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Regional Innovation Systems: An Annotated Bibliography

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Regional Innovation Systems

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Contents

I. Introduction

Innovation, the ability to create, diffuse, and adopt new ideas and to transform them into new profitable products, processes, and services has been increasingly seen as an essential, if not the primary, driving force behind the enhancement of productivity, competitiveness, and economic welfare. While people conventionally understood the mechanism of generating innovation as a straightforward linear process from basic research to technology transfer and completed by industrial commercialization, researchers have begun to challenge this rationale with a complex, systemic model for innovation, viz. the theory of the systems of innovation where the orchestrated efforts and interactions among governments, universities and industries, among others, is taken as the source of sustainable innovation.

This annotated bibliography grew out of a project to quantify the effects of regional innovation systems on economic development entitled "Performance Measurement and Asset Mapping of Regional Innovation Systems in the United States". The literature contained here represents a spectrum of ideas on both national and regional innovation systems. While there has been an explosion of literature on innovation in the past few years, the WVU Regional Research Institute (RRI) has attempted to narrow the literature down to key representative examples and categorize it to help future researchers become familiar with the topics involved. The categories include: definitions of innovation and regional innovation systems, methodologies for measuring innovation performance, and empirical applications of these methodologies at different levels and across different regions. When available, RRI has included the abstract of the article. When an abstract was not available, RRI has summarized the article's contents. Additional comments from the authors may follow as 'Notes' to direct the readers toward a better exploitation of selected literatures.

RRI expects to continue to update this bibliography throughout the duration of this project. RRI would like to thank the U.S. Economic Development Administration for supporting this research.

II. Literature by Category

A. General Theory of Innovation

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16. Carlsson, B., & et al. (2002). Innovation Systems: Analytical and Methodological Issues. Research Policy, 31(2), 233-245.

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B. Methodology and Measurement

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2. Acs, Z. J., & Audretsch, D. B. (1993). Analyzing Innovation Output Indicators: The US Experience. In A. Kleinknecht & D. Bain (Eds.), *New concepts in innovation output measurement.* (pp. 10-41): New York: St. Martin's Press; London: Macmillan Press.

3. Arundel, A. (2007). Innovation Survey Indicators: What Impact on Innovation Policy? In D. Organisation for Economic Co-operation and (Ed.), *Science, Technology and Innovation Indicators in a Changing World: Responding to Policy Needs* (pp. 49-64). Paris and Washington, D.C.: Organisation for Economic Co-operation and Development.

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III. Annotated Bibliography

Acs, Z. J., Anselin, L., & Varga, A. (2002). Patents and innovation counts as measures of regional production of new knowledge. *Research Policy, 31*(7), 1069-1085.

Abstract

The role of geographically mediated knowledge externalities in regional innovation systems has become a major issue in research policy. Although the process of innovation is a crucial aspect of economic growth, the problem of measuring innovation has not yet been completely resolved. A central problem involved in such analysis is the measurement of economically useful new knowledge. In the US information on this has been limited to an innovation count data base. Determining the extent to which the innovation data can be substituted by other measures is essential for a deeper understanding of the dynamics involved. We provide an exploratory and a regression-based comparison of the innovation count data and data on patent counts at the lowest possible levels of geographical aggregation.

Acs, Z. J., & Audretsch, D. B. (1993). Analysing Innovation Output Indicators: The US Experience. In A. Kleinknecht & D. Bain (Eds.), *New concepts in innovation output measurement.* (pp. 10-41): New York: St. Martin's Press; London: Macmillan Press.

Abstract

Conventional wisdom about innovation was based on studies using the measure of input of innovation, such as R&D expenditures, and the measure of the intermediate output in the process, such as the number of patented inventions. Recently, some new learning regarding technological change has emerged based on new data sources for the direct measure of innovative output. The purpose of this article is to summarize what has been learned from these new data sources, providing a direct measure of innovative output for the United States, and how these new measures have led to a new learning about the process of technological change.

Arundel, A. (2007). Innovation Survey Indicators: What Impact on Innovation Policy? In D. Organisation for Economic Co-operation and (Ed.), *Science, Technology and Innovation Indicators in a Changing World: Responding to Policy Needs* (pp. 49-64). Paris and Washington, D.C.: Organisation for Economic Co-operation and Development.

Abstract

Being first introduced in 1993, the Community Innovation Survey (CIS) is considered one of the most comprehensive major sources of new innovation data at the time. However, in practice, European policy relies more on long-established data for R&D than the CIS. This article is to examine why R&D indicators still dominate innovation policy making in Europe and to make several suggestion for improving the usefulness of the CIS. This requires returning to some of the original goals of the CIS and using the CIS to construct new indicators that better meet the needs of the policy community. Several examples of new indicators are provided, including an output measure with better international comparability, an indicator for knowledge diffusion, and a set of indicators for firms' innovative capabilities.

Asheim, B. T., & Isaksen, A. (2002). Regional Innovation Systems: The Integration of Local 'Sticky' and Global 'Ubiquitous' Knowledge. *Journal of Technology Transfer, 27*(1), 77-86.

Abstract

The paper examines how firms in three regional clusters in Norway dominated by shipbuilding, mechanical engineering and electronics industry, respectively exploit both place-specific local resources as well as external, world-class knowledge to strengthen their competitiveness. From these case-studies we make four points: (1) ideal-typical regional innovation systems, i.e., regional clusters "surrounded" by supporting local organizations, is rather uncommon in Norway; (2) external contacts, outside of the local industrial milieu, are crucial in innovation processes also in many SMEs; (3) innovation processes may nevertheless be regarded as regional phenomena in regional clusters, as regional resources and collaborative networks often have decisive significance for firms' innovation activity; and (4) regional resources include in particular place-specific, contextual knowledge of both tacit and codified nature, that, in combination, is rather geographically immobile.

Autio, E. (1998). Evaluation of RTD in regional systems of innovation. *European Planning Studies, 6*(2), 131-140.

Abstract

This paper focuses on the evaluation of research and technical development (RTD) in regional systems of innovation (RSIs). It is argued that regional systems of innovation are distinctly different from national systems of innovation, and, thus,

different approaches are called for in the evaluation of RSIs. The most relevant aspects of RSIs, from the evaluation perspective, relate to their largely tacit and context-specific character. In this paper, the concept and characteristics of RSIs are reviewed, and the implications of these for evaluation practice are discussed. Pointers for good practice in the evaluation of RTD in RSIs are listed.

Breschi, S., & Malerba, F. (1997). Sectoral innovation systems: technological regimes, Schumpeterian dynamics, and spatial boundaries. In C. Edquist (Ed.), *Systems of Innovation: Technologies, Institutions and Organizations* (pp. 130-156). London: Pinter Publishers.

Abstract

In this article, the concept of the sectoral innovation systems (SIS) is examined, in comparison with that of National Innovation Systems (NIS) and Technological Systems (TS). A sectoral innovation system can be defined as that system of firms active in developing and making a sector's products and in generating and utilizing a sector's technologies. Further, the authors claimed that the Technological Regimes (TR), defined by the level of opportunity and appropriability conditions, by the cumulativeness of technological knowledge, by the nature of knowledge and the means of knowledge transmission and communication, are a major factor that accounts for the dynamics of SISs and shape their spatial boundaries. Finally, an empirical analysis of some dimensions of SIS has been provided for six countries to confirm the relationship between TRs and SISs.

Bush, V. (1945). Science, the Endless Frontier: A Report to the President, from http://www.nsf.gov/od/lpa/nsf50/vbush1945.htm

Summary

In this post-WWII report to President Truman, Bush outlines a case for the United States to take on the role of funding basic research. Calling research a priority for disease prevention, public welfare and national security, Bush writes that scientific progress will improve the economic welfare of the nation. He also Congress to find ways to encourage more young people to go into scientific research and to strengthen patent laws to ensure that research is commercialized.

Carlsson, B., & et al. (2002). Innovation Systems: Analytical and Methodological Issues. *Research Policy, 31*(2), 233-245.

Abstract

Innovation systems can be defined in a variety of ways: they can be national, regional, sectoral, or technological. They all involve the creation, diffusion, and use of knowledge. Systems consist of components, relationships among these, and their characteristics or attributes. The focus of this paper is on the analytical and methodological issues arising from various system concepts. There are three issues that stand out as problematic. First, what is the appropriate level of analysis for the purpose at hand? It matters, for example, whether we are interested in a certain technology, product, set of related products, a competence bloc, a particular cluster of activities or firms, or the science and technology base generally—and for what geographic area, as well as for what time period. The choice of components and system boundaries depends on this, as does the type of interaction among components to be analyzed. The attributes or features of the system components that come into focus also depend on the choice of level of analysis. The second and closely related issue is how to determine the population, i.e. delineate the system and identify the actors and/or components. What are the key relationships that need to be captured so that the important interaction takes place within the system rather than outside? The third issue is how to measure the performance of the system. What is to be measured, and how can performance be measured at the system level rather than at component level?

Cooke, P. (2001). Regional Innovation Systems, Clusters, and the Knowledge Economy. *Industrial and Corporate Change, 10*(4), 945-974.

Abstract

This paper presents a systematic account of the idea and content of regional innovation systems following discoveries made by regional scientists, economic geographers and innovation analysts. It considers the conditions and criteria for empirical recognition and judgment as to whether scientifically analyzed, concrete cases of innovation activity warrant the designation of regional innovation system. The paper concludes by claiming that the source for Europe's innovation gap with the United States rests on excess reliance on public intervention, which signifies major market failure. The future will require widespread evolution of public innovation support systems along with stronger institutional and organizational support from the private sector.

Cooke, P., Gomez Uranga, M., & Etxebarria, G. (1997). Regional innovation systems: Institutional and organisational dimensions. *Research Policy*, *26*(4-5), 475-491.

Abstract

The paper explores the case for Regional Systems of Innovation. Acknowledging the major contribution of research on National Innovation Systems, it suggests that for conceptual and methodological reasons, mostly concerning problems of scale and complexity, that approach may be complemented in important ways by a subnational focus. Taking an evolutionary economics standpoint, the paper specifies the concepts of 'region,' 'innovation' and 'system' as the prelude to an extended discussion of the importance of financial capacity, institutionalized learning and productive culture to systemic innovation. Building on the notion of regions as occupying different positions on a continuum referring to processes constituting them and their powers vis-à-vis innovation policy, the paper concludes by advocating strengthening of regional level capacities for promoting both systemic learning and interactive innovation.

Notes

This paper explains the logical and theoretical connections between NIS and RIS, thus to justify the merits for RIS in subnational innovation policy analysis.

Cooke, P., Heidenreich, M., & Braczyk, H. (2004). *Regional Innovation Systems: The Role of Governance in a Globalized World*. New York: Routledge.

Abstract

Set within a broadly evolutionary economics perspective, accounts are given of the systems interaction occurring between firms and the innovation support infrastructure. Case studies include 'high road' instances such as Baden-Württemberg, Brabant and Singapore, and reconversion regions which emphasize 'upstream' innovation such as Tampere (Finland) with close university-industry links or 'downstream' near-market innovation such as Catalonia. Policy implications of the analyses offered and variation explored are set in a context where regional administrations have limited access to the full scale of innovation policy instruments.

Notes

This book contains fourteen case studies which have been put into categories concerning three fundamental issues in the governance of RIS: local-global interaction, governance restructuring and interregional government cooperation.

Cooke, P., & Memedovic, O. (2003). *Strategies for Regional Innovation Systems: Learning Transfer and Applications*. Vienna, Austria: United Nations Industrial Development Organization.

Abstract

The paper explains the concept of regional innovation systems. It argues that global economic forces have raised the profile of regions and regional governance not least because of the rise to prominence of regional and local business clusters as vehicles for global and national economic competitiveness. Key definitions are given and distinctions drawn. Then, by reference to a number of important dimensions characterizing innovation such as education, knowledge transfer, linkage and communications, four regions from Asia, Europe and Latin America are contrasted. It is shown that regional innovation systems can be underdeveloped by being too dependent on public support, but equally, an over-emphasis on private infrastructures needs to be guarded against except at the most advanced developmental level.

Notes

A combination of public and private governance at regional level to promote systemic innovation is advocated.

Diez, J. R. (2002). Metropolitan innovation systems: A comparison between Barcelona, Stockholm, and Vienna. *International Regional Science Review, 25*(1), 63-85.

Abstract

This article uses data from the European Regional Innovation Survey to provide insights into the innovative activity and innovation networking of the most important innovation actors, namely manufacturing firms, producer service firms, and research institutes. The innovation capacities of the metropolitan innovation systems differ markedly. In respect to cooperation partners, vertical relationships predominate. Only in Stockholm do research institutes play a significant role in assisting innovation processes in manufacturing firms. Spatial proximity of cooperation partners is very important, confirming the concept of territorially based systems of innovation. At the same time, the actors surveyed cooperate intensively with cooperation partners outside the region.

Notes

This paper identifies the key players in the metropolitan innovation system and compares the interaction models among them across three selected European regions.

Edquist, C. (1997). *Systems of Innovation: Technologies, Institutions and Organizations.* London: Pinter Publishers.

Summary

Edquist has three main goals in editing this book: to define a systems approach to innovation research; to provide a conceptual framework for the systems approach connect that framework to current theory; and to examine how innovation is carried out and evolves over time. Edquist argues that the systems-based approach encompasses more than firms introducing new products. He writes that systems entail looking at the ways in which governments, nonprofit organizations and for-profit enterprises work together to create new knowledge.

Evangelista, R., & et al. (2002). Looking for Regional Systems of Innovation: Evidence from the Italian Innovation Survey. *Regional Studies, 36*(2), 173-186.

Abstract

The empirical target of this article is two-fold: exploring the variety of regional innovative patterns in Italy; and assessing whether innovation systems can be found, and how they operate, at a sub-national scale. The empirical analysis is based on an in-depth analysis of the data provided by the first Community Innovation Survey (CIS). The article shows that the traditional north-south distinction does not give full account of the wider spectrum of regional patterns in Italy. In particular, regional innovative patterns differ not only according to the specific strategies and technological performances of firms, but also according to the relevance of systemic interactions and the presence of contextual factors favorable to innovation. However, proper regional systems of innovation are found only in a few well-defined areas. In most regions, systemic interactions and knowledge flows between the relevant actors are simply too sparse and too weak to reveal the presence of systems of innovation at work.

Notes

This paper provides a solution to identify and evaluate the RIS via tracking those key players innovation performance using survey information.

Fischer, M. M., Revilla Diez, J., & Snickars, F. (2001). *Metropolitan innovation systems: Theory and evidence from three metropolitan regions in Europe*. In association with Attila Varga. Advances in Spatial Science. Heidelberg and New York: Springer.

Abstract

Presents a comparative study of the innovation systems of the Vienna, Barcelona, and Stockholm metropolitan areas. Identifies the main actors and mechanisms supporting technological innovation in each of the metropolitan regions based on responses to postal surveys sent to local manufacturing units, producer-service providers, and research institutions in each region. Compares and explains the similarities and differences in innovation systems of the selected metropolitan regions and sheds light on issues of innovation and networking activities, economic performance, and regional development. Presents policy implications for Europe's regions as they face new challenges associated with the emergence of a globalized knowledge-based economy. Fischer is at the Vienna University of Economics and Business Administration.

Freeman, C. (1987). *Technology policy and economic performance: Lessons from Japan*. London and New York: Pinter; distributed by Columbia University Press New York.

Abstract

Concerned with innovation and its diffusion, following the Schumpeterian argument that technical and related social innovations are the main source of dynamism and instability in the world economy and that technical capacity is the main source of competitive strength of firms and nations. Develops the idea of a "national system of innovation" associated with pervasive technological changes. Focuses on the features of the Japanese system of innovations and their implications for other countries, concentrating on the institutions and experience of Japan. Begins with an international comparison of some long-term trends in science and technology indicators for the United States, Western Europe, and Japan, such as trends in research and development, gaps in productivity and technology, rates of growth, and output measures for science and technology. Analyzes the Japanese national system of innovation. Features the role of the Ministry of International Trade and Industry, company research and development, education and training and social innovation, and the conglomerate structure of industry. Stresses the importance of information and communications and describes the Japanese system of technological forecasting and diffusion of major changes in technology throughout the economy. Indicates some of the problems for the world economy and Japan arising from the success of its technology

policies, such as imbalances in world trade creating a world protectionist sentiment. The last Examines recent experiences in the United Kingdom in face of Japanese leadership and suggests programs for the U.S. and Europe.

Notes

Freeman's work here has been recognized widely as a breakthrough in understanding the sources and mechanisms of innovation with a systemic manner. Observations draw mainly on the Japanese case.

Gertler, M., Wolfe, D., & Garkut, D. (1998). The dynamics of regional innovation in Ontario. In J. de la Mothe & G. Paquet (Eds.), *Local and Regional Systems of Innovation* (pp. 211-238). New York: Springer-Verlag.

Summary

The authors use an innovation survey of firms in Ontario, Canada, to study both internal innovation and innovation through network relations. Gertler, et. al., write that the modern technology economies will require firms to join together in order to gain competitive advantage through technological innovation. They conclude that Ontario is not forming a densely networked economy, citing the province's regulatory environment, decentralized labor market and short-term focus of the capital markets as mitigating against the formation of mutually cooperative firms. But the authors note that Ontario is responding to globalization by taking advantage of the North American Free Trade Agreement and firms are doing more R&D.

Griliches, Z. (1990). Patent Statistics as Economic Indicators - A Survey. *Journal of Economic Literature, 28*(4), 1661-1707.

Summary

Griliches writes that there are two major problems with patents: classification and intrinsic variability. Classification into different industries, he argues, is largely a technical issue. But patents also have a lot of variability in the quality of the new innovation. He writes that there is a strong relationship between patents and R&D expenditures at firms, so it can be used as an indicator of inventive activity across firms. The author describes other uses of the patent data, such as seeing how patents spill over into new innovations at other firms. Using the data on a macroeconomic level is not as useful.

Grupp, H., & Mogee, M. E. (2004). Indicators for national science and technology policy: How robust are composite indicators? *Research Policy, 33*(9), 1373-1384.

Abstract

This article addresses a set of issues that were central to Keith Pavitt's research. that is the construction and use of tools to measure national innovative performance and to design national policies relating to innovation. It presents an overview of the development of science and technology (S&T) indicators and their use in national policy making and provides evidence of the vulnerability of composite S&T indicators to manipulation. A brief history of the development of S&T indicators begins with the role of the United States followed by their worldwide diffusion with particular emphasis on Europe. Newer developments towards composite indicators, benchmarking and scoreboarding are discussed. To investigate the robustness of innovation scoreboards, empirically, a sensitivity analysis of one selected case is presented. It is shown that composite scores and country rank positions can vary considerably depending on the selection process. Thus, the use of scoreboards leaves room for manipulation in the policymaking system. Further research is needed on alternative methods of calculation to prevent their misuse and abuse.

Hall, J. L. (2007). Developing historical 50-state indices of innovation capacity and commercialization capacity. *Economic Development Quarterly*, *21*(2), 107-123.

Abstract

Recent attention to innovation as the core of a knowledge-based economy has resulted in an array of studies and reports that seek to measure states' relative ranks as they advance their economic agendas. This study improves on state performance measurement by distinguishing innovation capacity from innovation outcomes by examining change over a 20-year period with consistent measures and by empirically grouping measures into core resource categories using factor analysis. Factor analysis is used to generate new measures of innovation capacity, and the efficacy of these new measures is tested using pooled cross-sectional time-series analysis to examine their effects on state patent generation. The findings indicate moderate to strong impacts of the innovation capacity variables on patent generation; the results provide a new grounded metric for examining state capacity for innovation and state financial capacity for commercialization over time.

Hall, J. L. (2009). Adding Meaning to Measurement Evaluating Trends and Differences in Innovation Capacity among the States. *Economic Development Quarterly, 23*(1), 3-12.

Abstract

How do states compare to one another, and to themselves, in innovation capacity and past innovation performance? Are there groups of states that are more or less similar in innovation capacity composition? Because different score dimensions vary independently, it is possible for states to be high on some dimensions and low on others. In an effort to give greater meaning to innovation index scores, it is necessary to evaluate the relationships among them. This article subjects Hall's innovation capacity index scores to cluster analysis to reveal clusters of states that are similar in innovation capacity levels across the three dimensions considered. A cluster typology is created, and state changes in typology are observed and compared over the 20-year period of the data set. Patterns observed across states and over time will help policy makers to identify major changes in their typology that may reflect goal progress or regression.

Holbrook, A., & Salazar, M. (2004). Regional Innovation Systems within A Federation: Do national policies affect all regions equally? *Innovation: Management, Policy & Practice, 6*(1), 50-64.

Abstract

The concept of national innovation systems was first developed to describe the process of innovation in developed economies. The approach has shifted from solely a national perspective to one including regional or local systems. This focus on spatial aspects has two major advantages: it recognizes that innovation is a social process and a geographic process. For federations, the national system of innovation is more complex than that of a unitary system, since there are often provincial/state level institutions and actors that parallel national level institutions and actors. Canada is one of the few true economic and social (as well as political) federations in the developed world. Consequently, it provides a unique laboratory for studies on the processes of innovation in regions and regional innovation systems. This paper reports on the initial results of research on the characteristics of industrial clusters being carried out through the (Canadian) Innovation Systems Research Network - ISRN.

Isaksen, A. (2001). Building Regional Innovation Systems: Is Endogenous Industrial Development Possible in the Global Economy? *Canadian Journal of Regional Science, 24*(1), 101-120.

Abstract

The article discusses regionalization as an important aspect of economic globalization and as a starting point in shaping endogenous industrial policy that is adapted to specific regional circumstances. For these tasks, the article suggests definitions of central concepts as regional clusters, regional innovations systems and systems barriers that emphasis the importance of "non-economic" factors to a much larger extent than typically found in the Porterian approach. The article then refers to the a consolidation attempt on the part of Ericsson, which took place in Norway a few years ago, in order to illustrate both threats and possibilities for local industrial development in the global economy. This event includes the decision made by the transnational corporation Ericsson to relocate one of their development departments from a small Norwegian town to the capital region, and the later change of plan because very few of the engineers seem to be willing to move along with the department. Lastly, the article departs from the Ericsson event to discuss, from the regional innovation system perspective, possible development policies to anchor units of transnational corporations to a local area.

Kleinknecht, A., van Montfort, K., & Brouwer, E. (2002). The Non-trivial Choice between Innovation Indicators. *Economics of Innovation and New Technology, 11*(2), 109-121.

Abstract

We discuss the strengths and weaknesses of five alternative innovation indicators: R&D, patent applications, total innovation expenditure and shares in sales taken by imitative and by innovative products as they were measured in the 1992 Community Innovation Survey (CIS) in the Netherlands. We conclude that the two most commonly used indicators (R&D and patent applications) have more (and more severe) weaknesses than is often assumed. Moreover, our factor analysis suggests that there is little correlation between the various indicators. This underlines the empirical relevance of various sources of bias of innovation indicators as discussed in this paper.

Kline, S. J., & Rosenberg, N. (1986). An Overview of Innovation. In R. Landau & N. Rosenberg (Eds.), *The positive sum strategy: Harnessing technology for economic growth* (pp. 275-305). Washington, D. C.: National Academy Press.

Abstract

Models that depict innovation as a smooth, well-behaved linear process badly mis-specify the nature and direction of the causal factors at work. Innovation is

complex, uncertain, somewhat disorderly, and subject to changes of many sorts. Innovation is also difficult to measure and demands close coordination of adequate technical knowledge and excellent market judgment in order to satisfy economic, technological, and other types of constraints - all simultaneously. The process of innovation must be viewed as a series of changes in a complete system not only of hardware, but also of market environment, production facilities and knowledge, and the social contexts of the innovation organization.

Lundvall, B.-A. (1992). *National systems of innovation: Towards a theory of innovation and interactive learning*. London: Pinter; distributed in the U.S. and Canada by St. Martin's Press New York.

Abstract

Thirteen papers combine the French structuralist approach to national systems of production and the Anglo-Saxon tradition in innovation studies in order to explain international competitiveness. Papers focus on a new approach to national systems of innovation; a closer look at national systems of innovation; and specialization, multinational corporations, and integration.

Malerba, F. (2004). *Sectoral systems of innovation: Concepts, issues and analyses of six major sectors in Europe.* Cambridge; New York and Melbourne: Cambridge University Press.

Abstract

Twelve papers apply a sectoral systems of innovation framework to analyze innovation in some major sectors in Europe. Papers discuss sectoral systems of innovation and production and their main building blocks; sectoral dynamics and structural change; pharmaceuticals analyzed through the lens of a sectoral innovation system; the processes of knowledge creation and diffusion in the chemical sectoral system; the fixed Internet and mobile telecommunications sectoral system of innovation; the European software sectoral system of innovation; the remaking of innovation processes and boundaries in the machine tool industry; services and systems of innovation; the role of institutions in sectoral systems of innovation; the interplay between national institutional frameworks and sectoral specialization; the factors affecting the international performance of European sectoral systems; and implications for European innovation policy.

Nelson, R. R. (1959). The Simple Economics of Basic Scientific Research. *The Journal of Political Economy, 67*(3), 297-306.

Abstract

Nelson argues that basic scientific research provides a wide range of positive economic externalities, but it is not easily privatized, because the research benefits a variety of different fields and firms. Predominantly research is not conducted by industry because it is costly and may not provide a benefit to the firm. Also, basic research at firms is economically inefficient, because the knowledge will not be used by a wide range of researchers. Since there are costs to private industry for basic research, he suggests that the evidence suggests that government should provide more support to take the burden of that research off the hands of private industry.

Nelson, R. R. (1993). *National innovation systems: A comparative analysis*. Oxford; New York; Toronto and Melbourne: Oxford University Press.

Abstract

Fourteen papers examine national systems of technical innovation in fifteen countries. Studies are designed, developed, and written to illuminate the institutions and mechanisms supporting technical innovation in the various countries, the similarities and differences across countries and how these came to be, and how the differences matter. Countries discussed are the United States, Japan, Germany, the United Kingdom, France, Italy, Denmark, Sweden, Canada, Australia, South Korea, Taiwan, Brazil, Argentina, and Israel.

NSF (1956). *Expenditures for R&D in the United States 1953*. Washington, D.C.: National Science Foundation.

Article unavailable.

NSF (1957). *Basic Research: A national resource*. Washington, D.C.: National Science Foundation.

Article unavailable.

OECD (1963). Proposed Standard Practice for Surveys of Research and Development. Paris: Directorate for Scientific Affairs. OECD.

Summary

As the internationally recognized methodology for collecting and using R&D statistics, this chapter is an essential tool for statisticians worldwide. It includes definitions of basic concepts, data collection guidelines, and classification for compiling statistics.

OECD (1992). Oslo Manual: Proposed Guidelines for Collecting and Interpreting Technological Innovation Data: Organisation for Economic Cooperation and Development.

Article unavailable.

OECD (1997). *National Innovation Systems*: Organisation for Economic Cooperation and Development.

Abstract

Systemic approaches are giving new insight to innovative and economic performance in OECD countries. The interactions among the firms, institutions and others involved in technology development are now seen to be as important as direct investment in R&D. This publication discusses the first phase of OECD work on national innovation systems and the attempt to develop indicators to map knowledge flows.

OECD, & Office, E. C. S. (1997). Oslo Manual: Proposed Guidelines for Collecting and Interpreting Technological Innovation Data: OECD/Eurostat.

Summary

This manual summarizes the definitions, criteria and methodologies for the studies of industrial innovation, the operation of international and national innovation surveys and the choice of indicators. Some alternative approaches other than those that had been included in the Community Innovation Survey (CIS) are also provided in contrasts to the 1992 version Oslo Manual.

OECD, & Office, E. C. S. (2005). Oslo Manual: OECD/Eurostat.

Summary

The Oslo Manual outlines a framework for conducting research into innovation. Responding to recent literature on a systems approach to innovation, the most recent edition introduces a chapter on innovation linkages. It also introduces two new types of innovation: marketing - changes in packaging or pricing - and organizational - changes in business practices. These innovation measures better define innovation in the service sector.

Oinas, P., & Malecki, E. J. (2002). The evolution of technologies in time and space: From national and regional to spatial innovation systems. *International Regional Science Review, 25*(1), 102-131.

Abstract

Complementing existing approaches on national innovation systems (NISs) and regional innovation systems (RISs), the proposed spatial innovation systems (SISs) approach incorporates a focus on the path-dependent evolution of specific technologies as components of technological systems and the intermingling of their technological paths among various locations through time. SISs utilize spatial divisions of labor among several specialized RISs, possibly in more than one NIS. The SIS concept emphasizes the external relations of actors as key elements that transcend all existing systems of innovation. The integrating role of these relations remains inadequately understood to date. This poses a challenge for future research.

Pavitt, K., Robson, M., & Townsend, J. (1987). The Size Distribution of Innovating Firms in the UK - 1945-1983. *Journal of Industrial Economics, 35*(3), 297-316.

Abstract

A survey of 4378 significant innovations shows that firms with fewer than 1000 employees commercialized a much larger share than is indicated by their share of R&D expenditures. Innovations per employee have been consistently above average in firms with more than 10000 employees, and have become so in firms with fewer than 1000. Intersectoral variation in the size distribution of innovating firms can be explained as a function of R&D-based technological opportunities, and of "technological ease of entry" by user firms with principal activities outside the sector.

Porter, M., & Stern, S. (1999). *The New Challenge to America's Prosperity: Findings from the Innovation Index* (No. 1-889866-21-0). Washington, D.C.: Council on Competitiveness.

Summary

This report by the Council on Competitiveness tracks the relative innovation capacities of 17 OECD economies and eight emerging economies using an Innovation Index developed by the authors. The rankings show that the United States could lose its leadership role in innovation because of declining commitment to innovation. The report identifies three main areas of innovative

capacity: a common innovation infrastructure, cluster-specific conditions, and the strength of the linkages among them. It also gives the methodology for creating the index, and ways to weight different factors for regression analysis, which will be useful for RRI's regional innovation study.

Rosenberg, N. (1982). *Inside the Black Box: Technology and Economics*. New York: Cambridge University Press.

Notes

This book is among those classics that examine the relationship between technology progress and economic development and the economic, political, social and cultural determinants of technology progress.

Sajeva, M., & Gatelli, D. (2005). *Methodology Report on European Innovation Scoreboard 2005*: European Commission, Enterprise Directorate-General.

Summary

The authors find that changes to indicators and methodology of the European Innovation Scoreboard (EIS) in 2005 did not markedly change the robustness of the results. The findings recommend equal weighting of indicators, and no imputation to fill in missing data.

Simmie, J. (2003). Innovation and urban regions as national and international nodes for the transfer and sharing of knowledge. *Regional Studies, 37*(6-7), 607-620.

Abstract

This paper examines the transfer and sharing of knowledge within and between regions in the context of the development of the international economy. It is argued that knowledge is a key resource for innovation which, in turn, is one of the major drivers of economic growth. The firms producing the most novel product innovations in the most significant regional concentrations of innovation are very adept at working across the interface of local and global knowledge transfers. Using data from previous studies combined with the latest regional data from the Community Innovation Survey 3, comparisons are made between the ways in which the most innovative firms in the Greater South East transfer and share knowledge from the local to the international level. The most innovative firms are shown to access international sources of knowledge. This raises questions over the relative importance of local versus international knowledge spillovers for the most innovative firms. Innovative firms tend to concentrate in a minority of key metropolitan regions. These are shown to combine a strong local

knowledge capital base with high levels of connectivity to similar regions in the international economy. In this way they are able to combine and decode both codified and tacit knowledge originating from multiple regional, national and international sources. As a result they are able to generate virtuous circles of knowledge, innovation, competitiveness and exports.

Smith, K. (2005). Measuring Innovation. In J. Fagerberg, D. C. Mowery & R. R. Nelson (Eds.), *The Oxford handbook of innovation* (pp. 148-177). Oxford and New York: Oxford University Press.

Abstract

It is sometimes suggested that innovation is inherently impossible to quantify and to measure. This article argues that while this is true for some aspects of innovation, its overall characteristics do not preclude measurement of key dimensions of processes and outputs. An important development has been the emergence of new indicators of innovation inputs and outputs. Following sections discuss first some broad issues in the construction and use of science, technology and innovation indicators, then turn briefly to the strengths and weaknesses of current indicators particularly R&D and patents. Final sections cover recent initiatives focusing on the conceptualization, collection, and analysis of direct measures of innovation, especially the rapidly growing use of the Community Innovation Survey (CIS).

Soete, L. (2006). Knowledge, policy and innovation. In L. Earl & F. Gault (Eds.), *National Innovation, Indicators and Policy* (pp. 198-218). Cheltenham: Edward Elgar.

Summary

In this survey of available literature, Soete concludes that the traditional definitions of research and development need to be expanded. He writes that countries with high research capacity do not necessarily have high economic growth if they do not have the proper institutional context to allow innovation to thrive. He concludes that four factors are crucial for innovation: social and human capital; research capacity; geographical proximity; and absorptive capacity. All four should be encouraged by policy makers.

Stokes, D. E. (1997). *Pasteur's quadrant: Basic science and technological innovation*. Washington, D.C.: Brookings Institution Press.

Abstract

Proposes a revised view of the relationship between basic science and technological innovation and shows how this revision could lead to a clearer view of several aspects of science and technology policy. Describes the problematic aspects of the postwar paradigm that basic science can serve as a pacemaker of technological progress only if it is insulated from thought of practical use. Addresses the paradox of how this vision of science and its role in technological innovation could have prevailed, given that those who built modern science were so often influenced by applied goals. Sets out a more realistic view of the links between basic science and technological innovation that is more faithful to the history of research. Considers renewing the compact between science and government. Considers a process by which American democracy could build agendas of use-inspired basic research by bringing together judgments of research promise and societal need.

Tijssen, R. J. W. (2003). Scoreboards of research excellence. *Research Evaluation,* 12(2), 91-104

Abstract

A critical discussion is presented of what could be understood as research excellence, and how to deal with fundamental issues and methodological challenges in operationalizing and evaluating this complex, multi-faceted notion in terms of measurable attributes at organizational levels. This paper argues for a systemic and interactive approach, combining multiple perspectives and stakeholders, while incorporating a wide range of information sources and quantitative indicators within the analytical framework of a 'scoreboard'. Context-specific and customized scoreboards show promise as a structuring tool in informed debate, indicator selection, comparative analysis and benchmarking studies of research excellence. Guidelines and recommendations are illustrated by way of a fictitious scoreboard with recent empirical data for economics research at the universities in the Netherlands.