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Spatial Aspects Concerning Economic Structures

**Johannes Glückler, Richard Shearmur,
Kirsten Martinus**

From Liability to Opportunity:
Reconceptualizing the Role
of Periphery in Innovation



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TORONTO



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Issue 2022-01 | Volume 17
www.spaces-online.com



Please quote as	Glückler, Johannes, Shearmur, Richard and Martinus, Kirsten (2022): From Liability to Opportunity: Reconceptualizing the Role of Periphery in Innovation. SPACES online, Vol.17, Issue 2022-01. Toronto and Heidelberg: www.spaces-online.com.
Authors	Johannes Glückler, Heidelberg University, Institute of Geography, Berliner Straße 48, 69120 Heidelberg, Germany. E-mail: glueckler@uni-heidelberg.de Richard Shearmur, McGill University, School of Urban Planning, 815 rue Sherbrooke Ouest, H3A 0C2 Montréal, Canada. E-mail: Richard.shearmur@McGill.ca Kirsten Martinus, The University of Western Australia, School of Social Sciences, Geography, 35 Stirling Highway, Rm 145, 6009 Perth. E-mail: Kirsten.martinus@uwa.edu.au
Keywords	Periphery, innovation, economic geography, regional development, social networks
JEL codes	O30 (Innovation, Research and Development, Technological Change, Intellectual Property Rights), R11 (Regional Economic Activity: Growth, Development, Environmental Issues, and Changes), R12 (Size and Spatial Distributions of Regional Economic Activity)

Abstract

The concept of periphery has remained implicit and ambiguous in economic geography, often characterized by normative accounts of laggardness and lack of innovation. In this paper we review discussions of the periphery in the context of the geography of innovation and unpack the logical fallacy of normative understandings of the term. Instead, we propose a *relative* definition of periphery as distant, disperse and disconnected positions within a field. We further combine geographic and network dimensions of peripherality into a dual core-periphery model to capture the complexity of geographic peripheries and centers, which each can house central and peripheral actors. An understanding of duality rather than dualism between core and periphery offers new potential to theorize the divisions and dynamics of innovation labor, which benefit from and transit between core and periphery positions in the course of the innovation journey.

Editors: Harald Bathelt, Johannes Glückler

Managing Editor: Sebastian Henn

External Advisor: Heiner Depner

ISSN: 1612-8974

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From Liability to Opportunity: Reconceptualizing the Role of Periphery in Innovation

1 Introduction

The periphery as a concept has a long history, sometimes explicitly identified (e.g. the land beyond Hadrian's wall), but more often an implicit residual category located far from urban centers of power (Eden 2013). Most recently, the periphery has played an important, but mainly implicit, role in research and policy that addresses the geography of innovation: if "*the city [is an] innovation machine*" (Florida et al. 2017), then non-cities (the periphery?) presumably are not (Shearmur 2017).

Indeed, despite research pointing to innovative activities in rural and remote communities (e.g. Lipton 1977; Sorensen 2009), mainstream stylized facts about innovation's geography describe cities and clusters as its main source (Feldman and Kogler 2010; Jacobs 1969; Knight 1995; Florida et al. 2017). Only recently have geographers acknowledged more broadly that innovation also emerges in scarcely populated and remote regions (Eder 2019; Pugh and Dubois 2021). Review papers provide an overview of the vast body of literature on the geography of innovation (Simmie 2005) and of recent interest in the periphery's role (Glückler 2014; Grabher 2018; Howells and Bessant 2012; Shearmur 2012; 2015).

Notwithstanding this body of work, the notion of periphery remains ambiguous and imprecise (Borgatti and Everett 1999; Langholm 1971; McKenzie 1977; Pugh and Dubois 2021). There are at least two dimensions of ambiguity in discussions of geographic peripheries. First, the distinction between peripheral territories and peripheral actors is rarely clarified, with actors located in territorial peripheries often assumed to be also at the periphery of networks and knowledge. Second, the periphery, whether of a territory or a network, is assumed to be an inherently disadvantaged position relative to the center: Because peripheral locations have also been peripheral to mainstream analyses of innovation dynamics and economic growth (Glaeser 2011), they have most often been articulated in the negative (Lipton 1977; Pugh and Dubois 2021). For instance, knowledge and interactions – the drivers of innovation – are often assumed to be most accessible and advanced in cities (Florida et al. 2017) as dynamic agglomeration processes are attributes of territories of certain sizes and densities (Camagni et al. 2016). Somewhat tautologically, therefore, urban areas (have) grow(n) because they are central, whilst being central because they (have) grow(n) (Krugman 1991).

In this paper, we aim to clarify the concept of periphery, focusing on innovation as a key example of how the periphery has been treated in economic geography. As a starting point, we suggest that geographic peripherality cannot be properly analyzed without making a clear distinction between *geographic* peripherality (of territories) and *network* peripherality (of actors). This allows the negativities often associated with peripherality to be reassessed as empirical possibilities rather than as defining characteristics, thereby lifting the apparent paradox of innovation in geographically peripheral areas (Eder 2018).

The framework we propose is generic in the sense that we do not discuss how it can be applied to different metrics of 'distance' and 'remoteness', nor how its implications may vary for different sets of actors and processes. Its purpose is to provide a heuristic framework allowing researchers and policy makers to more clearly think through what is meant when 'periphery' is evoked in economic geography.

The paper is structured as follows: section 2 critically reviews the literature and identifies three distinctive narratives about the relationship between periphery and innovation. In section 3, drawing on network theory, we propose a positional definition of periphery, before elaborating on the multiple dimensions of peripherality. We argue that a truly empirical research program on the role of periphery in innovation (or elsewhere) is only viable if a positional – rather than a substantive or normative – definition is adopted. Using our framework to readdress the relation between periphery and innovation in section 4, we highlight the opportunity peripheral positions (in geographic space, networks and organizational fields, etc.) offer for certain types and stages of innovation processes. We suggest that this has broader implications for how the 'periphery' is conceptualized in economic geography.

2 Three Narratives of the Nexus Between Periphery and Innovation

2.1 The 'No Innovation in the Periphery' Narrative

Broadly speaking there are three narratives characterizing the relationship between periphery and innovation (Table 1). The first narrative is presented as a stylized fact, as per Feldman and Kogler (2010), and treats the periphery almost as an antonym of innovation, where a periphery is the opposite to the core. The core has properties that facilitate the creation of knowledge, culture and technologies; the periphery has none of these, so impedes innovation. Indeed, Friedman's (1967) core-periphery model attributes knowledge and innovation to the core, and *laggardness* and *dependency* to the periphery at all geographic scales of global, national to local. Friedman explicitly defines the periphery "by its relation of dependency to the core" (p. 23), thus making its effect part of its definition.

The essential reason for innovation occurring in the core is the higher probability of information exchange there, which is absent in the periphery. These 'lack-of' approaches to peripheral laggardness draw on geographic understandings, which we loosely group into three geographic levels: those discussing global core-periphery theories, regional development theories describing regional core-periphery systems, and innovation studies focused on local contexts contrasting core and periphery locations.

Global core-periphery theories frame the core-periphery relationship underpinning much of geographic thought, include economic imperialism (Galtung 1971), *dependencia* (Palma 1978; Prebisch 1959; 1986) and world-system theory (Wallerstein 1974). All focus on the dualism between the global core and periphery to explain the magnitude and persistence of world social and economic disparities, arguing that the periphery's economic development is constrained by the core (Mabogunje 1980). One mechanism facilitating this dependence is the operation of multinational enterprises (MNEs). For instance, *dependencia* theory (Evans 1981; Moran 1978) argued that penetration of MNEs in peripheral host countries had long-term negative effects, as demonstrated by the impact of FDI stocks on economic growth and income inequality (Bornschier 1980; Chase-Dunn 1975). In the late 1970s, empirical analysis clustered all countries according to the four criteria of Galtung's theory of imperialism: underdevelopment, inequality, trade in raw materials, and feudal trade (Gidengil 1978). These core-

periphery differences emerged through mechanisms such as the ‘technological dependence syndrome’ of technology licensing (Mytelka 1978) and the redistribution of resources (profits, know-how, minerals) from resource peripheries to global core economies facilitated by governments (Tonts et al. 2013). Until the new wave of ‘thick globalization’ in the 1990s (Held et al. 1999), developing countries were usually not considered sources of new knowledge and innovation. Yet from the 2000’s, core areas in BRICS economies and the Global South have gained importance in industrial R&D and manufacturing (Crescenzi et al. 2020). Hence, scholars suggest that developed/developing binary is no longer appropriate, with inequality increasingly *within* nations rather than between them (Horner and Hulme 2017; Horner et al. 2018).

Similarly, regional development theories in economic geography draw on the seminal works of Porter’s (2000) cluster, Perroux’s (1988) growth pole and Freeman and Lundvall’s (Freeman 1995) national innovation systems models. As a result, they largely assume growth in peripheries occurs via the spillover effects of firm and worker agglomeration in core areas – the locations that provide preconditions for innovation (Simmie 2002).

Empirical research has drawn on territorial core-periphery understandings from political economy to examine the persistent under-development of industries (and agglomeration economies) in peripheries compared to the core. For example, Innis’ (1929) staples theory describes how governments and corporations of core regions extract wealth from resource peripheries, maintaining their *disadvantage* (Argent 2013; Martinus 2018a); and global production networks are drawn upon to explain how core metropolitan areas act as gateways for ‘poor’ (but resource rich) peripheries (Atienza et al. 2021).

At the local geographic scale, innovation studies focus on peripheries in relation to larger core cities that generate the clustering and connectivity needed to create innovative activity (Feldman and Kogler 2010). Eder (2019) identifies a seemingly infinite number of scarce or missing conditions in peripheries, including lack of: support infrastructure, human capital, R&D expenditure, knowledge, finance, demand, critical mass, private business, innovation networks, entrepreneurship, absorptive capacity, etc. Similarly, other scholars highlight how organizational or institutional thinness leads to the final exhaustion of regional development trajectories in peripheries (Isaksen 2015; Tödtling and Trippel 2005). Across all geographic scales, readers of economic geography could conclude that peripheries are characterized by the absence of positive core-characteristics, dependence on the core, and consequently a scarcity of innovation. Implicit in this approach is the assumption that peripheral actors are - like the peripheral regions they are located in - at the periphery of relevant networks.

2.2 The ‘Innovation Despite the Periphery’ Narrative

The second narrative examines how innovation occurs in spite of the periphery. It revolves around the inherent handicaps of the periphery and explores conditions and mechanisms that help overcome them. There are essentially three classes of argument: the role of absorptive capacity and cluster formation, the role of external connections, and the role of particular types of innovation processes.

First, a stream of research identifies peripheral regions that have managed to generate innovations via specialization and the positive externalities of clustering. Doloreux and Dionne (2007), for instance, describe how – despite the odds – La Pocatière generated the knowledge-base, absorptive capacity and local interactions necessary for a research-intensive agricultural system to develop. The region overcame its peripherality by assuming or emulating characteristics of centrality. Likewise, Maillat et al. (1994) describe territorialised

innovation networks (milieu) arising in certain regions: the Jura, a peripheral Swiss region, became and remains the heart of luxury watchmaking, developing know-how, technologies, dense local networks and institutions, as well as home-grown companies which act as curators of what constitutes a luxury watch (Jeannerat 2021). These geographic peripheries have generated endogenous dynamics, with their actors positioning themselves strategically in relevant networks.

Second, and more prominently, researchers build on the notion of peripheral disadvantage, exploring external connections, interactions and flows as sources of peripheral innovation. There are two mechanisms involved with this. One revolves around the way peripheral regions may ‘borrow size’ from core regions through long distance commuting arrangements (Martinus 2018b; Martinus et al. 2020). That is, labor from core areas increases available knowledge in otherwise highly remote peripheries. Innovative moments can also be created by temporarily gathering professionals in peripherally located research centers (Bathelt and Turi 2011; Ojala and Hautala 2019). The other mechanism relates to capacity-building leading to development of peripheral regions through connections to core. For example, Isaksen (2015) and Isaksen and Trippl (2017) discuss how laggard peripheral regions seize exogenous opportunities by renewing their development path through inflows of knowledge and investments from outside. Likewise, Nilsen (2017) describes exogenous path development in arctic regions, as multinationals locate subsidiaries there and interact with local firms. This evokes the equivocal effect of subsidiaries on peripheral regions, notably issues that emerge when, for strategic reasons, these mobile facilities relocate or close down (Massey 1985).

Third, scholars have examined innovation processes that may be specific to peripheral areas. Shearmur (2015), for instance, focuses on the time value of information and the differential conditions of information diffusion at the core and the periphery. When information value is time-sensitive, geographic proximity to markets, clients and information sources becomes important, and favors innovators closer to the core. But differential decay functions of various information types (market, technical, science) mean information with slower decay, i.e. information that retains its validity over longer periods of time, can be used by ‘slow innovators’ even if produced in distant locations. Information value also depends on place because of the contextual value of certain information and place-bound absorptive capacity (Shearmur 2015). This opens up opportunities for peripheries *qua peripheries* to succeed in (slow) innovation, including new solutions in knowledge fields less susceptible to fashions, short technological life cycles or other volatile environments (e.g. finance). It also opens possibilities for innovations specific to the periphery as contextual knowledge (and attendant know-how) combines with slow information and knowledge from elsewhere.

In essence, these ‘despite’ narratives look at factors and mechanisms that can overcome liability or deficiency of peripheries. Importantly, such research focuses on innovation activity in peripheries and pursues a scholarly interest in understanding how peripheries can reorient from their position of perceived disadvantage.

2.3 The ‘Innovation Because of the Periphery’ Narrative

Although there has been longstanding interest on peripheries by scholars focusing on innovation in agriculture, forestry and rural areas (e.g. Sorensen 2008; Lipton 1977; Makkonen et al. 2020), this research has been articulated at the margins of mainstream innovation studies. The stylized facts of innovation’s geography (cf. Feldman and Kogler 2010) – amplified by urban-based commentators, magazines and cultural producers – have

successfully transformed the connection between cities and innovation into a ‘common-sense’ that is difficult to dislodge.

Recently, however, more scholars have begun to address the periphery as a space of opportunity – beyond the traditional industries found in rural areas – rather than as a liability (Glückler 2014; Grabher 2018; Shearmur 2015; Frieman 2021). Acknowledging the differences across innovation types, this emergent narrative examines various aspects, types and stages of innovation – some of which can work better in the periphery than the center. We identify at least three concepts characterizing the periphery as an environment conducive to innovation processes: local knowledge idiosyncrasy (Glückler 2014; Shearmur 2015), controversial innovation (Glückler 2014), and the periphery as frontier (Frieman 2021).

We will return to this ‘innovation because’ narrative as effectively unpacking why the geographic periphery can be advantageous for certain types of innovation, we must revisit the concept of periphery and its heterogeneous understanding across these narratives. Only when the geographic periphery has been more clearly conceptualized, and distinguished from other types of periphery, can this narrative be fully discussed. Indeed, for this third narrative to be carried further – for it to break out of the margins of innovation theory – the apparent contradiction between periphery and innovation must be resolved.

Table 1: *Three Narratives of the Relation Between Innovation and (Geographic) Periphery*

‘No innovation’ narrative	‘Innovation despite’ narrative	‘Innovation because’ narrative
<ul style="list-style-type: none"> • <i>Dependencia</i> or world-system approaches theorize laggardness and underdevelopment as properties of the periphery (Evans 1981; Moran 1978; Chase-Dunn 1975) • Innovation happens in the core (Friedmann 1967) and only spills over to peripheries (Porter 2000; Perroux 1988; Freeman 1995) • Lack of diversity and serendipity (Jacobs 1969); lack of creative class and bohemia (Florida 2002) • Organizational and institutional thinness, e.g. lack of infrastructure, critical mass or positive externalities (Isaksen 2015; Tödtling and Trippl 2005; Zukauskaite et al. 2017) 	<ul style="list-style-type: none"> • Absorptive capacity and peripheral regional innovation system (Doloreux and Dionne 2008; Doloreux et al. 2007) • External information and linkages (Doloreux 2004; Dubois 2015; Fitjar and Rodríguez-Pose 2011; Jakobsen and Lorentzen 2015; Lagendijk and Lorentzen 2007; Martinus 2018b) • New Argonauts (Saxenian 2006; Saxenian and Sabel 2008) • Anchoring of foreign subsidiaries (Nilsen 2017), foreign workers in the periphery (Solheim 2016) • Slow innovation with an emphasis on secrecy and slow decay of information value (Shearmur 2015) 	<ul style="list-style-type: none"> • Local knowledge idiosyncrasy, e.g. place-specific discovery and knowledge (Glückler 2014; Shearmur 2015) • Organizational smallness and diversity, local information fluidity: diverse intra-organizational interaction (Glückler 2014) • Global information viscosity favors constructive probing of new and controversial innovation (Glückler 2014) • Partial disconnection and distance to the core (Glückler 2014; Grabher 2018; Rhiannon and Pugh 2021) • Effects of discourse and urban bias (Sorensen 2008; Shearmur 2017; Rhiannon and Pugh 2021)

3 Reconceptualizing the Periphery

We have so far used the term ‘periphery’ without fully discussing it. We have evoked the fact that the geographic peripherality of a territory should be distinguished from the network positionality of its actors, and that peripherality in both cases connotes distance from a core. In this section, we examine the concept in more detail, proposing a model that engages with the idea of periphery as opportunity and explores the connections between innovation and periphery.

3.1 A Positional Definition of Periphery

Though frequently left undefined or implicitly, the periphery is associated with different attributes, such as being remote or disconnected from a center, sparsely populated, marginalized from a dominant group or movement, weakly developed, with poor technologies and lack of innovation (Pugh and Dubois 2021). These attributes fail to elucidate what we mean by ‘periphery’: is it an inherent property? is it a normative/evaluative category? is it a position relative to others in a field of reference?

A decisive response needs clarification on what the *defining* characteristics of a periphery are, and what the *functions* or *outcomes* of these characteristics are. For example, the defining characteristic of a woman is an adult who identifies as female. If we further stipulate a woman is a *creative* adult who identifies as female, we face a problem because non-creative adults who identify as female would not be women. The same applies to periphery. If, for example, we define a periphery as a non-innovative (or dependent) remote location, then an innovative (or independent) periphery would either be a conceptual contradiction or no longer a periphery. Of course, no one has explicitly defined peripheries as non-innovative (though they have defined them as dependent). But, non-innovation is implied by assumptions that innovation requires the attributes of core regions: density, clustering and intense interactions (Florida et al. 2017; Friedman 1967; Glaeser 2011; Feldman and Kogler 2010).

From this perspective, research on innovative geographic peripheries would be ill-specified because a periphery, by definition, cannot possess the core attributes necessary for innovation. More insidiously, approaches to innovation accepting that peripheries can be innovative also raise questions on how to define a periphery, but then often identify peripheries as remote from the core without specifying the defining characteristics of that core. This returns us to the key question: how can periphery be defined so as to not conflate its characteristic (as periphery or core) with particular outcomes (e.g. innovation, growth, dependence, power, etc.)?

Furthermore, if we understand periphery as an *inherent quality*, it will be almost impossible to change. However, if we conceive periphery as a *relative concept*, any territory, technology or actor can transit between central and peripheral positions within a given field. Because actors as well as places can occupy core as well as peripheral positions, we need to find substantive characteristics that define these positions whilst, at the same time, allowing for dynamic transition between them. Even though a territory, unlike an actor, cannot change its geographic coordinates, its state as a periphery is not an inherent property but rather a position of spatial relation. For instance, places at the cold-war border between West and East Germany were peripheral in their respective countries, becoming more central after reunification in 1990. Likewise, certain Canadian regions, peripheral before highways were built, have been absorbed into metropolitan spheres as transport has become easier and more direct (Polèse and Shearmur 2002).

From our perspective, the defining characteristic of a periphery is one of relative position: if a periphery denotes a position in a field, then innovation, dependence or prosperity are not part of its definition, but possible outcomes. This requires defining a peripheral 'position' in a chosen field: only then are we able to explore and theorize the empirical relation between this position and certain outcomes within the chosen field, such as innovation or dependence). We draw on three basic concepts of network analysis to define the criteria characterizing a peripheral position within a field: *distance*, *dispersion* and *disconnection*. These are illustrated in Figure 1 and described below.

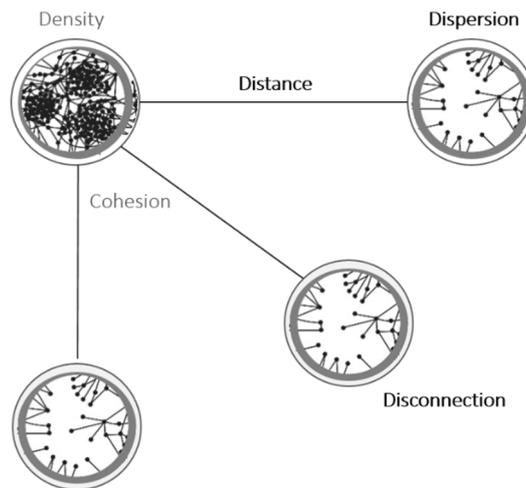


Figure 1: *A Positional Definition of Periphery*

Distance. The periphery is remote from the core (and vice versa). According to the Oxford Dictionary, the term periphery refers to the 'the outer edge of a particular area' and thus entails distance. The criterion to separate core from periphery used in geography has principally been access and geographic distance (Malecki 1991). Empirically, geographic distance from global core economies (often simply measured as distance in km across the globe, sometimes weighted by transport cost or time) has been statistically associated with level of economic development (Leamer and Storper 2001). And, gravity models of trade suggest trading volume between any two countries is proportional to the product of their GDPs divided by the geographic distance between them, which Leamer (2007) states is "*possibly the only important finding that has fully withstood the scrutiny of time and the onslaught of econometric technique*" (p. 110). Gravity models of trade therefore relate the lack of economic development with notions of geographic remoteness which is qualified as periphery. Accepting this empirical regularity, we must be careful about concepts and causality: while peripheries are remote from the core, the core is equally remote from the periphery. Hence, distance is not a *sufficient* definition of periphery: additional defining characteristics are needed.

Dispersion. We define periphery as a position that is not only remote from a core, but characterized by internal dispersion (i.e. low internal cohesion and interrelation between elements in the field), the core being a position of high internal density. Density is the proportion of realized relations amongst total potential relations with other elements of a system. For instance, if the field is a road network linking towns in regions in Germany, a

region's density would be measured as the proportion of realized direct links between towns within the region – irrespective of the length of these links. This criterion distinguishes core and periphery from each other and draws on the concept of sparse internal cohesion from network theory (Borgatti and Everett 1999). Thus, within the geographic field, a periphery will be characterized by fewer realized interconnections (typically transport and communications) between places than exist in the geographic core. Within a social field, a peripheral actor will have fewer realized interactions or relations with other actors than a more central actor. Although the combination of dispersion and distance enable us to distinguish the core and periphery, we cannot yet specify their interrelation in a system of interdependence. Therefore, we again borrow from network theory to introduce a third criterion.

Disconnection. We conceive core and periphery as being interrelated as follows. The core region is a group of elements that is more internally cohesive and externally interconnected with all other elements in the field than any periphery: a peripheral region is internally sparse and only loosely connected to the core and to other elements in the field (Borgatti and Everett 1999). This general understanding of the core-periphery relationship is not necessarily geographic, because it focuses on internal cohesion and external connectivity. The basic approach is to identify core elements in a given field (i.e. those that maximize density of connections). Peripheral elements are those areas of the field with the least network density, being disconnected from each other and only sparsely connected to the network core.

A simple measure to assess a peripheral position is topological farness (Christley et al. 2005). It is the sum of the shortest path lengths from one element to all other elements in a network. Farness is a consequence of sparse connection with other parts of the network. Instead of using multiple direct linkages to access different regions of a network, far elements use the same few bridging relations to reach all other elements over long paths of contacts. Similar to the empirical regularity observed for geographic distance and prosperity, topologically far elements have been shown to be less innovative, experience inferior performance and receive less pecuniary rewards in organizations (e.g. Burt 2004; Owen-Smith and Powell 2004; Tsai 2001). Farness and sparse connectivity are elements of peripheral integration in a network of relations.

In economic geography, an ambiguity persists regarding which elements and fields are being discussed. A geographically peripheral region connects to other regions by infrastructure, flows of goods and information, and by relations of coordination and exchange that move across the geographic field. Yet, a peripheral region is also composed of actors connected to other actors in multiple social networks, where all individuals are positioned and occupy positions of greater or lesser peripherality. A peripheral position is a distant, dispersed, and disconnected position in one non-divisible field. This abstraction offers the advantage of projecting the notion of periphery into different dimensions, such as the geographical, social, political, economic, cultural, etc., depending on the research question and on the underlying metrics of dispersion, distance and disconnection.

3.2 A Dual Core-Periphery Model

We build on the above definition of periphery to conceptualize a dual core-periphery model, incorporating the above criteria and reducing the multiple dimensions to two fundamental ones: geography and actor networks. We cross-tabulate these two dimensions to allow four possible positions to emerge. Each actor and each territory can be placed in the same analytical space (Figure 2).

First, *C-C positions* refer to central actors in central places, or to central places that house central actors. This includes, for example, corporate headquarters located in national administrative or government centers (e.g. Beijing or Washington); global cities (e.g. New York City) that house multinational financial corporations.

Second, *C-P positions* refer to central actors in peripheral places, or to peripheral places that house central actors. They include, for example, global mining company headquarters in resource-rich peripheral regions (e.g. BHP global headquarters in Perth, Western Australia); peripheral regions that house elite research institutions, e.g. the marine industrial complex in Ny-Alesund in the Arctic (Ojala and Hautala 2019).

Third, *P-P positions* refer to peripheral actors in peripheral places and include, for example, small low-tech business support firms in remote regions; peripheral regions with low value-added agricultural activities servicing local rather than national and global markets.

Fourth, *P-C positions* refer to peripheral actors in central places, or to central places that house peripheral actors. For example, small food-processing firms located in metropolitan regions yet positioned in marginal market positions. Certain major cities in developing countries also occupy P-C positions: they are at the core of geographic transport networks, yet actors within them are often at the periphery of global networks of power and economic flows.

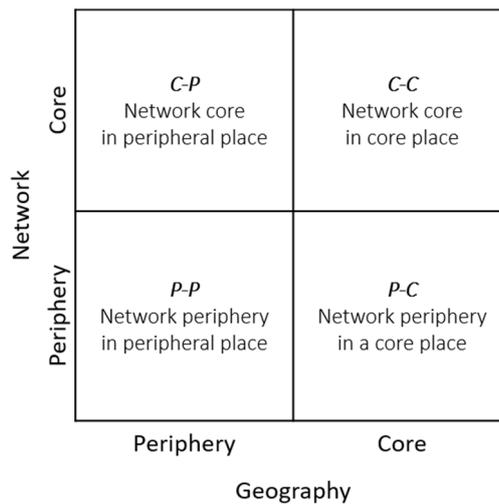


Figure 2: A Dual Core-Periphery Model

Note: The dichotomized core-periphery axes summarize continua. Only the extremities (core and periphery) of each continuum are shown to simplify and clarify the discussion.

Much economic geography research has focused the *C-C* to *P-P* diagonal, effectively conflating the positions of actors with that of the territories they are in (e.g. Feldman and Kogler 2010). In periods of slow communication and travel, this approximation was empirically justified (Pred 1973): but the decreasing homology between geographically-structured and communications-structured networks (Bathelt and Turi 2011) means the

approximation can no longer be relied upon, as evidenced by the geographic dispersal of knowledge workers during the COVID crisis.

This may explain why recent work on innovation in peripheral areas has begun to recognize that *C-P* positions exist, and that *P-P* positions are not necessarily antithetical to innovation. The *P-C* position is common, but rarely remarked upon in innovation studies: many firms in metropolitan areas cater to localized clients, provide banal goods and services, and are not central to any network. Likewise, many individuals in cities are isolated (Saenz 2005). Our matrix in Figure 2 also draws attention to opportunities that emerge by strategically choosing these positions. Actors in *C-C* positions might want to place activities in *C-P* positions to develop innovations in protected and opaque environments. Likewise, firms in *P-P* positions may want to place activities in *P-C* positions to raise product awareness, attract talent or identify resources for marketing.

The matrix reflects a conceptualization that allows a continuum of all core and periphery possibilities, both geographic and across networks that actors are positioned in. It would be almost impossible to specify a general core-periphery model which captures the multiple scales (geography) and scopes (multiplex networks) that can be envisaged of an actor-based field. These scales are continuous and not necessarily hierarchical (Marston et al. 2005). In line with calls for relational research in human geography (Glückler and Panitz 2021), determining the relevant field as well as its elements, networks and scales must be tailored to the particular empirical context, whilst retaining the key distinction between geographic peripherality and network peripherality within a focal field. These could be, but are not necessarily, correlated (i.e. lying along the *P-P* to *C-C* diagonal).

4 Innovation and the Duality of Core-Periphery Relations

Our model allows us to treat innovation as an empirical outcome rather than a defining quality of a position - be it core or periphery. Furthermore, the scattered research on innovation in geographical peripheries, as well as the more abundant research on innovation in clusters and agglomerations, can be understood and analyzed using the concepts and vocabulary we propose. This section reframes discussions of innovation in geography using the model, returning to the emerging ‘innovation because of periphery’ narrative evoked at the end of section 2.

4.1 Segmentation Into Types of Innovation

Because we distinguish innovation from position (geographic or network), there is no necessary connection between centrality and innovation: therefore, new questions can be articulated, such as: what types of innovation benefit from a *C-C* position, and what types of innovation may require other positions? A related question concerns what types of innovation are possible in each position.

Shearmur (2015), for instance, argues that slow innovation is possible in all positions: however, it dominates in the geographic periphery because fast innovation is only possible in *C-C* locations. His arguments are agnostic about the positionality of actors. He suggests that some innovation in the geographic periphery occurs in the *C-P* position, where some establishments in this periphery entertain strategic connections with outside

interlocutors (see also Grillitsch and Nilsson 2015); and some in the *P-P* position, where establishments located in peripheral places essentially rely on local knowledge specific to peripheral network positions.

Other research has shown that the *C-P* position can be important for ‘controversial’ innovation (Glückler 2014; Krackhardt 1997), i.e. innovation that overcomes or circumvents resistance because the geographic periphery sufficiently disconnects innovators from a resistant majority and from the pressure to conform that can emerge in *C-C* locations. In this case, one needs to distinguish between multinational subsidiaries as establishments, which occupy a geographically disconnected position, yet an organizationally central one (*C-P*), from individuals who work there who may additionally be socially disconnected from colleagues elsewhere in the company (*P-P* position).

4.2 Specialization in Stages of Innovation

Another question that arises from empirical research is whether cities internalize the innovation process as a whole or whether there is space for an interdependent division of labor in the innovation process across different places. A two-stage model of innovation (Shearmur 2015) suggests that in the first stage, an entrepreneur or organization introduces an innovation, which in the second stage, requires the finance, maturity and marketing necessary to diffuse it widely in the market. Whereas the first stage can occur from any position, the second stage is more likely to happen in *C-C* (and maybe *P-C*) positions.

There is empirical evidence of such a division of innovation labor at different levels or scales, such as at the organizational level. Re-assessing IBM’s enduring resistance to the Virtual Machine developed and promoted in its own geographic and organizational periphery (*P-P*), Schoenberger (1999) argues that corporate change often requires geographic and organizational separation from the center. However, although Schoenberger acknowledges some advantage of peripherality in breeding novel ideas, she expects the center to usually turn down these ideas and thus prevent innovation. To be accepted at large scale, an innovations’ promoters require network centrality (*C-C* or *C-P* position). Glückler (2014) evidences a case of corporate resistance to an internal innovation and analyzes how an organizational unit in a *P-P* position managed to successfully convey the value of a ‘controversial innovation’. The innovation became a globally used business model across the entire multinational corporation, and so ran through a *C-C* position of global headquarters before being broadly implemented.

Divisions of innovation labor that are coupled with core-periphery relations can also be found at the level of organizational fields. Recent research in the creative industries suggests *C-C* positions are less crucial for creating than for marketing new content. Empirical research on the business of stock photography, for example, evidences how digital technology has supported creative professionals and firms to increasingly locate outside metropolitan regions, towards *C-P* or even *P-P* positions, to create new content and build original collections and products (Glückler and Panitz 2016). This decentralization has spurred a new division of labor, in which lead firms remain in the cities (*C-C*) to collect and market the products and to canvass and maintain contractual relations with their client base. In addition, Norcliffe and Rendace (2003) have made the case for new geographical models of creative labor in the comic book industry, where the so-called neo-artisans enjoy the discretion to work remotely from *C-P* and *P-P* positions and deliver their creative content, stories, illustrations, graphics, colorings, etc. for digital assembly and marketing by publishers in *C-C* positions.

The organizational problem of transiting through these stages to attain a *P-C* or a *C-C* position necessary for successful diffusion can be solved in many ways (Shearmur 2015): an organization may relocate to the metropolitan area to seek network centrality by first acquiring geographic centrality, hoping to move from *P-P*, through *P-C* towards *C-C*; it may remain in its initial geographic location and open branches for marketing and growing the product in the urban core; it may outsource the business to partners in metropolitan areas so the firm externally acquires the network centrality of metropolitan partners, moving from *P-P* to *P-C*; or it may sell the local business to an outside investor who uses own resources to market the new innovation. In the latter case, the innovation is ceded to an entity in a *P-C*, but more likely in a *C-C*, position.

4.3 Periphery as an Opportunity for Innovation

Can the periphery be an advantage for innovation, or do innovators in the periphery simply overcome the inherent disadvantages of geographic and/or network disconnection? Our model makes no assumptions: innovative activity is not constrained *a priori* to any particular position in a field, but empirical analysis may reveal it is. Despite the stylized fact that innovation requires *C-C* positions (Feldman and Kogler 2010), firm-level innovativeness has been shown to be only weakly associated with locational variation between the urban core and the periphery (Grillitsch et al. 2013; Shearmur 2011). The link between innovation and *C-C* appears when certain types of data are used or when they are interpreted in certain ways (Shearmur 2017), as well as being the position from which innovation is most often studied and written about. The weakness of the tie between innovation and geographic position is partly attributable to firms' internal capacities playing a larger role in innovation than external conditions or regional environment (Beugelsdijk 2007; McAdam et al. 2004; Pfirrmann 1994). Moreover, in many studies, innovation is reduced to tangible indicators such as patents, which fail to capture other roles in - and types of - innovation, such as organizational, marketing, design and service innovations (Glückler 2017). It is therefore necessary to explore whether *all* kinds of innovation require a *C-C* position characterized by dynamic agglomeration externalities (McCann 2007), which is beyond the scope of this paper.

There are many examples of how peripheral positions can be sources of or contexts for innovation. From an archaeological perspective, Frieman (2021) argues that geographical remoteness "*provides freedom from dominant trends, fashions and compulsions¹ as well as from baked-in or path-dependent expectations of well-known processes and their presumed results*" (p. 170). Innovation, then, can be an outcome of the periphery's characteristics, i.e. of geographic and/or social disconnection (Glückler 2014). Gibson et al. (2010), for instance, reveal how the *P-P* position of artists and craftspeople in the town of Darwin relative to Australia's core metropolitan regions and influential cultural networks is not perceived as *P-P* by the incumbents. On the contrary, artists see Darwin as a place of confluence between settler and aboriginal cultures: the periphery, in this sense, is a liminal space, a frontier "*where people with different cultures, ways of life, technologies and beliefs come into contact and co-exist*" (Frieman 2021: 123).

These observations resonate with controlled experiments reported by Borgatti et al. (2009) which reveal that star-structured networks, i.e. networks with both cores and peripheries, do better in solving problems than circle-structures. Although, mathematically, a circular structure should do better (because it maximizes

¹ a quote from Gibson et al. 2010, p. 31

interconnections), it is the division of labor between peripheral and central actors that best selects a solution and diffuses it to all (Bavelas 1950): the periphery can accentuate originality, which the core can consolidate. Likewise, the principle of peripheral dominance suggests that peripheries play a key role for controversial innovation: *“It is more likely that a change will be adopted throughout the organization if the adopters occupy a cluster that is at the periphery and has relatively few bridges to the organization than if they occupy a position at the center of the organization’s structure”* (McGrath and Krackhardt 2003: 330). Similarly, it has been shown that institutional transformations often originate at the fringe of organizational fields (Leblebici et al. 1991).

Two key elements emerge from these examples. First, *P-P* positions can be beneficial for certain types of innovation. This does not mean that the *C-C* and other positions cannot also be beneficial, but calls into question the ‘city as innovation machine’. Second, whether or not a position is peripheral depends on the viewer: Gibson et al.’s (2010) interviewees perceive their location as central to their creative endeavors even though others may locate them peripherally. There are therefore multiple fields to which the model in Figure 2 can apply: the Darwin example shows that, however peripheral an actor or a territory may be in certain fields, it may be close to the core in others.

Thus, the dual core-periphery periphery model (Figure 2) should be applied in two stages. First, researchers need to identify the field relevant to the topic under study. Depending on the research question and the logics of connectivity and location, the field may expand across different geographic scales and multiple network scopes. Depending on how a field is determined, actors may be closer or further from the center of a network and will occupy a geographic location closer to or further away from core places. Second, once the relevant dimensions, scales and scopes of a field have been identified, the actors under study can be positioned as central or peripheral in the dual core-periphery model.

The simple two-dimensional space depicted in Figure 2 can of course expand to n dimensions, as the multiple fields within which each territory and actor can be positioned are taken into account. However, for geographic analysis of a specific domain (such as a specific type of innovation, a specific organization), distinguishing the geographic dimension from the network dimension may be sufficient to clarify discussion and analysis. Thus, for instance, distinguishing geographically dispersed workers (each being geographically isolated in their homes) from the organizations they work for (fields structured by specific information flows, hierarchies and power structures) can be a useful starting point to unpack the geography of economic activity during COVID.

These examples show that innovation is not necessarily connected to either center or periphery: however, it remains an open question whether it is possible to innovate if one is peripherally located in *all* relevant fields. Likewise, it is open to debate whether it is possible to innovate if one is centrally located in *all* relevant fields. Whereas total peripherality suggests complete disconnection, insufficient inputs for innovation and incapacity to diffuse it, total centrality suggests high costs to maintain multiple networks, issues with norm conformity, and restricted access to sources of originality. The research questions that our model open up lie in the complex space between centrality and peripherality.

5 Conclusion

The question of centers and peripheries in geography has often been implicit, as in the bulk of innovation studies, but has also sometimes been made explicit, as in world-system and regional development theory. There is a perennial issue with the definition of center and periphery in all geographic discussions (Pugh and Dubois 2021). Not only do these terms carry normative connotations, their very definition has often been elaborated by elites who consider themselves central (Frieman 2021). A self-reinforcing narrative emerges whereby peripheries are defined as those places which elites show little interest in, making it difficult -within work on the geography of innovation - to disentangle the concept of 'periphery' from that of 'non-innovation' (Shearmur 2017).

We have responded to this conceptual gap by proposing a definition periphery as a position rather than as an ontological or normative entity. As a position of distance, dispersion and disconnection, the periphery offers specific opportunities for innovation rather than only liabilities. The relation between periphery and innovation thus remains empirically open and worth studying. By proposing a dual core-periphery model, we offer vocabulary and concepts particularly useful for discussing the geography of innovation - and, indeed, of economic activity more broadly) - which involves both geographic places and actors.

A position depends on the definition of a field. The dual core-periphery model resonates with a relational perspective (Massey 2005; Glückler and Panitz 2021) and locates agency in a two-dimensional field of geography and network connectivity. Such an organizational perspective may contribute to a more productive understanding of the role of geographic peripheries in innovation because it includes strategic opportunities for actors to choose and transit between positions in the innovation process: actors can (i) rewire to core/peripheral network positions in peripheral or central places (Panitz and Glückler 2017), and (ii) move or relocate to peripheral/core places while maintaining core or peripheral network positions to best support their innovation journeys (Shearmur 2015; Hautala and Jauhiainen 2019).

Whilst our discussion has focused upon innovation, this is because it is one of the principal current examples of how the concepts of center and periphery are used in economic geography (Pugh and Dubois 2021). Our main contribution, however, is to offer a relational understanding and a conceptual vocabulary that encourages more nuanced theorizing of the relationships between social and economic activities on the one hand, and cores and peripheries on the other, across time and fields of enquiry.

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