Reviewing research on regional development in the AI era — new there(s), new actors, and an old call "from cluster to process"

JOHANNA HAUTALA

Hautala, J. (2024) Reviewing research on regional development in the AI era — new there(s), new actors, and an old call "from cluster to process". *Fennia* 202(2) 299-312. https://doi.org/10.11143/fennia.141937

The aim of this review is to present the current state and suggest next steps for research on AI-related regional development. Based on thematic content analysis of 37 articles in key journals of regional development and economic geography, I answer where, by whom, and how AI-related regional development takes place. The results reveal a strong narrative of increasing concentration and regional polarization, and a less considered narrative of the potential of dispersion that also enables the development of remote regions. I suggest advancing research through identifying 'new there(s)' as virtual and augmented realities, AI as a new actor, and a methodological step from 'cluster to process' to investigate the everyday spatial processes of creating knowledge and being creative with AI that catalyze regional development.

Keywords: regional development, artificial intelligence, innovation policy, cluster

Johanna Hautala (https://orcid.org/0000-0002-4451-6290), School of Management, Regional Studies, University of Vaasa, Finland. E-Mail: johanna.hautala@uwasa.fi

Introduction

The current artificial intelligence (AI) era provides opportunities and challenges for places, regions, and their development. In the technologically advanced world, AI applications such as ChatGPT and Dall-E have rapidly become part of our everyday work and life. Although the definitions of AI are often contested, in general, AI is seen as autonomous technology capable of mimicking what is considered human intelligence, such as learning, reasoning, and decision-making in real time (Russell & Norvig 2010; Hayles 2017). From the perspective of regional development, at best, AI can launch a, "virtuous cycle of increasing employment, innovativeness, and immigration of the creative class" (Vermeulen & Psenner 2022, 1798) when local companies apply and integrate it to improve public services and decision-making through large real-time data sets (Brynjolfsson & McAfee 2014; Lazzeretti *et al.* 2023). At worst, in the AI era, we may see increasing inequality between regions and

URN:NBN:fi:tsv-oa141937
DOI: 10.11143/fennia.141937

people with and without capabilities to apply AI, job displacement, and ethical concerns such as data privacy and bias, which would eventually erode trust in knowledge economies (Clifton *et al.* 2020; Crowley & Doran 2022; Lazzeretti *et al.* 2023).

Regional development means progressive activity of developing the region towards a desired and locally shared vision, such as a sustainable, resourceful, and innovative place to live (MacKinnon *et al.* 2022). Vast empirical research shows that desirable regional development is tightly connected to successful knowledge creation, creativity, and innovation processes (Saxenian 1994; Gertler 2004; Florida 2005; Tödtling & Trippl 2005; Grillitsch & Asheim 2018); visible in theories of knowledge economies (e.g., Foray & Lundvall 1998), creative cities and industries (e.g., Florida 2005; Mellander & Florida 2021), and innovation and clusters (Delgado *et al.* 2016; Doloreux & Turkina 2021). Learning, sharing, and creating justified knowledge about AI and with AI, leveraged in creating new startups, services, products, and processes, is widely expressed in national AI strategies as central for regional development (Ministry of Economic Affairs and Employment 2017; Smart Nation Singapore 2019; Australian Government 2021).

To enable virtuous AI-related regional development and to learn from the existing examples, the questions of where, by whom, and how (there) are central (Gherhes *et al.* 2022). Regions are traditionally considered to be developed by human actors including citizens, managers, and employees of public organizations and companies. However, it is required to consider if AI that learns, decides, and interacts, also should be considered as an actor (Wingström *et al.* 2024). To consider the uneven regional development of 'where' and 'how (there)' new technologies evolve and spread, economic geography applies the key concepts of cores, clusters and peripheries (Aoyama *et al.* 2011). In short, resource-abundant cores, such as major cities, include experts, technology, knowledge, investments, companies, higher education institutions, and public organizations, which often lack in peripheries described as rural, remote, and small (Iammarino *et al.* 2019). Clusters of related companies, completed with public and education organizations, can be found both in cores and peripheries (Delgado *et al.* 2016), and they can be recognized as landscapes of technopoles and science parks (Moisio 2018). Clustering benefits from economic externalities, such as the ability to attract investors, share costs, and connect to global networks (Delgado *et al.* 2016). Being there to build trust, share tacit knowledge and create innovative knowledge are also key benefits of clusters (Nilsson & Mattes 2015; Gertler 2004). In general, skills and resources to integrate AI into organizations and regions are likely, but not necessarily, found in cores and clusters.

Geographical concentration is also an ongoing process today. In Europe, metropolitan areas grow and develop, and regional disparities have increased over the last decade (Iammarino *et al.* 2019). However, AI and digitalization with the post-COVID-19 remote work practices could challenge current cores and peripheries (Haefner & Sternberg 2020) or at least conceptually re-spatialize this narrative to move from geographical face-to-face encounters and place-based resources to digital platforms (Barns 2019).

Current AI hype is part of a long history of cycles of advancement in the development and investment in AI traditionally followed by their downturn known as "AI winters" (Floridi 2020, 1). Although it takes time to see AI's consequences to a place (Clifton *et al.* 2020), since the first national AI strategies were published around 2017, such as in Finland (Ministry of Economic Affairs and Employment 2017), there have been investments, new education, research, companies, applications, and regulation related to AI. Today, there are examples of successfully anchoring AI into regions (Doloreux & Turkina 2021; Gherhes *et al.* 2022). Thus, this current review is justified to address the calls of research about AI in regional development and economic geography (Clifton *et al.* 2020; Haefner & Sternberg 2020; Li *et al.* 2022; Lazzeretti *et al.* 2023; Zhang *et al.* 2023; Lu *et al.* 2024). I build on and deepen Lazzeretti and colleagues' (2023) 'big picture' review on AI in regional sciences that aims to identify key journals and authors and to describe the overall themes. My aim is two-fold: To review the current state and suggest next steps in research about AI-related regional development. With a systematic review of Web of Science (WoS) journals of regional development and economic geography and thematic content analysis, I answer: Where, by whom, and how is AI-related regional development taking place in the identified 37 articles about AI? To address the focus on the northern dimensions of this journal, I conclude what kind of innovation policies would support AI-related regional development in the Nordic countries.

Review methodology and design

The articles are selected 'journals first' to see how much AI is discussed in key Web of Science ((WoS) SSCI core collection) or Finland-based journals of regional development research. I selected journals with the word 'region' in the title ('region-centered') and key region-relevant journals (economic geographical, 'Rural Studies', as well as 'Cities' and 'Environment and Planning B' (EPB), in which AI is widely discussed according to Lazzeretti *et al.* 2023). This resulted in 29 journals (Figure 1).

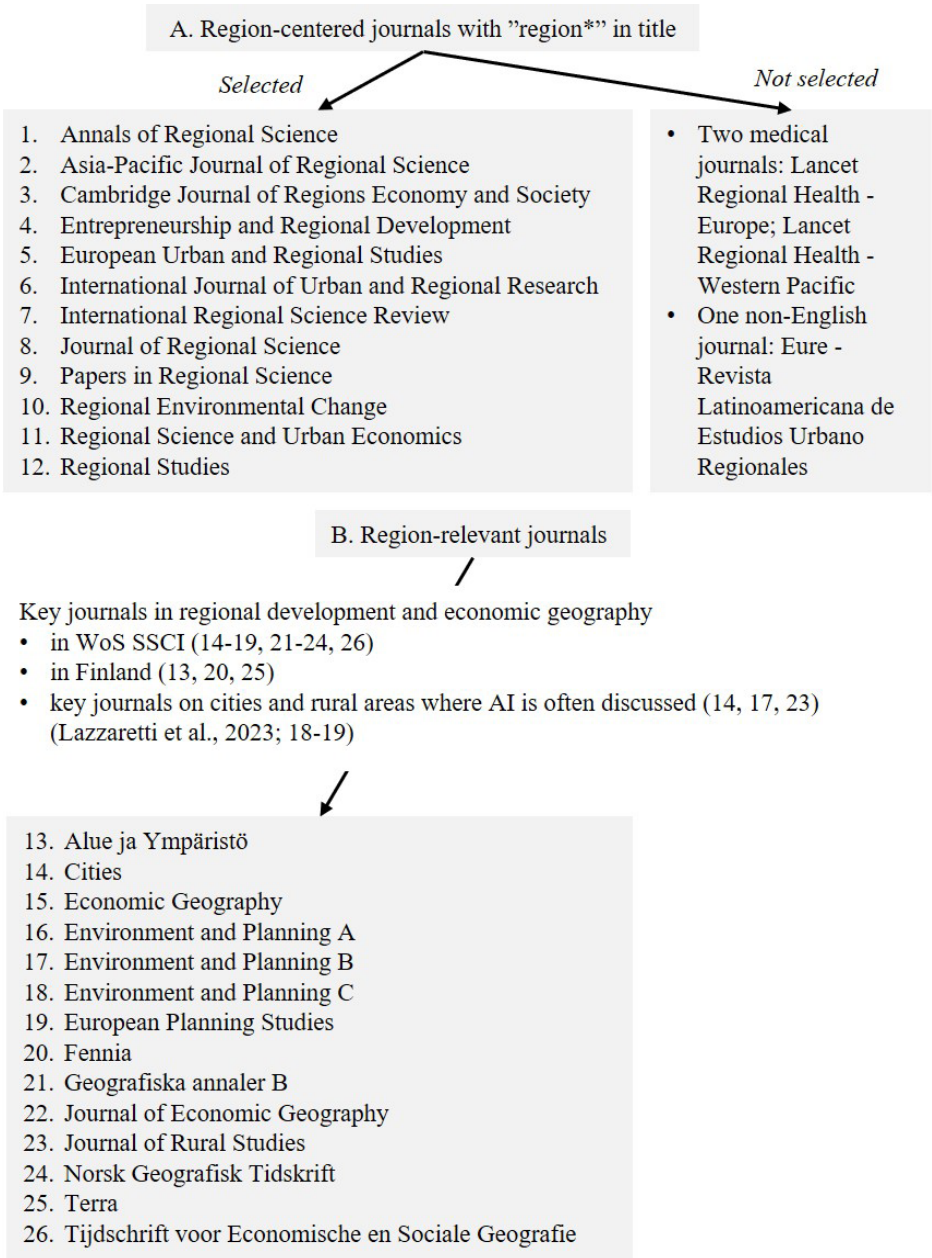

Fig. 1. Selecting the journals.

Selecting the articles from these journals included three steps (Figure 2). First, I searched the articles via SCOPUS; artificial intelligence or AI or machine learning or ML in title, abstract, or keywords. I applied English language and Finnish in the Finnish journals. In journals Cities and EPB, where AI-related articles are widely published, I selected specifically region-centered articles. Thus, I added 'and region*' in title, abstract, or keywords, which widens Lazzeretti and colleagues' (2023) careful analysis on smart cities. Altogether, 118 articles were identified. Second, I excluded articles that applied AI or ML as a tool or methodology, for instance, for spatial analysis, geoinformatics, and big data analysis (e.g., Openshaw 1992; Grekousis *et al.* 2013). This focused the set into 32 articles. Third, I completed the search through other WoS SSCI core collection journals (N=6).

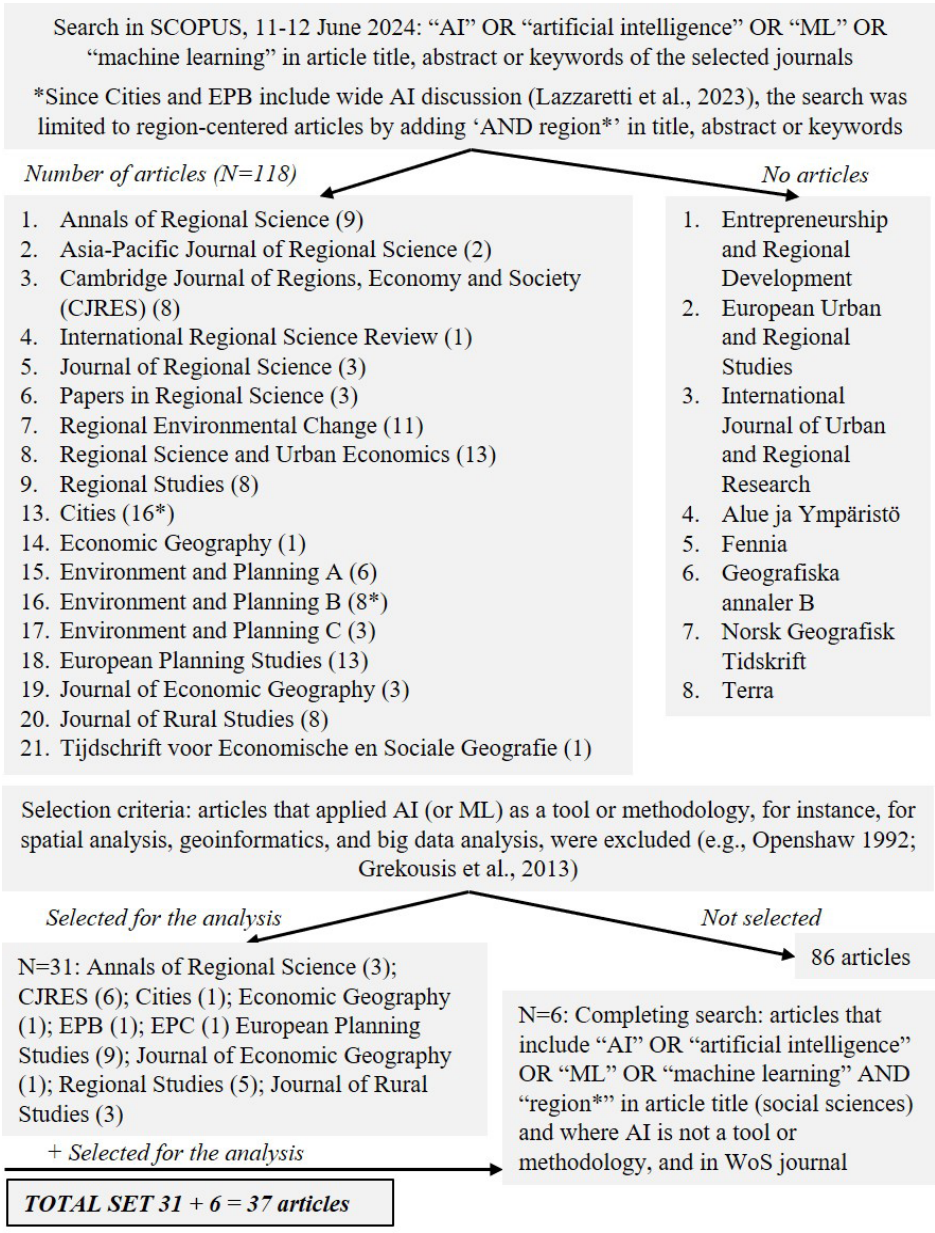

Fig. 2. Selecting the articles.

Next, I applied thematic content analysis (Nowell *et al.* 2017) (Figure 3). During the analysis, I moved between identifying and collecting the articles' necessary information, formed wider themes and revised them by reading the articles closely, and refined the themes into results with careful referencing back to articles. This review's key limitations are the rather small number of reviewed articles and the rather early timing of the review to see profound effects of AI on regional development in different parts of the world.

Step 1. Familiarize with the articles

I read the selected articles, made notes guided by the research questions, and returned to double-check searches in SCOPUS.

Step 2. Develop the codes

I created an excel file with the following information:

- Metadata: article title, year of publication, journal name, whether the article contains an empirical study (yes/no) and if yes, what is the empirical data and 'where' is the empirical case
- Content quotations about key terms (region, AI, actors, regional development, further research needs): I searched on the articles for the sentences where they discussed regions, AI, and regional development. I copy-pasted these quotations into the excel file.

Step 3. Search for themes

I read the excel file and focused on searching common themes that combine the articles and answer the research questions. I added the column 'early conclusions' to the excel file. There I added common themes, theories, and differences between the articles.

Step 4. Review the themes

I returned to reading the key articles within these themes, and added a column 'refined conclusions'. Into this column, I sketched the descriptions of the themes including references to the articles within the theme

Step 5. Name the themes and write the results

Finally, I named the themes and wrote the results as answers to the research question. The names of the themes are sub-headings of the article.

Fig. 3. How Nowell *et al.*'s (2017) five steps of thematic content analysis were applied.

Emerging regional dynamics in the AI era

Narratives of concentration and dispersion

Despite the current fast development and spread of AI, the journals include surprisingly little research, where AI or ML is in a prominent role but not a tool or method. Eight journals published no such articles (Figure 2). Moreover, the selected 37 articles were only published since 2015 and thus, date back to the beginning period of the current AI hype, which raised the need to consider AI's consequences for societies and regions — not only as a tool or method (Lazzeretti *et al.* 2023).

To answer 'where', 'by whom', and 'how', the articles demonstrate two narratives. First, the articles present a strong narrative of increasing the geographical concentration of AI application and development into technologically leading regions. The concentration narrative generally applies the concept of cluster, with virtuous regional development, and to a lesser extent, periphery, with limited regional development. The processes of attracting and anchoring AI experts and companies is the key to enable virtuous — and thus, successful — AI-related regional development. Second, the dispersion narrative challenges the cluster-dominant view and suggests we may need new place-flexible theories that consider locations of life, for example, home, work and meetings, along various places and mobilities between them. The key actors of regional development are humans, most often in leading positions in public organizations, companies — especially global platform enterprises and in the field of technology — and higher education institutions. Machine agency is seldom considered (except for Batty 2018; Clifton *et al.* 2020; Finstad *et al.* 2021).

The empirical research strategies reveal that regional development is commonly studied from pre-scientific and helicopter views of a region as an administrative and statistical unit (Paasi 2002) with quantitative materials such as patents or census data (e.g., Buargue *et al.* 2020; Crowley & Doran 2022; Xiao & Boschma 2023; Yang & Kim 2024). About half (9) of the 20 empirical articles in this set analyze quantitative data. Even though these articles contribute to identifying AI clusters and peripheries, they cannot properly consider the actors and their choices behind regional development. The other half of analyzed empirical articles consists of mostly case studies built on documents, interviews, and observation of events (e.g., Waldman-Brown 2020; Doloreux & Turkina 2021; Gherhes *et al.* 2022; Yu *et al.* 2022; Sultana *et al.* 2023). Such empirical strategy enables starting from key actors and events and from there, following the process, tracing the path, or snowballing the network without making presumptions of the region (Ibert *et al.* 2015; Sotarauta & Grillitsch 2023a).

Concentration into a technologically advanced world with superstar AI clusters

The concentration narrative is developed through research in the digitally advanced world: the United States; Canada (Waldman-Brown 2020; Lu *et al.* 2024); Europe, for example, UK, Germany, France, Finland, and Ireland (Ruohomaa *et al.* 2019; Buarque *et al.* 2020; Crowley & Doran 2022; Cicerone *et al.* 2023; Xiao & Boschma 2023), China (Li *et al.* 2022; Yu *et al.* 2022); and other key Asian countries such as the highly robotized South Korea (Yang & Kim 2024) and Vietnam (Than & Liu 2024). Silicon Valley is repeatedly mentioned as the globally leading region in AI development, even as the "cradle of digital revolution" (Lazzeretti *et al.* 2020, 1620). Four articles analyze Montréal as, "one of the most AI-intensive cities in the world" (Doloreux & Turkina 2021, 1752; Turkina *et al.* 2021; Gherhes *et al.* 2022; Sultana *et al.* 2023). AI superstar regions in Europe are mainly located in regions including big cities such as Île de France (Paris) and Oberbayern (Munich) (Buarque *et al.* 2020). Cambridge in the UK is considered a phenomenon and a smaller clone of Silicon Valley (Cooke 2017; 2018).

Cluster is the key theoretical framework for analyzing AI-related regional development. Because the global spread of AI follows, "current geographies of tech industries, higher education and personal wealth" (Clifton *et al.* 2020, 16), current high-tech clusters are expected to strengthen in the AI era. However, the concept of a cluster needs "modern conceptualization" to demonstrate the co-location of various interacting industries (Turkina *et al.* 2021, 778). Thus, the geographical boundaries of a cluster are blurring, which supports AI's adjustable nature as well as the logics and power of platform enterprises that are key actors in AI clusters. Silicon Valley is the home of global platform enterprises such as Meta, Google, and OpenAI, that have a monopoly over key social media data and have created, for instance, the widely spread ChatGPT and Dall-E. The platform economy increases the global concentration of AI development and related resources such as data, companies, funds, and experts. The platform enterprises have power to fuel and limit local AI- and data-driven industries (Doloreux & Turkina 2021; Yu *et al.* 2022). For example, Google Maps — where companies *need* to exist for customers to find them — is a, "powerful tool for observing the activity" of users and other firms (Kenney & Zysman 2020, 72).

For enabling virtuous regional development, it is important to understand how especially actors who develop AI can be attracted into a place and how the AI-related actors, knowledge, and innovation

processes can be anchored into a place. AI requires data, software, hardware, ideas, expertise, resources, and networks. Thus, regions need AI-related industry, in particular information and communication technology (ICT) (Xiao & Boschma 2023), but also, for example, green-tech expertise (Cicerone *et al.* 2023). "Regions with the most AI patents also tend to be regions where AI is most connected to the overall knowledge space" (Buarque *et al.* 2020, 117). According to Cooke (2017, 740), both Silicon Valley and Cambridge have clusters of leading research, "venture capital, incubators, business mentors and entrepreneurs". Such "cluster platforms" include areas of industry that AI systems require, for example, ICT hardware and software, and areas that apply AI to their activities, such as biotechnology, as well as supportive organizations (*ibid.*, 740). These are examples of the expressions that represent successful regional development.

Analyses of Montreal's AI cluster's successful regional path creation reveal an evolution that started decades ago through a strong ICT cluster where AI was attached and developed later "into its own social network structure" (Doloreux & Turkina 2021, 1760). Supported by the state, focused knowledge creating agency by local trailblazer star scientists and venture capitalists characterized the pre-formative phase of creating a new regional path (Gherhes *et al.* 2022). In the formative phase, the agency was deliberate, distributed, and directed to "system-building activities [...] and the anchoring of exogenous resources" (*ibid.*, 575). Doloreux and Turkina (2021, 1760) added that; "Montreal's AI industry gained momentum when firms such as Google, Facebook and others opened their AI labs in Montreal" and were embedded into the local cluster.

To imagine the regional path into near future, the critical question of jobs and growing regional polarization between superstar AI clusters and 'AI-peripheries' are considered (Vermeulen & Psenner 2022; Yang & Kim 2024). In the superstar AI-clusters, AI is developed and applied, which is expected to create a virtuous cycle (Vermeulen & Psenner 2022) that might spill over to neighboring regions, as China reported (Li *et al.* 2022). AI-related job openings also reveal strong geographical concentration, for instance, into the capital region of South Korea (Yang & Kim 2024). Regions where AI is only applied and not developed, may face "a vicious cycle of increasing unemployment, out-migration, and decreasing innovativeness" (Vermeulen & Psenner 2022, 1798). AI peripheries are "off-/de-shoring regions" where AI is not applied, but that "experience the impact" of the AI era because they are part of the transforming global production chains (*ibid.*, 1805). Regarding jobs, the expected effects are region specific (Green Leigh *et al.* 2020; Waldman-Brown 2020; Crowley & Doran 2022). In general, in the United States, robotization has created new employment at the metropolitan level (Green Leigh *et al.* 2020), and in small- and medium-sized and robotizing metalworking firms in Ohio, robots are incrementally brought to "complement rather than replace existing technologies and workers" (Waldman-Brown 2020, 99).

Potential of dispersion in the AI era

The second, less discussed (counter)narrative concerns geographical dispersion and re-organization of locations of home and work that digitalization and AI enable. I call this narrative potential because it follows the logics of AI as technology that can be applied almost anywhere and anytime with less costs for geographical dispersion (de Noronha & Vaz 2020, 2) and development potential for regions often described as remote, peripheral, and rural. The dispersion narrative can take the same place and time with concentration. Thus, in the AI era, regional dynamics are not only "a story of 'large' versus 'small' and 'leaders' versus 'laggards'— a much more complex geographical landscape is emerging" (Crowley & Doran 2022, 5). One study found that moderate AI-level regions — neither the AI cores nor AI peripheries — are good location choices for companies in the AI era (Lu *et al.* 2024). New companies arriving at "a region with a high AI-level" suffered from high costs and faced low income if settled in a low AI-level region (*ibid.*, 66).

AI clusters follow the logics of platform connectivity and carry "signs of 'de-globalization' via on-shoring of suppliers" (Cooke 2018, 1815). Therefore, Cooke (2018, 1815) calls them "post-clusters". Dispersion is supported in two ways: First, digital–social spaces and virtual realities become increasingly important spaces for existence and activity — parallel to actual locations and material–physical spaces. Second, some offshored companies require AI expertise that exists back home,

which refers to onshoring. Highly automated and remotely managed smart factories follow new types of logics of location, for example, in peripheral "warehousing hubs" with good material and digital infrastructure, where actors are not present, but can operate from a distance (Cooke 2021, 1637; see also de Noronha & Vaz 2020, 7). Such findings suggest that remote work technologies, specified expertise, and land space with good infrastructure, for example, can attract AI-related actors into peripheral regions.

Automation of work is an example of anchoring AI into regions with possible negative consequences for regional development. An interesting analysis of job automation in Ireland concludes that small towns can often take advantage of specific niche industries and thus, they can demonstrate more positive regional development than mid-sized towns can (Crowley & Dolan 2022). Otherwise, job automation is linked to the region's industrial sectors. For example, agriculture and manufacturing are "susceptible to automation", whereas mining, quarrying, arts, entertainment, and recreation are less so (Crowley & Doran 2022, 14–15). Despite the indicative role that work sectors may have for regional development, Clifton and colleagues (2020) remind that from iconic geographical analyses, we know that clusters, places, and regions have different cultures, resources, working practices, and actors with their specific agencies that have a major effect on diffusing and adopting new technologies (Saxenian 1994; Gertler 2004; Yeung 2016). For example, a case study of smart city development found that with the public sector's active role in creating a fruitful local ecosystem and selecting a suitable theme, small cities can progress efficiently towards smart cities (Ruohomaa *et al.* 2019).

Articles about automation in agriculture bring out refreshing insights about the actors and processes in AI-related regional development in rural areas. For example, immigrant and temporary agricultural workers are vulnerable because they may have challenges to "flexible-ize" themselves to meet the needs of digitalizing and automating farms (Rotz *et al.* 2019, 120). AI-boosted regional development has thus politicized effects on labor. Moreover, Finstad and colleagues (2021) call for a posthuman turn in rural studies. Their study shows how not only farmers and cows adjust to the milking robot but also the robot learns to function in the particular farm. Therefore, agencies in farming exist as human–animal–machine assemblages (*ibid.*).

Discussion and conclusions

Advancing research of regional development in the AI era

Thus far, according to the aim, I reviewed the current state of research about AI in regional development and economic geography. I answered, where, by whom, and how AI-related regional development takes place in the identified 37 articles about AI. Two observations form the key results. First, such research is young and surprisingly thin: Various journals have no articles with AI in the title, abstract or keywords, and the articles that do not consider AI as a tool or method of, for example, geoinformatics, have been published only since 2015. Second, this review reveals two main narratives of regional development in the AI era: a major narrative of concentration in technologically advanced centers and a minor narrative of dispersion. Research recognizes an increasing regional polarization into AI clusters and AI peripheries. In contrast, digitalization and advanced technologies are considered as *potential for* developing remote regions and small cities.

Next, I turn to the latter part of the aim, to suggest three steps to advance AI-related regional development research, each addressing one part of the research question: where, by whom, and how. First is the need to address critically the question of 'where' answered primarily through the concentration narrative. I suggest 'new there(s)': extending empirical research to varying and also peripheral regions and less successful cases of AI-related regional development. Theoretically, I support extending the spatial dimension to include augmented and virtual realities. Second is the need to consider AI as an actor, and thus a step towards posthuman approach is needed in regional development research. Third, following from acknowledging new there(s) and actors, I repeat an old call "from cluster to process" to understand the details of regional development processes in the AI era (Ibert *et al.* 2015, 323).

New there(s)

According to the review, much empirical research of AI-related regional development has focused on identifying and theorizing the 'success stories' of AI clusters such as in Montréal, which was studied in every fifth (4/20) empirical article (Doloreux & Turkina 2021; Turkina *et al.* 2021; Gherhes *et al.* 2022; Sultana *et al.* 2023). There is a risk of repeating a common phenomenon in economic geography (Pike *et al.* 2017) that supports constructing a strong and possibly biased concentration narrative. Scholars should critically consider how much theory can be created based on successful AI clusters and apply this theory to develop even "clones" (Cooke 2017, 740) to unique regions elsewhere. For instance, whether a region should try to attract the platform enterprises to the AI scene (Doloreux & Turkina 2021; Yu *et al.* 2022), or whether a cluster could stand out as a place where the role of platform enterprises is minimal. To challenge the concentration narrative and nuance the empirical cases, more research is needed in remote, rural, and peripheral regions, including degrowth cases (Lehtinen 2018), to develop the dispersion narrative. Moreover, research should also learn from unsuccessful attempts to leverage AI into regional development.

There is also a need to extend spatial theorization to acknowledge virtual and augmented realities. The review demonstrated that existence in digital space is critical for many companies' success (Kenney & Zysman 2020; Yu *et al.* 2022), and geographical boundaries of a cluster are blurring (Turkina *et al.* 2021). Today, clustering also takes place in cyberspace and extends "the production systems [...] out of their physical borders, thus opening new opportunities for non-central urban areas" (de Noronha & Vaz 2020, 7). However, digitalization does not simply compensate "for disadvantages in rural regions," but rather complements "agglomeration advantages" (Haefner & Sternberg 2020, 2). In the post-COVID-19 era, technologies such as telepresence robots and virtual realities as well as remote working practices enable us to create, share, and mobilize knowledge and to 'be there' in more than one place at a time. Such technologies also frame the regional developers' narrative of balanced growth in shrinking regions (Halonen 2022). New place-flexible work and life is emerging. Human and machine bodies, and various materialities connect actors and practices to a place. To understand which reasons, rhythms, and places drive clustering into temporary face-to-face meetings and longer-term location choices in the AI era, new there(s) need to be theorized and explored.

New actors

The connection between desirable regional development and successful AI-related knowledge creation, creativity, and innovation processes were prominently discussed in the reviewed articles. Creativity and knowledge creation are the same processes looked at from slightly different perspectives. Both are interactive processes in space and time, where actors create novel and valuable outcomes as part of a particular domain. Whereas knowledge emphasizes learning, justification, documentation, and repeatability (Hautala & Jauhiainen 2014), creativity emphasizes novelty and ability to think outside the box (Wingström *et al.* 2024). Whereas any creation process — even those that fail — includes knowledge creation and learning as well as likely moments when one feels creative, achieving innovation is more demanding. Innovation is still defined (Gault 2018) as a "new or significantly improved product, ... process, ... marketing method, ... method in business practices, workplace organization or external relations" (OECD 2005, paragraph 146). Thus, whereas any innovation requires knowledge creation and creativity, not all knowledge creation and creativity processes achieve innovations.

Considered further, the processes of knowledge creation, creativity, and innovation boil down to individual actors who interact, learn, know, are creative, and innovate. Therefore, understanding and facilitating these processes through individuals becomes the strategic capability of any public manager and a core research topic for economic geography and regional studies. Indeed, scholars have called for research approaches stepping from the bird's-eye view of regions 'out there' to detailed recognition of individual actors, their agencies, and interactions (Rutten 2014; Suorsa 2014; Ibert *et al.* 2015; Sotarauta & Grillitsch 2023b).

All the reviewed articles consider AI as either a desirable 'input' to reach further innovations in the region or a desirable outcome of successful innovation process and policy. With a few exceptions

(Batty 2018; Clifton *et al.* 2020; Finstad *et al.* 2021), these articles do not yet consider AI as a new actor with agency. Similar to Finstad and colleagues (2021), I call for a step towards a posthuman approach to advance AI-related regional development research. For example, the leading journals in regional development and economic geography (*Regional Studies*, *Journal of Economic Geography*, and *Economic Geography*) include zero publications with posthuman in the title, abstract, or keywords. Yet, for the first time in history (Brynjolfsson & McAfee 2014), people are now creating with AI that shares some key characteristics that we use to describe actors and their agencies. For Sotarauta and Grillitsch (2023a, 88), agency means capability to "influence the course of events" through justified actions, for example, creating knowledge and innovations and influencing regional path creation. To step further from the human/non-human binary, Hayles (2017) discusses cognizers, including humans, animals, and many technological systems, and non-cognizers, for example material forces. AI is a cognizer that can learn autonomously, make decisions, and exercise choice. Non-humans can be seen as possessing "agential qualities" as part of human-non-human assemblages (Huttunen *et al.* 2020, 206). However, Häkli (2018, 170) aptly points to a common misalignment in posthuman thought, "both to argue against human exceptionalism, and yet call for a sense of particular human (often scholarly) responsibility". In the field of regional development, the responsibility of making justified and equal knowledge-based decisions is called for. Based on empirical research, I do not consider current AI independently creative or knowledgeable, but as capable of co-agency with humans in innovation, knowledge, and creativity processes (Hautala & Jauhiainen 2023; Lundman & Nordström 2023; Nordström *et al.* 2023; Wingström *et al.* 2024). I see the recognition of AI as a potential actor and with co-agency along humans to advance responsible regional development. In this way, experts can acknowledge and critically decide on the role AI is given in the tasks and processes related to regional development, and they are also required to discuss and open up the role of AI to citizens. The idea of co-agency, where humans play the central role in terms of responsibility, supports *a step towards* a posthuman approach, similar to what Häkli (2018, 173) considers "humanised posthumanism".

Old call "from cluster to process"

The question 'how (there)' was investigated in several reviewed articles, especially through the theories of regional path dependence and new path creation that explain anchoring new related or unrelated industries to regional development processes (e.g., Doloreux & Turkina 2021; Gherhes *et al.* 2022; Cicerone *et al.* 2023; Xiao & Boschma 2023; Than & Liu 2024). 'How' is a process question that necessarily includes a time element to answer: tracing back in history, anticipating forward into future, or following the process on the go. Typically, the empirical research strategies in the reviewed articles started from the cluster and traced the path backwards. This strategy strengthens the concentration narrative. As already mentioned, empirical research outside clusters is needed to avoid the concentration bias (see 'New there(s)').

However, another and complementary research strategy is to start from the processes of creation and follow to which places they temporally attach. Such process approach applies "space as an analytical lens" of investigating the becoming of things, ideas, actors, and regions (Bathelt & Glückler 2003; Rutten & Boekema, 2012; Ibert *et al.* 2015, 323). The process approach was inspired by the calls of research of regional development and economic geography for moving from the 'helicopter perspective' to analyzing spatio-temporal processes of knowledge creation, creativity, and regional path creation via the individual actors (Rutten 2014; Ibert *et al.* 2015; Sotarauta & Grillitsch 2023a; 2023b). Similar to Wingström (2024), I repeat the old call "from cluster to process" (Ibert *et al.* 2015, 323).

The process perspective would advance research on regional development in the AI era for two reasons. First, the spatial process perspective could address new there(s) and (AI) actors in the complex geography of concentration and dispersion noted in the review (Crowley & Doran 2022). An example of conceptual contribution is the call in Turkina and colleagues' (2021) review article to re-define cluster and region: Rather than considering clusters as static geographically located agglomerations, from the process perspective, they evolve and extend in actual and virtual realities.

From the process perspective, knowledge moves geographically through actors, tools, and ideas. Creation processes stop in places through people and their interactions. Empirical research has proved peripheries to support particular phases of some creativity and knowledge-creation processes (e.g., Ojala & Hautala 2019; Power & Collins 2021). Rather than expensive core-centered infrastructure, the innovative use of technology (Dubois & Sielker 2022) and the analyses of mobile and remote work processes create an understanding of which 'flows', in which phases, and how to anchor to geographically remote but perhaps digitally centered regions.

Second, the focus on knowledge creation and creativity processes enables acknowledging the 'new theres' and 'new actors' in innovation policies. Due to the connection between regional development and innovation processes, innovation policies are key tools to support desired local and regional development via aiming to achieve innovation (Suorsa 2014; Kitson 2019). Many of the analyzed articles include messages for local policymakers. Namely, desired regional development means becoming an AI cluster, which requires good local related ICT industry and expertise as well as integrating AI into other existing industries and practices (Buargue et al. 2020; Xiao & Boschma 2023). Such a path follows smart specialization and connectivity models (Virkkala et al. 2017) by adopting AI into the local industry and practices.

I argue that for desired regional development in the AI era, we should focus on *policies of knowledge creation and creativity* rather than of innovation. Innovation policies are often outcome-oriented, which is inherent in the idea of innovations as 'implemented' (Kitson 2019). However, innovation processes are unruly and progress in sequences of encounters, stops, and setbacks (Mattsson 2007; Hautala 2015). The focus on the outcome may guide actors to ignore potential surprising seeds, the long-term view or complications regarding mobilizing and adopting innovations (Clifton et al. 2020; Scherrer 2021). Moreover, focusing on innovation as the outcome tends to prioritize economic growth over learning to create critically trustworthy knowledge and to be creative in human-AI assemblages. This choice is critical to ensure ethically sustainable and responsible regional development in knowledge societies of the AI era. The Nordic countries can make this choice as they have good AI expertise, well-functioning collaboration between public organizations, companies, and universities, and they follow policies to create responsible and ethical AI (Dexe & Franke 2020). These countries also have the opportunity to create new paths for developing rural regions via the popularity of remote work and the increasing use of virtual realities and telepresence robots that enable experiencing offices and colleagues elsewhere.

References

Aoyama, Y., Murphy, J. T., & Hanson, S. (2011) *Key Concepts in Economic Geography*. Sage, Thousand Oaks. https://doi.org/10.4135/9781446288078

Australian Government (2021) Australia's AI Action Plan [report]. https://apo.org.au/node/318137. 29.11.2023.

Barns, S. (2019) Negotiating the platform pivot. *Geography Compass* 13(9) e12464. https://doi.org/10.1111/gec3.12464

Bathelt, H. & Glückler, J. (2003) Toward a relational economic geography. *Journal of Economic Geography* 3(2) 117–144. https://doi.org/10.1093/jeg/3.2.117

Batty, M. (2018) Artificial intelligence and smart cities. *Environment and Planning B: Urban Analytics and City Science* 45(1) 3–6. https://doi.org/10.1177/2399808317751169

Brynjolfsson, E. & McAfee, A. (2014) *The Second Machine Age.* WW Norton & Company, New York.

Buarque, B., Davies, R., Hynes, R. & Kogler, D. (2020) OK Computer: the creation and integration of AI in Europe. *Cambridge Journal of Regions, Economy and Society* 13(1) 175–192. https://doi.org/10.1093/cjres/rsz023

Cicerone, G., Faggian, A., Montresor, S. & Rentocchini, F. (2023) Regional artificial intelligence and the geography of environmental technologies. *Regional Studies* 57(2) 330–343. https://doi.org/10.1080/00343404.2022.2092610

Clifton, J., Glasmeier, A. & Gray, M. (2020) When machines think for us: the consequences for work and place. *Cambridge Journal of Regions, Economy and Society* 13(1) 3–23. https://doi.org/10.1093/cjres/rsaa004

Cooke, P. (2017) 'Digital tech' and the public sector. *European Planning Studies* 25(5) 739–754. https://doi.org/10.1080/09654313.2017.1282067

Cooke, P. (2018) Generative growth with 'thin' globalization. *European Planning Studies* 26(9) 1815–1834. https://doi.org/10.1080/09654313.2017.1421908
Cooke, P. (2021) Image and reality: 'digital twins' in smart factory automotive process innovation. *Regional Studies* 55(10–11) 1630–1641. https://doi.org/10.1080/00343404.2021.1959544
Crowley, F. & Doran, J. (2022) The geography of job automation in Ireland. *The Annals of Regional Science* 71 727–745. https://doi.org/10.1007/s00168-022-01180-4
Delgado, M., Porter, M. E. & Stern, S. (2016) Defining clusters of related industries. *Journal of Economic Geography* 16(1) 1–38. https://doi.org/10.1093/jeg/lbv017
Dexe, J. & Franke, U. (2020) Nordic lights? *Journal of Cyber Policy* 5(3) 332–349. https://doi.org/10.1080/23738871.2020.1856160
Doloreux, D. & Turkina, E. (2021) New path creation in the artificial intelligence industry. *Regional Studies* 55(10-11) 1751–1763. https://doi.org/10.1080/00343404.2021.1919610
Dubois, A. & Sielker, F. (2022) Digitalization in sparsely populated areas. *Regional Studies* 56(10) 1771–1782. https://doi.org/10.1080/00343404.2022.2035707
Finstad, T., Aune, M. & Egseth, K. A. (2021) The domestication triangle. *Journal of Rural Studies* 84 211–220. https://doi.org/10.1016/j.jrurstud.2021.03.006
Florida, R. (2005) *Cities and the Creative Class*. Routledge, Oxfordshire. https://doi.org/10.4324/9780203997673
Floridi, L. (2020) AI and its new winter. *Philosophy and Technology* 33 1–3. https://doi.org/10.1007/s13347-020-00396-6
Foray, D. & Lundvall, B-Å. (1998) The knowledge-based economy: from the economics of knowledge to the learning economy. In Siesfeld T., Cefola, J. & Neef, D. (eds.) *The Economic Impact of Knowledge*, 115–121. Routledge, London. https://doi.org/10.1016/B978-0-7506-7009-8.50011-2
Gault, F. (2018) Defining and measuring innovation in all sectors of the economy. *Research Policy* 47(3) 617–622. https://doi.org/10.1016/j.respol.2018.01.007
Gertler, M. (2004) *Manufacturing Culture*. Oxford University Press, Oxford. https://doi.org/10.1093/oso/9780198233824.001.0001
Gherhes, C., Vorley, T., Vallance, P. & Brooks, C. (2022) The role of system-building agency in regional path creation. *Regional Studies* 56(4) 563–578. https://doi.org/10.1080/00343404.2021.1886273
Green Leigh, N., Kraft, B. & Lee, H. (2020) Robots, skill demand and manufacturing in US regional labour markets. *Cambridge Journal of Regions, Economy and Society* 13(1) 77–97. https://doi.org/10.1093/cjres/rsz019
Grekousis, G., Manetos, P. & Photis, Y. (2013) Modeling urban evolution using neural networks, fuzzy logic and GIS. *Cities* 30 193–203. https://doi.org/10.1016/j.cities.2012.03.006
Grillitsch, M. & Asheim, B. (2018) Place-based innovation policy for industrial diversification in regions. *European Planning Studies* 26(8) 1638–1662. https://doi.org/10.1080/09654313.2018.1484892
Grillitsch, M. & Sotarauta, M. (2020) Trinity of change agency, regional development paths and opportunity spaces. *Progress in Human Geography* 44(4) 704–723. https://doi.org/10.1177/0309132519853870
Haefner, L. & Sternberg, R. (2020) Spatial implications of digitization. *Geography Compass* 14(12) e12544. https://doi.org/10.1111/gec3.12544
Halonen, M. (2022) Multiple meanings and boundaries of growth in shrinking regions in East and North Finland. *Fennia* 200(2) 120–136. https://doi.org/10.11143/fennia.119537
Hautala, J. (2015) Interaction in the artistic knowledge creation process. *Geoforum* 65 351–362. https://doi.org/10.1016/j.geoforum.2015.01.002
Hautala, J. & Jauhiainen, J. (2014) Spatio-temporal processes of knowledge creation. *Research Policy* 43(4) 655–668. https://doi.org/10.1016/j.respol.2014.01.002
Hautala, J. & Jauhiainen, J. (2023) Co-creating knowledge with robots. *Journal of the Knowledge Economy* 14(2) 1467–1487. https://doi.org/10.1007/s13132-022-00968-1
Hayles, K. (2017) *Unthought*. University of Chicago Press, Chicago.
Huttunen, S., Salo, M., Aro, R. & Turunen, A. (2020) Environmental citizenship in geography and beyond. *Fennia* 198(1–2) 196–209. https://doi.org/10.11143/fennia.90715
Häkli, J. (2018) The subject of citizenship – can there be a posthuman civil society? *Political Geography* 67 166–175. https://doi.org/10.1016/j.polgeo.2017.08.006
Iammarino, S., Rodríguez-Pose, A. & Storper, M. (2019) Regional inequality in Europe. *Journal of Economic Geography* 19 273–298. https://doi.org/10.1093/jeg/lby021
Ibert, O., Hautala, J. & Jauhiainen, J. (2015) From cluster to process. *Geoforum* 65 323–327. https://doi.org/10.1016/j.geoforum.2015.06.023
Kenney, M. & Zysman, J. (2020) The platform economy. *Cambridge Journal of Regions, Economy and Society* 13(1) 55–76. https://doi.org/10.1093/cjres/rsaa001

Kitson, M. (2019) Innovation policy and place. *Cambridge Journal of Regions, Economy and Society* 12(2) 293–315. https://doi.org/10.1093/cjres/rsz007
Lazzeretti, L. (2020) What is the role of culture facing the digital revolution challenge? *European Planning Studies* 30(9) 1617–1637. https://doi.org/10.1080/09654313.2020.1836133
Lazzeretti, L., Innocenti, N., Nannelli, M. & Oliva, S. (2023) The emergence of artificial intelligence in the regional sciences. *European Planning Studies* 31(7) 1304–1324. https://doi.org/10.1080/09654313.2022.2101880
Lehtinen, A. (2018) Degrowth in city planning. *Fennia* 196(1) 43–57. https://doi.org/10.11143/fennia.65443
Li, B., Jiang, F., Xia, H. & Pan, J. (2022) Under the background of AI application. *Sustainability* 14(18) 11331. https://doi.org/10.3390/su141811331
Lu, R., Zheng, F., Ma, S. & Yang, R. (2024) Unpacking the inverted U-shape between regional AI and business performance. *International Journal of the Economics of Business* 31(1) 49–70. https://doi.org/10.1080/13571516.2023.2271755
Lundman, R. & Nordström, P. (2023) Creative geographies in the age of AI. *Transactions of the Institute of British Geographers* 48(3) 650–664. https://doi.org/10.1111/tran.12608
Mattsson, H. (2007) *Locating biotech innovation*. PhD Thesis. Kulturgeografiska institutionen. Uppsala universitet.
MacKinnon, D., Kempton, L., O'Brien, P., Ormerod, E., Pike, A. & Tomaney, J. (2022) Reframing urban and regional 'development' for 'left behind' places. *Cambridge Journal of Regions, Economy and Society* 15(1) 39–56. https://doi.org/10.1093/cjres/rsab034
Mellander, C. & Florida, R. (2021) The rise of skills. In Fishcer M. & Nijkamp P (eds.) *Handbook of Regional Science*, 707–719. Springer, Berlin. https://doi.org/10.1007/978-3-662-60723-7_18
Ministry of Economic Affairs and Employment (2017) Finland's age of artificial intelligence. Turning Finland into a leading country in the application of artificial intelligence. Objectives and recommendations for measures [report]. Publications of the Economic Affairs and Employment. https://julkaisut.valtioneuvosto.fi/bitstream/handle/10024/160391/TEMrap_47_2017_verkkojulkaisu.pdf. 27.09.2024.
Moisio, S. (2018) *Geopolitics of the Knowledge-based Economy.* Routledge, Oxon.
Nilsson, M. & Mattes, J. (2015) The spatiality of trust. *European Management Journal* 33(4) 230–244. https://doi.org/10.1016/j.emj.2015.01.002
Nordström, P., Lundman, R. & Hautala, J. (2023) Evolving coagency between artists and AI in the spatial cocreative process of artmaking. *Annals of the American Association of Geographers* 113(9) 2203–2218. https://doi.org/10.1080/24694452.2023.2210647
de Noronha, T. & Vaz, E. (2020) Theoretical foundations in support of small and medium towns. *Sustainability* 12(13) 5312. https://doi.org/10.3390/su12135312
Nowell, L., Norris, J., White, D. & Moules, N. (2017) Thematic analysis. *International Journal of Qualitative Methods* 16(1) 1–13. https://doi.org/10.1177/1609406917733847
OECD (2005) Oslo manual. Guidelines for collecting and interpreting innovation data 3rd ed. [report]. OECD Publishing https://www.oecd-ilibrary.org/docserver/9789264013100-en.pdf?expires=1726760430&id=id&accname=guest&checksum=F6CC6848A78D7F796871D266737B694A. 19.09.2024.
Ojala, M. & Hautala, J. (2019) Knowledge creation rhythms of a science project. *Polar Geography* 42(1) 1–17. https://doi.org/10.1080/1088937X.2018.1547328
Openshaw, S. (1992) Some suggestions concerning the development of artificial intelligence tools for spatial modelling and analysis in GIS. *The Annals of Regional Science* 26 35–51. https://doi.org/10.1007/BF01581479
Paasi, A. (2002) Place and region. *Progress in Human Geography* 26(6) 802–811. https://doi.org/10.1191/0309132502ph404pr
Pike A., Rodriguez-Pose A. & Tomaney J. (2017) *Local and Regional Development*. 2nd ed. Routledge, London. https://doi.org/10.4324/9781315767673
Power, D. & Collins, P. (2021) Peripheral visions. *Industry and Innovation* 28(9) 1150–1174. https://doi.org/10.1080/13662716.2021.1877633
Rotz, S., Gravely, E., Mosby, I., Duncan, E., Finnis, E., Horgan, M., LeBlanc, J., Martin, R., Neufeld, H., Nixon, A., Pant, L., Shalla, V. & Fraser, E. (2019) Automated pastures and the digital divide. *Journal of Rural Studies* 68 112–122. https://doi.org/10.1016/j.jrurstud.2019.01.023
Ruohomaa, H., Salminen, V. & Kunttu, I. (2019) Towards a smart city concept in small cities. *Technology Innovation Management Review* 9(9) 6–14. https://doi.org/10.22215/timreview/1264
Russell, S. & Norvig, P. (2010) Artificial Intelligence. 3rd ed. Pearson, Harlow.
Rutten, R. (2014) Learning in socio-spatial context. *Prometheus* 32(1) 67–74. https://doi.org/10.1080/08109028.2014.945291
Rutten, R. & Boekema, F. (2012) From learning region to learning in a socio-spatial context. *Regional Studies* 46(8) 981–992. https://doi.org/10.1080/00343404.2012.712679

Saxenian, A. (1994) *Regional Advantage*. Harvard University Press, Cambridge.
Scherrer, W. (2021) Industry 4.0 as a 'sudden change'. *European Planning Studies* 29(9) 1723–1737. https://doi.org/10.1080/09654313.2021.1963054
Smart Nation Singapore (2019) National artificial intelligence strategy. Advancing our smart nation journey [report]. Smart Nation Singapore. https://www.smartnation.gov.sg/nais/. 19.09.2024.
Sotarauta, M. & Grillitsch, M. (2023a) Path tracing in the study of agency and structures. *Progress in Human Geography* 47(1) 85–102. https://doi.org/10.1177/03091325221145590
Sotarauta, M. & Grillitsch, M. (2023b) Studying human agency in regional development. *Regional Studies* 57(8) 1409–1414. https://doi.org/10.1080/00343404.2023.2217224
Sultana, N., Turkina E. & Cohendet, P. (2023) The mechanisms underlying the emergence of innovation ecosystems. *European Planning Studies* 31(7) 1443–1465. https://doi.org/10.1080/09654313.2023.2185502
Suorsa, K. (2014) The concept of 'region' in research on regional innovation systems. *Norsk Geografisk Tidsskrift* 68(4) 207–215. https://doi.org/10.1080/00291951.2014.924025
Than, N. & Liu, L. (2024) (forthcoming) Artificial intelligence ambitions and regulatory pathways. *Communication Research and Practice*, 1–11.
Turkina, E., Van Assche, A. & Doloreux, D. (2021) How do firms in co-located clusters interact? *Journal of Economic Geography* 21(5) 761–782. https://doi.org/10.1093/jeg/lbaa019
Tödtling, F. & Trippl, M. (2005) One size fits all? *Research Policy* 34(8) 1203–1219. https://doi.org/10.1016/j.respol.2005.01.018
Vermeulen, B. & Psenner, E. (2022) Exploiting the technology-driven structural shift to creative work in regional catching-up. *European Planning Studies* 30(9) 1798–1823. https://doi.org/10.1080/09654313.2022.2028737
Virkkala, S., Mäenpää, A. & Mariussen, Å. (2017) A connectivity model as a potential tool for smart specialization strategies. *European Planning Studies* 25(4) 661–679. https://doi.org/10.1080/09654313.2017.1283391
Waldman-Brown, A. (2020) Redeployment or robocalypse? *Cambridge Journal of Regions, Economy and Society* 13(1) 99–115. https://doi.org/10.1093/cjres/rsz027
Wingström, R. (2024) Projects and pockets. *Geoforum* 148 103946. https://doi.org/10.1016/j.geoforum.2024.103946
Wingström, R., Hautala, J. & Lundman, R. (2024) Redefining creativity in the era of AI? *Creativity Research Journal* 36(2) 177–193. https://doi.org/10.1080/10400419.2022.2107850
Xiao, J. & Boschma, R. (2023) The emergence of artificial intelligence in European regions. *Annals of Regional Science* 71 747–773. https://doi.org/10.1007/s00168-022-01181-3
Yang, S. & Kim, D. (2024) Spatial distribution and characteristics of vulnerable occupations to artificial intelligence. *Annals of Regional Science* 72 1079–1103 https://doi.org/10.1007/s00168-023-01234-1
Yeung, H. (2016) *Strategic Coupling.* Cornell University Press, Ithaca.
Yu, Z., Liang, Z. & Xue, L. (2022) A data-driven global innovation system approach and the rise of China's artificial intelligence industry. *Regional Studies* 56(4) 619–629. https://doi.org/10.1080/00343404.2021.1954610
Zhang, Q., Webster, N., Han, S. & Ayele, W. (2023) Contextualizing the rural in digital studies. *Technology in Society* 102373. https://doi.org/10.1016/j.techsoc.2023.102373