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Forms of Innovation and the Core-Periphery Divide: (Non-) Technological Innovation and Geo-Remoteness in Israel

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ABSTRACT

Scholarly interest in innovation in the periphery has recently grown, along with the prevalence of studies investigating different forms of innovation. Given the relative paucity of research in these fields, this study aims to examine the probability of technological and non-technological innovation in peripheral areas, compared to core regions. Drawing on a sample of over 3800 Israeli firms, we analyzed how their peripheral geographic location impacts their chances to innovate, in comparison to firms in Israel's core regions. The results showed that the probabilities to technologically innovate in most of the defined peripheries significantly exceed the probabilities in the core. Those probabilities decrease with the region's increasing peripherality. Peripheral firms that do tend to technologically innovate were found to be deeply embedded in their region's economy. Unlike technological innovation, peripheries' non-technological innovation activity was found to benefit from urban agglomerations that endow local economies with an (technological) innovative buzz. The results have policy implications for the promotion of regional economic growth.

1 | Introduction

The literature on innovation in peripheries has increased in recent years (Glückler, Shearmur, and Martinus 2023), along with the prevalence of studies exploring different forms of innovation (Vu et al. 2022). Innovation is a multidimensional concept that includes both technological and non-technological forms, like organizational innovation dealing with administrative and marketing strategies (OECD 2005). The combination of both forms of innovation positively impacts business performance (Seböck et al. 2022; Bodlaj, Kadic-Magljalic, and Vida 2020) and regional competitiveness (Jeannerat and Crevoisier 2011). However, the literature on the spatial determinants of non-technological innovation, and how they differ

from those of technological innovation, especially within lagging regions, has thus far been limited. Given this, the current study aims to examine the probability of technological and non-technological innovation occurring in peripheral areas, compared to core regions.

Peripheries, or lagging regions are often described as “...deficient places with a fundamental lack of those quintessential urban qualities that fuel innovation” (Grabher 2018, 1786). Remoteness is characterized by low population density and aging populations (Jauhiainen and Moilanen 2012) that lead to reduced economic dynamism, namely, a dearth of organizations and institutions that support a thriving economy, a lack of academic establishments, brain drain of highly qualified human capital, and weakly

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developed local networks (de Noni, Orsia, and Belussib 2018). Other viewpoints caution against characterizing the periphery as merely lacking adequate internal resources (Nilsen, Grillitsch, and Hauge 2023; Pugh and Dubois 2021), and advise against confusing statistical patterns (such as economic and demographic decline) with the existence or lack of particular types of individuals (such as innovators) (Grabher 2018). Rather, they perceive the core and periphery as existing in a relational sequence, interconnected, and by no means reduced to a static dualism (Glückler, Shearmur, and Martinus 2023); the “lagging” is relative (Meili and Shearmur 2019), and not all peripheries are the same (Phelp 2012). Peripheries’ meanings, definitions and characteristics may thus differ within various national, cultural and infrastructural contexts. In some instances, remoteness may even contribute to diversity (Meili and Shearmur 2019), where marginality can be an important asset for creativity (Grabher 2018, 1788), providing a higher quality of life that may be desirable to certain employees, with the potential to advance innovation (Rupasingha and Marré 2020).

In light of this new perspective, the current study tackles three research questions: (a) Do firms in the periphery innovate (technologically and non-technologically) more, less or differently from those located in a core region? (b) How does remoteness from the core impact on the likelihood and characteristics of these innovations? (c) How do the factors that determine the ability to innovate (technologically and non-technologically) in core areas and peripheries vary between these two spatial contexts?

To this end, logistic models were operationalized, utilizing data from Israel’s Innovation in Business Sector surveys (Innovation Surveys). Here, Israel’s periphery was typologized into several sub-regions using the notions of individual affluence, distance (from the core), ethnic makeup, and level of urbanization. Relying on a comparison between the main core regions of Israel and the defined peripheries, the study explored whether all of Israel’s peripheral regions behave similarly from an innovation - technological and non-technological - perspective.

In this respect, the study contributes to literature on the geography of innovation in three distinct ways. First, we push the boundaries of knowledge on innovation in lagging regions, which has received little scholarly attention. While some studies have analyzed innovation from a comparative perspective (e.g., Rodríguez-Pose and Wilkie 2019; Fagerberg, Feldman, and Srholec 2014), few studies explored the factors that contribute to technological or non-technological innovation in lagging spatial contexts. Second, by focusing on the less familiar Israeli case study, our paper sets out to widen the scope of research in innovation geography, which has been mostly conducted in Europe and North America (Eder 2019). Finally, our research is focused on company-based informants, which is in line with a previous study of innovation in peripheral regions whose authors suggested the specific study of peripheral firms and related factors as one of further research options (e.g., Zarebski, Czerwińska-Jaśkiewicz, and Klonowska-Matynia 2022; Shearmur and Doloreux 2022; McAdam, Reid, and Shevlin 2014).

2 | Theoretical Background

2.1 | Basic Definitions of Peripheral Geography and Innovation Prospects

Since power is ultimately what separates “core” from “periphery” (Legendijk and Lorentzen 2007), it is manifested in a nebulous definition of periphery. Here, words like “remote,” “non-core,” and “lagging regions” are used (Pugh and Dubois 2021) to generally describe “...deficient places with a fundamental lack of those quintessential urban qualities that fuel innovation” (Grabher 2018, 1786). In line with Pugh and Dubois (2021), we consider the periphery both remote and lagging, thus including “non-core” and “less-preferred” territories, like distant mountains, remote post-industrial cities, and left-behind regions (Lang 2012; Bürgin and Mayer 2020). Remoteness is characterized by low population density and aging populations (Jauhiainen and Moilanen 2012), which lead to reduced economic dynamism. Sometimes, peripherality (remoteness and lagging) also includes urban periphery, which is riddled with deep and severe inequalities (e.g., Holston 2009), and was recently linked to social, cultural, or economic network peripherality (Glückler, Shearmur, and Martinus 2023). In such cases, both urban and rural areas suffer from a lack of organizations and institutions that sustain a vibrant economy, scarcity of academic institutions, a brain drain of highly educated people, and frequently underdeveloped local networks (de Noni, Orsia, and Belussib 2018).

Historically, the spatial literature that conceptualized innovation, in the context of the inherent tension between the core and the periphery, has placed particular emphasis on how geographical clusters and territorial agglomerations are common places for innovative ideas to emerge (Storper 1997). Large urban centers provide easier access to potential network partners, as well as to related job markets and distinctive qualities (Diez and Berger 2005; Agrawal et al. 2014), like improved finance, commercial services, institutions, public goods, and skilled individuals (Porter 2000). Firms located within a geographic cluster benefit from a heightened degree of access to novel technologies and operational opportunities, and thus experience accelerated growth and enhanced levels of innovation, in comparison to companies that operate in (peripheries’) isolation (Beaudry and Breschi 2000; Aldieri, Makkonen, and Vinci 2021).

Peripheries are less likely to flourish (than larger, more central, and more institutionally dense regions). Due to the absence of the advantages mentioned above (Ženka, Pavlik, and Slach 2017), peripheral areas are likely to see limited social mobility, as innovation plays a crucial role in fostering sustainable economic growth (Aghion and Griffith 2022; Aghion and Jaravel 2015). Conversely, innovation-led growth is associated with higher levels of income disparity (Aghion et al. 2019), thus increasing spatial inequalities, as diffusion of innovation to peripheral regions is limited by geographical distance (Beaudry and Breschi 2000; Aldieri, Makkonen, and Vinci 2021). It is also commonly believed that even if peripheries or laggard places house innovative businesses, their impact on local development and growth is often undetermined (Shearmur and Doloreux 2022).

Although institutionally underdeveloped regions have the potential to leverage external resources to foster local development processes (Morgan 2019), they often struggle to do so (Marques and Morgan 2021). One of the reasons for this outcome is that innovators in areas with limited institutional support, particularly those located far from major markets, are more likely to actively search for favorable conditions for outer expansion, which in turn hampers local growth (Shearmur 2015).

Peripheries' inferiority is thus durable, and innovation development strategies to remove place-based barriers in terms of human and social capital, local leadership, and networking assistance, are seemingly for the most part ineffective (Zarębski, Czerwińska-Jaśkiewicz, and Klonowska-Matynia 2022).

2.2 | The New Geography of Peripheries' Innovation

Over the last quarter of a century, several studies have presented new perspectives on peripheries' possibilities for innovation given their geography. A growing body of research has put forth the idea that firms in peripheries may actually benefit from their remoteness thanks to their access to resources (such as space, specific fauna, testing grounds, and local culture) that are unavailable in urban centers (Glückler, Shearmur, and Martinus 2023; Grabher 2018). Overarching, however, peripheral firms seem to be innovating through different processes than those of urban firms. For example, several processes assumed to be exclusively urban may occur in rural areas. McPherson, Smith-Lovin, and Cook (2001) imply that encountering new ideas and diversity is also possible in peripheral locations, since they are frequently multi-cultural, and the remoteness may bring together individuals who, in metropolitan settings, would have been inclined to seek out like-minded individuals. Additionally, there are claims that the lack of resources in the periphery (e.g., a vibrant environment and scientific research) necessitates effective internal organization (Grillitsch and Nilsson 2015; Isaksen and Karlsen 2016) and strategic efforts for innovation by firms (Copus, Skuras, and Tseggenidi 2008).¹

Recent literature also describes different modes of innovation in the periphery compared to core regions. Shearmur (2015) for example indicated how innovation processes in more isolated areas rely less on market connections, and more on technical knowledge, local information, and know-how. Firms as such will tend to focus on the combination of already existing knowledge and problem-solving skills. As a result, businesses may have a propensity there to rely on their own internal resources and be more "introverted" (Malecki and Poehling 1999).

Shearmur (2017) also indicates how innovators in isolated locations may require more technical or scientific information, which does not lose value rapidly. Shearmur (2015) identifies those peripheral actors with such knowledge advantages as "slow innovators," that is, actors that are less focused on fast-changing market information and less dependent on frequent interactions (i.e., fast innovators). This may give the impression that they are less likely to rely on the STI knowledge base (Jensen et al. 2007), and more likely to target unique

opportunities that require expertise that can only be utilized locally or in marginal economic domains (e.g., rural markets). Sorensen (2011), for example, corroborates such assertions by indicating that firms located outside of core regions may have better knowledge of issues relevant for industries and agrarian activities, found in remote regions, which are less likely to be relevant for core regions (Shearmur 2015).²

A recent paper by Makkonen et al. (2020) indicates that the "slowness" of peripheral innovation, which relies on internal capacities, local resources, and technical information, is advantageous to businesses. Due to the relative isolation of peripheral firms, innovations may well flourish in more traditional sectors, and be less dependent on R&D activities (Eder 2019; Shearmur and Doloreux 2016).

2.2.1 | Sources of Innovation

The literature on innovation in the periphery often focuses on the sources of knowledge used by remote firms to achieve innovation. This endeavor of the "local buzz and global pipelines" (Storper and Venables 2004) aspect highlights the importance of a network of collaborations within and across organizational boundaries, which is discussed in business model innovation literature (Massa and Tucci 2014; Teece 2010). The boundary issue of a firm in a model created around innovation, becomes a salient matter (Foss and Stieglitz 2015; Leih, Linden, and Teece 2015). Literature suggests that periphery enterprises may need this more than core ones (Eder 2019). Due to their minimal options for interactions (e.g., by participating in scientific research or cooperating with others) that could yield new ideas, firms in remote regions utilize external linkages that compensate for their relative isolation and may create new growth paths from a regional perspective (Tripple et al. 2018; Rodriguez-Pose and Fitjar 2013; Jensen et al. 2007; Dinis 2006).

While external connections are crucial to access the newest research, specialist service providers, and market expertise, the empirical data is not as obvious as this may seem (Eder 2019). The internet, for example, enables isolated entrepreneurs to remain informed, target specific interlocutors, and establish contact with sources of information, collaboration and markets (Grabher and Ibert 2014; Bathelt and Turi 2011). Recently, Martinus, Suzuki, and Bossaghzadeh (2020) and Martinus (2018) even suggested that long commutes benefit innovators in peripheral areas by allowing them to leverage the resources and opportunities available in core regions, hence facilitating the progress of peripheral innovation.

2.2.2 | Firm size

Connections to extra-regional players can help innovative SMEs in the periphery (Eder 2019). Larger firms have greater internal resources to develop endowments, while SMEs might need to build upon those resources that are available regionally (Eder and Tripple 2019). Peripheries' SMEs may be compelled to be adaptable and more innovative to survive (North and Smallbone 2000). Arguments in this context imply that the potential

creativity that comes with marginality (Grabher 2018; Karlsson and Olsson 1998) can benefit SMEs.

2.2.3 | Geo-Proximity

Accessibility and geographical closeness may also affect extra-regional network growth (Copus and Skuras 2006), as differences between peripheries (e.g., peri-urban, intermediate rural areas or very remote peripheries) could be crucial for innovative activity (Makkonen et al. 2020). Inter-regional exchanges may be affected by the ability of a firm in a remote region to collaborate with firms from highly innovative (knowledge-intensive) regions (de Noni, Orsia, and Belussib 2018; Martinus 2018). Collaborations between geographically distant companies, thus, may enhance the exchange of knowledge and foster creativity (Bathelt, Malmberg, and Maskell 2004; Bathelt and Cohendet 2014).

But as a region's remoteness increases, its firms' ability to rely on its closest neighbors as sources of knowledge that could compensate for the region's economic and organizational thinness decreases (Rodríguez-Pose and Wilkie 2019). For example, García-Cortijo, Castillo-Valero, and Carrasco (2019) concluded that firms situated in peri-urban areas, or closer to urban areas (intermediate rural areas), in Spain were more innovative than distant firms. Hjaltadottir et al. (2020) demonstrated how urban and/non-border regions were more successful at inter-regional innovation than rural and border regions. Hjaltadottir et al. found, however, that rural border regions engage in inter-regional cooperation with their immediate neighbors across the border, thereby compensating for the negative border effect.

2.3 | Forms of Innovation and the Geography of Core and Periphery

The abundant literature on innovation historically emphasized technological contributions that are spatially directed towards major urban agglomeration (Breau, Kogler, and Bolton 2014). Technological innovation was referred to as the discovery and development of new technology, resulting from investment in Research and Development (R&D) (Godin 2008). Just as R&D can be a hands-on experiment that is not necessarily related to a high-tech project led by research (Jensen et al. 2007), so does successful technological innovation not preclude other innovative strategies (Scaringella 2017).

The Oslo Manual (OECD 2005) provides a comprehensive description of various forms of innovation beyond the technological, and definitions of *marketing* and *organizational* innovative activities. *Organizational innovation* was described as "the implementation of a new method in the commercial practices of the firm's organization, the organization of the workplace or the external relations" (Acuna-Opazo and Castillo-Vergara 2018, 3). *Marketing innovation* was defined as "the implementation of a new commercialization method that implies significant changes in the product design or in the packaging, as possibly in the product placement, promotion of the product or of its price" (Acuna-Opazo and Castillo-Vergara 2018, 3). Dinis (2006) notes

that the success of any innovation depends on its marketing orientation, while the European commission (2003) emphasizes how the "fast follower", who adopts the innovative design that grabs the international market, and not necessarily the "early [technological] adopter", contributes economically. Non-technological types of innovation can thus be crucial for a firm's survival (den and Hertog 2000), as the research on business model innovation shows, illustrating how a firm's commercialization strategy is central to the success of a technological breakthrough, as well as an effective organizational structure that increases the potential benefits of that innovation (Leih, Linden, and Teece 2015). Van de Ven (1993) acknowledged that the "inter-organizational community ... is necessary to develop and commercialize a technological innovation" (p. 214).

By technological innovation, we mean the creation of what Jensen et al. (2007) identify as the codified scientific knowledge, namely Science, Technology and Innovation (STI) mode, as well as the doing, using and interacting (DUI) mode, that focuses on informal processes of learning and experience-based expertise. Asheim, Boschma, and Cooke (2011) additionally proposed the distinction between three knowledge bases: (a) analytical: science-based innovation. (b) synthetic: engineering-based innovation (c) symbolic: oriented towards the arts-based mode of innovation. While the first and third types tend to settle in denser urban agglomerations with rich social-cultural amenities and scientific anchors, the synthetic base is potentially active in both core and remote areas. Furthermore, it appears that while innovations that have a scientific or engineering basis are inclined to be technological in nature, one cannot exclude the possibility that organizational and marketing innovations might also be supported by science and technology, whereas symbolic innovations can be either technological or non-technological. Few researchers have thus far examined which knowledge base best fits a spatial innovation form. Nevertheless, a small but growing corpus of research has recognized how innovation happens in peripheries and borderlands (e.g. Lagendijk and Lorentzen 2007; Grillitsch and Nilsson 2015; Shearmur 2015).

2.4 | Unsolved Conundrum: The Dominance of Core or Periphery in Supporting Innovation Forms

Mainstream economic-geography research illustrates the effect of spatial factors on encouraging or inhibiting (non-) technological innovation by providing some (albeit scant) pieces of evidence in support of that effect. Eder (2019) and Dinis (2006) for example, noted how entrepreneurs in peripheral regions may face more challenges (compared to core regions) in technological innovation, due to lower business densities and the ensuing slower processes of diffusion and adoption (including the use of information technologies). Additionally, and concomitantly, Mas-Verdú, Ortiz-Miranda, and García-Álvarez-Coque (2016) claim that this does not in itself constitute a barrier to organizational innovation in rural areas in European countries. However, as Mas-Verdú et al. point out, the interaction between various market participants is essential for fostering non-technological innovation, such as organizational innovation, which has a greater probability of happening in geographic clusters and territorial agglomerations.

Consequently, places such as innovative milieus (or RISs and learning regions³), and more recently entrepreneurial ecosystems (Schafer 2021), may be more advantageous for non-technological innovation than those located in peripheries. Firms that innovate non-technologically are more likely to do better in large or dense than in peripheries (Zukauskaitė, Tripl, and Plechero 2017). Innovative milieus advance less-formalized, ad hoc processes such as learning, contacts with clients and tacit knowledge (Aboal and Garda 2016). Management and marketing services, for example, make-up a critical component for business expansion, and therefore (non-technological) innovation in these fields (by fast innovators) is likely to flourish in a milieu of frequent interactions (Shearmur and Doloreux 2016). In contrast, as Shearmur and Doloreux (2019) indicate, non-technological innovators in remote regions tend to be more formal (i.e., subcontracting), and less spontaneous (direct, face-to-face) in their collaborations.

2.4.1 | Firm Size and Economic Branch

Since not every company introduces innovations of the same kind, or at the same rate, the sector in which it operates affects the kind of innovation a company achieves (Alba, García Álvarez-Coque, and Mas-Verdú 2013; García Alvarez-Coque, López-García Usach, and Sánchez García 2013). For instance, whereas manufacturing organizations are more likely to focus on technological innovation, service businesses are more likely to innovate in the realm of organization (Tether 2003). Evidence concerning business size and knowledge bases can also indicate what would stimulate each type of innovation in various locations. Large firms that maintain their headquarters and R&D functions within cities, and their manufacturing establishments beyond metropolitan fringes, may benefit from abundant resources, which enable them to maintain linkages to other firms (Phelps, Fallon, and Williams 2001). These industrial manufacturers, when located (relatively) far from the core, despite their scarce “learning infrastructures” or limited knowledge of cutting-edge technology, may potentially stimulate innovation (Santner 2018) by excelling in synthetic knowledge bases (Asheim, Boschma, and Cooke 2011), led by engineering-based knowledge focused on problem-solving (Eder 2019).

From the perspective of SMEs and start-ups, a structured size limitation exists regarding their ability to overcome locational challenges (Eder and Tripl 2019). Thus, as Álvarez-Coque, Mas-Verdú, and Roig-Tierno (2017) showed, collaboration among SMEs and public and private R&D benefits both types of innovation, in varying regional contexts. As financially constrained organizations, however, SMEs may prioritize non-technological innovation, according to Bodlaj, Kadic-Magljalic, and Vida (2020), as it has a greater potential to improve business performance. Halpern (2010), in his discussion of venture size and innovation types, notes that major airports have a greater degree of innovation compared to small airports, and that marketing innovation had a substantial favorable influence on airports' marketing performance in the context of peripheral airports in Europe.

2.4.2 | Education

Human capital is important in our context, with the research stressing how technology-driven activities tend to cluster in areas with high levels of human capital (Afonso 2012). Concurrently, Álvarez-Coque, Mas-Verdú, and Roig-Tierno (2017) discovered that in regions with less non-technologically innovative activities, a lack of tertiary education can be compensated for by increased non-technological expenditure. Skilled labor may be essential to promote organizational innovation in peripheries such as rural regions (Mas-Verdú, Ortiz-Miranda, and García-Álvarez-Coque 2016). Mas-Verdú et al. indicate how in regions with low levels of tertiary education, the combination of a high level of collaboration among SMEs and public investment in R&D enabled high rates of organizational innovation.

3 | Research Hypotheses

The current study sets two initial hypotheses, exploratory in nature, which follow possible directions implied in the literature:

Hypothesis 1. *There is a positive relationship between a region's peripherality, and the chance that innovators will develop a place-based technological innovation there.*

Theoretical rational: A firm's technological innovation reflects an internal evolution that is adapted to its region's conditions and local contexts. Since knowledge in peripheral regions is locally based, and attuned to local needs, it is exclusive to the area, and less applicable elsewhere (Shearmur 2015; Cooke 2011).

Hypothesis 2. *Non-technological innovation is expected to flourish as the level of peripherality of a region decreases.*

Theoretical rational: Non-technological innovation is contingent on regional endowments that ensue from less formalized and ad hoc processes (Aboal and Garda 2016). Non-technological innovators perform better in placed-based buzzes (Zukauskaitė, Tripl, and Plechero 2017). Reducing such endowment, accordingly, is expected to reduce the chances for non-technological innovation.

To test the hypotheses, the paper concentrates on Israel, and its core regions and periphery.

4 | Methods

4.1 | Israel—Innovation, Regional Structure and Core-Periphery Gaps

In the past 2 decades, Israel became a vibrant, innovative economy (Frenkel and Maital 2014). Israel, a nation of 8.5 million people (2016–7) is often described as the start-up nation (Senor and Singer 2011). This status is supported by the country's defense industries and its strong scientific and technological base (e.g.

research universities) (Frenkel and Maital 2014; Breznitz and Ornston 2013).

Although small (with an area that totals 20,000 km²), Israel has developed unevenly (Zehavi and Breznitz 2017), divided between a highly desirable, rich, and densely populated core, and a sparsely developed and poor periphery. There are infrastructural, ideological, and historical explanations for these disparities, which are also related to the inequalities between Jews and Arabs, who disproportionately reside in the peripheral areas in the north and the south of the country (Tzfadia and Yacobi 2011). Israel's regionality is displayed in the Peripherality Index in Figure 1, a measurement produced by Israel's Central Bureau of Statistics.⁴

From an administrative perspective, Israel's 20,000 km² is divided into six districts, which are further divided into 15 sub-

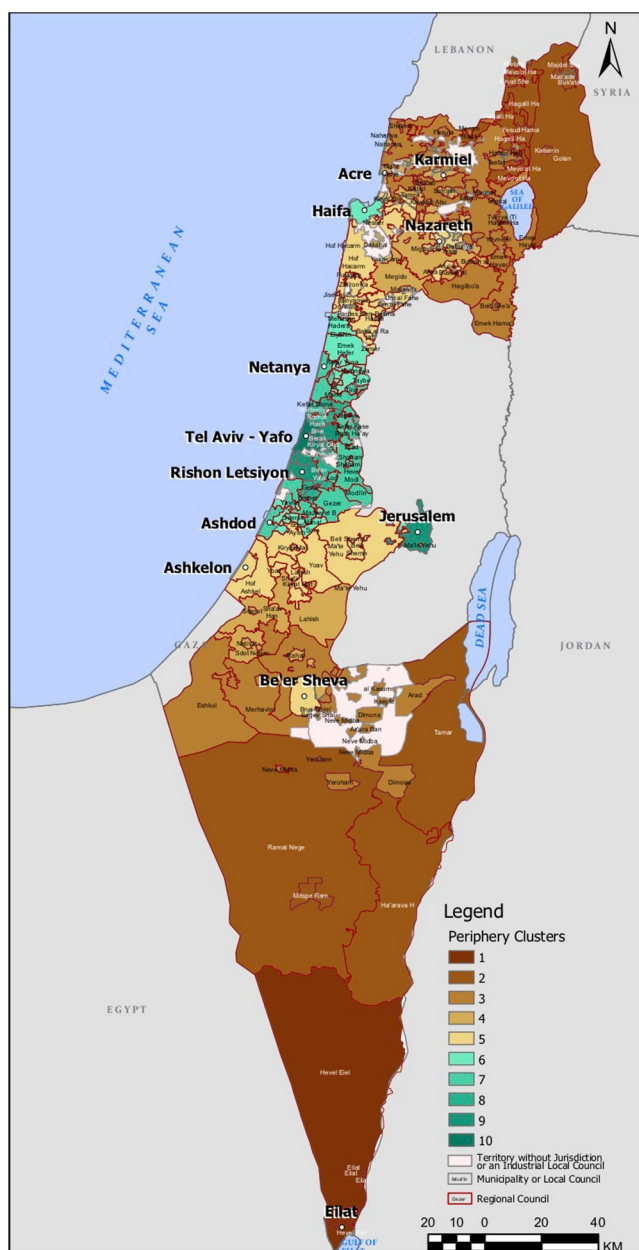


FIGURE 1 | Israel's division by peripheral clusters.

districts.⁵ The city of Tel-Aviv is the main urban center of the country. The city, along with a few other smaller centers, forms the Greater Tel-Aviv area (the Tel-Aviv district), which has a population of 1.4 million, concentrated in a highly dense area of 170 km² (2017). The Central district surrounds the Tel-Aviv district, and has a population of about 2.1 million people (2017). The district is mostly urban and is spread over an area almost eight times larger than that of Tel Aviv. Both districts, Tel Aviv and Central, comprise the central core region of Israel (Razin and Charney 2015). Additionally, two smaller and less wealthy urban cores, the Haifa and Jerusalem districts, conjointly constitute Israel's core region as defined in the current study. The Jerusalem district includes the capital city, Haifa's includes the city of Haifa, a de-industrialized city that hosts one of Israel's major seaports.

The periphery includes all of Israel's Northern District. The fact that the district's limits are Israel's politically hostile northern borders with no access to neighboring countries, exacerbates the region's economic deprivation. The Negev desert in southern Israel encompasses most of the second lagging region in the country. It is a sparsely inhabited region, with the city of Beer-Sheba as the largest urban center. Beer-Sheba, with population of about 207,000 (2016–17), is surrounded by small urban centers.

Though disadvantaged, the country's lagging regions experienced growth in innovative activity, such as the emergence of technology companies or an increase in R&D investments in more traditional industries (Shefer and Frenkel 2013; Frenkel et al. 2001). Such developments were supported by governmental policies that aimed to promote innovation, especially technological innovation (Zehavi and Breznitz 2017). As far as research, the existing body of knowledge concerning innovation in Israel presents a technologically oriented discourse. This discourse extends to both the supply and demand sides, encompassing economic actors and their location choices, as well as the state's innovation policy at the regional level. Within this context, the non-technological innovation being investigated in Israel's regional and economic study is negligible, and therefore enigmatic.⁶

4.2 | Data Sources, Variables and Analysis

In testing the hypotheses, the paper draws on data from the 'Innovation in Business Sector Surveys' that were carried out by the Israeli Central Bureau of Statistics (CBS). The surveys were conducted twice, in 2006–2008 and in 2010–2012, and focused on the sampling of the business unit ("establishment") in various locations. The surveys are based on the Community Innovation Surveys (CIS) of the OECD and EUROSTAT. Much like the Israeli ones, these surveys are designed to overcome the difficulty of sampling non-technological activity. The CISs and the Israeli 'Innovation in Business Sector Surveys' upon which we relied on scrutinize non-technological aspects of innovation, relying on firms' self-reporting. To this end, each sampled firm was asked whether it performed any technological and non-technological innovations. Based on the surveys' outcomes, we were able to generate two samples. One data set consisting of

firms that preformed technological innovation (in product/process), compared to those who did not, and a second dataset of firms that preformed non-technological innovation (in organization/marketing), compared to those who did not.

The questionnaire also included questions on the components of innovation (collaborations, implementation, competitiveness, barriers and motives, etc.). Both surveys succeeded in obtaining response rates of above 90% (CBS 2015, 2012).

Despite the apparent success, the sampling method used still struggled to represent remote areas, in Europe for example, where (i.e., CISs), the sampling relied on the representation of industries and sectors, but not regions (Eurostat 2014). The same challenge arose in the Israeli surveys, where the sampling focused on business activity. The firms sampled were from all economic branches of the Israeli business sector (only firms with 10 or more staffed positions were sampled). Due to the absence of regional sampling, the sample was fairly skewed toward the country's core. Considering this, and since most of the questions in both samples' questionnaires were identical, we were able to merge both surveys into two combined databases, one that sets 3858 observations, utilized to measure technological innovation, and the second comprising 3854 observations to measure non-technological innovation. The combined databases also allowed the merging of several sub-districts, or where possible, natural areas⁷ and cities, into new amalgamations, as illustrated in Figure 2. Thus, we were able to increase the number of firms representing the periphery in Israel (in comparison to the inherent bias in the country's core), while also dividing them into sub-regions representative of the periphery. This enabled us to define a large enough sample of observations for each sub-region, for use in data analysis. Table 1 delineates those new subdivisions and places the regions on a continuum between a low and high degree of peripherality. This determination is based on a qualitative evaluation of the variables listed in the table: level of peripherality, socioeconomic status, dominating urban form, and ethnic makeup.

The new continuum of peripherality aligns with recent studies on peripheries and remoteness that consider characteristics beyond the geographic distance from a country's core (e.g., Pugh and Dubois 2021). Rather, they place locations on a continuum encompassing cultural, political and societal contexts that provide varying qualities of infrastructure conducive to entrepreneurial ecosystems (Spigel 2017, 50). The study's depiction of peripherality offers a satisfactory representation of regions' (non-) urbanity (cities, peri-urban, non-urban, etc.), social class (middle class, working class, etc.) and ethnicity (i.e., Arab and Jewish); namely, key dimensions that manifest the peripheries' diversity and relative buzz that may encourage or inhibit innovative activity in smaller cities, fringe or isolated areas (Shearmur 2017). Table 2 elaborates on some of the (new) regions' characteristics, in comparison to the defined core.

4.3 | Model Specification

In order to test the hypotheses, and based on the surveys' variables, binary logistic regression models were employed. Those

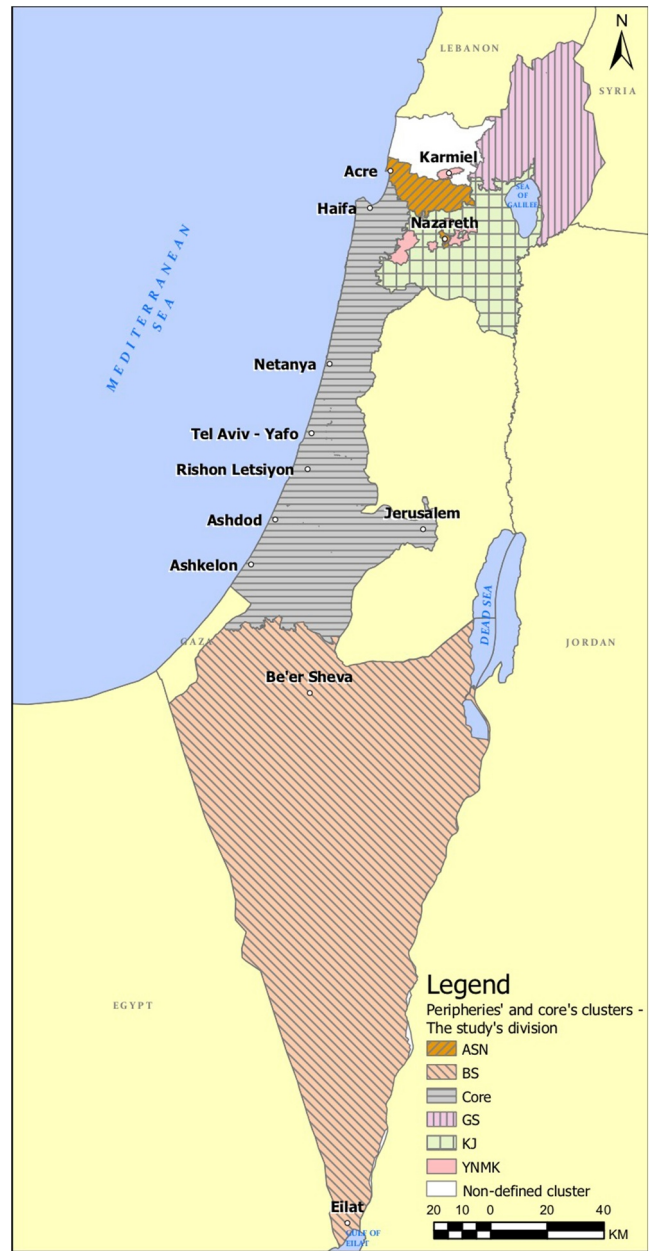


FIGURE 2 | Israel's new division to core and periphery.

models assume that a given company chooses a single alternative out of two, where the chosen alternative gets a value of 1, whereas the other receives a value of 0. The dependent variable in the models represents the likelihood to innovate (technologically⁸ and non-technologically⁹). Based on the insights from the literature review, several key factors, spatial and non-spatial, which influence this probability, have been defined and specified in the following regression model:

$$C_n = \alpha + \beta \text{GeoCluster}_n + \Omega \text{EcoAct}_n + \theta \text{InovSrc}_n + \sigma \text{Chara_Time}_n + \varepsilon_n \quad (1)$$

where C_n is the log odds ratio of a firm n to choose to perform an innovation activity. *GeoCluster* indicates the geographic location of firm n ¹⁰ *EcoAct* denotes the economic branch within which a firm n operates, including industrial firms (distinguished by their

TABLE 1 | Israel's lagging regions division into new clusters.

Acronym (variable code)	Ethnic-cultural distribution			Average socio-economic cluster ^a	Average periphery cluster ^b	Dominant urban form	Descriptive summary of the regions' characteristics and their degree of peripherality (DoP)
	Jews	Arabs	Others				
CORE	83%	13%	4%	100%	6	7	Urban The heart of the Israeli economy, which is mostly located on Tel Aviv and the inner reaches of the central district. It is home to the lion's share (71%) of Israel's population. Most of the core is Jewish and urban. Despite its economic diversity, the wealth centers of Israel's elite are concentrated in its various regions.
BS (BEER_SHEVA) ^c	59%	35%	6%	100%	4	3	Urban and peri-urban The farthest part of the southern district. Most of the economic activity is concentrated around the city of Beer-Sheba, whereas the vast territory south of the city is sparsely populated and characterized by a low level of economic activity. Most of the region is inhabited with both Jews (60%), and Arabs (35%), many of whom are economically weak. DoP: High
YNMK (YOKNEAM_AREA) ^c	84%	7%	9%	100%	6	4.8	Urban Located in the northern district, the cluster contains members of the urban Jewish middle-class (84%) in the Western Galilee. The region benefits from good accessibility to the metropolitan region of Haifa (and for the Yokneam area, good access to the Tel-Aviv region). DoP: Low
ASN (AKO_NTZRAT) ^c	13%	86%	1%	100%	2.9	4	Urban and peri-urban Located in the northern district, the cluster predominantly represents an urban Arab population (86% of its population), mostly of the lower-middle class, concentrated in the cities of Acre, Shefa'Amr, and Nazareth. DoP: High
KJ (KINERET_IZRAEL) ^c	48%	48%	4%	100%	4.2	3.9	Peri-urban and rural Located in the northern district, the cluster mostly represents rural communities in the lower Galilee and the Jezreel valley. The region comprises evenly of both Jews (48%) and Arabs (48%), with variegated levels of economic wealth. DoP: Medium

(Continues)

TABLE 1 | (Continued)

Acronym (variable code)	Ethnic-cultural distribution			Average socio-economic cluster ^a	Average peripherality cluster ^b	Dominant urban form	Descriptive summary of the regions' characteristics and their degree of peripherality (DoP)
	Jews	Arabs	Others				
GS (GOLAN_TZFAT) ^c	74%	23%	3%	100%	2.4	Peri-urban and rural	The far eastern segment of the northern district, that congregate four mountainous regional councils: Golan, Upper Galilee, Mevo'ot Hermon and Merom-Hagailil ³ , conjointly with three urban small-medium settlements in Safed, Kiryat-Shmona and Katzrin, and the Druze communities in the Golan Heights. Most of the region is populated by deprived and not privileged Jews (74%), and small portion of Arab population (23%). DoP: High

Note: Regional councils are one of the three tiers in Israel's local government, congregating number of rural settlements that are spread over a relatively large area (Israel and Frenkel 2015). The Socio-economic index is defined by the Central Bureau of Statistics in Israel. The index, based on cluster analysis that considers various social and economic variables, presents a socio-economic rating of the population among 255 municipalities in the country. The socio-economic index is calculated as a continuous number and allows comparison between one municipality and another. The index defines 10 such clusters. Cluster 1 indicates the lowest socio-economic level, the most deprived population and Cluster 10 indicates the highest level, the wealthiest and fortunate. The table indicates the average of socioeconomic clustering numbers defined for each of the municipalities included in the newly defined area.

See Note 1 on the Peripherality index. The table shows the average of the numerical values of the index, which are indicated for each of the municipalities included in the region.
^cGeographic description: BS (BEER_SHEVA)—Beer-Sheba sub-district. YNMK (YOKNEAM_AREA)—Natural area of Yokneam, and the cities of Nazareth-Ilit, Migdal-HaEmeq, and Karmiel. ASN (AKO_NTZRAT)—Natural areas of Acre and Shefa- Amr, and the city of Nazareth. KJ (KINERET_IZRAEL)—Kinneret and Jezreel sub-districts, excluding both cities of Nazareth and Nazareth-Ilit, and the Natural Area of Yokneam. GS (GOLAN_TZFAT)—Golan and Safed sub-districts.

TABLE 2 | Israel's spatial sub-division, and innovation potentialities.

	Geographic area	Population size 2016–7 (Thousands)^a	Companies supported by the chief scientist of the Israeli ministry of economy (2010–2014), by number of subsidies	Start-up and R&D companies (2015)^b
Core	Tel-Aviv district	1,388.4 (17.4%)	573 (25.6%)	1652 (52.2%)
	Central district	2115.8 (26.6%)	755 (33.8%)	611 (19.3%)
	Jerusalem District	1083.3 (13.6%)	135 (6.0%)	256 (8.1%)
	Haifa district	996.3 (12.5%)	251 (11.2%)	171 (5.4%)
	Ashkelon sub-district	532.0 (6.7%)	101 (4.5%)	115 (3.6%)
	Periphery	BS	712.2 (8.9%)	72 (3.2%)
ASN		366.9 (4.6%)	60 ^c (2.7%)	
YNMK		147.3 (1.8%)	137 ^d (6.1%)	
KJ		459.5 (5.8%)	98 (4.4%)	
GS		164.8 (2.1%)	55 (2.5%)	
Northern district				
	Total	7966.5 (100%)	2237 (100%)^e	3161 (100%)

^aC.B.S. - Statistical Abstract of Israel 2017. The reported population includes the territory of Israel within the so-called "Green Line." The natural areas of Yehi'am, Eilon and Nahariya were not included due to a small number of observations in the surveys' samples.

^cThe natural area of Nazareth-Turan, benefited from 50 supports in the reported years. For the convenience of the presentation, an equal distribution was assumed, equally dividing the supports between Nazareth-Illit and Migdal HaEmek (Jews) seemingly obtained 25 supports, and the city of Nazareth (Arabs) obtained 25 supports. These subsidies were added to those that benefited the natural regions of Acre and Shfar'am.

^dThe reported supports (25) in the previous asterisks were added to the subsidies, which benefited Yokneam's natural region.

^eNot including the natural areas of Yechiam, Eilon and Narariya.

^bTaken from Israeli High-Tech and Venture Capital Database (IVC).

technology level)¹¹; *InovSrc* is a vector of proxies for the firm n 's investment in innovation and the sources from which it achieves innovation¹²; *Chara_Time* is a vector of variables indicating a firm's characteristics and innovative activity over time¹³; β , δ , θ , Ω , σ are the parameters of interest; and ε is an error term.

5 | Empirical Results

5.1 | Descriptive Statistics

Table 3 shows that the approximately 4000 firms that were sampled represent Israel's economic activity well. The spatial sampling indicates that more than 80% of the sampled firms (Table 3) are in the country's core.

A relatively high percentage of the sampled firms performed both technologically and non-technologically innovative activities in the 2 years prior to their sampling. Approximately 50% of firms performed technologically innovative activity, while approximately 73% innovated in non-technological ways.

Table 3 indicates that most of the sampled firms belong to the industrial sector, with a more dominant share in the remote northern Israel, whereas in the southern region (BS), the share of industrial firms sampled is the same as the in the core. Most of the companies within the industrial sector are low and medium-low tech (approximately 65% in both samples), while

high-tech firms (in both samples) constitute 14%–15% of the industrial sector. According to the data, information and/or telecommunication services, which tend to entail R&D activities, make up the largest share of firms in the core region (approximately 20%) in the non-industrial sector. In the peripheral regions, this rate decreases greatly. For example, in the Kinneret and Jezreel sub-districts (KJ) information/telecommunication services constitute even less than 1% of the non-industrial sector, whereas in the Beer-Sheba sub-district (BS) the rate is about 5%. These disparities are echoed also in firms' R&D investments, which in the core region exceed those among companies sampled from the periphery (except for the natural area of Yokneam, and the cities of Nazareth-Illit, Migdal-HaEmek, and Karmiel. That is, the YNMK variable).

5.2 | (Non-)technological Innovation—Probabilities and Peripheries' Prospects

This section presents an analysis of the relation between the probability to innovate, and the key factors defined in Equation (1), distinguishing between technological and non-technological forms of innovation. The dependent variable in the models is dichotomous, based on firms' reports whether they innovated (1) in the past 2 years preceding their sampling, or not (0). The independent variables include categorical variables that depict the firms' spatial locations, and other statistically

TABLE 3 | Descriptive statistics.

Variable	Categories (%)							N	
	Innovation		Performed	Did not performed			Total		
TS ^a			50.3%				100.0%	3858	
NTS ^b			72.7%				100.0%	3854	
Industry firms' tech level	High tech	Med high tech	Med low tech	Low tech	Total	N			
TS ^a	15.0%	17.8%	36.3%	30.9%	100.0%	2040			
NTS ^b	14.3%	17.1%	35.4%	33.2%	100.0%	2006			
Geographic location	Core	BS	YNMK	KJ	ASN	GS	Total	N	
TS ^a	80.6%	5.1%	3.9%	3.3%	2.4%	4.7%	100.0%	3858	
NTS ^b	81.6%	4.8%	3.7%	3.3%	2.3%	4.3%	100.0%	3854	
Firm's average foreign ownership	Core	BS	YNMK	KJ	ASN	GS			
TS ^a		16%	6%	24%	11%	4%	7%		
NTS ^b		16%	4%	24%	10%	3%	8%		
Firm's average size (employees)	Core	BS	YNMK	KJ	ASN	GS			
TS ^a		278	198	181	113	90	150		
NTS ^b		276	163	192	111	87	148		
Firm's average R&D expenditures (millions NIS)	Core	BS	YNMK	KJ	ASN	GS			
TS ^a		13.2	3.7	23.0	1.9	1.6	2.5		
NTS ^b		12.9	3.7	24.0	1.9	1.6	2.9		
Firm's average % academic human capital	Core	BS	YNMK	KJ	ASN	GS			
TS ^a		33	17	34	19	15	17		
NTS ^b		32	18	34	18	13	17		
Economic Branch	INDUSTRY ^c	WH_ COMMERCE ^d	Trans_ SERVICE ^e	HOST_ SERVICE ^f	Inform_ SERVICE ^g	SUPPLY_SERVICE ^h	Other	Total	N
Core									
TS ^a	42.1%	6.3%	4.4%	4.2%	20.7%	4.1%	18.2%	100.0%	3109
NTS ^b	42.0%	6.8%	4.5%	3.8%	19.6%	4.4%	18.9%	100.0%	3144
BS									
TS ^a	45.6%	9.7%	5.6%	14.9%	4.6%	7.2%	12.4%	100.0%	195
NTS ^b	45.1%	8.7%	5.4%	14.7%	4.9%	8.2%	13.0%	100.0%	184
YNMK									
TS ^a	71.1%	1.3%	3.9%	0.7%	3.9%	2.6%	16.5%	100.0%	152
NTS ^b	69.7%	1.4%	4.2%	0.7%	3.5%	2.8%	17.7%	100.0%	142
KJ									
TS ^a	80.2%	1.6%	2.4%	1.6%	0.8%	3.1%	10.3%	100.0%	126
NTS ^b	79.1%	1.6%	2.3%	3.1%	0.8%	3.0%	10.1%	100.0%	129
ASN									
TS ^a	60.0%	5.3%	6.3%	3.2%	6.3%	12.6%	6.3%	100.0%	95
NTS ^b	57.8%	4.4%	5.6%	3.3%	4.4%	16.7%	7.8%	100.0%	90
GS									
TS ^a	72.9%	2.8%	3.9%	5.0%	3.9%	3.3%	8.2%	100.0%	181
NTS ^b	66.7%	4.2%	5.5%	5.5%	3.6%	4.2%	10.7%	100.0%	165

^aTS, Technological sample.^bNTS, Non-technological sample.^cIndustry.^dWholesale retailing.^eTransport, storage, postal or courier services.^fCatering and/or accommodation services.^gInformation and/or telecommunication services.^hUtilities services.

significant characteristics that define the sampled firms (see Supporting Information S1: Appendix A).¹⁴

Initially, the location effect was tested by defining a binary variable, where the remote regions initially observed in Table 1 were grouped into one weighted category (PERIPHERY),¹⁵ where the reference group is the core region. Models 1-2 in Table 4 examined the effect that location has on firms' odds to innovate (technologically and non-technologically).

The findings indicate that in comparison to the core region, the periphery yields an increase in a firm's odds of introducing technological innovation (Model 1). Conversely, peripheral location decreases a firm's chances of introducing a non-technological innovation (Model 2). The result shown in

model 2 is consistent with the literature, reflecting how non-technological innovators can benefit from operating in urban and dense areas, clustering and co-location (Shearmur 2015). But model 1's result is novel, as it indicates the advantages of periphery over the defined core, when technologically innovating. In the non-technological realm, this advantage vanishes. Table 5 unravels the said relationships, and among other things shows the weighted effects of the defined regions in Table 1 (as the reference group is the core region) on firms' innovative activity. It demonstrates how the degree of peripherality exhibits a varying relationship with innovative activity.

The results for the Beer-Sheba sub-district (BS) show that local firms yield a negative association ($p < 0.001$) with the probability of implementing both types of innovation (Models 3 and 4).

TABLE 4 | Model 1 and Model 2- Probability of implementing technological and non-technological innovation.

Model fit summary	Probability of technological innovation			Probability of non-technological innovation		
	Model 1			Model 2		
Number of observations	3858			3854		
-2 log-likelihood	5,109,374.255			7,050,721.086		
Cox & Snell pseudo-R ²	0.588			0.373		
Nagelkerke pseudo-R ²	0.784			0.546		
Parameter	Estimate	SE	Exp(B)	Estimate	SE	Exp(B)
Geographical location						
Periphery	0.068	***0.005	1.070	-0.626	***0.004	0.534
Economic branch (industrial firms, distinguished by their technology level)						
HIGH_TECH	1.777	***0.005	5.911	1.007	***0.006	2.737
MED_HIGH_TECH	1.002	***0.004	2.723	0.677	***0.004	1.967
MED_LOW_TECH	1.198	***0.003	3.314	0.224	***0.003	1.251
LOW_TECH	0.047	***0.004	1.048	0.428	***0.003	1.534
Economic branch						
WH_COMMERCE	-1.132	***0.007	0.322	0.544	***0.004	1.722
TRANS_SERVICE	-1.825	***0.009	0.161	0.031	0.005***	1.031
HOST_SERVICE	-1.007	***0.007	0.370	1.596	***0.005	4.933
INFORM_SERVICE	1.092	***0.004	2.980	0.166	***0.003	1.180
SUPPLY_SERVICE	-1.532	***0.008	0.216	-0.045	***0.004	0.955
Firm's characteristics and innovative activity over time						
FORIGN_OWNSHP	0.007	***0.000	1.007	-0.003	***0.000	0.997
Employed	0.001	***0.000	1.001	0.003	***0.000	1.003
HUMAN_CAP	0.565	***0.005	1.760	1.091	***0.004	2.977
YEAR_2012	0.277	***0.002	1.319	-0.994	***0.002	0.370
Firm's investments in innovation and the sources for achieving innovation						
R&D_EXPEND	0.077	***0.000	1.080	0.044	***0.000	1.044
COOPERATION	5.592	***0.007	268.363	5.684	***0.027	29,412,308
CONFERENCE	3.089	***0.004	21.951	0.5665	***0.027	261.386
PROFFESION_ORG	1.242	***0.006	3.462	3.1272	***0.019	22.38
Internet	2.619	***0.003	13.717	18.637	17.426	124,149,867
Constant	-3.076	***0.004	0.046	-0.348	***0.003	0.706

Note: ***significant at the 0.01 level.

TABLE 5 | Model 3 and Model 4– Probability of implementing technological and non-technological innovation.

Model fit summary	Probability of technological innovation Model 3			Probability of non-technological innovation Model 4		
	Estimate	SE	Exp(B)	Estimate	SE	Exp(B)
Number of observations			3858			3854
–2 log-likelihood			4,865,398.168			6,775,141.720
Cox & Snell pseudo- R^2			0.589			0.368
Nagelkerke pseudo- R^2			0.785			0.542
Parameter	Estimate	SE	Exp(B)	Estimate	SE	Exp(B)
Geographical location						
BEER_SHEVA	–1.298	***0.022	0.273	–0.648	***0.015	0.523
YOKNEAM_AREA	0.785	***0.022	2.193	0.357	***0.023	1.429
AKO_NTZRAT	0.224	***0.038	1.251	–1.198	***0.033	0.301
KINERET_IZRAEL	0.337	***0.028	1.400	0.112	***0.024	1.118
GOLAN_TZFAT	0.354	***0.019	1.425	–1.586	***0.021	0.204
Economic branch (industrial firms, distinguished by their technology level)						
HIGH_TECH	1.784	***0.006	5.951	0.955	***0.006	2.598
MED_HIGH_TECH	0.998	***1.004	2.730	0.677	***0.004	1.967
MED_LOW_TECH	1.229	***0.003	3.417	0.210	***0.003	1.233
LOW_TECH	0.017	***0.004	0.046	0.430	***0.003	1.537
Economic Branch						
WH_COMMERCE	–1.071	***0.007	0.343	0.559	***0.004	1.748
TRANS_SERVICE	–1.912	***0.009	0.148	0.002	0.005***	1.002
HOST_SERVICE	–0.935	***0.008	0.393	1.568	***0.005	4.797
INFORM_SERVICE	1.105	***0.004	3.020	0.1610	***0.003	1.174
SUPPLY_SERVICE	–1.506	***0.008	0.222	–0.024	***0.004	0.976
Firm's characteristics and innovative activity over time						
FORIGN_OWNSHP	0.006	***0.000	1.006	–0.003	***0.000	0.997
Employed	0.001	***0.000	1.001	0.003	***0.000	1.003
HUMAN_CAP	0.549	***0.005	1.732	1.092	***0.000	2.98
YEAR_2012	0.268	***0.002	1.307	–0.963	***0.002	0.381
Firm's investments in innovation and the sources for achieving innovation						
R&D_EXPEND	0.080	***0.000	1.084	0.043	***0.000	1.043
COOPERATION	5.650	***0.008	284.388	7.288	***0.063	1462.642
CONFERENCE	3.087	***0.004	21.907	6.935	***0.055	1027.619
PROFFESION_ORG	1.261	***0.007	3.528	2.061	***0.019	7.853
Internet	2.631	***0.003	13.889	18.621	17.695	122,179,276.1
Constant	–3.085	***0.004	0.046	–0.358	***0.003	0.699

***significant at the 0.01 level.

Figures 3 and 4 further indicate this and show how a firm in the core region whose characteristics point towards a 50% probability of implementing technological innovation, would have only close to 21% probability with similar characteristics if it was based in the BS region. Similarly, a firm whose characteristics point towards a probability of 50% to implement non-technological innovation if it is in the core region, will be characterized by a lower probability, of about 34% if it is based in the BS region.¹⁶

The results are consistent with the region's history. Prior to the dawn of the 21st century, there was no significant inflow of businesses into the BS region, due to factors like location expenses associated with the attractiveness of the core, nor was there much local innovative activity (Bar-El and Parr 2003; Bar-El and Felsenstein 1989). Both not unexpected, though, as the Beer-Sheba sub-district is highly peripheral (Table 1). Sparsely populated, it has no immediate proximate core region. Despite repeated

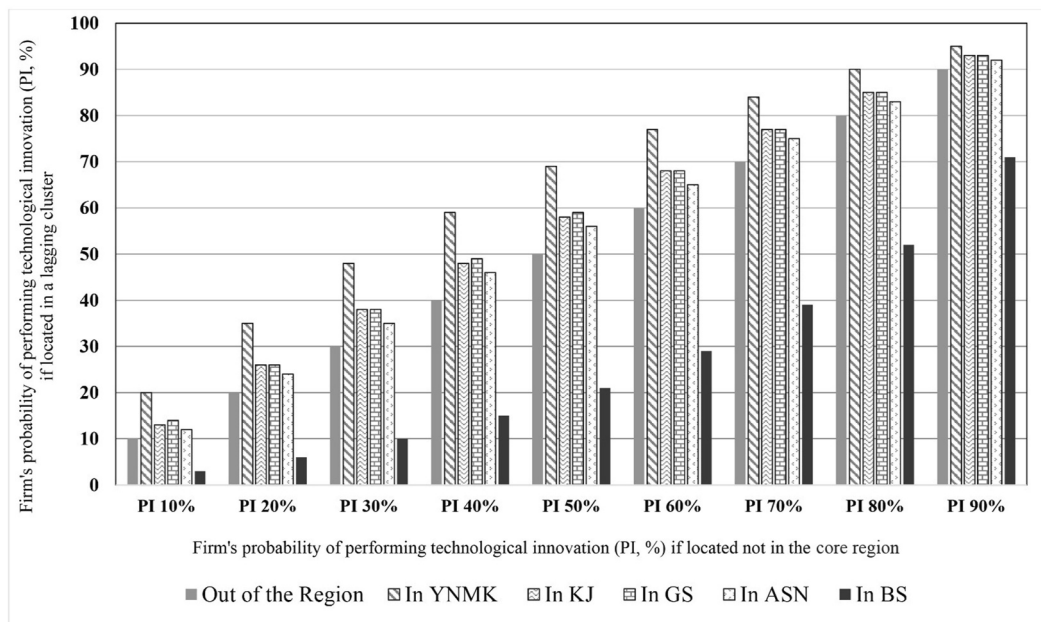


FIGURE 3 | Firm's probability of performing technological innovation if located in a lagging cluster compared to the probability of performing technological innovation if it is not located in it.

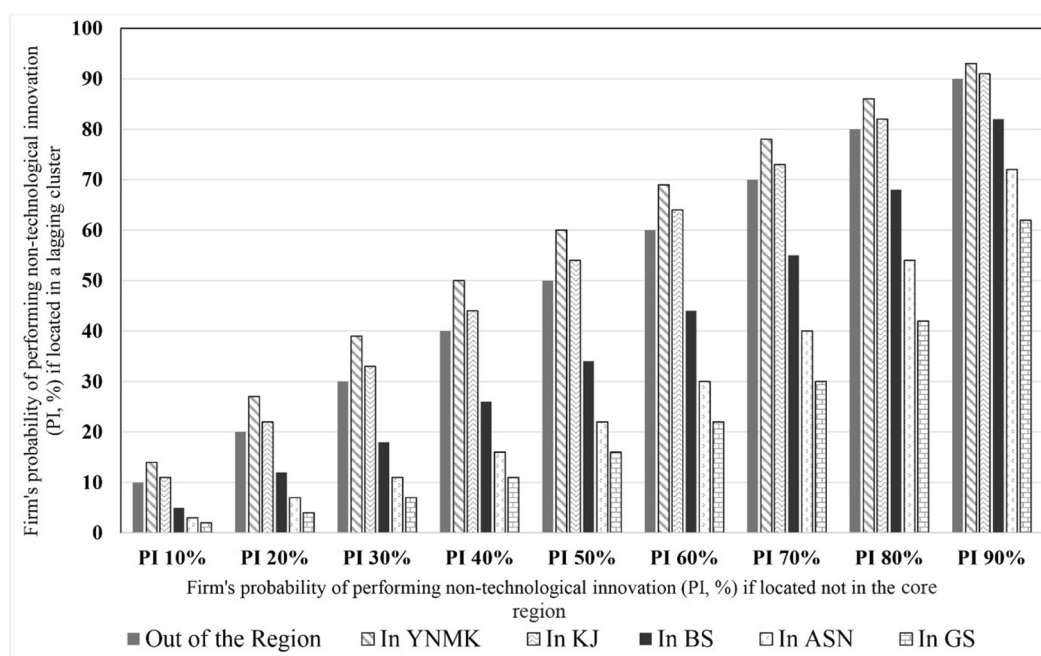


FIGURE 4 | Firm's probability of performing non-technological innovation if located in a lagging cluster compared to the probability of performing non-technological innovation if it is not located in it.

government attempts, the relocation of businesses from the core outwards, when it occurred, largely stopped at the periphery of the study's core region (Shefer and Frenkel 2013; Schwartz 2006; Gradus, Razin, and Krakover 1993). The weak regional economy is not compensated by external alternatives to innovative knowledge that might complement or replace the absence of a local buzz. The study's results indicate the positive correlation between such pipelines (e.g., COOPERATION, CONFERENCE, FOREIGN_OWNSHP variables) and probabilities to implement innovation (Models 1–4). However, the pipelines' utilization in the Beer-Sheba sub-district is relatively low.

The findings that pertain to the northern periphery of Israel will be presented in relation to key features of each region and the research hypotheses. In contrast to the Beer-Sheba sub-district, the probability of a firm located in the northern peripheries (YNMK, ASN, KJ and GS) to technologically innovate significantly ($p < 0.001$) exceeds the probabilities of a similar firm in the core. The regions' associations with technological innovation capacities are *ceteris paribus* positive (Table 5). However, the odds (*ExpB*) for technological innovation decrease as the distance from the core region increases (Model 3). For example, in comparison to other peripheral regions, firms located in the

region represented by the YNMK variable benefit from the highest odds of producing technological innovation (Table 5). The odds there are 2.2 times higher than for a firm with similar characteristics in the core (Model 3). These results imply that firms developing technological innovation in the YNMK region benefit from the region's economic conditions, and from local contexts, to a higher degree than if they had been located in the core region (the reference group of the variable). Figure 3 shows that in the region represented by the YNMK variable, the chances of innovating can be up to 20% higher than that of a company with similar characteristics located in the core.

The YNMK region is relatively close to the country's core, and to its innovation-promoting infrastructures, but it is nevertheless still defined by Israel's CBS as a periphery (Figure 1). Recognizing the region's peripheral position, Israel's government launched a stimulus program there roughly 20 years ago, with the goal of boosting the region's economy.¹⁷ The extensive expansion of physical infrastructure and communication networks in the region, alongside a range of financial incentives, encouraged technology-based companies to relocate to it, thereby enhancing its economic activity. As a result, the city of Yokneam Illit transformed into a hub of innovation within the region, denoted by the YNMK variable. The region's advantageous location, between Haifa and Tel Aviv, and within an acceptable commuting distance to the core, facilitated the creation of "opportunities for attractive jobs for young and skilled populations" (Frenkel 2001, 1098).

The results for the YNMK and BS regions suggests a strong positive relationship between innovation and regions' degree of peripherality (see Table 1). Moreover, the non-technological realm reveals that the chances of firms to innovate in the region represented by the YNMK variable (as with the case of the Kinneret and Jezreel sub-districts: the KJ variable, defined by a medium degree of peripherality, Table 1), significantly ($p < 0.001$) exceed the probabilities of a firm in the country's core (Figure 4). The results align with a recent qualitative analysis showing that peripheral innovators do not benefit from relocation to urban areas (Eder and Trippel 2019), but at the same time contradict the rationale of hypothesis 2. In the case of YNMK and KJ regions, both are keeping their relative advantage as long as companies there benefit from (geo-) proximity to the core's markets, or from certain regional endowments, as well as established infrastructures that support also non-technological forms of innovation (García-Cortijo, Castillo-Valero, and Carrasco 2019).

The highest probabilities for technological innovation for any region, apart from YNMK, are found in the Kinneret and Jezreel sub-districts (as seen in Table 5), which are adjacent to the region represented by the YNMK variable (Figure 2), and are relatively close to the core. Among the peripheral regions (Table 1 and Figure 4), KJ appears to function as an intermediary region, situated between the close periphery represented by the YNMK variable and the distant parts of northern Israel. Previous research indicated that technologically innovative firms in the region possessed a competitive advantage, due in part to Israel's small size, as the region's relative remoteness was not viewed by industrial businesses as a significant factor isolating technological innovators from markets and service

providers located mostly in the core (Frenkel 2001). The region's high-tech factories were furthermore found not to prioritize proximity to academic and research institutions in their location selection, nor market and service centers located in the core.¹⁸ Better land availability (compared to the core) and lower land prices in the region enabled the expansion or relocation of hi-tech plants to the area, allowing firms to maximize their innovative activities compared to the core (Frenkel, Shefer, and Roper 2003; Frenkel 2001; Felsenstein 1994, 1996). Government incentives encouraging firms to open factories in the region moreover guaranteed relative proximity to a pool of highly skilled workers residing both in the core and in its outskirts (e.g. YNMK).

Models 1-4 furthermore show the positive and significant correlations between innovation and the technological level of a firm (Tables 4 and 5). The predicted odds ratios (*ExpB*), indicate how HIGH_TECH significantly increases the chance to innovate. This relationship is clearly expressed in the region represented by the YNMK variable, and to some degree also in the Kinneret and Jezreel sub-districts. In Israel, a firm's technological ability was found to be a decisive factor in its choice to locate in the core area (Frenkel 2000). But the region represented in the variable YNMK, for example, benefits from a relatively large volume of investment in R&D, compared to the other peripheral regions (Table 3).

Although investment in R&D is a measure of technological ability, it has been discovered that internal R&D in traditional industries in Israel's northern periphery enhances the potential for technological innovation (Frenkel 2001). This may have to do with the odds ratio in the Golan and Safed sub-districts (GS) for technological innovation, which is second to that of the region represented by the YNMK variable (Table 5). This result seems to support the first hypothesis.

The Golan and Safed sub-districts represent the most remote areas in northern Israel (Figure 2); nonetheless, the findings in Figure 3 demonstrate the advantages firms in these regions benefit from when they opt for technological innovation, compared to their advantages had they been located in the core. However, the low level of R&D expenditures in firms from the Golan and Safed sub-districts, along with Acre and Shefa-'Amr, the city of Nazareth (ASN) and the Kinneret and Jezreel sub-districts, further supports the first hypothesis (Table 3). The evidence indicates, for example, that the information and telecommunication services is the only sector positively correlated *ceteris paribus* with technological innovation (in Models 1 and 3). Compared to the core, the services provided by that sector are sparse in those regions (Table 3). And yet, the odds of technological innovation in a firm from that sector located in these regions exceed those of a firm in the core. Consistent government policies on technological innovation (Bar-El and Maymoni 2023; Frenkel, Shefer, and Roper 2003), and additional policies on entrepreneurship supporting the establishment of small businesses, may shed light on the findings related to the demonstrated advantage of firms in peripheral regions (Heilbrunn 2023; Schnell et al. 2017; Dana 1999). These policies were significantly pronounced in the following two examples:

First, the economy of the Kibbutzim in these regions. Kibbutzim, a rural form of settlements, were able to develop agrarian technological local know-how and become highly innovative in areas like industry, science and bio-agricultural activity (Tal 2021; Schnell et al. 2017; Frenkel et al. 2001). The predominance of innovation in kibbutzim is not surprising, considering that kibbutzim human resources and plants had better average technology levels than the Israeli population average, while the national policy towards the country's northern peripheries allowed the kibbutzim to invest in R&D (Frankel 2000).

The second example is firms from traditional industries that were attracted from the country's more central regions. These are larger, younger plants that engage mainly in mass production, and are commonly found in Israel's farthest northern regions, where location does not constitute a disadvantage to developing technological innovations, compared to more advanced industries. Less advanced industries require much less human capital resources, technological complexity, and R&D resources (Frenkel 2000, 2001; Felsenstein 1996, Bar-El and Felsenstein 1989).¹⁹

The probability of non-technological innovation (Model 2 and 4) reverses the patterns of that of technological innovation for most economic activities. While activities in the study's lagging regions, such as wholesale retailing (WH_COMMERCE) and catering and accommodation (HOST_SERVICE), are sparse (Table 3), they require high levels of organizational and marketing capabilities. Lacking such endowments lowers the probability of non-technological innovation, like in the GS and the ASN regions, where, compared to the core, the probabilities for innovation are negatively associated within the non-technological realm ($p < 0.001$) (Model 4).

Though Acre, Shefa-'Amr, and Nazareth are urban in nature, and the Golan and Safed sub-districts mostly contains rural and peri-urban Jewish population (Table 1), both (like the Beer-Sheba sub-district) lack those substantial urban areas that could spur non-technological innovation. Figure 4 indicates this deficiency, showing the probabilities of non-technological innovation in the Golan and Safed sub-districts, as well as Acre, Shefa-'Amr and Nazareth, to be much lower than of a firm with similar characteristics located in the core.

The results buttress the logic of hypothesis 2. The regions represented by the GS and the ASN variables are highly peripheral (Table 1) and lack necessary endowments, like well-qualified human capital, that could advance non-technological innovation (local based and non-local based).²⁰ Models 1-4 display the positive correlation between firms' (non-) technological innovation and employees' level of qualification (HUMAN_CAP). In the regions represented by the GS and the ASN variables, firms' level of human capital is relatively low (Table 3). In the ASN region, the explanation for this may lie in ethno-racial inequality between Arabs and Jews (Schnell, Benenson, and Sofer 1999). Not surprisingly, R&D investments (R&D_EXPEND) are *ceteris paribus* positively ($p < 0.001$) correlated with the probability of innovation (Models 1-4). However, in the areas of Acre, Shefa-'Amr, and Nazareth these investments are the lowest among all regions (Table 3).²¹

6 | Discussion and Conclusions

The article explores how the location of firms affects the likelihood that they will innovate. Drawing on a sample of Israeli firms with varied economic activities, we examined the extent to which their location in peripheral regions (in comparison to core location) and other economic and technological characteristics (e.g., firms' size, foreign ownership, level of technology, R&D expenditures and external corporations) impacts innovative inclinations, and how the chances to innovate vary between technological and non-technological endeavors.

The study's results indicate that most of the peripheral regions are just as technologically innovative as the core region. The positive correlations between remoteness and technological innovation in all remote regions in northern of Israel suggest that remoteness may inspire fierce urge to innovate. As the Israeli test case exemplifies, this instinct for corporate survival inspires technological innovation in the periphery exceeding that in the core, where the challenge of isolation, and the need to overcome it is seemingly reduced.

Although it is well acknowledged that a firm's capacity and effort account for the majority of its innovation (García-Cortijo, Castillo-Valero, and Carrasco 2019), our research indicates that these factors are contingent upon the geographic setting. The odds to technologically innovate within lagging regions depend on a place's degree of peripherality - that is, firms' proximity to a core region and to other lagging regions, as well as the region's levels of urbanity and social deprivation (which in Israel criss-cross ethnic cleavages between Jews and Arabs).

The study's results also indicate that the endowments that support the ability to cultivate innovation in firms located in the periphery is exclusive. The study's findings align with the conclusions of Jensen et al. (2007), further indicating that technologically innovative capacities reflect an adjusted, or internal evolution that relates to regions' conditions and local contexts (McCann 2007). It is reasonable to expect a diffusion process of incremental innovations in the periphery, emphasizing enhancements in production processes rather than the creation of new products, while in the core radical innovations may be more likely, prioritizing the development of new products. The descriptive statistics of the study, as shown in Table 2, suggest this. Examples include investments in research and development, the quality of human capital, the proportion of communication and information services, and the share of start-up and R&D companies in Israel by regional division - indicators that suggest a comparative advantage of the core over the peripheries in terms of radical innovation capacity. However, this claim is beyond the scope of the current investigation and may be validated in a subsequent study.

Unlike technological innovation, where peripheral knowledge tends to be localized and exclusive, peripheries' organizational and marketing forms of innovation seem to benefit from clustering effects and proximity to markets (Shearmur 2015). Since business services congregate in core metropolitan regions (Shearmur and Doloreux 2016), the more a region is lagging, the thinner the activity of those services, thus the larger the

expected decrease in the firm's likelihood of cultivating non-technological innovation.

Regarding policy, the dearth of evidence concerning non-technological innovation in Israel is conspicuous. This is in opposition to the principal objective of Israel's national policy in recent decades, of promoting high-tech endeavors (Felsenstein 2015). Taking into consideration this gap, the findings indicate significant ramifications for policymakers. If the goal of a spatial economic policy is to strengthen non-technological innovation in the periphery, it will have to ensure maximum access to the core's services, or alternatively strive to encourage their development in more lagging contexts. Recognizing this need calls for a policy that emphasizes the role of urban clusters in innovation formation. It also calls for strengthening those cities that already exist to serve as anchor points to root innovation opportunities in lagging contexts. In Israel, for example, cities which would benefit from attention to become anchor points of innovation include both majority Arab and Jewish cities, where innovation policies can also be incorporated into a regional development agenda that strives to promote social policies to reduce inequality (Zehavi and Breznitz 2017). The importance of an urban location notwithstanding, a new policy needs to also benefit innovations located in isolated and peripheral contexts, especially those that Shearmur (2015) identified as slow innovators. Promoting such arrays of innovation potentially enable firms and regions to overcome what Oughton et al., (2002) identified as a regional innovation paradox; "the apparent contradiction between the comparatively greater need to spend on innovation in lagging regions and their relatively lower capacity to absorb public funds earmarked for the promotion of innovation and to invest in innovation related activities compared to more advanced regions" (p. 98). Overcoming the paradox requires sensitivity to local conditions in which local innovators, technological and non-technological, could benefit and flourish (Shearmur 2015).

Though our study centers on the Israeli context, its findings could be generalized in two important ways. First, the study further expands the research on innovation in peripheries (Eder 2019) by proposing a spatial analysis that compares core and periphery. As such, we are extending the common methodology for investigating innovation in lagging regions. Second, since innovation is by now a key element in strategies to advance development and prospects in peripheral regions, Israel should not be conceived as *sui generis*. Though the country carries distinct geopolitics features and/or geo-economics, the findings in the study emphasize the need to cautiously consider the distinct mechanisms that advances (non-) technological innovation, and their impact upon regions' prosperities. Specifically, given that such mechanisms vary across geo-cultural contexts, innovation is supposed to be manifested differently and, consequently, also decisions to promote innovation. Thus, for example, whereas regional growth might in some cases be the outcome of singular, or of local determinants, or even the consequence of non-transferable or non-duplicatable, this may not be the case in other lagging regions. There, some of the characteristics promoting innovation could be globally and possible to generalized. These contextual factors should be taken into account in future studies, as they explore forms of innovation in different spatial contexts. Since few

investigations have followed this path, future discussions and explorations would be welcome here.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available from The Central Bureau of Statistics, Israel. Restrictions apply to the availability of these data, which were used under license for this study. Data are available from the author(s) with the permission of The Central Bureau of Statistics, Israel.

Endnotes

¹ Undoubtedly, the survival of innovative firms in peripheral regions is a crucial element in fostering regional development and growth. As innovation increases, regions potentially attract a larger number of skilled individuals, investors, and entrepreneurs from outside the region (Meili and Shearmur 2019). These positive externalities can motivate governments to actively foster innovation in peripheries for the benefit of the local economy.

² This does not exclude the possibility of firms from core regions prioritizing innovation when addressing local issues. However, there is evidence that dealing with localized concerns may be more essential for firms in low-density locations, whereas diversity may be more vital for firms in larger metropolitan settings (Caragliu, de Dominicis, and de Groot 2016). Such observations are debatable and are frequently based on speculative and anecdotal evidence (Eder 2019; Shearmur 2015).

³ Regional innovation systems (RISs), learning regions, and innovative milieu, are all geographic concepts that adhere to the assumption that cities and metropolitan regions enable creativity (Shearmur 2017).

⁴ The Index defines 10 clusters scale which classifies municipalities' level of centrality in Israel from cluster 1, which includes the most peripheral local authorities, to cluster 10, which includes the most central local authorities. The index incorporates two sub-indices: 1. Potential accessibility index (weighing the municipality's proximity to all local authorities in the country and the size of their population), and 2. Proximity to the Tel Aviv District, Israel's main core region. See the Israeli Central Bureau of Statistic's 2017 peripherality index: <https://www.cbs.gov.il/en/publications/Pages/2019/Peripherality-Index-Of-Localities-And-Local-Authorities-2015.aspx>

⁵ See Supporting Information S3: Appendix B.

⁶ Scholarly interest in the issue we are examining in Israel began to increase in the mid-2000s. However, apart from the surveys that our study relies on for its examination, there is a lack of clear statistical or descriptive data on this topic of study, and there is no recent and accessible survey available.

⁷ Natural Areas are the CBS's division of sub-districts into smaller regions in as uniform a way as possible.

⁸ A firm presented technological innovation (be it in a product and/or process) in 2 years that covers each survey in each of the two periods examined. See Supporting Information S1: Appendix A1.

⁹ A firm presented non-technological innovation (be it in marketing and/or organizational) in 2 years that covers each survey in each of the two periods examined. See Supporting Information S2: Appendix A2.

¹⁰ This is a group of five dummies accounting for the current location of the sampled firms among one of the five new clusters defined. They

take the value 1 if the sampled firm is in one of the five new clusters (e.g. BS, YNMK, etc.).

¹¹ This is a group of dummies that refer to the economic branch in which the firms operate. They take the value 1 if the sampled firm is categorized as one of the economic branches defined in Supporting Information S1 and S2: appendices A1 and A2.

¹² See Supporting Information S1 and S2: appendices A1 and A2.

¹³ These proxies include the relative share of the firm owned by foreign investors, the firm's size (number of employees), the firm's age, and periodic changes in their innovative activities. See Supporting Information S1 and S2: appendices A1 and A2.

¹⁴ Tests undertaken to investigate potential endogeneity dismissed the concern over this issue.

¹⁵ The weighted category was needed due to the uneven geographic sampling in the innovation surveys, and the bias towards the core (even after the unification of the two samples from the two surveys, 2006–2008, 2010–2012), and the resulting under-representation of the periphery in the data (Table 3). Assigning weights to each defined region (by utilizing statistical techniques in SPSS) balanced out the over- and under-sampling of firms in different regions.

¹⁶ The econometric development is based on Ben-Akiva and Lerman (1985) and Pindyck and Rubinfeld (1991) through which the estimations in Figures 3 and 4 were calculated is presented in Supporting Information S4: Appendix C.

¹⁷ The YNMK region's fading and old industrial base (mainly concentrated in the small town of Yokneam) dominated its economy until 30 years ago. For this reason, the YNMK region was considered peripheral even when the study's surveys were carried out more than a decade ago. The surveys show the region's remarkable shift. Their soaring number notwithstanding, the economic geography literature provides little evidence of this success. Luckily, Tables 2 and 3 captures the said economic intensification in the region (e.g., R&D and technology start-ups), whereas additional internet-based sources provide contemporary data (for example see: <https://www.startupblink.com/blog/yokneam-israel-startup-ecosystem/>).

¹⁸ The diminished significance of proximity to the core was also associated with the limited size of the local Israeli market, which appeared to compel Israeli hi-tech enterprises to primarily depend on the expansion of international markets, rather than local ones (Frenkel 2001).

¹⁹ Government incentives provided in Israel's peripheral regions were mostly associated with construction and equipment acquisition. These incentives were typically less pertinent for facilities primarily engaged in technological R&D, which, as previously noted, tend to be situated in the core (Frenkel 2000).

²⁰ Current research supports this assertion. For instance, studies indicate that entrepreneurs in northern Israel often neglect non-technological innovation and strategies to overcome marginalization, such as increasing investments for growth and expansion, or promoting and marketing new products (Schnell et al. 2017; Farja, Gimmon, and Greenberg 2016). Although this evidence emerged subsequently to the surveys upon which our analysis is based, in the absence of any alternative testimony, it can be inferred to reflect the findings at the time of the surveys.

²¹ Studies from the previous decade reveal findings that differ from ours when significant innovation in technology began to emerge in the ASN region economy (apparently about the mid-2000s). The surveys whose data are examined here may represent its buds (see discussion above). Past evidence does not provide any concrete answers, including documented policy, for the factors that initially drove this innovation (Schnell et al. 2017; Khamaisi 2013). Only later did the Israeli Innovation Authority (IIA) expressly foster Arab entrepreneurship, consequently enhancing technological innovation and allowing the high-tech industry to thrive (Shilon et al. 2022). The existing research on this emerging industry indicates that

contemporary times Nazareth has become a hub for technological advancement among Arab entrepreneurs (Schneider 2018). Shilon et al. (2022) found that this advancement was made possible by the spontaneous growth of interactions between Jewish and Arab individuals, as well as the sharing of knowledge and entrepreneurial training between the core and the region in question.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section.