

Introduction: technology transfer in global perspectives – issues for the twenty-first century

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This edited volume is dedicated to the continued understanding of technology transfer, commercialization, and regional technology-based development with an emphasis on how issues converge or diverge in global context. All of the contributors are Research Fellows or associated scholars of the Institute for Innovation Creativity and Capital (IC²) at the University of Texas at Austin. For over three decades the IC² Institute has studied technology transfer and how it impacts the development of new companies, the enhancement of established companies, and the transformation of cities, regions, and countries. In 1986, George Kozmetsky, the founder of IC² and one of its greatest Fellows, noted,

Since the First Industrial Revolution, technology has been a basic motor for economic growth. The management of technology as a resource for economic development and wealth generation is a recent phenomenon. The lessons from the utilization of technology over the past two decades are clear. Those who manage technology creatively and innovatively will reap the benefits of sustained economic growth. They can also play an important leadership role in dealing with new issues regarding competition and cooperation. (1986, 1)

Over the last three decades policy makers, academicians, and those in government have shown an increased awareness of the importance of technology transfer.¹ This is a dynamic area of study that examines traditional topics such as intellectual property management, risk management, market identification, the role of public and private labs, and the role of universities.² The study of technology transfer can also be found in the literature on technology diffusion, which has its roots in the early agriculture literature as new technologies moved from agricultural labs to the market.³ This volume presents a collection of essays detailing how government, business, and academia influence technology transfer in different nations: how the infrastructure of a country enhances the technological

and contributes to the economy. The countries examined range in size and development and include China, Kenya, the United Kingdom, Iraq, Israel, Japan, Korea, Malta, Mexico, Poland, Portugal, Russia, and the United States of America. In an earlier effort, IC² Fellows established the groundwork for our perspective in a book entitled, *Creating the Technopolis: Linking Technology Commercialization and Economic Development*.⁴ As Global IC² Fellows, the authors utilized elements of this framework, or what we call the IC² Model of economic development, to understand how support systems from government, business, and academia influence the movement of science to the market and thus influence economic development. Although each country presented has its unique history, there is a considerable degree of overlap in the chapters.

The IC² Model of research and real-world experiments are in a series of publications starting in the 1980s.⁵ Perhaps the greatest real-world experiment was done in Austin, Texas. The 'Technopolis Framework', or the science city, became the driving theoretical paradigm. The force of the technopolis paradigm is the interlocking relationships among governments (quasi-public, private, and public institutions, respectively) to enhance technology-based economic development in regions. The paradigm is dependent on the continuous improvement of four major steps: (i) achievement of scientific pre-eminence in technology-based research; (ii) development of new technologies for emerging industries; (iii) attraction of major technology companies; and (iv) creation of homegrown technology companies.⁶ Nested within the theoretical framework are the mechanisms of the technopolis that include elements such as incubators, capital formation, networking, and the characteristics of the city or region (for example, uniqueness, pleasant place to live and so on). Research shows that Austin, Texas, moved rapidly to the forefront of literature that ranks cities according to their entrepreneurial opportunity, wealth creation, and job creation.⁷ The IC² Model of economic development through technology transfer served as the catalyst for 'experiment Austin'. This paradigm has been applied worldwide as countries and regions create strategies for technology-based economic growth.

To be sure, government laboratories and universities, as movers of the technology transfer process, have a prominent place in the growing research literature in the United States.⁸ Also becoming prominent is the literature on how technology transfer in the United States is influencing economic development in regions in different countries.⁹ With the IC² Model as the guiding theoretical force, this volume is in the tradition of how to research technology transfer as it moves through different stages in different countries. Contributors in this work combine the history of their country with issues of scientific knowledge, technology transfer, and

economic development. Although each country is a diversity of richness, there is uniformity to the volume when it comes to the importance of technology transfer for countries as we enter the twenty-first century.

Lan Xue and Ling Zhou's contribution on China (Chapter 1) examines technology transfer and the development of university–market linkages. This development is wrapped around the history and restructuring of universities from the founding of the People's Republic of China to the national restructuring of today's innovation system. This is a system of technology transfer that combines university–market–government interactions; government is seen as improving public infrastructures that will allow innovation and the enhancement of the high-tech business ecosystems. This contribution is an interesting study of how technology transfer contributes not only to the growth and continued development of China's economy but also to the development of intellectual property. The theme of the importance of government support and ecosystem development for technology transfer is continued in Kamau Gachigi and Crispus M. Kiamba's chapter on Africa (Chapter 2). Although the final focus is on Kenya, the authors stress the point that the overall understanding and success of technology transfer in the continent will depend on the economic and political ecosystem. The chapter concentrates on challenges of the creation of knowledge-based economies and then uses Kenya's data to illustrate how infrastructure is enhancing the development of that country. The relationship between developed and developing countries is also a lesson of this chapter.

An interesting finding of Robert Hodgson's chapter on the United Kingdom (Chapter 3) is how England's traditional universities, with an emphasis on academic teaching and academic research, have to transform themselves so that they can contribute to a knowledge-based, technology transfer economy. This means working with businesses to enhance the country's national competitiveness with a concentration on innovation. In a real sense, this is also a study of how a country rebuilds itself by changing policy that enhances economic development. In contrast, Uzi De Haan and Boaz Golany's chapter (Chapter 5) starts with the proposition that Israel has built a country that is the model for technology transfer and economic stability. The authors utilize a strong sense of history to show how Israel went from a poor, developing country or start-up in 1948 to one of the world's leading centers for economic development through technology transfer.

Technology transfer and business development are put to a great test in Corey P. Carbonara, Michael F. Korpi and Marc LeGare's work on Iraq, a country that is at war (Chapter 4). At the center of the IC² Model for economic development is creative and innovative management. This

model, which gives a strong consideration to flexibility and creativity to general management models, allows the authors to juxtapose the creation of a high-tech company and then see how that company can help build what is called the 'technopolis'. As such, it is an experiment that seeks to understand how management decision making actually drives markets and other important issues. From this experiment the entire country of Iraq can benefit as it moves forward in the area of economic development.

Japan exemplifies a country where innovation and technology transfer take place in established companies. Indeed, large companies represent the ecosystem for the commercialization of technologies. Michi Fukushima's work on Japan (Chapter 6) examines how a company interacts with inventors and then selects inventions for the technology transfer process. The chapter highlights how inventors approach established companies, select the parties for the discussion of their technologies, and build networks with the companies' research and development department. Korea, comparatively, has made a systematic effort to enhance technology transfer through the development of science parks and innovation clusters. This is in the tradition of the technopolis, or the focus on creating a science city. Deog-Seong Oh and Byung-Joo Kang analyze the historical development of science parks by examining the different stages of development (Chapter 7). This analysis of research and development facilities is also tied to venture firms and incubation.

Malta represents a country that has depended on the university for economic development. Juanito Camilleri and Albert Caruana's study (Chapter 8) could be right out of central casting if one were interested in a play that ties the economic growth of a country to the importance of a university. Indeed, the University of Malta, as the island country's only university, has been key to nurturing the country's economic development. The authors trace the historical development of Malta as an independent state paired with theories of knowledge that guide such a development. The chapter concludes by suggesting new and exciting legal and institutional frameworks that would enhance an ecosystem's ability to effectively generate a state–university–industry collaboration.

Economic development in Mexico has seen an intense effort to increase the importance of science and technology transfer for economic development. The government's intensive effort to transform its economy concentrates on enhancing the technology transfer ecosystem. Jaime Parada Ávila's contribution (Chapter 9) details the interaction of government support, universities, and research centers on economic development. After an overview of the country, the chapter concentrates on the state of Nuevo León. This regional study enhances the reader's ability to understand the dynamics of technological and innovative activities in Mexico.

Dariusz Trzmielak's treatment of innovation in Poland (Chapter 10) concentrates on linking entrepreneurs and scientists in a knowledge information network to aid in their understanding of rapid changes in high-tech markets in Europe. He develops a 'roadmap' for high-tech companies and presents an in-depth study of a company in the nanotechnology space. This allows Trzmielak to provide an excellent example of the management of technology transfer in Poland. Examples of scientists who have become successful entrepreneurs allow the reader to integrate science, entrepreneurship, and the developing dynamics of the Polish economy. Manuel Heitor and Marco Bravo continue the analysis of European continuous development with their contribution on the changing nature of the Portuguese economy (Chapter 11). The chapter traces the development of science in Portugal as measured by the number of researchers per thousand of workforce and argues that value creation requires a continued commitment in advanced human resource training and promotion of research. The authors place their analysis in the context of world regions and smaller nations that are joining international knowledge networks and the emerging worldwide debates on patterns of innovation.

Russia represents a European country that has a strong history of science and is repositioning itself in the context of market economies. Nikolay Rogalev's historical analysis takes the 1980s as its starting point and informs the reader of the relationship between science park development and technology transfer in Russia (Chapter 12). His analysis takes the reader through a rapidly maturing system that includes regional centers for training in innovation and entrepreneurship, scientific technical development assistant centers, significant numbers of science parks, and accredited university-based science parks. Rogalev also provides an almost unprecedented analysis of the presence of Russian science in the international market of science-intensive products. More importantly, his analysis reveals how a previously communist country is creating the infrastructure for a modern market economy.

Finally, Patricia G. Greene and Mark P. Rice provide a US university perspective on technology transfer and commercialization (Chapter 13). Their analysis is both historical and analytical, bringing together historical documents that trace the beginning of technology transfer in universities and interviews with technology transfer experts. The shift toward universities becoming just as important as private research laboratories in the United States began during the 1880s, when there were public complaints that American universities were not focused enough on the sciences. More recently, the Bayh–Dole Act, passed in 1980 and formally called the University and Small Business Patent Procedures Act, became the main catalyst for technology transfer as innovation became associated with

research universities. Greene and Rice examine emerging trends and the role of the office of technology transfer in the context of the future of the relationship between technology transfer and the university. This dynamic area of study becomes critical as regions are increasingly seeing universities as significant drivers of regional economic development.

The IC² Institute, its Research Fellows, and associated scholars around the globe understand that in the technology transfer and commercialization arena the study of the regional ecosystem in which it takes place is as important as the traditional emphasis on entrepreneurship as 'small business'. We hope that this volume will continue to influence policy makers and managers of regions about the importance of a transfer ecosystem. Silicon Valley, California, and Austin, Texas, are two exemplary regions where regionally based science and technology research has occurred and has been linked to economic development that teaches us how business principles interact with emerging technologies, knowledge, and know-how to launch and grow companies, enhance profit centers of established companies, and thus continue to create wealth and jobs.

NOTES

1. For an excellent review of the emergence of technology transfer in both academia and the public square, see Bozeman (2000); see also Godkin (1988); Zhao and Reisman (1992).
2. For excellent reviews of major concerns, see *Journal of Technology Transfer*. See also Shane (2005).
3. For a review, see the classic *Diffusion of Innovations* (Rogers, 2003), and Butler (2010).
4. Smilor et al. (1988b); see also Smilor et al. (1988a) and Gibson et al. (1992).
5. See, for example, Kozmetsky and Smilor (1986).
6. For a review of the model, see Butler (2010). An examination of the growth of Austin, Texas can be found in Harvard Business School Case Study (1998).
7. For an overview of the rise of the Austin Technopolis, see Gibson and Rogers (1994) and Gibson and Butler (n.d.).
8. For a contrast between university and federal laboratories in the technology process, see Crow and Bozeman (1987). For the history of the relationship between government and universities, see Fellwe (2005).
9. See, for example, Rosenberg (2001).

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