THE KNOWLEDGE ECONOMY AND THE GLOBAL TRENDS IN THE 21 st CENTURY

Chaya R. JAIN

Virginia State University

Two defining occurrences of the 21st Century, the weakened global economy and continuous advancements in technology, have generated renewed interest to search for innovative channels of knowledge transfer in creating and sustaining economic growth. Since knowledge along with raw materials, labor and capital is a crucial element for economic growth, this paper focuses on key elements of knowledge economy and its corollaries. Exploring select knowledge economy perspectives, this discussion examines international indicators of the knowledge economy as well as trends that constitute the contemporary knowledge framework; including, the world's academic bases and university-industry collaborations, knowledge competency, knowledge requisites and policy governance. A review of the complex institutional landscapes and challenges suggests that the creation, development, and dissemination of innovation are critical for engagement and collaboration among various stakeholders including government, academia, industry, community, businesses, and others. The purpose is to understand the processes involving multi-actor engagement to help enhance the transfer of knowledge for sustained economic growth and help develop conscious policy decisions.

Keywords: *knowledge transfer, knowledge economy, sustained economic growth.*

ECONOMIA BAZATĂ PE CUNOAŞTERE ŞI TENDINȚELE GLOBALE ÎN SECOLUL XXI

Două apariții definitorii ale secolului XXI – economia globală slăbită şi progresele continue în tehnologie – au reînnoit interesul de a căuta canale inovatoare de transfer de cunoştințe pentru promovarea şi susținerea creşterii economice. Deoarece cunoaşterea, împreună cu materia primă, forța de muncă şi capitalul, este un element esențial pentru creşterea economică, în această lucrare ne-am concentrat atenția asupra elementelor-cheie ale economiei cunoaşterii şi corolarelor sale. Prin explorarea perspectivelor economiei bazate pe cunoaştere selectate, în articol sunt analizați indicatorii internaționali ai economiei bazate pe cunoaştere, precum şi tendințele care constituie cadrul de cunoştințe contemporane, inclusiv: bazele colaborării dintre lumea academică şi cea universitară, competența de a cunoaşte şi de a obține cunoştințe şi competența de guvernare politică. O trecere în revistă a peisajelor instituționale complexe şi a provocărilor sugerează că crearea, dezvoltarea, precum şi diseminarea inovației sunt critice pentru implicare şi colaborare între diferitele părți interesate, inclusiv guvernul, mediul academic, industria, comunitatea, întreprinderile şi altele. Scopul este de a înțelege procesele care implică un angajament al mai multor actori pentru a ajuta la îmbunătățirea transferului de cunoştințe pentru o creştere economică susținută şi pentru a contribui la dezvoltarea de politici şi decizii conştiente.

***Cuvinte-cheie*:** *transfer de cunoştințe, economie bazată pe cunoaştere, creştere economică durabilă.*

Introduction

A context-driven phenomenon, knowledge refers to the theoretical or practical understanding of a subject and can involve information, facts, descriptions or skills that can be attained through education or experience. Knowledge is the most fundamental source of economic advantage in today's knowledge-intensive and fast-changing complex world. The contemporary knowledge-based economy is undergoing a paradigm shift due to the evolving global economic dynamics and the continuous proliferation in technological advancements. Artificial intelligence, robotics, the Internet, instant communication and virtual reality are now an essential part of our daily existence. To maintain the *status quo* let alone a competitive edge, every aspect of knowledge, from learning, expertise, research and development (R&D) to designing, manufacturing, marketing, supply and communication, must keep pace with emerging changes. R&D, now a well-established term of the global lexicon and a standard mainstay in industry, is affecting various forms of strategic alliances, acquisitions, mergers and networks to help decrease production costs and risks, and increase the economic potential.

Confounding the challenge is the fact that knowledge economy is inherently prone to provincial context therefore subject to differing governance-related practices and policies, which in turn influence intellectual property rights, knowledge, capital investments, organizational character, management structure, size, and mission of the stakeholders. This multiplicity adds to global competition, thus further affecting transformations in the character, role, and relationships among the economy's key stakeholders: industry, corporations, government, communities – and focus of this discussion, the academe.

The purpose of this article is to analyze the various components and characteristics of the knowledge economy and explore challenges, as well as creative ideas from the perspective of two key stakeholders– institutions of higher learning and industry and their respective roles in helping sustain economic growth.

Dimensions of Knowledge

In his book *The Tacit Dimension*, Polanyi (1966) identifies two types of knowledge; tacit and implicit. Tacit knowledge is highly personal and hard to formalize therefore difficult to communicate. Polanyi distinguishes two dimensions of tacit knowledge. The technical dimension encompasses the kind of informal, intuitive, personal and implicit skills we call 'know-how.' Then, there is the cognitive dimension that consists of individual beliefs, values, ideals, schemes and mental models that are deeply ingrained in us. Although difficult to articulate, this cognitive dimension shapes the way we perceive the world. As an applied element it is developed from direct experience, and is usually communicated through highly interactive conversations, actions, story-telling and shared experiences (Polanyi 2009, 1966).

In contrast, explicit knowledge can be more precise and formally articulated. Although more abstract, it can be more easily codified, documented, transferred and shared. Organizations employ and depend on explicit knowledge and consider it to be the most important factor of production in the knowledge economy (Romer 1995; Nonaka 1994). Examples of explicit knowledge include procedures, manuals, product literature, and computer software. Arguing a widely accepted theory of knowledge, Nonaka and Takeuchi (1995) present the SECI (Socialization, Externalization, Combination, Internalization) model linking interaction between explicit and tacit knowledge. Nonaka and von Krogh (2009) maintain that organizational knowledge is created through a continuous interaction between tacit and explicit knowledge. For example, while new knowledge is developed by individuals, organizations also play a critical role in articulating, amplifying and transferring that knowledge. Together, tacit and explicit dimensions (Polanyi 1966, 2009; Nonaka (1994; Brown and Duguid, 1991) and their integration, knowledge is a critical social component (Samara 2007).

Knowledge Transfer and Knowledge Economy

Obviously, knowledge by itself is not as useful a resource in creating value or competitive advantage until it can be shared and transferred for an intended or specific purpose – what Kuznets (1965) calls "useful knowledge"– in being a source of modern economic growth (Mokyr 2000). Technology, as a tributary of knowledge, involves the advancement of new discoveries as well as development of new truths and opinions that are achieved through the process called knowledge transfer. Such a process includes creation, techniques, crafts, usage and understanding of tools as well as organizational processes and systems to solve a problem or serve some purpose. As discussed earlier, knowledge can be implicit and requires gradual transformation into codified and explicit knowledge (Nonaka and Takeuchi 1995).

A timeless phenomenon, transfer of knowledge can be traced back to the dawn of civilization when human survival was, and still is, contingent upon some form of organized activity whether manual or cerebral. Those working with hands are readily distinguishable from others who rely on knowledge for existence, whom Martin Feregrino (1959) defines as "knowledge worker;" one who works primarily with information, develops and uses it in the workplace. Drucker (1966), distinguishing two types of workers, classifies those who work with hands and those who use their heads in producing ideas, knowledge, and information. His description of a 'knowledge society' emphasizes knowledge, not the familiar assets of capital, natural resources and labor to build systematic practices for managing self-transformation (Drucker 1993). Toffler's (1980) post-industrial society also portends the world to be dominated by brain not brawn.

A rather elusive concept, "the knowledge economy" covers a range of paradigms relating to economy and society (Powell and Snellman 2004; Brinkley 2006). It is so because knowledge economy and knowledge society are not only multidisciplinary academic concepts but also multidisciplinary policy concepts (Westlund 2006). From a generic definition, knowledge economy is a product. Others view it as 'knowledge' (know-how) to create new products and services (Gibbons et.al 1994; Donkin 1998). Yet others see it as a key component of value creation, productivity and economic growth.

The knowledge economy involves academe as a source that contributes to the modern industrial and industrializing nations' economies in producing "knowledge workers," applied research ideas, and activities (Mansfield and Lee 1996; Salter and Martin 2001; Cohen et al. 2002; Mowery and Sampat 2005). Further, it is seen as reliance on intellectual capabilities rather than physical inputs or natural resources–a concept where increasing role of knowledge is a factor of production and its impact on skills, learning, organization, and innovation (OECD 2001; Powell and Snellman 2004). With due consideration of these eclectic perspectives, for this discussion, "the knowledge Economy" is a reference to the overall mechanism that eventually shapes our economy, not a single or combination of explanations.

Knowledge-Based Economy

The basic premise of the knowledge-based economy is directly centered on production, distribution and use of knowledge and information (OECD, 1996). Rooted in the economic growth concept called "new growth theory" (Romer 1994; Cortright 2001), it suggests that economic growth results from the increasing returns associated with new knowledge and humans' pursuit for profit inspired, ever-increasing productivity and economic growth. This view maintains that innovation and new technologies require intense concerted perusal of new innovations and technologies. Further, that control over knowledge capital combined with the profit incentive propels the need to grow human capital and look harder for new innovations.

To achieve economic success, knowledge transfer and knowledge economy must be balanced with yet another facet called "knowledge management," which refers to organizational ability to attain economic value from its collective knowledge assets involving information, production, distribution and affiliated knowledge infrastructure such as technology and organizational structure. Knowledge management is commonly associated with knowledge engineering, which in itself is a field within artificial intelligence concerned in the advancement of knowledge-based systems as decision support or expert systems (Jianqiang et al. 2005; Olszak and Ewa 2006). Simply stated, knowledge management involves a host of considerations such as organizational culture, knowledge processes, acquisition, conversion, application, and protection (Gold et al. 2001). Arguing that knowledge-based economy is so fundamentally different from the resource-based system of the last century, Houghton and Sheehan (2000) emphasize a re-examination of the conventional economic understanding. They contend that increased knowledge codification is leading to a shift in the balance of the stock of knowledge causing a relative shortage of tacit knowledge or "handling skills" among the workers. Whether this is important to the continuing expansion of world economy is yet to be determined (Lundwall and Johnson 1994).

The Knowledge Economy and the Global Trends

The Academic Perspective

Historically, the latter part of the 20th Century, particularly the post-World War II era heralded an increasing dominance of corporate R&D that integrated knowledge workers with knowledge management (Duderstadt 2005; Black et.al 2007). Following the recommendations of *Science*, *The Endless Frontier Report* ("The Bush Report" 1945) the American system of higher education underwent a major overhaul. Instead of building separate research institutes, the *Bush Report* recommended federal government's renewed support for a partnership among government, universities and industry (GUI), implementing a competitive system for faculty to conduct basic research under the so-called "liner model" [1]. It also extended contracts to industrial R&D laboratories to expand applied research with specific goals, such as the national defense. The federal assistance was channeled through various governmental research agencies such as the National Science Foundation (NSF) and the National Institutes of Health (NIH) as well as mission agencies such as the Department of Defense, the Department of Energy and the Department of Agriculture. This creative and collaborative capitalization of knowledge through interlinking of academia, industry and government (termed the 'triple helix interaction' by Henry Etzkowitz in 1993) became a popular channel to create research-driven high technology clusters in the United States.

From academic excellence viewpoint, Table 1 provides a ranking of world's top 10 institutions for all academic disciplines that shows the United States' domination in every category.

Table 1

World's 2012 Top Ten Academic Institutions by Educational Discipline

Rank No.	Overall	Rank No.	Engineering	Rank No.	Life Sciences
1	Harvard U.	1	MIT	1	Harvard U.
2	Stanford U.	2	Stanford U.	2	MIT
3	MIT	3	UC Berkley	3	UCSF
4	UC Berkley	4	UIUC	4	U. Cambridge
5	U. Cambridge	5	UT Austin	5	U Washington
6	U. Caltech	6	UCSB	6	Stanford U.
7	Princeton U.	7	U Michigan	7	UT SW Med
8	Columbia U.	8	Georgia Tech	8	Rockefeller U
9	U. Chicago	9	Carnegie Mellon	9	UC San Diego
10	U. Oxford	10	Perdue U.	10	Yale U.

Rank No.	Medicine	Rank No.	Sciences	Rank No.	Social Sciences
1	Harvard	1	Harvard U.	1	Harvard U.
2	UCSF	2	UC Berkley	2	U. Chicago
3	U Washington	3	Princeton U.	3	UC Berkley
4	Johns Hopkins	4	Caltech	4	MIT
5	Columbia	5	MIT	5	Columbia U.
6	UT SW Med	6	U. Cambridge	6	Princeton U.
7	UCLA	7	Stanford U.	7	Stanford U.
8	Cambridge U.	8	ETH Zurich	8	Yale U.
9	Stanford U.	9	Tokyo U.	9	U. Penn
10	U. Pittsburgh	10	U. Oxford	10	NYU

Source: Shanghai Ranking Consultancy 2012, All Rights Reserved.

Table 2 offers an international comparative framework of the knowledge economy from academic-industry perspective for the world's top 500 universities. Academicians' collaboration with industries on marketable projects is not new and such associations can be traced back to the Industrial Revolution (Quah 2000; Mokyr 2002). The very nature of universities affords them to be the central agents of knowledge, research and innovation. University-industry research relationships tend to be mutually complementary since they enable both entities to sustain growth in their respective areas. Companies count on academic researchers for product innovations and faculty gain prestige through increased competition for external research funds. However, measurement indicators to determine the intensity of the knowledge economy, whether university-industry based innovations or general economy, generate a rigorous debate because of the dynamics differences between knowledge base of an economy and that of a political economy (Leydesdorff 2003). For example, the so-called "Mode 2" [3] indicators (Gibbons et al. 1994) focus on the interaction rather than the distinction between fundamental principles and applied knowledge. A review of indicators measuring both interactions as well as applied knowledge helps determine the contemporary global trends in the knowledge economy.

Table 2

World's 2011 Top Universities by University-Industry Research Output

		UIC Publication Output Range	UIC Intensity % (Rank Range)	UIC Intensity % (Rank Range)
University	Country	All Fields of Science*	All Fields of Science*	Engineering Sciences
Norwegian Univ of Sci & Tech	Norway	501-1000	10-20% (1-10)	>20% (1-10)
Eindhoven Univ of Tech	Netherlands	501-1000	10-20% (1-10)	>20% (11-25)
Keio University	Japan	501-1000	10-20% (1-10)	>20% (26-50)
Helsinki University of Tech	Finland	251-500	10-20% (1-10)	>20% (26-50)
Rensselaer Polytech Institute	USA	251-500	10-20% (1-10)	>20% (26-50)
Univ of Calif San Francisco	USA	> 1500	10-20% (11-25)	>20% (1-10)
Stanford University	USA	> 1500	10-20% (11-25)	>20% (1-10)
Karolinska Inst Stockholm	Sweden	1001-1500	10-20% (11-25)	>20% (1-10)
Lunds University	Sweden	1001-1500	10-20% (11-25)	>20% (11-25)
Georgia Inst of Tech Atlanta	USA	501-1000	10-20% (11-25)	>20% (11-25)
Waseda University	Japan	251-500	10-20% (11-25)	>20% (26-50)
Osaka University	Japan	> 1500	10-20% (26-50)	>20% (11-25)
Univ of California San Diego	USA	> 1500	10-20% (26-50)	>20% (11-25)
Univ of California Los Angeles	USA	> 1500	10-20% (26-50)	>20% (26-50)
Kagoshima University	Japan	100-250	10-20% (26-50)	>20% (11-25)
Kobe University	Japan	251-500	10-20% (26-50)	>20% (26-50)

Source: Thomson Reuters/CWTS Web of Science database (November 2011edition).
UIC Intensity % indicate share of UICs within each university's total publication output.
* Includes natural sciences, engineering, life sciences, medical and social sciences/humanities.

The data in Table 2 was derived from the University-Industry Research Cooperation's (UIRC) November 2011 Scoreboard, produced by the Center for Science and Technology Studies (WCTS) at Leiden University, the Netherlands [4]. Table 2 displays three indicators of university rankings: University Industry Co-publications (UICs) output ranges; the aggregate UIC intensity percentage (or share of UICs within each university's total publication output for all five disciplines (natural sciences, engineering sciences, life sciences, medical sciences, and social sciences and humanities); and, UIC intensity percentage in engineering sciences. Using data from the world 500 top-ranking universities, Table 2 arrays the highest 50 institutions in these two categories: the aggregate UIC intensity for all fields of science as well as the engineering sciences. The findings are arranged by "UIC Intensity % All Fields of Science," indicates share of UIC within each university's total publication output. In this arrangement, Norwegian University of Science and Technology ("NTNU") ranks among the top ten in both categories, and among the top 26-50 range for UIC publication output. This combination actually works in NTNU's favor because it suggests that even with rather limited UIC publication output, NTNU still ranged among the highest – the ultimate purpose of UIC collaborations.

Based on the UIC intensity in all fields of science, table 2 also shows the Nordic nations along with Japan among the highest ranking entities. Although only one U.S. university scores in the highest range for the aggregate 'All Sciences' category; two others, Stanford University and University of California (San Francisco), tie for the highest overall publication output along highest for the engineering science UIC percentage intensity. Table 2 below offers ranking of the same 500 universities having greater than 20% UIC Intensity in engineering sciences exclusively and presents an entirely different picture. Arranged by alphabetical order of the nations, it displays the world's top achievers within three successive ranges: the highest being 1-10, followed by 11-25 and 26-50. Based on this finding, four of the top ten world universities are from the U.S. Of the total 40, the majority 24 (60%) are from the United States as well. However, considering the proportional representation of universities from world nations, Japan with 9 (22.5%) displays a remarkable standing among world nations for engineering science UIC-intensity [5].

Although the United States leads in academic excellence in every discipline, the knowledge economy matrix continues to show a consistent decline since 2008. According to the World Bank Group Report (2012), the U.S. has suffered a decline in all four knowledge index factors: economic incentive and institutional regime, education, innovation, and information and communication technologies. Among the key contributing factors for this decline, the Global Competitiveness Report 2012-2013 (2012) suggests business community's lack of support for private and public institutions combined with distrust of the political figures. Nonetheless, its structural features that include a large economy, an extremely sophisticated R&D innovation system, combined with an excellent university system still make it extremely competitive society in the area of the knowledge economy.

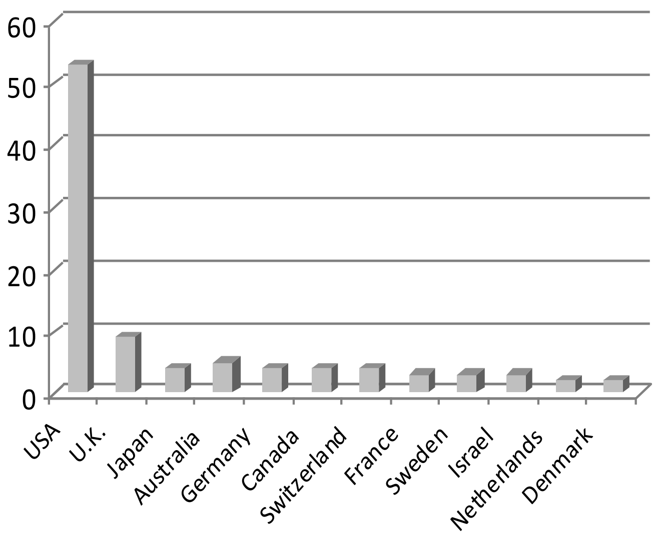


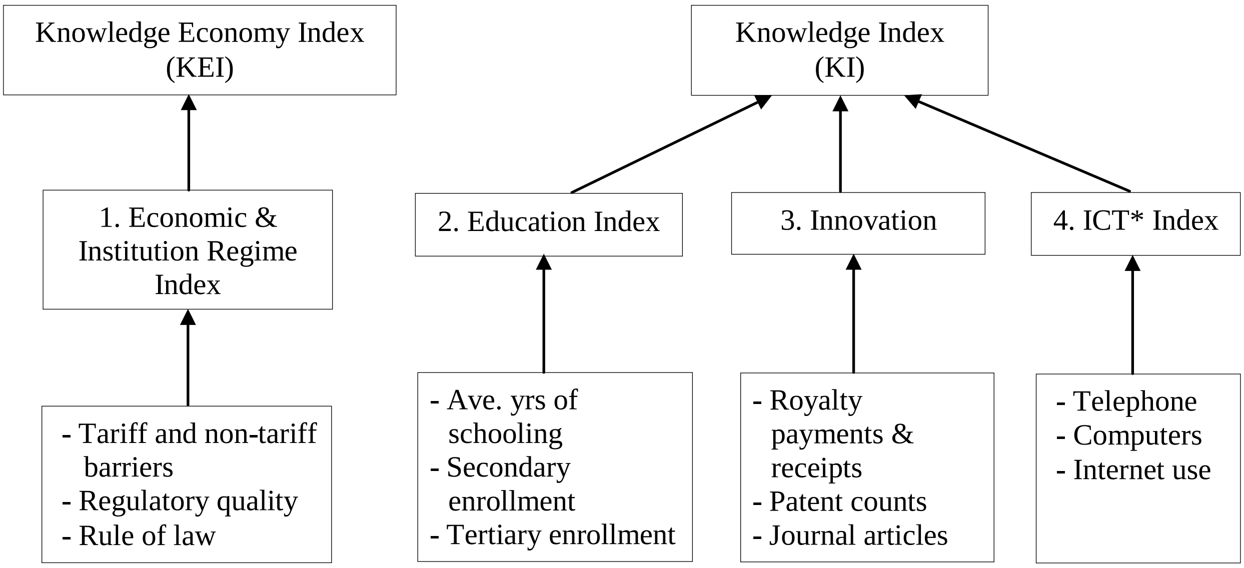
Fig.1. World's Top 100 Universities of 2012.

Source: Shanghai Ranking Consultancy, 2012 All Rights Reserved.

The Knowledge Economy Perspective

The World Bank Institute (WBI and also called the World Bank Group or WBG), uses an interactive online tool to produce the knowledge economy index (KEI) – an aggregate index representing a country or region's overall preparedness to compete in the knowledge economy. As demonstrated in Diagram 2, the KEI is based on a simple average of four sub-indexes, which represent the four pillars of the KE: (1) economic incentive and institutional regime (EIR) (2) education (3) innovation, and (4) information and communication technologies (ICT) index. The Knowledge Index (KI) measures a country's ability to generate, adopt and diffuse knowledge [6].

Diagram 1- Criteria to Determine the World Knowledge Economy Rankings



Source: The World Bank Institute, 2012.

Using the KAM criteria, Table 3 provides an assessment the world top ten knowledge societies among 146 countries. Sweden ranks as the world's most advanced knowledge economy in 2012. Four other Nordic countries: Finland, Denmark, the Netherlands and Norway occupy the subsequent four spots on the WBI rankings. According to the World Bank's in 2012, the United States ties with Taiwan in KE Index at 8.77 ranking 12th and has been in decline since 2008.

Table 3

The Knowledge Economy Scorecard -World's Highest-Ranking Nations in 2012

Rank	Country	KE Index	EIR Rank	Innovation Rank	Education Rank	ICT Rank
1	Sweden	9.43	4	2	6	2
2	Finland	9.33	2	3	11	6
3	Denmark	9.16	3	5	15	13
4	Netherlands	9.11	19	7	12	5
5	Norway	9.11	8	17	3	17
6	New Zealand	8.97	14	22	1	23
7	Canada	8.92	7	10	16	24
8	Germany	8.90	13	12	23	8
9	Austria	8.88	23	19	2	22
10	Switzerland	8.87	6	1	41	7

Source: KAM 2012 (www.worldbank.org/kam)

Yet another evaluation of the global knowledge economy titled *Global Benchmark Report* (GBR 2011) published by the Confederation of Danish Industry (CDI), provides an annual assessment of the long-term business environment and performance of global economy. The CDI uses knowledge and competency as a measurement indicator enlisting 86 international benchmarks, including the strengths and weaknesses for the 34 OECD-member countries. The GBR shows Switzerland advancing to the top of knowledge and competency hierarchy with the overall highest number of patent applications, followed by South Korea, which has taken massive investments in education for several years. The other nations among the top ten are: Sweden, Finland, Canada, United States, Denmark, Japan, Israel, and Belgium (CDI 2011).

The Knowledge Economy Trends in the United States

The distribution of R&D funds by the U.S. federal government is an important indicator because it provides insight into the nation's broad mission priorities for public expenditures. In general, six United States agencies are responsible for most of the federal obligations for higher education R&D. Together they provided an estimated 97% of the $25.7 billion obligated in FY 2009. Nation Institute of Health ranked as by far the largest funder, providing an estimated 65% of total federal academic R&D obligations, followed by National Science Foundation, which provided an additional 15%. Among other federal agencies, the Department of Defense (DOD) accounted for 8%, the Department of Energy (DOE) 4%, the National Aeronautics and Space Administration (NASA) 2%, and the U.S. Department of Agriculture (USDA) 2%. It should be noted that federal funding during 2009-2011 may not represent the 'normal' funding stream but a 'spike.' Although speculative, it remains to be seen if the R&D funding will continue to be as strong beyond the 2011 fiscal year (October 2010-September 2011) once the stimulus funding has run its course. Indicators of academic patenting are mixed as patent grants to U.S. universities declined to about 3,000 in 2008 (NSF 2010).

Key Inferences

So what do these trends represent? Irrespective of differing evaluation indicators and measurement methodology (and each having its inherent limitations and specific analytic issues regarding measurement), virtually all trends reveal three patterns in general: first, that globalization of the world economy and the vigorous pursuit of national innovation policies are creating new centers of high-technology manufacturing and knowledge-intensive societies. Second, that science and technology remains the main driver of industrial, economic and social development and innovation (non-withstanding the fact that all educational disciplines and "soft" sciences can be treated and cultivated as business, educational, or intellectual products and disseminated for a higher-value return); and third, that the United States – once considered the apex of knowledge economy and innovation – by some account, is slipping from its lead position among the global 'knowledge' community.

Further, while the global trends confirm the United States' preeminence in science and engineering, there is a decided shift in the previously established 'norms' and expectations. During 1995-2005, Asia's share has risen to nearly one-third, mostly because of China's rapid R&D growth as opposed to the traditional front-runners, namely United States and the European countries. The estimated numbers of researchers, although grown from 4 million in 1995 to approximately 5.8 million in 2007, has occurred in developing nations than the industrialized ones. In fact, the combined shares of South Korea, Taiwan, China, and Singapore, have almost doubled from 16% to 31% over the decade 1995-2007 (National Science Board 2010).

These trends also provide an informed understanding of the global knowledge economy landscape and a general preview of the emergent global patterns regarding economic preeminence, advantage, advancement, innovations, and competition. As global economies become increasingly knowledge-intensive, depending upon a nation's capacity for innovation, they represent opportunity or concern. Most important, they provide the policymakers with an opportunity – or dilemma – in assessing their respective nation's place among the world knowledge society and economy for setting up the policy agenda for decision-making.

The Transfer of Knowledge Economy and Challenges

Globally, knowledge transfer and innovation interaction are, to a great degree, predisposed by a discrete characteristic of the academic world called "center-periphery" hierarchy. The strongest universities, owing to their resources (endowments in particular) are able to strengthen their research prowess and reputation for excellence as centers. To strengthen their innovation performance, industries prefer to collaborate with center universities for three reasons: (1) to conduct collaborative basic research, (2) to support their new product development process, and (3) a combination of these two strategies (Raisch et al. 2009). Other motivators for such collaborations are reduced costs, shared risks, communication ease, opportunity for intellectual interactions with other scientists, and prospect to conduct short-term through applied research to solve a specific existing problem. Additionally, universities also educate potential employees (Dunowski et al. 2010). However, the center-periphery structure adds to the pressure of non-center academic institutions who must find creative ways to support innovation and growth in local economies.

In the United States, building regional collaborations and partnerships for economic growth and opportunity is an emerging phenomenon still because of two other reasons. Traditionally, U.S. coalitions have been backed by some type of federal funding (i.e., the *triple helix* interaction); and, a collaborative undertaking is an enormously complex task requiring considerable skill and energy. With declining federal support and the global economic downturn, new and effective methods are needed to create collaborations and sustain innovations to stimulate the economy.

Also, in spite of an increased interest and rankings of the world knowledge societies, a systematic model demonstrating practical collaborations among stakeholders is not available. Various case studies and empirical evidence suggest that there is no "one-size-fits-all" model. For a territory-embedded regional innovation system, the emphasis remains on the localized, path-dependent processes for short-term problem solving (Sinkovec 2011) however, does not serve as a feasible sustained model. The intense competition and decreasing government funding for research compels universities to turn increasingly to industry for support of their research programs. At the same time, industries facing downsizing of internal operations desire to maintain a viable research base during such periods. However, this seemingly ideal backdrop for mutual engagement does not necessarily transform as such. The reason is that such a scenario also warrants increased adjustments by both in reaching a balance: protection of the traditional 'openness' characteristic of university research and graduate training, and protection of the proprietary interests of industry. For universities, knowledge transfer may also require changes in education policy and practices.

Regional innovation systems and activities involve collaboration and engagement with other knowledge-creating and knowledge-diffusing organizations that house important know-how, trained labor, and requisite support system including funding, capacities and expertize. These systems include training organizations, R&D institutes, technology transfer agencies, business associations, and finance institutions. A recent report, "*Building Regional Partnerships for Economic Growth and Opportunity*" (the *JFF Report* 2011), a study spanning two decades on collaborative approaches involving four U.S. regions, researchers' hands-on participation, and two round-table discussions, provides a great cautionary tale on how to avoid pitfalls of collaboration.

The *JFF Report* (Carlson et al. 2011) emphasizes the criticality of practitioners' understanding of the region-based partnership structures for development and implementation to achieve economic growth. It cautions that a regional collaboration, by very nature, is fraught with fragmentation and even the creation of an overarching, general-purpose regional partnership effort is difficult to help sustain because of the competition among businesses, governments, and civic organizations for financial support. Even with a shared, *common* plan, the partnering organizations' own priorities, agendas, and institutional interests make collaborations difficult. Further, the differences in partners' scope, efforts, and a general lack of leadership add to the problem. Consequently, as a last resort option, ad-hoc coalitions are created to work on specific issues instead.

Another potential constraint against a successful collaboration (irrespective of scope or level) is knowledge workers. Articulating the criticality of the human factor, Kim and Mauborgne (1997) remind that unlike traditional factors of production – land, labor, and capital – knowledge is a resource that can't be forced out of people. Technology is another core factor which, although offers versatility, flexibility, access, convenience and personalization at a relatively lower cost, also increases competition and the need for codification. Globalization of education is yet another challenge that provokes a rigorous political and policy debate. Depending upon the perspective of a particular knowledge society it can be a double-edged corollary. For advanced research societies it attracts the best minds from around the world; for the developing countries, it causes 'brain drain', a dismal prospect.

A glimpse of challenges involving policy and governance framework can best be grasped through Thomas Jefferson's letter of July 12, 1816 to Samuel Kercheval, "Laws and institutions must go hand in hand with the progress of the human mind... as new discoveries are made... institutions must advance also, and keep pace with the times." However, laws and policies regarding cyberspace security, property rights, standards, rules, fair play and protection from piracy are difficult to implement because of the stealth nature of the information infrastructure. Regional systems and geography also play an important role because of the links between university-industry R&D collaborations. Regional innovation systems depend on the knowledge base of the industry as well as the accessible regional knowledge infrastructure. Equally important, each has to be aware of the other's capabilities and capacities along with compatibility of aims.

A few recent viewpoints emphasize a contextualized understanding of the actual role that universities play in regional economic development. One such perspective suggests that universities are not restricted to generating only new knowledge through primary research, but also provide technical support and specialized expertise and facilities for on-going R&D activities (Grossman et al. 2001; Nelles, Bramwell and Wolfe 2005). Another view notes the university role as that of a facilitator (*catalyst)* of technological innovation rather than *driver* (Doutriaux 2003). Expanding on Wolfe's (2005b) argument that presence of a leading research university in a community in itself is not sufficient to stimulate strong regional economic growth, yet it can still make significant contributions to the process (Wolfe 2005b) sets the stage for a discussion on creative strategies for innovation through engagement, discussed next.

Collaborative Engagement for Innovation

As an alternative approach, Bramwell and Wolfe (2005) support the "entrepreneurial research university" model, suggested by Tornatzky et al. (2002) that views innovation as a *social process* where users and producers actively learn from each other by regular 'learning-through-interacting' process (Cooke 1988; Maskell 2001). However, these suggestions of knowledge transfer strategies for innovation obligate a basic understanding of the conditions necessary to create successful and enduring collaborations. In that regard, studies on individual regional innovation systems and knowledge clusters may provide helpful processes and procedures on how to initiate a self-assessment plan and avoid pitfalls.

Learning from their case studies over two decades for a social model of multi-partner engagement, Carlson et.al (2011) propose a practical undertaking through shared objectives using these three steps: (1) taking an assessment of what is happening in the region, (2) a common understanding of what the key issues are, and (3) a common plan of how to address them. Together these steps provide a structure to support collective action while allowing each organization to take initiative within its own sphere of influence. In such a plan, each entity is connected to other organizations through a network of collaborative relationships, managed by a core group of leaders to stay on course by tracking whether or not their collective efforts are making a difference. However, the stakeholder leaders need to figure out *on their own how to collaborate*. The key is to avoid creating a *fragmented* structure among potential partners.

As preconditions for success regarding a university-industry model, Arvanitis et al. (2008) suggests first ensuring compatibility of aims, culture, bureaucratic structure and human resources among potential partners. Drawing from his empirical study in Turkey, Sinkovec (2011) suggests three prerequisites: firms comprising a region's main industrial clusters and their support industries; supporting knowledge organizations; and interaction between these two entities. Cooke et al. (2000) suggest two requisite sub-systems for a similar, regional knowledge-based collaboration: (1) the knowledge application and utilization sub-system that is principally occupied by firms with vertical supply-chain networks; and, (2) the knowledge generation and diffusion sub-system, consisting mainly of public organizations.

The case studies of twelve *exemplary* institutions by Tornatzky et al. (2002) highlight conditions that enable universities and faculty to develop effective linkages and external partnerships to improve regional economic development (Owen, 2002). While admitting there is no one model of effective university-industry collaborations, the researchers discuss ten domains of institutional behavior into three broad categories: mechanisms, institutional enablers, and boundary-spanning structures and systems. As best practice for universities, state/federal governments, agencies, and foundations, their recommendation for an enabling environment includes a clearly articulated mission and/or vision statements that underscore (1) the importance of collaborations with regional government and industry partners; (2) consistent and visible commitments among institutional leaders to partnerships; (3) effective and efficient infrastructures, policies, and procedures that facilitate collaboration and partnerships; and (4) receptor capacity in the region. Cautioning against the rhetoric of partnership and collaboration, Owen (2002) suggests recognition of the social and cultural capital of the research within the institutions as well as the ways in which knowledge is generated and transferred among disciplines.

Citing a successful case study using University of Waterloo, Canada, Bramwell and Wolfe (2008) suggest creation of an entrepreneurial research university that capitalizes on its consulting and R&D support through its faculty. They ask universities to act as enablers in launching educational programs that teach business skills critical to identifying, exploiting, and establishing new commercial opportunities with an emphasis on innovative technologies. Further, that the academe should create and share values--a "culture" that is explicitly stated in vision and goal statements for expanded boundaries, and manage these spanning structures and systems by establishing university-industry interface. However, it is important to note that a collaborative engagement is dictated by numerous common dynamics, as follows:

- Individual excellence – collaborators having shared value and goals
- Importance – collaborators' mutual support of major strategic objectives

- Interdependence – collaborators' mutual need of complementary assets and skills
- Investment – collaborators' investment of mutual resources
- Information – open communication among all collaborators
- Integration – building of mutual networks and shared ways of working
- Institutionalization – ensuring that partnerships exist beyond the involved individuals
- Integrity – collaborators having mutual trust

Conclusion

A review of the contemporary trends on the knowledge economy shows that institutions of higher education are critical in engaging knowledge transfer activities to help sustain innovation and growth in regional economies. Such expectations, by their very nature, dictate a multi-purpose function of the academe which most universities, given the dictates of their mission, purpose, size, priorities, etc., strive to implement. With the changing dynamics of today's world, new paradigms of knowledge transfer are needed to sustain innovation and entrepreneurial activities. With dwindling economic resources, world knowledge societies, particularly those within the U.S., must find innovative ways for regional collaboration and engagement to include pooling of resources, talent, and other commodities for achievement of common goals. Collaboration between academe and industry is the first step to strengthen mutual capacities and capabilities in advancing the knowledge economy, and eventually, economic growth.

Notes

[1] A linear model defines the roles played by different actors and institutions regarding research and development (R&D) and funding. It refers to a general idea that basic R&D provides the foundational knowledge for applied R&D, which provides the foundational knowledge for innovation, which then becomes a good to be diffused to users. The process is linear, with one stage feeding the next, and it is unidirectional. In this model, the role of universities is to do the basic R&D, thereby provide the foundational knowledge, information, data, and instrumentation and so on (Cowen 2005).

[2] Academic Ranking of World Universities (ARWU), compiled by the Shanghai Jiao Tong University and now maintained by the Shanghai Ranking Consultancy, explains the selection criteria as follows: every university that has any Nobel Laureates, Fields Medalists, Highly Cited Researchers, or papers published in Nature or Science is considered. In addition, universities with significant amount of papers indexed by Science Citation Index-Expanded (SCIE) and Social Science Citation Index (SSCI) are also included. In total, more than 1200 universities are actually ranked and the best 500 are published on the web.

[3] Mode 2 is a concept refers to a novel way of scientific knowledge production proposed by Michael Gibbons et al (1994) in their book *The new production of knowledge: the dynamics of science and research in contemporary societies.* The proponents argue that beginning with the mid-20th Century, a new form of knowledge production started emerging which is context-driven, problem-focused and interdisciplinary. It involves bringing multidisciplinary teams together for brief durations to work on specific problems in the real world. Gibbons and his colleagues labeled this "Mode 2" knowledge production.

[4] The UIRC Scoreboard lists the world's top 500 universities' University-Industry Co-publications (UICs), published during 2006-08 in all five disciplines: natural sciences, engineering sciences, life sciences, medical sciences, and social sciences/humanities. Details on data collection methodology and caveats are available at website: http://www.socialsciences.leiden.edu/cwts/products-services/scoreboard.html

[5] Of the 500 universities included in UIRC Scoreboard, 130 (26%) are from the United States.

[6] Methodology details to calculate Knowledge Economy Index (KEI) and Knowledge Index (KI) are available at: http://siteresources.worldbank.org/INTUNIKAM.

[7] In the United States, Virginia is first to experiment with the only collaboration of its kind in North America. Called the Center for Advanced Manufacturing (CCAM) initiative, it is an applied research center that bridges the gap between fundamental research typically performed at (three regional) universities and product development routinely performed by companies. CCAM accelerates the transition of research innovation from the laboratory to commercial use. Details of this initiative may be viewed at: http://www.ccam-va.com/about-us/

[8] The Leiden Ranking offers the following indicators of the scientific impact of a university:

1. *Mean citation score (MCS)*. The average number of citations of the publications of a university.
2. *Mean normalized citation score (MNCS)*. The average number of citations of the publications of a university, normalized for field differences, publication year, and document type. An MNCS value of two for instance means that the publications of a university have been cited twice above world average.

3. *Proportion top 10% publications ($PP_{top\ 10\%}$)*. The proportion of the publications of a university that, compared with other similar publications, belong to the top 10% most frequently cited. Publications are considered similar if they were published in the same field and the same publication year and if they have the same document type.

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