14	0,12	-44,44
55	Voss	5	12	17	0,14	140,00
56	Austevoll	7	11	18	0,15	57,14
57	Modalen	3	0	3	0,03	-100,00
58	Fedje	1	0	1	0,01	-100,00
59	Masfjorden / Gulen	0	1	1	0,01	100,00
60	Flora	19	10	29	0,24	-47,37
61	Solund	0	0	0	0,00	0,00
62	Høyanger	0	0	0	0,00	0,00
63	Vik	0	0	0	0,00	0,00
64	Sogndal	5	11	16	0,14	120,00
65	Aurland	1	0	1	0,01	-100,00
66	Lærdal / Årdal	12	27	39	0,33	125,00
67	Fjaler	1	0	1	0,01	-100,00
68	Førde	4	2	6	0,05	-50,00
69	Vågsøy	18	15	33	0,28	-16,67
70	Eid/Gloppen	8	4	12	0,10	-50,00
71	Stryn	0	1	1	0,01	100,00
72	Molde	29	35	64	0,54	20,69
73	Kristiansund	26	47	73	0,62	80,77
74	Ålesund	105	124	229	1,93	18,10
75	Vanylven	3	1	4	0,03	-66,67
76	Ulstein	42	27	69	0,58	-35,71
77	Ørsta / Volda	17	13	30	0,25	-23,53
78	Norddal / Stranda	0	1	1	0,01	100,00
79	Rauma	3	8	11	0,09	166,67
80	Sandøy	1	0	1	0,01	-100,00

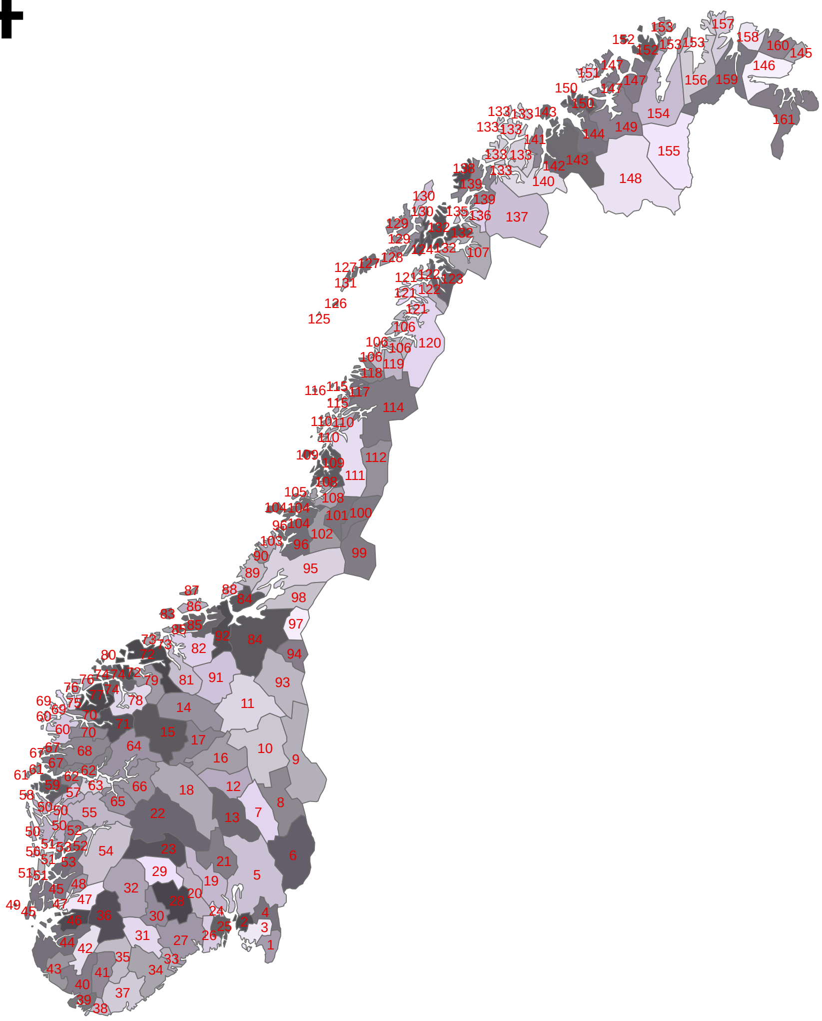
Annex 1: Region wise distribution of Patent in LMR regions of Norway (Page 2 of 2)						
LMR Id	Name	No of patent awarded during 1998 to 2000	No of patent awarded during 2000 to 2003	Total no of Patents	Regional patentshare (percentage)	Change (percentage)
81	Sunndal	30	39	69	0,58	30,00
82	Surnadal	5	9	14	0,12	80,00
83	Smøla	0	0	0	0,00	0,00
84	Trondheim	564	512	1076	9,08	-9,22
85	Hemne / Snillfjord	5	0	5	0,04	-100,00
86	Hitra	2	1	3	0,03	-50,00
87	Frøya	4	1	5	0,04	-75,00
88	Ørland	3	5	8	0,07	66,67
89	Åfjord / Roan	0	0	0	0,00	0,00
90	Osen	0	0	0	0,00	0,00
91	Oppdal / Rennebu	0	4	4	0,03	400,00
92	Orkdal	4	5	9	0,08	25,00
93	Røros	3	3	6	0,05	0,00
94	Tydal	1	1	2	0,02	0,00
95	Steinkjer	5	14	19	0,16	180,00
96	Namsos	7	1	8	0,07	-85,71
97	Meråker	0	1	1	0,01	100,00
98	Levanger / Verdal	5	7	12	0,10	40,00
99	Lierne	0	1	1	0,01	100,00
100	Røyrvik	0	0	0	0,00	0,00
101	Namsskogan	0	0	0	0,00	0,00
102	Grong / Høylandet	1	0	1	0,01	-100,00
103	Flatanger	0	0	0	0,00	0,00
104	Vikna / Nærøy	3	1	4	0,03	-66,67
105	Leka	3	0	3	0,03	-100,00
106	Bodø	18	13	31	0,26	-27,78
107	Narvik	8	14	22	0,19	75,00
108	Bindal	2	3	5	0,04	50,00
109	Brønnøy	2	2	4	0,03	0,00
110	Alstahaug	2	4	6	0,05	100,00
111	Vefsn	5	1	6	0,05	-80,00
112	Hattfjelldal	0	0	0	0,00	0,00
113	Nesna	0	0	0	0,00	0,00
114	Rana	22	7	29	0,24	-68,18
115	Lurøy	0	0	0	0,00	0,00
116	Træna	1	0	1	0,01	-100,00
117	Rødøy	0	0	0	0,00	0,00
118	Meløy	5	0	5	0,04	-100,00
119	Beiarn	2	3	5	0,04	50,00
120	Fauske	14	3	17	0,14	-78,57
121	Steigen	1	3	4	0,03	200,00
122	Hamarøy	1	1	2	0,02	0,00
123	Tysfjord	0	0	0	0,00	0,00
124	Lødingen	0	0	0	0,00	0,00
125	Røst	0	0	0	0,00	0,00
126	Værøy	1	3	4	0,03	200,00
127	Flakstad / Vestvågøy	1	4	5	0,04	300,00
128	Vågan	4	3	7	0,06	-25,00
129	Sortland	7	10	17	0,14	42,86
130	Andøy	2	0	2	0,02	-100,00
131	Moskenes	0	0	0	0,00	0,00
132	Harstad	39	26	65	0,55	0,00
133	Tromsø	67	61	128	1,08	-8,96
134	Bjarkøy	0	0	0	0,00	0,00
135	Ibestad	0	0	0	0,00	0,00
136	Salangen	0	0	0	0,00	0,00
137	Målselv	3	3	6	0,05	0,00
138	Torsken/Berg	0	0	0	0,00	0,00
139	Lenvik	21	4	25	0,21	-80,95
140	Balsfjord / Storfjord	6	2	8	0,07	-66,67
141	Lyngen	1	0	1	0,01	-100,00
142	Gaivuotna-Kåfjord	0	0	0	0,00	0,00
143	Skjervøy / Nordreisa	1	3	4	0,03	200,00
144	Kvænangen	0	0	0	0,00	0,00
145	Vardø	1	3	4	0,03	200,00
146	Vadsø	1	0	1	0,01	-100,00
147	Hammerfest	3	13	16	0,14	333,33
148	Guovdageaidnu-Kautokeino	1	0	1	0,01	-100,00
149	Alta	3	4	7	0,06	33,33
150	Loppa	0	0	0	0,00	0,00
151	Hasvik	0	2	2	0,02	200,00
152	Måsøy	0	4	4	0,03	400,00
153	Nordkapp	0	4	4	0,03	400,00
154	Porsanger	0	0	0	0,00	0,00
155	Karasjohka	0	1	1	0,01	100,00
156	Lebesby	0	0	0	0,00	0,00
157	Gamvik	0	0	0	0,00	0,00
158	Berlevåg	0	0	0	0,00	0,00
159	Deatnu / Tana	0	1	1	0,01	100,00
160	Båtsfjord	1	7	8	0,07	600,00
161	Sør-Varanger	2	1	3	0,03	-50,00

Annex 2: Sector wise distribution of Patent in Norway (1998-2003)

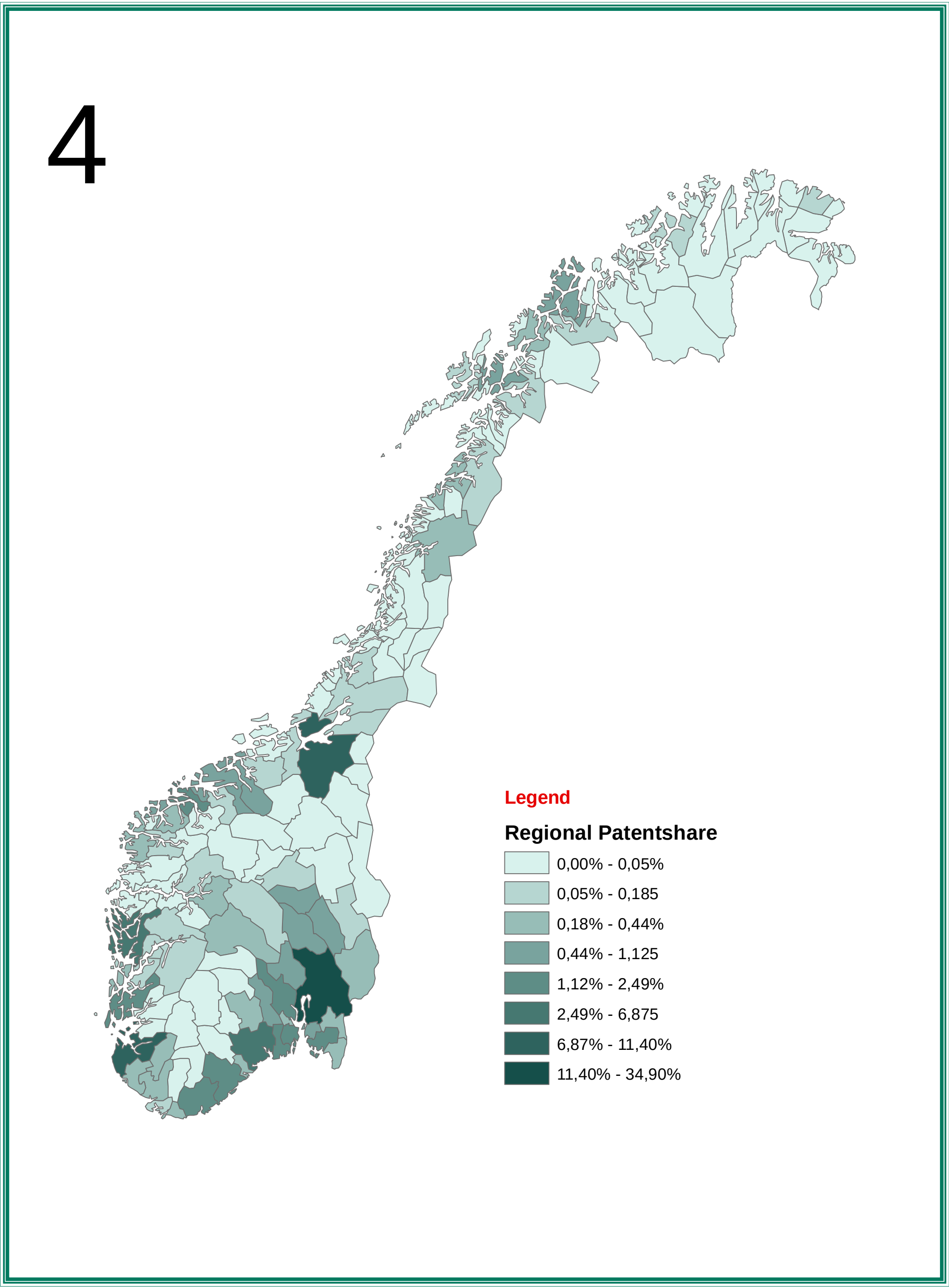
Tech group	Techgroup Name	Sector ID	Sector Name	No of patent awarded during 1998 to 2000	No of patent awarded during 2000 to 2003	Total no of Patents	Sector share (percentage)	Change (percentage)
1	Agro-business	1	Food, Beverages	115	119	234	3,88	3,48
		2	Tobacco Products	6	6	12	0,20	0,00
2	Textiles and Clothing	3	Textiles	6	6	12	0,20	0,00
		4	Wearing apparel	47	54	101	1,68	14,89
		5	Leather articles	10	13	23	0,38	30,00
		16	Man-made fibres	1	1	2	0,03	0,00
3	Wood Products	6	Wood products	114	114	228	3,78	0,00
		7	Paper	4	7	11	0,18	75,00
4	Printing and Publishing	8	Publishing, Printing	0	0	0	0,00	0,00
5	Non-metal & Chemicals	9	Petroleum products, Nuclear fuel	121	101	222	3,69	-16,53
		10	Basic chemical	338	332	670	11,12	-1,78
		11	Pesticides, Agro-chemical products	10	24	34	0,56	140,00
		12	Paints, Varnishes	0	0	0	0,00	0,00
		13	Pharmaceuticals	372	312	684	11,35	-16,13
		14	Soaps, Detergents, Toilet preparations	4	4	8	0,13	0,00
		15	Other chemicals	8	11	19	0,32	37,50
		17	Rubber and Plastics products	132	138	270	4,48	4,55
		18	Non-metallic mineral products	83	67	150	2,49	-19,28
6	Metal Product	19	Basic metals	76	61	137	2,27	-19,74
		20	Fabricated metal products	160	167	327	5,43	4,38
7	Machinery	21	Energy machinery	119	131	250	4,15	10,08
		22	Non-specific purpose machinery	334	291	625	10,38	-12,87
		23	Agricultural and Forestry machinery	207	187	394	6,54	-9,66
		24	Machine-tools	220	199	419	6,96	-9,55
		25	Special purpose machinery	641	670	1311	21,76	4,52
		26	Weapons and ammunition	52	40	92	1,53	-23,08
		27	Domestic appliances	80	73	153	2,54	-8,75
		28	Office machinery and Computers	273	207	480	7,97	-24,18
		42	Motor vehicles	88	80	168	2,79	-9,09
8	Electctronics and Electrical	29	Electric motors, generators, transformers	47	31	78	1,29	-34,04
		30	Electric distribution, Control, Wire, Cable	25	18	43	0,71	-28,00
		31	Accumulators, Battery	11	5	16	0,27	-54,55
		32	Lightening equipment	0	2	2	0,03	200,00
		33	Other electrical equipment	73	67	140	2,32	-8,22
		34	Electronic components	47	43	90	1,49	-8,51
		35	Signal transmission, Telecommunications	318	357	675	11,21	12,26
		36	Television and Radio receivers, Audiovisual electronics	49	51	100	1,66	4,08
9	Equipment	37	Medical equipment	203	233	436	7,24	14,78
		38	Measuring instruments	213	255	468	7,77	19,72
		39	Industrial process control equipment	29	28	57	0,95	-3,45
		40	Optical instruments	65	68	133	2,21	4,62
		41	Watches, Clocks	3	1	4	0,07	-66,67
		43	Other transport equipment	564	488	1052	17,46	-13,48
10	Furniture	44	Furniture, Consumer goods	333	297	630	10,46	-10,81
		45	Residuals	423	468	891	14,79	10,64
			Total	6024	5827	11851		-3,27
			r = 0,987, p<0.001					

Map No 1: Labour Market Regions (LMR) in Norway
(identified by NIBR, Norway)

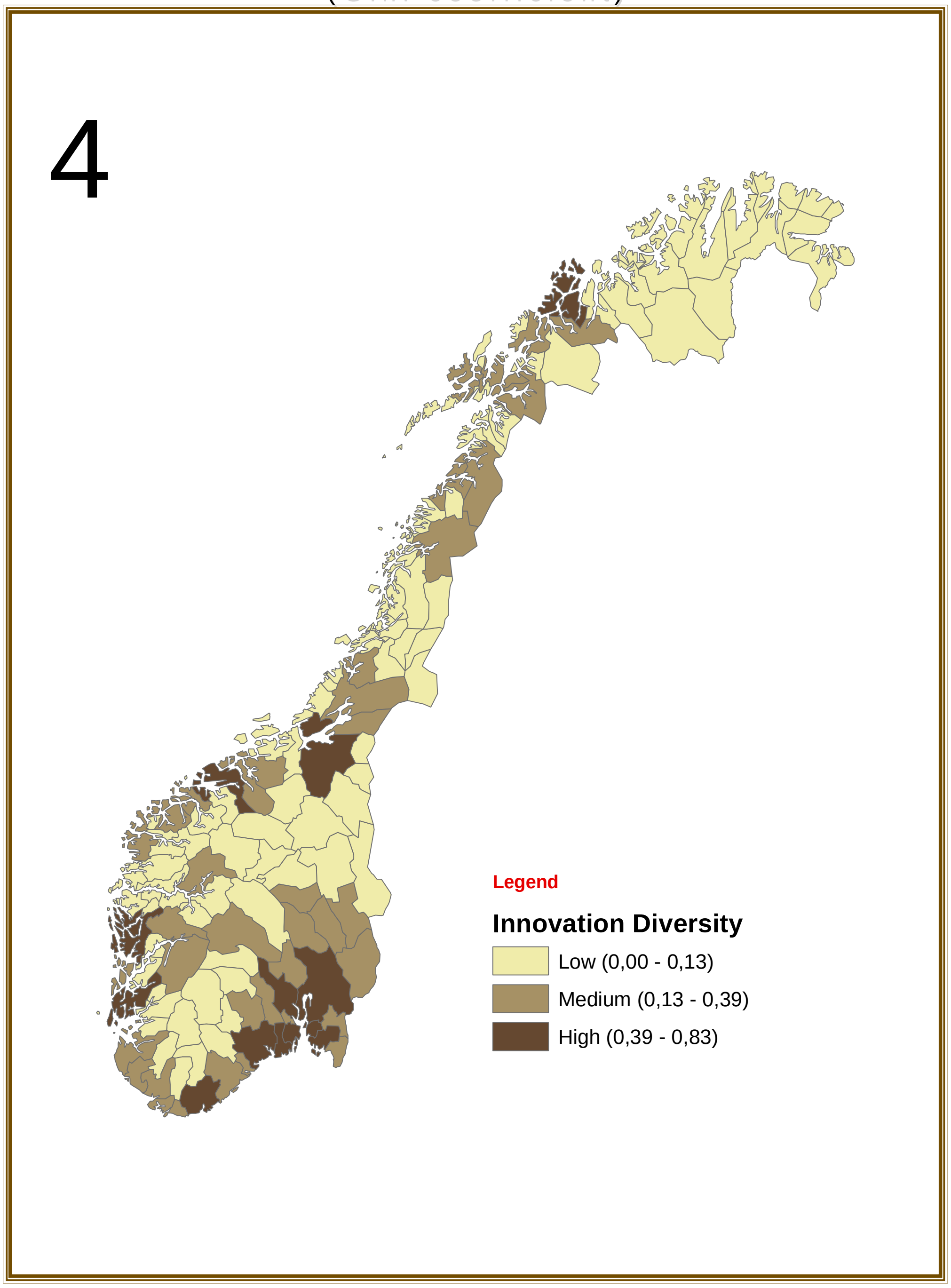
4



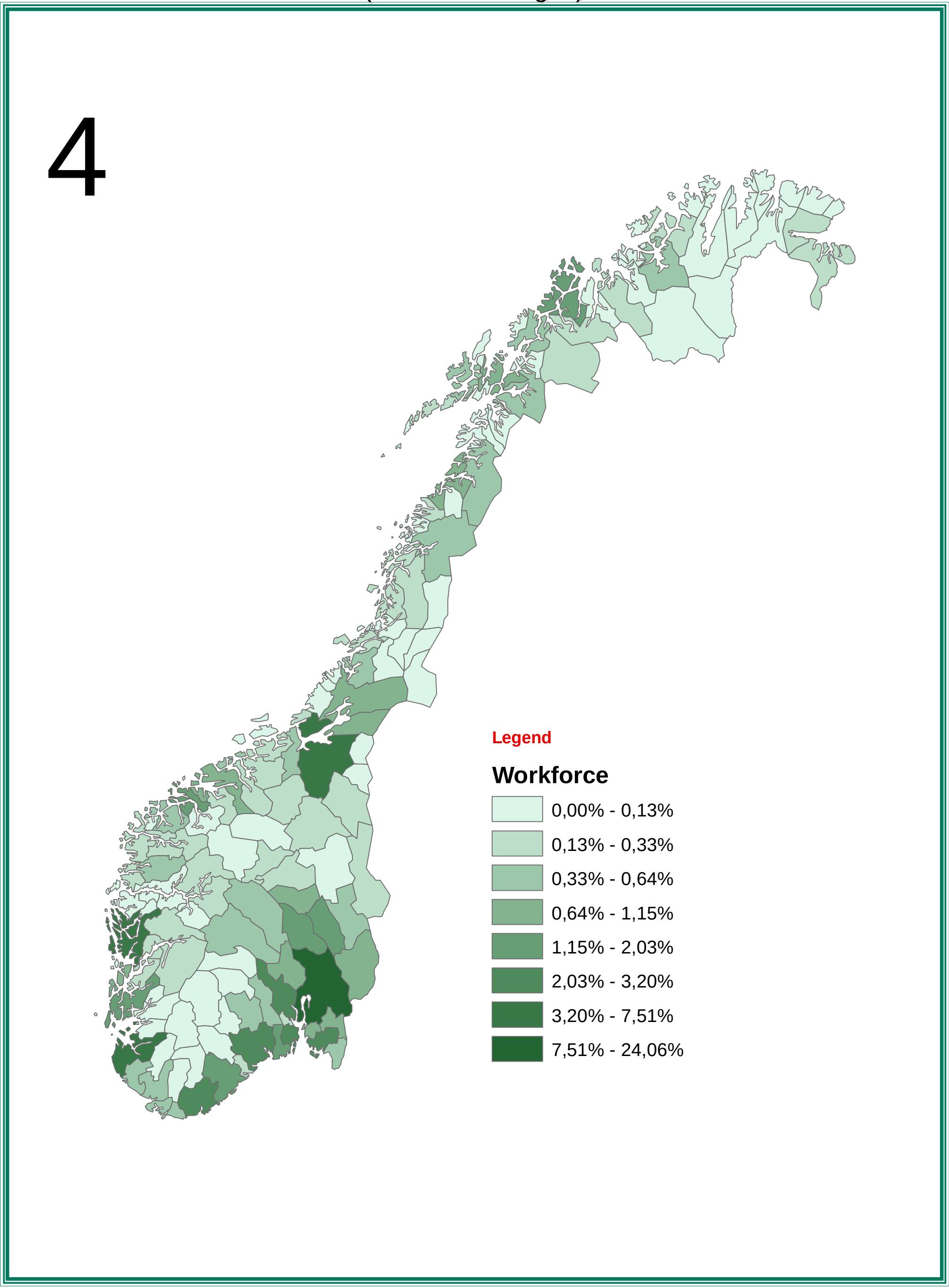
Map No 2: Regional Patent Share (1998-2003)
(Percentage)



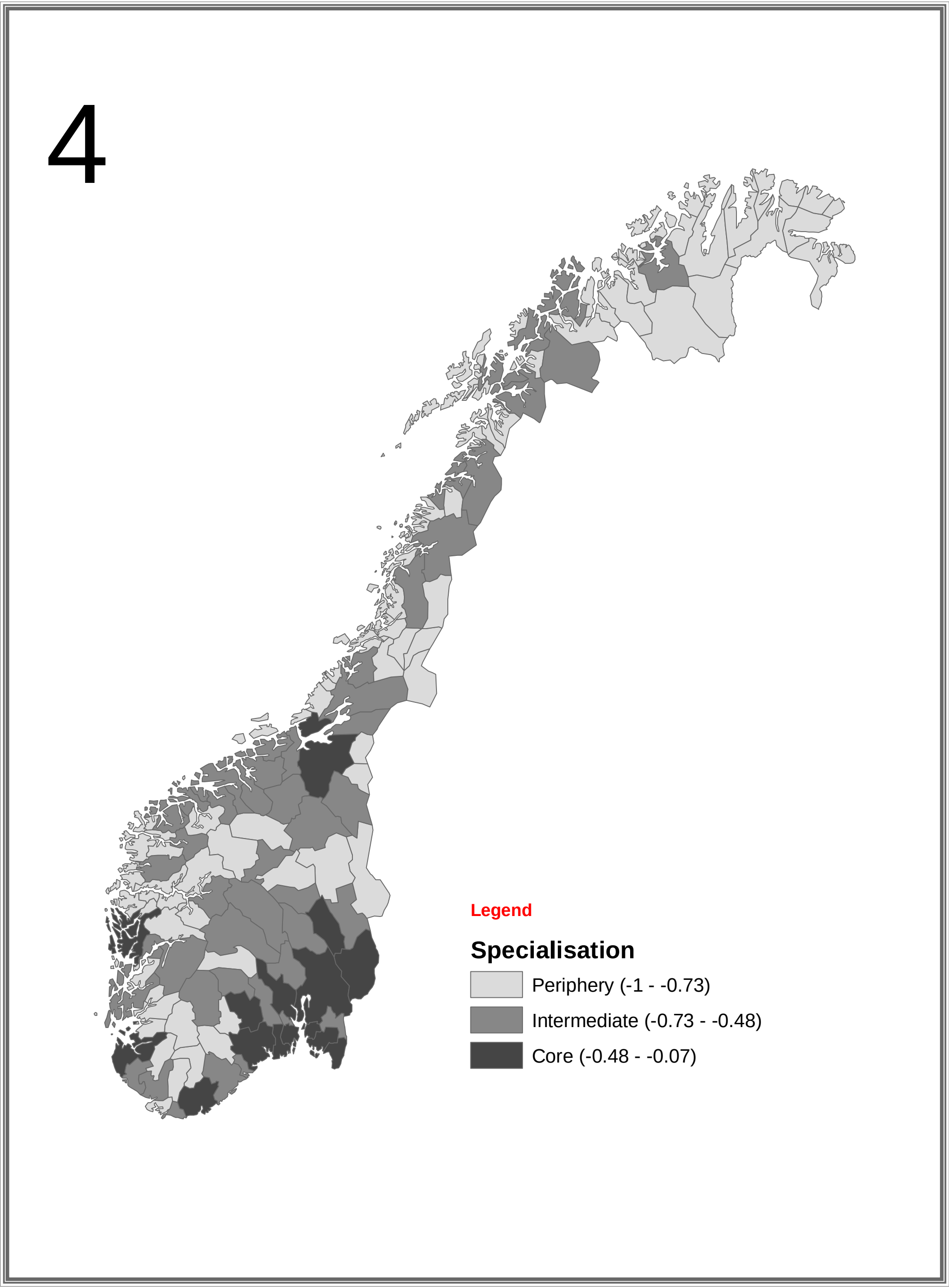
Map No 3: Diversity in Patenting Activities (1998-2003) (Gini coefficient)



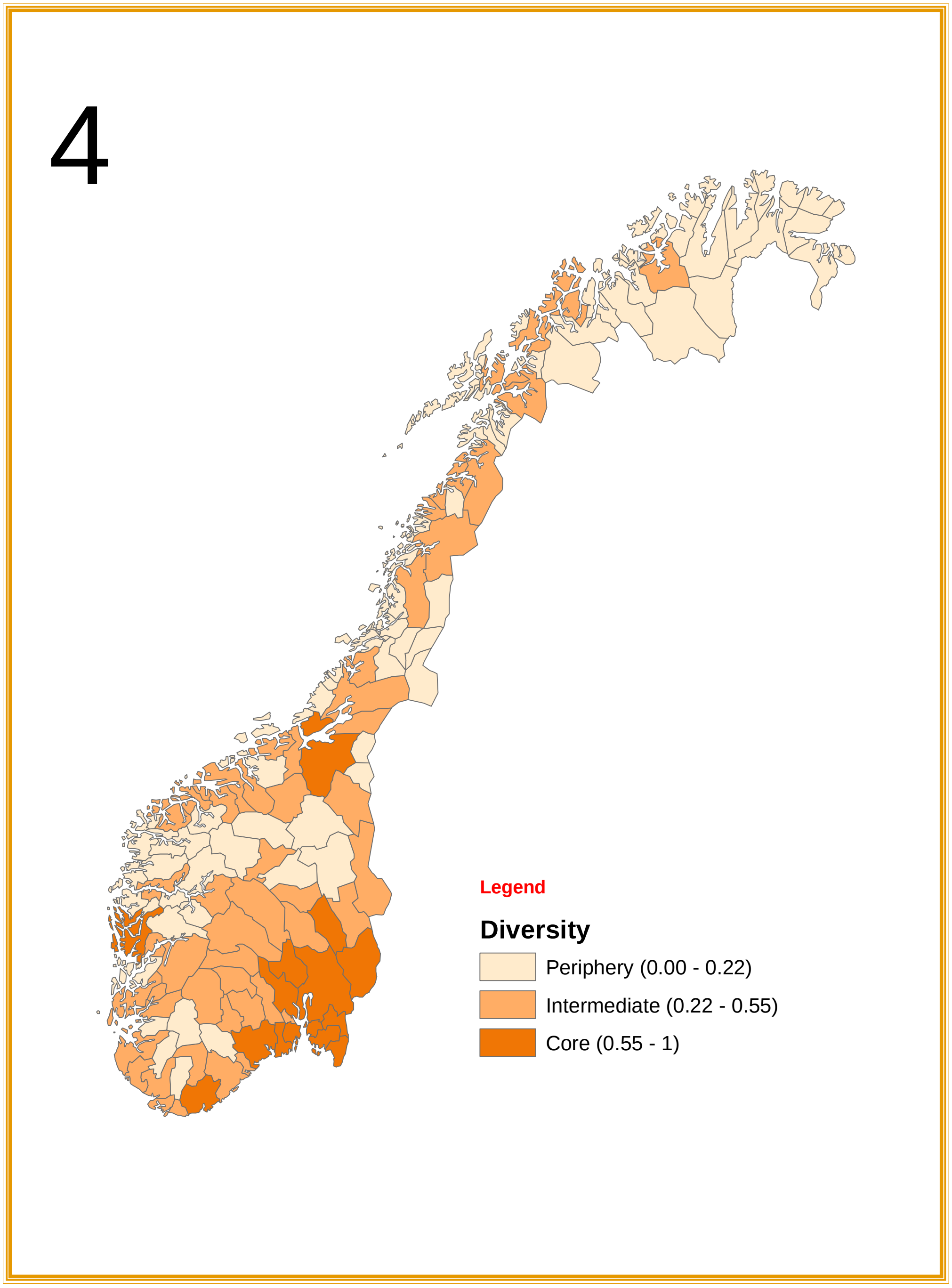
Map No 4: Regional strength of workforce (1995-2003)
(Percentage)



Map No 5: Index of Production specialisation (1995-2003)
(Regional mean value of Location quotients)



Map No 6: Index of Production diversity (1995-2003)
(Regional value of Gini coefficients)



Map 7: Moran scatter plot map of Patent distribution in LMR regions of Norway (1998-2003)