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Small cities: Regional motors or sponges? The case of Inland County, Norway

Atle Hauge · Giuseppe Calignano · Aleksander Bern · Karl Henrik Lønningdal

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Abstract In the innovation and regional development literature, regional areas that lie between prosperous core regions and struggling peripheral areas have been largely neglected, both theoretically and empirically, in recent innovation and regional research. In this paper, we analyse the role that small cities play as agents in regional development in their hinterland. Are they catalysts for growth, or do they drain the surrounding cities and villages? One concept or analytical tool that deals with this issue more explicitly is 'sponge cities', which refers to small and medium-sized cities that appear to 'soak up' talent and resources from the surrounding hinterland. By adopting and expanding this largely unexplored concept, we analyse the role of regional cities in the Norwegian context. Building on the original concept, we believe that adding commuting to migration patterns provides a more nuanced and precise assessment of whether small cities and regional centres are a blessing or a curse for their hinterlands. Using regional data, we classify cities as 'motors' (those that positively affect the hinterland thanks to well-balanced commuting and migration patterns at various spatial scales) or 'sponges' (those that soak up people from surrounding areas through migration). Further expanding our analysis, we label a third group of municipalities as 'local mobilizers', as they seem to have the potential to influence positively the growth of adjacent areas, and a fourth group as 'moderate attractors', which show moderately positive external commuting and migration flows.

Keywords Regional development · Small and medium-sized cities · Motor · Sponge · Commuting · Regional migration

A. Hauge (✉) · G. Calignano · A. Bern · K. H. Lønningdal
Inland University of Applied Science, Lillehammer, Norway
e-mail: atle.hauge@inn.no

Introduction

In this paper, we argue that small and medium-sized cities and those regions that lie between prosperous core and struggling peripheral areas have been somewhat disregarded in the more recent debate on innovation and regional development, both theoretically and empirically (Mayer & Lazzeroni, 2022a). The relationships between urban centres and rural hinterlands used to have a more prominent position in urban/regional planning (Hirschman, 1958; Myrdal, 1957; Parr, 1999a, 1999b), but have been more derelict in the current debate. For this reason, we have decided to systematically analyse the role of small and medium-sized cities in regional development. In particular, we are interested in the role that smaller cities play as agents for regional development in their hinterland (Partridge et al., 2007). Are they catalysts for growth, or do they drain the surrounding cities and villages (Bjarnason et al., 2021)?

A concept that deals with this issue more explicitly is 'sponge cities'. This concept has been studied in some specific geographical contexts, for example, in Australia (Alexander & Mercer, 2007; Argent et al., 2008) and northern Sweden (Carson et al., 2021), and is used to characterize a small number of urban areas that appear to 'soak up' talent and resources from the surrounding smaller regional cities.

By adopting and expanding this largely unexplored concept, we analyse the role of regional cities in the Norwegian context. Our analysis specifically considers the time span 2016–2021, which represents a 5-year period characterized by economic growth at the country level, but even development regionally. We use sponge cities as an analytical tool but expand Argent et al.'s (2008) initial theoretical approach to include the notion of 'motor' cities, which are defined as cities that have a net positive impact in their hinterland. This approach allows us to present a fuller picture of the role that cities play for development in non-metropolitan areas. To do this, we consider commuting as well as migration patterns to better understand the extent to which regional centres support peripheral regions as drivers of regional growth or undermine them by 'stealing' people and jobs from the rural hinterland (Bjarnason et al., 2021). We argue that the dynamism between a city and its surrounding areas is better understood when we include both where people choose to live and where people choose to work. Even so, we cannot provide a complete picture of the role of cities in regional development because the variables we employ are by no means comprehensive regarding the role of urban entities. For example, cities as service providers or urban amenities are not included in our analysis. Nevertheless, we offer a more nuanced perspective on the role of cities outside metropoles (Bell & Jayne, 2006; Mayer & Lazzeroni, 2022a). Do they act as motors or as sponges for their environs?

Our study addresses the recent call for more context-sensitive analysis (Gong & Hassink, 2020; Tödtling & Trippl, 2018). As already mentioned above, fewer analyses have focused on urban entities at a lower scale (Mayer & Lazzeroni, 2022b) in comparison with the studies examining how metropolitan areas lead the way in the knowledge economy (Glaeser, 2011; Haskel & Westlake, 2018; Moretti, 2012). The attention given to large metropoles and sprawling megacities, both by researchers and policymakers, has kept the potential and dynamics of 'intermediate cities' out of the spotlight (Rodríguez-Pose and Griffiths, 2021). In this paper, we analyse development dynamics at different geographical scales (from the urban to the national), and how cities interact with and impact their hinterland.

As our aim is to provide a first attempt to expand the concept of sponge cities by adding the concept of motor cities (i.e., urban areas that trigger the local environment without soaking up human resources), a county such as Inland Norway (Innlandet in Norwegian) seemed to us to be an interesting, relevant and useful regional case study. This county shares characteristics with numerous regions in Europe: It lies in close proximity to a dynamic metropolitan region—Norway's capital Oslo—but it lacks a metropole of its own. The country's settlement system is characterised by overall sparseness, but with a concentration of population and services around urban centres. These are generally the most dynamic areas of Norway, whereas the more peripheral ones struggle with population decline as well as limited employment opportunities.

As briefly sketched out above, but not yet specifically formulated in the present introduction, the research question addressed in our paper is: *What is the impact of small and medium-sized cities on their hinterland and the larger region?* Combining commuting and migration data (our focal variables) and a methodological strategy based on various geographical scales and cluster analysis allowed us to carry out our study successfully.

The remainder of the paper is structured as follows. We first present our theoretical tools focusing on the role of regional centres in regional development. The original sponge city hypothesis is explained, and we outline how we expand this. Then, the methodological approach and data are described, followed by our empirical case and findings. We end with a discussion and concluding remarks. The main limitations and possible developments of our study are also illustrated in the concluding section of our paper.

Theoretical framework

The role and effects of growing cities on the surrounding regions and neighbouring villages have been a primary topic in urban and rural studies

(Carson et al., 2021). Numerous theories and matching empirical approaches describe how development is unevenly dispersed, and how more dynamic regional centres affect regional development (Clark et al., 2018). Despite some exceptions (see Bosworth and Venhorst, 2018), these studies tend to focus either on population and migration patterns or on uneven economic growth and the dynamics that underpin them. Even though most theoretical and empirical approaches assume that these are typically two sides of the same coin, there is a tendency to focus either on the city as a hub for economic growth or as an attraction for people to live and work.

Some of the ideas on the role of regional centres as a catalyst for growth can be traced back to French economist François Perroux. His theories on growth poles have been influential in both academia and among policymakers. The main idea is that growth is unevenly distributed, even on a regional level. Growth takes place around a specific pole (or cluster) often dominated by key industries. Champions of the growth pole theory argue that the strengthening of the city economy will have spillover effects for the hinterland, and the dynamic urban centres will work as a motor for wider regional development (see Perroux, 1950; for a detailed overview of strategies and the historical background of the growth-pole concept, see Parr, 1999a, 1999b). A related concept/theory is Erik Dahmen's 'development blocks', where the basis for competitive success is the connection between the capability of one sector to develop, and the ability to ensure progress in another (Dahmén, 1988). More recently, Michael Porter's dynamic clusters have had a tremendous impact (Porter, 1998a, 1998b, 2001). These are geographically neighbouring interconnected companies with vertical (suppliers, producers) and horizontal (competitors) ties, and adjacent organizations such as educational institutions, government bodies and other institutions.

The idea of bundles of firms in adjacent economic connections is still very prevalent in regional development theory and associated policy. One example is so-called 'smart specialization', one of the European Union's favoured policies for regional development.[1] This strategy is embedded in and underpinned by the idea that related economic activities located in proximity will foster dynamic and positive development (Deegan et al., 2021).

Another strand of theory on uneven regional development and the role of regional centres focuses more on domestic population migration flows. *The hinterland around regional centres profits when the growth spreads, especially within daily commuting distance, allowing the more peripheral households to not relocate to these centres (*Partridge et al., 2007*).* Partridge et al. (2008) studied the notion of proximity to urban agglomerations and how this affects contemporary population growth in hinterland counties in the U.S. They find strong negative growth effects of distance to higher-tiered urban areas, which seem to increase over time. This is in line with recent theories stressing the effect of new technology on the spatial distribution of activities in a mature urban system (Partridge et al., 2008). Carson and Carson discuss whether larger urban centres may be key to navigating fluctuations in demography, thereby contributing to more stable and resilient population and economic development (Carson & Carson, 2021). However, Fothergill and Houston find that there is scant evidence that large provincial cities in the UK perform better than their adjacent municipalities. In fact, the opposite is the case, with the relationship between larger cities and their hinterlands being one of interdependence (Fothergill & Houston, 2016).

One analytical tool that explicitly focuses on the role of regional centres and the surrounding region is the sponge city hypothesis. This concept rests on the notion that population movement is a 'migratory rather than just a trade sense' (Argent et al., 2008, p. 111), meaning that the focus is on migration patterns ahead of commuting or other economic activities.

The concept of a sponge city was coined to describe development in the Australian context (Carson et al., 2021), and is applied to capture a change in population structure, where on the one hand, amenity-rich cities along with regional centres are growing, but on the other, rural and peripheral regions experience a decline in population and services. Sponge cities are believed to soak up the population from the immediate neighbouring regions. The metaphor stems from the observation that some larger regional centres are growing in population despite being located in areas characterized by a general population decrease. The

[1] See, for example, https://s3platform.jrc.ec.europa.eu/what-we-do.

assumption is that the declining municipalities and villages see their population migrate to the growing cities. Although the concept has received the attention of policymakers and the media, there is less traction in academia and research because it has been difficult to prove empirically (Argent et al., 2008). The process of sponge cities is explained by arising structural changes in agriculture, such as pressure for improvement and greater efficiency resulting in larger farm entities. This is believed to result in a situation where population and services are transferred from outlying districts to local provincial cities (Salt, 2001). In a study testing the sponge city hypothesis empirically, Argent et al. (2008) concluded that migration patterns and motives for moving were much more complex than the simple metaphor suggests (see also Alexander & Mercer, 2007). In their Australian case, they found that the share of population growth by in-migration from the nearby hinterland was relatively minor.

Nevertheless, to understand the role of non-metropolitan cities in regional development, regional migration patterns can be seen as a critical economic factor. In other words, by following Argent et al.'s (2008) approach, the cities that soak up population from their surrounding areas can be identified and defined as sponge cities. Thus, we started from this assumption and added commuting patterns to our empirical analysis. Numerous studies explain why the role of commuting is an important element in regional development dynamics, and include tax revenues, maintenance of good social services for the donor city, benefits for the retail market, enhancement of good and more sustainable transport infrastructure, and as a trigger for a dynamic local labour market (Andersson et al., 2018; Renkow & Hoover, 2000; Ribeiro & Fonseca, 2022; Shields & Deller, 1998).

Compared with the original approach of Argent et al. (2008), the addition of commuting to migration patterns allows us to give a more nuanced and precise assessment of whether small cities and regional centres are a blessing or a curse for their hinterlands. The geographical scale of analysis is critical in determining the sponge/motor effects because a city's closer hinterland can benefit from its growth, whereas the region as a whole might experience a "backwash" (Partridge et al., 2007). This will be informed by our data and findings and discussed in detail later.

In other words, by combining migration and commuting patterns, we classify cities in the targeted county of Inland Norway as motors (with positive effects on the hinterland thanks to well-balanced commuting and migration patterns at various spatial scales) or as sponges (where cities soak up people from their surrounding areas through migration). We also identify other types of 'intermediate cities' that cannot be classified as either motors or sponges and to which a specific definition can be attributed (i.e., 'local mobilizers' and 'moderate attractors' in our case study).

The geographical context

The county of Inland Norway is located in the central-eastern part of Norway. It was created on 1 January 2020 with the merger of the old counties of Oppland and Hedmark. The new county has an area of 52,113 km^2, making it the second-largest county in Norway after Troms and Finnmark.

Inland Norway is located between Trøndelag county in the north and Viken in the south, bordering Sweden to the east. Figure 1 shows that the southernmost part of Inland Norway is located close to Oslo and Norway's main airport Gardermoen, and the main north–south infrastructure of highways (European Route 6 and Norwegian National Road 3) and railroads. The three largest cities, Hamar, Gjøvik and Lillehammer, are all located on this north–south axis, and around Lake Mjøsa. All three have university campuses, and hospitals and the county administration are shared between Hamar and Lillehammer. Moreover, typical service functions, private, public and cultural, are concentrated in this sub-regional area, which is the most densely populated part of the county. The fourth-largest city, Kongsvinger, is located in the east, close to the Swedish border. The northern and western areas of the county are dominated by the mountainous areas of Rondane, Dovrefjell and Jotunheimen. Eastern and southern areas mainly comprise forests and agricultural land.

The regional economy of the county has a larger share employed in the primary sector, agriculture and forestry, than the national average. Regarding manufacturing, Inland Norway generally reflects the national level. There are a few agglomerations of

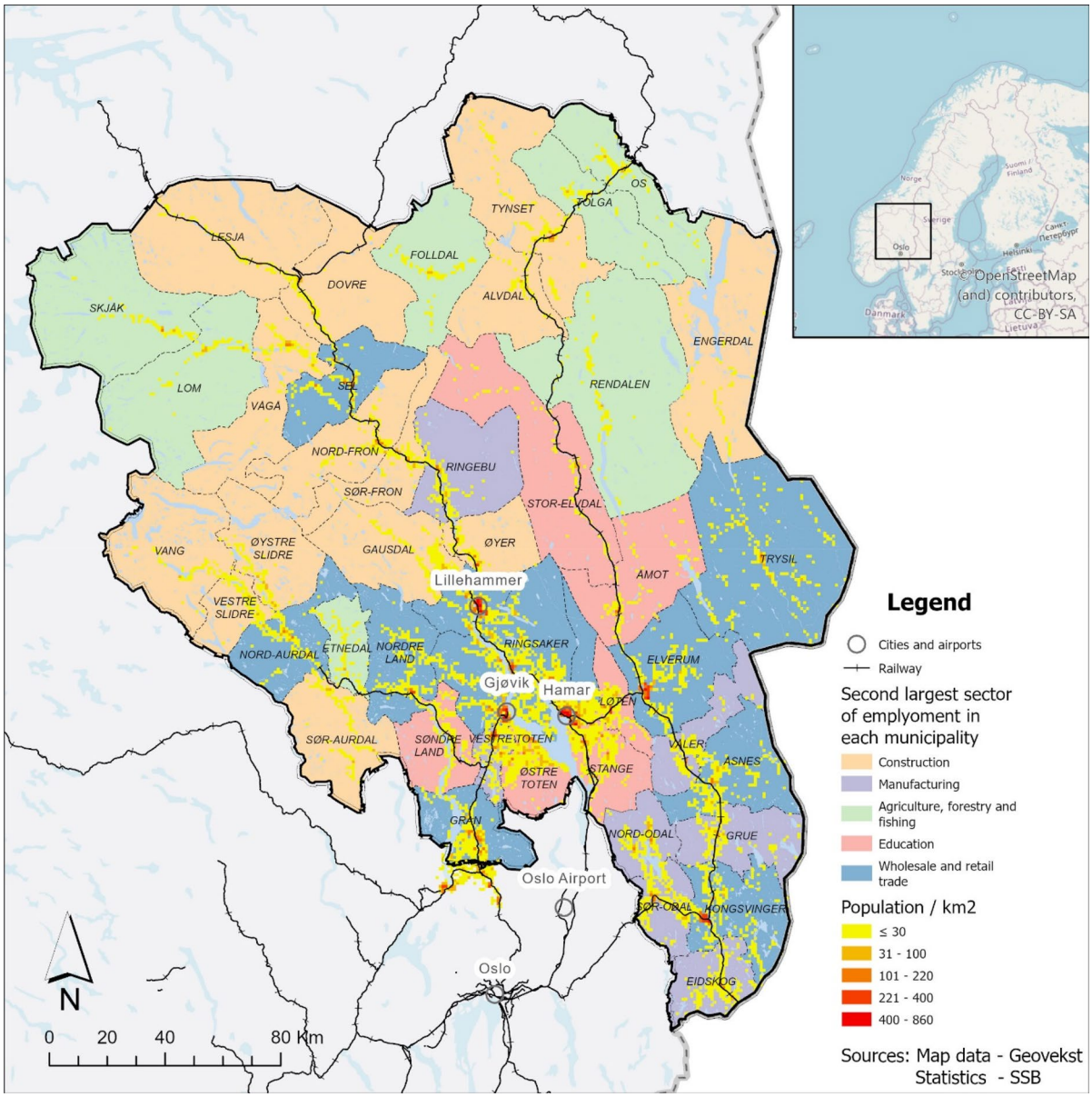

Fig. 1 The county of Inland Norway

manufacturing businesses, but these are connected to the primary sector. The employment growth in Inland Norway (like other Western economies) is primarily in the public and private service sectors, with the typical pattern in which the larger cities have a larger share of these jobs and serve a larger region (REDINN, 2022).

The methodological strategy

For cluster analysis, we used K-means clustering to identify motor, sponge and, possibly, other types of intermediate cities in Inland Norway. Official population databases for the period 2016–2021 were used and we adopted a methodological strategy comprising a multiscalar dimension (net intra-regional,

Table 1 Variables employed in the empirical analysis and related calculations

	Geographical level	Measure	Calculation
Commuting	Economic Region (LAU1/NUTS 4)	Net Regional	In Regional—Out Regional
	County (NUTS 3)	Net Extra-regional	In Extra-regional—Out Extra-regional
	Country (NUTS 1)	Net Extra-county	In Extra-county—Out Extra-county
Migration	Economic Region (LAU1/NUTS 4)	Net Regional	In Regional—Out Regional
	County (NUTS 3)	Net Extra-regional	In Extra-regional—Out Extra-regional
	Country (NUTS 1)	Net Extra-county	In Extra-county—Out Extra-county

Source: Authors' conceptualization and calculation of Statistics Norway data

extra-regional and extra-county commuting and migration) and ex ante and ex post validation tests (e.g., dendrogram inspection, the Kruskal–Wallis post hoc test).

Data collection and organization: migration and commuting

The databases related to migration and commuting at the municipal level (Local Administrative Unit-2, LAU-2) in 2016–2021 were provided by Statistics Norway.[2] They were set up as matrices containing origin and destination of flows, work municipality and home municipality, for all the municipalities in Inland Norway. International commuters and migration across the national border were not included in these datasets. Likewise, those working offshore on the Norwegian continental shelf (i.e., on oil platforms or in Svalbard) were also excluded. It should be stressed, at this point, how municipalities play a critical role in the Norwegian context. Even if in some cases they are towns with a few thousand inhabitants, municipalities represent providers of important welfare-state services such as schooling, elderly care and local infrastructure.

One major challenge with data at the municipal level is that recent years have seen a number of mergers. Both migration and commuting data were therefore transformed so that each year conformed to the municipalities as of 2021. Most of the changes have involved simple mergers between municipalities, and for these cases, the transformation introduced no errors; however, there may be a few cases of border adjustments that could not be controlled for. We consider this a negligible source of errors, as these changes do not include population centres and are mostly minor changes. This transformation was achieved using the Safe FME software so that each year and each variable could be run through the same transformation routine.

Subsequently, the data were aggregated at the economic region level (LAU-1, formerly Nomenclature of Territorial Units for Statistics 4, NUTS 4), as defined by Statistics Norway, and at the county level (NUTS 3) (Table 1). Gross and net in- and out-migration and commuting could then be calculated for each municipality, as well as how much of these flows occurred within the municipality's region or county and how much occurred outside of these categories. Table 1 indicates in detail how the variables included in the final dataset were calculated. We considered the average net migration and commuting in 2016–2021, and also weighted these values against the total working age population (16–75 years old) to provide an accurate representation of regional development dynamics in Inland Norway. However, to counterbalance the risk of overestimating the importance in statistical and practical terms of micro and smaller municipalities, in our final statistical analysis we considered only those municipalities with a population above the median. Thus, we used 23 municipalities instead of the 46 that make up Inland Norway.

Commuting from surrounding areas (i.e., other municipalities within the same economic region, NUTS4/LAU-1) and migration from the rest of the county (NUTS3) and the country (NUTS1) make certain municipalities ideal-type motor cities. Conversely, considerable migration flows from the same economic region (NUTS4/LAU-1) make certain municipalities potential sponge cities (see Table 2 and Fig. 2). Municipalities that do not correspond to these

[2] See https://www.ssb.no/arbeid-og-lonn/sysselsetting.

Table 2 Contribution of each variable to the identification of motor and sponge cities

	Motor	Sponge
(+) Net regional in-commuting	*	
(+) Net extra-regional in-commuting	*	
(+) Net extra-county in-commuting	*	
(+) Net regional in-migration		*
(+) Net extra-regional in-migration	*	
(+) Net extra-county in-migration	*	

* indicates that this is a variable defining the place

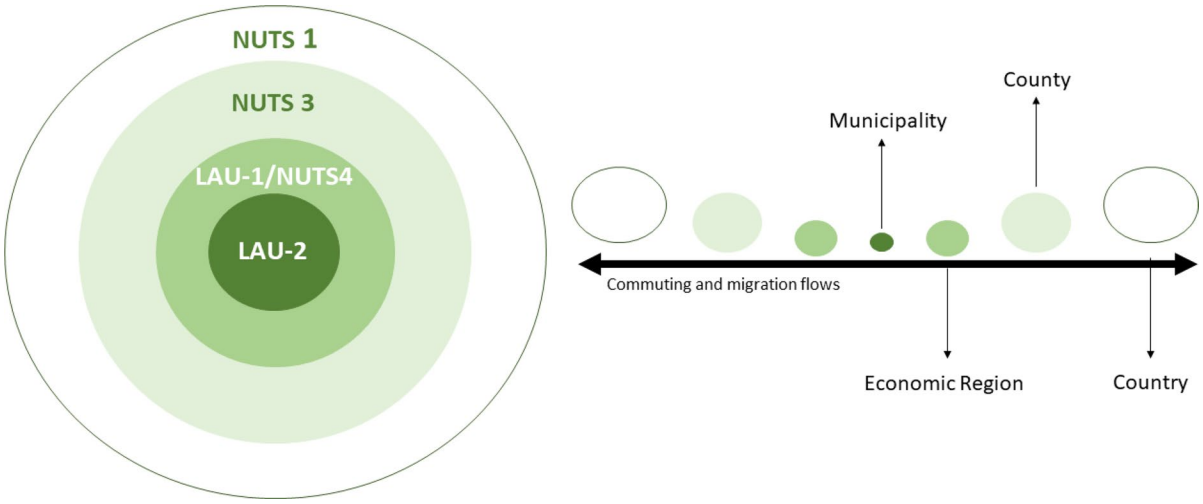

Fig. 2 Geographical units of analysis: LAU-2 (municipality), LAU-1/NUTS4 (economic region), NUTS3 (county) and NUTS1 (country)

ideal-type cities—'intermediate cities'—have been discovered, classified and named based on their specific characteristics as 'local mobilizers' and 'moderate attractors'.

K-means clustering is an unsupervised machine-learning algorithm by which it is possible to identify, classify and group objects (or cases) in a targeted dataset. In our case study, K-means clustering allows us to classify municipalities in Inland Norway and group them based on the six variables in Table 1 (i.e., net intra-regional, extra-regional and extra-county commuting and migration in 2016–2021). The identified clusters are characterized by high intra-cluster and low inter-cluster similarity and were defined by the following procedure. Initially, the K-means algorithm attributes one case to a given cluster when its distance from the central point of the latter is minimal. Then, by a step-by-step iterative procedure, the various centroids of each cluster, and the related cases belonging to them, are identified. This process stops when convergence is reached, that is, when the values of each identified cluster remain stable after a new iteration.

The problem with K-means clustering is that it is characterized by a certain degree of subjectivity in determining the ideal number of clusters, even though there are several methods that can test its accuracy and validity. We conducted a preliminary hierarchical cluster analysis, using Ward's method and Euclidean distance, to inspect the related reconstructed dendrogram (see, e.g., Calignano et al., 2023; Ejdemo & Örtqvist, 2021). Initially, this allowed us to identify a possible number of clusters, whose number was confirmed by the iteration history shown in Table 3, according to which

Table 3 Step-by-step progress of the clustering process: Iteration history table

Iteration	Change in cluster centres			
	Cluster 1	Cluster 2	Cluster 3	Cluster 4
1	1.951	0.000	1.546	1.768
2	0.000	0.000	0.000	0.000

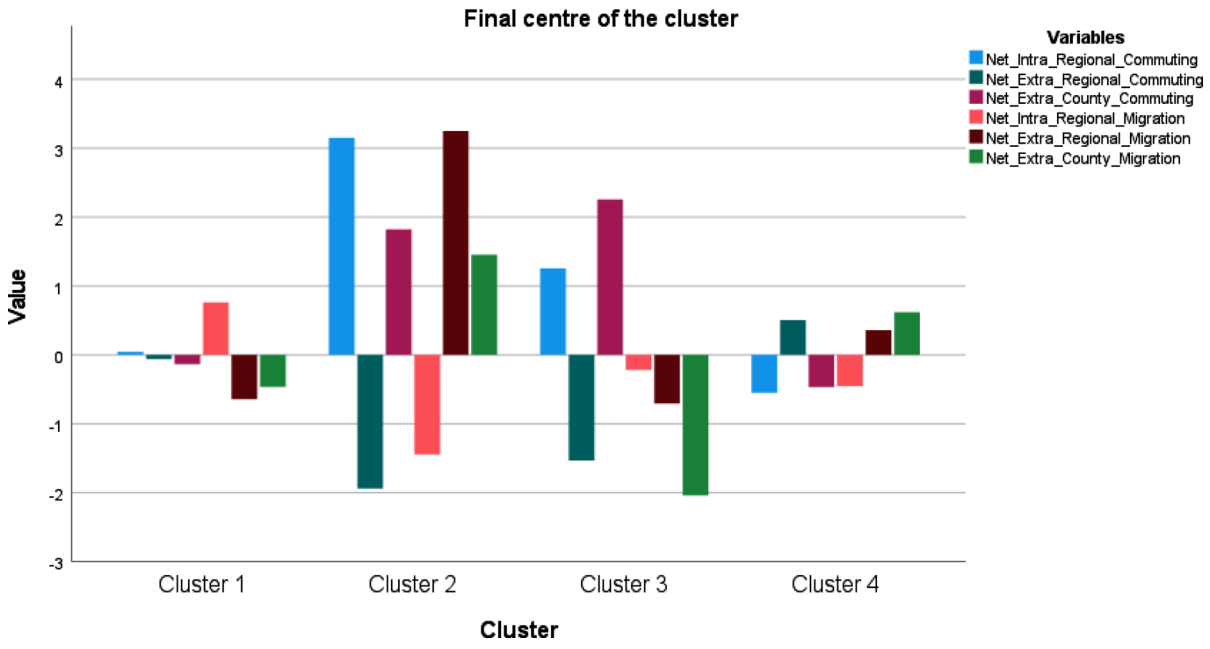

Fig. 3 Final centres of the clusters and contribution of each variable to the respective cluster

convergence was reached in correspondence with the second iteration.

In addition, the appropriateness of our empirical analysis was strengthened by applying the Kruskal–Wallis post hoc test. This allowed us to reject the null hypothesis that the distribution of our variables was the same across the four identified clusters, thus proving that the variance observed between and within them varies considerably. A table showing the results of the Kruskal–Wallis test in detail and the related box plots referring to each variable adopted in the empirical case of municipalities in Inland Norway are shown in "Appendix 1—Table 6" and "Appendix 2—Fig. 5", respectively.

The empirical case study: motors, sponges and other types of cities in Inland Norway

In the first step, we checked what variables mainly contribute to the formation of each identified cluster, and this is illustrated in Fig. 3. A bar above zero means that a certain variable contributes to the formation of a given cluster (i.e., positive values); a bar below zero means that variables show a negative value. The length of each bar determines the magnitude of the positive or negative contribution of each variable to the respective cluster. The number of municipalities comprised in each cluster and their names are reported in Tables 4 and 5.

Figure 3 clearly shows how Cluster 2 is associated with the definition of a motor city, as it shows high levels of positive intra-regional and extra-county commuting on the one hand, and high levels of positive extra-regional and extra-county migration on the other. This is based on the commuting patterns from surrounding areas and the migration patterns from more distant geographical areas (i.e., the rest of the county and the country) that are preferable to migration from the same economic region. In other words,

Table 4 Number of clusters and municipalities in each identified cluster

	Cluster	No
	1	9
	2	1
	3	2
	4	11
Valid Cases		23
Missing		0

Table 5 Clusters 1–4, municipalities in each cluster and city type: sponge, motor, local mobilizer or moderate attractor

	No	Municipalities	City type
Cluster 1	9	Kongsvinger, Åsnes, Elverum, Tynset, Nord-Fron, Sel, Østre Toten, Vestre Toten, Nord-Aurdal	Sponge
Cluster 2	1	Hamar	Motor
Cluster 3	2	Lillehammer, Gjøvik	Local mobilizer
Cluster 4	11	Ringsaker, Løten, Stange, Sør-Odal, Eidskog, Trysil, Øyer, Gausdal, Gran, Søndre Land, Nordre Land	Moderate attractor

the single municipality that comprises Cluster 2 (i.e., Hamar; see Tables 4 and 5 for details) seems to positively influence its surrounding economic region by attracting a good number of commuters from the neighbouring areas and a high number of migrants from the rest of Inland Norway and the entire country, but without soaking up migrants from the economic region of reference (Andersson et al., 2018).

Cluster 1, which comprises nine municipalities, is the cluster in which sponge cities are grouped. It is characterized by negative values related to almost all of the types of commuting and migration patterns we consider, with the only exceptions being an almost insignificant positive net intra-regional commuting pattern (i.e., a value close to 0) and, above all, a considerably higher number of intra-regional migrants. Thus, the municipalities in Cluster 1 soak up the surrounding population without mobilizing resources effectively in the neighbouring municipalities that make up the economic regions of reference.

Compared with the seminal work of Argent et al. (2008), an interesting feature of our methodological approach and related empirical analysis is that various types of intermediate cities can be identified. This is an important addition to the theoretical discussion on the existence and identification of sponge cities because it allows us to demonstrate not only the existence of motor cities that positively mobilize their surrounding areas, but also that cities are diverse and may play different roles that are not always classifiable as either sponges or motors.

We identified two key municipalities that we defined as 'local mobilizers', namely Cluster 3. Lillehammer and Gjøvik, together with the aforementioned motor city Hamar (Cluster 2), represent the largest municipalities in Inland Norway. As shown in Fig. 2, Cluster 2 (Hamar) and Cluster 3 (Lillehammer and Gjøvik) show similar patterns related to commuting, but divergent migration flows. In the latter case, Lillehammer and Gjøvik show negative net migration in all possible combinations, with a considerably high level of negative extra-county migration. In other words, these two cities seem to be good mobilizers for the surrounding municipalities that make up their respective economic region, even though they are unlikely to act as attractors for external (extra-economic region) resources, as in the case of Hamar. Hence, Lillehammer and Gjøvik can be defined as 'local mobilizers'.

Finally, we identified a fourth type of municipality in Inland Norway that we call 'moderate attractors'. These 11 municipalities making up Cluster 4 are characterized by moderately positive net extra-regional commuting and extra-regional and extra-county migration. It can be inferred that these municipalities do not have a clear (positive or negative) impact on the surrounding economic region, but mainly engender moderate positive external commuting and migration flows. Hence, they are 'moderate attractors'.

By employing a more qualitative assessment of the clusters, we see that the only city in Cluster 2, Hamar, is the fastest-growing municipality in both migration and job growth (based on data from the website Innlandsstatistikk[3]). Hamar has several positive endogenous variables. It is located relatively close to Oslo, and even closer to the main national airport Gardermoen. It recently enjoyed an upgrade in road and rail infrastructure towards the capital, and the journey now takes less than 90 min by car or train. For well-paid jobs that require higher education, Hamar is largely part of Oslo's living and job market.

The county's next two largest cities, Lillehammer and Gjøvik, are located in Cluster 3, which we have

[3] https://www.innlandsstatistikk.no/.

labelled local mobilizers. Both are regional centres with a wealth of public and private services, in addition to being somewhat specialized when it comes to business. Lillehammer has a large proportion of firms and jobs in the hospitality sector, in particular winter tourism, and is located more than two-hour drive from Oslo both by train or car. This means that it is close enough to Norway's largest market when it comes to leisure and tourism, but a bit too far when it comes daily commute to work for most people and occupations. By contrast, Gjøvik has a large presence in manufacturing sectors, as the city is located close to Raufoss, where there is a cluster of alloy and other light metal technology producers. They are typically producers for export, with the automobile and arms industries as their main customers. In contrast to Hamar, but similar to Lillehammer, the time to the main airport is almost twice as long as from Hamar.

In Cluster 4, the moderate attractors, we find that the majority of municipalities are located close to urban centres, including all of Hamar's neighbours, two of Lillehammer's and three municipalities located at the southernmost part of the county relatively close to Oslo. However, the sponge/motor effect cannot be reduced to a question of urbanity and proximity to urban markets. For example, Kongsvinger is the fourth-largest city in the county and is located less than 90 min from Osloand close to the Swedish border (the latter is not captured in our empirical analysis). However, this means that Kongsvinger is not located on the north–south axis that extends up from Oslo, and all the way to Trondheim. Kongsvinger, included in Cluster 1, is categorized as a sponge city. This shows that one should not conclude that the distance to Oslo and the nation's main airport is the only explanation for why these different cities have a different influence on the hinterland. Instead, spatial and functional links in a dynamic labour market and regional economy need to be explored in more detail. The targeted municipalities that constitute each cluster and their location are illustrated in Fig. 4.

Discussion of the main results and concluding remarks

In this paper, we have expanded the promising conceptualization of sponge cities, which soak up population and resources from the surrounding areas (Argent et al., 2008; Bjarnason et al., 2021; Carson et al., 2022; Lundmark et al., 2022). We do so by considering how some small and medium-sized cities may conversely act as regional motors through a beneficial combination of commuting and migration patterns at various geographical scales.

Our paper contributes to this limited strand of the literature from theoretical, methodological, empirical and policy perspectives. Theoretically, our paper demonstrates that small and medium-sized cities may play different roles in regional (NUTS 3) and, as in our case study, subregional (LAU-1/NUTS4) contexts. Moreover, by adding the concept of motor cities (that act as real engines of local demographic dynamics and, more broadly, local development) to the negative idea of sponge cities (that soak up people and resources from the surrounding areas), we revealed that a more nuanced situation can be observed in the specific targeted regions. Some cities are neither motor nor sponge, but they may still play an important role in the surrounding areas, for example, by mobilizing local resources or attracting people from different economic regions and countries. Interestingly, different types of 'intermediate' cities (as we have defined them) that show different characteristics and play a different role from those observed in Inland Norway could be discovered and classified differently in other regional contexts.

Our findings were made possible by the methodological approach adopted in our study. First, we used the new key variable of commuting (see, e.g., Andersson et al., 2018; Renkow & Hoover, 2000; Ribeiro & Fonseca, 2022; Shields & Deller, 1998) in addition to migration, which enabled us to conceptualize motor cities and attribute to them an opposite role and positive connotation compared with the negative influence attributed to sponge cities. Moreover, by applying a more sophisticated technique such as K-means clustering, instead of simpler descriptive statistics (as in Argent et al., 2008), we were able to provide a detailed and nuanced representation of the different municipalities that make up the urban scenario in Inland Norway.

Thus, our empirical analysis provides food for thought for regional policymakers in the targeted region by elucidating the different roles that small and medium-sized cities play in regional development. For example, the distinction between sponge and motor cities is too crude. Different cities play

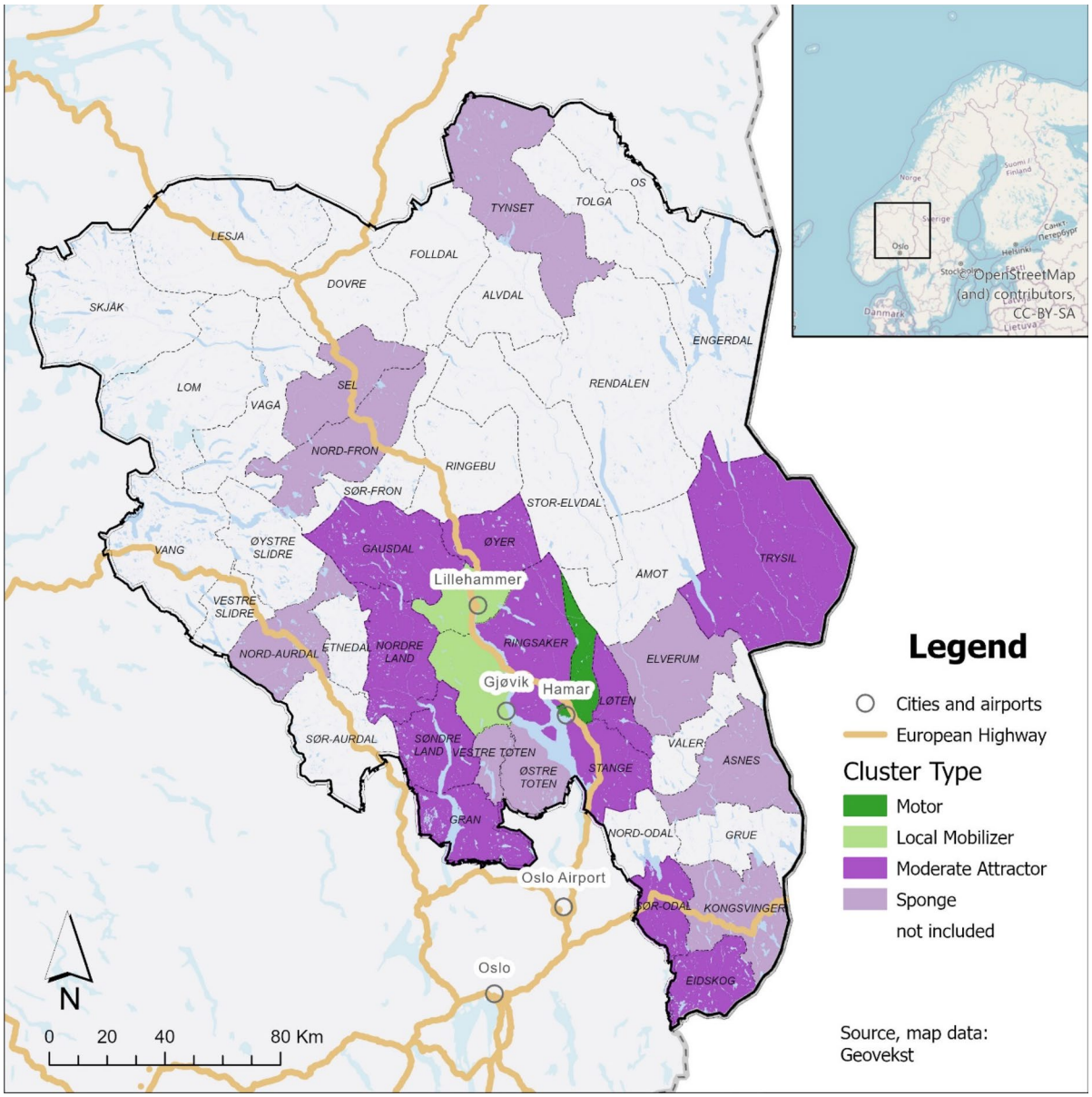

Fig. 4 Geographical location of the municipalities that constitute each identified cluster

different roles, and the same cities can even play different roles depending on the geographical scale.

Although richer than previous studies on the topic, our empirical analysis has some shortcomings to be addressed in future research. The geographical scale of analysis is critical in determining the sponge/motor effects and attributing a positive connotation to motor cities and a negative one to sponge cities. In other words, the various metaphors used in this paper and elsewhere (e.g., Alexander & Mercer, 2007; Argent et al., 2008; Carson et al., 2021) may be useful if policymakers and planners consider the optimal or, at least, the more appropriate 'spatial reach' of population flows, by avoiding the risk of using this promising analytical tool in an uncritical or a-spatial sense. For example, Hamar clearly represents a motor city for its surrounding areas (i.e., an economic region

at the LAU-1/NUTS4 level), but its role changes completely if we consider another geographical level of disaggregation. If we are interested in determining the role of cities at the county level (NUTS3), Hamar becomes a sponge for Inland Norway as a whole because it soaks up the population from the county of reference. That said, the new approach and the methods we used in this study represent a versatile and potentially promising tool for identifying motor, sponge and intermediate cities that can be adopted at the various geographical levels, from the local to the national. Moreover, as argued, the Inland Norway region shares similar attributes found in most countries in the developed world, and this case has a certain applicability to other geographies that are struggling with uneven development, population growth and job creation in few places.

In this paper, we have explored the reasons that led to the formation of clusters as we identified them, even though such a discussion is mainly based on the direct knowledge of the county under investigation and would need to be supported by further and more accurate statistical analyses. Future empirical studies based on a combination of methods and techniques (e.g., cluster analysis, social network analysis, factor analysis and qualitative comparative analysis) should cover an entire country with the aim of identifying a clear association between motor, sponge and intermediate cities, and critical socio-economic factors (such as spatial distance to core areas, skilled labour, economic sectors, infrastructure, housing and cultural indexes) in the targeted national context. What the present paper critically does is to lay the necessary foundation for future research on this important and largely unexplored topic.

Appendix 1

See Table 6.

Table 6 Kruskal–Wallis test (significance level = 0.050)

	Hypothesis test summary	
	Null Hypothesis	Sig
1	The distribution of Net_Intra_Regional_Commuting is the same across categories of clusters	0.004
2	The distribution of Net_Extra_Regional_Commuting is the same across categories of clusters	0.032
3	Net_Extra_County_Commuting is the same across categories of clusters	0.016
4	The distribution of Net_Intra_Regional_Migration is the same across categories of clusters	0.011
5	The distribution of Net_Extra_Regional_Migration.mean is the same across categories of clusters	< 0.001

Appendix 2

See Fig. 5.

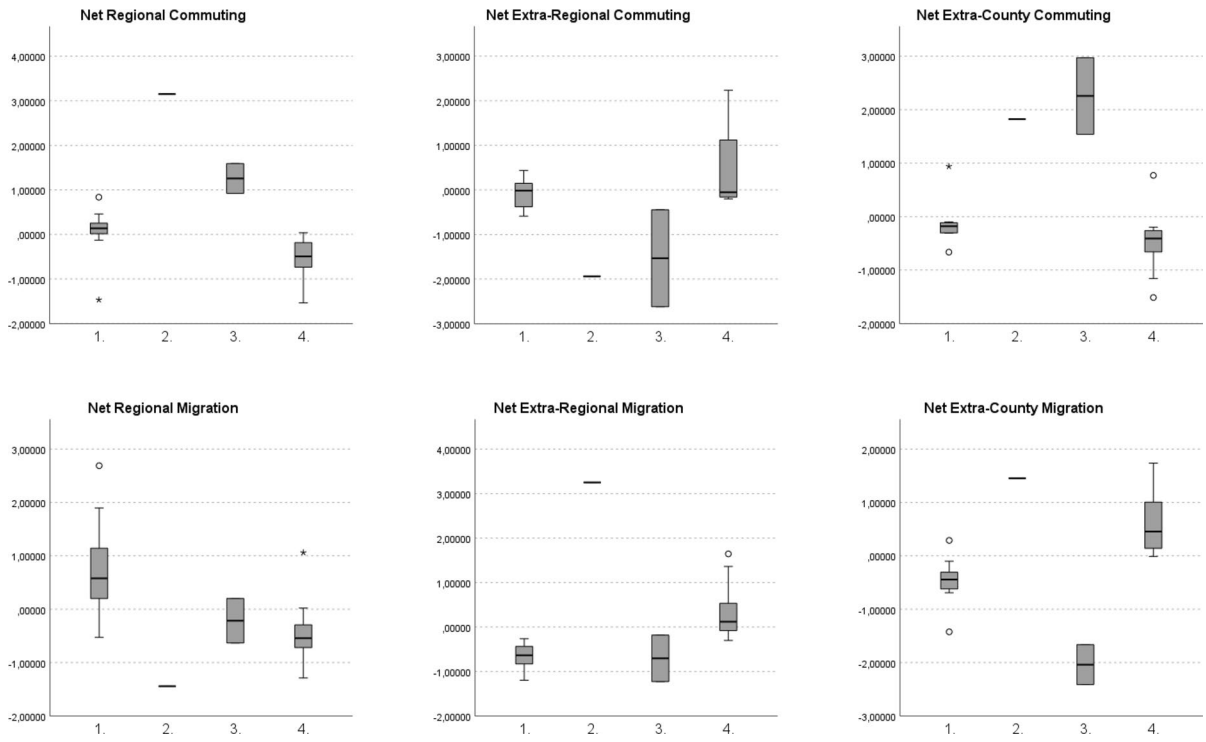

Fig. 5 Kruskal–Wallis post hoc test. Variance within and between the identified clusters

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