

Innovation at the Edges of the Metropolis: An Analysis of Innovation Drivers in Sydney's Peripheral Suburbs

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Abstract

This article discusses using the concept of innovation ecosystems to assess innovation intensity in peripheral areas of metropolitan regions. Innovation is a significant driver of prosperity, industrial growth, and job creation. Emergent areas of new technology applications have their roots in entrepreneurial and innovative practices. However, studies have focused on the strengths that cities—and central business districts and inner suburbs in particular—have relative to the industries of the emerging knowledge economy, notably information technology and financial, property, and business services. Most of the time, the peripheral suburbs have been neglected.

The results from a study of innovation drivers in Sydney, Australia, show that peripheral suburbs in metropolitan areas have local innovation processes that require specific planning measures to promote innovation intensity. Some of these processes are linked to local suburban characteristics that might not apply to the entire city or metropolitan region.

Keywords: Australia; Innovation; Suburbs

Introduction

Innovation is a significant driver of growth and hence one of the main contributors to a productive and prosperous region (Organisation for Economic Co-operation and Development [OECD] 1999, 2001a, 2001b). Industrial growth, job creation, emergent areas of new technology, and the development of smarter industries are based on entrepreneurial and innovative activity (OECD 2003). However, studies have focused on the strengths

that cities—and central business districts (CBDs) and inner-city suburbs in particular—have relative to the industries of the emerging knowledge economy, notably information technology (IT) and financial, property, and business services. Peripheral suburbs are often regarded as bedroom suburbs where industrial activity is linked to the CBD and where transportation planning plays a major role in making them sustainable.

This article provides empirical evidence to support the thesis that peripheral suburbs in metropolitan regions have particular innovation processes that require specific planning strategies for innovation intensity. Therefore, traditional policy approaches to innovation might not be transportable to different areas of the metropolitan region, and more attention needs to be paid to the local characteristics of suburbs or local government areas (LGAs)¹ where the culture of innovation needs to grow and flourish.

Despite the volume of analytical work in several countries, many of the policies put into effect at the national and regional scale have exhibited only moderate success. This may be due to the fact that the analysis has a national or state orientation and lacks the ability to drill down to a finer scale or lacks an integrated approach (Feser and Bergman 2000). A second problem has been that most of the investigative work on regional/local innovation and development has involved case studies with little comparative analysis. The difficulty has been that the way case studies are designed tends not to be very powerful analytically, and in most cases it has been hard to draw policy-relevant lessons. Markusen (1999) has noted that an analysis of articles on regional development appearing over 25 years reveals that few researchers used replicable methods and that some did not reveal their methods or the reliability of the inferences.

There has been a split between researchers from different disciplines that can be roughly characterized as more or less economic; some use quantitative methods, such as input/output or trade, and others use qualitative approaches focused more on relationships between players and emphasizing intangibles such as trust or collaboration. In research carried out in Canada, two observers collaborated in the analysis of innovation performance in Quebec. One, using quantitative methods, presented one picture (quite a lot of innovation) while the other, using qualitative interviews with players,

¹The LGA is a spatial unit that represents the whole, undivided geographic area of responsibility of either an incorporated local government council or an incorporated community government council of sufficient size and statistical significance in Australia's Northern Territory (Australian Bureau of Statistics 2001).

reported a different situation (pessimism about levels of innovation) (Nimijean and Landry 2000). Storper (1995), in a wide-ranging article, has discussed each of the major approaches to examining regional innovation. He concludes that an approach combining some of the quantitative input/output insights on agglomerations of activities and some of the qualitative analysis of relationships is helpful.

Moving toward an integrated approach to analyzing innovation is a useful development. An important feature of an integrated approach, and one that is often neglected, is the dynamics of spatial development and the interaction of different aspects of spatial activity under different systems of innovation. New approaches from the so-called triple bottom line (social, economic, and environmental) can be used to extend the analysis into new domains. However, the overall methodological difficulty of providing a useful study with regional economic data is an important limitation in studying local/regional innovation.

Therefore, it seems time to take a different approach. This article explores innovation indicators across a triple bottom line perspective. We explore the innovation dynamics of industrial knowledge intensity, environmental factors, and social/community issues. We argue that these areas do not belong to the same innovation system but rather have distinctive features, governing rules, scales, and dynamics and should be considered differentiated innovation ecosystems. The article explores this conceptual framework and explains the composition of these ecosystems and their role in innovation in peripheral suburbs.

Research questions

We analyze innovation drivers through the use of a set of indicators applied to the Macarthur region of southwestern Sydney, an area located at the edge of the city. Specifically, the study explores three innovation ecosystems: knowledge-intensive dynamics, environmental dynamics, and social dynamics. The specific research questions we investigate are as follows:

1. What innovation drivers do firms/regional organizations identify as important for innovation and development?
2. What knowledge-intensive activities do these firms/organizations perform?
3. For these firms/organizations, how important are environmental dynamics for innovation?

4. How much collaboration is there between firms and regional/community organizations?

Method

We investigated these questions by using a set of eight innovation drivers and 38 innovation indicators. The eight drivers are knowledge intensity; connectivity; knowledge generation, transfer, and integration; entrepreneurship; environmental dynamics; community engagement; livability; and accessibility.²

We used a combined methodology: a horizontal analysis using indicators and an Innovation Dashboard™³ plus a vertical analysis using 12 case studies of firms and organizations.⁴ The Innovation Dashboard was built to visualize and summarize the quantitative data collected through the innovation indicators. It normalizes indicator information via a comparative ranking system. An indicator is ranked among geographic cases (cities, regions, countries, etc.), where it is allocated a score and a ranking color. We also

²*Knowledge intensity*: activities and inputs requiring intelligence and high application of knowledge and skills.

Connectivity: the importance of interaction, activities, and engagement to networks, other companies, and research institutions, etc.

Knowledge generation, transfer, and integration: the capacity to produce knowledge inputs that can be transferred and then integrated into other organizations.

Entrepreneurship: the capacity of start-up organizations in commercializing products and/or services.

Environmental dynamics: environmental factors contributing to the development of livable spaces, growth in knowledge economy and high-technology jobs, and the conservation of natural capital in the face of resource scarcity and degradation (e.g., pollution-treatment technology).

Community engagement: the capacity to interact with the broader community (e.g., with community organizations).

Livability: the capacity of a city or region to enhance quality of life by the services it provides and the resources it offers for human interaction.

Accessibility: accessibility and mobility within the region (e.g., transport, Internet, mobile communication).

³The Dashboard Model is a visually engaging online tool that converts indicator data into normalized scores and indices, and presents information in the form of a dashboard. The software can be downloaded from the Joint Research Centre and European Statistics Laboratory Web site (2004).

⁴Twelve case studies were selected according to a series of indicators comprising the size of the organization, the subregion, the phase of company life, the industry sector, and the receipt of an innovation or industry award. The case studies broadly represent the diversity of organizations but not all of the industry or institutional sectors of the Macarthur Regional Organisation of Councils area. Nor do they represent a statistically significant sample of the total number of organizations in the region. When possible, comparisons were made between organizations that have an innovation award and those that do not. Two of the case study firms were public organizations, four were manufacturing firms, four provide services, and two were in agriculture.

examined knowledge intensity and innovation at the firm/organizational level through an analysis of knowledge-intensive service activities (KISA).⁵

The contribution of this article lies in two related outcomes. One is in conceptualizing innovation drivers as closely dependent on local factors and actors and thus recognizing the peripheral suburbs of metropolitan regions as places where innovation and development have distinct characteristics. Another is the use of a methodology that is easy to replicate and that takes both quantitative and qualitative techniques into account. We first discuss the conceptual framework and then key findings and conclusions.

Innovation ecosystems: A new conceptual framework

Our conceptual framework is based on the view that economic or industrial factors alone cannot explain why some regions are innovation intensive while others stagnate. In particular, we argue that three different systems critical for urban development—the knowledge intensity, environmental dynamics, and social dynamics—can coexist in any given space. While the interaction of the first two is starting to be discussed in the literature (Bellamy et al. 2003; Hargroves and Smith 2005), an understanding of the dynamics of the social dimension and of its effects on local development is still at an early stage. Our study tries to unravel some of the innovation drivers that belong to each of these systems. We refer to them as innovation ecosystems because of their complexity, different indicators, and different roles in innovation.

The notion of innovation involves knowledge-based approaches that rely on the willingness and ability of firms and institutions to interact and hence share and exchange knowledge (OECD 2002). However, this approach needs to expand to use cities and regions as the unit of analysis and to consider how learning is embodied in the innovation process at a local/regional level. Using the taxonomy of innovation as process (technological and organizational) and product (goods and services) (Edquist, Hommen, and McKelvey 2001) to explain regional innovation is therefore limited, because the interaction of activities happening in a certain space is not fully considered.

We propose to analyze place-related innovation from a different perspective, one based on systems of activities from knowledge, environmental, and social dynamics (see figure 1). The focus on the interaction of activities pro-

⁵KISA is defined as the production and integration of service activities (technical and nontechnical) undertaken by firms in manufacturing or service sectors, in combination with manufactured outputs or as stand-alone services. KISA can be provided by private enterprises or public sector organizations. Typical examples include research and development (R&D) services, management consulting, IT services, human resource management services, legal services such as intellectual property-related issues, accounting, financing, and marketing services (Martinez-Fernandez and Miles 2006; OECD 2003).

vides a more precise picture of the innovation system of a particular place. In this way, the innovation system of CBDs in cities can be very different from the innovation systems linked to suburbs or systems of suburbs on the periphery. Therefore, the role of local institutions in producing and promoting programs and policies is affected by a unique innovation system. A lack of understanding of local innovation dynamics might result in a mismatch of planning policies and user needs.

Drivers and indicators

On the basis of the ecosystem framework, we identified eight innovation drivers⁶ for the knowledge intensity, environmental, and social ecosystems potentially interacting in a certain space. We chose a total of 38 indicators to analyze these drivers (see table 1).⁷

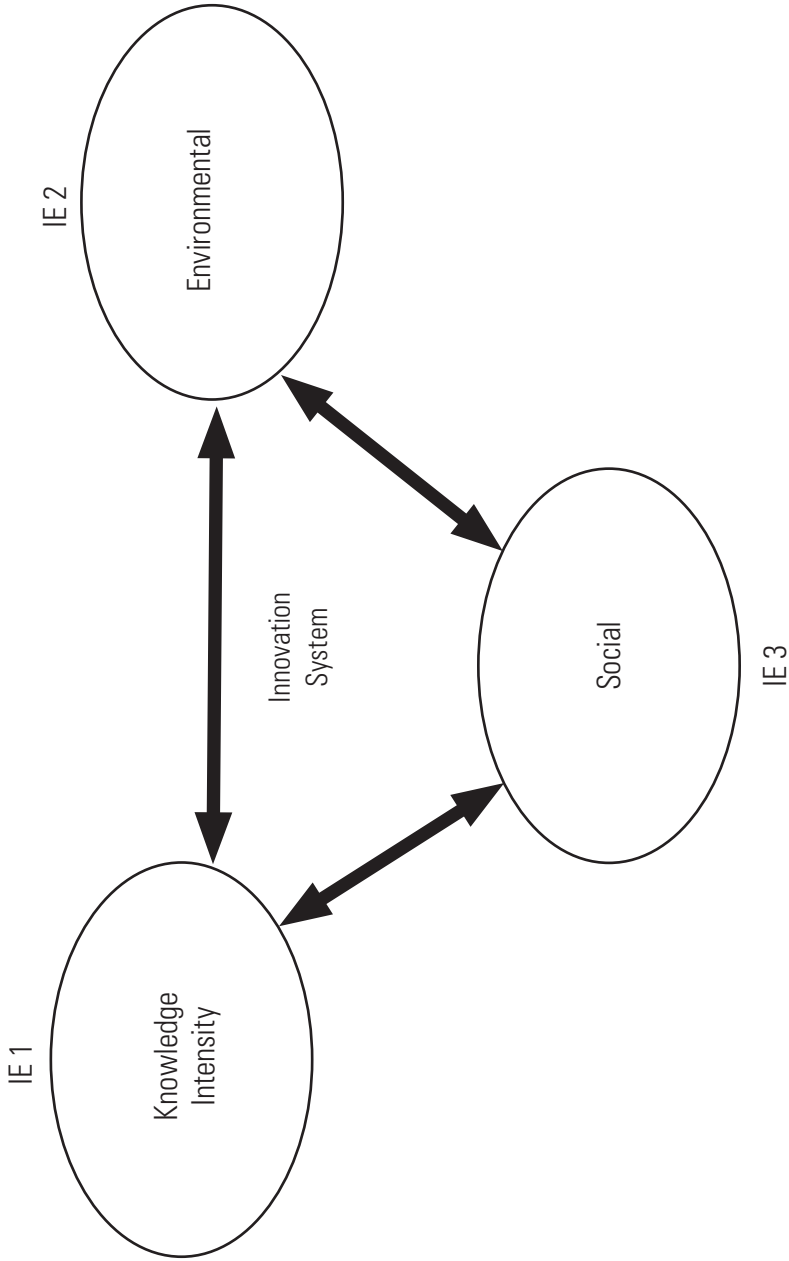
To have any significance for planning practice, regularly reported sustainable development and innovation information should emerge over time at the local and regional levels. The lack of data sets and suitable information is an ongoing problem, particularly for the connectivity, knowledge generation/transfer/integration, entrepreneurship, and community engagement dimensions. In addition, environmental dynamics indicators (water use and greenhouse emissions), livability (facilities and social capital), and accessibility (Internet and broadband accessibility, health indicators, transport) need to be refined on a regional scale. Crossing all dimensions is the need for participation by stakeholders and agreement on a reported set of sustainable innovation indicators linked to regional decision-making processes (and decision makers). Our set, although limited⁸ by information and resource constraints, contributes to this debate.

⁶These were identified through a combination of literature reviews and industry workshops.

⁷This is not a complete list of possible indicators.

⁸The statistical information we collected was limited by time and resource constraints. The set of innovation indicators is not a complete list for metropolitan regions but a list to test the conceptual framework in the area under analysis. The number of case studies is small and does not represent all economic sectors in that area. There are limitations related to the use of the Innovation Dashboard, since it relies on a series of geographic cases as the basis for comparison. Having more cases in the dashboard results in increasingly detailed rankings and outcomes. For example, the United Nations Sustainability Dashboard used 60 indicators across 230 countries (Joint Research Centre and European Statistics Laboratory 2004). Our study uses 38 indicators across three LGAs, leading to a limited analysis that could be adjusted in the future with more case studies. However, the goal of the study was to examine the utility of this tool in the context of the innovation ecosystem framework. The relative ranking of the indicators and LGAs by the dashboard allows for examination of the interaction of policy fields and systems. Rankings of the indicators provided should not be interpreted as a definitive outcome for the regions and suburbs under analysis but rather as a tool for influencing debate and capturing the attention of policy makers.

Figure 1. Innovation Ecosystems (IE)



Source: Martinez-Fernandez et al. 2005.

Table 1. Innovation Indicators

Innovation Ecosystems	Drivers	Indicators
Knowledge intensity	1. Industry knowledge intensity	Percentage of employees in manufacturing Percentage of employees in knowledge-intensive business services Percentage of employees in cultural and recreational industries Percentage of employees in health
	2. Connectivity	Number of business networks Number of industry clusters Number of development networks
	3. Knowledge generation, transfer, and integration	Number of master's and doctoral students in the region Proportion of science/engineering/IT postgraduates Number of students from University of Western Sydney cooperative programs working in industry Number of university/industry partnerships
	4. Entrepreneurship	Mean number of business start-ups, 1999 to 2004
Environmental	5. Environmental dynamics	Waste generation per capita Recycling per capita Commercial water use Residential water use Total water use Greenhouse gas emissions Pollution licenses and breaches Local government expenditure in environmental management
Social	6. Community engagement	Number of council-funded community organizations Funding attached to these organizations
	7. Livability	Australian Bureau of Statistics socioeconomic index Mortgage stress Museums and libraries Recreational expenses per capita Community service expenses per capita 10-year population growth Crime index Unemployment National parks in the LGA
	8. Accessibility	Internet use at home Hospitals and community medical facilities General practitioners in the LGA Share of available jobs in the Macarthur Regional Organisation of Councils area Percentage of people who use cars to get to work Percentage of people who use trains to get to work Percentage of people who use buses to get to work

Source: Martinez-Fernandez et al. (2005).

Area of analysis

The area of analysis is the Macarthur region of southwestern Sydney (see figure 2), comprising the LGAs of Campbelltown, Camden, and Wollondilly—more than 50 suburbs in all. Although this area at the boundaries of the city shows commonalities for a macroanalysis, there are considerable and observable differences at the micro level. Campbelltown is the most industrial area, Camden is largely rural and residential, and Wollondilly has semirural characteristics. The Macarthur region is located approximately one hour from Sydney's CBD (north), less than one hour from the city of Wollongong (south), and two hours from the capital, Canberra (west). The population is approximately 240,000.⁹

Key findings

The Innovation Dashboard was useful for providing a horizontal analysis of innovation drivers, while the case studies of firms and organizations provided a vertical, in-depth analysis in the areas indicated by the dashboard. The study is conclusive in that a combined methodology (quantitative and qualitative) was used to analyze regional innovation systems, because each method alone does not provide an analysis at the required level of complexity. Many quantitative studies fail to provide the depth and consideration of processes needed to design improved policies and programs.

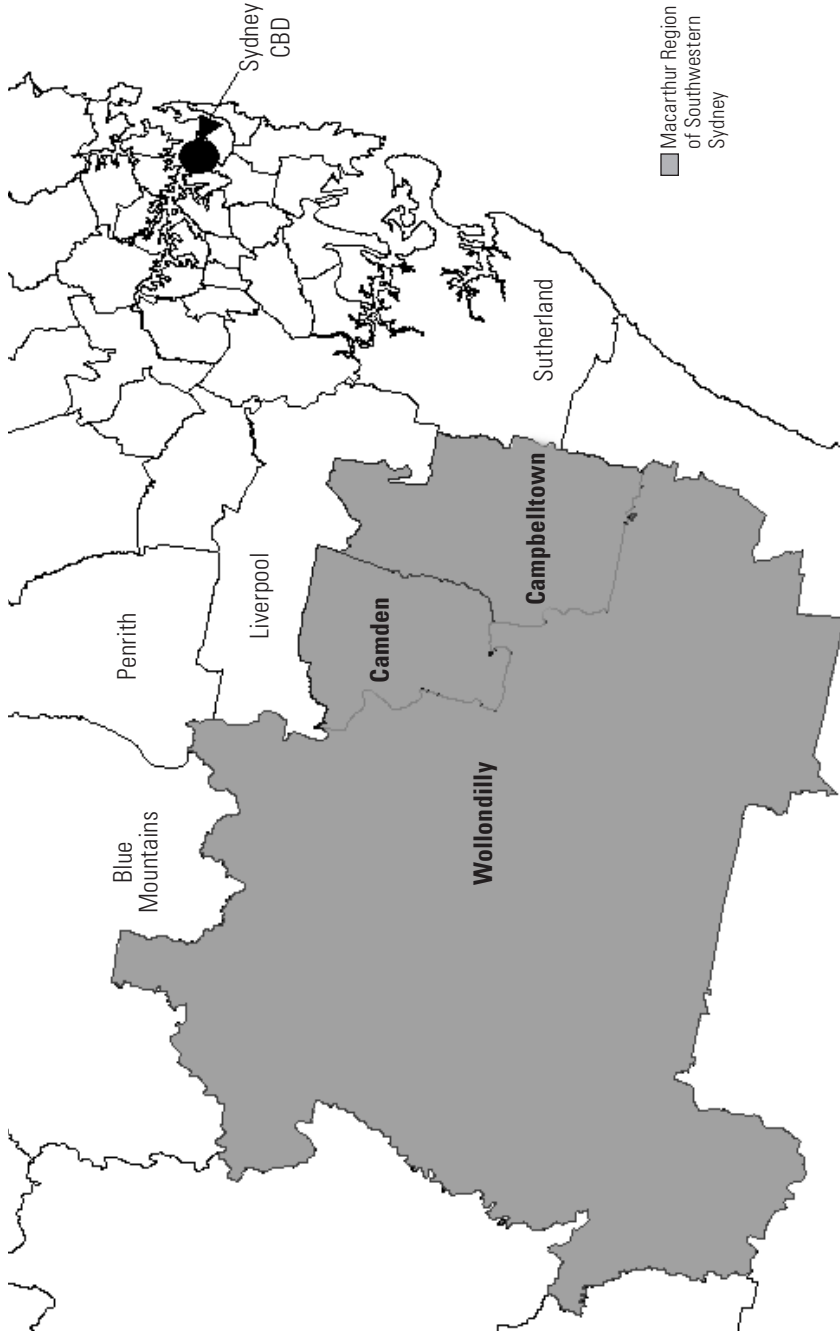
Overall, the study conclusively showed the importance of knowledge intensity, environment, connectivity, and accessibility as the key drivers of innovation for the region under analysis. While the organizations that were interviewed highlighted a link between environmental dynamics and knowledge intensity, the social dimension was more disconnected and not clearly linked to socioeconomic development or to business development apart from the vision of some firms relative to the importance of this system for corporate social responsibility and future activities.

Regional innovation indexes

We developed regional innovation indexes applying the dashboard approach to the three LGAs under analysis. One advantage of using the dashboard is the ability to create indices based on the indicators and aggre-

⁹See a review of the area in Department of Transport and Regional Services (2003), Randolph and Holloway (2003), and Fagan, Dowling, and Langdale (2004).

Figure 2. The Macarthur Region of Southwestern Sydney



gate them into an overall performance index. The shades in the dashboard indicate the relative ranking of the standardized indicators; in this case, dark shades indicate a lower ranking (scores in the 100 to 300 range), while light ones indicate a higher relative ranking (scores in the 700 to 1,000 range).¹⁰ The regional innovation index highlights the diversity of issues that can contribute to local/regional innovation. The index is calculated as a simple average of the component indicator ranks, but the dashboard has the ability to set weighting measures according to user preference. In the index scores, the LGAs of Campbelltown and Camden have similar results and higher ranks (570 and 567, respectively) than Wollondilly¹¹ (365). It is interesting to note that the ranks for Campbelltown and Camden have been derived from different subindex results (see figure 3), indicating the multidisciplinary nature of innovation activity in local areas.

Campbelltown has a high ranking for the innovation drivers, suggesting that it is well placed for contributing to regional innovation. According to the dashboard, the key advantages of the region are in knowledge generation, industrial knowledge intensity, entrepreneurship, and accessibility—key components of innovative regions. This highlights the role of Campbelltown as a regional hub of activity for education, knowledge, and accessibility to services, jobs, and mobility, often drawing on the populations of Camden, Wollondilly, and the surrounding LGAs.

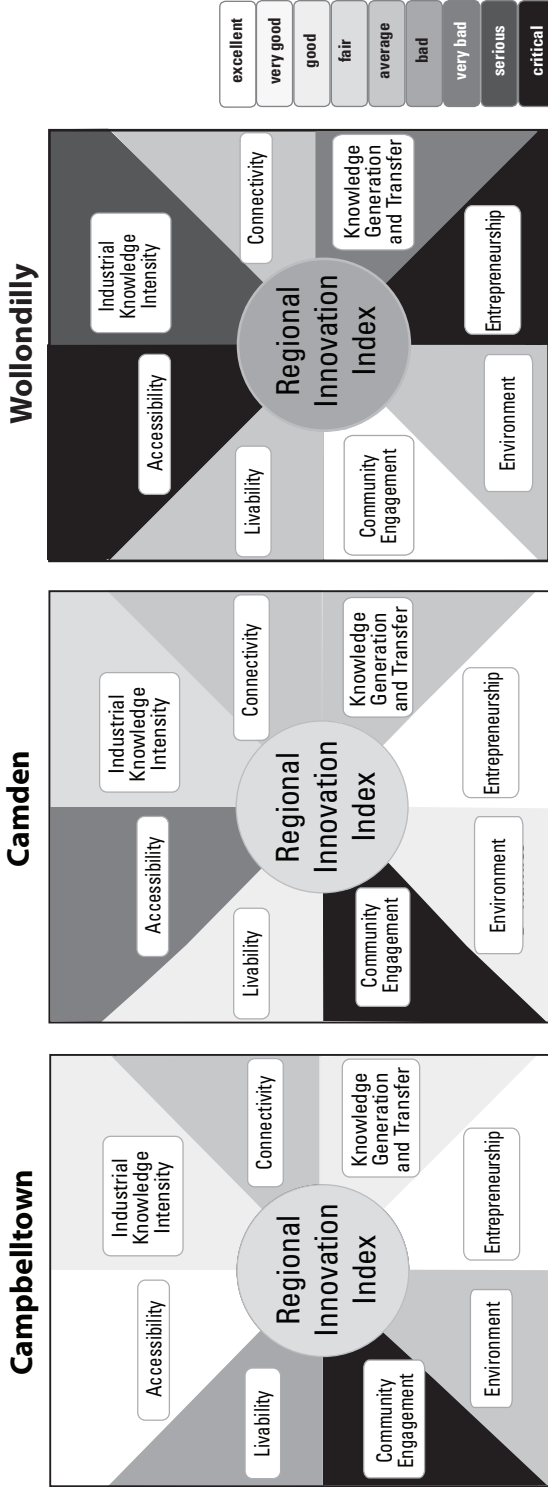
Camden ranked high in the livability, environmental dynamics, entrepreneurship, and industrial knowledge intensity fields. This pattern suggests that Camden has significant quality of life features that make it an attractive place to live. Accessibility issues were ranked lower than other factors in this region, highlighting transport and services problems. Knowledge transfer initiatives and improved business connectivity would also benefit the region's innovation potential.

Wollondilly has the most to gain from developing innovation drivers. On the basis of the indicator set, it ranks third overall in the regional innovation index. Wollondilly performed well in connectivity and community engagement, but these are fields in which data were limited or difficult to obtain. Knowledge intensity, knowledge transmission, entrepreneurship, and accessibility are areas in need of attention to boost innovation.

¹⁰In this article, the dashboard uses shades of gray. However, the software typically uses a 9-point color scale to maximize visual uptake—moving from red to yellow to green to indicate the relative ranks of the parameters. Red ranks the lowest while green ranks higher (see Martinez-Fernandez et al. 2005).

¹¹The maximum rank score is 1,000, while the lowest is 0.

Figure 3. Regional Innovation Index for Campbelltown, Camden, and Wollondilly



Two important methodological issues should be considered when reviewing this figure:

- The **size** of a segment reflects the relative importance of the issue described by the indicator.
- The **central circle** (Regional Innovation Index) summarizes the information provided by the component indicators.

Source: Martinez-Fernandez et al. (2005).

Note: This figure has been adapted for black and white print publication. See footnote 10.

Which innovation drivers are identified by regional organizations as important for the area's development?

Most of the case studies mentioned three highly important innovation drivers: knowledge intensity, environmental dynamics, and accessibility. Connectivity, entrepreneurship, and community engagement were considered of medium importance, while knowledge generation/transfer/integration and livability were not considered very important. Both manufacturing and service companies mentioned knowledge intensity as a critical factor to drive the business and keep up with identified innovation goals. Environmental dynamics were widely noted as highly important and second only to knowledge intensity (we will discuss this later). Some organizations mentioned accessibility as important to contact more people and to do so more quickly and more easily; according to Martinez-Fernandez et al. (2005), accessibility "is a key to retain people, as well as bringing other people in" (39). Accessibility was noted in relation to transport networks in the area but also in relation to broadband and IT facilities across the region. Access to the Sydney area was important, but equally important was access to the nearby city of Wollongong and to Port Kembla, indicating the polycentricity of the wider metropolitan region.

Which elements of knowledge intensity are present in the region?

We found that the use of KISA by the case study companies was limited to IT consulting, marketing, and R&D activities considered highly important for innovation purposes. Service provision for these activities was mainly in-house and in collaboration with the private sector when external expertise came from outside the firm/organization. Expertise was drawn mainly from the local area and through the use of referrals and networks. In the Wollondilly subregion, the local area for sourcing expertise extends to the city of Wollongong¹² more than to Sydney, including the use of the University of Wollongong instead of the local University of Western Sydney (UWS) Campbelltown campus for specific industry/university collaboration. This particular knowledge ecosystem indicates that the functional region for KISA extends south to an area within a 30-minute drive and hooks into the big coastal city of Wollongong and the Port Kembla harbor. Geographic proximity seems to be a more important factor than participation in international networks.

¹²Wollongong is part of the Sydney Metropolitan Region, 80 kilometers south of the CBD. It is Australia's ninth largest city.

Connectivity to other businesses and networks was considered an important factor for business development. The firms we studied refer to the use of informal arrangements with innovation partners such as other firms within the same industry group, customers, competitors, research and technology organizations, and regional organizations.¹³ Formal agreements drive the collaboration when knowledge-intensive business services, public institutions, and industry institutions are used, while informal agreements are in place for other network relations within and outside the local area.

How important are environmental dynamics for innovation in the region?

Environmental dynamics, based on the notion of sustainable development, were identified within the conceptual framework and the literature as a driver for establishing innovative and competitive firms, organizations, and regions (Hall and Vredenburg 2004; Hargroves and Smith 2005; Martinez-Fernandez et al. 2005). As highlighted by innovation driver indicators, regional public organizations and firms are increasingly concerned about the conservation of potable water, energy efficiency/climate, and the impact of pollution and waste. With the Sydney metropolitan region expanding and the southwestern Macarthur region particularly earmarked for rapid population expansion (New South Wales Department of Infrastructure, Planning, and Natural Resources 2004), the role of environmental innovation and resource efficiency is particularly important in ensuring sustainable growth.

Case study interviews consistently indicated that environmental dynamics were important for innovation. There was recognition within the organizations that environmental dynamics are emerging as a driver of business success with positive efficiency outcomes in resource use, a reduction in waste and associated costs, the creation of competitive organizations, and the opening of new markets. One company noted during our interviews in 2004 that “[its] strong environmental innovation base contributes to cost effectiveness and gives [it] an edge on market rivals.” Although environmental innovation is a growth area for organizations, the interviews and indicator data highlighted an ongoing problem. Most organizations recognize that environmental innovation could lead to successful outcomes but were unsure about how to resolve these issues within the business context. The results show a clear case for collaboration between and within firms and organizations and for the development of regional learning networks. Further regula-

¹³This refers to public research institutions such as universities and public sector research departments.

tory reform, creation of business incentives, and establishment of markets for environmental technology, including carbon trading, will further strengthen the role of environmental innovation outcomes.

The indicator results emphasized that research is needed on regionally significant measures that relate to innovation capacity and progress. Indicator measures need to move toward investments in environmental innovation, R&D outcomes, and data on resource efficiency in particular sectors. A balance between process and outcome indicators is required to tell the full story. In addition, future indicators will need to explain the links among knowledge outcomes, knowledge-intensive industries, and environmental dynamics because the different drivers often overlap. An example from the case study region was the issue of water conservation in firms and the role of regulation in driving demand for expertise (knowledge) and operational systems. This demand for knowledge is manifest across several sustainability issues and business sectors, with a particular focus on energy efficiency and adaptation to production climate change (Hargroves and Smith 2005). There is considerable opportunity for innovative new firms and strategic advantages for existing firms (Griffiths 2004).

The indicators presented in this study illuminate the need for better information on environmental innovation across key sectors, its role in driving competitiveness, and uptake by firms, organizations, and communities.

How much collaboration is there between industry and regional organizations?

Collaboration between industry and regional organizations in the area is very limited. Out of 12 cases, only 4 to 5 collaborated¹⁴ with regional organizations. The maximum number of projects with UWS¹⁵ was only five. The organizations with high interaction with firms were UWS; technical colleges; the Department of Infrastructure, Planning, and Natural Resources; and the various local chambers of commerce. Both formal and informal interaction is involved, but the latter predominates.

Nevertheless, collaboration and community engagement were considered increasingly important as innovation drivers, despite the fact that the elements involved and their effects on firm innovation or in the regional

¹⁴What we mean here is the number of collaboration links such as specific projects or committee participation.

¹⁵UWS is the only university in the region, with nine campuses across Greater Western Sydney.

innovation system as a whole are still poorly understood. Respondents also indicated that accessibility issues (transport and access to broadband) were considered highly important because they had an impact on connections with knowledge sources and professionals at the regional, national, and international levels and broader markets of goods.

Most firms refer to engagement with the community as a driver that has changed rapidly during the past five years: “In the past, we would not have considered it a priority to engage with the community. However, nowadays it is a compulsory activity for us and is considered strategic for the development of our businesses” (Martinez-Fernandez et al. 2005, 56). This has been driven particularly by the corporate social responsibility agenda, but the link to social capital and innovation strategy remains a key research agenda.

Overall, the observed engagement with regional organizations is very limited and not significant in most cases. The firms consider community engagement as an activity focused on charitable entities, but not necessarily as engagement with regional networks of organizations to promote regional development.

Collaboration and social dynamics suggest the most challenging position and potential to contribute to the regional innovation system. The lack of understanding of the elements involved in the social dynamics ecosystem and the lack of company knowledge relative to community engagement highlight an area for strategic and policy attention. Local institutions such as councils have much to offer in facilitating this process of engagement across, for example, companies and community groups. At this level, the national innovation systems framework (Lundvall 1992) has little to offer, because it is too detached from what is happening on the ground. New local analytical tools need to be developed so policy makers can drive innovation at their constituency level and harness the benefits for social capital and knowledge societies.

Conclusion

The study we have discussed reveals that the spatial dynamics of innovation can be analyzed from the perspective of innovation ecosystems consisting of knowledge intensity, environmental dynamics, and social dimensions. Critical differences between these innovation ecosystems in the three areas under analysis show that even when areas were in relative geographic proximity and were part of the same metropolitan region, each innovation system was composed of different elements. These different spaces of activity and influence give rise to policy questions on the promotion of knowledge-inten-

sive industries, environmental innovation, and the integration of community dynamics in peripheral suburbs.

Increasing regional connectivity at the industrial and community level will help establish the information and knowledge networks so important in innovation processes. Pathways for increasing connectivity include the establishment of regional innovation forums, the formation of business networks, and the targeting of public/private partnerships to promote community engagement. Local councils have an important role to play in promoting knowledge intensity in their suburbs. For example, they can intensify their activities with firms and organizations in their LGA to reach a higher level of industry/community engagement and social collaboration that could result in public/private partnerships for innovation.

Environmental innovation is an area of natural competitive advantage for organizations and firms. Our study recommends promoting regional networking activities where experiences and expertise in environmental innovation are discussed and encouraged. The case studies indicate that local regulatory reform, the creation of environmental innovation incentives, and the diffusion of programs to minimize adverse effects will influence local environmental innovation activities. There is a strong role for universities and the public sector in establishing regional research partnerships for environmental innovation. This will enable organizations to access expertise to develop new environmental technologies and processes.

Activities to support the development of industrial networking activities or the establishment of business networks would intensify the development of KISA and connectivity between users and providers of knowledge. Specifically targeting an awareness of KISA's role in company innovation would influence the development of knowledge intensity in the region and would therefore contribute to the competitiveness of the city and its metropolitan region from the core to the periphery and vice versa.

Our study suggests the need to shift the analysis of innovation into a broader conceptual framework than has been traditionally employed:

1. Innovation analysis needs to be connected to the analysis of place as the context where innovation is occurring, and the national innovation system approach therefore offers limited applicability at the regional, local, or suburban level. In the context of a large city or a metropolitan region, the results of this analysis might be different for different parts of the city, since particular suburbs present particular industrial, environmental, and social characteristics.

2. The notion of a unique regional innovation system is no longer enough to explain the complexity of factors interacting in particular suburbs. Instead, we have proposed to analyze industrial knowledge intensity, environmental dynamics, and social dynamics as different innovation ecosystems governed by different rules and expectations on the part of stakeholders.
3. To look at local innovation systems, methodologies and measuring techniques need to be adjusted. Standard indicators do not provide a complete picture, and new indicators, often qualitative in nature, need to be developed to advance the analysis of innovation ecosystems.

We have presented an early attempt to develop indicators and measuring techniques related to innovation drivers in peripheral suburbs, and our results show the special needs of these suburbs in large metropolitan regions. Future work could focus on the analysis of different regions across the country and on international cases.

Authors

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