

Innovative Efficiency, Energy Use and Territorial Disparities: A Municipal DEA Assessment for Paraná

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ABSTRACT

Innovation efficiency is crucial for regional development, yet remains uneven across territories. This study evaluates the innovative efficiency of Paraná's 399 municipalities in 2021, examining their ability to transform energy use and knowledge-intensive activity capacity into GDP and intellectual property outcomes. An output-oriented DEA model and a log-linear OLS regression were applied. Results show substantial disparities, with most municipalities operating below the efficiency frontier. Energy use and KIA density increase efficiency, while GDP and PI display negative elasticities. The study offers insights for place-based policies aimed at strengthening local innovation ecosystems.

KEYWORDS: Innovation; DEA; Energy Efficiency; Territorial Disparities; Paraná.

1. INTRODUCTION

Innovation and knowledge-intensive activities play a central role in shaping regional development, productivity and long-term competitiveness. In emerging economies, however, the capacity to transform knowledge assets into concrete economic and technological outcomes is unevenly distributed across territories, reinforcing structural disparities and limiting the diffusion of innovation benefits [1,2]. Recent empirical evidence highlights that local innovation systems are strongly conditioned by the density of knowledge-intensive activities, infrastructural endowments and institutional capabilities, which jointly influence how regions absorb, combine and exploit knowledge [3-5].

In Brazil, and particularly in the state of Paraná, the expansion of knowledge-intensive sectors, higher education institutions, and research infrastructure has not been accompanied by a homogeneous pattern of innovative performance across municipalities. While some localities concentrate economic activity, qualified human capital and intellectual property generation, others exhibit limited capacity to convert available resources into innovation outcomes. This context highlights the need to examine how municipalities differ in their efficiency in using knowledge-intensive structures and infrastructure to generate economic and innovative results, and how these differences are spatially distributed within the state [6,7].

In this context, the general objective of this article is to evaluate the innovative efficiency of the 399 municipalities of Paraná in 2021, considering their ability to transform energy use and knowledge-intensive activity (KIA) capacity into GDP and intellectual property (PI) outcomes. Specifically, the study (i) estimates municipal efficiency scores through a Data Envelopment Analysis (DEA) model [8], (ii) investigates the determinants of these efficiency differentials using a log-linear regression framework [4,7], and (iii) examines the spatial distribution of innovative efficiency to identify intra-state disparities.

The study is justified on both analytical and policy grounds. Analytically, it contributes to the literature on regional innovation by combining frontier efficiency analysis and econometric modelling at the municipal level, offering evidence on how local structures condition the use of knowledge-intensive resources [4,9]. From a policy perspective, Paraná is a relevant case due to its diversified productive base and a growing innovation ecosystem, as well as its persistent territorial inequalities. Understanding which municipalities are more efficient (and under which conditions) provides useful insight for designing place-based strategies that strengthen local innovation systems and promote more balanced regional development [1,2].

2. THEORETICAL FRAMEWORK

2.1 INNOVATION, REGIONAL DEVELOPMENT AND TERRITORIAL INEQUALITIES

Innovation has become a central element in contemporary discussions about regional development, particularly in countries

where productive structures are heterogeneous and institutional capacities vary significantly across space [10]. Rather than being restricted to firms or isolated technological centers, innovation is increasingly understood as a process shaped by territorial conditions, local institutions and the capacity of regions to absorb, adapt and recombine knowledge [11].

This perspective has shifted analytical attention toward the geography of innovation, emphasizing that proximity, networks and regional capabilities influence how knowledge circulates and how benefits are distributed across territories [5,12]. These dynamics become even more evident in emerging economies, where regional disparities in infrastructure, productive complexity and organizational density condition the formation of innovation ecosystems and the intensity of local innovation efforts [9].

Regional development in knowledge-based economies depends on the capacity of territories to mobilize and transform knowledge into economic and technological outcomes [1]. The author argues that regions differ not only in the volume of resources they possess but also in their ability to orchestrate learning processes and coordinate actors.

These differences generate persistent territorial asymmetries. Some regions sustain dynamic innovation ecosystems supported by universities, research centers and knowledge-intensive sectors, which enhances their ability to generate and diffuse knowledge [13]. Others face structural constraints such as limited institutional density, weak infrastructure and low levels of human capital, conditions that reduce their capacity to transform available resources into innovation and technological progress [8].

The persistence of territorial inequalities has been documented by several empirical studies. Innovation tends to concentrate in regions with strong networks of collaboration and diversified productive structures [2]. These areas usually present higher creativity levels and greater resilience in moments of economic instability. In contrast, territories with lower technological density struggle to participate in innovation networks, which limits opportunities for the diffusion of advanced knowledge. Such patterns create a cumulative dynamic in which leading regions maintain their advantage while lagging ones face increasing difficulties in catching up.

The Brazilian context illustrates this dynamic clearly. Spatial disparities in innovation capacity reflect historical patterns of development, unequal access to infrastructure and institutional fragmentation. Brazilian regions exhibit significant variance in their ability to generate and combine knowledge within local innovation systems [3]. Areas with strong research institutions and diversified industries tend to form more cohesive innovation environments. Meanwhile, municipalities with lower socioeconomic indicators often depend on external knowledge sources and face obstacles in sustaining innovative activities over time.

Institutional structures play an essential role in shaping territorial innovation capacity. Regional innovation ecosystems are influenced by governance arrangements and the ability of public and private actors to coordinate strategies that support learning, experimentation and technological upgrading [14]. When local institutions operate in isolation or lack strategic orientation, innovation efforts become fragmented. The result is a scenario where even regions with potential resources fail to generate consistent innovative outcomes.

Energy infrastructure also interacts with regional development paths. Although often treated as a purely technical factor, energy availability conditions the viability of modern productive activities and the adoption of advanced technologies. Recent contributions demonstrate that territories with more robust energy bases tend to experience faster technological diffusion and greater capacity to maintain complex industrial processes [5]. Energy, therefore, supports not only production but also the operational environment necessary for innovation.

One of the persistent challenges in regional development research is identifying how efficiently territories transform their resources into innovation outcomes. Traditional economic indicators frequently fail to capture these nuances, which motivates the use of alternative analytical approaches. Frontier-based methods provide insight into how regions differ in their ability to convert knowledge, infrastructure and production factors into technological and economic results. Innovation efficiency depends not only on the availability of inputs but also on institutional coordination, absorptive capacity and the broader environment in which innovation occurs [4].

Overall, the theoretical literature reinforces the idea that innovation is uneven across space because territories differ in their institutional maturity, productive complexity, and capacity to support knowledge generation [15]. These factors shape long-term development trajectories, influencing how regions accumulate capabilities and build comparative advantages over time [16]. Understanding why municipalities exhibit different innovation performances requires examining structural conditions, governance mechanisms and the spatial organization of economic activities [17]. This understanding is essential for designing territorial policies that encourage balanced development and strengthen regional innovation ecosystems [18,19].

2.2 KNOWLEDGE-INTENSIVE ACTIVITIES, LOCAL CAPABILITIES AND INNOVATION EFFICIENCY

Knowledge-intensive activities are widely recognized as core drivers of regional development, shaping the ability of territories to create, transform and apply knowledge in ways that support long-term economic performance. Their emergence is strongly

conditioned by localized learning processes, institutional arrangements and the capacity of regions to sustain cumulative trajectories of capability building [20]. The interplay between these elements helps explain why some regions become persistent centers of innovation, while others face structural limitations that restrict their engagement in knowledge-based activities.

The formation of knowledge-intensive structures depends on the articulation of local institutions, networks of collaboration and territorial infrastructures that support knowledge circulation. Innovative activities increasingly rely on interconnected systems in which local and global knowledge flows intersect [21]. Regions capable of integrating these flows tend to develop more robust innovation ecosystems, while those lacking coordination mechanisms often struggle to benefit from external knowledge sources.

The role of technological regimes and sectoral conditions also influences innovation efficiency. The structure of industries affects how knowledge is generated, appropriated and disseminated across space, shaping the potential for localized learning [22]. This process is closely related to institutional capacity, and regions with stronger governance arrangements can better coordinate strategic actions and foster environments conducive to innovation [23].

Territorial differences in knowledge accumulation are further reinforced by socio-economic and cultural conditions. Relational assets, shared norms, and interactive learning play a fundamental role in enabling regions to transform knowledge into productive outcomes [24]. Similarly, the ability to attract skilled human capital has been identified as a central element for sustaining innovation, since regions with more diversified labor markets tend to exhibit stronger adaptive capacity [25].

Empirical evidence shows that regions with more developed institutional frameworks and thicker knowledge infrastructures are better positioned to convert inputs into innovation results. Reports emphasize that innovation systems are shaped by interactions among firms, universities, government agencies and intermediary institutions whose density varies significantly across territories [26]. These differences affect not only the quantity of innovation but also its efficiency, since the presence of specialized services and research capabilities tends to facilitate knowledge spillovers.

More recent literature reinforces the relevance of relatedness and cognitive proximity in shaping innovative performance. Regions benefit from technological complementarity, which facilitates the recombination of knowledge and the emergence of new activities [27]. In a similar perspective, diversification into technologically related sectors enhances regional resilience and supports more dynamic innovation trajectories [28].

Scholars have also highlighted that innovation policies must be sensitive to territorial specificities. Policy interventions disconnected from local capabilities often fail to generate meaningful impacts, especially in regions with weaker institutional foundations [29]. Complementary research emphasizes that localized learning depends on continuous interaction among firms, institutions and knowledge-producing organizations, which varies significantly across municipal contexts [30].

Finally, structural barriers continue to shape innovation efficiency in many regions. There are three types of regional innovation challenges (organizational fragmentation, lack of critical mass and institutional weaknesses) that influence the capacity of territories to support innovation processes [31]. These factors contribute to the heterogeneity of innovation performance observed across municipalities and underscore the importance of designing policies aligned with local conditions. Understanding these dynamics is essential for strengthening regional innovation ecosystems and promoting more balanced patterns of development.

2.3 INSTITUTIONAL CAPACITY, TECHNOLOGICAL TRAJECTORIES AND REGIONAL INNOVATION PERFORMANCE

Institutional capacity plays a decisive role in shaping regional innovation outcomes, particularly in contexts where economic structures are heterogeneous and knowledge-intensive activities are unevenly distributed. Institutions influence the incentives, coordination mechanisms and learning environments that make innovation possible, affecting how regions accumulate capabilities over time [32]. In territories where institutional frameworks are fragile or fragmented, innovation processes tend to be discontinuous, poorly coordinated and less efficient, reinforcing uneven development trajectories [33].

Technological trajectories also exert a strong influence on how regions transform knowledge into innovation outcomes. Territories follow cumulative learning paths in which prior knowledge, local competencies and historical specializations condition the types of technologies they are able to develop and absorb [34]. These trajectories shape both the quantity and the quality of innovation, determining whether regions remain at the technological frontier or fall behind in processes of economic transformation. In this sense, targeted innovation policies may strengthen or redirect local trajectories, especially when oriented toward strategic mission-driven goals [35].

The structure of local economies further contributes to disparities in innovation performance. Research on economic complexity shows that territories with more diversified and sophisticated productive structures exhibit stronger capacity for knowledge recombination and innovation upgrading [36]. Empirical evidence suggests that regions embedded in dense and diversified networks of production and knowledge generation tend to generate more innovative and resilient growth paths [37]. Conversely, territories specialized in low-complexity activities often face structural constraints that limit their ability to engage with advanced technologies.

Territorial inequalities in innovation outcomes also reflect broader patterns of socio-economic development. Regions lacking institutional quality, human capital and infrastructural endowments tend to fall into persistent traps of underdevelopment, where innovation efforts are insufficient to overcome structural disadvantages [38]. Similarly, institutional coordination and investment in quality infrastructure significantly moderate the relationship between innovation and regional growth, highlighting the importance of governance for long-term development [39].

The role of learning processes is also central to understanding why innovation efficiency varies across municipalities. Early contributions from the literature on national and regional systems of innovation emphasize the importance of interactive learning, organizational routines and institutional complementarities in shaping innovation outcomes [40,41]. Such perspectives underscore that innovation does not arise solely from the availability of resources, but rather from the quality of interactions among firms, universities, research institutions and public organizations.

Finally, structural conditions such as income levels, human capital and investment capabilities influence the capacity of territories to sustain innovation over time. Classical empirical evidence suggests that differences in economic performance arise from the ability of regions to accumulate physical and human capital and to adopt new technologies [42]. Complementarily, the evolution of technological paradigms and sectoral dynamics affects how regions generate, diffuse and apply knowledge, shaping long-term trajectories of innovation and productivity [43].

Understanding how these institutional, structural and technological factors interact is essential for interpreting the heterogeneous innovation performance of municipalities. These elements highlight that innovation is not merely a technical process, but a territorially embedded phenomenon shaped by complex, cumulative and institutionally mediated dynamics. Addressing these disparities requires policies that strengthen local capabilities, align innovation strategies with regional characteristics and foster environments conducive to sustained technological upgrading.

3. METHODOLOGY

This study employs a quantitative approach to evaluate the innovative efficiency of all 399 municipalities in the state of Paraná for the year 2021. The state was selected due to its economic relevance and the availability of detailed municipal data that enable a comprehensive analysis of regional innovative performance [6,7]. The year 2021 was chosen because it provides the most recent and consistent dataset for economic, energy, and technological variables.

The database includes four main indicators: Gross Domestic Product (GDP), electricity consumption (Energy), the number of intellectual property registrations (PI), and an aggregated index of knowledge-intensive activities (KIA_{total}). The KIA_{total} index was constructed by standardizing and averaging employment, groups, and establishments in knowledge-intensive sectors, representing the density of knowledge-based production across municipalities [3,4,14]. These variables align with recent studies that highlight the roles of technological infrastructure, human capital, and knowledge diffusion in regional innovation [5,9].

To measure the relative efficiency of municipalities in transforming productive and cognitive resources into economic and technological outcomes, a Data Envelopment Analysis (DEA) was applied with an output-oriented specification and variable returns to scale (VRS) [8]. This non-parametric model identifies efficient and inefficient decision-making units based on the ratio of weighted outputs to weighted inputs:

$$E_i = \frac{\text{Weighted Outputs}}{\text{Weighted Inputs}}$$

where $E_i = 1$ denotes full efficiency, and $E_i > 1$ indicates relative inefficiency. The inputs used were Energy and KIA_{total}, while the outputs corresponded to GDP and PI. Finally, a log-linear OLS regression was estimated to identify the determinants of innovative efficiency:

$$\ln(E_i) = \alpha + \beta_1 \ln(GDP_i) + \beta_2 \ln(Energy_i) + \beta_3 \ln(KIA_{total,i}) + \beta_4 \ln(PI_i) + \varepsilon_i$$

The coefficients were interpreted as elasticities, expressing the expected percentage change in efficiency resulting from a one-percent variation in each explanatory variable. The integration of DEA and OLS follows recent empirical approaches to regional innovation and endogenous growth [4,5,7].

4. RESULTS AND DISCUSSION

The empirical analysis begins by estimating efficiency scores for the 399 municipalities of Paraná in 2021 using the output-oriented DEA model under variable returns to scale. This approach captures how effectively each municipality converts its

available inputs (energy consumption and knowledge-intensive activity (KIA) capacity) into outputs associated with economic and innovative performance, represented by GDP and intellectual property (PI) generation.

Table 1: Descriptive statistics of innovative efficiency (DEA model, 2021).

Variable	Min	1st Qu.	Median	Mean	3rd Qu.	Max
Efficiency score (E_i)	1.000	2.713	3.646	4.017	4.973	11.305

Source: Author's elaboration based on DEA results (output-oriented, VRS).

Table 1 presents the distribution of innovative efficiency across municipalities. The average efficiency score of 4.02 indicates a considerable performance gap among local economies, suggesting that several municipalities operate below the efficiency frontier established by the best performers. The median score (3.65) and the relatively high upper quartile (4.97) highlight a strong heterogeneity in the transformation capacity of knowledge-related resources into innovative and economic outcomes. This dispersion reinforces the notion that innovation-based productivity remains spatially uneven across the state.

To further explore the determinants of innovative efficiency, an Ordinary Least Squares (OLS) regression was estimated in log-linear form, linking efficiency to GDP, energy consumption, the aggregated KIA index, and intellectual property registrations. The results are reported in Table 2:

Table 2: Log-linear OLS regression results for innovative efficiency determinants (2021).

Variable	Coefficient	Std. Error	t-value	Significance
Intercept	3.9642	0.1956	20.27	***
$\ln(PIB)$	-0.8975	0.0253	-35.50	***
$\ln(Energy)$	0.7642	0.0225	33.92	***
$\ln(KIA_{total})$	0.2977	0.0196	15.17	***
$\ln(PI)$	-0.1246	0.0068	-18.41	***
Observations	399 municipalities			
R-squared	0.833 (Adjusted $R^2 = 0.831$)			
F-statistic	491.4 ($p < 0.001$)			

Source: Author's elaboration based on OLS estimates. Notes: *** $p < 0.01$; ** $p < 0.05$; * $p < 0.10$.

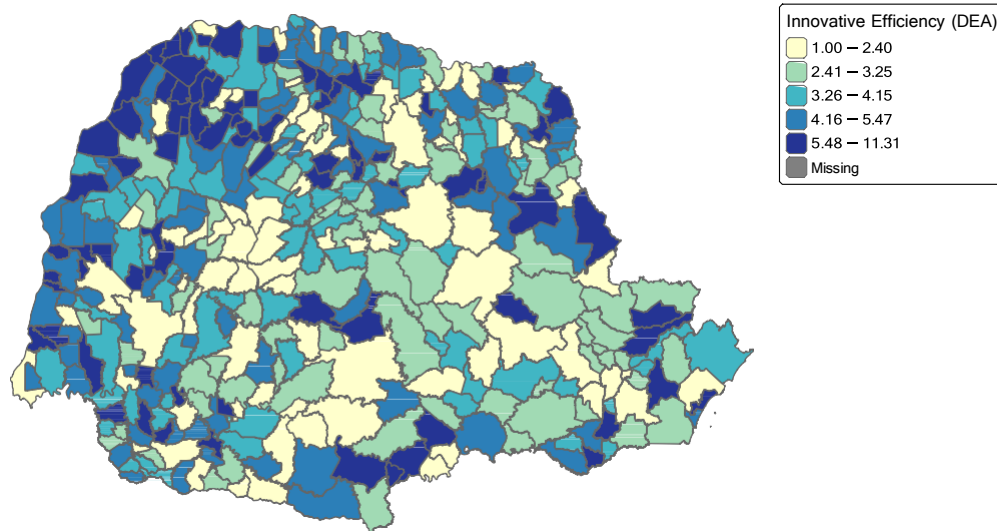
Table 2 reveals a strong explanatory power of the model, with an adjusted R^2 of 0.83. The negative coefficient for GDP ($\ln(PIB)$) suggests that a larger economic scale does not necessarily imply greater efficiency in innovation, which may reflect diminishing returns in municipalities already operating near capacity. Conversely, energy use and the KIA composite index exhibit positive and highly significant effects, confirming that the expansion of knowledge-intensive activities and energy infrastructure are key driver of innovative productivity. The negative relationship between intellectual property ($\ln(PI)$) and efficiency could indicate that patent activity, although concentrated, may not immediately translate into higher short-term innovation efficiency, consistent with previous findings in regional innovation studies.

To ensure the robustness of the results, conventional econometric diagnostics (such as normality, multicollinearity, and heteroskedasticity tests) were conducted, with the necessary corrections already incorporated into the final estimates presented above.

Finally, the spatial distribution of efficiency scores was analyzed using municipal-level mapping, providing an

intuitive visualization of regional disparities.

Figure 1: Spatial distribution of innovative efficiency in Paraná (2021).



Source: Author's elaboration based on DEA estimates and IBGE cartographic data.

Figure 1 reveals a heterogeneous spatial pattern: while some municipalities achieve higher efficiency levels, a large group remains concentrated in lower classes, especially in areas with weaker productive and institutional structures. This configuration is consistent with the literature on spatial concentration of innovation and smart specialization [1,2], reinforcing the argument that policies aimed at strengthening local knowledge bases, supporting KIA sectors and improving access to infrastructure are essential to mitigate intra-state disparities in innovative efficiency.

5. CONCLUSION

This article aimed to evaluate the innovative efficiency of the 399 municipalities of Paraná in 2021, analyzing their ability to transform energy use and knowledge-intensive activity capacity into economic output and intellectual property generation. The evidence obtained through the DEA model and the log-linear regression confirms that the general objective was achieved, as significant efficiency differentials were identified among municipalities, strongly associated with local infrastructural conditions and the density of knowledge-intensive activities [1,2].

The results indicate that municipalities with more consolidated knowledge-intensive activities and robust energy infrastructure tend to exhibit higher innovative efficiency, while economic scale alone does not ensure a more efficient use of resources. These findings reinforce the importance of public policies that go beyond traditional growth models and focus on strengthening local innovation ecosystems [11]. Policy initiatives should prioritize the development of knowledge-intensive sectors, expansion of technological and digital infrastructure, collaboration between universities, firms, and governments, and the diffusion of innovation capabilities to less efficient municipalities [7,10]. Such place-based approaches are aligned with contemporary perspectives on regional innovation and smart specialization, contributing to more balanced territorial development.

However, some limitations must be acknowledged. The analysis focused exclusively on a cross-sectional perspective, which restricts dynamic inference about the temporal evolution of efficiency. Additionally, the use of aggregate indicators (particularly intellectual property registrations) does not fully capture informal or incremental innovation processes. Future research should extend the DEA analysis to a panel framework, integrate environmental and digital transformation indicators, and employ spatial econometric models to explore inter-municipal spillover effects and the role of innovation networks [6,13].

CONFLICT OF INTEREST

None.

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REFERENCES

1. Foray D, 2018. Regional development in knowledge-based economies. *Regional Studies*; 52(8), 1133–1146. <https://doi.org/10.1080/00343404.2018.1507170>
2. Fitjar RD, Rodríguez-Pose A, 2023. Innovation and regional disparities. *Regional Studies*; 57(3), 353–366. <https://doi.org/10.1080/00343404.2022.2036286>
3. Almeida B, 2023. Are Brazilian innovation systems innovative? Regional and sectorial decompositions of triple-helix synergies. *El Profesional de la Información*; 32(5), 2023. <https://doi.org/10.3145/epi.2023.sep.36>
4. Liu X, et al., 2025. Regional innovation efficiency and spatial performance. Unpublished manuscript, 2025.
5. Bai R, et al., 2024. An in-depth analysis of green innovation efficiency: Convergence and network structure characteristics. *Journal of Environmental Economics and Management*; 2024, 102725. <https://doi.org/10.1016/j.jeem.2024.102725>
6. Viana M, et al., 2024. Municipal innovation patterns and territorial disparities in Paraná. Working paper, 2024.
7. Pinar M, 2025. Regional productivity and innovation dynamics. Unpublished manuscript, 2025.
8. Banker RD, et al., 1984. Some models for estimating technical and scale inefficiencies in data envelopment analysis. *Management Science*; 30(9), 1078–1092. <https://doi.org/10.1287/mnsc.30.9.1078>
9. Cassanego R, Oliveira D, 2024. MNEs, FDI and regional innovation intensity: Evidence from Brazil. *Gestão & Produção*; 31(3), 2024. <https://doi.org/10.1590/1806-9649-2024v31eNqntPLY>
10. Autio E, et al., 2024. Innovation ecosystems and policy: Toward a framework for place-based innovation. *Research Policy*; 53(1), 104822. <https://doi.org/10.1016/j.respol.2023.104822>
11. Asheim BT, et al. 2019. *Regional Innovation Systems: Theory, Empirics and Policy*. Cheltenham: Edward Elgar.
12. Manavgat G, Erkan B, 2023. Geography of innovation and regional capabilities. Unpublished manuscript, 2023.
13. Foray D, 2023. Smart specialization and regional innovation ecosystems. Working paper, 2023.
14. Rovere R, Albuquerque E, 2021. Governance and regional innovation ecosystems. Working paper, 2021.
15. Boschma R, 2005. Proximity and innovation: A critical assessment. *Regional Studies*; 39(1), 61–74. <https://doi.org/10.1080/0034340052000320887>
16. Crescenzi R, Rodríguez-Pose A, 2011. Innovation and regional growth. *Economic Geography*; 87(2), 165–185. <https://doi.org/10.1111/j.1944-8287.2011.01116.x>
17. Balland PA, et al., 2020. Smart specialization and regional innovation: A complexity perspective. *Regional Studies*; 54(9), 1232–1244. <https://doi.org/10.1080/00343404.2019.1582762>
18. Kline P, Moretti E, 2014. People, places, and public policy: Some simple welfare economics of local economic development programs. *Annual Review of Economics*; 6, 629–662. <https://doi.org/10.1146/annurev-economics-080213-041024>
19. Farole T, et al., 2011. Cohesion policy in the European Union. World Bank Policy Research Working Paper, 2011.
20. Audretsch DB, Feldman MP, 1996. R&D spillovers and the geography of innovation and production. *American Economic Review*; 86(3), 630–640.
21. Castells M, 1996. *The Rise of the Network Society*. Oxford: Blackwell.
22. Breschi S, Malerba F, 1997. Sectoral innovation systems. In: Edquist, C. (Ed.), *Systems of Innovation*; 130–156.
23. Morgan K, 1997. The learning region. *Regional Studies*; 31(5), 491–503. <https://doi.org/10.1080/00343409750132289>
24. Storper M, 1997. *The Regional World: Territorial Development in a Global Economy*. New York: Guilford Press.
25. Florida R, 2002. *The Rise of the Creative Class*. New York: Basic Books.
26. OECD, 2006. *Innovation Systems and Policy Frameworks*. Paris: OECD Publishing.
27. Feldman M, Kogler D, 2010. Stylized facts in the geography of innovation. In: Hall, B.; Rosenberg, N. (Eds.), *Handbook of the Economics of Innovation*.
28. Boschma R, Frenken K, 2011. The emerging empirics of evolutionary economic geography. *Journal of Economic Geography*; 11(2), 295–307. <https://doi.org/10.1093/jeg/lbq053>
29. Uyarra E, 2010. Conceptualizing the regional roles of universities. *Regional Studies*; 44(9), 1227–1236. <https://doi.org/10.1080/00343400903280434>
30. Maskell P, Malmberg A, 2007. Localized learning and industrial competitiveness. *Cambridge Journal of Economics*; 31(4), 603–617. <https://doi.org/10.1093/cje/bem020>
31. Tödtling F, Trippl M, 2005. One size fits all? *Research Policy*; 34(8), 1203–1219. <https://doi.org/10.1016/j.respol.2005.01.018>
32. Acemoglu D, et al., 2001. The colonial origins of comparative development. *American Economic Review*; 91(5), 1369–1401. <https://doi.org/10.1257/aer.91.5.1369>
33. Rodrik D, et al., 2004. Institutions rule. *Journal of Economic Growth*; 9(2), 131–165. <https://doi.org/10.1023/B:JOEG.0000031425.72248.85>
34. Fagerberg J, 2006. Innovation and economic growth. In: Fagerberg, J.; Mowery, D.; Nelson, R. (Eds.), *The Oxford Handbook of Innovation*.
35. Mazzucato M, 2013. *The Entrepreneurial State*. London: Anthem Press.
36. Hausmann R, et al., 2014. *The Atlas of Economic Complexity*. MIT Press.

37. Hidalgo CA, Hausmann R, 2009. The building blocks of economic complexity. PNAS; 106(26), 10570–10575. <https://doi.org/10.1073/pnas.0900943106>
38. Rodríguez-Pose A, 2013. Do institutions matter for regional development? Regional Studies; 47(7), 1034–1047. <https://doi.org/10.1080/00343404.2012.748978>
39. Crescenzi R, Rodríguez-Pose A, 2012. Infrastructure and regional growth in the EU. Papers in Regional Science; 91(3), 487–513. <https://doi.org/10.1111/j.1435-5957.2012.00439.x>
40. Lundvall BÅ, 1992. National Systems of Innovation. London: Pinter.
41. Nelson RR, 1993. National Innovation Systems. Oxford: Oxford University Press.
42. Barro R, 1991. Economic growth in a cross section of countries. Quarterly Journal of Economics; 106(2), 407–443. <https://doi.org/10.2307/2937943>
43. Dosi G, 1988. Technological paradigms and technological trajectories. Research Policy; 17(3), 147–162. [https://doi.org/10.1016/0048-7333\(88\)90030-1](https://doi.org/10.1016/0048-7333(88)90030-1)