Centrum Transferu Technologii
Uniwersytet Łódzki

International cases on innovation, knowledge and technology transfer

University of Łódź

.

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Foreword

I was asked to review the collected work entitled, “International Cases on Innovation, Knowledge and Technology Transfer”, edited by Dariusz Trzmielak, PhD, and David V. Gibson, PhD. This multi-author monograph was prepared by; employees of the University of Texas in Austin, Edward’s University at Austin, Claremont McKenna College, Delft Technology University, Technology University of Monterrey, EGADE Business School, National Technical University of Athens, the Institute of Biochemistry and Biophysics of Polish Academy of Sciences, Warsaw School of Economics, University of Łódź and Łódź University of Technology.

The subject matter, currently still extremely topical, refers to cooperation between academic centres and the business sector whose aims are to transfer knowledge and technologies to the market. The validity of this theme arises from the dynamic advancement of the global economy. This process has forced companies operating in both the market and in the public sector to notice the increasing role of such transfer in fostering academic entrepreneurship and accelerating the commercialisation of a number of indispensable innovations which determine the socio-economic development of both the state and its individual regions.

The work consists of 17 articles (based on case studies) written by 28 authors. It has a logical and clear composition, which makes it reader friendly and facilitates easy comprehension of the issues presented. The layout of the work has been divided into four closely corresponding parts. The first includes an introduction to innovation and technology transfer and includes articles by authors Gregory P. Pogue, PhD, Francesca Lorenzini, Keela Thomson (employees of IC2 Institute of the University of Texas in Austin) who, in a most professional manner, present a new model reflecting the mechanisms which accelerate technological innovation transfer to the market.

The second, comprising 7 articles, is devoted to technological innovation management in its international context. Professor Andrzej Rabczenko, PhD, from the Institute of Biochemistry and Biophysics of the Polish Academy of Sciences, in an enticing manner, points to the low connection of Polish science with the needs of the economy. Using the examples of the United States and Israel, the author indicates the type of such relationships necessary in order for science (especially academic institutions that carry out R&D work) to impact economic development in individual countries.

Marta Czarnecka-Gallas bases her deliberations on the case of Brazil and asserts that an effective innovative policy should not rely solely on centralized support programmes but mainly depend on the pro-innovative attitudes of individual companies.

Marta Kightley, PhD, from the Warsaw School of Economics, in a captivating manner, presents the evolution model of the growth of South Korea’s economy, which was led by the stimulation of pro-innovative attitudes of large companies of the hi-tech sector that invested in R&D processes.

Carlos Scheel, PhD, and Eduardo Aguiñaga investigate the rules of conventional regional development as the systemic approach to innovation. The main drivers and barriers to regional innovation systems in Monterrey, Medellin, Bangalore and Curitiba are discussed. The four cases were described to rethink how to innovate effectively, to show that the impact of innovation on economic business activities depends on the inclusive democratization of non-conventional initiatives.

Renata Lisowska, PhD, collected her empirical material during the visit she paid within the educational project, Lifelong Learning Programme, Innovative Responses to the Delivery of Creative Industries Education (project number 2013 -1-PL1 - KA101 - 42923) and carried out an in-depth analysis of British experiences based on good practice case studies within the development and support for creative companies.

In the case study of Greece, Professor Emmanuel G. Koukios, of the National Technical University of Athens, conducts an interesting deliberation on the novel approach to the management of technologies, which are described in two aspects that combine ‘bio’ and ‘economy’ elements. For this new approach the author proposes four unique development scenarios: fertile valleys, poles of crystallisation, hospitable plateaus and islands of survival,.

Jacquelyn A. Zehner (from Claremont McKenna College in California), Prof. William Bradley Zehner II (from Edward’s University in Austin) and Edyta Gwarda-Gruszczyńska, PhD, and Dariusz Trzmielak, PhD (from the University of Łódź), discussed the evolution of the growth of American high technology industries supported by academic incubators. They draw particular attention to the development of the diversified portfolio of the technology incubator in Austin.

The following part comprises five articles devoted to the role of university research, technology transfer as well as the operations of spin offs.
It opens with an interesting article by employees of IC^2 Institute from The University of Texas in Austin. David V. Gibson, PhD, and John S. Butler present research activities and the building of stakeholder networking (industry and public sectors) by this scientific institution in order to commercialise their research results.

Another article written by Dariusz Trzmielak PhD, gives an overview of the role Technology Transfer Offices (TTOs) play in selected E.U. countries (such as Spain, Holland, Great Britain, Austria, Belgium, Denmark, Finland, Norway, Slovenia, Germany, France, Sweden, Hungary and Italy), Switzerland, the United States and in Poland.

Jan Koch, Professor, discusses the role of University Centres for Technology Transfer in the commercialization of scientific research results and in the transformations at modern day universities. Article is inspired by best practice from

Wrocław Centre for Technology Transfer and describes implementation of a fully functioning and self-financing System for Technology Transfer.

Professor Marina van Goenhuizen and Qing Ye, from Delf Technology University, in their comparative study, present the conditions for the development of spin-offs and the barriers encountered in Finland, Holland, Poland and Portugal.

Małgorzata Grzegorczyk, PhD, from the University of Łódź, conducted a case study on the University of Texas Health Science Centers (The Health Science Center in San Antonio and Houston Health Center) and, in an interesting manner, presented the cooperation between educational institutions and companies in the area of knowledge transfer and commercialisation of technologies.

The final section of the monograph includes four articles devoted to good practice in the sectors of education and industry.

Magdalena Ratalewska, PhD, and Professor Janusz Zrobek, of the University of Łódź, in their case study skilfully describe the development of e-learning education provided by Universitat Oberta de Catalunya in Spain.

Marco Bravo and David Resende shows the actions taken to develop University Technology Enterprise Network in Portugal to improve the Portuguese Innovation Ecosystem. Their analysis illustrates the growth of organization competencies in international technology transfer and commercialization by facilitating industry access to the world's leading markets.

Anna Adamik, PhD, and Sebastian Bakalarczyk, PhD, Łódź University of Technology, illustrate the critical role played by corporate social responsibility and its measurement in the course of the development and implementation of new technologies. Authors focus on the innovative operations on the base of the case study of good practices, drawn from KGHM Polska Miedź S.A.

This collection is completed with a captivating text by Paulina Kosmowska from Łódź University of Technology, that addresses industrial property management and research results trading exemplified by special purpose vehicle at Łódź University of Technology.

I can unequivocally assert that the monograph "International Cases on Innovation, Knowledge and Technology Transfer", edited by Dariusz Trzmielak, PhD, and David Gibson, PhD, is an exceptionally successful scientific work and ought to be published in its presented form. It will no doubt become a valuable scientific book which is certain to attract the interest of academics, managers from the fields of industry and the public sector. Publishing of the monograph in English will most certainly expand the potential range of readership in both Poland and beyond.

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INTRODUCTION TO INNOVATION AND TECHNOLOGY TRANSFER

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TECHNOLOGY TRANSFER AND THE INNOVATION REEF

Abstract

The facile transfer of technologies, developed through public research support, into marketed goods and services is an important contributor to regional and national economic development. We explore a new model, the Innovation Reef, to illustrate mechanisms that accelerate the transformation of technology innovations into economic impact. The contribution of government policy is found to be similar to environmental conditions conducive to reef growth, while technology transfer processes provide the ecosystem structure much like coral, and players, as fish and invertebrates in a reef, actively work together through mutualistic currency exchanges to achieve commercialization goals. This model highlights important factors essential to healthy technology transfer ecosystems.

Keywords: technology transfer, innovation ecosystems, coral reef, intellectual property, government policy, technology commercialization.

Introduction

In the past decades, public investment in basic research has sought to accomplish three goals:

1. Fuel basic understanding in the sciences and engineering
2. Provide a vehicle for training new thinkers and researchers and
3. Generate new technologies that can build a regional economy.

Technology transfer refers to the mechanism through which raw innovations or inventions - developed through basic research – are transformed into finished products and commercialized. This process creates economic impact by bringing valuable new products into the marketplace, which creates jobs, increases GDP, and brings wealth to new regions. This process includes legal protection of intellectual property assets, assessment of market interest in a potential product, identification of technical requirements for the product, and commercialization.

Commercialization can be achieved through several different paths, including financial vehicles such as licensing the intellectual property to an existing entity, industry-sponsored research and new enterprise creation.

The financial support of basic research by government entities is necessary due to the lack of predictable and timely return on investment from such spending. However, these seemingly non-directed investments of public funds have led to advancements including better understanding of infectious diseases, the discovery of compounds that interdict disease, new approaches for medical care, mechanisms of human thought and the understanding of our genetic blueprint - decoding the human genome [Ballabeni et al., 2014]. Through the mentorship offered by seasoned researchers, the practice of basic research goes beyond the generation of new knowledge and simultaneously develops new scientists, engineers, instructional experts and thinkers.

After the conception of a basic discovery it must move be developed through further academic laboratories and transition into the private sector for practical solutions in order to be fully realized. Product realization can often require 3-7 years [Mansfield, Lee, 2005; Markman et al., 2005], though some, such as healthcare innovations, require longer. This temporal disconnect, due to the time lag from discovery to product emergence, de-incentivizes private sector support of curiosity-based endeavors. Indeed, in 2008 in the United States, the federal government funded greater than 57% of all basic research, while universities and colleges contributed 15% and non-profits 11%. Private industry funded only about 18% of basic research [Maloney, Shumer, 2010]. Private sector funding is more often available if basic research reaches a stage at which it can be shaped into a definable good and/or service. At this point, private sector contributions dramatically expand: Although the private sectors funds a small minority of basic research in the U.S., private sector funding comprises upwards of 75% of research and development spending as a whole [Boroush, 2008]. The importance of R&D spending to drive the development of economies is argued by policymakers and economists alike. Technological progression from discovery to product development stimulates business success, job creation and overall economic health. Although the absolute contributions to economic expansion are difficult to precisely measure, the value to individual business is undeniable [Griliches, 1992; Griliches, 1994; Jones, 2002].

Despite the role of public research investments to promote the public good, national budgets to accelerate research investments in basic research are limited. Therefore, the U.S. government has strategized to extract all possible value from basic research funding to realize the maximal impact on society. One innovative policy encourages academic and industrial collaborations through new funding mechanisms, such as the Small Business Innovation Research grants. Furthermore, public agencies encourage consortiums of private and public sector entities to find solutions for critical issues by positioning priority topics and allocating special funding mechanisms. However, due to the complexities of science and business incentives, it is often difficult for public agencies to make accurate predictions about the societal impact of any. These predictions are skewed further due to the lack of predictability in transitioning any basic innovation into a marketable product or service. Some innovations prove to be worth less than expected, whereas some research produces innovations with surprising applications or value. As an example, investments in the U.S. Space Program produced technologies used to improve the chassis for buses leading to their growth as a major transportation source [Wilson, 2008]. Other Space Program research provided the initial pump design used to generate the artificial heart pump by Michael DeBakey of the Baylor College of Medicine and David Saucier of the Johnson Space Center [Wilson, 2008].

The innovation reef model

This paper will explore mechanisms that can reduce challenges associated with transforming innovation into economic impact by coalescing necessary policy, processes and players into new or existing technology transfer activities. To illustrate this process, we propose a new model for technology transfer ecosystems: the coral reef. This model has been applied to more generalized innovation ecosystems [Markman, 2012] and will be thus referred to as the Innovation Reef, as it applies to technology transfer and the commercialization of innovations that emerge from basic research activities.

It is clear from simple observation of marine environments that life is not equally distributed through the near-shore to deep ocean environments. Life near a sandy beach shore appears less rich in support resources (food, protection, relationships), leading to a lower density of life forms. In contrast, deeper water life is organized into schools of “like” organisms, larger predator organisms, and infrequent collaborative or mutualistic relationships due to a highly competitive environment. In regions with special environmental conditions, the coral reef separates near shore and deep-water environments. The reef provides an organizing center for a very different ecosystem to grow. The physical reef structure, inhabitants and relationships will serve as the physical model for the conceptual Innovation Reef that can assist realizing commercial benefit from innovations. The reef environment is fragile, existing only at depths less than 70 meters and under a small range of temperature and salinity conditions. Reefs can be easily disrupted by changes in conditions such as changes in light availability, temperature and dissolved gas concentrations in nutrient currents. Further, reefs occupy a fraction of the ocean surface area (less than 0.001%) but contain a tremendous diversity of life (32 of the 34 animal Phyla exist in coral reefs). Approximately 25% of biodiversity in ocean fish exist in association with coral reefs [Spalding et al., 2001]; [Wilkinson, 2002]; [Paulay, 1997]. Finally, organisms in a reef must survive by developing complex, mutualistic relationships with the reef structure and/or other reef dwellers. The mutualistic relationships provide reef-dwellers protection, shelter, cleaning, nutrient processing, growth and increased biodiversity.

It is interesting to note that successful technology transfer environments share many characteristics with the reef. They are both fragile structures that require specific conditions to thrive. In this model, we explore how public policy regarding innovation commercialization can act as the oceanic conditions that can either favor or disfavor the growth of an Innovation Reef. If policies are properly defined and aligned with recognized economic incentives, technology transfer offices (TTOs) within research institutions can define processes which facilitate the movement of ideas from the invention stage, through building intellectual property assets and out into the marketplace using proactive commercialization activities. These processes, when appropriately defined, can act as healthy and growing coral structures that encourage the circulation of a wide variety of players. These players are analogous to the staggeringly diverse and concentrated life forms sustained by a healthy coral reef. The players interact to form relationships of mutual benefit, facilitating technology commercialization and the growth of the local Innovation Reef. The manner in which policy, processes, and players are optimized to produce results will be discussed through applying the Innovation Reef model to the localized technology transfer environment.

Government policy

The mutualistic relationship between coral organisms and the zooxanthellae algae drive the localization and growth rates of coral reefs. The zooxanthellae inhabit the coral gut and provide most of the coral's raw nutrients (sugars, lipids and oxygen) in exchange for water and carbon dioxide. This relationship is particularly efficient: as much as 90 percent of the photosynthetically produced nutrients are transferred from the zooxanthellae to the host coral, even in nutrient poor waters [Sumich, 1996]. This efficiency is responsible for sustaining the remarkable growth properties of coral reefs and the productivity of the ecosystem [Barnes, 1987]; [Barnes, Hughes, 1999; Levinton, 1995]. Because of this mutualistic relationship, coral reefs are only found in oceanic regions that support algal growth.

The conditions are rather particular. Reefs generally live only 30 degrees North or South of the Equator, such that warm currents of 23 and 29 degrees Celsius are present. Although coral can live below 18 degrees Celsius, their algal inhabitants cannot and thus reef structures are absent in waters that fall below this temperature [Veron, Smith, 2000]. Another requirement is particularly high salinity within a specific range (32 to 42 parts per thousand). Finally, the water must be clear to allow for high light penetration to support algal growth and photosynthesis [Lalli, Parsons, 1995]. Thus, reefs are restricted to waters that are less than 70 meters in depth and that do not have an accumulation of water sediments, pollution or excess carbon dioxide [Barnes, Hughes, 1999].

The U.S. Model

The strict environmental conditions supporting the elegant interplay between the mutual relationship of coral and algal is illustrative of the role of government policy and economic practice. While economic activities can occur in the absence of or contrary to government policy, legal economic incentives accelerate commercialization. When incentives are withheld, such as in the absence of advantageous government policy, developing the necessary relationships for technology commercialization is difficult. In this manner, governmental policy provides the ecological conditions (similar to a reef's temperature, salinity, water depth and light quality) that are appropriate to recruit structural elements and players essential to build an Innovation Reef. Without the proper policy choices, the "coral" structures of proper technology transfer processes will not be built in a region, and the essential constituent players will not co-habitat such that beneficial technology transfer outcomes are realized. The U.S. is an excellent example of the impact of building the right structural components through policy to incentivize and grow technology transfer outcomes to economically benefit the country.

The Bayh-Dole Act is one important policy innovation in the United States that creates partnerships between private and public sector [Loise, Stevens, 2010; McManis, Noh, 2011; Siepmann, 2004]. This Act, passed in 1980, has transformed the relationship between innovation and the economy. It integrates the power and impact provided by the U.S. federal government funding into the economic progress of the nation. The careful wording of the Act provides individual institutions considerable latitude to implement its provisions. It does so while setting up implicit proactive requirements which, in turn, create a cycle of actions that both align participants and position institutions and the country to realize commercialization success from academic innovation. By transferring intellectual property (IP) ownership to institutions that report inventions rather than retaining rights as the national government, the act has yielded dramatic results. Disclosures of inventions have risen roughly four-fold in the period of 1991-2008, corresponding to a similar increase in new patent applications filed each year [Loise, Stevens, 2010]. Commercialization of these inventions has produced roughly seven-fold growth in cumulative licenses of IP to private entities and an approximately six-fold increase in revenue yielding licenses or options during this same period. University licensed products created an estimated 279,000 jobs between 1996-2007 and contributed about $187 billion to the U.S. GDP during that time [Roessner et al., 2009]. The Act gave preference to commercialization through small business, supporting the creation of over 6,600 companies from 1980 - 2008 [AUTM, 2008]. Credit is given to the Bayh-Dole mechanism of commercialization (the university start up) for creating the biotechnology industry. Roughly 50% of all biotech companies started from a university license [BIO, 2009]. This industry alone has grown to comprise over 1.4 million direct jobs in the U.S. Each new bioscience job creates on average 5.8 additional jobs in the economy resulting in dramatic economic advances for the country [Battelle/BIO State bioscience initiatives report, 2010]. The Act's impact on product realization can be demonstrated by the frequency of new drug approvals by the U.S. FDA. Between 1970 and 1981, five approvals of new drug entities were sourced from public or university sector research. However, in the period following the Act, from 1985 to 2008, over 190 new drugs originally discovered through public sector research received approval from the U.S. FDA. This dramatic turn in commercialization cannot be solely attributed to the Act, but leading economists credit the Bayh-Dole act as the force liberating inventions made in U.S. laboratories originally funded by taxpayers' monies [The Economist 12, 2002].

The Virtuous Cycle

How can policy create such impressive results within a complex economic environment? The explicit provisions within the Act set up a series of implicit proactive imperatives driving a "Virtuous Cycle" from invention, to economic benefit, back to more invention:

1. Disclosing of inventions
2. Seeking intellectual property protection of inventions
3. Commercialization of intellectual property assets
4. Sharing of revenue between inventors and university participants
5. Creating new enterprise instruments to develop technologies and share equity value
6. Encouraging new inventive activities

This cycle of activities and shared participation by all players in the technology transfer Reef fosters strong financial incentives that can align players in the technology transfer ecosystem. This alignment of incentives captures latent creativity and turns it into assets that can be monetized. These financial incentives can also be viewed as problematic – defocusing academic research from the pursuit of knowledge to the targeted pursuit of profit [Loewenberg, 2009]. Therefore, other non-monetary incentives must exist to participate in the technology transfer process. The intrinsic desire to realize the potential of ideas, create solutions for public good, fulfill goals, develop alternative career opportunities for students, or give back to the society that has funded their research can give people an appropriate "nudge" to participate in technology transfer, and in such a way that they do not act contrary to academic freedom or ethical boundaries [Thaler, Sunstein, 2009]. Ultimately, financial alignment is essential if technology transfer realizes commercial success – no one will think it fair to not participate in upside from a product they helped make possible. Thus linking financial and other less tangible interests is key for a successful technology transfer environment – one that realizes the potential of publicly funded research and the commercial potential inherent in innovations emerging from it. Such alignment demonstrates that mutualistic relationships based on common purpose can build value for all participants – value that expands beyond monetary gain to regional wealth. Such benefits encourage academic researchers to re-engage in the commercialization process through further innovative research and disclosure of inventions.

Strategies to Reproduce Bayh-Dole Act Outside the U.S.

These dramatic economic results emerging in the U.S. as a result of Bayh-Dole Act have prompted other countries to consider similar legislation. Some countries have not passed definitive legislation, like the Bayh-Dole Act, and have instead sought to cobble legislation together to accomplish similar goals. However, this approach has often failed to produce a coordinated policy solution integrating the proactive responsibilities inherent in the application of the Bayh Dole Act: invention disclosure, intellectual property asset development, commercialization of assets and revenue sharing among players in the commercialization Reef. In contrast, some countries, such as India, have built laws that more closely resemble the U.S. Act: "The Protection and Utilization of Publicly Funded Intellectual Property Bill, 2008." The Indian legislation supports the generation of awareness of the need to identify innovations and pursue appropriate intellectual property protection in publicly funded laboratories, universities, centers as well as small and medium sized enterprises throughout the country [Sampat, 2009]. Further, the law encourages developing technology transfer that emerges from publicly funded sources. Finally, the law seeks to produce licensing income from proactive commercialization of intellectual property protecting innovations developed in India. Although these proactive measures are similar to Bayh-Dole, the Virtuous Cycle of commercialization appears not fully formed. The sharing of this income is left vague, potentially de-incentivizing distal players in the Innovation Reef from participating. While promoting incentives and access, the sharing of royalty income will be an institution-by-institution decision – which could result in alignment of the Innovation Reef around an institution, or alienation of essential commercialization players. Thus, the ability of this law to align the interests of inventors with their organization is limited and still requires institutional policies that insure cooperation. In other words, it comes short of the Virtuous Cycle in the Bayh-Dole Act resulting in the share of royalty income with originating inventors.

The lack of explicit financial alignment in the Indian law raises the question of the appropriateness of the commercial benefits derived from public funding research. This question is of considerable significance within academic and government laboratory communities and creates additional alignment issues preventing the development of an effectively functioning Innovation Reef. This concern has prevented the European Union from developing a consistent legal framework similar to the Bayh-Dole Act. Issues emerging from the mixing of profit with the pursuit of knowledge were acknowledged previously in this chapter. This concern receives more weight in Europe, where it is an active rationale for lack of participation in technology transfer. This leads to a deepening of the long-standing division between academia and industry [Verspagen, 2006; Siepmann, 2004]. Inventions made through public funds are largely viewed as public knowledge, making European researchers hesitant to exploit commercially – even when the opportunity exists through local government policy. Several European countries have pursued laws that allow effective technology transfer, including the United Kingdom, Germany, Denmark and Belgium. However the structure, the alignment and participation from academic inventor through private sector commercialization strategy with attendant royalty sharing has not had the same impact as the Bayh-Dole Act in the U.S. [IPEG]; [Siepmann, 2004]. Due to the fact that various approaches to this topic exist between countries, the use of EU funding as an effective stimulus for economic growth is a very fragmented and uncoordinated in Europe.

As changes in ocean pH, concentrations of dissolved carbon dioxide, and increases in ocean temperatures threaten the health of coral reefs worldwide, governmental policy changes can threaten or facilitate commercialization activities. The EU has failed to produce a coherent, aligned set of policies regarding innovation. Thus, an Innovation Reef has yet to emerge throughout the EU. This gives natural advantage to ecosystems that develop workable policy (i.e. UK and Germany) and leaves other countries in an economically disadvantaged situation (i.e. Portugal, Greece and other nations). Extending the structural elements throughout the EU would provide new mechanisms for struggling economies to compete and participate with leading nations through the conversion of basic knowledge and innovation into economic return.

Process

Coral communities form the structural basis for all reefs and make important contributors to the ecosystem. Corals come in many shapes, each with a host of adaptive living strategies. The well-known stony corals that build reefs take on a dizzying array of shapes and sizes, from low, furrowed brain corals, to the high reaching pillar and staghorn corals, to the typical rock corals of the Caribbean.

Together, individual corals build structures that coalesce into a broad, recognizable reef. Effective technology transfer processes, much like healthy coral structures, start with many small processes but together build a structure around which commercialization players can associate and create broad economic impact [Siegel, Phan, 2005]. However, for these processes to emerge, favorable policy conditions, as discussed above, must establish the environment and promote continued alignment of players, not only in interest, but in action.

The principal processes of technology transfer, for the purposes of this chapter, are:

1. Researcher Engagement
2. Invention Disclosure
3. Opportunity Evaluation
4. Asset Development
5. Business Strategy Development
6. Deal Creation
7. Royalty Allocation and Compliance

Researcher Engagement

For coral to grow, they must receive nutrients that cannot be provided in adequate concentration in normal ocean waters. Algal cells living in the coral, as plants, have remarkably simple requirements for metabolism and growth – primarily light, carbon dioxide, water and micro-nutrients. When each is provided at adequate levels, zooxanthellae convert oceanic regions that lack adequate nutrition to support complex animal life into an environment ripe with life through stimulation of coral growth and attendant growth. Researcher engagement is the launching practice for any technology transfer activity. High quality, well-funded science is the light and nutrients within the Innovation Reef – without a steady stream of innovative research that produces new inventions - the system dies from lack of nutrient availability. A researcher's decision to share their invention with their institution or the TTO, or disclose their invention, is often a function of how they perceive the value offered by patent protection and the incentives provided by the technology transfer process. Investigators weigh these benefits against the costs of their participation in commercialization [Owen-Smith, Powell, 2001]. Therefore, technology transfer professionals must educate researchers about the commercialization process, the support provided by the TTO office and the involvement expected from faculty. Researchers are not primarily driven by the potential of financial return [Thursby, Thursby, 2002], but by their past experience with commercialization activities, including sponsored research, advancing career goals and the impact of explicit institution policy requirements [Jensen, Thursby and Thursby, 2003; Link et al., 2007]. As experienced by the first author, active outreach and person-to-person communication are often the most successful processes to educate faculty about the benefits and requirements associated with commercialization, although larger educational forums also may be effective. Informal mechanisms to assist researchers with their expressed goals, including technical assistance, consulting activities and collaborative introductions can greatly assist establishing and maintaining the flow of technological knowledge within an institution [Link et al., 2007]. Such flow is essential as the building block for the Innovation Reef.

Invention Disclosure

Inventions arising from basic research are highly diverse depending on their scientific field, the nature of the inventor, the potential commercial application and time and steps required to take a raw invention and transform it to a commercial product. Therefore, one key function in the disclosure process is to provide a structural manner to characterize the innovation so that it can be properly organized and evaluated. The content of an invention disclosure differs between institutions, but in its barest form, it should detail the nature of the invention, the names of inventors, the source of funding supporting research resulting in the invention, barriers to obtaining intellectual property protection, known barriers in the scientific literature, and competitors in the marketplace [Thursby, Thursby, 2002]. The nature of the funding source and explicit declaration of inventorship often reveals obvious commercialization encumbrances including prior ownership or agreement right provisions. Written disclosures, either in printed or online forms, allows inventor acknowledgement of obligations of both researchers and the TTO in the commercialization process [Friedman, Silberman, 2003]. Such mutual agreement reduces friction and helps unite activities toward jointly agreed commercialization goals. Since disclosure is determined by researchers who self-select to comply with institution regulations and support commercialization efforts, memorialization is often an aligning action [Markman et al., 2005].

Opportunity Evaluation

The opportunity evaluation step focuses TTO attention and effort around inventions that have high commercial potential, rather than diluting effort on inventions may not be promising. One common concern that must be addressed is potential encumbrances to ownership of an invention due to previous signed agreements. Such agreements remove inventions from institutional control – making their commercialization pathway remarkably straightforward. An invention disclosure must be viewed as the essential starting point for the evaluation process that seeks to identify inventions that are, as originally defined in 1983 by Goldhor and Lund, revolutionary, ripe, defensible, portable and possessing broad commercialization potential. The fit of an invention into these criteria must be established through two active dialogues, one with the inventor and the second with the market. Initially, detailed understanding of the invention, its relationship to competitive science and the vision of how it may fit into existing or new commercial activities will come from detailed discussions with the researchers. Market fit and interest must be tested through primary and secondary research where the general features and benefits of the invention are presented, and feedback is received. Most TTOs make evaluations based on the salability of the invention in the marketplace and the time required to realize a product integrating the invention [Jensen, Thursby, 2001; Siegel, Waldman and Link, 2003]. This is critical to understand since commercialization of an invention can require 3-7 years from original disclosure [Mansfield, Lee, 2005; Friedman, Silberman 2003]. Further, time to market also determines the time horizon of the return on investment because the TTO office must provide both monetary and time-based investments in order to transform an invention into a salable asset protected by appropriate intellectual property mechanisms [Shane, 2004].

Asset Development

Coral reefs are ripe with interesting biological properties, relationships and ultimately, stories illustrating the diversity and intricacy of life. These properties are studied, documented and are subject of innumerable papers and television programs. As human cultures have grown, their activities increasingly threaten the sustainability of reef ecosystems. Humans may not change their behavior when presented with the threat they poise to this important biological system. Change often occurs when the flow of valuable assets from the reef into their culture is threatened. Humans have transformed the invention of nature in the reef into a source of highly valued resources, which play critical roles in human life around the world. A natural reef is a rare and highly valuable asset to a region that promotes many commercial activities from fishing, coastal protection, maintaining biodiversity, beach-front vacationing, natural sources for medicines and cosmetics, and materials for jewelry. The aggregate value of coral reefs has been estimated at over $30 billion per year [Cesar et al., 2003]. Reefs directly impact the lives of greater than 500 million people [Wilkinson, 2008]. Thus the conversion of a unique ecosystem into a set of valued assets is the principle driver for human behavior change in order to sustain reef life. Likewise, commercialization depends on the flow of new, natural insights and inventions, much like the occurrence and growth of reef ecosystems. However, these inventions have little value in society, produce little change in the economy unless they are converted into assets that can be both defined and protected. The process of intellectual property (IP) development turns an invention into a monetizable asset form allowing it to be protected, sustained and grow into a product of shared value within an economic community.

Ideas or disclosed compositions or methodologies are readily copied in a world where technology can be viewed as merely a commodity. Therefore, protection of inventions as assets through appropriate IP protection is essential if a defendable and unique product position in the marketplace is sought. This first investment in a new product, or new enterprise, is made by the TTO. The costs associated with procuring an IP asset must be weighed against the potential royalties based on the market proximity of a given invention. Although a dramatic increase in patenting has occurred since the passage of the Bayh-Dole Act and other like laws [Colyvas et al., 2002], the costs to procure an IP asset are significant (upwards of $20,000 per patent) [Carlsson, Fridh, 2002]. These costs can be amplified if one seeks international patent rights, which can significantly increase the value of an invention, creating an important dilemma for TTO offices – cost versus potential value [Siegel, et al., 2003]. Due to the limited budgets TTO's have to procure and manage IP assets, carefully weighed investment decisions must be made at the point of filing, prosecution and issuing of patent assets. It is not surprising that IP related issues require up to 80% of TTO personnel time [Clarysse et al., 2007] and significant, and often growing proportion of their budget. The complicated processes required for IP applications in the U.S. and international offices, along with the attendant funding decisions, are significant and can become paralyzing to ill-prepared offices. These offices can become obsessed with the intricacies of IP procurement, thinking IP assets are the primary goal. Nonstrategic TTO practice can result in many assets being developed and lots of money spent, but no commercialization. Therefore, offices must view IP assets as essential, but merely means to an end. The true goal is commercialization – realization of the technology in a product for the public's good and financial return to the institution.

Business Strategy Development

As noted previously, humans value coral reefs primarily for the ready access of materials used to derive products and realize commercial benefit through entire industries. Only recently has the high inherent value of reefs been recognized to sustain a large proportion of the Earth's life, promote effective nutrient exchange and provide sustainable fisheries. The commercialization activities associated with reefs begin at fisheries and expand to highly derivative biotechnological applications in medicine and cosmetics. The products derived from the reef require commercial relationships within the human world to realize the latent value present in the "raw" coral ecosystem. In a similar way, a business strategy is required to define and unite an IP Asset with its best commercial outlet. Three principal business strategies are used as technology transfer outlets:

1. Industry Sponsored Research
2. Licensing to Established Company in Appropriate Industry Sector
3. Licensing to a Start Up Company.

The nature of the most appropriate strategy for a given asset must be determined through careful and disciplined investigation. Significant infrastructure must be developed by obtaining personnel with established competencies to describe the business value of an IP asset in the value chain of an industry. These individuals must further reach efficiently into the marketplace with this compelling business message describing value to both licensee and licensor [Etzkowitz, 2003; Markman et al, 2005]. An IP asset at an early stage of development, distal to market realization, may be best used as a catalyst to establish an ongoing relationship with an industry component. Continued development of the IP asset through sponsored research provides inventors with the necessary funding to continue innovative research while providing a pathway for commercialization implicit for future inventions. These companies can be logical choice for a commercialization partners for the academic institution through licensing relationships. Both the personal networks of TTO personnel, along with their knowledge of users and industry structure/practice are essential to make appropriate value proposition presentations to companies for sponsored research or licensing [Siegel, Phan, 2005]. Other inventions offer platform or broad commercialization opportunities that are poorly realized through targeted field of use, or geographic licensing strategies to existing companies. Indeed, attaching such limitations to the asset through a licensing agreement may create significant disincentives to engage in a relationship with the TTO. Therefore, licensing to a startup company may be the best strategy. Development through a startup allows a new commercial strategy to be custom-created for the IP, without other constraints facing existing companies, which may help increase the IP'a value.

Deal Creation

Strategies are not converted into value until completion of the deal creation step. As opposed to patent numbers, the number of licenses an institution has executed is the greatest predictor of commercial return [Thursby, Kemp, 2002]. Therefore, licenses are a measure of IP productivity within a TTO. The inventors' continued support of commercialization is critical to argue technical merit, solve integration issues and produce belief in the technology through the promise of the researchers reputation, data or continued involvement [Jensen, Thursby, 2001]. Licensing for cash in the form of upfront payments, annual licensing fees, milestones and royalties on sales is the most frequent strategy for TTO offices as they interact with existing companies as the commercialization partner for an invention [Markman et al., 2005; Bray, Lee, 2000]. The inventor can often be a technology evangelist in the marketplace drawing entrepreneurs and financiers to an invention to create the potential startup [Thursby, et al, 2001]. Licensing for equity is most frequently the mechanism employed to establish a relationship with an entrepreneur and associated startup enterprise [Markman et al., 2005].

Royalty Allocation and Compliance

Fisheries associated with coral reefs provide vital food (often in the form of protein), tools (including sponges, echinoderm spines, and shells), and other remains for jewelry for coastal communities throughout the world's tropical regions. Reefs are rich in fish and useful invertebrates. Indeed, reefs can yield a net annual value of U.S. over $5,000 per square km [White, 2000]. This value is critical to the economies of developing countries. For the value of these reef-originated products to be realized by the native inhabitants, these must be moved from the reef to the coastal community and then disseminated into the broader world through established commercial mechanisms, including shipping, intermediaries and currency exchange.

Similarly, inventions rarely produce significant value if hoarded locally, thus the imperative of determining and executing an appropriate business strategy culminating with a business deal. However, once the deal is struck, the work of the TTO has not ended. With approximately a 7-year lag between licensure or startup creation and the initiation of royalty receipts, the TTO must monitor all licensees to insure that internal company development work does not eliminate the validity of the license agreement provisions and that emerging products provide a fair and reasonable return to the originating institution. When royalties are received, the TTO must ascribe these to the appropriate licensee and distribute revenue to the inventor and institution (as called for by the Bayh-Dole Act). This activity requires accurate accounting, soft skills to explain royalty sharing proportions to inventors and insure that receipts build the Innovation Reef rather than splinter it through self-interest. Therefore, royalty allocation and compliance activities are essential to insure that licensees cooperate with license provisions and that all involved in commercialization of an invention reap the reward of the success.

Correct Process is No Guarantee of Success – The Importance of Critical Mass

Although the processes of technology transfer can be readily enumerated and defined, the simple practice does not guarantee success. Review of the literature detailing the performance of technology transfer offices from the U.S., E.U., Australia and other regions [Siegel, Phan, 2005; Mansfield, Lee, 2005; Phan, Siegel, 2006; Siegel et al., 2003; Siegel, et al. 2003; Siegel et al., 2007; Kim et al., 2008; Wright et al., 2004; O'Shea et al., 2005], suggest that those regions with 10-30 years of technology transfer experience success according to a set of definable variables. Such variables are identifiable and can strongly influence the degree of economic impact any particular technology transfer practice may produce. These include:

- Outcomes from Academic Research Activities:
  - New invention disclosures (IDs) appear in technology transfer offices as a function of research budget. The literature suggests that >$1.0M in extramural academic research is required to generate one new ID.
  - Current practice suggests that technology transfer offices file patents for <50% of submitted IDs.
  - Only 10-15% of submitted patent assets are subject to a commercialization agreement, including licensing deals or new company startup.
  - Of executed licenses by technology transfer offices, less than 15% generate revenue in excess of $1M.
  - It can require on average between 3-7 years, and possibly much longer depending on the field, between a commercialization agreement or event and the recognition of royalty revenues in excess of initial patent prosecution costs incurred by the technology transfer office.
- Start Up Output at University
  - From the published data, about 10% of academic technology transfer licenses are used to initiate a company startup or spin out.
  - A total of $30-300M in extramural research funding appears required to produce one viable start up company. The variation noted is dependent on the basic and applied focus of the academic institution studied.
  - Of startup companies initiated, only about 66% receive funding required to operate independently beyond the first year of operations.
  - Only about 20% of funded startup companies create sustained value for the academic group providing the license.
  - It can require, on average, 15 years from receipt of the ID in the technology transfer office to the realization of a liquidity event associated with a startup company, to which the ID or subsequent patent application was licensed.

These data argue that not all academic institutions, local regions or countries, can equally participate in the economic impact of technology transfer. A stable and profitable TTO requires a critical mass in extramural research funding provided, availability of adequate funding for pursuit of patent assets, effective commercialization relationships and practice, and linkage to necessary equity financing to fuel commercialization activity. Further, the talent of technology transfer experts are another factor influencing predictors of TTO success. Experienced licensing specialists are critical to link raw invention to the commercial market.

These observations necessitate the development of strategies to accelerate the acquisition of inventions from researchers and rapidly move meritorious assets into the commercialization process. A single or group of licensing specialists within a TTO is insufficient to accomplish the complex processes detailed. Therefore, strategies must be developed to create a critical mass surrounding each process through the recruitment and involvement of diverse players in the technology transfer process. This not only offers acceleration, but also bench strength to support internal transitions and changes in a TTO.

Players

Under appropriate oceanic conditions, the mutualistic relationship between coral animals and algae can grow from single coral organisms to expansive reef environments covering over 348,000 km, in the case of the Great Barrier Reef. It is impossible to overstate the nucleating activity of the coral reef on associated biological life. Reef structures are essential for the recruitment and sustaining of complex vertebrate and invertebrate life. They provide the most biologically diverse environment on earth. Within the reef, organisms breed and spawn, young are protected, and feeding grounds are found for 32 of the world’s 34 animal Phyla. In contrast, only 9 Phyla are found in the tropical rainforest [Wilkinson, 2002]. In addition to thousands of invertebrate species and larger animals (e.g. sea turtles, large fish, such as sharks, etc.), coral reefs contain more than 800 hard coral species and over 4,000 species of fish [Spalding et al., 2001; Paulay, 1997]. Some biologists suggest that over 1 million undefined organism species live in or around reefs making the biodiversity of this ecosystem difficult to fully comprehend [Reaka-Kudla et al., 1997]. Although many organisms spend their entire lifespans within the reef, many species only frequent reefs for particular activities, including hunting for food, nursing of juveniles and protection of adults during spawning.

As in a coral reef, successful TTOs must recruit and sustain relationships with diverse players in the community, building a functional Innovation Reef in which different types of people, talents and business roles are represented. The talent, wisdom and facilitators are essential for technology commercialization ecosystems. The acquisition and maintenance of this talent pool is often the limiting factor separating successful environments from mediocre ones [Markman, 2012]. Density of players with sufficient experience in their field, frequency of interactions between players, and the currencies exchanged in these interactions are critical [Hwang, Horowit, 2012]. The Reef model provides an excellent structure for exploring these important questions.

Mutualism in the Coral Reef

For the Innovation Reef, as with coral reefs, the key characteristic of relationships is mutualism – the development of close relationships of mutual exchange and benefit. Mutualism differs from two other common relational conditions in biology, parasitism and direct food chain interactions. All biological relationships exist through a series of value, or 'currency'. Parasitism and relationships within the food chain, found primarily in tidal and deeper ocean regions, are interactions that primarily or solely benefit one participating organism. The nature of exchanges in parasitic and food chain interactions are stark, generally requiring life or substantial energy exchange as currency while the other participant either consumed or harmed. Mutualistic transactions keep all participants incentivized and engaged in fair exchanges, sustaining and growing life's footprint in an area. Currency exchanges in mutualistic relationships are diverse, but provide tangible benefits for each participant that vary from:

1. Food or energy exchange zooxanthellae algae, as described in detail previously;
2. Reciprocal protection from predators: The ocellaris clownfish live: corals and
3. directly among the tentacles of Ritteri sea anemones and provide protection from predatory fish that target the anemone, while the stinging tentacles of the anemone protect the clownfish from its predators [Litsios et al.,2012].
4. Alert of danger and housing: Burrowing shrimp construct burrows for both themselves and co-dwelling goby fish. In exchange, goby fish provide early warning signals for the shrimp when predators are near. Further, some shrimp species provide parasite-cleaning benefits to associated goby fish [Facey et al., 1997; Soares et al., 2008].
5. Dwellings: The construction of helical extensions produced by encrusting bryozoans from empty gastropod shells provide hermit crabs a suitable shell for living [Klicpera et al.,2013].
6. Food and reproductive facilitation: Often mats of algae accumulate on reef surfaces preventing young corals from settling extending reef structures. However, the grazing activities of some parrotfish scrape away the algae and adjacent coral structures providing fresh sites for coral juveniles (planulae) to establish new colonies [Bonaldo et al., 2009].

As one can see, the reef is ripe with creative currency exchanges that are required for mutual survival and prospering. The extension of this analogy to the Innovation Reef provides an illustration of roles and currencies used, which in turn incentivize players in the Reef to work together for mutual benefit and for the benefit of the local region [Hwang, Horowit, 2012; Markman, 2012].

Inventors

Currency exchange within TTO ecosystems begins with governmental policy – is the Virtuous Cycle established and functional within your state or institution? The Cycle is critical because sharing royalty income with inventors often drives their participation. While some universities do recognize patents and commercialization outcomes in tenure decisions, most do not [Lowery, 2012]. Therefore, commercially oriented interests, including entrepreneurial experience and interactions with industry or direct royalty sharing are generally viewed as potential research funding sources [Bradley et al., 2013] and serve as the common form of currency. It should be noted that with the lack of royalty sharing, other commercial outlets may be used by inventors. This leads to loss of inventions by the institution and ultimately movement of academic researchers to the private sector or to other academic institutions with more supportive innovation policies.

Institutional Administration

Any successful TTO effort must have support from the top institutional administrators. Often, administrators see commercialization as a potential Pandora's Box full of controversy and conflict of interest. It is essential to directly address the publicity and legal concerns. Indeed, focus solely on the risks of commercialization can paralyze research institutions. Therefore commercialization players must proactively work with administrators to develop institutional policies to reduce the risks associated with openness and conflict of interest. This process exchanges important currency among players producing cooperation between administration, researchers, the TTO and commercialization experts. To develop these cooperative policies, administrators must see the value of researcher involvement, commercial interactions and creation of incentives for all participants. The resulting policies must take overarching government policy and developing suitable and aligned policies for their institution. The Virtuous Cycle must be acknowledged and institutional policy should not short circuit the flow of inventions funded by government mechanisms into the commercialization process, nor should the flow of royalty revenues from deals back to inventors be hindered. Many administrators of institutions expect that the Virtuous Cycle can function outside of the model of mutualism – that their active support and energy to develop aligned institutional policies in support the Cycle is not required. Not surprisingly, this attitude and practice inhibits technology transfer. Administrators must understand the inherent mutualism in the Cycle and the requirement for investment to encourage the Cycle to initiate and turn. When institutional administration engage in proactive participation in this mutualistic cycle, they realize currency repayments in various forms, including: the experience of how TTO activities can fuel basic research through industry sponsored research, that the opportunity for commercialization can be a strong incentive for leading researcher recruitment and retention, and that the realization of institutional inventions into products and/or services benefiting the public enhances the reputation and support (monetarily and otherwise) of their institution.

TTO Experts

Experts in a TTO, including licensing specialists and other participants, trade with researchers the currencies of credibility, efficiency of process, job satisfaction and recognition by researchers as colleagues. The currency upwards into institutional management is either financial, through the receipt of royalty income, or intangible, such as building up the reputation of the institution through the provision of ascribed IP assets or commercialization successes, and improved competitiveness to retain leading researchers [Bercovitz, Feldman, 2006; Bradley et al., 2013]. Industry introduction and reputation advocacy by licensing specialists for faculty assists the acquisition of alternative funding for research from industry sources or alternative granting mechanisms. Some universities build research centers that benefit from having government supported research assets, such as specialized equipment and highly specialized experts, catalyzing relationships with industry on the research level that can move into broader commercialization interactions. These capabilities are particularly critical for startups that benefit from incremental cost requirements of sponsored research rather than the high costs of capital equipment and talent acquisition. TTO experts are required to develop the manner the services of research centers are provided and how revenues are recognized within an institution.

Wisdom and Expertise Providers

Experts provide key wisdom to technology transfer experts with regards to technical requirements for technology acceptance in the marketplace, competitive intelligence about competitive products, insights into industry-specific value chain relationships, regulatory requirements, introductions to particular advisors or market participants and open conversations with potential licensees. These activities accelerate licensing specialist practice influencing commercialization priorities and decisions. Why do technical and business experts provide “free” advice to TTOs? How would a research institution and its TTO recruit experts to support technical experts? Based on the authors’ experience with the Austin Technology Incubator and its Office of Technology Commercialization, experts receive the currency of satisfaction arising from being involved in cutting edge science and business activities, the opportunity to “give back” to the community, potential collaboration opportunities in the commercialization process and finally, the chance to mentor others as they were mentored. Not all giving is altruistic, building of personal reputation, becoming a “valued asset” in their community, and the opportunity for consultation agreements or professional positions are also motivators for many experts in the Innovation Reef.

Entrepreneurs

Entrepreneurs join the Innovation Reef as the risk-takers who translate early technologies into active ventures where equity, consulting, and growing employment opportunities provide rich currency for the Innovation Reef. Early ventures must benefit from mutualistic relationships since they lack liquid financial currencies and must trade for expertise, support and participation with the promise of greater future interactions. Entrepreneurs trade risk bearing for favorable licensing terms for TTO-sourced technologies, often pushing financial obligations later in their development and a willingness of the TTO to "be paid, when the entrepreneur gets paid" approach. This mutualistic opportunity allows for equable financial sharing while recognizing time and risk constraints. In addition to technical and business experts, entrepreneurs benefit from financial and transactional experts who help new ventures structure their capital tables and business strategies for strategic transactions with larger industry components resulting in deep collaborations involving leveraged financial contributions and acquisitions. Strategic planning for these events help new ventures scale manufacturing, build product inventories or find new markets are essential to consider from the initiation of the venture. Therefore, the Innovation Reef must provide broad wisdom networks through mutualistic currency exchanges.

Service providers

The ability of service providers to work with startups is an important component of Innovation Reefs – both for TTO and new company activities. Service providers are also essential to assist TTOs to commercialize institutional innovations. The accounting, human resources and legal services provide support for TTOs. The support of legal experts to define, file and prosecute university IP is critical. Often legal providers offer lower cost structures to universities than commercial clients in exchange for the potential of a regular flow of IP filings. Consistent business provides for improved resource planning and builds long terms relationships. Accounting, corporate, legal and human resources services accelerate new corporate structuring and growth through currency exchanges involving lower rates in association with modified rate packages as company activities scale or through equity participation.

Summary

Currency exchanges must be developed to preserve aligned interests incentivizing the formation and growth of relationships between players in the Innovation Reef. These mutualistic relationships are essential for new innovations to receive the varied support required to achieve commercial success. Relationships must be built around the structure provided by efficient processes linking inventors through their respective TTO offices with commercialization players. Strong structures encourage player participation. These processes must effectively recruit inventions from researchers, build a valued asset portfolio surrounding the most promising opportunities and translate these into commercial reality through the Innovation Reef players: entrepreneurs – for new ventures; established and startup companies – for sponsored research; and established companies – for effective out-licensing and commercialization. Finally, the right environmental conditions must be present to allow the processes and players to assemble, build and sustain an Innovation Reef. The alignment of government and institutional policies supporting the Virtuous Cycle and thus effective technology transfer practice creates alignment among all players from inventors to commercialization players and stimulates the formation and growth of regional and international commercialization through the Innovation Reef model.

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SCIENCE, INNOVATION AND TECHNOLOGY MANAGEMNET IN INTERNATIONAL PERSPECTIVES

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SCIENCE – ART OR A PART OF ECONOMY UNITED STATES AND ISRAEL CASES

Abstract

What is the role of science in society? How do citizens benefit from dedicating a portion of their taxes to scientific research? What constitutes scientific research in Poland? How should it be adjusted to better suit modern times and contribute to a higher standard of living?
These pressing questions need to be addressed more so than ever. Meanwhile, discussions center on superficial concerns regarding "Poland's input to the world of science" as a matter of prestige, rather than as a matter of economic growth. The latter requires an inquiry into whether or not it is possible to create a connection between scientific and practical goals that will result in innovations which will contribute to Poland's GDP. This article aims to shed light on this issue through an analysis of two leading examples of systems that accept science as the foundation for economic strength.

Keywords: Innovative enterprises, innovation performance.

Introduction

For centuries, the role of science remained a controversial one. In the distant past, kings used to hire astrologists, alchemists and geometricians to fulfill a similar role to that of jesters - entertainment. Eventually, astrology transformed into astronomy, alchemy into chemistry, and geometry expanded into mathematics. However, for a long time, these disciplines were viewed as seemingly useless. For how could Copernicus' observations possibly improve day-to-day life? Instead, scientific studies were oftentimes considered an expensive hobby reserved for the elite.

This perception underwent considerable change with the emergence of print and mail, soon coupled with the erection of institutions for higher education, which made it increasingly feasible for individuals to exchange ideas, opinions, and knowledge. In the XVII century, there was an expansion in communities dedicated to the study of nature and mathematics. Eventually, these propelled the rise of institutions, such as the Italian *Accademia dei Lincei*, the German *Leopoldinian Academy of Naturalists*, the British *Royal Society*, the French

Academie des Sciences, followed by the German *Wissenschaften zu Berlin* and the Russian *Academy of Science*, which developed in the XVIII century. The key function of the institutions was to accumulate knowledge; developing the economy was still left to innovators and engineers, as we call them nowadays.

While the industrial revolution of the end of the XIX and beginning of the XX century was sparked by studies conducted by Faraday, it was still an *engineering* revolution. It was not until the Second World War, the single most powerful force to prompt major developments in the world of science, that the aforementioned areas of study were found imperative. The invention of the radar and the ability to decode German encryptions saved Great Britain, while astonishing developments by physicists enabled the creation of one of the deadliest weapons known to mankind, the atomic bomb, which shortened the war with Japan. Inspired by these developments, in November, 1945, Vannevar Bush[1] sent President Truman a copy of his new report titled 'Science the Endless Frontier', where he explored basic science's beneficial effects on society. In effect, the report contributed to the inclusion of basic research as a strategic element in the making of the USA's economical might.

A country's economic strength is based on pillars, such as its geographical location, natural resources, climate, culture and political system. However, the single most important element in generating economic benefits from these pillars is the citizens' intellectual capability to identify their potential and then transform it into profit. Therefore, without an open system of education and the ability to exploit global knowledge, which is only possible with an investment in teaching, vast potential will be wasted.

Technology-Oriented Countries

Because Western countries have limited natural resources (in the USA this can considerably vary by state), they have heavily invested in technological developments that enable them to remain in the world's elite. The following pyramid depicts the relationship between the economy and science (Figures 1, 2).

The basic sciences are incorporated into the educational system, as well as the knowledge transfer system that aims to deliver knowledge to the society.

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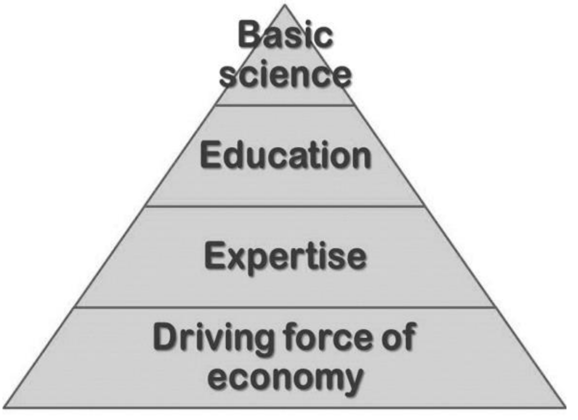
[1] Vannevar Bush: organizer and chairman of the world's first governmental agency coordinating civilian scientists seeking military applications - *National Defence Research Committee* (1940) – then chairman of a new Presidential institution – *Office of Scientific Research and Development* (1941). His efforts gave birth to key discoveries that contributed to ending World War II, such as the first general-purpose electronic computer ENIAC, the mass production of penicillin and sulfamide, a mobile radar fire control system, artillery shells equipped with a proximity fuse which caused an explosion when the shell came close to its target, the atomic bomb and many more.

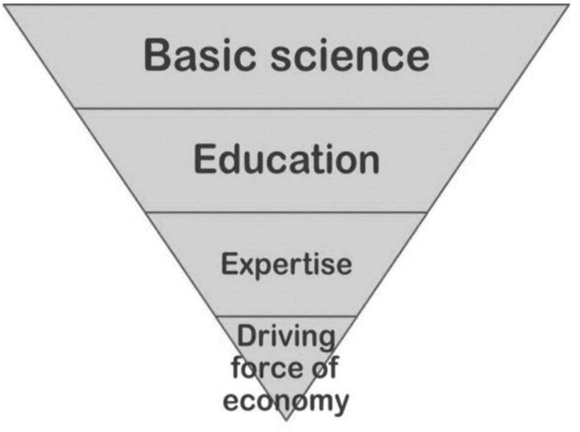
Consequently, scientific discoveries are made available for the use of the public. In effect, science is the leading force pushing the economy forward. In Poland, the relationship between the economy and science is the exact opposite.

Figure 1. Science involvement in different activities in the “Tech” countries



Source: Own work.

Figure 2. Science involvement in different activities in Poland

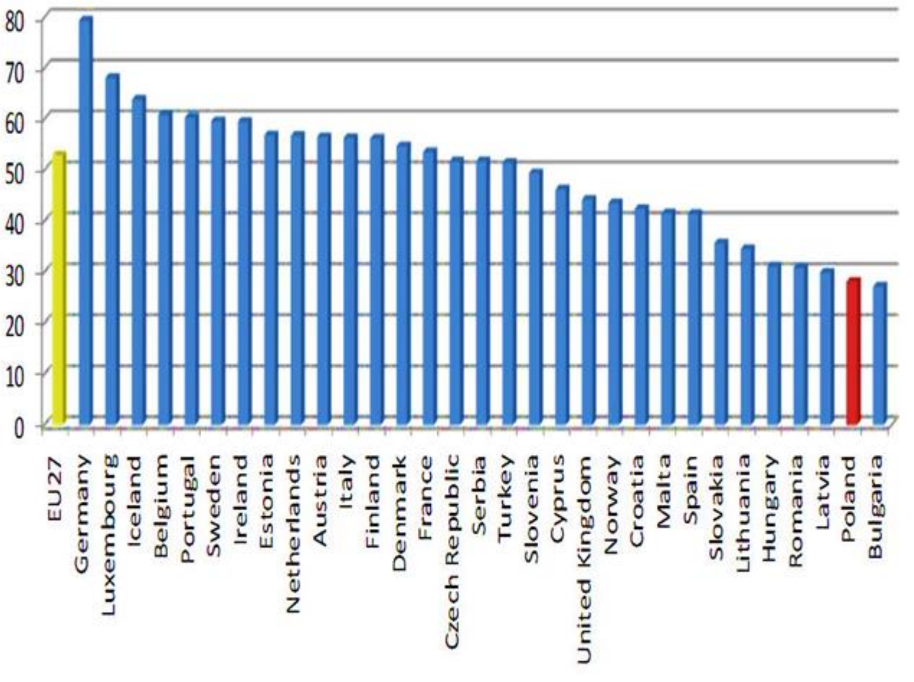


Source: Own work.

The scientific studies conducted at universities and other research institutions usually have no practical value, even if they are described as having wider applications.

Why is this happening? What is the reason behind the lack of transferability of our immense intellectual potential into viable innovations? The data is shocking – according to *Eurostat,* Poland is one step away from being the least innovative country in Europe (Figure 3).

Figure 3. Proportion of innovative enterprises in European countries 2008-2010

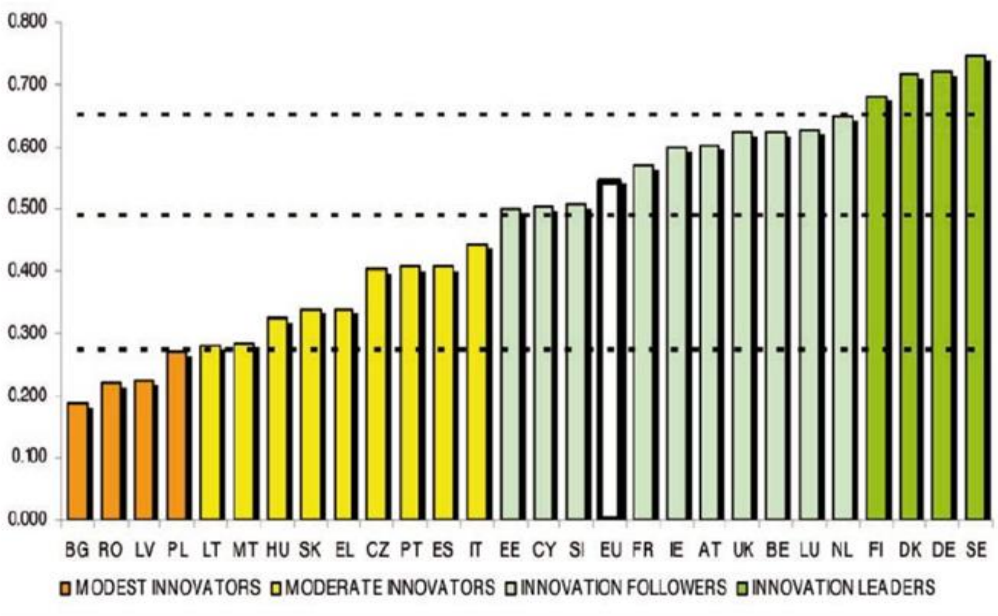


Source: On the base of Eurostat News Release, 11 January 2013. http://goo.gl/wT1ox.

The *Global Innovation Index* [The Global Innovation Index, 2013] ranked Poland as 49th; behind countries such as Costa Rica, Montenegro and Barbados. While another report of the European Commission - *Innovation Union Scoreboard 2013* - has ranked Poland as one of four modest innovators that are considered the least innovative in Europe (Figure 4.).

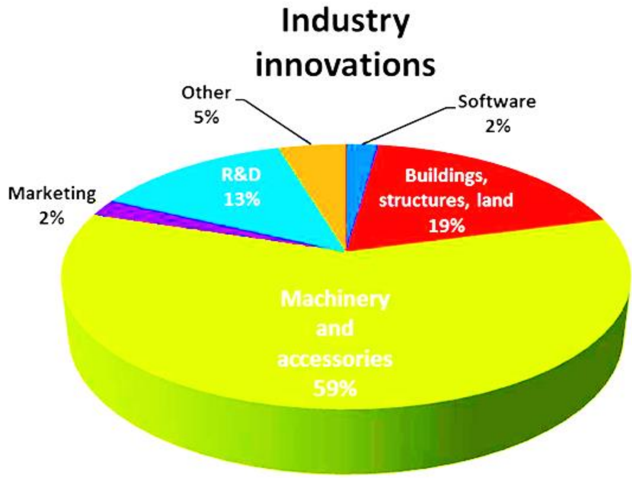
One of the parameters used to establish the rankings is the amount of funds dedicated to the development of innovations. In Poland, this aspect is a tricky one – while the funds are there, they are mainly invested in machinery and accessories, as can be seen from the Figures 5 and 6.

Figure 4. EU Member States' innovation performance



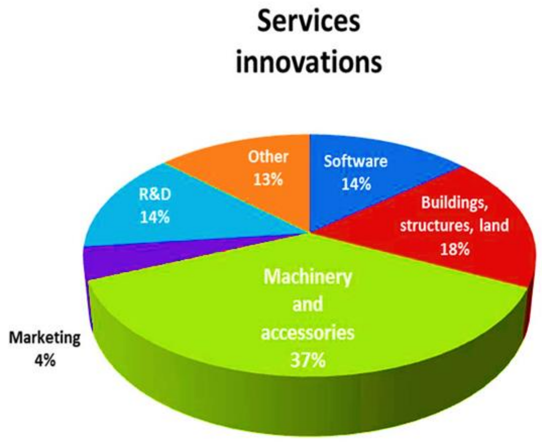
Source: Innovation Union Scoreboard 2013, p. 5.

Figure 5. Proportion of different kind of innovations in Polish industry sector in 2011



Source: Graph based on data from: Działalność innowacyjna przedsiębiorstw w latach 2009-2011, Główny Urząd Statystyczny, Urząd Statystyczny w Szczecinie, Informacje i Opracowania Statystyczne, Warszawa 2012, p. 55.

Figure 6. Proportion of different kind of innovations in Polish service sector in 2011



Source: Graph based on data from: Działalność innowacyjna przedsiębiorstw w latach 2009-2011. Główny Urząd Statystyczny, Urząd Statystyczny w Szczecinie, Informacje i Opracowania Statystyczne, Warszawa 2012, p. 56.

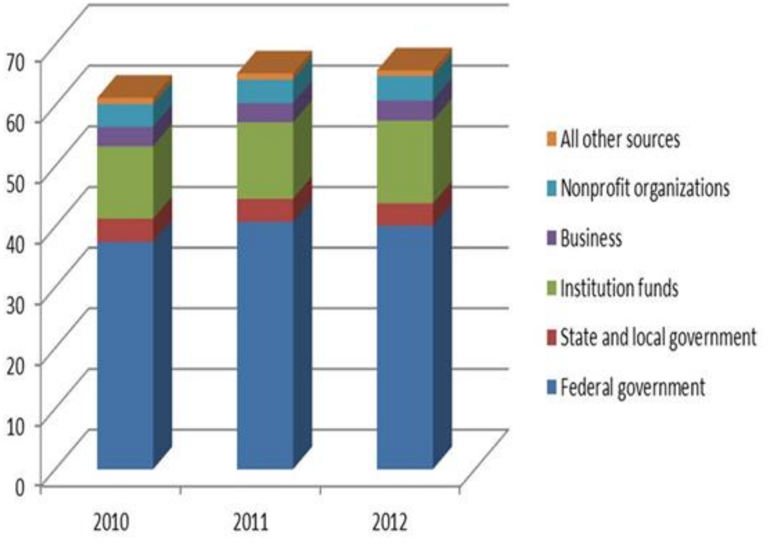
Around 19% of funds in this area are used to finance buildings, structures and the purchase of land. The funds spent on boosting innovation itself, in the form of research and development, amount to a humble 13%.Why does Poland score so low on such rankings then? According to officials, it’s a matter of inappropriate statistical data that does not reflect all of the recent legislative changes that have supposedly improved the situation and will improve it further in the near future [Kudrycka, 2013]. However, the real problem stems from the fact that generating practical innovations is a creative process that requires a system of knowledge transfer, not an ever-increasing number of orders and regulations.

So, how do the technology-oriented countries do it? The answer is rather straightforward – they take a proactive approach to their knowledge transfer systems, instead of leaving them up to ambiguous legal regulations. In other words, they have created a system that is stimulated as and when perceived necessary in any given situation, rather than one constricted by a list of do’s and don’ts. Countries such as the USA, Germany, France, Norway, and Finland, have officially defined these strategies only recently. Their implementation was then followed by an agenda to support the relation between science, education, and the economy. We will now discuss how this system operates in the USA and Israel.

The United States of America

In the USA, academic institutions are the main source of new inventions. This can be attributed to the fact that they do not operate within an enforced educational paradigm because the American constitution prohibits the federal government from influencing the educational system. Instead, these rights belong to the individual state authorities. In spite of the lack of centralization, educational systems across the various US states operate under the same premise, which is to cater to the needs of society. Aside from their role as educational centers, leading American universities generate high-quality scientific research in both basic and applied science. For this reason, the US government ensures that the universities' R&D receives all of the support it needs (Figure. 7).

Figure 7. University R&D funding by source (expenditures in billions, FY 2012 dollars)



Source: Higher Education R&D Expenditures Remain Flat in FY 2012 by Ronda Britt, InfoBrief, National Center for Science and Engineering Statistics, November 2013,NSF 14-303.

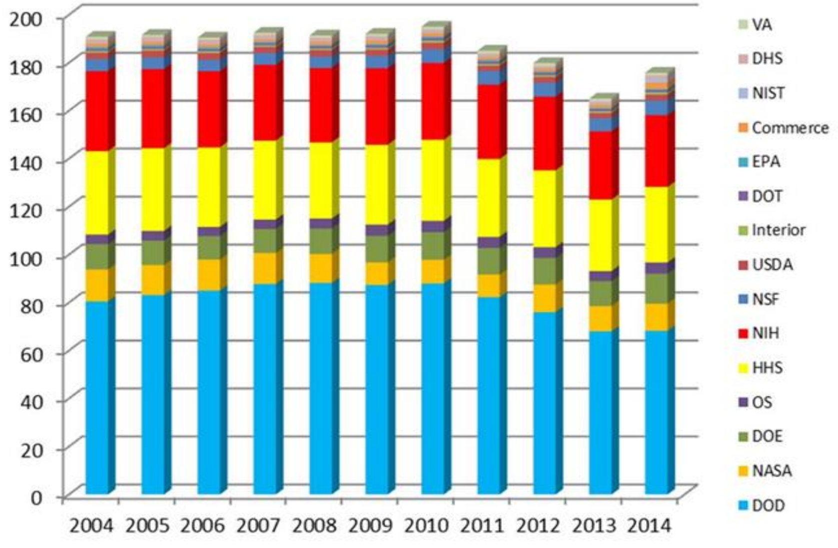
The federal government is supporting research, not only that provided by the universities. The finances are managed by the appropriate governmental departments and independent agencies, such as the *National Institute of Health* (the NIH finances and leads studies related to health) and the *National Science Foundation* (the NSF finances an array of studies, aside from those concerning health) (Figure 8).

Alongside university research, the government finances the operation of the *National Institute of Health*, which consists of 30 independent units, and 41 Federally Funded R&D Centers (FFRDC). The latter are managed by external institutions – 12 of them by specific universities or corporation, 3 by private companies, and the rest by nonprofit organizations which are not affiliated with universities. The centres lead basic research (37%), applied research (29%) and development (34%)[2]. The 2013 fiscal year budget for the NIH is accepted as $ 30.8 billion. FFRDCs are mainly financed through the governmental departments

[2] www.nsf.gov/statistics.

and agencies. In the year 2011, the centers spent $17.8 billion. Notably, only $424 million were derived from businesses, nonprofit organizations, local and state authorities, and other sources.

Figure 8. Financing federal R&D by agency, FY 2004-2014 (billion constant USD 2013)



Source: AAAS Report XXXVIII: Research and Development FY 2014, 2013, June, Table I-10 p. 60.

A relentless crowd of interested entrepreneurs and investors awaits study results, eager to convert them into new ventures. Some of the inventors fear directly implementing their idea into the market; Engaging in an enterprise is a risky business that significantly departs from the relatively safe world of science. For this reason, scientists often do handover their findings to experienced entrepreneurs whilst securing a percentage of the profits and offering paid consultations during the R&D period.

Conducting the process of 'proof of concept', creating the technology and introducing the product or service into the market is an extremely dynamic procedure.

In the USA, building a start-up company is a form of commercializing the new invention. The running of a small enterprise is relatively simple – it is taken care of by different types of technological incubators and specialized commercial firms that cater for all start-up needs. The Silicon Valley and Boston areas are flooded with numerous law firms which specialize in servicing start-ups. Naturally, the lawyers help in finding appropriate patent attorneys who protect intellectual property, but they also help in finding investors and writing up agreements to protect the rights of the inventor. A small enterprise is easy to sell or expand if it succeeds, and liquidate if it fails.

The most critical time for a start-up is the initial period, often referred to as 'death valley', as it determines whether or not it will succeed or fail. New enterprises are similar to heavy investments which are associated with high risks. As always, the deciding factor is the market –it's easy to miscalculate the product demand (for example, changes in fashion or the entrance of another competitive product), production costs, or product quality (for example, toxicity or other side-effects). Therefore, the financing of this critical stage is under the special care of the federal and state governments, as well as research institutions.

From commercial ideas to practical applications

Technology Transfer Offices (TTO) are the most common link between the inventor and the businessman. They operate close to every academic institution in the USA. Their duties consist of supporting the inventors, finding business partners, and formulating agreements.

TTOs may initially seem complex – however, its average employee does not have to possess exceptional knowledge in a specific area, nor does he or she have to know anything about technology. What they do need is the ability to cooperate with both academics and businessmen. They should also have a wide circle of informal connections within relevant industries, outstanding listening skills (necessary to support the inventors throughout the creative process), and a thorough understanding of the requirements sought out by entrepreneurs and investors. According to good practice, contained in an excellent guide for TTOs[3], it takes roughly 10 years for the TTO to create any financial returns and throughout that time they must be provided with sufficient funds.

Proof of Concept Centers (PoCC) are newly developed organizations devoted to facilitating the spillover and commercialization of university research. The first two PoCCs were established at *University of San Diego – von Liebig Entrepreneurism Centre* (created in 2001) and *Massachusetts Institute of Technology – Deshpande Centre* (created in 2002). Since then, several universities have followed in their footsteps and created their own PoCCs, which provide special 'proof of concept' grants to faculty and student alike; they also educate in entrepreneurship and provide help with formulating a solid business offer, which is necessary to place the product on the market. Bradley et al. [Bradley et al., 2013] claim that there are currently 30 PoCCs in the USA and that the number is growing year by year.

Business Incubators are nonprofit or for-profit organizations that ensure new start-ups have access to reasonably priced offices, basic and high-tech equipment, legal and book-keeping services, mentoring, and assistance in finding additional funding. In the USA there are over 1,250 business incubators that support start-

[3] http://www.iphandbook.org/

ups. *The National Business Incubation Association*[4] revealed that 87% of businesses that used incubator services were still operating 5 years later; the percentage drops to 44% for businesses that did not use an incubator.

Financing the initial start-up phase

FFF – is an abbreviation used jokingly to refer to the first investors in most start-ups – 'Family, Friends & Fools'. At the same time, the acronym is an accurate depiction of the level of risk for those setting up a new enterprise. Yet, without this initial stage, which involves engagement, enthusiasm, belief and hard work, no one can attract investors who seek a documented business plan that includes a Net Present Value and an Internal Rate of Return. In addition, the business plan will be useless if it does not include a working prototype of the product or a model of the service.

<u>Angel Investors</u> are, according to the recently approved federal law *Jumpstart Our Business Startups Act [Jumpstart Our Business Startups Act, 2012]*, persons who are accredited as start-up investors by the *U.S. Securities and Exchange Commission*. In order to be accredited, they must possess a $200,000+ annual income, or net worth[5] that exceeds $1 million. Angel Investors may invest between $10,000 to $1 million, the only condition is that the money come from their own pocket. Oftentimes, because of the risk associated with such investments investors organize themselves into groups, this way lowering the danger of losing their entire capital. Based on a report by the *Center for Venture Research at the University of New Hampshire* [*The Angel Investor Market in 2012, 2013*], in 2012 alone more than 268 thousand Angel Investors contributed to 67 thousand entrepreneurial ventures; the total investment came to $22.9 billion. A report summing up investor activity in the first half of 2013 *[The Angel Investor Market In Q1Q2, 2013]* indicates that there has been a 5% rise. In order to increase the numbers of Angel Investors, which are now concentrated in California and Massachusetts, other states are implementing various stimulators, such as tax credit systems [Nwosu, 2010].

<u>Crowdfunding</u> is a new form of financing start-ups. Simply speaking, it is a collection of money from the public which will soon be regulated by the Securities and Exchange Commission. In November 2013, the *Commission* published a proposal of legal regulations [Securities and Exchange Commission, 2013] that will soon officially govern crowdfunding. According to this publication:

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[4] http://www.nbia.org

[5] Net worth – assets minus total liabilities.

Crowdfunding is a new entity – a funding portal – to allow Internet-based platforms or intermediaries to facilitate the offer and sale of securities without having to register with the SEC as brokers. Under the proposed rules, the offerings would be conducted exclusively online through a platform operated by a registered broker or a funding portal, which is a new type of SEC registrant.
Consistent with the JOBS Act, the proposed rules would among other things permit individuals to invest subject to certain thresholds, limit the amount of money a company can raise, require companies to disclose certain information about their offers, and create a regulatory framework for the intermediaries that would facilitate the crowdfunding transactions.

Under the proposed rules: A company would be able to raise a maximum aggregate amount of $1 million through crowdfunding offerings in a 12-month period.

Investors, over the course of a 12-month period, would be permitted to invest up to $2,000 or 5% of their annual income or net worth, whichever is greater, if both their annual income and net worth are less than $100,000; 10% of their annual income or net worth, whichever is greater, if either their annual income or net worth is equal to or more than $100,000. During the 12-month period, these investors would not be able to purchase more than $100,000 of securities through crowdfunding.

This legislation is to prevent the common repercussions of raising money from anonymous sources *via* the Internet.

SBIR – Small Business Innovation Research is a fund-raising program that constitutes 2,5% of the total extramural research budgets administered by federal agencies. The funding takes place in two stages:
Stage I (start-up) consists of grants of up to $150,000 for a period of 6 months with the purpose of 'exploration of the technical merit of the feasibility of an idea or technology'

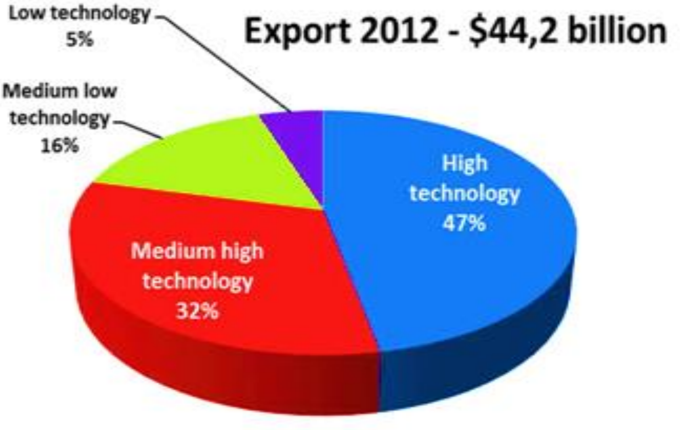
Stage II consists of grants of up to $1 million for a period of 2 years 'in order to facilitate expansion of Phase I results'
In 2009, the SBIR spent over $26.9 billion to finance 112,500 projects. Notably however is that the final implementation is not financed by the SBIR program.

The above mentioned programs are only a fraction of all of the initiatives, many of which exist on a local, state or county level. This goes to show that the US government understands the importance of maintaining an innovative economy to the well-being of its citizens. Aside from exploiting their countries' tangible natural resources, the USA is also pursuing a calculated strategy to exploit their more abstract natural resources in the form of human intellectual power.

Israel

Compared to the USA, Israel's innovative economy has a relatively short history. Ever since 1948 the country has been involved in a continuous civil war, which called for technological innovations to support army efforts. Israel reached a critical point during the French embargo on weapon transfers to the countries in conflict after the Six Day War. Seeing as Egyptian and Syrian armies were supplied with weapons from the Soviet Union, the Israeli government was forced to rely on its own weapon industry using its own R&D. Currently, there are over 150 Israeli firms dealing with weapon production, which has made the country the world's 7th largest exporter of weapons [Harel, 2013], with an export rate of nearly $7.4 billion in 2012. Aside from the export of weapons, Israel is also known for its export of diamonds, which amounts to $8.3 billion. Interestingly, Israel also exports several other market goods, which amount to $44.236 billion, as of the year 2012; Four-fifths of this export is made up of high and medium-high technologies (Figure 9). At the same time, the export of business services is expanding, and, notably, 26% of this export is comprised of computer services, while 24% is made up of R&D services; together these add up to $4.8 billion. What is worth noticing is that the export of services of startup companies (valued at $1.1 billion in 2012) is sharply rising, as can be seen from recent numbers that indicated a twofold increase between 2011 and 2012. In 2012, Israel also sold over 50 technology companies for $9.3 billion (this trend continues, for example, in November, 2013, Apple bought PrimeSense for $350 million).

Figure 9. Israel manufacturing exports, by technological intensity in 2012



Source: Foreign Trade 2012, Israel Central Bureau of Statistics, 2013, May, p. 16.

The short overview of the Israeli export structure highlights the strongest aspects of the Israeli economy. It shows that economic success does not have to be dependent on natural resources, cheap labor, or fruitful land. For the success of the Israeli economy is directly correlated with its exploitation of the country's intellectual potential, which is achieved through a system that links the economy with education and science (in operation for the last 20 years). It is this system that made Israel one of the leading innovative economies [The Global Innovation Index, 2013], allowed for the creation of 5 thousand technological start-ups, and persuaded over 250 global companies to locate their R&D centers in Israel. As a consequence, Israel is now referred to as the second Silicon Valley or the 'start-up country'.

Despite this focus, these pro-business efforts have not had a negative impact on general studies or basic research – since the year 2002, eight Israelis have received the Noble prize (6 in chemistry and 2 in economy). Thus, the Israeli system of cooperation between science, business and the government can be seen as an example to others.

The basis of Israel's innovation system

The authors of 'Israel's Innovation Ecosystem' [Frenkel et al., 2011] give 53 reasons that stimulate this pro-innovation climate. Of these reasons, the most relevant are: *Infrastructure supporting ideas; Education creating global perspective; Low govt. regulation; Proximity to US.*

Other reasons include the cultural situation that arose as a result of the governmental strategy accepted in 1991, as well as the unique political system. Finally, the authors also highlighted 26 processes fostering Israeli innovation, which are listed below (Table 1):

Table 1. Processes fostering Israeli innovations

Ranked number (by importance)	Process Name
1	Chief Scientist's programs for supporting technological innovation
2	Constant government investment in basic research
3	The new Council for Higher Education model for the creation of human capital
4	Private initiative programs for supporting innovation
5	Incentives for supporting foreign R&D centers of MNCs in Israel
6	Creation of capital and infrastructure in 1990's
7	Ministry of Defense programs for supporting technological innovation (TALPIOT, MAFAT)
8	International cooperation in business as a way of life
9	Globalization
10	Technological incubators
11	Interdisciplinary programs in universities
12	Nanotechnology - targeted research that supports cooperation
13	Independent financial infrastructure
14	Dialogue and ties between industry and government
15	Programs for incorporating the ultra-orthodox and Arab populations in the workforce
16	Increasing demand for technological development in biomedicine and biotechnology
17	Weakened public sector

Ranked number (by importance)	Process Name
18	Technology transfer companies in universities & technology transfer between academe and industry
19	Government support for colleges in the periphery that creates human capital infrastructure
20	Synergy between military and civilian R&D
21	Israeli Industry Center for R&D (MATIMOP) and the Israel Export Institute
22	Government and international funds for research
23	Government programs for strengthening scientific and technological education
24	Local policy for supporting entrepreneurship
25	Conducting research and implementing new methodologies in innovation
26	Supporting R&D and innovation in traditional industries

Source: Towards Mapping National Innovation Ecosystems; Israel's Innovation Ecosystem, A. Frenkel, S. Maital, E. Leck, D. Getz and V. Segal, The Samuel Neaman Institute, Technion City, Haifa, 2011, October, p. 3.

These processes are tactics encompassed in an overarching strategy that has led to the full utilization of the world's scientific knowledge in developing innovations, which has transformed the failing economy of the pre-1990s into the prosperous economy of 2013.

Through clever allocation of resources, Israel created a harmonious relationship between economy, education and science, whilst understanding that entrepreneurship and innovation are cultural phenomenons that need to be stimulated and rewarded. You cannot enforce a cultural change through force; instead, what you need is determination and flexibility to create positive feedback alongside all the stimulants discussed above.

Neither innovation, nor commercialization will come into being if the people involved do not perceive possible gains. Therefore, the Israeli system effectively lowered the risk involved in the process of transforming an invention into something practical.

For instance, in order to encourage scientists to get involved with the business world, in 2004, the government introduced an amendment that decreased scientists' tax for their sabbatical year from 55% to 35%, if they were working in industry during that time [The Encouragement of Industrial Research and Development Law, http://www.moital.gov.il].

The key role of the innovation system

The Israeli Office of Chief Scientist *of the Ministry of Industry, Trade and Labor* **(OCS)** plays a crucial role in maintaining this particular system. Namely, it administers programs intended to boost innovation as and when necessary. These are conducted using the steps below (Table 2).

Table 2. Office of Chief Scientist' programs supporting innovations

Pre-Seed	Competitive R&D	Generic R&D
Technological Incubators	R&D Fund	MAGNET
Supports startup companies	Supports industrial competitive R&D projects	Joint industry- academia development
TNUFA		Mini - MAGNET
Supports an individual entrepreneur		Joint industry- academia development, (one to one)
NOFFAR		Generic R&D
Supports applied academic research in biotechnology		Supports generic long term R&D investments

Source: Office of Chief Scientist http://www.moit.gov.il/CmsTamat/Rsrc/MadaanEnglish/MadaanEnglish.html, date: 15.11.2013.

It would be impossible to discuss all of the above programs within this short article. For this reason, we will now focus on a few of the systemic elements.

Commercialization of the results of academic research

The ground rule at Israeli universities is academic freedom. Nevertheless, the application of this rule is considerably limited by the need for money, which comes from a competitive research grant process. Institutions for higher education receive this funding from the state budget *via* the *Planning and Budgeting Committee of the Council for Higher Education*, and special agencies such as the *Israeli Science Foundation* (finances for 2013/2014 amount to $2.8 billion).

Israel has seven academic centers. The *Weizmann Institute of Science*, the *Hebrew University of Jerusalem* and the *Technion – Israel Institute of Technology* – are commended for maintaining the strongest relationship with industry.Each of the universities has its own 'commercial arm', known as the Technology Transfer Office (TTO), which is responsible for managing the relationships between the university and businesses. All of the TTOs share some common characteristics:

1. The TTOs are legally considered limited liability companies. They have a relatively simplistic internal structure – every one of them has a director, his deputy financial manager, patents' attorneys, lawyers specializing in license agreements, technology brokers (usually specialized in particular

fields of science). The basic team consists of about 10 people, all of whom are involved in the decision-making process, the creation of specialized project teams, and the hiring of external experts as and when necessary.

2. The TTOs are embedded into the university structure. The university staff treats TTOs as a tool for commercialization. Also, the TTOs take on an active role – their employees participate in scientific seminars, have several contacts in the labs, and, very often, they are the ones to come up with commercial ideas.
3. When a commercial idea arises, the TTOs put together an external team to develop the idea. The scientists involved are treated as a national treasure, so to say, - they are to be the best in their field and during the commercialization process play the role of a consultant rather than that of an executor. If the idea succeeds in the market, on average, the scientists then receive 40% of the profits (20% is passed on to the labs, and the rest covers the TTOs' costs, or supports the university).
4. The TTOs formulate close bonds with enterprises – they organize seminars also open to entrepreneurs and then survey them in order to get an idea of their capabilities and expectations, all in the hope of encouraging cooperation.
5. The TTOs seek financing for the 'proof of concept' phase, as it is the most important and most difficult to overcome in the process of materializing an innovation.
6. They have accepted a set of rules to govern their cooperation with business, which are to maintain a balance between basic and applied research. For instance, the *Weizmann Institute of Science* accepts four principles of cooperation:
   - Financing provided by industrial sources is limited in terms of time and scope. This is to prevent scientific labs from being converted into industrial ones, which would limit the researchers' ability to explore new areas of study and obstruct the delicate balance between academia and market purposes.
   - The institute remains the rightful owner of the studies' results and can publish it freely. A funder can prohibit this only when the publication may interfere with patent rights or the established scope of know-how.
   - The licensee has to adhere to the license in practice. All license agreements should contain a clause excluding the purchase of a license with the aim of blocking its use.
   - The institute maintains the ability to continue working in the area of the commercialized product, as well as the ability to commercialize future ideas in this field, even if they would compete with the original commercialized technology.

The other TTOs accept similar principles, in accordance with the 'Nine Points' formulated by an American TTO Conference held in 2007 [In the Public Interest , 2007] amongst other things, the 'Nine Points' suggest putting public interest above private interest.

7. The legal protection of intellectual property is incredibly pertinent to the role of the Israeli TTOs. Usually, they seek a temporary patent in the USA, after which they either abandon further intellectual property protection, or they take up intellectual property protection internationally. Moreover, TTOs have the possibility and resources to lead the process of protection of their intellectual property in the case of patent violation.

Startup companies incubation

In 1991, the program supporting technological incubators was created and now is administrated by the *Office of the Chief Scientist* (OCS) [OCS-Office of the Chief Scientist, 2013]:

"GOALS

The primary goal of the program is to transform innovative technological ideas, that are too risky and in too early stage for private investments, into viable start-up companies that, after the incubator term, are capable of raising money from the private sector and operate on their own.

BACKGROUND & GOALS

The Technological Incubators Program was established in 1991 and is administrated by the Office of the Chief Scientist, Ministry of Industry, Trade & Labor. The primary goal of the program is to transform innovative technological ideas that are too risky for private investments, into viable startup companies that after the incubator term should be able to raise money from the private sector and operate on their own. Secondary goals of the program are as follows: 1. Promote R&D activity in peripheral and minority areas. 2. Create investment opportunities in the private sector, including venture capitalists. 3. Transfer technologies from research institutes to the industry. 4. Create an entrepreneurship culture in Israel."

The program currently contains 24 OCS licensed incubators. Incubators are for-profit firms, which receive an 8 year license through open competition.

The incubation period of a startup company takes around two years. During this time, the company obtains a grant between $500,000 to $800,000 - the incubator covers 15% of the costs, while the rest is left to the OCS. An incubator can invest only 15% of the project budget and can only receive maximum 50% revenue. The government grant is paid off if the project turns out to be a success; until the grant is paid off, the government will receive 3-5% royalties from the project's revenue, as long as the production takes place in Israel. According to the 2011 amendment to the earlier mentioned law on financing R&D [The Encouragement of Industrial Research and Development Law, 1984], production transfer to a foreign country requires agreement from the OCS, and, as a result, the royalties can be increased by up to 300% of the aggregate grant amount.

This seemingly complex system is an effective one. By the end of 2012, it initiated 1700 SMEs (governmental investments of over $650 million); So far, 1500 firms have left their incubators and around 40% of them are still in operation. Later investments (private ones) in the operating firms amounted to $3.5 billion.

R&D companies in Israel

An incredibly important element within the innovative and entrepreneurial culture of Israel is the presence of over 250 R&D centers in Israel, most of which belong to global, tech-savvy firms (80 of these are *Fortune 500*[6] companies) [Shamah, 2013]. These firms employ tens of thousands of people, and their annual budget is around $12.4 billion. However, the Israeli R&D centers are not just workplaces, they are places where people develop and eventually become part of a growing elite of highly qualified and creative employees.

The link to the USA

An extremely important aspect of the Israeli System is its close ties with US scientific institutions and businesses. To an extent, one can even say that Israel is now treated as one of the US states. The USA invests in Israel, and Israel invests in the USA. There is a growing number of joint initiatives, such as the building of the *TCII – the Technion-Cornell Innovation Institute* – signed in December 2011 by *Technion – Israel Institute of Technology* and *Cornell University*. Furthermore, New York City donated a grant in the form of land on *Roosevelt Island*, along with 100 million USD for infrastructure improvements.

Summary

The Israeli case is a great example of a well-developed strategy supported by courageous governmental actions. As shown above, this led to an impressive balance between the pursuit of academic findings and their role in the Israeli economy, which eventually transformed a poor country into a rich one through simply shifting the focus to what is important – exploitation of human intellectual potential.

[6] 65 years on, Israel is top choice for tech by multinationals.

Ending Note

All in all, seizing new research territories is a burden to the public, and a sizable one at that. So, is it an unnecessary expense? Although they are a costly venture, scientific studies can and do provide returns that far surpass the initial investment. As a result, the revenue from a successful end product can provide the researchers with creative freedom, and cover the costs of failed products, as well as all of the mishaps along the way. The USA and Israel are just two of many examples of well-managed intellectual capital. However, aside from the current innovation leaders such as Switzerland, Sweden and Finland, one must remember about the growing competitiveness of the BRIC countries (Brazil, Russia, India and China).

This is a wake up call for Poland which must quickly reform its knowledge transfer system to join the innovation club; this is no longer an option, it is a necessity. Soon enough, buying new technologies will no longer be sufficient. In order to spur changes, there is a need for a facilitator, a professional institution financed by the country's administration, to create a bridge between the creative field and the harsh market environment. There is a need for a third party to alleviate investment risks as this is the only way to encourage the much-needed action. There is a need for the government to finally take a leap forward and work towards stimulating the 'proof of concept' process. When these needs are fulfilled, basic research will no longer be an art, it will become an essential pillar to support our country's newly found strength; it will become a part of our economy.

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INNOVATION AND SUPPORT POLICY – THE CASE OF BRAZIL

Abstract

Innovation policy has become an integral part of economic policy in the majority of countries both developing and highly developed states strive to promote economic growth based on high technology and research implementing a variety of programmes of innovation support, starting with local regulations up to national innovation centres. Such a situation can be observed in Brazil particularly since the presidency Ignacio Lula da Silva who reorganised industrial and innovation policies and strengthened the governments participation in the state's economy. However, despite the undisputable benefits of government innovation support, Brazil faced serious issues resulting from its new development strategy promoting the hi-tech sector. Primarily, it is exceptionally hard to build an innovation economy in a centralised way, relying on governmental programmes rather than the real economic climate as well as the industriousness and innovation of the business class. Moreover, there are clear discrepancies between the official goals or administrative guarantees and the true pro-innovation attitudes of companies, which causes the government's strategy to remain just an unrealised intention. Thirdly, activities such as 'rent-seeking' jeopardise the effectiveness of innovation policy and can even be detrimental to the very process of programme and law formulation to support modern technology. Finally, in the case of such countries as Brazil one can question the validity of an innovation based development strategy as these states gain a comparative advantage in low-tech industry, agriculture, raw materials. Is it necessary to seek new paths of economic growth in sectors which the country has never before specialised in or should the government strive to develop already developed sectors in order to enhance their comparative advantage and within their possibilities ensure their position as world leader.

Keywords: economic growth, innovations, innovation policy, Brazil.

Introduction

There are few countries like Brazil that experience such ground-breaking changes in policy strategy development within a mere half a century and having such deep involvement of the government in shaping the national economy. Brazil, which in the 1930s favoured strong intervention and active industrial policies, became one of the best examples of the implementation of import substitution strategy. Later, in the face of growing socio-economic issues, this strategy was abandoned completely for the economic liberalism promoted by international financial institutions. However, this laissez-faire approach did not last, especially in the government's withdrawal from active participation in state industries. Despite this reversal, drastic reforms, whose aims were to free market forces and create a more open economy (among others, privatisation of state companies, reorganisation of financial systems, free trade, new laws pertaining to the job market, etc.), permanently changed the economic landscape of Brazil. Within just three decades Brazil witnessed the glorification, rejection and rehabilitation of its intervention policy. At present, there is a return to the active role of the government in shaping industry mainly through aggressive industrial diplomacy, active industrial and trade policies as well as an increasingly promoted innovation policy. This state engagement is constantly raising controversy and has become a subject of discussion within its university and political circles as well as amongst foreign observers.

The politics of innovation and the support of modern technologies has a strategic position in the industrial development of Brazil, particularly since the presidency of Ignacio Laula da Silva between 2003 and 2011. The key constituents of Brazilian innovation policy in its institutional aspect are, *Innovation Law, PITCE, PDP and 'O Plano Maior'* the latest development strategy and decrees facilitating the national innovation system including the National Strategy for Science Technology and Innovation passed for the years 2011-2014. The aim of the above initiatives is to stimulate innovation in national companies, increase their research activities, promote cooperation between companies and universities and research centres as well as technology transfer. An equally important role is attached to building high quality human resource capital, from widely promoting higher technical education to programmes attracting experts, scientists and doctoral students from abroad through an extensive scholarship and grant system.

The aim of this article is to analyse the main activities of the Brazilian government within the area of innovation policy and modern technology support, as well as highlighting this plan's place in the strategy of the state's industrial development. Moreover, the author attempts to identify the key factors which hamper or even curtail any effective innovation conducted by the Brazilian government. The author also analyses internal circumstances, such as a strong lobby of traditional branches of industry and their powerful representation in the highest legislative and consulting bodies of state administration, the discrepancies between the official goals of industrial policy, including the promotion of modern technology industries, and the real backing given to the industry (financial system of investment supporting mainly large companies, etc.) including external circumstances stemming mainly from the global trade structure, the prices of raw materials on the world market and the international division of labour.

The first section, preceded by a short theoretical introduction on innovation policy, depicts the evolution of Brazil's strategy of industrial development over the last few years. Next, the author highlights the place of innovation policy in the state's development strategy, analysing the country's institutions and pro-innovation legislation. In the third part, the author takes a closer look at the factors which hinder or curtail the innovation policy of Brazil. The summary and conclusions are presented in the final part of the article.

Innovation policy support- selected theoretical themes in the literature on the subject

The literature does not provide a homogenous definition of innovation, therefore, there is not one coherent term for innovation support policy. The most common definition, applied frequently when analysing innovation and connected policies, is the one suggested by the OECD. This regards innovation as, 'the introduction of a new or significantly improved product, service or process including new organisational or marketing methods in business practices, workplace organisation or external relations' [OECD, Eurostat 2008]. Such a view of innovation embraces a few key features, the most important of which is that not every new solution is innovation, particularly when it cannot be practically applied, and that innovation does not always have to have a technical nature as innovation also includes process, organisational and marketing changes, and that 'not every innovation means sensu stricto novelty [Bukowski et al, 2012]. The very notion of innovation and its measurement is given great importance in both theoretical and empirical literature.

The literature on innovation support policy is equally extensive and one of the main issues addressed is the question of the innovation systems used in the analysis of science, technology and innovation analyses in national (see i.a.: Nelson 1993: Freeman 1997), regional (see i.a.: Cooke 2001), sectors or technological system aspects. This systemic approach enables us to apply an extensive definition which includes institutional contexts and accentuates the role of the interconnections between the parties participating in the creation of an innovation system through interaction, mutual educational processes and building competencies, thanks to which the flow of know-how and technologies, indispensible for the growth of innovation potential, is promoted [Klochikhin, 2013]. Moreover, it points out the validity of the application of various support tools from favourable institutional solutions (a coherent national structure of innovation systems, clear-cut universally accepted principles of innovation support, a transparent range of competencies of the responsible bodies, etc.), through educational activities (for example, information points, career advice bureaus or workshops), to financial instruments (technological loans, low interest loans, subsidies, tax breaks and commercial and private funding).

Innovation support policy is often perceived as an element of industrial policy and, what is more, is depicted as its less controversial aspect [Cimoli M. and Dosi G. 1995], [DiMaio M. 2008]. The state's support for innovation attracts fewer opponents than other manifestations of interventionism and is universally promoted by public bodies. This does not mean though that innovation support policy is unequivocally positively received. There is a clear division among economists into for and against camps for such policies implemented by state institutions. Those pro, are unwilling to invest through the public sector in research and development as such investment does not generate profit in the short term or is too risky, hence the need for the state to support such investment [Chaminade, C. and Edquist, C. 2010]. The other camp claim that excessive intervention in the development of innovation causes innovation gaps between regions in the level of innovation support, for example, between the European Union and the United States [Cooke, 2001]. Additionally, there is the problem of comprehensive and trustworthy assessment of the innovation support policy, as both universally applied groups of methods: 'in-put'- referring to the tools of innovation support which analysis mainly investment in innovations measured through expenditure on R&D, staff training, etc. or 'out-put'- focussing on the results, such as patents, licences or trademarks, do not allow comprehensive verification of its effectiveness [Pavitt et al, 2987; Hall, Trajtenberg, 2001]. Despite certain deficiencies in the accepted standards of innovation support policy assessment, both *in-put* and *out-put* methods are widely applied when researching its effectiveness with the former (*in-put*) being the leading approach.

Evolution of Brazilian industrial strategy- from import substitution to a pro-export policy

Brazil is defined by the high involvement of its government in shaping national industry and the direction of its industrialisation. The tradition of protectionism and interventionism are deeply rooted in the socio-political mentality of Brazilian people, stemming from the era of colonialism, which probably caused the failure of the economic liberalism promoted in the 1980s and the beginning of the 1990s.

Long before the Second World War, Brazil attempted a variety of pro-industrial initiatives but, up to the 1930s, these initiatives lacked coherence and effectiveness [Versiani, 1987]. Interventionism sped up during the period of the Great Industrial Crisis but as late as the 1950s, Brazil started implementing its industrial policies in today's meaning of this idea. Since somewhere around this time, the country has extensively developed institutional and legislative foundations whose aim is to apply the progressive goals of industrial growth and industrialisation.

Initially, from the 1930s till the end of the 1970s, Brazil applied the strategy of import substitution. The main goal of which was to protect Brazilian business and the home market from foreign competition as well as allowing time for local companies to obtain know-how, introduce modern production and organisational solutions and to increase international competitiveness. It is worth noting that despite being based on a few basic theoretical assumptions, this strategy frequently mutated and adapted to the changing market conditions. These changes can be observed in the evolution of certain institutions responsible for shaping industrial policy and the state's development strategy, as well as, in particular, administration and legislative decisions taken by successive governments [Almeida, 2004; Suzigan, 1995].

The initial success of the export substitution strategy, which achieved its peak during the, so called, Brazilian Miracle between 1968 and 1973, reinforced the conviction in the validity of interventionism as well as protection policy. Brazil registered a constant increase in GDP and industrial production which was the most far-reaching amongst South American countries. From the 1960s till the beginning of the 1980s, the value and volume of Brazilian exports increased, enriched by new products of a higher level of advanced production. Moreover, Brazil managed to promote a few sectors supplying products to the global market which gained an international competitive edge (from raw materials through footwear to the vehicle and aviation industries). One of the biggest achievements is the construction and promotion of EMBRAER aircraft, which, after overcoming a few hitches in the 1990s, remains an important export product and is proof of the positive influence of governmental initiatives on the development of Brazilian industry.

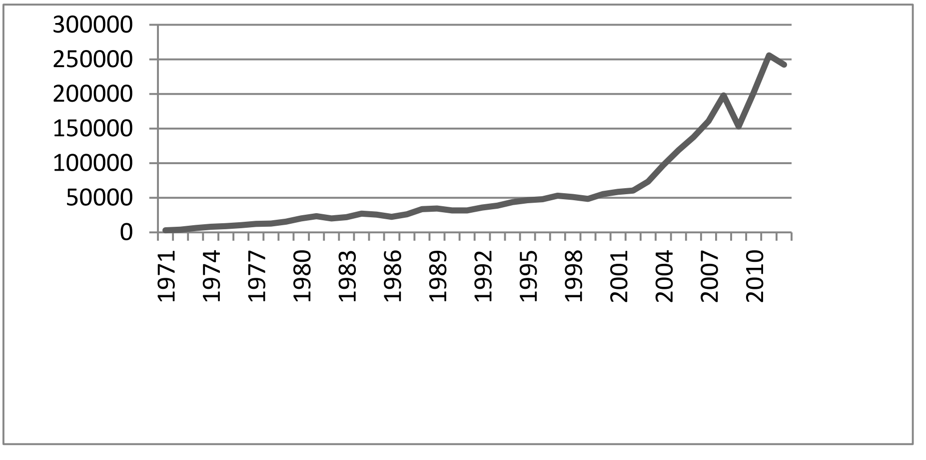
Sadly, as time passed, Brazil's situation worsened dramatically due to the effect of global market conditions (among others the petroleum crisis which triggered a global slowdown) and the huge costs of the import substitution strategy and an increasingly less efficient system of its maintenance. Squandering funds or their misuse was relatively common and strong pressure from certain business groups made it impossible to create and implement reforms that would open up the market. Many national companies did not generate profits and still feared privatisation. In addition, the barriers to entering the Brazilian market, whose aims were to protect national companies in order to give them time to increase their competitiveness and introduce innovation, had the opposite result- companies had no fear of competition from abroad and remained passive with little innovation taking place. Consumers incurred the highest cost as they paid over the odds for goods of shoddy quality. The final straw for this import substitution strategy was the level of Brazil's international debt, the imbalance in its macro-economy and the financial crisis. Resulting in the country turning for help to international financial institutions where it was obliged to implement reforms known as the Washington Consensus in order to get this support.

The reforms dictated by the International Monetary Fund were geared towards market liberalisation, privatisation, reforms of the financial system, legislative changes in the job market and the abandonment of interventionism. According to these new concepts, the government was only to create a favourable business climate and to promote exports. However, it turned out that such a policy, in

Brazil and other South American countries, was not an effective one for the existing crisis and in fact worsened the economic plight of the region. Many researchers claim that the reform failures of the 1980s and 90s stemmed from institutional and political circumstances- this period also witnessed transition from an authoritarian system to a democratic one. Nevertheless, the introduced socio-economic changes permanently transformed the economic situation of Brazil and, viewing its current market position, it seems that long-term they have increased Brazil's international competitive advantage and contributed to steady economic growth.

The pro-export strategy, despite slight alterations since its introduction, still dominates Brazil's economic policy. Since the presidency of I. Lula da Silva, state engagement in the economy has increased again and includes many areas, from trade policy to innovation policy. Export promotion, new market acquirement and the expansion of traditional markets have become the priority. The extensive system of Chambers of Commerce (which is one of the most dynamic economic diplomacies), an increased number of trade missions and Brazil's multi-lateral engagement served these purposes. Additionally, exporters have access to various forms of financial aid with low interest loans from the Brazilian Bank of Economic and Social Development, BNDES, as the main source. A pro-export strategy and a favourable world market climate have resulted in a huge growth in Brazil's exports in recent years, now standing at the level of 240 billion USD and 1.4% of global exports (Figure 1).

Figure 1. Brazil's exports between 1971 and 2012 in billion USD.



Source: Own work based on UNCTAD statistics on-line, accessed 18th March 2013.

The position of innovation in the Brazilian strategy of economic growth

Innovation support policy and the introduction of new technologies is probably the least controversial of a wide range of governmental and developmental programmes as it is commonly believed that it is necessary to anchor economic growth in innovations. Such a view is widely propagated by the advocates of neo-Schumpeterian synthesis, which is a protective shield for all governmental initiatives whose aim is promotion of market innovation. Individual countries worked out their own strategies of boosting innovation in a variety of ways [Casalet 2003; DiMaio 2008; Amsden 1989].

One of the most common tools of innovation strategy is the national innovation system. In Latin America, from the 1940s, national research institutes and public companies were established in order to serve as a source of innovation and one decade later, there were already a few important agencies promoting science and new technologies and providing funds for technological development, coordinating R&D programmes, promoting technological achievements and know-how as well as administrating the system of copyrights [Cimoli, Primi, 2004]. Among the first initiatives undertaken in the post war era and during the period of import substitution strategy was the Brazilian National Commission for Scientific and Technological Development (CNPq), established in 1951, one of the most active institutions. In addition, in many developing countries innovation was propagated through special science institutes whose aim was to lay personnel and technology foundations for building new industries out of high technology sectors. The Brazilian Centre for Aviation Technology (CTA) may serve as an example of an institute which significantly affected the success of the aviation industry [Bonneli, Pinheiro, 2006]. The policy of innovation was accompanied by educational programmes which, particularly in Brazil, became very successful. On the one hand they reduced the rate of illiteracy and on the other increased the amount of qualified labour and increased the number of citizens with a higher education.

The current innovation policy goes along with Brazil's strategy for national economic growth and its industrial policy, which is formed according to the concept of policies integration: trade, science and technology, procurement, ownership regulations, impact on foreign investment and allocation of funds. Such a wide concept of industrial policy supports the process of 'institutional engineering', shaping the market and its participants as well as managing public and legal interaction [Stiglitz, Dosi 2008].

The key constituent of the industrial policy is the national system of innovation and its accompanying initiatives which raise the level of the state's technological advancement and promote an innovative approach. The Brazilian system of innovation relies on the National Commission for Science and Technology (CTT), which is an advisory body of the President and the Ministry for Science and Technology (MCT). Furthermore, a key role is played by: FINEP- the ministerial agency administrating financial support for innovative ventures, CNPq- the National Commission for the Development of Science and CGEE- Management Centre and Strategic Studies. Additionally, innovation affairs are the focus of the Ministries of Development, Industry and Foreign Trade (MDIC), mainly through the operations of the Secretary for Innovation, the National Commission for Industrial Development (CNDI) and the Brazilian Agency for Industrial Development [Almeida 2009; Brito Cruz 2006].

Central legislation is the legal foundation of the Brazilian innovation system. Currently it consists of: Innovation Law 10.973/04, The Bill *Incentives* 11.196/05, The Decree 5.798/06, The Plan of Action for Science, Technology and Innovation (PACTI), The national industrial strategy (consisting of PITCE- The Policy of Industry, Technology and Foreign Trade, The Policy of Production Development-PDP and the so called O Plano Maior). Apart from central legislation, individual states introduce other complementary regulations based on the needs of their given region.

Innovations have an important position in Brazil's development strategy. In the *O Plano Maior* prepared for the years 2011-2013, which is a part of the Brazilian tradition of strategic planning and is a continuation and extension of the preceding PDP (The Policy of Production Development) and PITCE (The Policy of Industry, Technology and Foreign Trade), the pro-innovation goals constitute 50% of key strategic aims, with the remainder referring to building an industry based on knowledge or its transformation. The national strategy for industrial development highlights the necessity of increasing funds for R&D calculated as a percentage of GDP (which is to rise from 0.59% to 0.90% over 5 years), increase the role of high technology sectors in the whole of industry by 1.4%, boost by 2% the participation of national companies in global, technology and energy markets as well as wider access to goods and services improving the standard of living (including broadband internet) (MDIC, 2010).

Another separate document within Brazil's strategy for industrial development is The National Strategy for Science, Technology and Innovation (ENCTI), passed for the years 2011-2014. This strategy is put into practice through the Ministry for Science, Technology and Innovation and is based on five pillars, each having their own coordination panels. The pillars of ENCTI are, a)innovation promotion, b)new financing regulations for scientific and technological development, c)extension of scientific and technological infrastructure, d)support for human resource development and e)CT&I: the plan for social development. Additionally, the Ministry for Education participates in the following programmes: PRONATEC- The National Programme for the Access to Technical Education, The National Pro-engineering Programme and The Programme of Education without Borders. Thanks to these particular programmes, Brazil is hoping to attract world-class scientists and implement innovations, especially as the country lacks private innovative companies and the majority of patents arise from the public sector. The strategy is geared towards increasing access to broadband internet and boosting fivefold (from one billion to five billion USD) the funds for FINEP whose aim is to propagate and finance innovation (ibid.).

However, the complicated institutional and legal system which determines the innovation policy, not only shows how significant it is to the Brazilian government, who officially considers it as part of its industrial policy as well as a strategy for industrial development but also causes uncoordinated and even contradictory institutional operations among bodies responsible for policy implementation. The proliferation of governmental agencies as well as ministerial bodies whose aim is to create and coordinate the policy of technological development support, contribute to the fact that decision processes are lengthy and lack transparency.

Factors undermining the effectiveness of Brazilian innovation policy

The effectiveness of innovation policy depends on many factors and in order to analyse and identify the factors undermining the effectiveness of Brazil's innovation policy, they have been divided into four groups: a) *institutional factors:* public-private partnerships, a strong lobbying of traditional sectors of industry, powerful interest groups; b) *external factors:* the structure of international trade, international division of labour, world market prices; c) *internal factors stemming from innovative and entrepreneurial attitudes,* measured by, among others, the number of patents, level of investment, R&D, the percentage of market share of innovation companies; d) *internal factors coming from the structure of industry:* traditional comparative advantage, high participation of the low and medium technology sector, etc.

Institutional factors

One of the key features of Brazilian political and industrial life is the existence of various formal and quasi-formal groups of interests and the strong impact of public-private partnerships. This problem has been branded by Evans as 'embedded autonomy' [Evans, 1995] and is widespread among developing countries in their period of transformation but does not have only negative effects.

In the case of Brazil it seems however that these partnershipss weaken innovation pol icy, pointed out by, among others, Menezes [Menezes, 2010]. This is mainly due to the fact that representatives of traditional sectors hold most of the influential power over the country's industrial policy. This influence was measured by taking into account the number of private representatives in public institutions whose responsibility was to create and implement industrial policy. According to Menezes' research, there is a correlation between the companies financing election campaigns and those having representation in CDES, which is the highest advisory body to the president on industrial policy. It is worth highlighting the fact that these election funds arrived mainly from large companies operating in the low technology sector. In addition, the members of CDES who promoted innovation, survived for a shorter period of time than the advocates of conservative solutions (ibid., p.28). This situation has led to a paradox where innovation policy is created by the representatives of traditional sectors who are not particularly concerned with the development of innovative initiatives and who strongly advocate financial support for the technologically low-tech sectors

Similar conclusions have been drawn after analysis of the loan operations of BNDES- Brazilian Bank for Economic and Social Development. Based on regularly published financial data, one can conclude that subsidies go not to small innovation companies which could utilise them in order to develop and carry out research which they would otherwise be unable to do, but to large companies which already have their own resources for R&D and do not pose an investment risk. Such activities make BNDES similar to commercial banks which also grant loans to companies with credit worthiness. Meaning BNDES acts against its own mission. In addition, statistical data show that between 2002 and 2007 BNDES increased financing of the low and medium technology sectors by 15%, despite the announcement of support for mainly pro-innovation companies which produce advanced technologies [Almeida, 2009]. The operations of BNDES serve as yet another example of the significance of political influence connections in Brazil. According to research, the bank provides more resources for companies which actively support the campaigns of the winning politicians [Lazzarini et al., 2011].

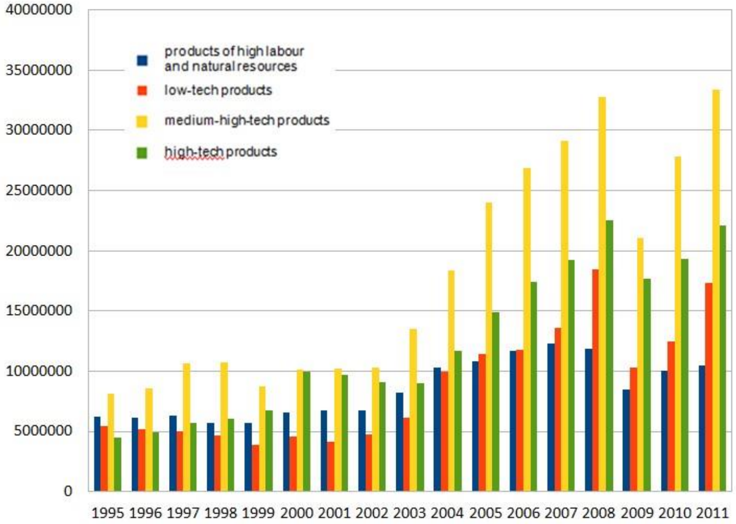
External conditions

Another group of factors undermining an effective innovation policy in Brazil are external factors, which mainly reflect the situation of the world markets and international trade. Statistics show that despite the fact that the share of Brazilian exports in the global export market has risen (from 0.86% in 2000 to 1.4% in 2011, according to the WTO 2012), this growth concerns mainly raw materials whereas the participation of high technology sectors has not risen and has even fallen. This trend is mainly affected by the price of raw materials which have been extremely high recently, and therefore a stimulus for Brazilian exporters towards further expansion in the hope of generating higher profits.

Moreover, close trade cooperation between Brazil and China also plays an important role. Within just 15 years, China has become the major importer of Brazilian goods and their share of the Brazilian export market rose from 1.89% in 1994 to 13% in 2009. At present it stands at 30.7 billion USD, which is about 15.2% of all Brazilian exports (SECEX/MDIC 2012). This spectacular growth also includes imports, which rose from 1.4% in 1994 to 14.1% in 2010 exceeding, 25 billion USD (ibid.). These intense trade relations have made China the key trade partner for Brazil ever since 2009, replacing the USA. In Brazil, economic cooperation resulted not only in the gaining of new markets and an increase in revenue from exports, but also in access to cheaper consumer goods imported from China and reduced production costs in the sectors using Chinese parts and semi-finished goods. Nevertheless, the structure of trade between the countries is not a favourable one for Brazil. In 2009 (when China became the main trade partner of Brazil) about 78% of the goods exported to China were basic products, mainly raw materials and low technology goods (as much as 68% of the exports was represented by iron ore, soya and fuels). According to the latest data for 2010, this trend has grown and at present as much as 83.7% of Brazilian exports to its Asian partner are basic goods (SECEX/MDIC, UNCTAD). The exact opposite trend occurs within Brazil's imports from China. Along with import growth, the import share of hi-tech products has also risen. In 2010 imports from China were mainly based on industrial products, which were 97.5% of the total imports. and are ever more technologically advanced (ibid.).

This imbalance in trade reflects more serious problems of Brazilian exports which go backwards as far as technological advancement is concerned as lower production costs in China means that their consumer goods are far more competitive than Brazil's own (Figure 2). If we consider the fact that Brazil helps China to achieve such an advantage due to the supply of relatively cheap raw materials, one may put forward the idea that, in their bilateral trade, it is China which is the true winner. Furthermore, in many sectors Chinese products are/were the immediate competition for Brazil's own and have either supplanted Brazilian goods on the world market or are on the way to achieving this state. It seems that the increase in Brazil's exports, which is mainly raw materials and low-tech goods, does not necessarily mean a significant improvement in the condition of Brazilian industry. Raw material price hikes encourage Brazilian companies to export even more of these products, which boosts profits with little investment expenditure.

Figure 2. Structure of Brazilian exports between 1995 and 2011



Source: Own work based on UNCTAD statistics on-line, accessed 18th March 2013.

Internal factors stemming from innovative and entrepreneurial attitudes

The level of a society's innovation can be measured by various tools, the most common and easiest of which is the number of patents reported and/or granted, trademarks and innovations within industrial design. Brazil witnesses regular growth in application for registration for all the innovations- shown in Table 1. As far as patents are concerned, recent years (2009-2010) witnessed a sharp drop, which is most likely connected with cost-saving plans introduced during the economic crisis, which hit Brazil hardest. It might be presumed then that an innovative attitude of a society is praiseworthy and that follows the government strategy for growth based on creating hi-tech sectors.

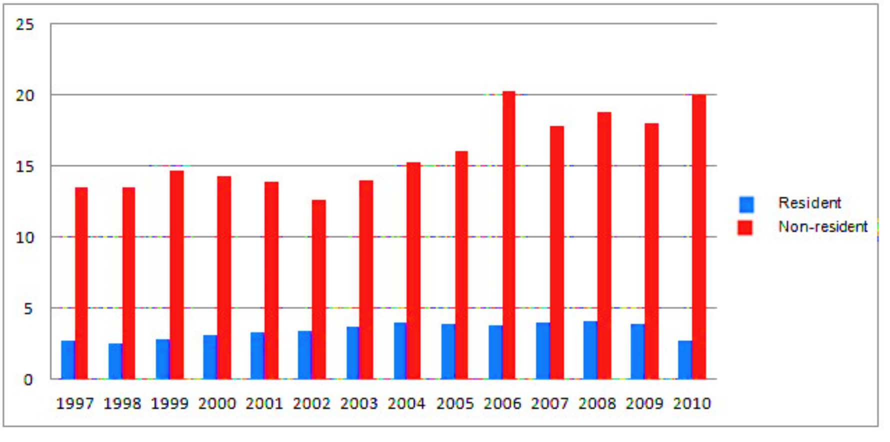
However, in-depth analysis reveals that the main applicants for patent registration are non-resident (Figure 3) and it is they who boost Brazil's innovation indices. Investigating international ranking, the number of patent applications puts it in the top ten, whereas, when you consider the applications solely from residents, Brazil falls to the teens or even further (WIPO 2013).

Table 1. Applications for patent registration, trademarks and industrial design by companies located in Brazil between 1997 and 2010

Year	Patent	Trademark	Industrial design	GDP (constant prices for 2005 US$)
1997	3,097		2,019	1318.76
1998	3,093	64,918	1,818	1319.26
1999	3,33	79,64	2,276	1322.57
2000	3,683	92,757	2,99	1379.55
2001	3,832	89,874	3,258	1397.63
2002	3,915	85,559	3,577	1434.78
2003	4,274	88,997	4,483	1451.27
2004	4,728	88,238	4,469	1534.17
2005	4,771	93,162	4,273	1582.64
2006	4,823	88,171	3,97	1645.24
2007	5,222	93,443	4,395	1745.46
2008	5,325	111,237	3,099	1835.72
2009	5,07	103,628	5,229	1829.70
2010	4,212	112,468	5,14	1967.54

Source: Own work, WIPO statistics on-line, accessed March 2013.

Figure 3. Applications for patents in Brazil between 1997 and 2010, expressed in thousands

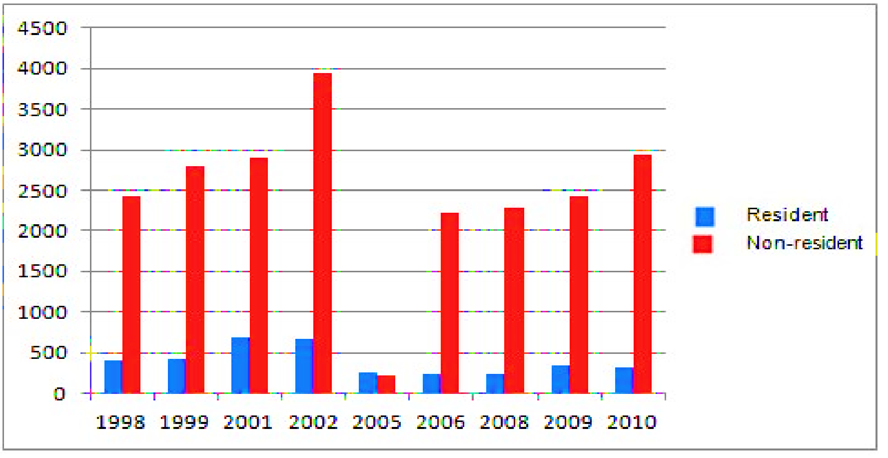


Source: Own work, WIPO statistics on-line, accessed March 2013.

Brazil scores even worse in the case of patents granted, where the differences between residents and non-residents (except 2005) are huge (Figure 4). In addition, the number of patents granted compared to applications is strikingly low and means the country occupies an extremely low ranking, in the case of residents, 36th, 35th and 34th, between 2008 and 2010 respectively, while the number of patents granted to non-residents sits in the teens (WIPO 2013).

The picture is different when it comes to trademarks and industrial design, where residents are a significant majority of the applicants. These innovations have however a slightly different dimension and significance.

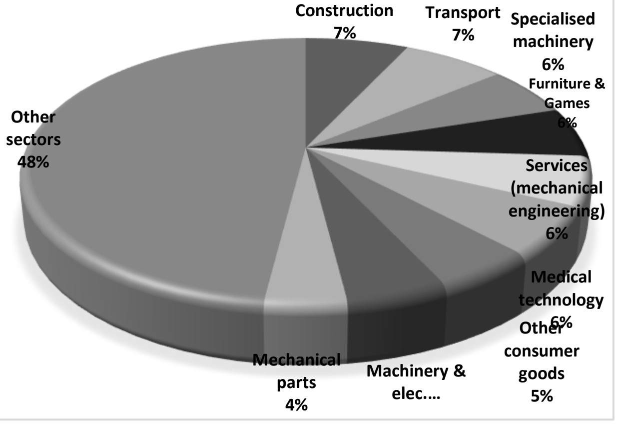
Figure 4. Patents granted, selected years



Source: Own work, WIPO statistics on-line, accessed March 2013.

For a while now construction has been the most innovative sector in Brazil, ahead of both the transport and machinery industries (Figure 5). As for the hi-tech sectors, they are not particularly active in the areas of patent registration apart from medical technology as the share of the Brazilian market for high technology sectors is relatively low.

Figure 5. Patent registration applications between 1997 and 2011, division according to business activity



Source: Own work, WIPO statistics on-line, accessed March 2013.

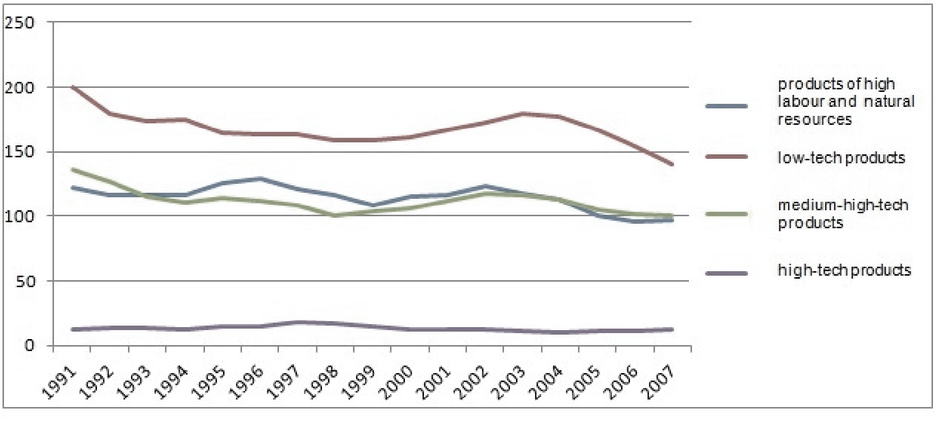
Internal factors stemming from the structure of the economy

An IPEA report on the industrial administration policy of the ex-president L. I. da Silva concluded that, despite the high sounding slogans and strategies, a contrary model of growth was in fact promoted rather than the one based on neo-Schumpeterian synthesis to which the ex-president referred to [Almeida, 2009].

Analysing Brazil's industry structure one can clearly see the dominance of low-tech sectors. We cannot ignore the fact that innovations may be introduced into traditional industries, in effect, a product whose production is very innovative while the product itself is counted as low-tech. This fact points to the problems with classification and may give a false impression, which will cause a certain distortion in interpretation. Bio-fuels serves as the best example.

A significant factor hampering the effectiveness of the growing participation of the hi-tech sector is the very nature of products in the production of which Brazil has traditionally had a revealed comparative advantage. Access to raw materials and their abundance means that the industries utilising them already have an advantage over other sectors which rely on factors such as labour or capital. With the lack of external stimuli to invest in other types of business activity (for example during the favourable international economic conditions for traditionally exported goods), investors do not take risks and instead choose to grow their current activities. This tendency explains the situation which can be currently observed in Brazil. At the same time it has to be pointed out that the despite the drop in the revealed competitive advantage in almost every aspect of industrial production, for the hi-tech products it has been growing for many years and is still the highest in the region (Figure 6).

Figure 6. Revealed competitive advantage of Brazilian goods in selected export activities



Source: Own work based on Discussion Paper No. 1692, IPEA 2012.

Summary and conclusions

Thanks to the gradual evolution of industrial policy, Brazil currently has at its disposal a range of modern institutional solutions whose aim is to modernise the country's industry and to support new technologies. Promotion and finance programmes for the development of human capital to undertake the innovation challenges are conducted along with a support policy for the part of the labour force which experiences most severely the negative results of the transformation process. Particular attention is drawn to technological development, which is reflected in the government's growth strategy, in expenditure on the national system of innovation and aid given to emerging sectors.

Despite this, Brazilian innovation struggles with many challenges. These include, predominantly, the strong influences of interest groups. The powerful lobbying of traditional sectors which finance political campaigns gain the right to decide on the direction of economic development and often hamper pro-innovation initiatives, particularly when the beneficiaries are not companies in their own sectors.

The world market climate is another factor which can weaken innovation attitudes among Brazilian companies. Prices of raw materials and permanent access to markets convinces Brazilian exporters that their businesses are worthwhile, and while the situation is profitable, few companies choose to implement new innovations. The structure of international trade also shows that in spite of dynamic growth, Brazilian exports still rely on raw materials and low processed goods, stemming from Brazil's comparative advantages in these areas.

As a result, despite the government's official promotion of the development of hi-tech sectors and the encouragement to invest in innovation, this is not reflected in the data on Brazilian industry innovation.

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STIMULATING TECHNOLOGICAL GROWTH – THE CASE OF SOUTH KOREA

Abstract

The aim of this article is to analyse the developmental policy of South Korea in the second half of the 20th Century based on the induction by the state of technical advancements in production. South Korea performed the most spectacular leap towards development in the 20th Century. Both long-term high economic growth and permanent changes in the economy structure led to one of the poorest countries in the world advancing to the status of a developed state. The policy of rapid industrialisation based mainly on Korean capital was initiated at the start of the 1960s. The author proves that this technological growth in production occurred in three consecutive stages which can be described as follows : copying, development of Korean technical ideas, world class innovation. Initially, the state played a key role in stimulating this economic growth through in-depth selective intervention and acting as a partner for the private sector while developing new areas of production. Nowadays, the state, although it still determines the direction of development, limits itself to development activities in the private sector by introducing universal regulations and incentives.

Keywords: South Korea, development.

Introduction

South Korea's economic growth in the 20th Century is regarded as the most spectacular in the world. Even in the first half of the last century this country was among the world's poorest. The Korean Republic's[1] intense economic growth only commenced in the 1960s at the time when the military dictator General Prak Chung Hee came to power. At that moment, GDP per capita at the current price stood at almost 100 dollars, and most of its population lived in abject poverty. Since the beginning of the 1960s, and throughout the next three decades, the country adhered to its five-year plans, which enabled it to achieve a rate of economic growth exceeding, on average, 9% per year [SaKong, Koh, 2010]. The government's programs were geared towards the implementation of their planned consecutive stages of economic development starting from light industry through

[1] further referred to as Korea.

heavy industry, chemical industry, manufacturing of electrical, including household, goods to production based on cutting edge technologies particularly in electronics and telecommunication. Nowadays, the production of such Korean companies as Samsung, LG and Hyundai is considered among the most advanced in the world, and GDP per capita now exceeds 30,000 dollars[2]. All the above contribute to the fact that the Korean path is regarded by numerous developing countries as an example to be followed.

The aim of this article is to analyse the state's industrial policy which leads to constant technological advancement in production. The author points out that from the very beginning through to today (applying varied tools of different strengths) the state has targeted constant technological growth in production determining and actively supporting those sectors of industry which are earmarked to become the driving force in the coming years. The policy that combines the active role of the state in industry, development based on local capital and stimulating increasingly technologically advanced production, has led to a transformation of the whole economy.

The Korean Model of Development

Korean economic growth has had two determinants: firstly, involving close cooperation between the state and the private sector, secondly, based on internal capital. There are various degrees and types of a state's intervention into its economy beginning with a centrally planned one where the state governs the whole of the economy and ending with the countries where, according to the leseferistic approach, the state's role is that of an overseer. Similarly, there is a vast range of views and experiences in the case of foreign capital involvement in economic development. On the one hand, there are supporters of free access for foreign capital while on the other, there are advocates of total reliance on national capital [Todaro, Smith 2011]. The supporters of the first approach claim that this is the only path open to developing countries ensuring indispensible investment, acquisition of modern technologies and know-how. Others put forward the idea that the involvement of foreign influences may lead to neo-colonialism, when, at the will of the foreign investment countries, the economic development of poor countries may be stifled. Foregoing foreign investment raises the issue of bridging the technological gap. Korea serves as an example of a state that wisely utilised foreign investment while simultaneously developing its national manufacturing base ensuring smooth transfer of technologies to national organisations. Such a policy made Korea a spectacular success.

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[2] according to Purchasing Power Parity, data for 2011, The World Bank.

The consecutive stages of development were accompanied by the policy of promotion of technological production. Initially, the growth was based on the import of technologies and copying foreign solutions. However, the late 1970s witnessed the beginning of support for Korean technological development. The state established R&D centres, cooperated with companies developing specific technologies and increased funding for education. As the economy grew, the private sector adopted the role of innovators. From the early 1990s, Korean manufacturing, in particular sectors, has become a leader in innovation.

Developing through copying

The initial acceleration of Korean industrial growth did not rely on innovation, as was the case in the 18th Century English or 19th Century German or American industrial revolutions. Against international expert advice, Korea did not rely on external investment having adequate technologies and capital. It focussed on intensive education, failure analysis, importing and painstaking copying of foreign solutions [Amsden, 1998]. The Korean private corporations, called Chaebol, were responsible for this development through close cooperation with and under the supervision of the state. The government, in progressive five-year plans, directed this development keeping a firm hand on its implementation. The first two five-year plans, implemented in the 1960s, were geared towards the development of light industry which focussed on the export market. The 1970s saw the beginning of the implementation of the development programme for the chemical, heavy and electronic industries.

Commencing the process of industrialisation, Korea did not have adequate tools at its disposal, that is to say modern technologies, expertise, neither a skilled workforce nor sufficient capital. It relied completely on importing technologies, foreign experts, educating its management abroad as well as accessing foreign loans. The latter were requested by General Park who conducted an unpopular but effective foreign policy [3]. Not only were the full technological processes imported but the same technologies were purchased many times from a range of producers in order to study the various patterns, avoid reliance on a single supplier and to be able to negotiate the best terms and conditions. The acquisition of foreign technologies was the first step towards the creation of Korea's own solutions and the development of its own technological ideas.

The development of Korea's motor industry [Lee, 2011] may serve as an example of such a process. Korea's motor industry history goes back to the 1960s and the assembly lines of foreign companies. With time, this cooperation with such companies was based increasingly on Korean influence, which, as a conse-

[3] In mid-1960 Korea was involved in the war in Vietnam. Diplomatic relations were established with Japan, its ex-occupant. Both moves generated benefits in the form of billion dollar loans, grants, investment and orders for the Korean industry.

quence, led to vehicle production that relied to a large extent on their own technical solutions. Thus, Daewoo's car production started from the Japanese company Nissan's assembly line, there followed a takeover in collaboration with Toyota and later with General Motors, while cars produced by Kia motors initially relied on technologies from the Italian firm Fiat. Hyundai, which is considered to be the most successful, started up in cooperation with Ford. Later, diversifying parts production cooperation among other world leading companies, with the most prominent role played by Mitsubishi. In the mid-1970s, Hyundai produced the first solely Korean passenger car, the Hyundai Pony, 10 years later, entering the American market.

Making its motor industry paramount for the development of other sectors, the state supported its development and, over time, ensured its competitiveness on the world's markets. It prevented excessive competition and imposed solutions whose aims were to boost productivity. Sub- contractors were encouraged to manufacture as many standardised parts across all producers in order to benefit from scale of production. In the mid-1960s, it was decided to build an engine plant in cooperation with a foreign investor, which, thanks to the scale of production, was intended to supply its products to all national car manufacturers. For many years, Korean cars were exported exclusively to developing countries, as they failed to fulfil the criteria of developed countries. Production issues were overcome as they arose and improved year by year. Long term forecasts turned out to be particularly positive, as a consequence, the country, which at the start of the 1960s had no motor industry, by the beginning of the 21st century, was classified as the fifth largest car producer.

Technological advancement of Korean production is best exemplified by the changes in the main export products over the last six decades (Table 1). They reveal the transformation from an agricultural and mining based economy through chemical, light and heavy industry to hi-tech computer and telecommunication technologies. In the 1960s, the main export goods were predominantly natural resources and agricultural products. The 1970s and 80s witnessed the export of light industry products, the gradual appearance of chemical and heavy industry, including ships, as well as advanced technologies. Beginning with the 1990s, there was ever higher export sales of semi-conductors, cars and computers, which, along with mobile phones and flat screens, had become the top Korean export products by the 21st century. Korea chose to rely on indigenous companies for its industrial development. It's economy orientated politicians believed that the free inflow of foreign investment may, in many case, hamper economic development. They were afraid of becoming dependent on foreign, especially Japanese [4], capital and therefore preferred to keep foreign technological know-how separate from ownership of capital. During the first two decades of rapid economic development, the value of direct foreign investment was way below 1% GDP which was many times

[4] The aversion of the Koreans towards Japan stems from their history. Between 1910 and 1945 Korea remained under the brutal Japanese occupation whose aim was to get rid of the Korean identity.

lower than in other developing countries[5] [Amsdem, 1989]. Koreans valued foreign investment as long as it provided them with access to new technologies that were key to the implementation of their economic plans and which would otherwise have been unobtainable. At the same time, they ensured that this investment was beneficial in the assimilation of technology and production know-how and only then were Korean companies open to such investment.

Table 1. Ten leading Korean export products between 1960 and 2007

	1960	1970	1980	1990	2000	2007
1	Iron ore	Textiles	Textiles	Clothing	Semi-conductors	Semi-conductors
2	Tungsten	Plywood	Electronic devices	Semi-conductors	Computers	Vehicles
3	Raw Silk	Wigs	Steel products	Footware	Vehicles	Portable telecommunication devices
4	Anthracite	Iron ore	Footware	Ships	Petroleum products	Ships
5	Calamari	Electronic equipment	Ships	Video equipment	Portable telecommunication devices	Petroleum products
6	Fish	Vegetables	Synthetic resin products	Steel	Ships	Flat screens
7	Graphite	Footware	Metal products	Synthetic fibre	Steel	Computers
8	Plywood	Tobacco and copper products	Plywood	Computers	Clothing	Synthetic resin
9	Rice	Steel products	Fish	Audio equipment	Synthetic fibre	Vehicle parts
10	Hair	Metal products	Electrical equipment	Vehicles	Electronic components	Steel

Source: *Dynamic History of Korean Science & Technology*, D. Oh edit., MEST, 2011, p. 158.

The Korean government passed a law stopping foreign investment in areas where competition would be with national manufacturers. Foreign investment selected by the state was meticulously scrutinised according to its value for the development of the whole industry and the implementation of the set goals. The decision to sign any agreement with a foreign company was preceded by an in-depth report on the proposed venture, the source of this investment, the degree of

[5] Compared to Brazil or Mexico it stood at 30%.

involvement of the foreign partner, the degree of technological transfer, the range and methods of training of the Korean employees, the planned production scale and the share earmarked for export [Mardon, 1990].

The beginning of Korea's own technical ideas

In the mid-1970s, the economy reached such a level that they realised there was a necessity for their own technical ideas and the capabilities to provide them in specific areas of the economy. One of the chief aims of the fourth five-year plan (1997-1981) was the emphasis put on the development of engineering personnel, research and development centres and creation and export of technologies connected with industrial engineering. This stage saw the fostering by the state of new technologies and their implementation by the manufacturing sector. The private sector was stimulated firstly by initiating and then supporting research and development and the ordering of hi-tech solutions through a few select companies.

One example of conducting such a policy is reflected in Chaebols stimulating the technology of manufacturing 4 megabyte memory chips DRAM [Evans, 1995]. The project was carried out through the support given to the development of the IT sector, one of the six selected as driving forces for growth. At the start of the 1980s, the manufacturing of the above semi-conductor memory required the application of cutting edge technologies which were only in the hands of the IT industry leaders: Japanese companies and IBM. The national research institute, Electronics and Telecommunications Research Institute (ETRI) was the department responsible for stimulating and co-ordinating Chaebol research. At its disposal it had a budget of over 120 million USD and employed 1,200 researchers and technicians. Preferential loans and tax breaks were the incentive for participating in the project. The teams representing the participating companies used to hold monthly meetings and compare achievements. ETRI monitored the progress and released the loans according to the advancement of the product. Thanks to this project, as early as the mid-1980s, Samsung followed by Lucky Gold Star invested substantial amounts of money and launched a successful production of semi-conductors, which, with time, became a core Korean product.

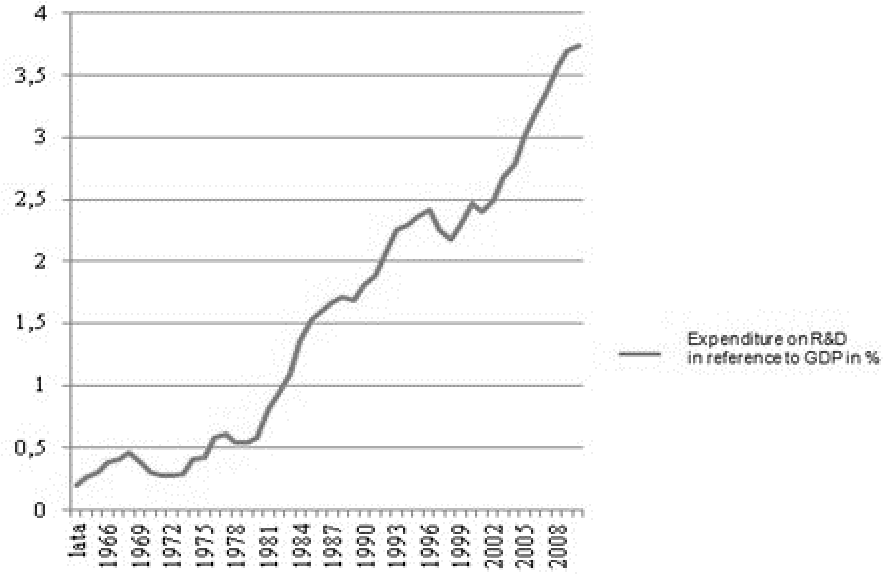
However, not all of the innovation programmes ended in success. In the mid-1980s, the computerisation of state administration was implemented with the aim of making it technologically independent from foreign imports in both the areas of hardware and software. The state insisted on the development of these products for the local market and then planned to re-export them. Cooperation with a small foreign company was set up on the agreement that the necessary network technologies were transferred. Four selected Chaebols, through ETRI, had access to these acquired technologies which they were to develop under the supervision of a research institute. The project, conducted by a group of experts from the presidential palace, through just one order, tripled the local market for these products. Nevertheless, due to the failure to achieve the expected results over a longer period of time, the administration was forced to suspend the project and purchase IBM systems.

The state encouraged engagement in risky areas where, otherwise, companies would have been reluctant to get involved and which were necessary for the further development of the economy and were to limit the loss of vital currency for a developing country through having to import these necessary components from abroad. Companies at their initial stage of development, guided by market requirements and their own potential, would not choose to take this risk. The state policy of managing research and development and reducing the investment risk, financial support and ensuring a buyer's market, sped up the national technological development. The main feature of the Korean government's involvement was its selective nature, the state did not back the whole national production but only specific sectors that were regarded as paramount for further economic growth. Similarly, support was only directed at particular partners, the state aid awarded to such companies was always determined by prior achievements. Companies received batches of preferential loans in stages according to the level of progress of an innovation project.

The stress on state-of-the-art development was accompanied by high expenditure on education [Shin, 2003]. The education of young people was geared towards the future needs of the developing economy. In the 1970s, particular emphasis was put on vocational, middle and higher technical education as key to development based on copying. The mid 1980s saw a shift of the state's emphasis towards science and technical faculties. The long term aim of the education policy was to train 150,000 employees of science and research and development centres by the year 2001. At the same time, the percentage of young students increased from 16% in 1980 to almost 55% in 1995. Expenditure on education topped expenditure on other social issues, about 20% of the budget, which was roughly 3% of GDP.

The turn of the 1970s and 80s marked the beginning of intense expenditure on research and development, which in the first half of the 1980s exceeded 1% of GDP (Figure 1). During this period state budget expenditure increased fivefold in comparison to 1960. In addition, the private section was gradually taking over the burden of financing the development of new technologies [Evans, 1995]. Back in 1970, only one Korean private company could boast a research and development unit, sixteen years later, there were over six hundreds of such companies. Despite the constant increase in state expenditure on research and development the share of the total budget designated for this purpose dropped. At the beginning of the 1960s it stood at 97% whereas towards the end of the 1980s only 20%.

Figure 1. General expenditure on R&D in Korea between 1964 and 2011 in reference to GDP expressed as a %

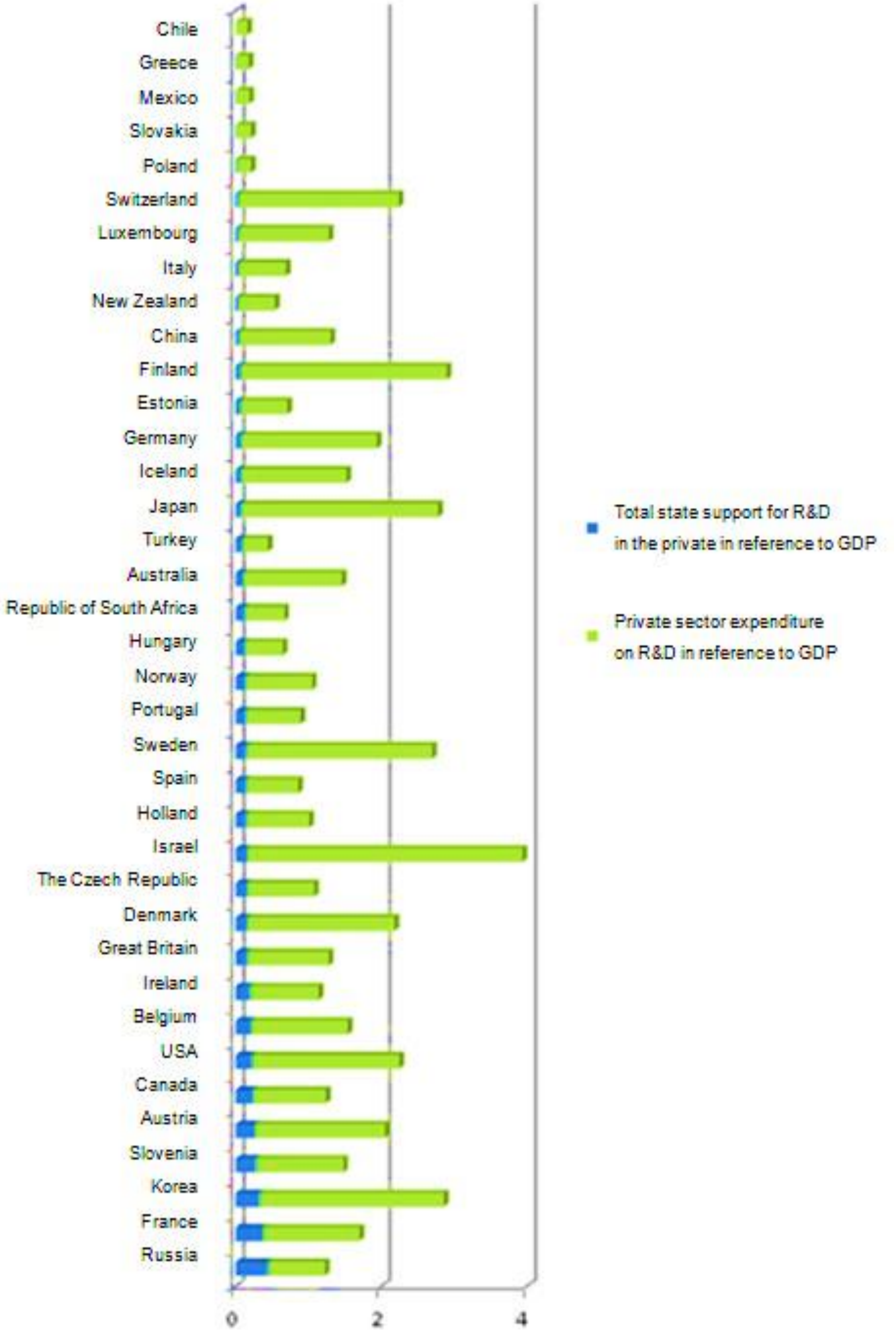


Source: Own study based on *Dynamic History of Korean Science & Technology*, D.Oh edit., MEST, 2011, p.336, The World Bank.

Innovation leader

The next stage in Korea's technological development commenced in the 1990s when the expenditure on research and development exceeded 2% of GDP. The 21st century saw a steady increase in expenditure towards that goal. Nowadays it exceeds 3.7% of GDP, which is one of the highest in the world (Figure 2). The sustained increase in spending on research and development in the private sector is the highest among OECD countries. What is characteristic for the structure of Korean industry is that most of this spending is generated by the country's twenty biggest companies including LG Electronics, Hyundai Motors, Hynix and GM Daewoo Auto and Technology. Samsung Electronics, the largest of all, is also sixth in the world as far as spending on R&D is concerned. Its spending stands at about 30% of the total resources allocated by the private sector for research and development in Korea [Hemmert, 2007]. 11% of research staff employed in this country, including foreigners, work for Samsung. Unlike large companies, small and medium sized firms remain at a fairly low technologically advanced level.

Figure 2. State support and expenditure on R&D- international comparison



Source: Own study based on OECD Economic Surveys: Korea 2012.

This highest level of expenditure on R&D is the result of the leading companies attempts to improve the international competitive advantage of their products[6] in order to obtain or sustain their prominent position on the world's markets. As a consequence, the expenditure on R&D is focussed on absorption and development of micro-electronics and telecommunication technologies as well as those related to the motor sector. Moreover, expenditure on R&D receives strong backing through tax breaks, reduced income tax payments for employees of R&D departments and quicker depreciation payments. This aid stands at 0.3% of GDP, which is the second biggest among OECD countries (Figure 2). The majority of the state's expenditure on research is aimed at developing engineering technologies that have a direct link to production. Research in this area is conducted by 55% of all research staff employed in the public sector.

The state is still an active participant in directing the development of Korean industry, supporting the technological development of sectors chosen as the driving force of economic growth. In 2009, a new strategy of economic growth, based on eco-technologies, was announced: 'National Strategy for Green Growth' [Jones, Yoo, 2011]. The programme contains a five-year plan for the years 2009 through 2013 and a development strategy until 2050. The key element of the new vision is a change in the development paradigm which highlights the decrease in the economy's dependence on high-energy consuming sectors and the move towards more modern, energy efficient technologies. Such a shift is not only aimed at boosting economic competitiveness but also at decreasing the high dependency on raw material energy imports.

The strategy, created in cooperation with a 360-person research staff team, designated 27 branches which are to constitute a new drive for growth [OECD, 2012]. These sectors are mainly linked to energy production and ecology including: technologies of clean coal, biofuels, solar panels, fuel cells, nuclear energy, innovative motor and shipbuilding industries, new generation screens, wireless communication technologies, electroluminescent diodes, robots, nanotechnologies, biotechnologies and medical devices and services. According to the plan, by 2013 the investment in green technologies was to reach the value of 10bln dollars. New legal regulations were introduced in 2010 whose aim was to provide support for the development of eco technologies. The government was obliged to create appropriate financial tools, direct financial aid for pro eco-companies and incentives for investment in green infrastructural projects. An ecological producer's certification system was put into operation. In order to access this state aid, a company must have gone through a technology appraisal issued by the Korean Institute for Technological Development.

[6] Korean advanced production is still dependent on the import of a substantial number of components.

The methods of backing private company participation in the new strategy of development included: Higher expenditure on green technology R&D, which is 20% of all spending on R&D, preferential credit terms, credit guarantees and tax exemptions. Most public spending on R&D affects 27 selected technologies and their further funding depends on the progress made, which is regularly monitored through the number of patent applications and expert assessment. It was announced that an investment company will be established with the aim of investing the entrusted resources in green technologies and then redistributing the profits back to the investors. Central and local governments are to offer technological and financial backing for those companies which utilise green technologies, in particular, those which seek foreign investors or companies from eco sectors that are creating new workplaces. Aid is also given to projects cooperating between large and smaller and medium sized companies operating in the green sector. Promises have been made to improve the workings between research on new technologies, production and sales as well as the creation of favourable conditions for investment in the designated sectors. In the start-up phase of the development of the new sectors, it was planned to promote the purchase and application of goods produced by these sectors in the public sector. The emphasis is put on the gearing of the current largest manufacturing companies: semi-conductors, steel, vehicles, electronics, etc. towards green technologies. The support was to cover the cooperation of the machinery sector with companies developing hybrid technologies, fuel cells, carbon capture and storage. It was hoped to combine the sectors of semiconductors, screens and household goods with the development of solar panel technologies. The decisions about which technologies would receive state backing depend on their contribution to economic growth, their environmental impact or their strategic importance.

It is still too early to assess the effectiveness of the new strategy. Up to date data point towards higher involvement of private companies in green technologies and advances in their growth. In 2010, thirty of the largest companies increased their expenditure on eco-technology three fold in comparison to 2008. Spending mainly concerned renewable energy, new generation electrical devices and vehicle eco technologies. Fifty seven companies have received ‘green certification’ up to October 2011. By mid-2011, credit guarantees had been granted for a sum of approximately 12bln dollars for green technologies. In 2010, Korea became the second greatest producer of lithium-ion batteries and LED devices. Experts claim that between 2009 and 2011 the technological advancement of the selected ecological products in comparison to the world leaders increased from 50% in 2009 to 75%.

The Korean strategy of a focussed approach towards R&D is to concentrate the expenditure on research in those technologies which can be directly translated into production, meets two main areas of criticism from international experts

[OECD, 2012]. On the one hand, taking into consideration the current rate of economic growth, accurate forecasting of which fields will bring benefits is questioned. The state support given to the selected branches to boost their growth, in the case of failure, may lead to substantial losses for the economy as a whole. On the other hand, the consistently low expenditure on basic research and low university participation in R&D stifles creativity and the ability to make breakthrough discoveries. Attention has been drawn to the fact that in international statistics Korea is located low on the list as far as international publications, patents or international technological exchange are concerned [Hemmert, 2007]. Similarly, there are noticeable drawbacks in the Korean education system. Although the country enjoys a high higher education ratio and 80% of high school leavers continue their education at university, the standards of higher education are far from those in developed countries. As a consequence, Korea lacks its own local top-class specialists, which leads to the largest companies employing a mainly foreign workforce and the establishment of research centres abroad.

Conclusions

One of the bedrocks of the Korean economic miracle, begun in the 1960s, was the constant stimulus of technological production growth. Cooperation between the state and the private sector succeeded in transforming this poor agricultural-based economy into one of the world's biggest industrial producer. The Korean government did not solely rely on foreign investors but also supported local capital in order to implement an increasingly advanced level of production. Economic growth was accompanied by a shift from importing and copying advanced technologies through direct application of technological development in cooperation with selected companies and ending with trendsetting and innovation support through universal regulations. Manufacturing policy was accompanied by an education policy geared towards the changing requirements of the economy. The Korean path has turned out to be extremely effective. The incredibly concentrated and pragmatic approach to R&D and focussed innovation in a small range of selected sectors has hugely benefitted the whole economy and enabled Korea to catch up with other developed counties in many areas. Today, the Korean government continues its policy of setting trends for industrial development and backs technological advancement in selected sectors. It seems that these tried and tested methods, focussed on rapid results, should be enriched by the states greater involvement in the improvement of the quality and diversification of education. Ignoring basic research which is not directly linked to production at this stage of the countries advancement, may result in the hampering of its potential. Korean companies emerging as world leaders in their fields will no longer be able to continue through copying, they must themselves become leaders of innovation. The policy of employing foreign staff and setting up R&D centres abroad, although currently effective, may no longer be sufficient in the future. In the coming decades, the country's success and economic growth will be determined by the emergence of a truly creative and broadly educated society.

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A SYSTEMIC APPROACH TO INNOVATION: BREAKING THE RULES OF CONVENTIONAL REGIONAL DEVELOPMENT – THE CASES OF MEXICO, COLOMBIA, INDIA AND BRAZIL

Abstract

Companies, the engines of economic development, require economic, sociopolitical and environmental conditions aligned with their business strategy to achieve global positioning and regional sustainable development. Emerging countries, lacking these factors and conditions, are not capable of fully profiting from the impact of innovation, which limits the development of regions. To break with the rules of conventional regional development, this chapter proposes a mechanism to rethink the impact of innovation on a region and the enabling mechanisms and conditions responsible for it by offering a new systemic approach to innovation. The main drivers, performance characteristics and barriers to regional innovation systems (RIS) are discussed. Successful cases of extraordinary regions around the world suggest that innovation is systemic, and the holistic development of regions requires unique management and governance structures that enable a harmonious, balanced and holistic articulation, capable of producing a better global positioning and differentiation for emerging regions planning to be innovative, sustainable and competitive. This is a profound change of paradigm, transforming the innovation of products and business models into innovative design of systems, of great impact for regions.

The paper indicates the innovation drivers in three following emerging countries: Mexico, Colombia, India and Brazil Authors present the cases of Monterrey, Medellin, Bangalore and Curitiba, where efforts of cities and regions have succeeded in limiting factors by becoming clusters of innovation.

Keywords: Systemic innovation; regional ecosystems; holistic regional development; systems design approach; innovative cities.

Introduction

Companies, which are the drivers of economic development in western countries, require several environmental conditions to be able to operate optimally. To thrive, companies need industrial, social and environmental conditions well aligned with their operation, business strategies and vision. If these conditions are not present in the region, truly sustainable development is inhibited. This situation is more evident in emerging countries, where the absence of political and entrepreneurial initiatives and basic elements prevent the proper seizing of opportunity for innovation in the economic and social development of these regions. To effectively innovate and exploit the ensuing benefits, the close, complex dependence of innovation on the political, social and environmental structures of the regions must be taken into account.

The misalignment between recently emerged companies and the macroeconomic model in which they are immersed usually prevents them from having a successful business strategy or in some cases can create a hostile environment, despite the fact that these companies may follow world-class best practices in management. For example, an NGO could not operate successfully in a totalitarian capitalist environment that pursues only the economic profit of its organizations, minimizing any social or environmental objective that does not generate a reasonable economic return on investment. The resulting imbalances might create socially undesirable situations, such as inequality, migrations, violence and insecurity, that adversely affect the economic progress of a region [Scheel, 2014].

Consequently, the success of companies in emergent and developing countries is dependent on the regional conditions and the impact that the industry can have to add value to its business practices, academic, financial or government ties and to the environmental responsibility it has with the ecological surroundings. Ignoring the interrelation that exists among actors, which represents the systemic side of growth, could lead to misalignments that could cause not only economic, but also significant social and environmental problems.

This lack of alignment among the three core systems of sustainable development can create vicious cycles, for example, cycles biased towards economic development that encourage companies to incur in corrupt activities, pollution of the environment and a widening of the gulf in income distribution. In the long run, this creates a bigger gap between a desirable sustainable wealth and a myopic economic wealth.

Therefore, the impact of innovation on a corporate economic activity rests on two pillars. First, it depends on the structure of the political, social and environmental ecosystem and, secondly, on the democratization of the initiative to develop a regional ecosystem as the joint space of economic, socio-political and environmental sub-systems. In other words, it is not possible for an economic bonanza to last when unequal social sectors, deplorable support infrastructures, irrational exploitation of natural resources, and non-inclusive, non-transparent rule of law persist.

Furthermore, Engel and del-Palacio [2011] contend that in order for companies and their region to grow rapidly, certain characteristics must be present. Among these is the presence of a rich and diverse environment where corporations of all sizes, investors, and service providers, as well as research centers, support each other. Also, the high mobility of human, technology and capital resources is needed to create companies with an aligned international perspective and set of goals.

According to these authors, from the conjunction of these elements the conformation of a cluster of innovation (COI) derives [Engel, 2014]. Despite the fact that the cluster concept comes from Porter [1990], which he defines as aconcentration and interconnectedness of entities in a particular field, Engel and del-Palacio [2011] define a cluster of innovation differently:

An environment that favors the creation and development of high potential entrepreneurial ventures and is characterized by heightened mobility of resources, including people, capital and information (p. 32).

Considering both approaches (the systemic one and the COI), we can formulate the following hypothesis: Innovation, which is the engine of regional development, should have a systemic approach. This means that for a region to truly innovate and create sustainable (triple bottom line) wealth, growth must be balanced by combining the social, economic and environmental aspects [Elkington, 1997].

This article proposes a mechanism to rethink what innovation requires to be successful: the impact of innovation on economic business activities depends on the structure of not only its political, social, and environmental ecosystems, but also on the democratization of these kinds of initiatives to generate a holistic regional development toward sustainable wealth creation, mainly for emerging countries.

To support these arguments, first we review the main enabling factors that are the engine for innovation, along with the performance factors, which provide a standard measure of the innovative capacity of a region and the impact on the regional performing indexes. We discuss the main barriers to regional innovation and development. Then we present several examples of these barriers in cities in emerging countries, such as Monterrey, Mexico and Medellin, Colombia. Next, we discuss the importance of a systemic, balanced growth by describing cases where cities, despite the fact that they made a breakthrough, still need to work on balancing the triple bottom line. Finally, we expand our hypothesis by arguing the need for innovating the way we innovate by bringing into the equation a more systemic approach.

We conclude that in order to become an innovation pole, regions must develop a master plan with a systemic approach to balance the three dimensions of sustainable growth, a socially inclusive development, an economically viable and competitive strategy, and efficient environmental recovery.

A field study carried out from 2007 to 2010 [Scheel, 2011; Scheel, Rivera, 2013; Scheel, Pineda 2015], focused on cities around the globe that have made tremendous transitions in short periods of time, has produced interesting research topics. The cities studied were Austin (U. S.), Auckland (New Zealand), Bangalore (India), Barcelona (Spain), Curitiba (Brazil), Medellin (Colombia), Metz (France) and Stavanger (Norway). These cities were chosen because they have changed their traditional behavior of steady growth, have used innovative practices to deliver outstanding performances, and today are internationally well positioned as prosperous wealth creation poles. But, what is it that these cities have in common?

All these cities have used a series of enabling mechanisms by which they were able to make possible these large-scale changes, while at the same time they have created interdependent spaces in which a harmonious, balanced development among citizens, social communities, businesses and their local environments have created trust, diversity, reciprocity and respect.

Most of these regions-cities have followed a systemic innovation approach to development, identified by Scheel [2011], Scheel and Rivera [2013] and described in detail in Scheel and Pineda [2015], along with their main enabling drivers that made the breakthrough from a steady growth toward successful innovative cities possible. They have leveraged several mechanisms to achieve a sustainable growth, which means a balanced development of the three dimensions of growth, their social development, and their economic growth, all immersed in a recoverable use of natural resources.

Most of the cities studied are located in developed countries, where the conditions are propitious for sustainable growth through innovation. But a critical question emerges: Are cities in developing countries ready to become innovative attraction poles? What do these cities in emerging countries need to become innovacities?

Regional innovation systems: The main drivers that have leveraged innovacities

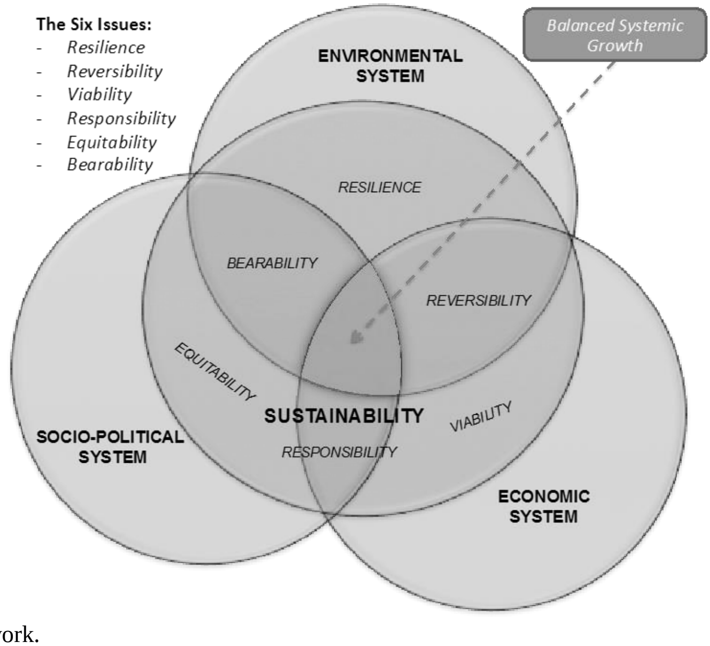
To achieve the special characteristics of innovacities that were able to make the breakthrough to exceptional performance, the study identified a group of drivers that were able to propel these cities forward. These enabling drivers were grouped in eight types that were found in most cases:

1. Infrastructure. Smart structures built to implement innovative strategies
2. Openness to associativeness and 'holistic awareness'. Based on the capacity of the city to have a systemic vision and synergies to assemble interdependent clusters of industries, academe, government, entrepreneurship programs, and financial institutions to move toward a sustainable holistic development
3. Entrepreneurial/entrepreneurship programs. Leveraged by the creation of a culture for converting knowledge and experiences into high-value business models, start-ups, magnificent events and institutions
4. Technology. Measured in terms of special 'technological innovation', designed to support the integrated 'industrial-social-environment' breakthrough paradigm

5. Talent. Measured in terms of specialized capabilities to create innovative solutions to support breakthrough innovations
6. Public policies. Special policies designed to leverage, empower and promote innovation strategies and innovation clustering strategies
7. Innovation strategies. Special policies to support innovation chain development
8. Spectacular successes. Based on the existence of great events planned and executed by local authorities.

Derived from the cities observed and other cases around the world, the innovacities study concluded that these enabling drivers represent the key enablers-- most of them unique and difficult to replicate-- responsible for empowering cities to achieve worldwide recognition [Asheim, Coenen, 2005; Florida, 2010; Hargroves, Smith, 2005; Munroe, Westwind, 2007; Scheel, 2011]. Although the drivers by themselves are important, more significant is the articulation of the drivers through well-designed innovation strategies, along with well-tuned public policies and the alignment with societal, economic and environmental resilience, all under the principle of a systemic perspective, responsible for the truly sustainable growth of regions (Figure 1).

Figure 1. The foundations of a balanced systemic growth enabler of systemic innovation



Sources: Own work.

Most of innovacities develop their interactions within the intersection of the systemic growth. From the innovacities study, we can conclude that most of these cities have created zones of balanced sustainability, where companies, institutions, and citizens can live in a harmonious environment of economic competitiveness, social equality and environmental resilience. This means that through a systemic perspective of growth, all structural forces converge toward a common goal where all stakeholders share in integral-holistic- wealth creation.

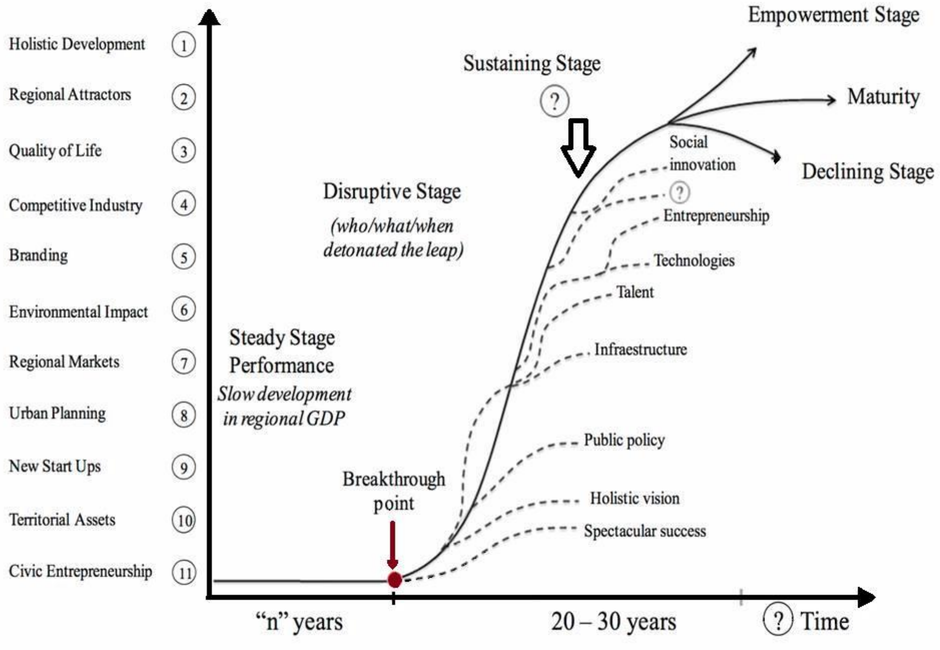
The performance characteristics

Once the main key enabling drivers for innovation in a region were recognized, several performance metrics were identified to diagnose and measure the innovative characteristics of certain regions. The characteristics that have determined the world class positioning of these cities, which have undergone innovative breakthroughs, are the following. Most of them have had:

1. A holistic sustainable development
2. Regional attractors (attractors of talent, culture, industrial partners and FDI)
3. Excellent quality of life
4. Strong competitive industrial sectors
5. A worldwide (recognition) branding
6. Conscientious environmental protection programs
7. Emerging well-managed regional markets
8. Excellent standards of urban planning
9. A large numbers of new high-impact start-ups
10. Enviable territorial assets
11. Inclusive civic and social entrepreneurial programs

The following figure (Figure 2) displays the group of enabling drivers responsible for empowering the cities to attain higher performance characteristics. The “S” shape indicates the behavior of certain characteristics through time. Despite the fact that no exact correlation can be drawn from the figure regarding drivers and characteristics, it is important to stress that these are interrelated overall [Scheel, 2014].

Figure 2. The breakthrough innovation S-curve (enabling drivers in the cities that have generated outstanding performances



Source: C. Scheel, Innovacities: In search of breakthrough innovations producing world class performance, International Journal of Knowledge Based Development 2011, Vol. 2, No. 4, pp. 372-388.

Scheel and Rivera [2013] validated these producer-product relationships between drivers and performance factors and conclude that the drivers for producing outstanding characteristics most often employed were the following: (a) public policies, (b) smart infrastructures, (c) associative culture and holistic vision, and (d) technologies, all aligned to regional sustainable development.
Furthermore, as mentioned before, these drivers produce certain characteristics typical of an innovacity. The most frequent of these performance characteristics produced by the main drivers include: (a) industrial competitiveness, (b) regional branding, and (c) regional attractiveness. These remarkable behaviors give innovation strategies a special place in turning the cities into global players, but at the same time as effective creators of sustainable wealth.

Although these drivers and performance factors have been validated, a critical question emerges: Are cities of emerging countries ready to incubate clusters of innovation, capable of becoming poles of attraction while at the same time generating sustainable growth? If not, what are the barriers they must overcome to be ready to become incubating world-class innovative poles of competitiveness?

The following section is devoted to discussing these barriers that must be overridden or mitigated to achieve effective clustering for the development of innovative cities in emerging countries.

How some cities have hurdled the barriers to innovation

Emerging countries are immersed in the constant task of improving their economic, social and environmental development to become as developed as the so-called first world countries. But despite their efforts, there are often numerous barriers hindering their development. Through several studies regarding regional innovation systems, clustering strategies and innovative cities, most of these barriers have been identified [Contreras et al, 2013; Scheel, Ross, 2007].

According to Scheel and Pineda [2015], a number of characteristics of innovative regions are either absent or underdeveloped in cities in emerging countries, which correlates to the existence of practices and structures that inhibit the process of cluster formation in these regions. Among the most severe of these barriers are the following:

1. Over exploitation of natural, physical, knowledge, and relational resources
2. Myopic, reductionist adoption of practices, technologies, economic models, and political models of industrialized countries
3. Inability to associate in large networks (economic and/or social)
4. Poor capacity of association at all levels (regional, industrial, enterprise, entrepreneurs, and chambers)
5. Underlying distrust that prevents long-lasting relationships among stakeholders and systems of capital
6. Lack of sensitivity to the effects of industrialization growth on social and environmental affairs
7. The inability to practice an unbiased, uncorrupt and transparent rule of law
8. Disarticulated (or nonexistent) intergovernmental (municipal, state, federal) industrial policies
9. Lack of joint-venture investors and inadequate support of the private banking system because of perceived high risk
10. The absence of holistic awareness and holistic conscience among most citizens, politicians, and NGOs.

In the absence of suitable civic, industrial and regional conditions, there cannot be a fair and competitive development for anyone. This is evident in emerging countries; where there are neither elements nor the business and political will to properly leverage the impact of innovation on the economic and social development of these regions. For emerging countries to attain high levels of innovation ecologies, effective environmental resilience and high impact socio-economic welfare, the existence of proper regional and industrial conditions is vital. A region with all these barriers and lacking in the proper enabling conditions is bound to fail in creating innovation and sustainable wealth through the creation of attracting poles.

Despite the presence of these barriers, coupled with a lack of proper innovation drivers in most emerging countries, there have been cases where efforts of cities and regions have succeeded in circumventing these limiting factors by becoming clusters of innovation. Two important cases are the city of Monterrey (Mexico) and Medellin (Colombia) [Scheel, Pineda 2015; Scheel in Engel 2014].

First of all, why were these two cities selected for this benchmark, if they do not appear in any of the main studies on competitiveness or doing business, or any other special world class factors? [Monterrey ranks #90 and Medellin scores #96 out of the 120 the world's major cities on competitiveness [The Economist, 2012].

Medellin, Colombia: From an extremely violent city to a highly innovative city

Known as the most violent city in the world in the 1980s as the result of warfare among drug gangs, Medellin started its transition in 2002. It began with a series of impressive policies proposed by the current mayor [Pineda, 2014], and the involvement of the entrepreneurial culture of the inhabitants, the government and private economic leaders, that started to enhance the infrastructure to support social, economic and structural change [Pineda, Scheel, 2010]

Of the many enabling drivers the city implemented to support its innovation strategy, the following represent the most successful ones:

Creating smart infrastructures. The Regional Innovation System (RIS): Ruta N, a research technology park has been the responsible for the implementation of the Plan for Science, Technology and Innovation in the city's industrial activities. This center has been the core of the development of the innovation chain of incubators, transfer offices, entrepreneurial programs, etc. and the Metro Medellin. The implementation of the Environmental Policy of Medellin program, with the vision to create 'a sustainable city for future generations', has been another important initiative.

Using enabling technologies. Industrial and service activities in the region are supported by novel enabling and access technologies, as well as by local industrial policies and technology-based entrepreneurs.

Promoting entrepreneurship. Strong development of entrepreneurial programs focused on small businesses and specialized agencies, seeking equity and providing the same opportunities for all citizens.

Creating specialized talent. Universities and research centers focused on the development of innovation in the city, as well as spaces for the arts, poetry and drama, poles of attraction for external visitors

Developing public policies. NGOs and official organizations focused on social welfare (e.g., programs for street children) and inclusion of the people in public decision making.

Besides the previous drivers propelling Medellin into becoming an innovative city, the most transcendent of all has been the effective bonding between: the public administration (Medellin's mayor's office), the public companies, such as Empresas Públicas de Medellin (Public Enterprises of Medellin), and the support of private groups, such as Grupo Industrial Antioqueño (Antioquia Industrial Group). The alignment and strong articulation of triple helix actors have provided the city with a critical mass of ABIIGS enabling agents (academy, bank, infrastructure and innovation, supporting industries, government and social capital), which resembles a COI [Engel, del-Palacio, 2009], where all ties among the diverse and multiple stakeholders are aligned to a common goal of creating sustainable wealth. For a detailed review of this case, see Pineda [2014]. As result of all of these initiatives, Medellin became the "Innovative City of the Year" according to the City Bank Contest in 2013.

Monterrey, Mexico: Getting back on track to become an innovative city

Regarded as one of the principal industrial cities in Mexico, Monterrey has passed through divergent situations. Given its proximity to attractive U. S. markets [Cerruti, 2000; Zambrano, 2005] and businesses, along with the development of the steel industry and railroad linkages in the earlier part of the 20th century, the Monterrey region began a long period of growth as a key economic center. In recent years [2009], however, the city has suffered a tremendous decay resulting from the increase in violence, insecurity, corruption, migration of many of the most valuable and talented residents and a diminished rule of law. These factors have led to a significant loss of the city's regional competitiveness, attractiveness, quality of life and branding [Scheel, 2014], which translates into a decrease in investment, a decline in incoming human capital, less networking and association, and decreased quality of life, to mention a few.

To respond to this crisis, in 2005 Monterrey implemented the State Master Plan. This plan aims at transforming Monterrey into a city with top international competitive levels and talented human capital generator of high value-added goods and services rooted in knowledge and innovation, thus raising the quality of life for its inhabitants [Parada, 2012].

The State Master Plan promoted several successful strategies that have led the Monterrey region to restore its previous rank as an innovative city. Among these metrics, derived from innovacities [Scheel, 2011; Scheel, Rivera, 2013], Monterrey has:

Entrepreneurial/entrepreneurship infrastructures. Nine different industrial clusters were started to promote knowledge-intensive industries, such as software, healthcare biotechnology and nanotechnology, in addition to well-establish industries, such as agro-business, auto parts, food, construction and domestic appliances.

Infrastructure and technology. The I2T2 Institute (the state of Nuevo Leon's Institute of Innovation and Technology Transfer) was created, designed to transform Monterrey into a "knowledge city" through the implementation of an Innovation Ecosystem Model that articulates a long-term group of goals, strategies, policies and mechanisms to promote knowledge, research and technological innovation [Parada, 2012].

Innovation strategies. The Plan for Science, Technology and Innovation (by I2T2) was formulated as a strategy for regaining industrial competitiveness, improving quality of life (mobility, public safety, reduction of poverty, attraction of specialized education), and recovering the city's branding and capacity to attract high value industries, investment funds and talent.

Public policies. Moreover, efforts in diverse arenas have been implemented, encompassing the generation of new educational agendas, policies, urban infrastructure, cultural offerings, industrial and research parks, reduction of the gap between rich and poor, support for business incubation and entrepreneurship and, more importantly, a strong legal framework (rule of law).

Currently [2014], after the deployment of the efforts mentioned above, Monterrey has regained most of its branding as a competitive city, attractiveness for talent and anchor companies, as well as its status as a pole of clusters in areas such as health, agro-business and biotechnology, to mention a few. These efforts have spurred an improvement in the quality of life (a decrease in violence and crime, and the return of "high value" migrants), enhanced infrastructure, and implementation of public policy and safety programs, in conjunction with an increase in economic development (GDP per capita above the national average) [INEGI, 2010], equitable social growth, and sustainable environmental resilience. The city is slowly recovering its invaluable position in the country and in Latin America as one of the best cities in which to do business [Moonen, Clark, 2013].

Both of these cities are exemplars of how the use of a holistic perspective, a systemic synergy of the ABIIGS stakeholders (triple helix plus supporting players), a well-articulated master plan of science, technology and innovation, and effective public policies have created a "virtuous cycle of growth", by improving their characteristics as an "innovacity", such as: branding, regional attractiveness, quality of life, entrepreneurial mindset and diversified markets, that together attract more assets to the region, closing the cities` abundance loop.

Furthermore, despite the fact that there is no general formula for a city`s global positioning, what we found from the innovacities study [Scheel, Pineda 2015], is the necessity to redesign the right enabling conditions--resources, interconnectivity and governance--for each region to create a long-term breakthrough and empowerment conditions. In sum, these cities have overcome the lack of articulated strategies among the main stakeholders and divergent objectives that pull in different directions and they have created a disruptive paradigm change.

The following section briefly reviews other cases of cities in emerging countries that are implementing the enabling drivers to advance toward becoming innovacities, in spite of their country`s conditions. In addition, it offers several lessons learned from these cases and the importance of the systemic perspective in regional innovation, to achieve the breakthrough for a change of paradigm.

Cities in transition

The importance of balanced growth and systemic innovation: Bangalore, India. The third most populous city and fifth most populous urban agglomeration in India, this city is a growing metropolis. It is home to many of the most well recognized colleges and research institutions of the country, many heavy industries in the public sector, software companies, aerospace, telecommunications, and defense organizations. Known as the Silicon Valley of India, it has accomplished a breakthrough by becoming an important IT exporter [Scheel, 2011].

Bangalore managed to develop high growth by attracting information technology (IT) industries, despite the fact that it is located in a region with a ring of absolute poverty. The city made a breakthrough by positioning itself as a leader in the IT industry, although it has the lowest number of drivers used to achieve great performances [Scheel, Rivera, 2013]. It has gained world recognition in economic development, but has not advanced in the other two dimensions, social and environmental recovery and resilience. For example, up to the present, the city has experienced serious environmental and social problems, like scarcity of water, economic inequality, and social discrepancies, as a result of the imbalances created by focusing too much on strong economic development and leaving aside social and environmental issues. In summary, from this case, it can be concluded that a breakthrough can be accomplished using few drivers, but perhaps the only way for cities and regions to achieve real and durable sustainable wealth is to assume a more holistic perspective, one in which systemic innovation can flourish as a result of a balanced interplay among economic, social and environmental enabling drivers.

The sustainable approach: Curitiba, Brazil

Considered the 'Greenest city of America', Curitiba is the capital of the state of Parana and is one of the most successful cases of urban and environmental innovation. The main enabling drivers of this region were the spectacular development of urban activity and strong programs in ecological urbanism.

The city council endeavored to create strong public policies focused on establishing a network of effective public mobility among the neighboring municipalities through an innovative transport system based on buses. Self-financing programs were also the enablers of such innovative initiatives. As a result, Curitiba has achieved greater municipal coordination than any other Brazilian city, has improved the quality of life, social and interconnectedness and reduced pollution, wastes and use of natural materials, while lowering the fuel consumption per vehicle to the lowest level in Brazil [Rabinovitch, 1992; Smith, Raemaekers, 1998].

The principal enablers of Curitiba's success as an innovacity were (a) the continuous development of a unique urbanization plan, (b) the correct integration of the triple helix (government, universities and industry) to develop regional programs, and (c) the deployment of strategies promoting entrepreneurship with economic and social objectives through targeted government funds [Ferreira, 2010; Pedrera, Goodstein, 1992].

Despite the breakthroughs created by the implementation of an urban development plan, along with the transportation system, there are still areas for improvement in this innovacity. According to Lundqvist [2007], there are several challenges that must be overcome. First, the socio-economic issues remain, as 32.9 % of the population lives in poverty. Moreover, given that the public transportation system is one of the best in the world, increasing usage has saturated it, thus, ownership and use of private automobiles has risen, resulting in escalating congestion patterns.

Curitiba is nowadays a world-class example of what can be achieved through the correct alignment of stakeholders and a systemic strategy to tackle several archetypal problems of emerging countries when faced with issues such as increased population, transportation problems, violence, insecurity, pollution, decay in the environment and the quality of life. Although issues remain to be addressed, Curitiba created a region with a social and industrial growth around a very well planned and executed eco-city development, which has made the region an example that "it is possible" for a city in an emerging country to improve its overall sustainability.

These cases further stress the importance of a balanced growth in the social, environmental and economic aspects of a region. Any disequilibrium can create either a social, economic or environmental issue. The case of Bangalore demonstrates this imbalance. By focusing too much on attracting capital and developing the economic side of the region over the social, important imbalances may translate into major societal problems that in the long run will affect the quality of life and, with it, the branding of the city and, consequently, its attractiveness. Likewise, even correctly balanced among the triple bottom lines [Elkington, 1997] of sustainable development, to maintain its innovacity status Curitiba must keep a constant watch over the entire regional ecosystem. This is necessary because the impact of innovation is systemic and democratic, and not an isolated one-shot initiative. It works as a system and functions as part of a complete ecosystem where companies, universities and government must work together to boost a disruptive development of the region [Cooke, 2002].

The need for a new type of innovation: Innovating systemic structures versus innovating products or processes

From the cases presented above, it has been observed that innovation processes have become of pivotal importance for human development, social evolution, economic prosperity and environmental resilience [Gunderson, 2000]; [Holling, 1973, Holling, 1986]. According to several authors [Senge et al., 2008], for a region to innovate, organizations must have: the capacity to perceive bigger systems, and the ability to collaborate across frontiers and to acquire the vision to see desired goals. These three key components comprise the concept of a learning organization, even at the size of a large municipal organization.

Innovation is the key to coping with high-velocity, hypercompetitive [D'Aveni, 1994] and globalized markets, [Cooke, 2002]. Some authors suggest product and process innovation, as well as strategic innovation from the microeconomic perspective, while others add social and political innovation as an important component to create innovative communities [Scheel, 2012; Senge et al, 2008]. Nevertheless, innovation is part of a socio-geographic phenomenon. There are neither simple formulas nor fast-track strategies; the complexity of city-regions cannot be handled lightly or simply by focusing on one type of innovation.

Frequently, regional innovation stems from fleeting political decisions or is based on traditional regional vocation. But for success, regions must first empower cities with regional conditions, industrial capabilities and very special interconnections among all stakeholders. The lack of this empowerment is noticeable in emerging countries, especially as growth derived from innovation is not properly exploited. In other words, the impact of innovation on an economic activity depends on where it is generated, along with political, social and environmental systems, as well as democratization initiatives to develop regional ecosystems and the resulting synergies among all agents (stakeholders) coexisting in a region.

This is the “innovation of innovation”. It involves the simultaneous, harmonious and inclusive articulation of economic and political institutions that results in a paradigm-breaking new model that allows for a win-win scenario for all the stakeholders in the region.

The effective and inclusive articulation of four main areas--human, sociopolitical, environmental and economic--of development drives this new kind of innovation. The systemic, simultaneous and harmonious synergies derived from these four main areas converge into the creation of hyperspaces. To construct these hyperspaces as creators of sustainable wealth and balanced growth, innovation as we know it must be extended into what it is called systemic innovation, or the design of innovative systems--not products, not processes, not business models, but well-structured systems. It means shifting from a light bulb to an electrification system of great social impact).

Systemic innovation breaks with the paradigms of thinking and acting that are reductionist or isolated from the context of interest to achieve inclusive, joint regional innovation ecosystems, capable of generating wealth through synergy between regional companies, organizations and individuals. Its basic concept is to connect, coordinate and assemble a value system: " to transform good ideas into clusters of ideas with the greatest impact on achieving regional needs”.

This new kind of innovation must create ecosystems or clusters of innovation, rather than isolated (e.g., process or product) innovations, where interconnectivity, knowledge and space sharing create holistic wealth shared among all the individuals in a region. Furthermore, this kind of innovation is able to democratize the results and transform the region into an effective system of inclusive, permanent and sustainable value.

Supporting evidence is found in the work by Scheel and Rivera [2013] describing successful cases of innovacities that have assembled effective regional innovation systems [Cooke et al., 1997; Cooke, 2001; Cooke, 2002; Asheim, and Gertler, 2005]. These innovacities have broken with the paradigm of steady growth and created a new perspective for the territories, a new way of working and living, as Florida [2010] has described with great detail in several of his works.

The core of systemic innovation is the combination of political, cultural, environmental, and economic forces, all involved in the creation, dissemination and transfer of knowledge [Carlsson et al., 2002], and the attraction of skilled workers in knowledge-intensive activities [Hospers, 2003] to articulate effective value systems [Senge et al., 2008] and regional ecologies of innovation [Munroe and Westwind, 2007]. This has worked in dozens of city-regions around the world.

Systemic innovation is not a temporary or isolated phenomenon. It is diverse and multi-factorial, and arises from visionaries and champions, individuals who exploit exceptionally both knowledge and capital by implementing solutions to fulfill the needs of the community [concepts validated in Florida and Gates, 2003; Florida et al., 2008]. Following this reasoning, we contend that innovation is systemic, with a democratic, inclusive effect on value relations, not only encouraging competing for markets, but also requiring the regions to find new ways to generate holistic wealth. This sustainable and systemic wealth demands the attraction of the best talent, technology partners, anchor companies, direct foreign capital, ecological effectiveness, better quality of life standards and more social equality. All of these elements must move through a sustainable growth, recovering scarce natural resources exploited by irrational industrialization, such as drinking water, clean air and productive soils.

Conclusions

The message is clear. Today the creation of social, economic and environmental wealth requires the systemic articulation of all members of a region. This applies especially in emerging countries that lag behind first-world countries in such matters as economic, social and environmental development, and have a need for a more complete holistic vision of their regional potential. Several cases were presented where these characteristics emerged.

We described a number of cases to rethink how to innovate effectively, to show that the impact of innovation on economic business activities depends on the "structure" of not only the surrounding political, social, and environmental ecosystems, but also on the inclusive democratization of non-conventional initiatives, in order to generate a "holistic" regional development toward sustainable wealth creation. This applies mainly for emerging countries.

This is the "systemic approach to innovation", where the conventional rules for regional development are broken. We contend that this new perspective on innovation is the cornerstone for transforming economic, environmental and social subsystems into thriving self-organized regions environmentally resilient, reversible and durable; socially responsible, inclusive and equitable; and, of course, economically viable, responsible and competitive.

We reviewed the cases of Medellin and Monterey to validate the premise that a sensible change of paradigms is needed to create the enabling conditions that can transform a region into a pole of attraction. Factors such as establishing a smart infrastructure, using enabling technologies, promoting entrepreneurship, developing specialized talent, entrepreneurship, innovation strategies, and focused public policies, among others, are more critical than market forces or economic competitiveness strategies that can be benchmarked against world-class economies. These factors do not come as islands. Their real impact lies in the articulation of these conditions within a systemic approach. The case of Bangalore addressed this lack of balance, where more attention was given to attracting information technology industries than to societal and environmental aspects of the region, creating serious imbalances.

Systemic innovation as a process must be implemented through the use of local resources to have a real impact on the creation of sustainable regions. Emerging countries, whose hostile local conditions, insufficient resources, and poor connectivity create barriers, need to implement regional innovation system strategies, focused on first creating the enabling conditions that serve as stepping-stones for the construction of effective innovation ecosystems.

In summary, the most important characteristic of world-class innovacities has been their ability to consider the design of conditions in a systemic, harmonious, balanced and holistic articulation, capable of producing a better global positioning and differentiation for emerging regions that are planning to be innovative, sustainable an highly competitive.

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THE DEVELOPMENT OF CREATIVE INDUSTRIES AND THEIR EFFECT ON INNOVATIVENESS OF THE ECONOMY AND ENTERPRISES – THE BRITISH EXPERIENCE

Abstract

The aim of this paper is to assess the role of creative industries based on British experiences in the development of innovativeness in both companies and the economy. The first part includes theoretical deliberations focussed on the definition and the essence of creative industries in European countries, the second provides analysis of British experiences – good practice in the area of the development and support for creative industries. Good practice was compiled based on the empirical material collected during a professional visit within Lifelong Learning Programme, project number 2013-1-PL1-KA101-42923, *Innovative Responses to the Delivery of Creative Industries Education* at City of Glasgow College.

Keywords: Innovation, creative industries.

Introduction

Creative industries contribute to the development of innovativeness in companies as well as the economy as a whole, and significantly boost transfer of knowledge, new ideas and innovations in the modern economy. The significance of creative industries is twofold, firstly they are groups of particularly innovative companies which provide a range of new products and services, secondly they are important for new ideas and approaches that other enterprises avail of. They are therefore focused on activities stemming from new ideas and innovations and strive to meet customer demands, which have become more individualised.

Creative industries develop dynamically and are interdisciplinary, which means they combine art, culture, business and technology, being tightly linked with the economy which relies on individual creativity, skill and talent and, as a consequence, produces intellectual property [UNCTAD, 2008]. Creative industries are providers of 'creative start-up capital' in the regional innovative system, thanks to which they boost innovative potential in other companies [Miles, Green, 2008].

Creative industries – review of definitions and approaches

Creative industries are defined in a variety of ways in the literature on the subject. The German model determines creative industries as creative enterprises which are particularly geared toward the market, and deal with creation, production, distribution and/or spreading creative goods and services through the mass media [Mackiewicz, et.al 2009]. They are a part of the culture sector, which focuses on artists and participants in culture. Creative activities can be observed in: (i) the private sector (creative companies, the media, news and communication enterprises), (ii) the public sector (public culture services, e.g. theatre, opera, museums, libraries and festivals) and (iii) the non-profit sector (non-profit organisations, associations and foundations).

France perceives creative industries as a collection of activities that combine conceptual and creative features with industrial operations and widespread distribution of goods and services which are generally subject to copyright [Etamowicz, 2009].

Holland does not differentiate between creative industry, culture industry, art and entertainment, but creativity is regarded as the key factor in production. Following this approach culture is divided into:

- art (performance art and photography, visual arts and art events, etc.)
- media and entertainment (film, the audio-visual sector, literature, journalism, etc.)
- creative business services (design, fashion, architecture, new media and games, advertising, etc.) [Etamowicz, 2009].

The Creative Industries Taskforce in Great Britain defined creative industries as operations that originate in individual creativity and talent, having the potential to generate wealth and employment through production and usage of intellectual property rights, along with the potential to provide wealth and the creation of work through generations and explorations [Analiza potencjalnych sektorów kreatywnych Mazowsza, 2012].

The report *The Economy of Culture in Europe* compiled by Kern European Affairs (an organisation based in Brussels supporting the development of art, culture and sport) defines the creative industry by two types of activities: culture industries and creative industries. Culture industries focus on cultural operations whose results are artistic, as well as traditional sectors of art such as film and video, television and radio, video games, music, books and the press. Creative sectors include design, advertising and architecture, however creative industries use culture as added value in manufacturing non-culture products [The Economy of culture in Europe, 2006].

Eurostat regards creative industry as [ESSNet-Culture, 2012]:

- culture sector companies producing and distributing goods and services which at the time of their production have particular features, applications or aims and convey cultural expression independent of their commercial value
- creative industries and culture industries are engaged in the creation and provision of market goods and services which are the results of a cultural and creative input that determine their value. Therefore, the creativity sector consists of the following cultural areas: national heritage, libraries, archives, books and the press, visual arts, performance arts, multi-media and audio-visual arts, architecture, advertising and arts and crafts.

Creative industries have also been defined by the World Intellectual Property Organization (WIPO). According to whom such industries are those that regard intellectual property rights as the key issue *(intellectual property rights is the catalyser which transforms creative activity into creative industry)* and whose operations include creativity, production, presentation, broadcasting, exhibition, distribution and sales of goods protected by copyright [Mapowanie sektorów kreatywnych, 2010]. Depending on usages of copyrights, there are three groups of creative industries which form the creative economy sector [Klasik, 2010], [Mapowanie sektorów kreatywnych, 2010]:

- *the main creative industries protected by copyrights* (e.g. advertising, film and video, music, stage arts, publishing, software, television and radio, graphic design and visual arts)
- *co-dependent creative industries protected by copyrights* (e.g. electronic storage devices, electronic devices, musical instruments, photographic equipment)
- *creative industries partly protected by copyrights* (e.g. architecture, clothing, footware, design, fashion, household appliances, toys).

According to the definition put forward by the United Nations Conference on Trade and Development (UNCTAD), creative industries are the cycles of creation, production and distribution of goods and services using creativity and intellectual capital as main constituents [Etmanowicz, Trzebeński, Martela, 2012]; [Kowalik, 2013]. Following this definition, a creative product which is a resultant of a creative individual's labour (the creator) may be of a tangible as well intangible nature.

The features of a creative product which are clearly distinctive from others consumer products available on the market include: originality, individuality and creativity. Creative products are divided into simple and complex. Simple products include [Analiza potencjalnych sektorów kreatywnych Mazowsza, 2012]:

- a creative product, an object – a tangible product
- a creative product, a service – independent creative service (e.g. film scenography, painting exhibitions)
- a creative product, content – an intangible product (e.g. literary, musical or artworks).

Complex products include [Analiza potencjalnych sektorów kreatywnych Mazowsza, 2012]:

- a creative product, an event (e.g. concerts, recitals, book promotions, advertising picnics)
- a creative product, a location – combines both tangible and intangible features; this is a place, often avenue, where creative services are provided.

Creative industry is also defined as a sector of the economy which is based on creativity and originality of operations applying intellectual resources [Mackiewicz et al., 2009]. In this approach, culture, through its products, becomes a creativity bearer, having an impact on current economic processes and becomes capital that stimulates creativity sector development [Etmanowicz et al., 2012].

In Poland, creative industries are regarded as ones based on individual creativity, skills and talent having the potential to generate employment and profit due to the intellectual property produced. GDP from 2007 highlighted creative sectors which included: architecture and interior design, publishing, national heritage, libraries and archives, art education, fashion and industrial design, film and TV production, radio and music production, programming, advertising and similar fields, arts and crafts, performance arts and visual arts [Gałka et al., 2012].

Based on the above examples of definitions of creative industries one can assert that the perception of these industries amongst European states varies according to:

1. Operation scale (production size), some companies of the creative sector manufacture and distribute on a mass scale (films, video games, radio and TV programmes, publishing), some run art/craft activities and their products are consumed in a particular time frame by a particular customer at a particular location (e.g. art events)
2. 'Value added' (product specifics, intellectual contribution) here, according to certain definitions, the antiques trade or culture tourism for example do not fit the category of creative activities as they are not a new quality protected by copyright (intellectual property)
3. The economic conditions for operations is a debated issue when defining, as some companies operate having support from a variety of sources while others operate relying on market principles [Mackiewicz et al., 2009, p. 6].

Creative industries are characterised by the following features [Caves, 2000]; quoted after: [Zakrzewska-Krzyś, 2011]:

- nobody knows – due to its experimental character as well as the subjectivity of experience, the uncertainty regarding demand remains high
- art for art's sake – artists draw satisfaction from the act of creation
- production requires many people with both a range of specialised skills and a variety of tastes, while each person's contribution must be delivered at a certain minimal level of quality and quantity
- variety – both of quality and content, the required creative factor combinations are unique
- slight differences in skills leads to major differences in remuneration
- time coordination of particular elements of a production process is crucial
- products are long term, as is the process of benefits gained by their creators.

The role of creative industry's potential in strengthening the economy and enterprise innovativeness

Creative industry is a unique area of economic activity, involving uncertainty and risk in decision making, requiring the skill and talent of the creator. This forms the essence of this industry, rich in knowledge applied in production of goods and services, having added value in the form of high quality and unique features [Kowalik, 2013]. Companies operating in creative industries perform the role of a partner for enterprises of various other sectors, supporting, among others, development of new products (e.g. design) and services, production as well as extensive marketing, particularly promotion and advertising. This cooperation can be multifaceted – from a relatively simple operation e.g. R&D participation in brainstorming in order to design products, to cooperation in product launch on the market or constructing marketing strategy.

The essence of operating in creative industries is the wide range of products which may contribute to the high growth potential of the market which are not based on standardisation and production cost reduction, as occurs in tradition sectors of industry, but on boosting and meeting 'refined' customer demands in reference to the final product [Mackiewicz et al., 2009].

Creative industries are regarded as innovative, and the type of introduced innovations is often defined as 'hidden innovations' [Miles, Green, 2008], which manifest themselves in six areas:

- culture products – products conveying cultural in put (e.g. film, sculpture or a game)
- cultural concept – information input of a product (e.g. characters, narrations)
- delivery – how the product is made available to the customer

- user profile – how the consumer uses the product thereby gaining experience, which is a creative activity
- production process – process organisation
- technology – technological engagement [Mackiewicz, et al, 2009, pp. 14].

This is why in creative industries the measurement of innovativeness is not always possible due to the frequent lack of formal innovative processes and difficulty in measuring an innovative component in services. Moreover, the substantial participation of micro and small enterprises in creative industries, the high structural dynamics of these industries, together with the significance of intangible products and services greatly hamper even a rough assessment of innovative activity measurement and their direct effects in this sector of the economy [Hill, 1999]. Products and services of companies from creative industries are to a great degree ‘empirical goods’, where the satisfaction factor is subjective, intangible and difficult to measure. This contributes to significant uncertainty in regard to the demand for the produced goods and services. In addition, scattered demand for the commercial applications of creative ideas means creative companies search for buyer’s markets for their products and services beyond their own region’s and country’s borders. while this leads new/micro and small companies to enter the global market rapidly, it is also worth emphasising that these companies find such conditions challenging, which increases the risk in their operations.

R. Florida claims that creativity leads to innovations due to the application of knowledge and information as fundamental tools in this process. The key element of this concept is accentuating the high percentage of the workforce employed in professions whose main objective is ‘to create’, meaning a creative class whose core are scientists and engineers, architects and designers, people working in education and entertainment, and artists and musicians, in essence, personnel whose main economic function is to create new ideas, technologies and creative messages. These people, active in various sectors of the economy, mainly creative industries, have the ability to create new ideas and solutions. A wider group of creative professionals congregate around this creative class core. These include professionals from business and finance, law, health protection and affiliated sectors. The construction of this structure is aided by institutions applying so called new systems for technological creativity and entrepreneurship, new more effective models for production of goods and services, and an extensive socio, cultural and geographical environment which is creativity friendly [Florida, 2002].

Ch. Landry coined the term ‘the creative city’, whose development requires ten types of capital connected to social not material infrastructure, defined as human capital, social capital, culture capital, intellectual capital, science and technological capital, creative capital, demographic capital, natural environment capital, leadership capital and financial capital. In order to maintain the balance of the intensity of particular capitals it is important to maintain networking and cooperation channels through which flows regular exchange of thoughts, ideas and views which foster implementation of the idea of the creative economy and, as a consequence, build the competitive advantage of some cities or regions over others. Various forms of open dialogue and effective communication which lead to efficient exchange of information are consequently shown to be the key factors indispensible for building development potential (see footnote).

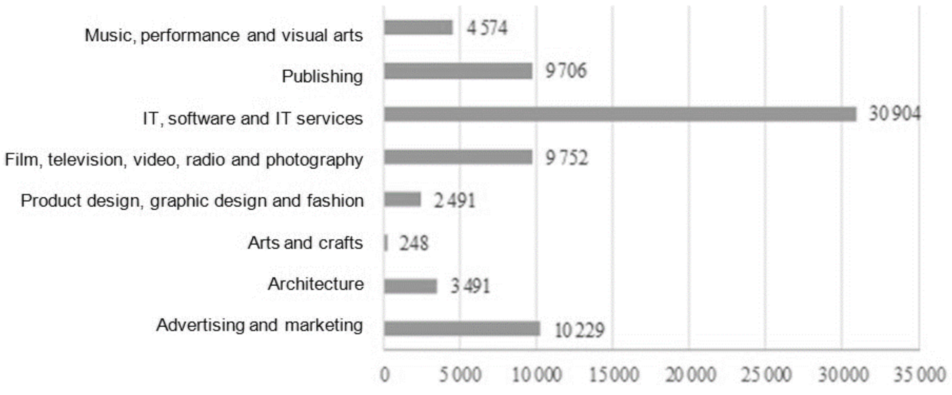
J. Potts and S. Cunningham [Potts, Cunningham, 2008] proposed four models of the relationship between creative industries and the economy and enterprises. The first being *welfare*, in which creative industries are treated as a burden for industry due to the fact that their productivity is lower unlike in other sectors and they develop at the expense of these sectors. The operations of these creative industries cause resources to flow out of the economy. This is the market for goods that are beneficial for the public and whose production of goods and services is to improve welfare. In another, the *competition model*, like the one above, the creative sectors deliver socially beneficial goods. Their growth has a neutral influence on the economy as creative industries do not bring anything more to the development of technology or to an increase in innovation in other industries. As a result, they do not require special treatment on the part of the state. The *growth model* assumes a positive relation between economic growth in creative industries and the economy as a whole, which is why these industries are drivers of growth. Creative industries are seen here as a source of new knowledge which penetrates other sectors of industry where it is then modified and commercialised. According to this concept, creative industries should be supported in order to generate growth throughout the economy. The *innovation model* proposes another definition of creative industries which operate in an economic system at a raised level implementing projects and ventures of particular importance. Creative industries initiate and coordinate the flow of knowledge in the economy and draw economic value from the processes of strengthening as well as directing innovative changes in the economy. In this model, the uniqueness of creative industries does not lie in their percentage of economic value created but in their input into the coordination of new ideas and technologies along with the processes of change [Głowacki, 2014].

For example, creative industries in Austria are a significant source of original innovative ideas, meaning the introduction to varying sized markets of so called radical innovations, namely cutting edge products which were not previously offered by other companies. In many cases they are niche products or specialised services geared to the needs of specific customers. Creative industries therefore are constantly developing and testing innovative ideas which in future may result in identifying a product/service of high market demand and consequently significant sales success [Kimpeler, Georgieff, 2009].

Good practice for development and support of creative industries in Great Britain

In 2011 creative industries in Great Britain stood at 5.2% of gross added value, this value had grown annually and steadily since 2008 [Creative industries economic estimates, 2014, pp. 16]. In 2012 gross added value of creative industries amounted to 71,395 million pounds with the following industries as key contributors: IT, software and IT services, advertising and marketing, film, television, video and photography, as well as publishing (see Graph 1).

Graph 1. Gross added value (in million pounds) from creative industries in Great Britain in 2012

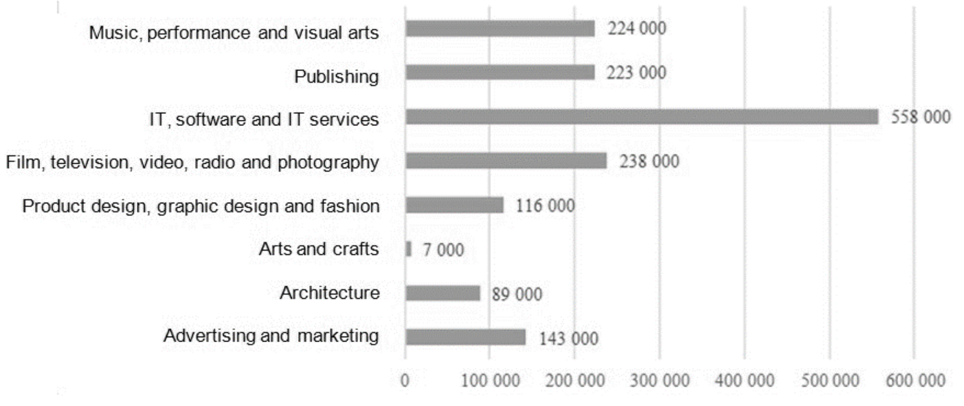


Source: Own work based on: *Creative Industries Economic Estimates* - Statistical Release, Department for Culture, Media and Sport, 2014, p. 16.

Creative industries in Great Britain in 2012 employed over 1.5 million people, which was 5.6% of the whole workforce in the country [Creative industries economic estimates, 2014, pp. 13]. The majority were employed in IT, software and IT services, film, television, video and photography, music, performance and visual arts and publishing (see Graph 2).

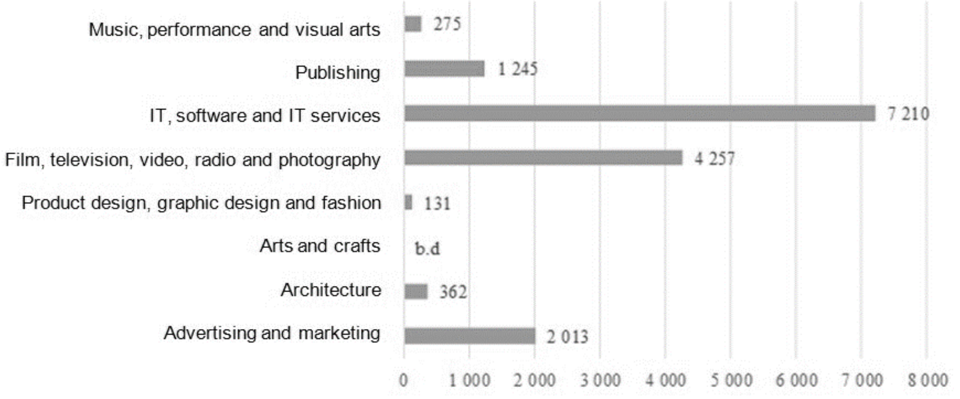
The export of creative industry services in 2011 stood at 8.0% of the total exports in Great Britain [Creative industries economic estimates, 2014, pp. 21]. When considering the size of this export, one should draw attention to such industries as: IT, software, IT services, film, television, video and photography, along with advertising and marketing (see Graph 3).

Graph 2. The number of employees in creative industries in Great Britain in 2012



Source: Own work based on: *Creative industries economic estimates* - Statistical Release, Department for Culture, Media and Sport, 2014, p. 13.

Graph 3. Export of services from creative industries in Great Britain in 2011 (in million pounds)



Source: Own work based on: *Creative industries economic estimates* - Statistical Release, Department for Culture, Media and Sport, 2014, p. 21.

Taking into account the above statistical data, one can assert that the creative sectors are a vital and dynamic part of British industry due to their increasing percentage of gross added value, creating new employment and exports. In addition, such industries have a major impact on stimulating innovativeness in other industries and, as a consequence, within enterprises.

Missfit Creation[1] (a clothing company) may serve as an example of company development within creative industries. Great Britain, similarly to other European countries, faces the greatest development barriers of low funding for innovative operations and the low quality clothing imported from Asian countries. The company was established in Great Britain in 2006 by Debbie Murphy, whose passion was music and fashion. Prior to establishing her own business, Debbie worked as a tailor in a costume hire company and lacked experience along with inadequate knowledge of clothes design. She is self-taught in the area of clothes design and fashion, trying to create something unique. The decision to set up her own company was instigated by the closure of the costume hire company and the opportunity to purchase the costumes at a preferential rate. She also identified a market niche for designing and tailoring unique costumes and clothing, mainly for artists, entertainers, actors, musicians and individual clients. In the start-up phase of company operations, the owner ran two activities, clothes design and costume hire. The outfits were tailored from offcuts of fabrics and eco-friendly materials, which often came from recycled goods or from the highest quality materials sourced Worldwide. To finish her costumes she applied a variety of techniques, such as painting, decorating with glitter, crystals and studs, as well as embroidery.

The initial period saw dynamic development, the demand for projects and tailoring of clothing increased, leading to the decision to give up costume hire and sell off this branch of operations. Further development of the company received financial backing by Advantage Creative Fund (ACF)[2], which allowed the purchase of new machinery and equipment and the designing of a professional website. The company is promoted through this website which is its 'business card' and avails of 'whisper marketing'. Also equally important in its promotion is the constant care of its page ranking on widely-used search engines. Unusual marketing strategies includes product promotion during a range of events that attract potential customers, like artists, actors and musicians. Such operations allow the company to position itself closer to potential clients.

The investment carried out resulted in a boost to both nationwide and worldwide sales. To expand its operations to other buyer's markets the company undertook steps in order to:

- monitor European markets in respect to changing trends and customer preferences and adjust to these changes
- modify and control the quality of offered products
- develop own distribution channels in the EU
- participate in international promotion events, fairs and exhibitions

[1] good practice was compiled based on www.missfitcreations.com and knowledge gained during studies within Lifelong Learning Programme, project no. 2013-1-PL1-KA101-42923, *Innovative Responses to the Delivery of Creative Industries Education* at City of Glasgow College.

[2] Advantage Creative Fund (ACF) is a venture capital fund for small and medium sized companies of creative industries, support is given of high growth potential, namely dynamic companies seeking capital in order to develop or newly established companies with high growth potential. ACF is finance from public funds in order to develop creative industries.

The company's clientele includes renowned artists, actors and dancers from across Europe as well as individuals searching for clothing in order to 'stand out from the crowd'. The innovativeness of this type of business relies on original design geared towards the needs of the customer, who is in fact the idea-bearer of innovation. Before the commencement of the production process each project is visualised and a few variations are prepared. The customer can select and modify the proposal, facilitating the adjustment of the final project to their needs.

The owner of the company is open to any cooperation with entrepreneurs of other creative industries, which allows the exchange of knowledge and experiences on business operations and the enrichment of the offer by additional products e.g. unique jeweller or accessories to the costumes.

Great Britain, appreciating the significance of creative industries in economic and social development, has worked out an array of ways to support them, such as investment funds, training and workshops, adjustment of education to the needs of creative industries, setting up 'fab labs' (fabrication laboratories), and information, communication and education platforms. *The Lighthouse* in Glasgow – The National Centre for Design and Architecture serves as an example of such an initiative. The building was designed by Charles Rennie Mackintosh a Scottish architect and painter and now serves as the centre for design and creative industries. The centre houses many initiatives aimed at supporting and promoting creative industries in Scotland. It operates as a gallery for budding artists where they may exhibit their works, and a library of building materials and design where you can find descriptions of the properties of the collected materials. The centre also houses MAKLab, which is a part of a global fab lab network. It is a kind of small lab where young people have the opportunity to apply their own projects and ideas. This is a place for people wanting to realise their dream, hobby, knowledge and work but are in need of tools, space and technical knowhow. The lab is equipped with specialised machinery and equipment as well as computers with professional software. In order to implement ideas one does not need expertise, an innovative idea is enough, and MAKLab's panel of experts will guide you, selecting the appropriate technologies in order for you to realise it. Frequently, such operations conclude with the creation of a prototype, a starting point for mass production. Moreover, MAKLab is linked to a network of about 100 laboratories around the World in order to exchange ideas and solutions between the participants of particular fab labs.

The economy of Great Britain faces a great challenge to use the potential of creative industries to increase employment, which is why teaching entrepreneurship in art schools is an important support area for creative industries. Manchester Metropolitan University (MMU), Departments of Art and Design and City of Glasgow College – Art and Design, may serve as good examples whose activities are geared towards increased employment opportunities for arts graduates. Students learn how to run a company, methods of product and service valuation, drawing up a business plan, market analysis and accessing business operation funds. The classes are conducted by professionals who run their own companies with experience in creative industries. The students are encouraged to self-develop, both personally and professionally, aiming at self-employment that will utilise their own personal potential. During the course, many projects are realised which fosters cooperation between art students and business and constitutes a platform to showcase their own work or ideas. '*Rosa Red'* is an example of such a project. The aim is to make the internship participants aware of the importance of interconnections between education and business that commercialise applicable solutions (designs, prototypes) created in City of Glasgow College. Without such cooperation many utility models would not 'see the light of day', remaining unnoticed. Other projects include '*Based Learning and Collaboration'* and '*Biennale',* which reflect the cooperation between City College of Glasgow and industry and have resulted in the commercialisation of new designs and prototypes, information exchange between students from different countries on the possibilities of setting up and running a company in creative industries, artist visits, open air events, exhibitions and participation in trade fairs.

Conclusion

Creative industries in Great Britain play a significant role in boosting innovation and the competitiveness of both the economy and businesses. However, despite major development, they still require support, particularly funding. It is also important to:

- educate society on the role creative industries play in business and the economy
- draw up strategy documents that would clearly establish conditions for the development of these industries
- build an information base on creative industries
- organise information and promotion campaigns
- set up creative spaces e.g.
- facilitate communication and cooperation between creative industries and other industries.

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TECHNOLOGY MANAGEMENT FOR THE BIOBASED ECONOMY: MAPPING, DYNAMICS AND POLICIES – THE CASE OF GREECE

Abstract

A new definition of the concept of biobased economy or bioeconomy is presented in the form of a 2-dimensional matrix, linking the "bio" to the "economy" components. A new approach will be employed to map the dynamics of the matrix and put together 4 scenarios for growth and change: fertile valleys, poles of crystallization, hospitable plateaus, and islands of survival. Strategy and policy implications and related recommendations on innovation and technology management issues will be offered for the particular case of Greece.

Keywords: Bioeconomy, biobased economy, biotechnologies, technology & innovation policies, research priorities, growth, development, foresight, scenarios, Greece, Southern Europe.

Introduction

Biobased economy or bioeconomy are terms increasingly used to express the broad spectrum of potential applications of biological sciences and technologies for improved production of products and services in various fields of the economy [European Commission, 2012]. The purpose of this paper is first to contribute to a better understanding of these novel concepts, and then make full use of their value for technology- and innovation-based growth and development; especially under the present critical conditions of Southern European economies, such as the Greek one.

The work presented here draws heavily upon the reports of the Working Group (WG) on Biotechnologies, which operated within the first ever technology foresight exercise in Greece that took place in the period 2002-2005, and had as its time horizon the year 2021 [Koukios et al., 2005; GSRT, 2005]. The idea to use WG material within such an emerging bioeconomy context developed gradually through subsequent presentations of the WG results before various fora in the period 2006-today. It has become apparent that there was a shift of interest from biotechnologies to the biobased economy [European Commission, 2010; Cichocka et al., 2010], and that the WG findings contained elements potentially useful to illuminate that particular shift [Koukios, 2013].

On the one hand, this rather unusual type of utilization of selected outcomes from foresight projects can be considered as part of their mandate, i.e., to be ahead of future developments. On the other hand, as our present time (2013) is exactly mid-way in the original range of the foresight considerations - between 2006, when the WG final report was published, and 2021 which is the time horizon of the WG foresight scenarios - we can still use the scenarios for the remaining 8 years – and beyond – with the appropriate modifications due to the interim developments.

This chapter consists of three main parts; the first part concerns our effort to define bioeconomy by a new approach and its potential for mapping the emerging landscape; in the second part we will present and discuss the dynamics of the Greek bioeconomy as far as change drivers and growth scenarios are concerned; and in the last part we will summarise the preconditions and implications of a national development plan focusing on bioeconomy, and including research priorities and other technology management issues.

Mapping bioeconomy

In order to improve our understanding of the bioeconomy landscape, particularly during periods of high volatility – as the next several years will be for the biobased technologies – a map-based approach will be employed to define and describe the bioeconomy field. This approach should capitalise on those elements of the field's topography which are expected to remain relatively stable.
Establishing a comprehensive definition of biobased technologies and their applications which would also be acceptable to all involved parties, is still very much an open issue, especially as the rapid developments in biosciences and bioengineering keep shifting the boundaries of the area referred to internationally as "biotechnology", a 3-part complex term derived from the Greek language, where "bios" means life, "techne" means art, and "logos" means rationality.

An alternative type of definition of the biobased economy, which may prove useful in the above sense, and that is why we propose it here, is the one adopted and used – albeit not explicitly stated – in the work of the European Commission's FAST (Forecasting and Assessment in Science and Technology) Unit ever since the 1980s (studies on bio-society etc.) [Macris, 1983]. According to this approach, after adapting it to the requirements of a technology foresight exercise, and taking into account the experiences and issues which have emerged in the long intervening years, we can define bioeconomy by the following (A_iB_j) - Table 1.

Table 1. Defining bioeconomy by a 2-dimensional matrix

B_j: Bio-sciences **& Bioengineering**	A_i : Economic and Other Fields of B_j Applications							
	A_1	**A_2**	**A_3**	**A_4**	**…**	**…**	**…**	**A_m**
B_1								
B_2								
B_3								
B_4			B_4/A_4					
…								
…								
B_n								

Where:

- B_1, B_2, B_3 etc. are the groups of specific scientific knowledge, processes, techniques and methods; e.g. molecular biology, genetic engineering, biochemical engineering, bio-economics; and
- A_1, A_2, A_3 etc. are the specific application fields, sectors and areas, of varying extent, for B_1, B_2, B_3 etc.; e.g., agriculture, stock raising, aquaculture, food industry, metal processing, healthcare, energy and fuels, protection of the environment.

Source: Own work.

Thus, for example, the cell B_4/A_4 of the bioeconomy matrix stands for the industrial use of some genetically engineered biocatalysts, i.e., enzymes (technique B_4) in the papermaking industry, for the bleaching of paper (application A_3), without the chemical pollution typically caused by the use of chlorine bleaching compounds.

This proposed "AB" definition approach of bioeconomy ensures certain important features, which most other definition types ignore. So, through its use, it is possible first to distinguish in an effective manner what IS from what is NOT part of bioeconomy, and then to map its internal area and external links in a way characterised by interactivity, conceptual clarity, and imaging flexibility.

Topography

The resulting topography of the Greek bioeconomy map is consistent with the above definition of the field. In particular, this national map was found to contain three different "continents" of biobased technological applications, hereby classified on the basis of axis A (see above) as follows:

A_I. Agriculture & Food; i.e., agro-bioeconomy;
A_{II}. Healthcare; i.e., health and biomedical economy;
A_{III}. Environment & Industry; i.e., eco-biological and bio-industrial economy.

We should note that the emergence - through this mapping exercise - of the "3rd continent" of the so called "White Biotech", i.e. of environmental – industrial applications, many of which are not agriculture- or healthcare-related ones, has been one of the key findings of the WG's research for the future of bioeconomy in Greece.

When the WG panel attempted to establish a list of the major scientific/technical elements involved in the Greek bioeconomy, i.e., moving along the axis B of the above definition, they saw that their categorisation was not only difficult, but also prone to changes as the field itself develops, thus becoming non-functional for the purposes of our work. In the following obtained list of the 20 key bio-tools, asterisks are used to denote technological applications which are present in at least two out of the three "continents" defined as above:

Genetic engineering*, biosynthesis*, gene treatment methods*, tissue culture, in vitro organogenesis, gene integration*, transgenic animals, improvements in animal feeds, quality control, bio-information management*, drug delivery, molecular indicators, genetic diagnosis, production of monoclonal antibodies, enzyme engineering, microbial technology*, biosorption, biofuels, bioenergy, biosensors.

Strengths and Weaknesses

The relative advantages of Greek bioeconomy, as identified through mapping the past and current situation in the field in accordance with the proposed new mapping approach, are summarised in the following Box 1:

Box 1. Strengths regarding the development of biobased economy in Greece

- Strong biological character of the national economy (large agricultural sector, significant food industry, Mediterranean diet etc.);
- Other biological particularities of Greece (biodiversity, Mediterranean ecosystems, coastal and marine bio-systems, desertification risks etc.);
- Significant scientific human resources, especially among the Greek Diaspora, specialised in critical biotechnological areas, supported by significant European and global networking trends;
- Experiences through ca. 30 years of efforts for systematic actions and for establishing and implementing relevant policies (national programmes and various initiatives).

The categorisation of current difficulties that hinder the development of the field of biobased technologies in Greece reveals a completely different topography, with three groups of critical, thus limiting, growth factors:

- *Economy*: lack of success stories, low investments, limited funding, few new bio-enterprises, unsuitable institutional framework, limited provision of information, missing infrastructure, structural gaps, unprepared workforce.
- *Research – Technology*: long-standing problems, suspicious public attitudes, very low public and private funding, few links to industry, scale-up difficulties, fragmentation, lack of coordination.
- *Society*: insufficient information to the public and to politicians, imported criticism, strong ideological debates, underestimated safety and bioethics issues, as well as intellectual property rights, need to re-orient education.

The Way to the Future – Problems and Goals

The analysis of the responses of the WG panel members to the questions regarding the future of bioeconomy in Greece, i.e., on challenges and limitations vs. national goals and priorities, confirms the value of the above proposed mapping approach. More specifically:

- Regarding the perception of the challenges and limitations on the path to the future, the topology of the three groups of factors prevails, in which however, Public Administration and National Politics gain significant autonomy. These additional limiting factor areas consist of relevant (educational, administrative etc.) elements, which tend to dissociate themselves from the three main factor groups and merge to form corresponding strategic action cells.
- Regarding the formulation of national goals for the future, the topography of the three application "continents" prevails, coupled with selected elements from all the groups of limiting factors, including the secondary ones (education, politics), together with a strong international cooperation dimension.

Therefore, the success of the transition pathway towards a biobased economy in this country will ultimately depend upon the efficient combination of the three continents of potential applications with the 3+ groups of rate-limiting factors. To navigate efficiently through such complex geography, we need to have a good idea of its dynamics of change.

Dynamics of Change

The potential for biobased technologies developing in a country over the next 1-2 decades will determine not only whether this country will be part of the global biotechnological revolution, but also whether it will draw concrete benefits from unlocking the potential of its bio-systems though corresponding developments, thus playing a leading role in connection with selected evolution paths or milestones towards this future.

This potential will be derived as a combination of two types of parameters: those expressing objectively the potential for change, which are encapsulated in the drivers, and those expressing the subjective aspects of change, i.e., the specific objectives and priorities set for the next 10-20 years.

Drivers

The current dynamics in the field of bioeconomy in Greece are characterised by what could be called a “double blockage” - or even a “trap” – coming as a result of the following:

- A low level of social acceptance of some key non-medical biotechnological applications, which might develop into a model for negative social and ethical attitudes in other areas of bioeconomy, thus risking the creation of highly problematic situations, the social cost of exiting from which could significantly hinder the “winds of change”, i.e., any further developments.
- At the same time, Greek bioeconomy experts – the “agents of change” - appear to be relatively absent from crucial public debates concerning the strategy and future prospects of their field at national and European levels, especially in comparison to other small EU countries (e.g. Austria, Denmark, Finland etc.), thus leading to Greece’s lagging behind on strategic issues.

Giving serious consideration to this situation, and in combination with other analyses and findings, we have identified the following two drivers with regard to dynamics in the field, in decreasing order of significance:

Driver 1:
- Support of biobased applications by the social partner involved

Driver 2:
- Acquisition / support of scientific & technological excellence in selected bioeconomy areas.

By way of clarification, and linking this finding with the mapping above, we observe that these drivers correspond to two out of the three groups of limiting factors which determine developments across all three bioeconomy application “continents”. More specifically:

- The first driver is the most important of the two as it affects in a decisive way the start-up (acting as a control mechanism) as well as the long-term “sustainability” of developments (e.g. through the active participation of users). This driver attempts to express the side of the so-called “social acceptance”, and also encompasses ancillary concerns. Within this driver, we can distinguish between four different aspects, which cover key societal issues such as communication, safety, ethics and ideology.
- The second driver acts as the field’s “technology push” and generator of knowledge, methods and “tools” addressed to the social and economic partners. Its content results from the options and priorities, as these are set each time.
- As for the third group of factors, that of economy, the Greek foresight panel considered that, despite its already established significance regarding short-term developments, its real role with respect to long-term potential may be

considered as auxiliary, appearing to be connected more closely with the quantitative rather than qualitative aspects of bioeconomic change, such as for example the scale of application of a successful bio-solution.

Scenarios

By combining the two drivers identified in the previous section, and assuming that each one of them can have only two values, namely "+" (plus) for achieving, and "-" (minus) for failing to achieve the corresponding objective by 2021, then we arrive at four combinations, which generate four distinct potential "universes" for the field of biobased economy in Greece by that year and beyond.

Adopting a terminology of geographical metaphors inherent in the topography of the field (see above), we can proceed to describe in more detail these four scenarios for 2021 (Table 2), to which we have given the following names:

Table 2. Scenarios matrix

Driver 1: Support by Social Partners	**Driver 2: Scientific & Technological Excellence**	
	(-)	**(+)**
(-)	SCENARIO 1 "Islands of Survival"	SCENARIO 3 "Crystallisation Poles"
(+)	SCENARIO 4 "Welcoming Plateaus"	SCENARIO 2 "Fertile Valleys"

Source: Own work.

The topography of this scenario is one of small and isolated points – niches of scientific and technological excellence in an "ocean" of low-tech solutions and applications, which engulfs the three continents of the national bioeconomy field. What follows is a list of certain features of this potential universe, which is reminiscent of some aspects of the national field's current situation:

- Survival of these niches is quite difficult and is only guaranteed if combined with financial viability cells, such as for example an R&D laboratory within a financially viable enterprise or a research centre and a university unit with internationally acknowledged achievements.
- Direct communication and collaborations between survival islands is difficult, and sometimes only effected through the mediation of foreign centres.
- As the problem of social acceptance remains unsolved, tensions accumulate and become more acute. As a result, the field of biotechnologies resembles a "battlefield" where social partners fight with each other. As an example, certain types of banned research may be carried out clandestinely.
- Finally, as the field's internal frictions absorb the vital energy of the leading social and scientific actors, the area is left unprotected against the influx of goods and services with built-in biotechnological innovations, which thus dominate the market.

The bioeconomy topographies according to the scenarios matrix are presented in the tables 3, 4, 5, 6.

Table 3. A view of the bioeconomy topography according to the "Islands of Survival" scenario

Biosciences & Biotech nologies	**Industrial Areas of Application**							
	A1	**A2**	**A3**	**A4**	**…**	**…**	**…**	**Am**
B1			XXX					
B2	XX				XX			
B3								XX
B4			B4/A3					
…	X							
Bn						X		

Source: Own work.

The topography of this scenario, which is the exact opposite of the previous one, is that of a scattering of many interconnected small and bigger units of scientific and technological excellence, and of –primarily – the "bridges" between them (valleys), which ultimately form almost a continuum of high-tech solutions and applications across all three continents of the bioeconomy field. Following is a list of certain features of this potential universe, which is reminiscent – and not only by its name – of the information technology's "Silicon Valley" and its structure:

- In this scenario, biotechnologies become nuclei, shaping new, triple-helix symbiotic actions and relations between enterprises (market) – state (regulatory framework) and society (users/consumers/other partners).
- The emerging technological applications are characterised by a trend for smooth and balanced expansion, without preferences for high peaks (e.g. for very profitable solutions), but spreading across all "altitudes" and showing a clear preference for the "valleys".
- Under such conditions of social acceptance and easy alliances, biobased technologies flourish and contacts with other countries allow exploitation of complementarities and development of synergies, thus boosting the broader development potentials (both intrinsic and extrinsic).
- A national model for biotechnological development ultimately results, relatively effortlessly, having as its foremost values the priorities of a National Bioeconomy Programme, including environment, "green" industry, bioenergy, quality farming, rational management of Mediterranean ecosystems.

The topography of scenario 3, which appears to contain elements from both the previous ones with the emphasis on scenario 1, is characterised by bioeconomic applications covering a larger area, by exploiting the relatively more favourable conditions encountered, but whose further development is limited by the lack of social support and broader acceptance.

Table 4. A view of the bioeconomy topography according to the “Fertile Valleys” scenario

Biosci-ences&Bio-technologies	**Industrial Areas of Application**							
	A1	**A2**	**A3**	**A4**	**…**	**…**	**…**	**Am**
B1		XX		X		XX		
B2		X			X			XX
B3	X	XX	X	XXX		X	X	
B4			B4/ A3		X	X		
…		XX	X	XX		XX		
Bn							X	

Source: Own work.

Below is a list of certain features of this potential universe, which is also reminiscent of some aspects of the field’s current situation, especially those where the lack of support from the social partners is the main limiting factor (e.g., some agro-biotechnologies):

- Bioeconomy poles, as a rule, develop as far as possible in each particular situation, exploiting scientific and technological excellence, on the one hand, and any favourable social and economic conditions, on the other – or usually both.
- Their spread, beyond that referring to sectors and areas of economic activity, may also refer to the actual geographical regions of the country, reaching as far as the specialisation of some of them (e.g. the region of Crete could be considered today as one such pole).
- Their further growth and the likelihood of collaborations – and thus the potential for synergies – depend on the potential balancing-out of the negative effects from the lack of social support by the positive effects of technological developments, in combination with any favourable financial conditions such as incentives.
- Furthermore, in the event that a change occurs in the core dynamics of drivers, a field organised in the form of “Crystallisation Poles” may evolve either towards (a) a “Fertile Valleys” form of organisation, by following a favourable shift in social attitudes (e.g. one caused by a change in politics), or (b) towards an “Islands of Survival” form of organisation, if a considerable lag builds up regarding the field’s capability to follow scientific developments (e.g. one caused by a major hazard such as war or earthquake).

The topography of scenario 4, which appears to contain elements from both the first two scenarios, with emphasis on scenario 2, is characterised by biotechnological applications which are more intensive, but do cover a limited area, exploiting the relatively more favourable conditions encountered, whereas their further development is limited by the substantial shortfall in terms of the acquired scientific and technological levels.

Table 5. A view of the bioeconomy topography according to a "Crystallisation Poles" scenario

Biosciences&Biotech-nologies	**Industrial Areas of Application**							
	A1	**A2**	**A3**	**A4**	**…**	**…**	**…**	**Am**
B1							X	
B2			X			X	X	X
B3		X	XX	X			X	
B4			B4/A3	X				
…		XX	XX	X				
Bn								

Source: Own work.

Following is a list of certain features of this potential universe, which is reminiscent of some aspects of the field's current situation, especially those where, although the support from the social partners is not a problem, there are serious scientific and technological deficiencies, which thus become the main limiting factor (e.g. limited transfer of the results of research in healthcare biotechnologies from the laboratory environment to industry):

- The biotechnological applications of this type, as a rule, develop as much as possible in each particular situation, exploiting the favourable social and economic conditions, and in areas that do not require strong scientific and technological excellence (and corresponding policies).
- Thus, they are characterised by a trend to move towards the low-tech end of the spectrum, and therefore tend to restrict intrinsic development and trap the entire field into increasing under-development rather than a high-profile image. This is a serious limitation, as, in this way, the country can not exploit substantial global opportunities (e.g. those caused by favourable international conditions).
- As also happens under scenario 3, the spread of applications beyond that referring to sectors and areas of economic activity, may also refer to the actual geographical regions of the country, reaching as far as temporary specialisation for some of them.
- Their further growth and the likelihood of collaborations –and thus the potential for synergies– depend on the potential balancing-out of the negative effects from the lack of an integrated R&D policy and the positive effects from the development of a positive attitude in society, in combination with any favourable financial conditions such as incentives.
- Furthermore, in the event that a change occurs in the core dynamics of drivers, a field organised in the form of "Hospitable Plateaus" may evolve either towards a "Rich Valleys" form of organisation, following a favourable turn in technology (e.g. caused by a breakthrough), or towards an "Islands of Survival" form of organisation, if it looses the favour of society (e.g., as a result of a major hazard such as war or earthquake.

Figure 6. A view of the bioeconomy topography according to a "Hospitable Plateaus" scenario

Biosciences&Biotech-nologies	Industrial Areas of Application							
	A1	**A2**	**A3**	**A4**	**…**	**…**	**…**	**Am**
B1						X	X	X
B2						X	X	X
B3		X	XX	X				
B4		X	B4/A3	X				
…		X	X	X				
Bn								

Sources: Own work.

Technological strategy and policy issues

Agro-biotechnologies

The potential mega-roles of biobased applications in the "continent" of agriculture concern:

- BIOLOGICAL FLOWS: Modification of processes, techniques, conditions and means across all stages of the production chain (primary productions, inflows, harvesting, manufacturing, consumption).
- BIOLOGICAL CAPITAL: Protection, conservation, exploitation and improvement of biological capital (traditional varieties, gene banks, promotion of properties, control of undesirable features etc.).
- BIOLOGICAL SYSTEMS: Understanding and protection of complexity, ecosystem management, biodiversity, new land uses.

Greek Technological Priorities in Agriculture & the Food Industry are presented in Box 2.

Box 2

- Food safety control – Scientific and technical support of requirements for regulatory action, e.g., labelling.
- Quality Food Farming, with emphasis on the quality and safety of consumer nutrition, and on the agricultural environment.
- Evaluation of indigenous genetic material for the purposes of protection and exploitation.
- Technological support of compatible Greek crops and breeds, including "Organic" Farming & Stock Raising.
- Improvement in the provision of technological information to Greek farmers, consumers and other involved parties, and of their technological level.

Biotechnologies in Healthcare

The potential mega-roles of biotechnologies in the global healthcare sector consist of the following:

- Growing understanding of brain functioning and of the biological basis of human behaviour.

- Neuro-pharmacology and management of emotions and behaviours.
- Decoding the secrets of life and addressing the effects of aging.
- Genetic engineering in terms of both its diagnostic and corrective aspects.

Greek Technological Priorities in Healthcare are presented in Box 3.

Box 3.

- Molecular prognosis, diagnosis, vaccines, treatment - Genetic identity
- Gene therapy of Mediterranean diseases
- Bio-informatics
- Nano-biotechnology
- Spin-offs in molecular medicine
- Development of interdisciplinary education/training with emphasis on new specialisations – Genetic advisor
- Incentives for the return to Greece of leading Greek scientists in their field

Bio-informatics and Public Health

One of the most important factors for acceptance and application of biotechnologies in the public health sector is proper management of information. More specifically, this requires a minimum of infrastructure and organisation in order for information to be shaped dynamically and be exploitable by every interested party. In parallel, the *"biological identity"* is instituted and the appropriate legal framework for its use is created. The required infrastructure includes:

- Communication technologies for access to information,
- Services regarding information exploitation,
- Special software,
- Special security protocols, and
- Specialised human resources for managing knowledge and promoting molecular biology.

Environmental & Industrial Biotechnologies

This bioeconomy sector is expected to represent the 3rd generation (here: "continent") of global biotechnological evolution. Within this complex area, the mega-roles of biobased technologies are the following:

- Production of bio-molecules presenting interest for energy/industrial purposes,
- Introduction of bioprocesses (e.g. biocatalysis, bioconversions, bio-remediation) in industrial and waste treatment systems,
- Other applications (quality control, pollution control, management of complex bio-systems etc.).

Greek Biotechnological Priorities in the Environment & Industry are presented in Box 4.

Box 4.

- Development of biotechnological industries (bioindustries, bioprocesses): bioenergy, biofuels. Other bio-products: bio-materials, high value-added bio-molecules. New industrial and energy plants.
- Biotechnological methods at the service of rational environmental management, especially of sensitive Mediterranean ecosystems (desertification, eutrophication). Biodiversity issues (maps).
- Enforcement of strict environmental legislation, especially in industry, energy, agriculture and transport.
- Encouragement (through research, education, incentives and relevant policy) of the creation of "clean" industrial and other enterprises (zero environmental load).
- Assistance (through research, education, incentives and relevant policy) for the creation of small-scale, flexible innovative industrial and other enterprises.

Proposed Bioeconomy Action Plan

For a country like Greece to maximise its bioeconomy-based development potential, a comprehensive and multi-actor action plan is required, consisting of 7 key points:

1. Drawing up of a long-term national strategic PROgramme for BIOeconomy (PRO-BIO), through "public" consultation procedures. A tentative list of stakeholders to be involved in the process is presented in Table 1 below.
2. Formulation and application of a national programme for Biobased REsearch & Development (BRED), which will be operating within the PRO-BIO frame. BRED will consist of two parts.
3. BRED-A will concern technological applications in the three bioeconomy "continents" (agriculture, healthcare, environment-industry); it will strictly cover the development of tools and solutions for the various applications; after reaching "maturity", these elements will be transferred to the corresponding sectoral, thematic and other RTD Programmes, for quick integration and assimilation as enabling technologies.
4. BRED-B will concern activities regarding the first driver of the field (see above), and will focus on issues of social acceptance, safety, risk, bioethics and communication.
5. BRED and the other related actions of the action plan will be in continuous two-way communication with the other actors responsible for related policy-making (see below), as well as with the social partners, so that research can support the social and political practice by addressing questions and supplying answers.
6. During implementation of PRO-BIO and BRED on-going monitoring will be applied, with possibility for revisions. In all cases, planning of the next BRED actions should be based on monitoring and assessing the results of the first cycle.

The field of Bioeconomy will be the subject of regular technology foresight exercises, used to assist the overall effort; as a result of these initiatives, Greece can become a model country in the context of Foresight of Bioeconomy (FOR-BIO). A list of actors and stakeholders to be involved in a national bioeconomy action plan presents Table 7.

Table 7. A list of actors and stakeholders to be involved in a national bioeconomy action plan

POLICY-MAKING ACTORS	SOCIAL PARTNERS
• Agriculture	• Non-Governmental Organisations
• Industry	• Consumers
• Environment	• Employees
• Healthcare	• Business
• National Defence	• Local Government
• Employment	• Societal Institutions (Church, Army etc.)
• Finance	• Ecological Movements
• Regional Development	• Alternative Movements
• Regulators - Standardisation	• Cultural Movements - Art
• Legislation (Parliament)	• Other Groupings within the Civic Society
• Patents – IP Agencies	• International Organisations

Source: Own work.

Strategic recommendation

The following two groups of recommendations, corresponding to the two drivers identified above, concern the efficiency of a national bioeconomy strategy.

Technology & Innovation

- Emphasis on post-genomic biotechnologies.
- Priority on hybrid technologies, at the level of both “tools” (e.g. info-bio, nano-bio) and interdisciplinary applications (e.g. bio-conservation of works of art).
- Avoidance of focusing on genetic engineering.
- Contribution of the “third wave” of environmental biotechnologies to the transition of the area of environmental technologies from “end-of-pipe” solutions to prevention strategies through “lifecycle” and “greening of industry” approaches, and emphasis in the rational management of natural resources.
- Development of new environmental/industrial biotechnologies should take into account the Best Available Technologies (BATs) available in each sector, and contribute to them appropriately.
- Strategic importance (a) of the so-called “basic research” (essentially: knowledge-oriented research), as this is necessary for future applications, and (b) of the stage involving the diffusion of innovations to the “market” (e.g. clinics, farmers, industries), as our country is characterised by long-standing and serious structural obstacles (e.g. lack of intermediary bodies and of relevant culture).

- Biotechnologies can contribute to transforming Greece into a model "eco-friendly garden", provided that the harmonious participation of the social partners in the corresponding processes is achieved, with due consideration to their (constructive) criticism, where that exists.
- The issue of human resources is crucial to the development of the field (the negative experiences from the field of information technology must be avoided).
- The priority target groups of the necessary education/training measures are the following: (a) young people, starting from the lowest education level possible (primary); (b) the general public, so that it may be protected against obsessive ideas, phobias and myths (e.g. the myth of "zero-risk" solutions); (c) crucial decision and policy makers; and (d) educators.
- These educational needs require appropriate support using existing and/or new communication means to achieve results through relevant research.
- Emphasis on the interdisciplinary nature of education (e.g. combined programmes of post-graduate studies, combining biology with economics or social studies).
- Careful and responsible risk assessment and management in the field of biobased technologies is key to other new technologies which follow (e.g. nanotechnologies).
- Progress in the field of bioeconomy has to go through a phase of building "communication bridges", often of an innovative character, connecting researchers, technologists, enterprises, users, policy bodies, target groups and other involved parties.
- Greece, being a small country, must place emphasis on quality (instead of quantity) and on concentrating on a small number of clear national goals (e.g. olive bioeconomy) that promote developments towards achieving an ambitious vision.

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BUSINESS INCUBATION IN THE USA

Abstract

Business incubation has a history in the US dating back to the late 1950s. The growth of US business incubation parallels the growth of the US high technology industry. This article defines business incubation, explores the founding and current status of business incubation in the USA, and discusses specific examples of incubators in Austin, Texas.

Keywords: Austin Technology Incubator, business incubators, entrepreneurship, new ventures, US incubators, and technology startups.

Introduction

As the USA recovers from the "Great Recession" business incubation is exploding – up 28% in the last five years - across the USA – especially in areas which foster innovation and creativity such Austin, Texas, Atlanta, Georgia, Boston, Massachusetts, Boulder, Colorado, Los Angeles and Silicon Valley, California, Seattle, Washington, as well as numerous smaller cities. These innovative areas embrace business incubators as both an effective and efficient mode to match entrepreneurs with the intellectual capital, management, and financial resources required to create successful new enterprises.

Definition of a Business Incubator

A business incubator is an organization designed to promote the growth and success of entrepreneurial companies by providing an array of business support resources and services which may include capital, coaching, physical space, common services, and networking connections.

A business incubator's main goal is to produce successful firms that will leave the incubator as financially viable and freestanding organizations which commercialize new technologies and create jobs.

USA's First Incubator

The Batavia Industrial Center (BIC) is recognized as the first US business incubator. The Batavia Industrial Center was founded in 1959 by Joseph L. Mancuso in Batavia, New York. The original aim of BIC was to create jobs in the region where the local economy was flagging, but what group however was a whole new methodology of creating successful new ventures.

In 1958, Massey Ferguson, a large manufacturer of tractors and related farm implements, shuttered its 850,000 square feet (78,968 square meters) manufacturing plant in Batavia, New York. The factory employed 2000 members of the community of approximately 16,000 (Hurley, 2002). As a result, unemployment in Batavia, New York jumped to 20%, and the local economy rapidly deteriorated.

The Mancuso family purchased the Massey Ferguson complex and tried to lease it unsuccessfully to large corporations. After about a month, Joseph Mancuso decided to divide the building and rent the space to separate businesses including a winery, a charitable organization, and a chicken company. Joseph Mancuso nurtured the firms by providing shared office services, assistance with raising capital, and business advice [James, 2002]. Within five years, the Batavia Industrial Center was fully leased and the new concept of business incubation was born [NBIA, 2008]. As are most successful new ventures, the first US business incubator was born to address a market need.

USA Incubation Profile Today

In 2012, National Business Incubator Association (NBIA) surveyed 1,195 of the 1,400 incubators in North America with 235 responses [Knopp, Linda, 2012, p. 3] and published its findings in the 2012 State of the Business Incubation Industry study.

The NBIA research team concluded the survey "represented a good cross section of incubation program type, age, size, and location. The research team believes the results reflect an accurate profile of the US incubation industry [Knopp, Linda, 2012, p. 64]."

Much of the quantitative data cited in this paper is from the 2012 State of the Business Incubation Industry study since it is the most comprehensive, accurate, and up to date study available.

Three Types of USA Incubators

In the USA, there are three fundamental types of business incubators. The largest percentages (54%) of the US incubators are mixed use incubators – incubators that work with clients from many industries. The second largest (37%) segments are incubators which foster technology clients. There is an increasing interest in technology incubators since they create higher value add jobs than mixed incubators. The remaining 9% of incubators focus on manufacturing, service, and other economic sectors [Knopp, Linda, 2012, pp. 10].

There is wide diversity of incubators ranging from large-scale incubators such as the still operational mixed use Batavia industrial Center (BIC) incubators to the technology focused Silicon Valley Industrial Park founded by Stanford University as well as programs such as Louisiana State University's “incubator on wheels,” founded after hurricane Katrina, to help small business owners in rural Louisiana rebuild their businesses [D’Angostino, 2009].

Number of USA Incubators Operational Today and Economic Impact

Today, the National Business Incubator Association (NBIA) “estimates that approximately 1400 business incubation programs were operating in North America in 2011, up from 1100 incubators in 2006 [Knopp, Linda, 2012, p. 1].”

The 1400 US incubators have a significant monetary impact on the US economy and have more fun far-reaching effects in fostering new technology commercialization as well as the establishment of new jobs. In 2011, NBIA estimates that North American incubators assisted approximately 49,000 startup companies that provide full-time employment for nearly 200,000 workers while generating annual revenues of approximately US$15 billion (€11.74 billion).

Business Incubator Goals – Economic Development – Creating Jobs and Entrepreneurial Cultures

When surveyed, virtually all of incubator managers reported their incubator programs as important economic development tools for their region. The incubator managers ranked job creation and fostering an entrepreneurial culture, accelerating growth of local industry, diversifying the local economy, retaining business in the community, and commercializing new technologies and other business development goals as their incubators’ highest priority [Knopp, Linda, 2012, pp. 26]. The focus of incubators is on job and wealth creation via fostering new ventures.

Emerging Social Entrepreneurship Incubators

Louisiana State University is not alone in creating business incubators focused on social entrepreneurship. One of the recent trends emerging among USA incubators are incubators focused on social entrepreneurship - the nurturing a new ventures as a means of enhancing societal well-being. This trend is not limited to nonprofit incubators but includes private for-profit incubators. For example YCombinator, a Silicon Valley, a for profit accelerator founded in 2005 and named by Forbes as the top start up and accelerator in 2012 [Mac, 2012], announced in September 2013 that it has started a program specifically for social entrepreneurship ventures [Graham, 2013].

Target Client Populations and Industries by USA Business Incubators

A number of incubation programs offer targeted services to entrepreneurs in specific industry sectors or from specific demographic groups.

Thirty seven percent (37%) of business incubators target a specific industry sector. The most commonly targeted industry sectors are information technology (26%), bioscience and life science (22%), computer software (18%), energy (18%), and the environment (18%) [Knopp, Linda, 2012, pp. 11]. Technology focused business incubators frequently provide expensive "wet labs" and analytical equipment needed by the startup to demonstrate the "proof of concept" to potential investors.

The most common demographic groups targeted by incubation programs were micro-entrepreneurs (19%), college and university students (12%), and social entrepreneurship (7%). There is a movement among universities and colleges to increasing student involvement in via business incubators. University faculties perceive incubators as "teaching laboratories" to merge theory with practice. Incubators also target under represented populations in the USA's entrepreneurial economy such as Hispanics (9%), women (9%), and black Americans (8%) [Knopp, Linda, 2012, pp. 12]. Helping the underrepresented populations to create successful businesses moves them from society's fringe to the mainstream.

Funding USA Incubators

Founding an incubator requires a significant initial investment coupled with the ability to sustain patience capital for several years necessary to impact economically the local community and justify the return on investment. For these reasons 32% of US incubators are affiliated with academic institutions, 25% are sponsored by local or regional economic development organizations, 16% are sponsored by governments, 15% have no sponsoring entity, 4% are for profit, and remaining 8% are hybrids or have another type of sponsors [Knopp, Linda, 2012, pp. 8]. Most incubators must be affiliated with sponsoring organization for long-term fiscal viability.

Facilities – Description Occupancy – Average Number of Client Companies – Graduation Rates

Despite increasing interest in virtual incubation where a new organization is incubated electronically, the vast majority of incubation programs (93%) have an incubator facility to house and assists clients. Among programs with an incubator facility, 28% were located in rural communities, 25% in the suburbs, and 47% in urban areas [Knopp, Linda, 2012, pp. 17].

The average size of the incubation facility in 2012 was 32,319 square feet (3,002 square meters). Technology incubators represent the largest facilities with 37,631 square feet (3,496 square meters) (Knopp, 19). Fifty four (54%) percent of the incubator's space is devoted to client companies, 22% to common areas, 15% to anchor tenants, and 9% to administrative offices [Knopp, Linda, 2012, pp. 22].

Average incubator facility occupancy rate was 74%. Most incubator managers target an 80% occupancy rate which enables them to bring "on board" new companies as well as providing expansion room for current clients [Knopp, Linda, 2012, p. 21]. Studies of European incubators reflect similar occupancy levels, "there is a need to operate at no more than around 85% occupancy levels" so as to remain flexible for changing clients' needs [Benchmarking of Business Incubators, 2002].

On average, the typical US business incubator has operated for approximately 12 years [Knopp, Linda, 2012, pp. 15, 16]. In 2012, the average number of client companies per incubator program reached an historic high of 35. The typical incubator reported graduating an average of 6.5 client companies annually and 61 clients since the incubator's founding [Knopp, Linda, 2012, pp. 54].

Incubator Services Provided

Nearly three quarters (73%) of incubators surveyed offered pre-and post-incubation services, or both. Incubation programs provide entrepreneurs with a broad array of business services to help the entrepreneurs launch their venture successfully. These services include help with business basics (71%), high-speed Internet access (71%), marketing assistance (71%), and networking activities (71%). Helping clients access funding (71%) and providing connections to specialized resources were also viewed as very important [Knopp, Linda, 2012, pp. 26, 33]. Each startup faces challenges which are unique. One of the most valuable services incubators provide their client companies is where to find the expertise and intellectual capital to address their unique challenges.

Incubator Management and Staffing – Levels - Hours Worked Weekly – Tasks

Most business incubators in the US are under staffed with relatively few (4 to 5) full time employees.

Incubator managers reported spending an average of 33 hours per week on program duties but the range was from 5 to 100+ hours weekly. Incubator managers spent 36% of their time delivering business development services, 17% building and managing the business resources network, 14% on facility management, 11% on client recruitment, 7% on fund raising, and the remaining 15% on variety of tasks [Knopp, Linda, 2012, pp. 37, 40].

The combined hours per all paid incubation staff reported working was 77 hours per week – about 1.9 paid staff members - with a range between 5 to 340 paid staff hours per week [Knopp, Linda, 2012, pp. 36-41]. Thirty eight percent of the staff's time was devoted to the delivery of business development services, 13% on building and managing the business resources network, 15% on facility management, 8% on client recruitment, and 25% on a variety of tasks ranging from fund raising to accounting / billing [Knopp, Linda, 2012, p. 41].

Note that the largest amount of time spent by both the managers and staff was on business development. Most companies in incubators are product focused and success is only found in the marketplace. Consequently, successful incubators emphasize activities related understanding the market and product launch. In depth understanding the target market increase client companies' ability to raise capital.

Client Companies - Time Spent in Incubators

The average time incubator clients spend in the program before graduating varies widely depending on a number of factors, including the entrepreneurs' expertise and type of business. The typical time spent in all types of US incubator prior to graduation was 28 months [Knopp, Linda, 2012, p. 52]. Mixed use and technology incubators both reported average times of 29 months [Knopp, Linda, 2012, p. 53].

The typical incubator graduated an average of 6.5 clients annually and 61 clients since the incubators founding [Knopp, Linda, 2012, p. 54].

Eighty nine percent (89%) of the incubators surveyed reported they mandate companies leave when they have outgrown the available space, 58% of the companies leave when they achieve the mutually agreed on business milestones such revenue levels, staff size, market penetration targets, 27% of the companies leave when they have spent the maximum time allowable, and 26% of the incubators have no specific graduation policy [Knopp, Linda, 2012, pp. 34 - 35].

Jobs Created in US Business Incubators by Client Companies

In terms of job creation, the US business incubators are doing a good job. In 2012, the companies housed in the incubators created an average of 96 total full time jobs and 43 part time jobs [Knopp, Linda, 2012, pp. 58, 59]. Technology focused incubators reported client companies employed an average of 217 full time employees and 93 part time workers [Knopp, Linda, 2012, pp. 58 - 59]. The incubators themselves have a positive economic impact on their communities.

Client Companies Revenues

The average revenues for client companies in 2012 were $10.7 million (€7.81 million) with a median of $2.1 million (€1.53 million). The average revenue of companies in technology incubators was $19.4 million (€14.77 million) compared to $5.9 million (€4.31 million) for companies in mixed-use incubators [Knopp, Linda, 2012, p. 55].

Equity Investments by Investors in Client Companies

The average equity investment was $10.7 million (€7.81 million) with a median of $1.0 million (€.73 million). Companies in mixed use incubators attracted $3.4 million (€2.48 million) in equity investments. In contrast, companies in technology incubators attracted $20.5 million (€14.97 million) in equity investments [Knopp, Linda, 2012, p. 57].

Business Incubators Equity in Client Companies

Fewer than one in five (18%) of the business incubators take equity in all or some of their client companies. As expected for-profit incubators and technology programs (29%) were more likely than mixed use incubators (13%) programs to take equity in clients. Overall, 14% of the incubators took equity in selected client companies, and 4% took equity in all clients [Knopp, Linda, 2012, pp. 23 - 24].

Success Metrics – Data Collection

To prove the effectiveness and impact of their programs to their sponsoring organizations, 67% of the incubators collect data on their programs. Twenty one percent of the incubators collect data from more than 5 years and 18% percent of the incubators collect data for 5 years [Knopp, Linda, 2012, p. 36].

Funding of USA Business Incubators - Revenues and Expenses

Most of the revenues for US incubators came from client rents and service fees (53%), 23% came from cash operating subsidies from sponsoring organizations, and 18% came from service contracts for entrepreneurship education and training that the incubator provided to third parties [Knopp, Linda, 2012, p. 46].

In 2012, the average annual incubation program revenues were approximately US$540,000 (€398,629). Technology incubators reported the highest revenues of $713,805 (€524,867) with median revenues of $439,500 (€320,970). In contrast, mixed-use incubators reported average revenues of $408,790 (€298,496) with median revenues of $180,000 (€131,434) [Knopp, Linda, 2012, pp. 42 - 43]. The older the business incubator, the higher its revenues (Table 1).

Table 1. The founded decade and the average revenues of incubators

Decade founded	Average Revenues
1980 to 1989	\$790,775 - €577,419
1990 to 1999	\$666,821 - €486,908
2000 to 2009	\$499,751 - €364,915
2010 to 2012	\$186,808 - €136,406

Source: Own research.

Incubator Expenses

In 2012, average expenses were \$516,610 (€377,225) and the median expenses were \$300,000 (€219,058). Technology incubation programs reported higher average and median program expenses \$734,009 (€535,968) and \$491,000 (€358,525) respectively than did other types of incubators. Mixed-use programs reported annual average incubator expenses of \$438,563 (€320,236) with a median of \$239,450 (€174,844) [Knopp, Linda, 2012, pp. 44 - 45]. The older the incubator, the higher its expenses (Table 2).

Table 2. The founded decade and the average expenses of incubators

Decade founded	Average Expenses
1980 to 1989	\$761,375 - €555,951
1990 to 1999	\$640,344 - €467,575
2000 to 2009	\$464,019 - €338,823
2010 to 2012	\$220,500 - €161,007

Source: Own research.

Incubator Surpluses / Loss

US business incubators operate on slim margins - 4.9% of revenues. Business incubators started in 2010 to 2012, operated at a loss of \$33,692 (€24,601) or 18% of their revenues as the incubators amortize their startup expenses.

US Business incubators appear to generate their maximum surpluses at 7.1% approximately ten years after being started (Table 3).

Table 3. The founded decade and the average surplus o incubators

Decade founded	Average Surplus/ (Loss)	Average Surplus / (Loss) - % Revenues
1980 to 1989	$29,400 – €21,467	3.7%
1990 to 1999	$26,477 – €19,333	4.0%
2000 to 2009	$35,732 – €26,091	7.1%
2010 to 2012 - Loss	($33,692) – (€24,601)	(18.0%)

Source: Own research.

USA Business Incubators Association with USA Universities

The majority, 32% of US business incubators (32%) are associated with US universities. Given the deep pool of intellectual capital at universities, many universities focus on technology based incubators. Seventy to eighty per cent of companies which graduate from technology incubators are still operating three years post-graduation. This contrasts with a US government Small Business Administration study which found a survival rate of less than 50% for non-incubated startups after three years [O'Neal, 2005, p. 11]. Additionally, growth companies with university ties are two thirds more productive than non-university peer organizations and "Companies that used university resources also project 21% higher annual revenues, 32% more bank loans, and 23% more capital investments [O'Neal, 2005, p. 14]."

Today, US universities, and business schools in particular, seek to build their reputation as the best school for startups. More and more business schools are increasing their business plan competitions while simultaneously offering more courses on entrepreneurship. Many of the winners of the business plan competitions graduate into their associated university business incubator. For example, Babson College's Arthur M. Blank Center for Entrepreneurship currently "has more than 400 undergraduate and graduate students conducting feasibility studies, learning how to develop a management team, and prototyping products [Korn, 2013]".

Worcester Polytechnic Institute is heavily oriented toward a wide range of engineering courses [Gloeckler, 2013]. Worcester Polytechnic Institute recognizes that the most innovative ideas arise at the intersection disciplines [Kuhn, 1970]. Consequently, entrepreneurship is incorporated into nearly every Worcester Polytechnic Institute undergraduate courses in both engineering and business.

In the Stanford MBA program, 99% of the students take at least one entrepreneurship course [Gloeckler, 2013]. At MIT, business students compete in a $100,000 (€73,019) competition in which the winner receives $50,000 (€36,509) to start a new venture. Since the competition was founded in 1989, more than 130 companies have been launched raising more than $770 million (€562 million) in venture financing [Gloeckler, 2013].

In 2013 *Bloomberg BusinessWeek* [Gloeckler, 2013] rank ordered the following schools in terms of their entrepreneurship programs (Table 4)

Table 4. Entrepreneurship programs Bloomberg BusinessWeek ranking

Ranking	Undergraduate Institutions	Graduate Programs
1.	Worcester Polytechnic Institute	Stanford University
2.	Babson College	Massachusetts Institute of Technology
3.	Baylor University	Babson College
4.	Cornell University	University of California, Berkeley
5.	Syracuse University	University of Chicago
6.	Texas Christian University	Carnegie Mellon University
7.	University of Southern California	Imperial College
8.	Case Western University	University of California, Los Angeles
9.	Washington University	IE Business School
10.	University of Arizona	University of Texas at Austin.

Source: G. Gloeckler, *MBA Rankings: Top schools for entrepreneurship*. Bloomberg BusinessWeek, 14 January 2013.

Austin Technology Incubator (ATI), Texas, USA - A Case Study

The Austin Technology Incubator was founded by Dr. George Kozmetsky, co-founder of Teledyne and mentor to Michael Dell, founder of Dell Computers. After 16 years as dean of the University of Texas at Austin (McCombs) Business School, Dr. Kozmetsky started the IC^2 (Innovation, Creativity, Capital) Institute (http://ic2.utexas.edu) as a "think and do tank" in 1977 to research the entrepreneurial wealth creation process. Today, the University of Texas at Austin McCombs Business is ranked tenth globally in entrepreneurship education.

After about a decade of research and formulation of "think" theoretical entrepreneurship models, Dr. Kozmetsky decided to found the Austin Technology Incubator (AT) as a "do" laboratory to test the theoretical entrepreneurship models. Dr. Kozmetsky often stated, "Biologists, chemists, and physicists have laboratories to test their ideas, entrepreneurship scholars also need a laboratory to test their wealth creation constructs."

Currently, the Austin Technology Incubator explains its role in technology incubation as:

"The Austin Technology Incubator harnesses business, government and academic resources to provide strategic counsel, operational guidance, and infrastructure support to its member companies to help them transition into successful, high growth technology businesses.

Since its founding in 1989, ATI has worked with over 200 companies, helping them raise over $1 billion (€. 730 billion) in investor capital. Over the past five years, including the "Great Recession," ATI has worked with over 100 companies, helping them to raise over $250 million (€183 million) in investor capital. During that same 5-year period, ATI alumni companies realized approximately $400 million ((€292 million) in exit value. Roughly 75% of companies admitted into ATI receive external funding.

ATI is committed to working with the best founding teams in Austin. Out of an annual "pipeline" of 100 - 150 prospective companies, ATI typically admits only 5-10 into membership in the incubator. Investors, executive talent, and mentors recognize this selectivity.

ATI is a program of the IC² Institute of The University of Texas at Austin. It has a dual mission: promote economic development in Central Texas through entrepreneurial wealth and job creation, and provide a "teaching laboratory" in applied entrepreneurship for UT-Austin students. ATI works closely with other commercially-focused and business-building programs at The University (http://ati.utexas.edu)".

The initial funding for the Austin Technology Incubator was from "the University of Texas at Austin, the Greater Austin Chamber of Commerce, the City of Austin, Texas, Travis County, and local businesses [Collinson et al., 2003, p. 195]."

The success of the ATI business incubator may be attributed to [Collinson et al., 2003, p. 196]:

- A rigorous vetting and selection process. Only 5% to 7% of potential clients are accepted into the Austin Technology Incubator which dramatically increases the selected clients' odds of success.
- Application of the most appropriate mentoring, managerial, marketing, technical, financial, and other support tailored to the client companies' unique needs.
- Leveraging economies of scale in dealing with suppliers and service providers to minimize expenses during the critical startup phase of the venture.
- Establish clear metrics for success [Wiggins and Gibson, 2003].

Collinson [Collinson, 2000] points out that "small, startup firms are arguably constrained far more by knowledge limitations than by financial limitations." The real secret to ATI's success is its ability to focus intellectual capital from the University of Texas at Austin, a variety of local governmental entities, and most importantly, the Austin, Texas business community which has created a globally recognized economic ecosystem to support entrepreneurial ventures.

ATI is incubating a wide range of technologies ranging from bio medical products and services to clean energy to information technologies. The diversify creates a wide range of intellectual vigor with the ATI. The current portfolio of ATI client companies is (Table 5):

Table 5. Austin Technology Incubator's current portfolio

Incubation area	Companies	Area of interest
Bio / Health Sciences	Admitance Technologies	Algorithms and associated hardware that enhance the performance of existing cardiac devices (e.g., heart failure diagnosis, pacemaker 'tuning')
	Alafair Biosciences	Advanced post-surgical adhesion barrier. First application: tendon repair
	Xeris Pharmaceutical	Drug stabilization platform. First application: diabetes
Clean Energy	AdBm Technologies	Low-cost noise-abatement technology for marine environments
	BeHome 247	Remote premises management and monitoring system targeted at property managers. Partners: HomeAway, Yale Locks
	nCarbon	Novel material that enables higher energy density, lower-cost ultra capacitors
	Nuve	M2M device management platform, initially targeting transportation market. First application: fuel theft reduction
	Ridescout	Kayak.com for ground transportation. Mobile application that aggregates ground transportation options in real time
	Seismos	Proprietary algorithms that allow real time monitoring of oil and CO2 flow without shutting down production; reducing waste and downtime in the enhanced oil recovery market
	Terra Pave International	Ozone-friendly asphalt substitute, validated by TxDOT
	Yan Engines	Novel D-cycle engine retrofit increases torque by 200% and improves fuel economy by 80%
Development	Beyonic	Mobile payment aggregation technology targeting aid distribution in the developing world
	Clay.io	HTML 5 platform and marketplace for game development
	Predictable Data	Automated database correction for small and medium businesses' distribution lists
	Hoot.me	Facebook application that makes it easy for students to collaborate with classmates, teachers and tutors online. Acquired by Civitas Learning in 2013

Incubation area	Companies	Area of interest
IT / Wireless	Aunt Bertha	Enterprise platform for the social services sector
	Circle Media	SaaS platform for live events that allows clients and their agencies to design mobile and digital engagement strategies
	Ceyfeon Solutions	Multi-sourced, data analytics and action platform targeting financial services
	Datical	Phurnace Software founding team's next startup: database schema automation software for the $22B IT Systems Management (ITSM) market
	Decision Grid	Big data analytics targeting military and security markets
	Dish Opinion	Enables restaurants and other local businesses to collect consumer feedback right at their location and provide a higher level of intelligence to help increase customer acquisition, retention, and satisfaction
	eye Q	Intelligent retail analytics and in-store marketing platform based on facial recognition and demographic biometrics
	InXero	SaaS platform for B2B channel marketing
	Lynx Labs	Software/hardware solution that enables real time 3D rendering at 1/10th the cost of current technology (LIDAR)
	M87	Multi-hop wireless technology to address bandwidth and battery life bottlenecks
	Macrolynk	Social media platform connecting supply chain managers and suppliers
	Ordoro	Shipping and inventory management for e-commerce. Ordoro has raised over $1.8 million and processed over $54 million in orders since graduating from ATI
	Rockify	Social discovery and curation platform initially targeting music videos
	SalesVu	Cloud-based mobile payment solution for your iPhone and iPad
	Set.fm	Rapid post-event access to concert sessions that you can download to your mobile device
	Stormpulse	Suite of internet-based weather risk management tools targeting supply chain and logistics dependent customers
	Structured Polymers	Novel inks for 3D printers. Technology that expands polymer ink library from less than 10 to more than 1,000
	Toopher	Two-factor authentication using location-based awareness in smart phones
Landing Pad	BlackLocus	Automated and optimized pricing tools for mid-market and large online retailers. Acquired by Home Depot in 2012

Incubation area	Companies	Area of interest
	Amatra	Emergency notification program management tools for federal, local, municipal governments and corporate campuses

Source: www.ati.utexas.edu (accessed 22.12.2013).

The Relationship between the University of Texas at Austin's Intellectual Capital and the Austin Technology Incubator

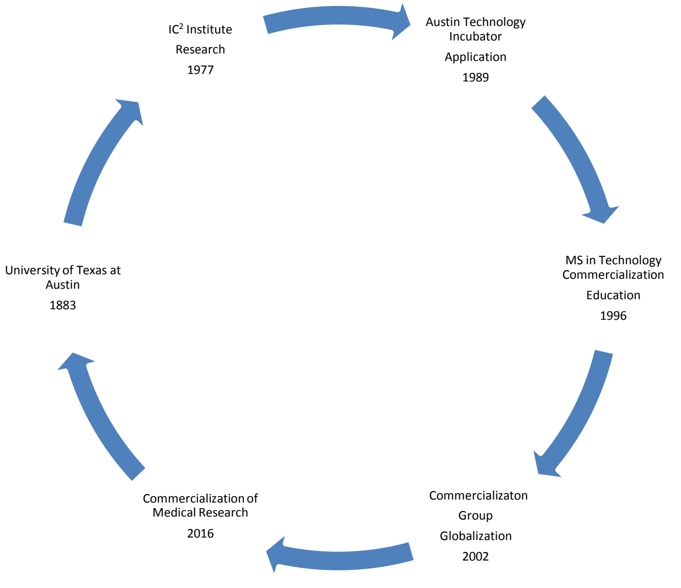
In 1996, the IC^2 institute and The University of Texas at Austin, founded in 1883, started the world's first MS degree focused on the commercialization of science and technology based on its research findings and practical observations of Austin Technology entrepreneurs in action.

In 2001 and 2002, the University of Łódź successfully replicated The University of Texas at Austin's MS in Technology Commercialization program in Łódź, Poland.

About 2002, using the intellectual property developed in the MS in Technology Commercialization degree, the IC^2 institute started the Global Commercialization Group to package the knowledge to help nations to foster entrepreneurs and new ventures. The University of Texas at Austin has motto, "What Starts Here Changes the World." The Global Commercialization Group has implemented the University of Texas at Austin's guiding vision by successfully completing economic development programs in Latin America, Europe including Russia and many of the former Soviet Bloc nations, Middle East, India, Africa, and Asia. Currently, The Global Commercialization Group offers two educational programs in basic and advanced incubator management.

In 2016, the University of Texas at Austin will launch a new medical school. Part of the new medical school's curriculum is to educate the medical researchers on how to commercialize their medical research and related medical devices (Figure 1).

Figure 1. Interaction among the Research, Incubation, Education, and Dissemination of Commercialization of Texas at Austin IC² Institute's Commercialization Process



Source: Authors work.

It is important to recognize that the government and business communities played, and continue to play, a pivotal role in the Austin Technology Incubator's success. The diagram illustrates the relationship among theoretical knowledge creation the IC² Institute, practical applied research at the Austin Technology Incubators, knowledge dissemination via educational programs both locally (MS in Technology Commercialization degree) and globally (Global Commercialization Group), to a cultural shift in society's awareness of applied knowledge as exemplified by the new medical school.
ATI has many success stories incubating companies. Some of the most recent successes are delineated in the table 6.

Table 6. Examples of ATI success stories

Spredfast (IT/Wireless	Funding to date - $32 millon (€23.4 million) Key initiatives: • Market analysis to support the social application opportunity • Strategic advice on shift from social applications to social media management play • Assisted with beta customer acquisitions • Provided product feedback as a beta customer • Advised founders during the Series A funding
Omni Water Solutions (Clean Energy)	Funding to date - $11.9 million (€8.7 million) How the ATI helped: • Helped secure $7.9 million (€5.8 million) in funding from Austin Ventures • Connected the company to industry experts who helped navigate regulatory and IP issues • Provided marketing exposire at SXSW and Clean Energy Venture Summit
Ideal Power (Clean Energy)	Funding to date - $25.7 million (€18.8 million) How the ATI helped: • Helped Ideal Power raise $1 million (€ .73 million) from Emerging Technology Fund (ETF) • Found alpha and beta customers for testing and demonstration project • Extensive work in market analysis, funding options, and competitive analysis
Xeris Pharmaceuticals (Bio/Health Sciences)	Funding to date - $12 million (€8.8 million) Value Added”: • Assisted with relocation from California to Austin • Helped Xeris raise $1.9 million (€1.4 million) from Texas’ Emerging Technology Fund • Connected the company with leadership in the biotech industry

Source: www.ati.utexas.edu (accessed 22.12.2013).

Six Austin, Texas Incubators

With a relatively small population of approximately 1.8 million in the Central Texas area, the City of Austin pulsates with intellectual capital and is currently supporting six incubators. Virtually all US business incubators provide access to intellectual which would be difficult for entrepreneurs to access on their own. Additionally, the incubators provide business guidance and access to business professional such as attorneys and accountants. Many incubators facilitate investments in their client companies in a variety of ways. It must be emphasized that each incubator is unique with specific requirements. Some of Austin incubators deal requirements and services provided which are typical of US incubators are [Merino, 2013]:

Austin Technology Incubator –Founded 1989

ATI does not invest in its client companies. It is a non-conflicted advisor in helping them raise funds.

In addition to the standard incubator services, ATI has access to the State of Texas $100 million (€73 million) Emerging Technology Fund to accelerate Texas startups. To date, ATI client companies have captured over 40% of the Emerging Technology Fund awards.

Tech Stars Austin- Founded 2006

Tech Stars is looking for "great teams tackling interesting ideas [Merino, 2013]." Tech Stars accepts 1% of companies applying. Tech Stars receive 6% of its startups common stock in exchange for the program worth approximately $18,000 (€13,143) plus access to a $100,000 (€73,019) convertible note.

Dream It ventures Austin – Founded 2008

Dream It focuses on technology companies. "Since 2008, Dream It entrepreneurs have raised over $80 million ((€58.4 million). Dream It takes a 6% stake in each client company. In exchange, companies receive $5000 (€3,650) per founding member, up to $25,000 (€18,254) maximum [Merino, 2013].

Tech Ranch Austin-Founded 2008

Tech Ranch Austin is not a traditional incubator/ accelerator but rather a place where entrepreneurs can tap into a network of like-minded and supportive individuals as well receiving many of the traditional incubator services. The Tech Ranch client companies receive no money but lots of information and access to several classes on venture startup as well as coaching and mentoring. Tech Ranch has relationships with startups in Chile.

The Capital Factory – Founded 2009

"The Capital Factory's goal is to help startups achieve profitability with less than $1 million (€.73 million) in funding [Merino, 2013]" and is focused on startups with a clear business model and plan. The Capital Factory takes 2% equity stake in each venture. Frequently, Capital Factory startups are mentored by investors who can contribute up to $50,000 (€36,590). The Capital Factories fund may match any investment made by a startup lead mentor up to $50,000 (€36,590).

Incubation Station – Founded 2012

Incubation Station is an accelerator for consumer product goods. "We look to invest in companies that have proved the existence of a large market and the viability of their product, and are aligned with consumer trends – such as eco-friendly, socially conscious, and organics [Merino, 2013]."Incubation Station takes a 2 to 10% stake in client companies. Incubation Station's average equity in client companies is 6%. The Incubation Station contributes $5000(€3,650) per founder up to $20,000 (€14,603) total. In addition to the cash, client companies receive mentorship from industry leaders as well as space.

Each of Austin's six incubators provides standard incubation services but each also focuses on separate niches while creating different deal structures.

Summary

The USA business incubation industry is growing and prospering. The USA business incubators have demonstrated that they accelerate both the wealth creation process with a community by raising the success rates of incubated companies above non incubated companies by matching entrepreneurs with both intellectual and professional capital. In the process, the incubated companies create jobs both in and out of the incubators.

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THE ROLE OF UNIVERSITY RESEARCH, TECHNOLOGY TRANSFER AND SPIN OFF COMPANIES

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THE ROLE OF THE RESEARCH UNIVERSITY IN SUSTAINING THE TECHNOPOLIS: THE CASE OF AUSTIN, TEXAS[2]

Abstract

In “Creating the Technopolis: High Technology Development in Austin Texas,” [Smilor Kozmetsky et al., 1988] make the case that in the mid-1980s Austin was becoming a globally competitive high tech region. Indeed though effective regional public-private collaborations Austin has established its reputation as an leading entrepreneurial and technology center and “talent magnet.” Delegations from across the US and worldwide visit Austin to better understand how this central Texas city went from being a state government and university town to become a fast growing, globally competitive, technology hotspot leading the state and nation in job creation. Over the years the concept of the Triple Helix has been established as it emphasizes the importance of university, business, and government cooperation at the regional level. As emphasized in both the Triple Helix and Technopolis Frameworks it is the interaction or networking across public/private sectors that is most important and that sets regions apart in terms of their creative and innovative capacity. This paper describes how The University Texas at Austin was a key engine in the growth and sustainability of the Austin Technopilis from 1988 to 2012.

Keywords: Technopolis, The Triple Helix.

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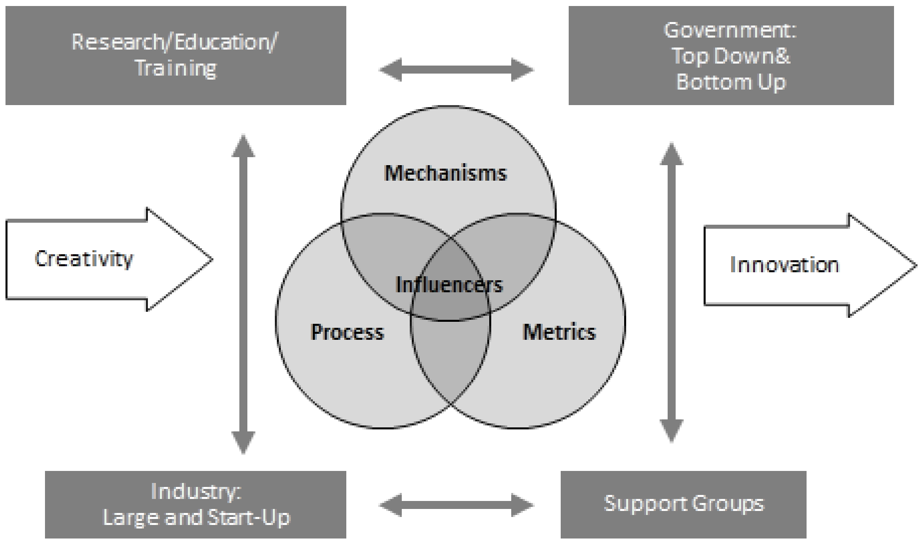
Introduction

The Triple Helix thesis [Viale, Etzkowitz, 2010] is that the potential for innovation and economic development in a knowledge society lies in a more prominent role for the university and the hybridization of elements from university, industry and government to generate new institutional and social formats for the production, transfer and application of knowledge. The Triple Helix concept relies on three main ideas: (1) a more prominent role for the university in innovation, on a par with industry and government in the knowledge society; (2) a movement toward collaborative relationships among the three major institutional spheres, in which innovation policy is increasingly an outcome of interaction; and (3) in addition to fulfilling their traditional functions, each institutional sphere also "takes the role of the other" performing new roles as well as their traditional function [Triple Helix Research Group, 2013]. The Technopolis Framework [Smilor, Gibson et al., 1988] adds the support groups sector to the Triple Helix as well as a finer delineation of the academic, business, and government sectors. The support groups sector, which is key to innovation ecosystem development, includes such things as VC and angel financing, legal and management talent, professional and industry associations, entrepreneurship support activities, chambers of commerce, non-profit and non-government organizations, etc. As stated by Saxenian [Saxenian, 1994], support groups are a segment of regional institutions that set the tone for social interaction, and both influence and are influenced by the culture of a region.

Institutional excellence in any sector or subsector is not sufficient. As emphasized in both the Triple Helix and Technopolis Frameworks it is the interaction or networking across sectors that is most important and that sets regions apart in terms of their creative and innovative capacity [Smilor et al., 1988]; [Gibson, Rogers, 1994]; [Philips, 2008]. As noted in Figure 1, we identify the key role of influencers across mechanisms, processes, and metrics as linking the university, business, government, and support groups. Mechanisms include such things as policy (e.g., the Bayh Dole Act or governmental research funding agencies). Structures include such entities as science parks, incubators and business accelerators. Processes focus on how these policies and structures are managed. For example, is communication highly structured and vertical or is it more informal and horizontal? Is there a high tolerance for entrepreneurial risk taking and the ability to try again, i.e., is failure seen as an important learning activity or as the end of an individual's entrepreneurial career? Metrics concern how results are measured and often determine or at least influence behavior. Are key metrics the number of patents a university generates or the number of published articles? Is it the amount of research funding, the impact of the research, or commercial applications? In short, mechanisms, processes, and metrics have a great deal to do with facilitating or frustrating attaining win-win-win activities across The Triple Helix or Technopolis Framework.

Figure 1. A Continuing Regional Challenge Worldwide



Source: IC^2 Institute, The University of Texas at Austin.

The Key Role of Influencers

There are many regions in the US with excellent research universities, proactive city governments and chambers of commerce, and a highly-touted quality of life that have not been very successful in leveraging these assets for accelerated technology-based regional development. In “Creating the Technopolis: High Technology Development in Austin Texas,” [Smilor, Kozmetsky et al., 1988] the authors stressed the key role of 1st and 2nd level influencers who networked across academic, business, government, and support groups sectors to envision and enact important economic development policies and strategies. A main conclusion of the current research is that the “momentum” for successful regional cooperative activity in Austin, Texas has continued to come from key influencers - visionaries and champions – within and working across sectors or sub-sectors to connect and leverage otherwise unconnected and perhaps competing actors for a common purpose through formal and informal collaboration, coordination, cooperation and at times synergy during key targets of opportunity [Phillips, 2008].[3] The focus is on influencers and the networks in which they are embedded as opinion leaders and as communication bridges [Rogers, Kincaid, 1981].

1st level influencers are usually successful leaders in "their" sector, but they also maintain extensive personal and professional links to other sectors and they effectively cross sectors with credibility and influence. 1st level influencers also tend to mentor and at times "protect" 2nd level influencers as they work across different public-private sectors to structure and implement action oriented activities that challenge institutionalized rules, procedures, and established expectations of conduct.[4] Second-level influencers act as informal communication bridges to first-level influencers while initiating boundary-spanning activities with their colleagues and trusted friends in other sectors whether within large institutions like the research university or across business, academia, or government. The personal communication networks of such influencers tend to be outward looking and open as opposed to being closed and provincial and such "outward looking" networks tend to be multidisciplinary and international. Social Network researchers look to the individual's social environment for explanations, whether through influence or leveraging processes, on how certain things get done because of the connections one has to others [Borgatti et al., 2009]. "Collaborative Individualism" is when individuals with disparate organizational affiliations voluntarily come together to accomplish specific tasks of limited duration [Cunnington, Gibson, 1991].

The University of Texas at Austin

This paper supports the view that a research university's most important deliverable for industry and society is to graduate educated students. With a 2013 enrollment of about 38,500 undergraduate and 11,500 graduate students, UT Austin is a major supplier of educated talent for regional, as well as national and

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[3] "Collaborate" means to cooperate with the enemy. "Coordinate" means to bring into proper order or relation; to harmonize; to adjust. "Cooperate" means to act or work together with others for a common purpose; to combine in producing an effect. "Synergy" is the simultaneous action of separate agencies which together have a greater total effect that the sum of their individual effects. (Websters New World Dictionary; [Gibson, Rogers, 1994].

4 Such a first level influencer was Dr. George Kozmetsky, co-founder of Teledyne who was recruited to Austin in 1966 as the Dean of UT's College of Business Administration. Dr. Kozmetsky is considered an early visionary of the Austin Technopolis. He founded and initially funded the IC² (Innovation Creativity Capital) Institute at UT Austin in 1977. He became an important influencer and champion for building regional academic-industry-government alliances. He was a key mentor to Austin-based entrepreneurs like Michael Dell; Jim Truchard of National Instruments; Jim McKay of Whole Foods; and 100s of entrepreneurs at home and abroad. Kozmetsky was a key catalyst in developing Austin's strategy for winning the MCC in 1983 and in championing such regional catalytic organizations as The Austin Technology Incubator and The Capital Network in 1989 and The Austin Software Council in 1991. In 1993, George Kozmetsky received the National Medal of Technology from President Clinton.

global, industry and academia as well as the public sector.[5] Following in order of relative importance, after the number one priority of graduating educated students, Austin's industry's top needs from the university are reported to be: Continuing education opportunities; consortia and research centers; consulting; and sponsored research followed by intellectual property (IP) and technology licensing.[6] UT-Austin is considered the keystone institution for fostering technology-based growth through: (1) The achievement of scientific preeminence, (2) the development of new technologies for emerging industries, and (3) the attraction of major technology companies and the creation of home-grown technology companies. In the regard we describe three key aspects of UT-Austin that have been crucial to the growth and sustainability of the Austin Technopolis: (1) endowed research chairs, (2) research and development (R&D) expenditures, and (3) enhanced technology licensing and spinoff activity including the University's Austin Technology Incubator and the growth of entrepreneurship programs and activities across a broad range of University collages and departments.

Endowed Chairs

Endowed chairs help attract top researchers who are key to winning competitive state, federal, and international research grants that fund fellowships and attract superior graduate students. The resulting outcome is a clustering of established and emerging talent in centers of research and education excellence and rising prestige for a university. Competition is intense among research universities worldwide to recruit the best and the brightest professors and students. At UT-Austin endowed chairs help recruit and retain these highly ranked "star" professors as well as top graduate students.

There was a dramatic rise in the number of endowed chairs at UT-Austin in 1982 (32 Chairs) and 1983 (41 Chairs) which was directly linked to Austin's winning The Microelectronics and Computer Technology Corporation (MCC) in 1983.[7] The dramatic rise in UT Endowed Chairs from under 50 pre-1982 to over 300 in 2012 resulted, in large part, from private donations that were enhanced by

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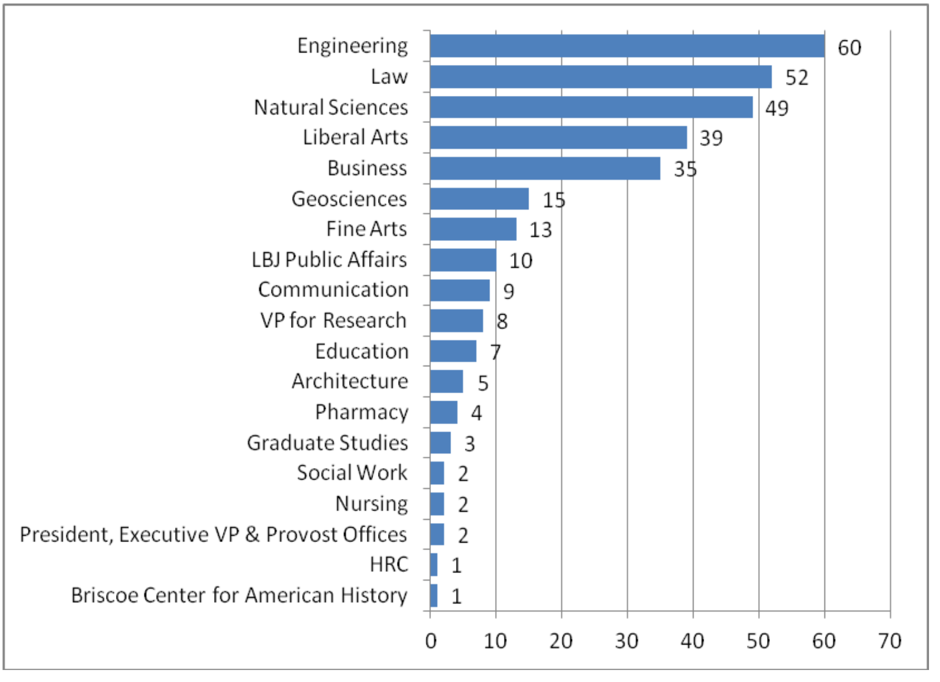
[5] The University of Texas at Austin, established in 1863, is the flagship campus for the UT-System which is comprised of 9 universities and 6 health institutions. UT Austin enrolls about 50,000 students/year with 18 colleges and schools and 86 doctoral programs. The Cockrell School of Engineering's has 267 faculty and more than 7,800 students enrolled in nine undergraduate and 13 graduate degree programs. The College of Natural Sciences has 370 faculty and 10,800 students and 37 research units.

[6] Bill Catlett, Office of Industry Engagement, The University of Texas at Austin and cited in Corporate Relations Functions at the Nation's Leading Research Universities, Tim Mulcahy, University of Minnesota, 2007).

[7] The Microelectronics Computer and Technology Consortium (MCC) located in Austin, Texas in 1983 after a major national promotion and competition. MCC was the first for-profit R&D consortium in the US and motivated the passage of the National Cooperative Research Act of 1983. MCC was a key and early catalyst for Austin's rise as a globally competitive technopolis.

UT Austin's matching program.[8] By 1986 UT Austin's Department of Computer Science was receiving three times as many graduate student applications (about 700/year) as they had prior to 1983 and the Department was admitting candidates with substantially higher Graduate Record Exam (GRE) scores. Figure 2 illustrates that as of 2010 the vast majority of UT endowed chairs exist in the College of Engineering (19%); School of Law (16%); College of Natural Sciences (15%); College of Liberal Arts (12%); College of Business (11%); and Geosciences (4%).

Figure 2. UT Austin Endowed Chairs by Academic Unit (Total 317, as of 12/21/2010)



Source: The University of Texas at Austin.

In August 2004, The University of Texas System Board of Regents approved $32 Million funding from the Permanent University Fund to be awarded to System Institutions to help attract and retain highly qualified faculty. The resulting STARS (Science and Technology Acquisition and Retention) program provides

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[8] Winning the MCC provides an excellent example of public and private sector synergy at the regional level while strengthening UT Austin as a top research university. Peter O'Donnel, a successful Dallas businessman arranged with UT administrators to leverage his $8 million gift for endowed chairs with an additional $8 million from the private sector which was matched with $16 million from the University of Texas Permanent University Fund (PUF) to create, in 1983, 32 million dollar chairs in computer science and engineering. The Permanent University Fund (PUF) is a Sovereign Wealth Fund with total assets of about $14 Billion as of December 2012. The PUF was created by the State of Texas in 1876 to fund public higher education. A portion of the returns from the PUF are annually directed towards the Available University Fund (AUF).

funding to help purchase state-of-the-art research equipment and laboratory renovations to help retain STAR faculty in UT-System institutions. The program evolved and expanded in 2005 to include additional support for faculty retention, research, and teaching. For example, in 2010 under the STAR program, UT Austin recognized 34 faculty member recipients for outstanding teaching at the undergraduate level. As a research-to-commercialization oriented example, two UT Austin "star" faculty founded Molecular Imprints with $3 Million support from State of Texas Emerging Technology Research Fund. This research built on Cockrell School of Engineering patented ink-jet technology with a revamped manufacturing process known as "ink-jet roll-to-roll nano-patterning" in order to produce large, inexpensive manufacturing tools needed for electronic devices and photovoltaics.

A different Science and Technology Affiliates for Research (STAR) Program at UT Austin was launched in 2012 by the Texas Advanced Computing Center (TACC) and offers supercomputing, advanced visualization, grid computing, and massive scientific data management to benefit both science and business. For example, Aramco Services Company, a Houston-based affiliate of the Saudi Arabian state oil company, used STAR to remotely execute a billion cell mesh visualization of an oil reservoir. The TACC-STAR Program is currently expanding into undergraduate and PhD-level computational education to better fulfill growing industry needs.

Research Funding

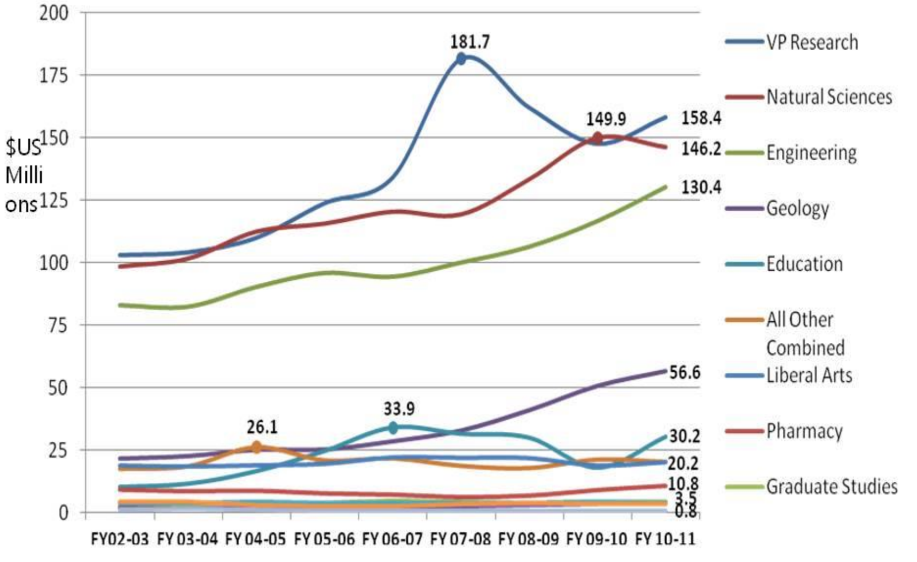
UT Austin research expenditures grew from $376 million (FY02-03) to $589 million (FY 10-11) significantly up from $120 million in 1986.[9] During 2010-2011, federal government funding to UT Austin totaled $355.5 M and the main funding agencies were Department of Defense (DOD) at $122 million; National Science Foundation (NSF) at $76.5 million; Health and Human Services (HHS) at $72 million; Department of Energy (DOE) at $42.5 million; and National Aeronautics and Space Administration (NASA) at $13 million. For the same time period, corporate funding to UT Austin was about $68 million; state and local research funding totaled about $41 million; non-profits about $31 million; and institutional funding at about $88 million. As of FY 10-11, research expenditures by academic unit have been $158 million for the VP for Research[10], $146 million for the College of Natural Sciences, $130 million for the College of Engineering, $56 million for Geology, and $30 million for the College of Education (Figure 3). As of early 2012, UT Austin's Cockrell School of Engineering had 21 science and

[9] The total dollar amount of contracts and grants awarded to UT Austin was about $55 Million in 1977 and increased to about $120 M in 1986. In 1989 Federal funding totaled almost $90 M or about 60% of UT Austin research funding as compared with 7.5% State grants and 7% industry funding (Austin Technology-Based Industry Report, 1991).

[10] VP for Research funding includes university activities and programs such as UT Austin's Applied Research Labs (APL), Center for Electromechanics, The Center for Computational Engineering and Sciences, The Texas Advanced Computing Center, and the IC² Institute.

technology (S&T) research units with annual budgets greater than one million dollars followed by the College of Natural Sciences with 27 such research units; UT Austin's VP Research with eight units; and the Jackson School of Geology with four research units each with annual funding greater than one million. Twenty-eight research units have annual budgets of greater than $ 5 million.

Figure 3. Total Research Expenditure by Academic Unit and Year (US$, millions)



Source: The University of Texas at Austin materials.

As an example of UT-Austin research-industry collaboration is the Cockrell School of Engineering's Wireless Networking and Communications Group (WNCG). WNCG's research funding has exceeded $20 million since its formation in 2002 with the support of 13 industry affiliates and sponsors.[11] In 2012 WNCG was named as a prestigious National Science Foundation (NSF) Industry/University Collaborative Research Center (I/UCRC). The award provides WNCG with about $400,000 in initial funding over a five-year period. The funding is renewable up to 15 years. The I/UCRC program is an annual competition created by NSF to reward university research centers that demonstrate great promise for research breakthroughs while exhibiting a strong track record of collaboration with companies and other universities. As noted by Dean Gregory L. Fenves, Cockrell School of Engineering, WNCG is one of the

[11] These sponsors are: AT&T, Cisco Systems, U.S. Department of Defense, Panasonic, Yokogawa, Powerwave Technologies, Commscope Corp., Samsung, National Instruments, Dell, Qualcomm, Texas Instruments, and Huawei, who participate as Industrial Affiliate members, as well as major government support from the Army Research Laboratory, NSF and the Defense Advanced Research Projects Agency.

world's leading wireless research centers, involving more than 16 faculty and 120 graduate students in electrical engineering, aerospace engineering and computer science. The crucial support provided by NSF will allow WNCG to accelerate its research on the greatest wireless challenges that society needs to solve in the next several decades" (UT web, "WNCG Awarded NSF Industry Collaboration Center," Wednesday, February 2, 2011).

Knowledge Transfer and Commercialization

UT Austin's Office of Technology Licensing (OTL) was launched in September 1991 and reflecting university concerns of the time the office was staffed by lawyers who emphasized the protection of UT's IP. As a result of increased state political and societal pressure calling for greater economic impact of UT Austin research, more emphasis has been placed on transferring knowledge and technology out of the university and into the marketplace. In brief, the transition of increased emphasis on S&T commercialization has been a difficult challenge given the established norms and values of a state university funded, in large part, by public money. In September 2003, the OTL was renamed The Office of Technology Commercialization (OTC). While undergoing difficult institutional change, UT Austin's OTC continually works to improve processes for transferring university research to industry including:

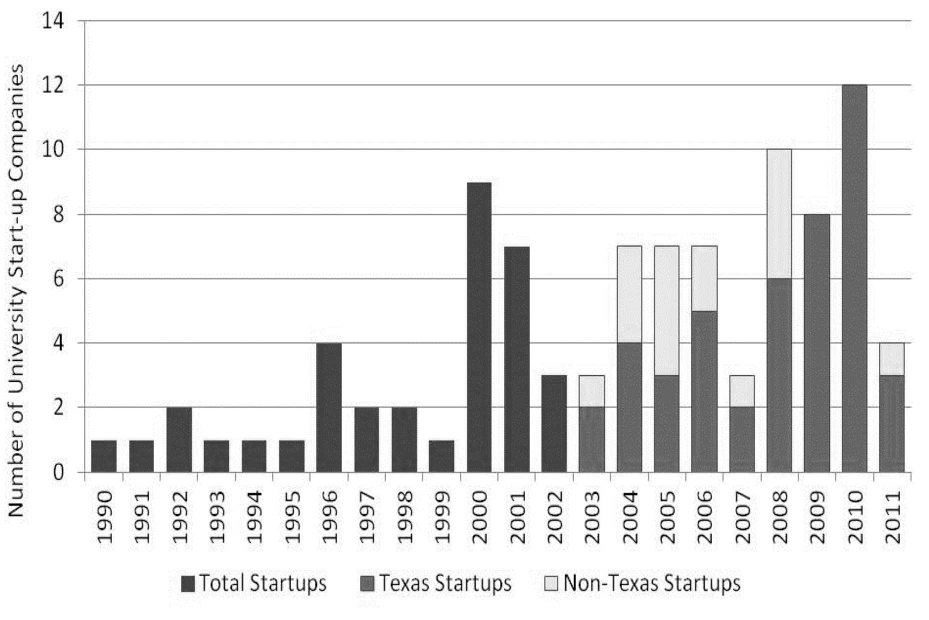
- Evaluating, protecting, marketing, and licensing university inventions and software
- Assisting in the formation of startups
- Promoting collaboration with industry, investors and other stakeholders in the technology commercialization
- Informing UT Austin faculty on appropriate and current patent protection and commercialization processes.

Between FY 2003 and 2011 UT Austin was issued 276 US and 148 foreign patents. In FY 2010-2011 34 US patents were issued in the US and 28 in foreign countries with the most foreign patents being filed in Japan followed by Denmark, Sweden, Ireland, the UK, Switzerland, Germany, France, India, and Mexico. Annual tallies of license agreements at UT Austin have ranged from the mid-twenties to a high of 58 in 2008 for a total of 306 license agreements over the past nine years. Licensing income has increased considerably from about $500,000 in 1992 to over $25 million in 2011. As is common in most university royalty streams, a few patents provide the great percentage of financial rewards. One of OTC's key responsibilities is to serve as a startup or spinoff catalyst for the University. Figure 4 shows the number of UT-Austin IP-based Texas and Non-Texas located startups per year from 1990 to 2011. There have been 58 spinoffs based on UT Austin research since 2003 with a high of 13 spinoffs in 2010.[12] We

[12] A university spin-off is considered to be a company that licenses a technology from a university in order to function; that is, the company did not exist until the time the university technology was

believe it is also important and correct to include non-IP spinoffs in any assessment of the economic development impact of a research university. For example, in Austin, it is important to include university connected companies such as National Instruments and DELL Corporation in the UT affiliated spinoff category as it was UT Austin that brought the founding entrepreneurs to Austin: Jim Truchard and colleagues launched National Instruments while working at UT's Applied Research Labs (ARL) in 1976 and Michael Dell launched his entrepreneurial effort as an undergraduate business student in 1984 It is also noteworthy that these entrepreneurs chose to grow their companies in Austin, in part, because of the regions quality-of-life which they and their colleagues and employees and their families enjoyed and because of the critical importance of having a continuing supply of qualified talent graduating from UT Austin and other regional education institutions. In addition, we argue that UT Austin also deserves considerable credit for the founding of non-technology Austin-based entrepreneurial enterprises such as Whole Foods, Inc. and SXSW Interactive, Film and Music Festival as both were founded by former UT Austin students and have been supported in their local growth by UT students and graduates as employees and as customers.

Figure 4. Number of UT-Austin IP-Based Spinoffs by Year, 1990-2011



Source: Texas Higher Education Coordinating Boards, 1990 through 2003; OTC 2003 through 2011.

licensed. A company is considered a spin-off regardless of whether or not the company founders were involved in the creation of the licensed technology.

The Austin Technology Incubator

Beginning operations in 1989, The Austin Technology Incubator (ATI) at UT Austin has been a key catalyst in developing Austin's entrepreneurial and innovation ecosystems continuing into 2013. In 1989, Austin was in an economic slump and "see through" buildings were prevalent.[13] Led by the IC² Institute, the Austin Technology Incubator "experiment" secured modest 3-year funding of $50,000/year from the City of Austin and $25,000/year from The Greater Austin Chamber of Commerce and a onetime donation of $70,000 from Travis County plus $50,000 from a private donnar. ATI was launched, near the epicenter of emerging software technology companies, in 4,000 sq. ft. of "borrowed" office space with donated furniture from university storage and an Austin retail store with some "difficult to sell" furniture.[14] University administration was not entirely comfortable with the idea of a state supported educational institution hosting a business incubator, even if it was not-for-profit, so the concept was "presented" as a technology venturing laboratory for UT students and professors much like a chemistry or physics lab.

In 1989 the lack of Venture or Angel Capital was a noted challenge for the successful operation of ATI and the growth of a regional entrepreneurial culture. Recognizing this need, IC^2 Institute launched the Texas Capital Network (TCN), as a non-profit Angel Fund that matched promising ventures to potential investors. TCN was built on the participation of wealthy influencers state-wide who agreed to review business plans in technology sectors that they were interested in, and if they so desired, provide seed funding to a particular entrepreneurial venture. TCN, which was based at ATI, was renamed The Capital Network and grew to be the largest Angel Fund in the Southwest facilitating more than $150 million in total investments with 2000 registered entrepreneurs. TCN's annual Venture Capital Conference regularly attracted upwards of 300-500 investors and entrepreneurs who came from across the nation and internationally to hear venture pitches from Texas start-ups. As VC and business angel groups became more prevalent in the Austin region, TCN terminated operations in 2001. ATI and TCN and the Austin Software Council which IC2 founded in 1993, were

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[13] In 1982 Austin had 16 million sq. ft. of office space and the occupancy rate was 95%. In part motivated by the economic development hype of winning the MCC headquarters, by 1986, 14 million sq. ft. of office space had been constructed and the occupancy rate had dropped to 70% and by mid-1987 an additional 6 million sq. ft. dropped the office occupancy to 60% (Gibson and Rogers, 1994). In 2012 Austin's vacancy rate is at 17% and leases are being signed at 32% over 2011 prices (Forbes Web, May, 2012).

[14] As one of the wealthiest Texans, Dr. George Kozmetsky could have simply underwritten the start-up expenses of ATI; however, he wanted to secure buy-in and commitment from key public and private stakeholders and he wanted to emphasize building an entrepreneurial start-up culture as being most important to the launch and sustained success in the management and operation of the Austin Technology Incubator. As an additional challenge to the launch of ATI, a previously launched and well-funded Austin-based technology incubator called Rubicon had closed its doors with no successful graduate companies and millions in lost investment.

key catalysts in building Austin's emerging innovation ecosystem by conducting training seminars on business plan development, deal structuring, managing the investment process, and by organizing venture competitions.

Since its inception ATI has had the dual purpose of service to the University as an education and research laboratory on entrepreneurship and technology venturing and as a regional catalyst for economic development. Over the years, as Austin's regional innovation and entrepreneurial support systems have grown and matured, so has ATI. Austin's current entrepreneurial ecosystem has a broad range of private and public support structures and associations supporting technology venturing, consequently ATI incubation activities have focused on providing high value mentoring in four technology verticals: IT, clean energy, wireless, and biosciences. ATI brings to its portfolio of companies, in each industry sector, deep domain management expertise and investor network access. It is important to note that each of these industry verticals has important formal and informal links to UT Austin research and education as well as to city and chamber of commerce economic development objectives. In brief, ATI has been central to assisting entrepreneurs with building successful business teams to support technology ventures and to better access angel, VC, and state funding; mentoring students from across campus; mobilizing the regional business community around emerging technology sectors; and graduating high-growth ventures into the Austin community. With active support from local business professionals and the chamber of commerce, city government, and the University for 25 years, ATI has maintained a well-earned reputation as of one of the nation's finest examples or models for technology business incubation. [15]

UT Austin's Growing Entrepreneurial Fever

Starting in 1977 with the founding of the IC2 (Innovation, Creativity, Capital) Institute at The University of Texas at Austin entrepreneurship teaching, competitions, and other activities have grown campus-wide from the Moot Corp Competition for entrepreneurs established in the Business School in 1984 and the Chair of Free Enterprise established in the College of Engineering in 1985 to an explosion of campus-wide programs and classes on entrepreneurship continuing into 2013, Figure 5. To highlight the increasing importance of fostering the entrepreneurial experience in university environments, in February 2012, the UT System issued a call for proposals for Novel Programs in Education for Innovation and Entrepreneurship. As stated,

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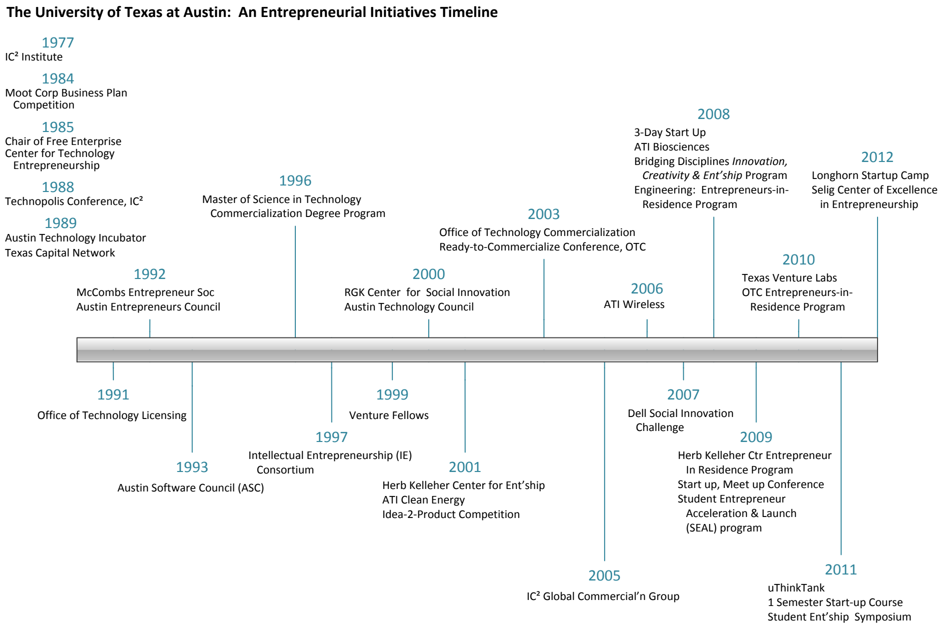
[15] Since its founding in 1989, ATI has graduated over 150 companies; raised more than $720 million; had 4 IPOs; 25 acquisitions; created an estimate of over 10,000 direct and indirect jobs; and trained hundreds of UT-Austin students from a range of UT colleges and departments. Capital raised by ATI member companies and alumni in recent years totaled $111,571.00 in 2011 and $103,918 in 2012. Overall the estimate of capital raised by ATI since 1989 is $1,081,186,000.

There is an emerging call for research universities to serve as entrepreneurial centers that drive research breakthroughs and discover solutions to large-scale scientific and social problems many argue that innovation and entrepreneurial activity must grow exponentially if we are to continue to advance American science and technology. The institutions of the UT-System are an ideal ground from which to advance a highly-visible, cross-institutional culture that fosters entrepreneurship rather than entrenched "silo" thinking. To accomplish such goals, fresh, new methodologies must be developed that will advance the education of established and budding scientists and train research leaders who are facile in forming academic-industry partnerships and creating companies and enterprises.

Figure 5. Timeline of Entrepreneurial and Technology Transfer Initiatives at The University of Texas at Austin



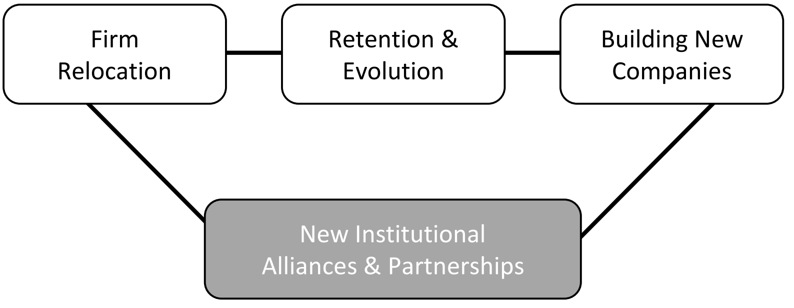
Source: IC2 Institute, University of Texas at Austin.

Thinking and acting entrepreneurially in academia, business, and government in for-profit and not-for-profit activities and in fostering innovative environments is seen as a good thing. But one should be careful of the metrics used to measure the success of such programs. In the end, the success and growth of any entrepreneurial venture depends heavily on the innovation ecosystem in which it is embedded. While many of Austin's current role models (such as Michael Dell; Jim Truchard of National Instruments; or Jim MacKay of Whole Foods Inc.) launched their enterprises without such formal institutional support, they benefited in centrally important ways from key Austin academic and business mentors and influencers.

The industry sector

Successfully recruiting, retaining and growing, and creating firms in one or more globally competitive industry sectors or clusters is perhaps the most important indicator of a successful innovation ecosystem. We suggest that there are four main strategies of regional technology-based growth: firm recruitment, firm retention and expansion, new firm and industry sector development, and newer institutional alliances and partnerships, Figure 6. The University of Texas at Austin has been a central and important asset to each of these strategies.

Figure 6. Four Strategies for Regional Technology-Based Development



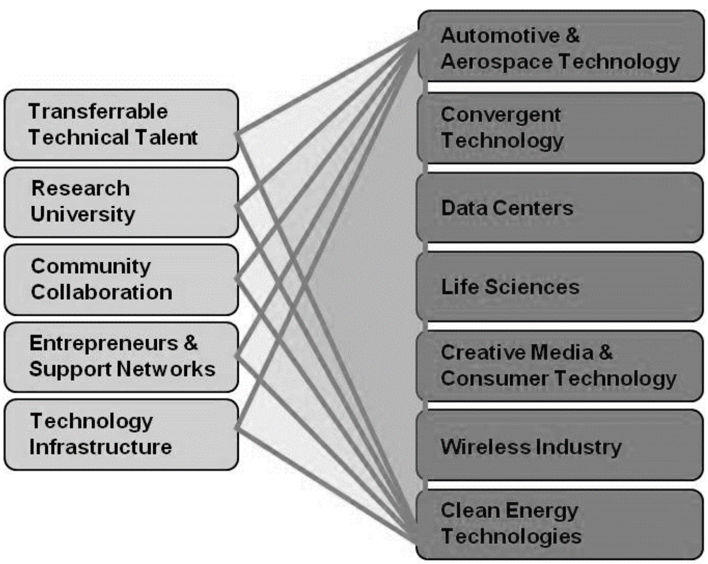
Source: IC^2 Institute, The University of Texas at Austin.

In 1984, the public-private collaboration effort led by the “MCC location Team” of government, business and academic influencers successfully recruited 3M R&D operations from Minnesota to Austin and four years later led the successful bid for Sematech, the nation’s preeminent semiconductor R&D consortium, followed by Applied Materials in 1992, and Samsung in 2005. Austin’s development unfolded over time as large and small software, semiconductor, and PC companies located in Austin in what may best be described as a snowball effect—as more companies located in the Capitol City more were attracted to the region. The recruitment of businesses and the founding of Austin-based firms fueled the region’s development by providing high value jobs and careers, discretionary income, and taxes while branding Austin as a technology region capable of competing with national and international technology centers.

A Regional Challenge

In 2007, given the considerable downsizing of Austin-based semiconductor manufacturing as a result of increased global competition, it was clear to business and community leaders that the region should not base its future job and wealth creation so heavily on this one industry sector. Furthermore it was also clear that Austin's PC Industry, i.e. DELL Corporation, would not be the main accelerator for job and wealth creation that it had been in the 1990s. The regional challenge was how to leverage Central Texas' considerable assets in fabrication facilities and experienced talent and trained workers to the benefit of emerging industry sectors. In response to these challenges, the City and the Greater Austin Chamber of Commerce worked together to target the following seven industries for recruitment and entrepreneurial support: Automotive and Aerospace research and components manufacturing; convergent technology; data centers; life sciences; wireless; clean energy; and creative industries and multimedia, Figure 7. It is important to note that each of these industry sectors had an established and growing Austin presence including relevant research, education, and training programs at the University of Texas and other regional universities and colleges.

Figure. 7. UT Austin's Assets Supporting High Tech Industries & Targeted Industry Start-ups



Source: P. Powers, *Building the Austin Technology Cluster: The role of government and community collaboration in the human capital*, unpublished paper, 2007.

In addition to firm relocation and technology venturing, firm retention and growth is important to regional economic development and sustainability. For example, initially attracted by Texas' lack of corporate and personal income tax, cheap land, and a relatively low cost of living IBM came to Austin in 1966 to manufacture the Selectric Typewriter. More importantly, IBM elected to stay in Austin and transition into a major research center. From the creation of the world's fastest UNIX servers and the groundbreaking Cell Processor, IBM Austin has evolved as a critical component of IBM's globally integrated enterprise and is recognized as one of IBM's eight main research laboratories worldwide. The Austin research facility was created in 1995 to explore the usage and expansion of microprocessor research through the growing technology market of high-speed microprocessors with an emphasis on very fast circuits and computer-aided design tools to support complex, high performance microarchitectures. More recently IBM Austin research includes software and hardware systems, high-speed communication chips, formal verification, distributed systems software, innovative cooling technologies, low power microprocessors, systems management, and performance evaluation. IBM and UT Austin have partnered to build substantial education and research programs while working with the City and The Greater Austin Chamber of Commerce to help shape the region's technology landscape.[16] With more than 6,239 employees and an annual payroll of about $ 600 million, IBM Austin is the largest corporate R&D operation in Texas. In 2008, IBM received 4,186 US patents, the most of any US company. IBM-Austin contributed 825 patents to the total, more than any other IBM location worldwide.[17] As noted by Ben Streetman, Former Dean of UT Austin's Cockrell School of Engineering,

Through the sharing of technology, resources, and talent, IBM and The University of Texas have enjoyed mutually beneficial relationship that goes back many years. IBM is a top hirer of UT engineering graduates year after year. We consider IBM and invaluable partner. (IBM Press Release, October 3, 2007).

Figure 8 shows the number of jobs created by Austin's new and expanding Hi Tech and Non-Hi Tech companies from 1994 to 2011. Over this 17 year period, Hi Tech company growth created the most jobs in Austin (56,101 or 49%) followed by the growth of Non-Hi Tech companies (26,470 or 23%), followed by new Hi Tech company formations (17,775 or 16%) followed by new Non-Hi Tech companies (13,775 or 12%).[18] Clearly, while start-up and entrepreneurial ventures are important, the retention and expansion of existing firms is a key regional job and wealth creation strategy.

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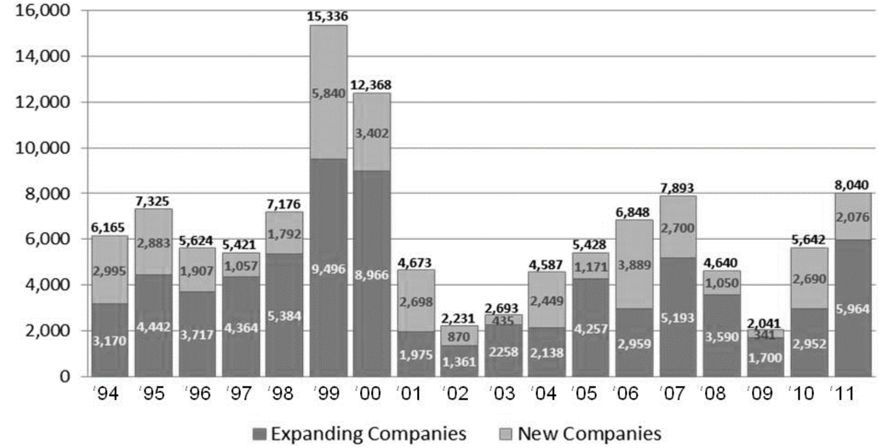
[16] Forbes in their first ever ranking dubbed "The Silicon Hills" of Austin as America's 2nd most innovative city after Silicon Valley, CA. The ranking was based on the 100 largest metropolitan statistical areas in the US using data from the US Patent and Trademark Office combined with venture capital investment per capita along with ratios of high-tech science and "creative" jobs. Greenburg, Andy, "Americas Most Innovative Cities," Forbes.com, April 24, 2010.

[17] About 3,050 patents were issued to Austin area inventors per year in 2010 and in 2011 (US Patent and Trademark Office).

[18] Data were extrapolated from longitudinal datasets provided by The Greater Austin Chamber of Commerce. High technology companies were selected according to the following parameters: R&D and manufacturing in IT, software, and semiconductors; precision parts and applications (i.e. semiconductors and medical devices); clean energy companies (but not fossil fuel energy companies); business-to-business high tech products and services; b2b and b2c internet or technology infrastructure services. Default, and therefore error margin, falls toward the non-technical or "other" categories.

Figure 8. Austin Jobs Created by New Company Creation & Company Expansion, 1994-2011



Source: Greater Austin Chamber of Commerce.

As of 2011 Austin's technology company employment totals about 101,000 in the following industry sectors: High tech information and other IT 32,000; high tech manufacturing 28,000; creative media 26,000 (employed in 2,160 firms); computers and electronics 24,000; engineering, R&D and labs/testing 19,000; and semiconductors 12,000. Dell with 14,000 employees tops the list of Austin's largest technology company employer followed by IBM with 6,239; Freescale Semiconductor with 4,336; AT&T 3,450; Advanced Micro Devices 2,933; National Instruments 2,500, Apple 2,500; Applied Materials 2,500; Flextronics 2,113; and Samsung Semiconductor 2,000.

Government sector

In the US, the government segments can be usefully identified at three levels of analysis: federal, state, and city government. Each of these sectors can contribute to or frustrate regional strategies for technology-based growth.

Federal Government

The influence of the federal government on Austin as well as other technology-based regions in the US has been largely manifested in policy initiatives such as the Bayh Dole Act of 1980, funding for university-based research (e.g., NSF, NIH, DoD), and most recently improving national capability for retaining international talent educated in the US through improved immigration and visa procedures. Federal Government policies have also had major indirect impact on Austin's development as exemplified with the transition of a WW II magnesium plant in North Austin to a university research park. In 1949, with the assistance of then-Congressman Lyndon B. Johnson, UT-Austin purchased the site for an off-campus research center that in 1953 became the University's Balcones Research Center and home to Applied Research

Laboratories. In 1994 the center was renamed The JJ Pickle Research Campus (PRC) in fond memory and recognition of US Congressman and UT alumnus, J.J. Pickle. The PRC is a collaborative effort of government, industry and academia in science and engineering research and development. The PRC is home to 19 UT Austin affiliated research centers including Applied Research Laboratories, Bureau of Economic Geology, Center for Energy and Environmental Resources, Microelectronics Research Center, Robotics Research Group, Texas Advanced Computing Center (TACC), and the Institute for Geophysics. All of these research centers have benefitted from federal and state research funding.

State Government

Low taxes and no personal income tax and a generally pro-business environment have been touted as key to Texas economic development. However, specific state sponsored economic development initiatives have been key to Austin's growth as a Technopolis. For example, in 2003 the 78th Legislature enacted an economic development plan that included taking $390 million from the state's Economic Stabilization Fund (also known as the Rainy Day Account) to create a Texas Enterprise Fund (TEF), to help attract industry to Texas and to create jobs. TEF projects must be approved by the governor, lieutenant governor and speaker of the House.[19] The TEF was re-appropriated funding in 2005, 2007, 2009 and 2011. Clearly, Austin's growth as a major technology center has been enhanced with the use of TEF funds as exemplified in the recruitment of such high profile companies as Facebook in 2010, e-Bay in 2011, and Apple's major expansion in Austin beginning in 2013 as well as retaining companies that were in danger of being recruited away from Austin as was Heliovolt in 2007. To date, the TEF has invested more than $ 443.4 million and, it is argued, closed deals on projects generating more than 62,000 new jobs and more than $15.4 billion in capital investment in the state.

As a companion to the TEF, the Emerging Technology Fund (ETF) was created by the 2005 Texas Legislature to provide funding for research, development, and commercialization of emerging technologies. ETF grants have been awarded in the following three areas:

Commercialization Awards to help companies take ideas from concept to market.

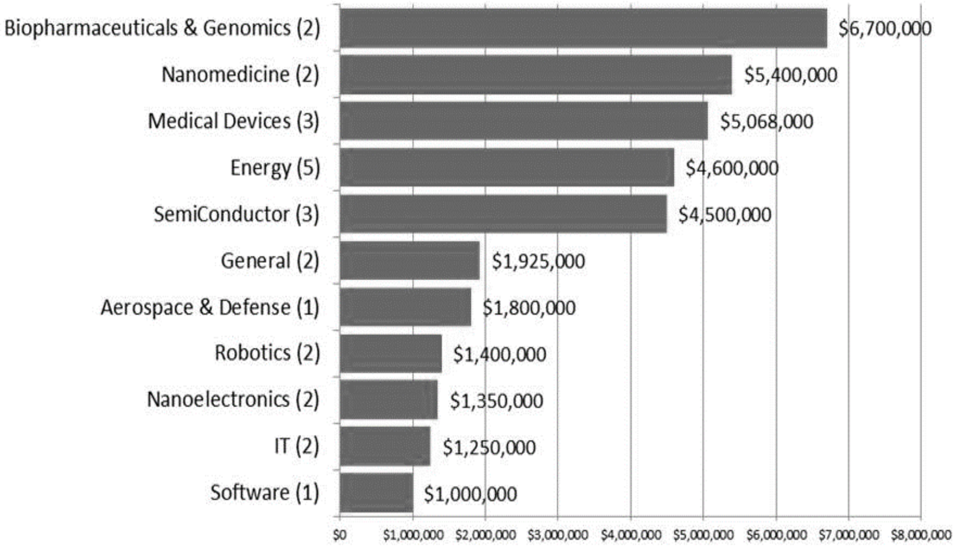
Matching Awards to create public-private partnerships leveraging the strengths of universities, federal government grant programs, and industry.

Research Superiority Acquisition Awards for Texas higher education institutions to recruit the best research talent in the world.

[19] The Fund grants discretion to the Governor of Texas when it comes to awards and this has drawn criticism from Texans for Public Justice among others while advocates call the Fund "a deal closer." Companies that pass the state's selection criteria are also usually approved for tax and other incentives from city and county levels and school districts if applicable (Brian Gaar, "Fund called a 'deal closer,'" AAS, 4/22/12: A10-11).

By 2012 the ETF had invested $192 million in 133 companies which made it the largest seed investor in the State of Texas. Outside investors put three times this amount in the startups which attracted almost $1.3 billion in investment. Under the ETF the State also awarded $178 million in research grants and other assistance to Texas universities including assistance in the recruitment of 52 "star" researchers and their colleagues. (L. Copelin, "Tech fund deals touted," in AAS, B1-2). As shown in Figure 9, in Central Texas (the Austin region), the TEF has invested $34,993,000 in 25 companies across 11 technology sectors. As required by the TEF, each of these companies has an affiliation with a Texas University. The University of Texas at Austin has research collaborations with 23 of these ETF funded companies.

Figure 9. Central Texas: Texas Emerging Technology Fund Commercialization Investments by Industry Cluster



Source: Greater Austin Chamber of Commerce, 2013.

City Government[20]

Since 1983, a key challenge in Austin's sustainability as a growing technology region, has been striking a balance between fostering economic development, a rising cost of living, and protecting the regions natural and cultural assets so prized in Austin. Ongoing grievances for tenured Austinites and new arrivals include lack of affordable housing, escalating property taxes and utility rate hikes, and increasing traffic congestion. Austin's growth has outstripped the capacity of existing roads and public transport and the citizens are conflicted over

[20] Austin's government is comprised of an elected mayor and six council members as well as a City Manager who is appointed by the City Council.

options to improve the situation such as light rail.[21] Austin's City Government has continually worked to maintain the region's attractive, diverse, and accessible quality of life for new arrivals as well as established residents but it has been a continuing challenge. As a result, over the years, mayors and council members have championed actions and policy that impact Austin in different, important, and often conflicting ways.

The Importance of Austin's Creative Industry

Much has been written in recent years about the importance of quality of life and creative enterprise assets in regional development. Richard Florida's *The Rise of the Creative Class* [Florida, 2002] documents the environments favored by workers who create ideas, technologies, and content in a variety of fields ranging from science and engineering to arts and music. Such environments foster climates that value diversity and creativity, freedom if economic opportunity, abundant natural amenities, and a thriving urban culture. Given Austin's education assets, green rolling hills, abundant lakes, thriving music scene, and openness to diversity the region exemplifies many quality of life characteristics desired by the "creative class."

Gibson and Rogers [Gibson, Rogers, 1994] credit Austin's historic music venues and cultural icons for inspiring the free and creative spirit and "Keep Austin Weird" culture. Austin's music scene gained significant momentum in the 1970's as live music artists and venues began to multiply.[22] The 1976 launch of Austin City Limits at UT Austin's College of Communication TV studio was a seminal event in the city's branding as "Live Music Capital of the World." After the pilot episode featuring Willie Nelson set fundraising records for Public Broadcasting (PBS), the show was launched by showcasing Texas blues, western swing, progressive country and Tejano music and overtime has included a diverse array of genres including jazz, alternative rock, folk music, and jam bands. In 2003, ACL was awarded the National Medal of Arts. ACL continues as the longest running music show in the history of American television and in early 2011 began its 37th season with the first live performance in the new Moody Theater and studio located in Austin's new W Hotel next to Willie Nelson Blvd. and the Willie Nelson statue in downtown Austin

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[21] "Austin America's Fastest Growing City" (Forbes, web May 2012). Austin's MSA population grew 37% from 2000 to 2010 as the population growth for Texas was 20.5% and for the US 8.7% (US Bureau of the Census). As of 2012 Austin is the 2nd fastest growing US metro area (at 3.9%) between April 2010 and July 2011. Austin Metro area's population is at 1.8 million. Austin's projected growth rate is 2.8%/year almost triple the national rate and is projected to be 2 million by 2015 and to double every 20 years.

[22] Threadgill's garage of 1950-60's, in addition to gas and an oil change, also served beer and music while welcoming local and emerging guest artists such as Janis Joplin and a wide sampling of local musicians. Armadillo World Headquarters (1970 – 1980) located in an old National Guard Armory was the iconic venue for established and yet to be established music talent as well as an occasional ballet, poetry reading, and other performing artists. The "dress as you want and come as you are," audience included university professors, students, bikers, cowboys and hippies all sharing the music, Shiner and Lonestar, quacamole and marijuana.

As Austin's live music scene developed and was increasingly seen as an integral part of the region's economy, the City Council, in 1991, declared Austin the "Live Music Capital of the World". The City's Parks and Recreation Department lends support by sponsoring musical performances, seasonal events and outdoor concerts that showcase local musicians. The City sponsors annual events that celebrate individuals who have made major contributions to Austin's music and creative environment. In terms of the gaming and digital entertainment industries the City and Chamber work with local educational and workforce development organizations to educate and train a highly skilled workforce for careers in gaming and film.[23] As of 2013 Austin's digital media industry is the 3rd largest in the US and is a hub for game development across casual, social media, mobile and online platforms. Austin-based IBM, AMD, Freescale, AT&T, Apple, Facebook, and Google develop hardware, products and services for next generation entertainment and media technologies. Employment in Austin's video game industry has grown from 2,848 employees in 2005 to 7,274 employees in 2010, with an annual economic impact of $1 Billion.

Support group sector

While considerably less developed in the mid-1980s than in 2013, the Support Groups sector (e.g., venture and angel capital, chamber of commerce, business professionals and associations) has been critically important to the launch, growth, and sustainability of Austin. Over the years such Support Groups have matured and multiplied in numbers and variety and have become increasingly important in building Austin's regional innovation ecosystem. Business-based support groups include professional services such as law, finance, accounting and related professional associations that foster regional entrepreneurship and innovation. Such groups are an important source of expertise and services for supporting Austin's entrepreneurs, new ventures, and for growing globally-competitive technology-based firms. A key contribution of these groups is providing the business know-how and to be able to scale select ventures to become major employers with their national and international headquarters based in Austin. Other Support Groups include those representing minority issues, environmental concerns, nonprofits, and community lifestyles. Such groups proliferated as

[23] The Austin Film Society founded Austin Studios in 2000 through a partnership with the City of Austin to lease about 10,000 square feet of production office space in what used to be airplane hangars and office space at the recently closed Robert Mueller Airport. Improvements to the facility include, at 87 feet, the largest cyclorama wall in Texas and two fully soundproofed production stages. Austin Studios goal is to support Austin's film and digital industry including offering areas for set construction, wardrobe, storage, and access to vendors as well as film locations and studios. To strengthen the local film industry the City passed a $5 Million bond initiative to upgrade the hangers to state-of-the-art soundproof, air conditioned studios with expanded bandwidth and access for digital film production.

Austin grew. For example, in addition to the formal and informal entrepreneurial support activities resident at UT Austin and other regional colleges, the City of Austin, and the Greater Austin Chamber of Commerce, a 2010 survey found 24 community-based organizations and associations focused on supporting entrepreneurs with 4 of these focused on women entrepreneurs and 3 representing minority groups; 16 groups (not including Austin's established VC and Angel organizations) providing venture funding advice including bootstrapping; 12 community-based education groups and 12 regularly scheduled entrepreneurial events; 6 incubators in addition to The Austin Technology Incubator; and 6 blogs focused on fostering regional entrepreneurship.

Civic and Social Entrepreneurs: Giving Back

An important category of community-based support groups concerns civic- and social-entrepreneurship and philanthropic foundations which are crucial to quality of life activities and are an increasingly important category of support groups integral to Austin's regional development. A good deal of Austin's current philanthropy comes from wealth created successful entrepreneurs who reinvest in their community in terms of social, cultural, and educational initiatives as well as business ventures. The Michael and Susan Dell Foundation established in 1999 is one of the largest family foundations in the US. Over the years the Foundation has committed $450 million to education, health and financial programs with the goal of improving the lives of children living in poverty worldwide. The Foundation gave Austin United Way its first $ 1 million contribution; $ 1.9 million to Austin's Seton Healthcare Network's Insure-a-Kid program to enroll uninsured local children in state - and federally-subsidized health insurance plans; $ 25 million to the DELL Children's Medical Center; $ 38 million to the DELL Pediatric Research Institute; $ 3.3 million to the Austin Independent School District, $ 5 million to the Ronya and George Kozmetsky (RGK) Center for Philanthropy and Community Service, and in early 2013 $ 50 million toward building a medical school at the University of Texas at Austin. DELL Corporation's spectacular growth enhanced the wealth of many DELL executives who have remained in Austin after leaving DELL and have continually given back to Austin with time, effort, and money with such important community projects such as The DELL Children's Medical center, The Long Center for the Performing Arts, and the Zachery Scott Theater.

Summary

The Austin case has identified key elements that accelerated the creation and supported the sustainable development including visionary leaders; a university with a high level of scientific and technological research; large and small technology companies linked in clusters of activity; supportive government policy especially at the local level; and a broad range of support groups working to sustain a creative and high quality environment. However, institutional excellence in any or all of academic, business, or government sectors is not sufficient. The present research has emphasized the key importance of boundary-spanning networking across all sectors by 1st and 2nd level influencers to achieve important community objectives, to build and sustain a regional innovation ecosystem, and to accelerate development through important mechanisms and processes.

We highlight several instances where influencers initiated mechanism and defined processes to facilitate collaboration across Austin's academic, business, government, and support sectors that facilitated the public-private collaboration needed to win the MCC in 1983; to fund endowed professorships and research center development at UT Austin; to launch the Austin Technology Incubator at UT Austin; to link state economic development funds and programs to university research; to transform UT Austin's Office of Technology Licensing to a more market oriented Office of Technology Commercialization; to build an entrepreneurial education support structure across the UT Austin campus; and to link economic development efforts of the city of Austin with those of the Greater Austin Chamber of Commerce and University of Texas.

Two cultural assets define Austin's DNA and have helped set the community apart from other regions that also have excellent research universities, public and private sector champions, and a high quality of life: One is the open and accepting "live and let live" or "Keep Austin Weird" culture that we suggest was born out of Austin's historic music and cultural venues and is sustained by Austin's current creative industries. It is important to emphasize that UT-Austin with its 50,000 students plus the region's other universities and colleges are central to attracting a seemingly never ending flow of young talent which continually energizes Austin's creative and entrepreneurial culture. The second defining asset or characteristic is the cooperative "can do" attitude that technology, social, and civic entrepreneurs exhibit when coming together at important moments to implement regional action strategies.

An important limitation of this study is that it focuses on one case in which considerable assets and circumstances helped launch and sustain the Austin Technopolis including the winning of important national competitions for major R&D operations, the discovery of oil on university land that has helped fund the education and research excellence at UT-Austin, and having a high quality of life exemplified by Austin's green rolling hills, lakes, an entrepreneurial culture sustain by young talent and a broad range of creative industries. In short, Austin enjoys important assets for community influencers to leverage to sustain the Austin Technopolis. While other regions in the US or in other nations may not enjoy such advantages, it is argued that all regions have positive assets -- whether human, geographic, cultural, or historic – that can be leveraged through public-private collaboration to overcome considerable challenges and to build creative and innovative ecosystems that are capable of producing wealth and jobs. We conclude that a key dimension of a sustainable technopolis strategy is the ability to grow and attract 1st level influencers and to nurture 2nd level influences that foster an environment of creative cooperation. Over the years, Austin has demonstrated that these influencers can come from the academic, business, government, or support sectors depending on a particular regional vision or challenge and depending who, at the time, occupies key positions of authority in each sector.

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THE ROLE OF TECHNOLOGY TRANSFER OFFICES (TTOs) IN EU MEMBER STATES, THE UNITED STATES AND POLAND

Abstract

High-tech markets encourage the inventors to apply their inventions to commercial project. Many new trends on the world markets depend on factors that generate the ideas and their capacity to be absorbed. The main goal of this article is to present the theoretical and practical contexts concerning Technology Transfer Offices (TTOs) activities. The paper presents the views and desk research results on TTOS, good practices from US and the UE countries and professors privilege idea as the main stimulants or barriers of high technology commercialization.

Practical part concentrates on and TTOs r future competitive perspectives. The examples of TTOs role on the high-tech market are based on the studies carried out by author at the US and the UE universities. The relationship between TTOs and scientists and entrepreneurs on emerging markets are examines in the article as well.

Keywords: Technology transfer

Introduction and theoretical outline

As scientists and engineers are the source of knowledge and technology that is transferred to industry, technology-transfer organizations have become crucial players in the commercialization process on the market. These organization have to be knowledgeable and enthusiastic in a university's and research and development institute's transfer efforts. A major part of TTO transfer activity is the passing of intellectual property from a scientific organization to business [Cart, 1992]. Technology Transfer Offices (TTOs) have been the central university organization in bringing university research to the market. They operate together with science and technology parks and business incubators for knowledge and technology

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transfer and business start-up development. The main goal of TTOs is to reduce the barriers between university–industry. The TTOs' interaction with entrepreneurs stimulates cooperation on the market in general. TTOs are also offices for recognizing patenting possibilities or acting as intermediaries between a university and patent attorneys [Muscio, 2010]. One of the first known TTOs is considered to be Wisconsin Alumni Research Foundation, established in 1925 in the United States of America [Apple, 2008].

Academic institutions develop offices for technology transfer which differ from each other. Government philosophy plays a specific role which is expressed through the commercializing of the inventions which arose from the use of public funds [Jansen, 1994]. Research organizations establish offices of technology transfer to seek patent protection on their inventions and commercialization opportunities. An additional reason is that a minority of academic scientists make the effort to commercialize their own scientific findings [Stevens, 2010]. The commercialization of scientific findings is based on knowledge from different fields, such as economy, law and management.

A typical TTO is a unit at universities or laboratories. The organizational model is based on the first steps in the commercialization process. Most research organizations have TTOs responsible for intellectual property management. American TTOs usually manage patenting and licensing processes. After a TTO recognizes the novel, useful and unusualness of an invention, it is responsible for applying for the patent and then it starts capitalizing on the potential technology or product. TTOs can license the intellectual property to an established corporation or create a new business (spin-off) to allow a new firm to exploit the invention [Apple, 2008]. These two main responsibilities make TTOs crucial organizations in negotiating between a university and industry in the case of knowledge and technology transfer. A critical part of the negotiations focuses on the expected commercialization pathway. Much of the negotiations is devoted to agreeing how much the value will increase by, what stage and how much of that increase in value should be shared with the university and scientists .

Basing on these assumptions, we can formulate the following aims of TTOs and the main knowledge and technology transfer activities:

1. Support from the university for entrepreneurship collaboration, and for the process of opening academic companies *(spin-offs and spin-outs)* - allows the numerous limitations of the first phases of the innovation process to be overcome, significantly increasing its effectiveness.

2. The search for tools for intensifying cooperation between science and industry within the frames of national policy brought about numerous top-down initiated concepts of networking.

Integration activities undertaken by universities can bring about very dynamic development of academic clusters within the academic environment, improvement of their image and measurable economic profits. Searching for tools for the intensification of science-industry cooperation within the national policy will bring numerous top-down initiated concepts of networking – science parks, academic incubators, technology platforms or innovation centers.

Collaborative research and personnel mobility are frequently highlighted by authors as important factors that strengthen knowledge and technology transfer and TTOs. Furthermore, knowledge and technology transfer and the activity of TTOs are taken into account more frequently if the joint research programs exist that promote direct scientist and entrepreneur cooperation [Sellenthin, 2009].

Hülsbeck et al (2013), analyzed literature which indicated an additional significant role of TTOs within the regional and national innovation system. They argued that the necessity of separate and specialized organizational units at the universities or R&D laboratories to manage industry–university collaborations had its roots also in regional innovation policy. TTOs are seen as the institutionalized way to transport and channel the ideas and inventions of academic researchers into the regional industry and society.

Good practice of TTOs at universities in the USA

The role of CTTs in E.U. countries, the USA and Poland follow similar patterns, however each country has their own specifics in the operations of these support units.

In the USA, CCTs grant licenses through universities. TTOs usually operate as a part of universities as Technology Transfer Offices (TTOs). Licenses are granted for an existing company or with the objective of setting up a new company. TTOs in American universities in their operations follow university regulations, however the standardization of operations was influences by the so called Bayh-Dole Act (an act on patent procedures at universities as well as in small and medium-sized companies), which facilitated patent granting of research results through universities by the scientific personnel. Apart from transfer of intellectual property rights to universities, this act clearly favors granting licenses to small and medium-sized businesses, which is why American TTOs implemented extensive procedures of cooperation with such companies. TTO operations (in USA, TTOs), through universities, stem from national regulations which clearly give universities the right to their own inventions created by their personnel, aided by government financial resources. Therefore, access to governmental resources demand from universities and TTOs the following: Passing information to government institutions as well as presenting a list of all inventions, patent applications and licenses granted for implementation of technologies funded from government resources to appropriate central agencies. As well as granting licenses for research results, another objective of American TTOs is to seek opportunities for further technological development. The cost of these activities is covered from the income generated by individual faculties from the sale of their research results[2]. TTOs in the USA also deal with internal issues connected with the distribution of income from the sale of research results to laboratories of faculties where the research was carried out, they also collect reports in which scientists inform universities about their cooperation with industry[3].

A typical feature for TTOs in the USA when compared with TTOs in Europe is the involvement of support centers in the negotiation of investment conditions in university companies. This is a result of the Bayh-Dole Act (passed in 1980), which prioritizes small companies in license granting. Managing licenses at American companies, TTOs participate in setting up university companies and supervising investor involvement in a start-up university company. Therefore, TTOs at American universities play the role of a middle-man between the author of the research results and any potential investor. The American university model of intellectual property protection, based on the Bayh-Dole Act, facilitates the selection of the most profitable university inventions (patents). This helps TTOs to control the effects gained from the commercialization of university patents by entrepreneurs more effectively and smoothest the information flow between an entrepreneur, inventors and a university.

The American experiences show that the form of technology transfer depends on the number of years of operation and experience of centers (offices) of technology transfer. More recently set up organizations mainly focus on the granting of licenses and license fee management. Bringing intellectual property in exchange for shares in a company is implemented mainly by more established centers of technology transfer which have experience in this area. The USA can boast great experience in the transfer of intellectual academic property to companies. This results from, amongst others, the fact that over two-thirds of patents registered by American institutions are academic patents (which may belong to both universities as well as companies) [4].

Core activities of TTOs in selected European countries

The discrepancy between the number of patents in Europe and the USA is huge. In Europe, the majority of university patents were registered in Holland and Great Britain (respectively, every fourth Dutch patent is applied for via universities, and every fifth British patent was registered by a scientist or university) [Lissoni, 2012]. Therefore, in Europe, one can observe a lesser importance attached to licensing and licensing fee management within TTO operations. Legislation in European countries in reference to TTO operations is focused mainly on

[2] TTO material, John Hopkins University.
[3] TTO material, Duke University.
[4] An academic patent is defined as one whose copyrights belong to at least one scientist.

the rights of universities, which manage projects and a scientist's rights to their inventions. The main objective of TTOs in European countries is bringing industry and universities together, accessing funds for intellectual property rights protection and support for further scientific research for industry and the consulting of scientists in their cooperation with business.

These differences in TTO operations in Europe also stem from institutional or individual rights to academic inventions. In the countries of Austria, Belgium, Denmark, Germany, Finland, Norway, Slovenia and Hungary, which limited or totally scrapped regulations granting scientists property rights to research results which were created in science and research centers, TTO objectives are extended by management of universities' and scientists' rights to the results and technologies from their research. Germany focuses its TTO objectives on the search for and preparation of offers for scientists and industry. It is facilitated by the industry structure in which many companies seat their research centers, cooperating with German universities or the search for a scientist to cooperate with. Similarly to Poland, TTOs operate as university institutions and commercial law companies (Stuttgart University may serve as an example, where management of intellectual property and university offers is taken care of by TTOs that operate through the Dean's office within university administration units and university companies as well as the implementation of research results carried out by the company–Technology Transfer Initiative GmbH). TTOs, through German universities, utilize a number of instruments which provide their professors with property rights to their inventions. These include contracts for carrying out scientific research in which the inventors are obliged to inform their employer in writing of the creation or application of any invention. Active cooperation of TTOs in Germany with industry provides universities with research funding, brings industry and universities closer, ensures greater resources for intellectual property protection and further research, equally allocates benefits from the commercialization of knowledge and technologies between universities and scientists, guarantees the competencies of personnel dealing with the commercialization of research results and a high degree of consulting for scientists cooperating with business[5]. However, TTO operations are highly influenced by regional policy and the market structure from which the innovations are generated. In Germany, within the framework of regional policy, two clusters were created within the last two years which concentrated on a very narrow sector. This impacts the specifics of TTOs within a given structure. Moreover, German inventions are introduced to the market and do not come to such an extent (as in Great Britain and the USA) from applied and development research in research centers. Innovations of small, medium-sized and large companies stem from market leaders' research in their own research centers (e.g. Siemens, Daimler, Volkswagen, Robert Bosch, SGL Carbon AG) [Hülsbeck, 2013].

[5] Internal data, Technology Transfer Initiative GmbH.

In France, first legislation of TTO activities took place in 1978. As in Germany, TTO operations are determined by the law that, since 1978, has regulated property rights for the inventions of employees, dividing them into two main groups: Company or independent inventions. The former are connected to the employee's responsibility to carry out research. Property rights for a company invention is granted to the employer. TTOs manage the right to a company's invention. The latter category refers to the situation when an employee was not obliged to conduct research and then the property rights belong to them. However, this category also includes so called transferable inventions, which occur as a result of performing a position in a company, and TTOs in many cases supervise cooperation of scientists with industry.

In Switzerland, Great Britain, Sweden and Italy, the role of TTO varies in the areas of management of licenses and research results created at universities. The variety of tasks stems from so called professor's privilege. Research results and industrial property produced through university activities belong to the scientist. Due to the greater creative freedom that exists at universities in Switzerland, Great Britain, Sweden and Italy, the transfer of results unbound and free from regulations funded from the public purse, TTOs have developed consulting services for scientists, newly set up university companies and external institutions seeking cooperation with universities. In recent years, Sweden and Italy have come in for criticism for the low level of commercial application of their research results in industry and for the low number of patents applied for by scientists (4% of all Swedish patents fall into the category of university patents). Despite the fact that Sweden has retained, until today, professor's privilege, introduced in 1949, a number of changes were introduced in the 1990s whose objectives were to boost interaction between a university and industry [Smith et al., 2013]. This has resulted in an increase in the effectiveness of knowledge and technology transfer centers, through science and research centers. TTOs have become centers of excellence, not only bringing universities closer to industry but also being involved in educational activities. The fact should be emphasized that the legislation in Sweden allows scientists to commercialize their research results and inventions themselves. As a consequence, TTOs are ignored by scientists when transferring knowledge and technology to industry. A scientist selects himself as an appropriate distribution channel for an invention on the market.

TTOs in Italy and Sweden are active participants in creating curricula for students, including those at a PhD level. Institutional changes, such as in Sweden, and organizational ones at Swedish universities, boosted the number of academic companies between 2003 and 2010, by almost 35% [Jacobsson et al., 2013] [6].

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[6] The increase in spin-off academic companies in the USA was even greater than in Sweden and stood at approximately 40%, comparing the years 2003 and 2010.

Great Britain does not possess the number of CCTs which are typical of other European countries or the USA. This role is performed by commercialization offices, centers for entrepreneurship, innovation centers and science parks. The variety of titles and goals stems from individual rights for inventions financed through the public purse. A scientist is free to choose the commercialization path. Support centers in Great Britain, through business related activities (e.g. consulting), and business-related infrastructure development, encourage science and technology commercialization within internal structures. Science parks, along with centers for innovation and technology transfer, not only prepare the path for patents, intellectual property protection strategy, licensing procedures and licensing conditions but also competences during business negotiations with a potential research results purchaser. Support institutions facilitate access to specialists of almost all fields[7]. British support centers enable scientists to use internal commercialization paths and access funds of seed capital through cooperating with universities. Support centers often allow further funding of scientific research, preparation of prototypes, invention and market testing or company start ups. Their main objectives depend on the following investment targets:

- Finding commercialization paths (market potential assessment, capabilities of interaction with a business or determining of implementation strategy).
- Determining the strategy of intellectual property protection.
- The development of an idea (conducting industrial research, creating a prototype, testing, further scientific research in the search for a new technology or product fit for market launch, pre-competitive research).
- Setting up a new company.
- Development of a company.

In Great Britain, a scientist is legally bound to report to a university support centre and to confirm their rights to research results in order to cooperate further with industry. However, cooperation with a university support centre is not compulsory, which is why university support centers are extremely active in ensuring the necessary consultation and facilitating the search for funding for research or technology transfer to industry.

The support centers that perform the tasks of TTOs in Great Britain are very scientist friendly. The scientist is the centre of attention of the support centers, as it is the scientist's decision what to do with the research results. A university, apart from economic rights (to a part of the income from commercialization), cannot demand rights to an invention or research results. The author of research results in Great Britain enjoys a free hand with partner selection and the manner of introduction of inventions to the market. Through consultation and extension of business related infrastructure, British support centers encourage commercialization of science and technologies within the university's internal structure.

[7] Internal data, Cambridge Enterprise, University of Cambridge.

Denmark is also a country whose TTO experience may serve as an example. In 1999, on the basis of the Bill on Innovations in Public Research Institutions, new objectives for university support centers were introduced. Danish universities, along with their TTOs, were obliged to report inventions of patentable capability to patent protection (changes do not refer to 'know-how' created at university). According to the new regulations, Danish TTOs have two months to make a decision whether to report an invention to patent protection or transfer it to the authors or investors. In Denmark (for the last 20 years), university support centers have carried out or developed activities connected with patent protection, utility and industry patterns and the search for buyers or investors for university inventions. According to the data obtained from technology transfer offices, in the first year of the bill, new regulations resulted in the doubling of patents reported to protection [Lissoni et al., 2009] [8]. Overall, since the 1990s, the objective of Danish TTOs, apart from patent protection, has been to increase the number of university inventions utilized by companies and to encourage investment in university inventions [Jacobsson et al., 2013].

Spain initiated changes in the intellectual property protection system in the 1990s. In their attempt to catch up with E.U. leaders, they were forced to change their attitude to science. Universities set up TTOs and introduced changes which concentrated on the transfer of knowledge and technologies to industry. An analysis of the intellectual property system at Spanish universities[9] pointed to a typical feature connected to TTO operations. The division of tangible benefits between scientists and universities in the process of research result commercialization mostly favors the inventors. Transfer of knowledge and technologies is dominated by a project manager's decisions. It is up to the project manager to decide how the net income is distributed. Therefore, Spanish TTOs are often involved in science and research project administration.

European support centers operating within university intellectual protection models most of all:

- Help businesses to utilize inventions of market potential
- Reduce the cost of the search for partners for economically viable inventions (patents)
- Supervise university property rights or confirm to the scientists the purchase of individual property rights
- Manage the process of industry property rights protection, their commercialization method and profit division
- Select and support scientists in the choice of intellectual property commercialization paths

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[8] Professor's privilege was exclusively at universities. The bill for employee inventions of 1957 did not extend professor's privilege to state research organizations.

[9] At the universities of Cadiz and Pamplona.

- Solve conflicts of interest among scientists, universities and university companies
- Supervise intellectual property created through teaching activities

Within the E.U.'s standardization activities, the Joint Research Centre (JRC) set up a European Technology Transfer Office (TTO) Circle. The objective of this institution is to initiate the cooperation of TTOs with the largest research organizations in Europe. At present, the aims of European TTOs include advertising best practice in knowledge and technology transfer, standardization of training for technology transfer brokers, setting up communication channels between TTOs and representatives of regional and national authorities in E.U. countries along with the introduction of international standards for professional technology transfer from science and research institutions to industry.

TTO operations in Poland

Many business support centers in Poland are called Centers of Technology Transfer and operate within a commercial market of knowledge and technology transfer in the area of public support assistance [Resende et al.,2013] as well as in the close environment of science and research and research and development institutions. The analysis of the role of TTOs in Europe and the USA points to the fact that Polish TTOs, at the set up stage, focused not on the role played in the structure of the knowledge and technology commercialization market but on their own financial needs, access to public funds in order to set up and develop support centers of knowledge and technology transfer in Poland as well as in the E.U., led to a clear division of the centers into so-called academic and those operating within the commercial market of knowledge and technology transfer. The former mostly addresses the needs of the university to manage intellectual property and to commercialize knowledge and research results, whereas the latter utilized public support for the processes of invention and innovative idea transfer to the economy. At present, the market of Polish TTOs is entering the stage of saturation with support funds and it is clear that support centers under the name of center of technology transfer should be affiliated with science and research or R&D centers. TTOs are institutions which should sign contracts that regulate any cooperation with academic and research centers. The contracts should state clear terms of conditions of cooperation and should remain active, namely by determining minimum cooperation [Mażewska, Milczarczyk, 2013].

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THE ROLE OF UNIVERSITY CENTERS FOR TECHNOLOGY TRANSFER IN THE COMMERCIALIZATION OF SCIENTIFIC RESEARCH RESULTS

Abstract

This paper discusses the transformations at modern day universities which, as so called Third Generation Universities, should, apart from their scientific and educational role, play an increasingly more active involvement in the objective of the commercialisation of research results. In this context, university technology transfer centres appear to be indispensable institutions if a university intends to commercialise its research results. The system of transfer and commercialisation of research results drawn up by Wrocław University of Technology is presented in the final chapter.

Keywords: Commercialization, technology transfer.

Changes in the significance and role of modern day universities

The educational system creates so called human resources capable of initiating and carrying out innovative processes through new discoveries and the technologies based on them. Being the final link in this system, universities play a crucial role and, with the steady and continuous advancement of civilization, are subject to significant changes within their lifespan. Currently, they are experiencing fundamental changes, shifting from the model of a university based on science towards one called The Third Generation University (3GU). Both internal and external university 'landscapes' undergo these changes. So far, universities have adjusted to changes in their own environment, e.g. starting new departments or new faculties, providing education in newly created disciplines. These changes however require a new perspective. The Third Generation University features several fundamental characteristics which are a real challenge for universities [Wissema, 2012]:

1. Basic research remains the core of a university's operations.
2. Research conducted should be largely interdisciplinary or even transdisciplinary.
3. 3GUs are network universities, cooperating with industry, R&D institutions and with professional service providers.

4. Such universities operate on a competitive international market, dynamically competing for the best scientists along with research commissioned by industry or governmental agencies.
5. The operation of 3GUs is twofold, they cannot avoid having mass appeal, however they should also gear specific offers to the best and most talented students and employees.
6. They adhere to the principle of consilience and creativity as drives as equally important as rational scientific methods.
7. Universities are cosmopolitan organisations, as they operate internationally and their students and staff come from diverse backgrounds. The English language has become the new lingua franca.
8. The application of gained know-how becomes, along with science and education, the third objective of universities regarded as the cradle of entrepreneurship.

The strategy for higher education, as well as the general strategy for education, is the subject matter of an ongoing discussion in nearly every country across the World. This stems from the simple fact that we would all like a broader and improved education for the next generation and are well aware that it conditions our future existence and wellbeing. At the same time however, we must bear in mind the expense, as the cost of research and education has been clearly on the increase for the last number of years. The difference between higher vocational education and scientific education has been sacrificed to egalitarianism. For example, the faculties of first level studies at most universities have little to do with scientific education, while the lecturers at these faculties receive a large portion of the state budget devoted to science. We spend considerable amounts on the illusion that all students are trained to be scientists, when in fact merely a handful choose a scientific career path. The division of universities into those which grant the titles of master and doctor and vocational universities would facilitate on the one hand the preservation of the role of 'true' universities while on the other boost the economy with graduates better adjusted to practical professions. It is of greater value to allocate funds for scientific research to the best scientists rather than sticking to a fictitious conviction that every university lecturer may and should conduct worthwhile scientific research.

The role and objectives of University Centres for Technology Transfer

Society avails of university research in a number of ways, and many scientific ventures are obliged to openly publish their results. When the research is not commissioned directly by industry but by the Ministry for Science or its agencies, has its own programme and avails of university funds and is market viable, then it can be sold or used to set up a new company. If so called commercialisation is to be taken seriously by universities then a specialised Centre for Technology Transfer (CTT) is required. The role of such a centre is key and should operate on principles different to a university department funded through the budget.

Based on visits paid to a number of centres in the majority of developed European countries, in spite of their individual differences, their objectives can be covered in several points. The main objectives of CTTs include [Turyńska-Gmur, Cichocki, 2012]:

- Identification and valuation of scientific, technological and innovative potential at a university, as well as in the region, building a database (offers of universities/regions), along with developing and sustaining networking between science and business.
- University intangible asset management – drawing up patent strategy (covering patent fees, selection of markets where protection is in place or foregoing protection), granted licence portfolio management, spin-off share management and support for scientists throughout the process of scientific potential protection (drawing up intellectual property protection paths, analysis of patent databases and available solutions – the so called patent landscape).
- Pre-investment studies and analysis of the possibility of solution implementation on national and international markets - in order to recognise the benefits of new products and technologies and their comparison with the existing alternatives, assessment of potential market size, evaluation of production and distribution costs as well as other necessary investment expenditure, etc.
- The search for companies and institutions interested in the implementation of discoveries produced by universities along with an indication of the best manner of commercialisation and assistance in liaising with international institutions.
- Support during the negotiations of licence agreements or intellectual property sales. After protection operations (e.g. in the form of patent applications), a commercialisation strategy should be designed. Commercialisation forms include the sale of rights, licence granting or setting up spin offs.
- Advertising and development of technological entrepreneurship – support for setting up spin offs.
- Assistance in finding sector investors

Based on discussions with representatives of these centres, and an in-depth analysis of information and documentation obtained from the CTTs visited, one may assert that the following factors are key to the success of university technology transfer systems:

- Strategic focus on cooperation between universities and the market, which mainly involves support for research that can be applied in the said market. Universities provide assistance for entrepreneurial ventures and participate in the economy of the region (guilds, incubators, technology parks).

- Highest level of research. Universities motivate their employees to obtain funds for research from various sources. Some universities have set the objective of the level of employee engagement in research. The successful cooperation with the market often becomes a point in periodical assessment.
- An interdisciplinary approach to science. An interdisciplinary character of scientific teams is key to success in the area of technology transfer. At present, mainly research stemming from various disciplines of science, both technological and social, as well as cooperation between scientists from various fields may initiate innovative solutions of commercial potential.
- Decisive investment in the technology transfer system. Universities are aware of the fact that gaining financial independence through CTTs is time consuming – it is necessary to identify and build a portfolio of patents, licence agreements and stakes in companies. This is why they are secured with regular funds in exchange for the implementation of set business objectives.
- University funds supporting innovations. When commercialising research results, a university often faces the problem of a lack of funds for creating a prototype or proof of concept. Leading universities set up their own seed fund to finance these elements (In Britain, university funds were created through a governmental project).
- Drawing up and communicating intellectual property protection right principles as well as cohesive and transparent internal regulations for CTT operations. Universities guard their property. Adequate rules come from university regulations, employment or cooperation contracts, while the division of benefits is clearly communicated and widely available. Moreover, fostering favourable cooperation conditions between scientists and business requires clear and transparent procedures along with an effective information flow which will increase efficient decision making. It originates from the structure and decision making process in the private sector, which relies on instant reactions and meeting deadlines.
- An experienced CTT workforce. Working for CTTs requires a number of skills. Consultants must be familiar with the fields of both technology and economy and must possess interpersonal skills to talk to scientists, business people and investors. CTTs employ experienced personnel often boasting doctorates, MBAs and having an impressive track record in industry.

The system of transfer and commercialization of research designed for Wrocław Univerity of Technology

Inspired by best practice from abroad, implementation of a fully functioning and self-financing System for Technology Transfer (STT) requires time, money and determination. Towards the end of the last decade Wrocław Centre for Technology Transfer (WCTT) commenced conceptual operations in order to determine the optimal system for this university. Moreover, since 2008, the university has been implementing effective processes in their university management. The possibility of obtaining external funds was a significant stimulus for the design of the system and its implementation. Since April 2011, the project of Construction of Technology Transfer System at Wrocław University of Technology underway.

When preparing an STT, it was assumed that it had to refer to all the aspects of technology transfer, which in the case of universities include:

1. Legislation framework guaranteeing the university proprietary interest to intellectual property which is a result of research carried out at the university. These include, among others, regulations in university statutes, rules and regulations, clauses in agreements with cooperants, employment contracts and agreements with students.

2. Monitoring of research conducted. Operations, geared on the one hand for the early identification of potential results in order to protect them, on the other, raising employee awareness and, as a consequence, facilitating the strategic goals of the research.

3. Research results protection systems. Scientists inform the appropriate body of an invention followed by an assessment of its commercial potential and implementing protection operations before the publication in scientific papers.

4. The hunt for companies and institutions interesting in applying the inventions, along with the indication of the best form of commercialisation. After protection operations (e.g. patent applications), a commercialisation strategy is drawn up, including the search for an external partner. Commercialisation forms include the sale of rights, licence granting or spin-off set up.

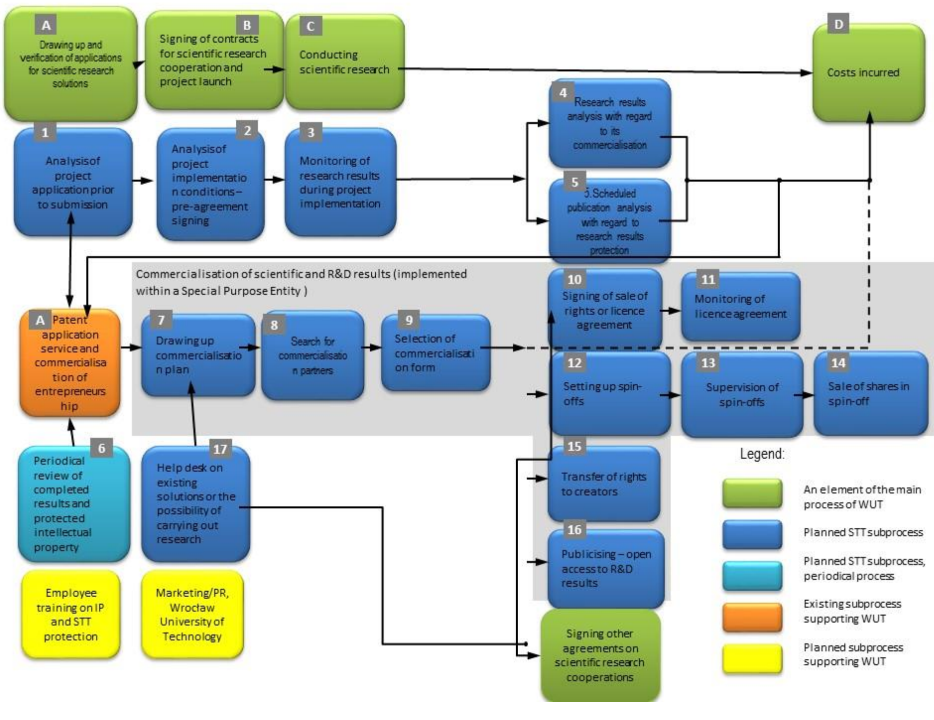
5. University intangible asset management. This refers to patent strategy (patent fees, market selection, protection market coverage, foregoing this protection), management of granted licence portfolio, management of spin-off shares (share in board of management, dividends, sale of shares).

As a result of conceptual work based on national and international experience, the project team, in December 2011, proposed an STT concept to the project's board of management and drew up a description of the subprocesses that constitute STTs. In January 2012, the above mentioned project consultations were conducted among the employees and PhD. Students of Wrocław University of Technology and a decision on the introduction of certain amendments was taken. The model below assumes compatibility of the technology transfer processes with process management concepts and a close link with other processes occurring at the university, research in particular. The chart of STT processes is presented in Figure 1.

The main objective of STTs is the maximisation of knowledge within research work for the benefit of society, business and the university. Thanks to STTs, Wrocław University of Technology is expected to identify economically attractive solutions arising at the university, to protect and then commercialise them in a manner ensuring optimal advantages for the university and its employees.

STT processes commence at the stage of writing an application for the funding of a research project. Selected project applications within a subprocess.

Figure 1. System for Technology Transfer processes at Wrocław University of Technology



Source: Own work.

1. Analysis of project application before submission, will undergo analysis with regards to commercialisation potential and their authors will receive feedback on the matter. At this stage of identifying solutions eligible for intellectual property protection, protection activities will be undertaken.
After granting funds but prior to signing an agreement, selected projects will be reviewed in the process, **2.** Analysis of project implementation conditions – pre-agreement signing, in order to identify and eliminate the risks that the project may pose and to ensure that the proprietary rights to a project's results will belong to the university.
Research work will be subject to periodical monitoring in order to identify

solutions of commercialisation potential. This will take place within the process, **3.** Monitoring of research results during project implementation. In the case of identifying such a solution, a subprocess, **4.** Research results analysis with regard to its commercialisation, will commence, which will result in, in the case of positive results, implementing pre-existing intellectual property protection processes. These processes will also include preparation of introductory plans (visions) of commercialisation. An extra subprocess will be, **5.** Scheduled publication analysis with regard to research results protection, which will encompass all prepared publications on the projects that fulfil certain criteria (obligatory) or submitted by authors (voluntary). In the case of identifying a solution with commercialisation potential, the intellectual property protection process will commence.

The above presented subprocesses are in parallel to the main research process at Wrocław University of Technology and are largely integrated with it. Therefore, STT effectiveness would benefit from the implementation of a comprehensive research project management system at the university. It would facilitate identification of research projects and their products, which should be the focus of STTs. As a result of the above operations, the university will be more dynamic in its search for commercially attractive results and will compile an intellectual property rights portfolio. The results collected during these operations will be implemented in other STT subprocesses.

The following STT subprocesses refer to the active search for recipients of the identified and protected intellectual property of Wrocław University of Technology. These subprocesses include:
7. Drawing up a commercialisation plan, **8.** Search for commercialisation partners, **9.** Selection of commercialisation form, **10.** Signing of sale of rights or licence agreement, **12**. Setting up spin-offs, **15.**Transfer of rights to creators, **16.** Publicising – open access to R&D results. As a result of operations within these subprocesses, for selected solutions owned by the university, commercialisation plans will be drawn up which highlight the benefits connected to the ways of transferring intellectual property rights to other institutions. For some solutions the university will actively look for recipients. In the case of an interested buyer, procedural processes will be concluded with the signing of an agreement of intellectual property rights transfer (in the form of sales, licence agreement or a spin-off).

All protected intellectual rights of the university will be monitored within the process, **6**. Periodical review of completed results and protected intellectual property, in order to identify solutions which will require changes in the commercialisation strategy.

Within the operations linked to the dynamic search for recipients of solutions belonging to Wrocław University of Technology, another subprocess has been put forward, 17. Help desk on existing solutions or the possibility of carrying out research, whose aim is to find solutions at the university required by external

institutions. This subprocess operates within the ‘pull’ model – transfer of knowledge arising from outside interest. Respectively, the subprocesses describe earlier operate within the ‘push’ model (transfer arising from the creation of new knowledge). Some projects that set commercialisation as their objective, in order to assess the cost, require implementation of other STT subprocesses including, **9.** Selection of commercialisation form.
After transfer of intellectual property rights, subprocesses whose aim is to supervise licencing agreements and spin-off commence. These include: **11**. Monitoring of licence agreements, **13.** Supervision of spin-offs, **14.** Sale of shares in spin-offs. As a result, the university is able to monitor what happens to its intellectual property and act accordingly.

The description of STT subprocesses at the present stage ignores the issue of consulting performed by university employees as well as renting of laboratories and equipment. These operations however are linked more to services rather than technology transfer itself. The project team will focus on these issues in the future. Consultation carried out highlighted that STT operations are significantly influenced by employee and student awareness (training on intellectual property protection and STTs) as well as marketing subprocesses linked to building the image of Wrocław University of Technology as an organisation competent in technology transfer and innovative solutions. These were included in the chart as indispensable elements supporting STTs.

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INTERNATIONALIZATION: CHALLENGES AND BARRIERS AMONG UNIVERSITY SPIN-OFF FIRMS – THE CASE OF FINLAND, NETHERLANDS, POLAND AND PORTUGAL

Abstract

Sections presented in this paper focus on project research of the authors. The problem of firms internationalization is the main issue of the paper. The sample of university spin-off firms pictured in the study has been composed within the framework of the Spin-Up study, an European project aimed at picturing key entrepreneurial skills in performance of university spin-off firms, particularly missing skills, in order to develop an effective training and coaching program to enhance growth. The countries presented are Finland, Netherlands, Poland and Portugal.
Additionally, paper shows the estimation results of two internationalization models, one for exports and the other for knowledge collaboration with partners abroad. In the final part, authors indicate the barriers for spin-offs firms internationalization on the base of five case studies.

Keywords: Spin-offs firms, the internationalization of firms activity.

Introduction: the challenge of internationalization

Internationalization of a firm can be described as extending business operations abroad, thereby crossing national borders. In a more advanced definition it is a combination of innovative, pro-active and risk-seeking behavior that crosses national borders with the intention of creating value in business activity [McDougall, Oviatt, 2000]. Most often it includes sales abroad, but it also encompasses imports, gaining specific knowledge, and subcontracting manufacturing to low-cost countries.

Various circumstances make the need for internationalization among small high-technology firms urgent. We mention the progressively disappearing of barriers and borders in the European Union (EU), exposing all EU firms both to new market opportunities but also to new international competition. In addition, specialized knowledge is increasingly created all over the globe. Thus, it is not only the US and Japan, but increasingly Brazil, Russia, India, China and Korea that develop global economic power and high-level R&D and innovation [OECD, 2012]. Accordingly, high-technology small and medium-sized enterprises (SMEs) that do not consider internationalization are imposing a severe restriction on their own potential for long-term survival and growth [EC, 2010].

The need for internationalization of high-technology SMEs, particularly university spin-off firms, has become evident by differences in performance measured in growth and innovativeness [EC, 2010]. In the EU, internationally active SMEs create more jobs, an employment growth of 7 percent versus only 1 percent for SMEs without any international activities, and international SMEs are more innovative**,** 26 percent of internationally active SMEs introduce products/services that are new for their sector in the country, versus 8 percent among other SMEs. Most recently, it is found, specifically for university spin-off firms, that among other factors employing international knowledge relationships tends to enhance growth, both with regard to employment and turnover [Taheri, 2013].

However, paths of extending economic activity abroad, be-it in manufacturing activity, exporting, collaborative research projects, etc., is littered with many stumbling blocks. University spin-off firms are often poor in resources and capabilities due to their young age and one-sided (technology) origin [van Geenhuizen, Soetanto, 2009]; [van Geenhuizen, Ye, 2012a], they lack for example market knowledge, marketing skills and financial investment capital. Drawing on research by the UK Department for Business Innovation & Skills (BIS) (2010) the following three types of barriers can be distinguished. First, there are *resource barriers*, like shortage in finance and human capital (absorptive capacity) to be able to identify opportunities and practical options, causing a poor 'readiness' for internationalization [van Geenhuizen, Ye, 2012b]. Second, there are *information and network barriers,* encompassing poor knowledge on opportunities in foreign markets and market segments, inability to contact potential partners and customers and establish an initial dialogue with them, and to build trustworthy relationships with key decision makers e.g. [Liu, 2012]. This type of barriers also includes cultural barriers, like lack of awareness and knowledge of local cultural norms, as well as language barriers. The third type of barriers is *legal and procedural barriers,* encompassing difficulty in dealing with laws, financial and tax regulation, product standards and patent and trademark issues.

All barrier types have a dynamic character, meaning that they grow/change with progress in internationalization and with growth of the firm. Barriers tend also to be different for the various models and entry modes of internationalization, for example, the mode of being present in the foreign country, namely, indirectly using an agent or directly present in an own site or office.

It is the very challenge for university spin-off firms to overcome above indicated barriers and reap the fruits of internationalization. However, there is not much knowledge about the extent in which university spin-off firms are internationalized [Taheri, van Geenhuizen, 2011]. In addition, what drives internationalization among these firms and which barriers are encountered by them, is not known due to scarcity of systematic research.

Against these backgrounds, the following research questions will be addressed in this chapter: (1) To what extent are university spin-offs internationalized? (2) What factors influence the strength of internationalization? (3) Which are most important barriers to internationalization and how can these be overcome? In answering these questions, we make use of a mix of the literature and original empirical work, by drawing on a sample of about 85 spin-of firms and five in-depth case studies selected among them.

Methodological aspects

The sample of university spin-off firms underlying the current study has been composed in the framework of the Spin-Up study, a European project aimed at picturing key entrepreneurial skills in performance of university spin-off firms, particularly missing skills, in order to develop an effective training and coaching program to enhance growth (URL: www.spin-up.eu). The countries involved are Finland, Netherlands, Poland and Portugal.

There are many definitions of university spin-off firms (USOs) [Djokovic, Souitaris, 2008]; [Bathelt et al., 2010]. We follow Pirnay et al. [Pirnay et al. 2003] by adopting the following definition: newly and independently established firms that bring university knowledge to market. This definition puts an emphasis on the knowledge/technology link with the university, and on availability of technology/innovation skills among the founders. Usually, members of the founding team of USOs are university staff and/or university graduates. Due to their one-sided origin, young age and smallness, USOs are facing various shortages in resources. A previous study indicates that the lack of marketing and management skills and understanding of the market act as an important barrier to growth [van Geenhuizen, Soetanto, 2009]. However, spin-off firms may be considerably different in resources at their start and subsequently, the resources they need to be able to realize their strategies [Mustar et al., 2006].

The aim of the research part of the international Spin-Up study was to identify which skills are present and which absent among the current management team members of the USOs. In picturing the skills [van Geenhuizen, Ye, 2012a]; [Oliveira et al., 2013], two selections were made, namely on age and size/growth. To avoid a large differentiation, age limits were set at 2 and 10 year, with the exception of those sectors where development and bringing inventions to market go relatively slowly, like in medical life sciences and material (nano) science (around 15 years). With regard to size/growth the sample represents the following variation: small as well as larger firms, and growing firms as well as firms that are stable or declining; this to enable to assess a 'causal' relation between absence/presence of particular skills (experience) and different growth patterns, including internationalization.

In this chapter, we use the outcomes of a full questionnaire in face-to-face interviews and a condensed questionnaire in a web-based/e-mail survey conducted in 2011 [van Geenhuizen, Ye, 2012a], in addition to the websites of the USOs. The following 'blocks' of questions are important for the current study:

1. *Entrepreneurial skills*: Presence/absence of entrepreneurial skills in the current management team (17 skills), for example, concerning technology, management, finance, market and marketing, internationalization, all measured on a five-point scale ranging from absence to strong presence.
2. *Background of entrepreneurial skills*: Education of team members (discipline and level) and pre-start experience concerning starting a firm, work, technology and/or management, and cross-cultural nature of this experience.
3. *Firm demography and growth*: Year of establishment; employment size at start and in 2011; size of turnover in 2011; level of internationalization, with regard to size of exports, presence (offices/site) abroad, and knowledge collaboration with partners abroad.
4. *Strategy and the business environment*: What the firm actually sells, for example, patented knowledge, end-products, advice, etc.; type/scope of technology activity (science-based or otherwise); newness of the product/process; intellectual ownership (IO) protection.

The sample size including valid responses on internationalization is 85 in total, meaning a non-response of 14.1 percent among 99 firms approached to fill in the questionnaires. The non-response is connected with filling out the web-based questionnaire and seems no reason for concern of causing bias. Responses per country are as follows: Finland (21 percent), Netherlands (33 percent), Poland (16 percent) and Portugal (29 percent), meaning an overrepresentation in the sample of spin-offs in the Netherlands and Portugal.

The methods used in this study include a descriptive analysis of strength of internationalization, an estimation of internationalization models to identify the most influencing factors including barriers, and an in-depth investigation of spin-off case studies that represent different strength of internationalization and different barriers.

Strength of internationalization

Among the USOs in the sample 56 percent is not internationalized with regard to export, but 44 percent is internationalized in this respect (Table 1). Among the last category, 19 percent reach a share of export in turnover between 1 and 30 percent, 8 percent a share between 30 and 60 percent, and 17 percent a share between 60 and 100 percent. This pattern means an almost equal part of USOs being modestly internationalized and strongly internationalized with regard to export.

Regarding knowledge collaboration, 28 percent of the USOs in the sample are not internationalized at all. A majority (72 percent) of the USOs, however, does employ knowledge relationships abroad, of which 46 percent on a moderate level (some relations) and 26 per cent extensively (many relations). The share of 72 percent is somewhat higher compared to another sample of university spin-off firms, drawn in the Netherlands and Norway, namely 62 percent [Taheri, 2013].

Overall, employing knowledge collaboration with a partner abroad tends to be more common than exports, which can be understood by considering the sometimes early development stage of USOs, producing no sales yet, and the comprehensive decisions in shaping exports, like concerning the country of export and the market segments, use of agents and market channels, product specification/standards, and adjustment to local needs, etc. Knowledge collaboration abroad, by contrast, can be established already in research at university (like in a PhD study) and in European research programs.

Table 1. Extent of internationalization of USOs (N=85)

Internationalization mode	**Share of all USOs (%)**
Exports (% of turnover)	
- No export	56
- 1-30%	19
- 30-60%	8
- >60%	17
Knowledge relations	
-No relations	28
-Some relations	46
-Many relations	26

Source: Own research.

Regarding availability of internationalization skills (Table 2), these skills tend to be absent among almost one third of the 85 USOs (30.6 percent), 44.7 percent consider having a strong presence of internationalization skills. It is possible that there is some positive bias here based on over-confidence among the responding managers. In addition, 24.7 percent tend to see no specific presence or absence. The importance of internationalization is well recognized by 14.1 percent of the firms, who understand that missing these skills severely hampers or will hamper their growth.

Table 2. Scores on internationalization skills (N = 85)

Scores	Share of all USOs (%)
1 (absence)	10.6
2.	20.0
3.	24.7
4.	23.5
5 (strong presence)	21.2
Missing internationalization skills hampering growth	14.1

Source: Own research.

Influences on internationalization

Theory and model structure

This section presents the estimation results of two internationalization models, one for exports and the other for knowledge collaboration with partners abroad. The theoretical background to the model is the resource-based view (RBV). Resources are inputs into a firm's production process, and if these inputs are valuable, rare and inimitable (including non-substitutability) than the firm faces the potential of achieving superior performance [Barney, 1991]; [Barney, Clark, 2007]. By extending the theory, it is also argued by Barney [Barney, 1991] that aside from valuable, rare and inimitable resources, the firm must also be able to take advantage of these resources by an appropriate organization, in other words by management to utilize these resources most effectively while interacting with the environment [Wiklund, Shepherd, 2003].

Establishing international relationships is one of the aspects of organization, through which the resources of the firm can be improved or through which a better use can be made of the available resources. However, internationalization also requires the use of available resources, like skills in dealing with cultural borders and with institutions and regulation abroad, management time, and investment capital.

The following factors are included in the model: age of the USO, cross-cultural pre-start experience, the sector in which the USO operates, the country, and various entrepreneurial skills. These will be discussed in more detail below.

Drawing on resource-based theory, it can be argued that internationalization increases by age of new ventures through the progressive accumulation of experience and generation of profitability, the last allowing for internal financing of various steps in internationalization. The accumulation of experience (learning) increases the ability to sense changes in the business environment, to select the important changes, respond to them and translate that into new actions, strategies, etc., among others the strategy of internationalization. This ability is also named 'absorptive capacity' [Zahra, George, 2002; Taheri, 2013].

The moving of young ventures towards internationalization, specifically exports, after various years of existence, refers to the so-called 'gradual model' as a fairly slow process, in which the firm adapts its international activity incrementally through learning and dealing with risks. However, aside from this model, there is the model of 'born globals', a type of high-tech ventures that is internationalized from the beginning [Madsen, Servais, 1997; Knight, Cavousgil, 2004]. Crossing national borders already takes place during or quickly after inception, as the founding team has already developed networks abroad and uses these to access foreign markets. This model is often associated with dynamic environments, in which 'newness' is taken as a positive asset and not as a negative factor that needs to be solved first on the basis of the firm's learning experience. Accordingly, the influence of age on internationalization may be questioned, however, how planned or unplanned the involved strategies are, can also be questioned [Crick, Spence, 2005]. There seems some doubt on following conscious strategies according to one of the two models and this points to the idea of 'opportunistic behavior', that is responding to main opportunities that arise in internationalization, not matching the two models.

Aside from age, a second factor in the model is availability of pre-start working experience, specific its cross-cultural character. Pre-start experience of members of the founding team may be a valuable resource for internationalization if cross-cultural aspects are involved [Reuber, Fisher, 1997]. Examples are being familiar with different 'ways of communication', like straightaway (direct) or more indirectly, and dealing with different hierarchies in working relations and in the relation with government officials. In general, the availability of pre-start experience and subsequent learning is increasingly addressed in the recent literature on new ventures, specifically regarding internationalization e.g. [Colombo et al., 2005]; [Clercq et al., 2012; Taheri, 2013].

As a third factor, we mention that ways of learning and spatial reach in learning are associated with different industry sectors in which the firm operates (science-based or otherwise) [Tidd, Bessant, 2013; Asheim et al., 2007]. Accordingly, in science-based sectors, the learning deals with laws of nature and tends to be globally oriented due to the universal character of science, while in other sectors the adaptive (problem-oriented) learning, as it is pushed more strongly by demand or market context, tends to benefit more from local or regional face-to-face contact.

As a last factor in this 'block', the country is included because internationalization may be pushed more strongly in small and open economies compared to other ones. For example, the Netherlands and Finland's domestic economies tend to be small and open, while Portugal is also facing a small domestic market but needs to develop a higher degree of openness. The same need for openness tends to be true for Poland, particularly in science-based sectors.

On a different ‘level’, internationalization may vary according to missing skills, mainly on internationalization itself, but also skills that are related, like concerning marketing, sales, gaining financial capital and economic principles.

The above means that our models on internationalization include two different ‘blocks’, the first encompassing three spin-off profile factors related to resources and the country of location (Table 3). The second ‘block’ encompasses specific entrepreneurial skills, selected as a result of a systematic scan using single correlation of 17 entrepreneurial skills with exports and knowledge collaboration, and indicating a high correlation. As a result of this selection process, internationalization skills, sales skills, and skills in economic principles of high-tech entrepreneurship are chosen out of the 17 skills and included in the model.

With regard to the profile, USOs in our sample are on average seven years old and they are mainly active in non-science-based sectors (64 percent of USOs). In this category, there is dominance of ICT including software technology (40 percent). Firms active in science-based sectors are a minority (36 percent) and mainly involved in life sciences (14 percent) focusing on new medicines but also products for advanced processes, like geno-typing. Material science serving, for example, new batteries, diodes, and membranes, is a smaller science-based sector in the sample.

The availability of cross-cultural experience, gained in internationally oriented PhD research, a career as an international scientist or as a manager in an international firm (often abroad), turns out to be very different among the USOs in the sample, among others dependent upon the number of management team members with such experience (Table 3). The average years per USO amounts to about 15, with a standard deviation of 21, in a range from 0 to 80 years, the last indicating that there are USOs without any cross-cultural experience and those of which almost all management team members have gained such experience in previous jobs abroad or in an international company in the home-country. An abundant cross-cultural experience is often found in science-based firms, as a result of various rounds of ‘professionalizing’ the management team, thereby replacing young founders by more experienced business professionals.

With regard to skills (Table 3) internationalization has the lowest score of the three selected skills, but also the largest standard deviation indicating relatively large differences between the USOs. In fact, however, the average scores are close to each other, in-between 3.25 and 3.50.

Model estimation

Two different types of regression analysis are applied, namely, Tobit Regression with regard to export, this because the size of export is censored as a percentage of turnover between 0 and 100, and Ordered Logistic Regression with regard to knowledge collaboration, because this variable is measured at the rank level.

Table 3. Model and descriptive statistics

Descriptive	
Number of USOs	85
Dependent variables	
Size of export: share in exports in 2011 (% of turnover)	Avg.: 0.22; Sd.: 0.35; min-max range: 0-1
Knowledge collaboration: knowledge collaboration abroad (% of all USOs)	No: 28% Some: 46% Many: 26%
USOs profile	
Firm age: continuous variable as number of years since firm foundation	Avg.: 6.67; Sd.: 3.43; min-max: 2-17
Cross-cultural experience: continuous variable as the added sum of years of founders' cross-cultural experience in management or technology *(log transformation in model)	Avg.: 14.80; Sd.: 20.75; min-max range: 0-80
Sector: variable in two categories, science-based (1) versus non-science based (0)	Science-based: 36%; Non-science based: 64%
Country: dummy variable indicating location of the firm	Finland: 21%; Poland: 16% Portugal: 29% Netherlands: 33%
USOs Entrepreneurial skills	
Internationalization skills: doing international business, crossing cultural borders	Avg.: 3.25; Sd.: 1.29; min-max range:1-5
Sales skills: negotiation, contract arrangement and control	Avg.: 3.33; Sd.: 0.90; min-max range:1-5
Understanding economic principles of high-tech entrepreneurship: e.g. cost-profit relations, economic indicators, risk-taking	Avg.: 3.47; Sd.: 1.03; min-max range:1-5

Source: Own research.

Note that in order to prevent multi-collinearity, the two 'blocks' of independent variables, the one on USOs profile and the one on entrepreneurial skills, are inserted into the model separately (Table 4).

The beta-coefficients of age are positive and significant only for export, the ones for cross-cultural experience are positive and significant both for export and knowledge collaboration, and the ones for science-based sector are positive and significant only for knowledge collaboration. Surprisingly, country of location yields no significant results. The previous outcomes lead to the following interpretation with a view on barriers:

- The older the USO the larger the propensity for export, suggesting that spin-offs tend to first develop a position in the domestic market and then to develop export. Lack of basic resources seems the major barrier at young age.
- The more cross-cultural experience, the stronger the involvement in exports and knowledge collaboration abroad. Lack of such experience tends to act as a barrier most often in teams of young graduates without any pre-start working experience causing difficulty in finding the right partners abroad and dealing with cultural differences.
- Being active in science-based sectors gives a high propensity of knowledge collaboration abroad. This is not true for export, a situation which seems not related to barriers but to the specific development stage of science-based USOs, in which they have no substantial sales yet, like in new medicines in life-sciences.

With regard to entrepreneurial skills, the beta-coefficients of absence of internationalization skills are negative and significant both for export and knowledge collaboration, the ones of sales skills are positive but not significant, and the ones of economic principles skills are negative and significant only for export. The previous model results lead to the following interpretation:

- The absence of internationalization skills tends to severely limit the propensity to develop both export and knowledge collaboration. This relationship underlines the consistency of the study, and indicates the influence of typical internationalization barriers, like difficulty in attracting capital to finance export activities and difficulty in presenting the firm in international partnerships and taking benefit from them.
- The less understanding of economic principles of high-tech entrepreneurship, the weaker the propensity for exports. This relationship indicates the influence of some specific barriers, namely in reading/valuation of economic indicators of firms, particularly costs and profits and risk of export.

Table 4. Results of regression estimation of export and knowledge collaboration abroad

	Export (Tobit)		**Knowledge Collaboration (Ordered logistic)**	
	β (s.e.)	β (s.e.)	β (s.e.)	β (s.e.)
USOs profile				
Age (firm)	0.17 (0.07)**		0.45 (0.42)	
Cross-cultural experience	0.04 (0.02)*		0.35 (0.15)**	
Sector (science-based = 1)	0.09 (0.08)		1.37 (0.49)***	
Country of location	0.01 (0.03)		-0.08 (0.19)	

	Export (Tobit)		Knowledge Collaboration (Ordered logistic)	
Entrepreneurial skills (ranked 1-5)				
Absence of skills in internationalization		-0.09 (0.03)***		-0.61 (0.18)***
Absence of sales skills		0.02 (0.04)		0.27 (0.25)
Absence of skills in economic principles		-0.08 (0.04)**		-0.33 (0.22)
N	84#	85	84#	85
LR Chi^2	12.56**	17.93***	21.74***	16.99***
Pseudo R^2	0.20	0.29	0.12	0.09
Log likelihood	-24.49	-21.69	-78.82	-81.98

* p<0.1; ** p<0.05; *** p<0.01

#: One spin-off missing for cross-cultural experience.

Source: Own research.

In the next section, specific attention will be paid to barriers and overcoming them using various representative case studies.

Barriers to internationalization

The case studies to be used in the analysis are selected according to the schedule in Table 5. The differences refer to the prevailing influences on internationalization as discussed above, mainly age, science-based activity, cross-cultural prestart experience and internationalization skills.

Case study 1

This firm is a combination of young age, lack of prestart cross-cultural experience, non-science-based activity, lack of internationalization skills (score of 1), but high presence of skills of economic principles concerning high-tech entrepreneurship. The firm entirely focuses on the domestic market and it employs some knowledge collaboration abroad. With this profile and skills pattern, the firm – active in design and producing hygienic products in elderly care as a wireless notification system - represents young USOs that hesitate to develop exports, they first want to establish a solid position in the domestic market and actually lack the required resources and the internationalization skills. The firm is not profitable yet, meaning that there is no capital available for setting-up the activities preparing for export, and due to a quick growth, the firm is also missing management time. Without any experience abroad, the outlook for developing exports on the short term, seems really weak.

At the same time, the market for products/systems of the firm is clearly growing and – though the product/system is patented – similar products could be designed abroad and become a serious threat to the firm. Accordingly, instead of following the 'stepwise' model, the firm may be advised to develop the domestic and some foreign markets, with sufficient similarity to the Netherlands' elderly care (like in Germany, UK and Scandinavia) simultaneously. This would mean gaining financial support from a solid investor and adding at least one new manager to the team, particularly a person with large cross-cultural experience and familiar with the healthcare market for elderly, who can bridge the information and network barriers. If this is not affordable, customized training/consultancy may work.

Case study 2

This spin-off is a combination of very young age, lack of prestart cross-cultural experience, non-science-based activity, strongly present internationalization skills and moderately present skills on economic principles. This spin-off is almost only active in export markets and employs some knowledge collaboration abroad. It clearly exemplifies 'born globals'. With its patented solar simulators (single/systems) as testers for improved solar cells, the firm is strongly specialized and depends totally on a global niche market. Though this spin-off is highly involved in export, it nevertheless is facing various barriers. One is lack of skills in contract negotiations and in 'tactics' to gain satisfactory contracts abroad. Another one is not knowing how to deal with the 'risk of copying' in China, but the firm takes the risk.

Table 5 Selection framework of case-studies

Spin-off (size in 2011)	**Exports/knowledge collaboration**	**Age (2011)**	**Cross-cultural experience**	**Science-based/ otherwise**	**Internat. Skills**	**Economic principles skills**
Case study 1 (7 fte)	No export Some collaboration	3 years	None	Non-science	Score of 1	Score of 5
Case study 2 (5 fte)	90% export Some collaboration	2 years	None	Non-science	Score of 4	Score of 3
Case study 3 (7.5 fte)	Small export (5-10%) Strong collaboration	7 years a)	6 years	Science (life-sciences)	Score of 2	Score of 3

Spin-off (size in 2011)	Exports/knowledge collaboration	Age (2011)	Cross-cultural experience	Science-based/ otherwise	Internat. Skills	Economic principles skills
Case study 4a (175 fte)	-100% export Strong collaboration	12 years	44 years (2 managers)	Science (physics)	Score of 5	Score of 5
Case study 4b (8 fte)	-80% export Strong collaboration	10 years	69 years (3 managers)	Science (material science)	Score of 5	Score of 3
Case study 5 (80 fte)	No exports Strong collaboration (strategic alliance)	9 years	80 years (4 managers)	Science (life-sciences)	Score of 5	Score of 3

a) Predecessor firm

Source: Own research.

Case study 3

This spin-off is a combination of a somewhat older age, some years of prestart cross-cultural experience, science-based activity, a low presence of internationalization skills and moderately present skills on economic principles. So far, the spin-off has only developed small exports of its patent-based genotyping system which is gaining importance in the development of ‘personalized’ medicines. However, the firm employs extensive knowledge collaboration abroad, the last in the EU FP7 context. The modest level of export – perceived by the firm as a main problem – can be ascribed to a complex situation of shortage in skills and capabilities in interaction with the Polish and foreign business environment for science-based spin-offs [Mroczkowski, 2010].This includes difficulty in attracting venture capital to finance the development of export, and difficulty in accessing marketing channels and in adopting sales capabilities that are effective abroad, particularly in the pharmaceutical industry. Hiring a sales person from abroad is relatively expensive and not always successful. What may remain as a solution is to use the EU research network to attract attention from a pharmaceutical firm abroad and develop a partnership (strategic alliance). Learning from other partnerships in the sector in finding the right partner and extracting the full benefits from a working partnership, may support this approach. A recently awarded financial grant may increase ‘credibility’ of the firm in this effort.

Case study 4 (a and b)

Spin-off 4 (a) is a combination of older age, many years of prestart cross-cultural experience, science-based activity (physics), strongly present internationalization skills and equally strongly present skills on economic principles. As a ‘born global’, the spin-off merely sells abroad and employs much knowledge collaboration abroad. With its patented technology of optically ‘writing’ in chips (lithography machines), the firms' sales are confined to a small global niche and knowledge collaboration to the few (potential) global customers. The huge availability of cross-cultural experience has facilitated this strong internationalization since the start of the firm through an internationally oriented founding professor, and it was reinforced by 'professionalizing' the management team in the course of the years. With an employment size of 175 fte, this spin-off is also the largest among the case studies.

While the previous spin-off operates in the Netherlands, similar ones are in Poland, represented by spin-off 4b, these are particularly similar in the high level of exports and science-based character, but tend to be stronger connected with the university or Polish Academy of Science. It seems that these spin-offs cannot do without strategic alliances with large firms abroad or without partial ownership by a venture capital firm that provides investment capital and crucial internationalization skills. Two important skills in Poland tend to be to motivate employees to increase work efficiency up to international levels and to successfully negotiate about finance and strategic alliances in situations mainly abroad. Spin-off 4b is active in advanced membranes covering a large market with many applications, but it is clearly relatively small (8 fte). This situation results from a strong integration with activities at the university, meaning that on a daily basis and particular in times of high demand, university employees and students fulfill various tasks for the firm.

Case study 5

This spin-off, active in patented medicines, is a combination of older age, many years of prestart cross-cultural experience, science-based activity (life sciences), a strong presence of internationalization skills and moderately present skills on economic principles. In fact, this spin-off is similar to spin-off (4a) with two differences: first, the spin-off has no export, because the new medicine is not yet for sale (still in clinical testing), and secondly, the spin-off acts - since 2009 - within a strategic alliance with a large foreign pharmaceutical industry, as a source of innovative research results 'in exchange' for financing and advice. The current management team is clearly different from the founding team, with a strong emphasis on managing and financing, and without 'technocrats'. As a consequence, various previously missing skills are now present in the management team of the spin-off. There remains, however, one particular skill to be further developed, namely the skill as a manager to present himself in international meetings in a convincing fashion, to negotiate with power in different international 'arenas' (partner, shareholders, venture capitalists) and to achieve the best results for the firm. Practical courses may support in achieving such skills, in which actual presentation, negotiation and persuasion situations are simulated and in which can be learned from other managers.

Summary and discussion

Increasing evidence in the literature suggests that high-tech SMEs, in particular university spin-off firms, which are acting internationally, perform better than their counterparts without internationalization. This chapter had a focus on export and knowledge collaboration, while addressing the following questions: (1) To what extent are university spin-offs internationalized? (2) What factors influence the strength of internationalization? (3) Which are most important barriers to internationalization and how can these be overcome? These questions were answered drawing on a mix of the literature and original empirical research, a sample of 85 spin-of firms and five in-depth case studies.

Spin-off firms tend to be widely different in strength of internationalization, namely export varies from null to 100 percent and knowledge collaboration with partners abroad varies between no collaboration and strong collaboration. The share of firms active in export is 44 percent, while the share of spin-offs employing knowledge collaboration abroad is 72 percent. This pattern means that with regard to improvement a larger effort is necessary for export to be increased compared to knowledge collaboration. Given the limited scope of the study, the following influencing factors and challenges could be identified using multiple regression analysis and case study analysis.

- *Age of the spin-off* tends to influence export positively, indicating a gradual model of export development. Access to basic resources, like financial capital and human capital, is the main challenge aside from access to information and networks, in moving to a model of simultaneous growth in domestic and foreign growth.
- *Prestart cross-cultural experience* tends to influence both export and knowledge collaboration positively, indicating the challenge among young graduates' firms to access information and networks, and probably also to deal with legal and procedural barriers.
- *Activity in science-based sectors* tends to positively influence knowledge collaboration. However, main challenges in exports are increasing labor productivity and improving access to market channels and international partnerships (strategic alliances) (like in Poland).
- *Internationalization skills*, if absent, tend to negatively influence export and knowledge collaboration, indicating mainly challenges in improving access to information and networks, like market channels and sales/marketing tools.
- *Skills in economic principles*, if absent, tend to negatively influence export, indicating challenges in improving particularly costs/profits and risk of exports. Note that signs of barriers and challenges were somewhat weak in the case studies.

The case-study analysis also produced some interesting additional results on missing skills. So far badly identified are missing skills in the performance of managers in personal presentation ('how to convincingly present myself') and in negotiation and persuasion in establishing financial contracts and partnership agreements abroad. One way of responding to this situation is adding professional managers (if affordable) to the management team, and another way is partnering with investment companies that provide some of the specific skills. Coaching of managers with strong personal attention and learning in simulated negotiation and decision-making may also be a solution.

Training and coaching may also be effective in another situation, namely, in which the development of export among young spin-offs, elaborating a promising innovation, needs to be accelerated and access to resources, particularly information and networks but also financial resources, needs to be improved. Customized learning in small groups, mixed with personal consultancy, in which experience of similar spin-offs plays a substantial role, may be important here [SPIN-UP Program Evaluation Report, 2013].

At the same time, internationalization – mainly concerning exports - should be a well-considered part of the overall strategy of the spin-off, requiring a sufficient managerial commitment and a full integration with resource-allocation, as well as the design of an export plan [van Geenhuizen, Ye, 2012b]. All this means that strategies concerning export cannot be changed overnight and not in the same way. Overall, we may conclude that solving barriers to internationalization requires a multi-faceted approach and that there is no solution as 'one fits for all', due to differences between spin-off firms.

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COOPERATION BETWEEN HIGHER EDUCATION INSTITUTIONS AND BUSINESS IN THE PROCESSES OF KNOWLEDGE TRANSFER AND TECHNOLOGY COMMERCIALIZATION – THE CASES OF UNIVERSITY OF TEXAS HEALTH SCIENCE CENTERS

Abstract

A very competitive environment and dynamic changes in the global economy have forced private and public sector institutions to unite in their efforts to foster the diffusion of knowledge within innovation systems. This has led to a focus on long-term commercialization partnerships rather than single transactional exchanges. This paper provides insights into such partnerships by outlining the role of the integration of relationship marketing, especially internal marketing and technology transfer theory. Such an attitude may provide a novel framework for understanding research-oriented university-industry relationships. The paper describes two different models of knowledge transfer and commercialization in the area of biotechnology, implemented by two Technology Transfer Offices in the USA: The Health Science Center in San Antonio and Houston Health Center.[1] Both centers belong to the University of Texas and work in a similar organizational and financial environment. The results should be of particular interest to universities, research units, technology transfer offices, industry managers, consultants, new technology brokers and other bodies aiming at researching commercialization success.

Keywords: Cooperation, knowledge transfer.

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Technology Transfer Offices in commercialization processes

The overall macroeconomic objective of technology transfer is to strengthen economic development through increased innovation, create new jobs and capital. Successful cooperation of higher education institutions in synergetic relationships with governments and businesses (the 'triple helix') [Etzkowitz, 1998] is considered to be an essential driver of knowledge-based economies. It has even been argued that too much focus upon transactional mechanisms such as licenses and patents may distract from the development of personal intimacy and trust [Dooley, Kirk, 2007]. According to certain recent research, relationship drivers, especially mutual trust, commitment and respect, are the highest rated commercialization success drivers [The State of European…, 2011].

Technology Transfer Offices (TTOs) play a main role in commercialization processes in Poland. They create a diverse group of non-profit organizations offering consulting, training and information services active in the area of technology transfer, commercialization, and all tasks accompanying this process [Matusiak, 2001]. TTOs' activities at the interface between science and business should result in the adoption of modern technologies by small and medium-sized companies or the creation of new businesses based on new technologies, thereby contributing to the increasing innovation and competitiveness of enterprises and regional economic structures. TTOs are designed to provide a kind of buffer, allowing for the conciliation of commercialization, research and teaching activities at universities. Professional technology transfer institutions first began to emerge in the world in the late sixties in American and British universities in the form of university technology transfer departments, whereas the first Polish TTO appeared in the early nineties. Thus it is important to study different models of TTOs from more advanced countries to find out the best practices. The theory of commercialization identifies two types of technology transfer: transfer arising from research and directed towards commercialization, and transfer of creative and innovative technologies to create companies [Trzmielak, Wojciechowicz, 2013]. The key drivers in both types are well-educated people supporting the commercialization process.

In technology transfer offices different approaches to commercialization can dominate depending on what primary emphasis is put on:

1. The technological approach - to promote scientific development of research units and support the development of new technologies.
2. The relational approach - to promote and develop a culture of cooperation in the research community.
3. The economic approach – to use innovation to support the economic development of a region.
4. The market-based approach – research results as a product which needs to hit the market.

The role of the TTOs, which in Poland mostly operate as an internal administrative unit of the university, is to search for and discover innovative solutions primarily at the universities but also to assess the commercialization potential of external innovation, marketing of innovations, and introducing new technologies to the market.

The primary purposes of TTOs include [Matusiak, 2009]:

- Assessment of science and innovation potential at the university and regional level,
- Creation of databases of innovative ideas and technologies,
- Development of relationship networks between science and the economy,
- Assessment of the commercial potential of innovations and other pre-investment analysis,
- Identification of the needs of innovative units (technology audit),
- Popularization, promotion and development of technological entrepreneurship.

The nature of internal marketing

Internal marketing is closely related to the concept of a company which is based on the search for synergy of technical and psychological factors. In this type of organization the use of participatory techniques and distribution of responsibility is assumed, and the company's internal environment is treated as a system of setting targets and discussing ideas designed to lead to the most effective solutions. Internal marketing cannot be developed in an organization where there is a principle of absolute subordination. There must be a climate conducive to the implementation of employee goals and ideas. Internal marketing can function effectively only in an open internal communication which allows the gathering of high quality information regarding the expectations of the employees. Traditional internal marketing refers to the company’s environment and results in the higher quality of customer service. However, internal marketing is not just the simple organization of internal communication, it should also create conditions for a competitive market to create a variety of internal products corresponding to multiple needs and their promotion. This refers to includes the needs of self-realization. It is conducive for the creation of innovative ideas, which is why it could also be helpful in fostering commercialization processes at research and higher education institutions (HEIs).

J.Otto gives the following basic principles of internal marketing [Otto, 2004]:

- Each organization has its own internal market,
- Each employee is an internal customer of an organization.,
- On the internal market, there are at least two bidders (the employer and the people implementing the objectives of the company),

- The internal market has its own life, moving changing the roles, tasks, functions, customers (only the employer's own client),
- There is a constant exchange transaction ("something for something") between internal providers of services,
- There are internal conditions to advance the exchange of services (products),
  - The internal labor market affects the social and environmental conditions.
  - The internal market sets its own laws and principles of operation.

Gummesson also underlines the aspect of the internal market and internal customer, which are broad concepts that can embrace a number of different areas [Gummesson, 1987, 2002]. These involve relationships and networks which stretch across the organization, sometimes impacting on the organizational structure itself [Godson, 2009]. In addition to training and development, it is argued that organizations should empower the employee to take decisions and solve problems quickly and efficiently without having to recourse to higher authority [Gordon, 1998]. Examining models of relations in the process of knowledge transfer, one should take into account the complexity of the communication and cooperation resulting from the diversity of relationships and partners. Note the complexity of the relationships in the home organization for the invention – the higher education institution. In practice, the entrepreneur is not in contact with the 'representation' of the university ("the university as an organization speaks with one voice") but with its various representatives, authorities, bodies responsible for the commercialization of the university (e.g., technology transfer offices, incubators, cooperation with business departments, scientists, research team members) [Grzegorczyk, 2013]. The complexity of these relationships results from different objectives and motives of interaction, different organizational cultures, structures, strategies, experiences, preferred communication styles and modes of action. The objectives and priorities of the researcher may differ significantly from the objectives of the university as an institution. What is more, in many situations there is the relationship between the researcher and the company outside the university. Results of particular research confirm that the focus of activities to foster university-business cooperation should be on researchers and teaching staff, the actual players within the HEI involved in relationships with business [The State of European…, 2011]. Without their passion and inner drive, there would be no cooperation and no commercialization.

Case study – examples of two different models of TTOs' cooperation with scientists

Two technology transfer offices have been chosen for analysis: 1) The UT Health Science Center in San Antonio, 2) The UT Health Center in Houston. Both centers are organizational units of one university (the University of Texas, USA) and are subject to the same conditions, including internal procedures, rules and sources of funding. The described TTOs operate in a similar environment, as both, the city of San Antonio and Houston, are main centers of the medical bio-technology basin in South Texas.

Characteristics of San Antonio:

- Because of its high creativity index, San Antonio was recognized in 2002 as the capital of creativity in Texas, ahead of the state capital – Austin',[2]
- During 2000-2010, San Antonio, with its population of more than a million, was recognized as the fastest growing city of the 10 largest U.S. cities,
- 5 of the top 500 companies are located in San Antonio, as well as the famous South Texas Medical Center, bringing together a large number of medical research centers and hospitals,
- In San Antonio more than 100 000 people are employed in Biosciences. Most research is conducted in the basin of the South Texas Medical Center, which brings together 45 medical institutions, including 5 medical colleges (the largest being the UT Health Science Center), separate schools of medicine, dentistry and nursing, 12 hospitals and 5 specialized institutes. Here also is the world's largest program of clinical research of the first phase for new anticancer drugs, the new Children's Cancer Research Institute, estimated at $ 200 million and the national bank of cord blood stem cells.

Characteristics of Houston:

- Houston is the largest city in the state of Texas and also the fourth largest city in the United States,
- The University of Houston System, a system comprising four independent state universities, has, each year, an impact on the local economy comparable to the activity of a large corporation, attracting $ 1.1 billion of new funds and $ 3.13 billion of total economic benefits, creating in addition 24,000 jobs,
- In 2006, the Houston metropolitan area ranked first in Texas and third in the United States on the list of the best places to develop business and careers by Forbes,
- In 2008, Houston took second place on the list of cities that concentrate the largest number of corporate headquarters of Fortune 500,

[2] Creativity index is a combination of four factors: 1) the share of employed in creative's waters, 2) Tech Field Index - shares of employment in the advanced technology sector to the general, 3) patents per capita, 4) social differentiation.

- Houston is the seat of the renowned Texas Medical Center, the largest medical center in the world. It is composed of 49 research institutions and health care providers - all non-profit organizations. The Texas Medical Center includes thirteen hospitals and two specialized institutions, two medical schools, four nursing schools, several schools of dentistry, pharmacy and public health, where employment totals over 73,000 people,
- The Texas Medical Center established the World's first - and largest - ambulance flights, Life Flight, as well as developing an inter-institutional transplant program. The center performs more heart surgery than anywhere else in the world.

Many similarities in the external environment of both TTOs can be noticed. First of all, they operate in a similar ecosystem and have similar resources available. Both centers belong to the central structure coordinating the processes of commercialization, which has an office in the main unit of the University of Texas at Austin, the state capital. Both units, as well as their parent units (faculties of medicine of the University of Texas), strongly compete for federal financial resources. Both units use the traditional model of pushing innovation to the market, which is used in most academic centers in the world, and both operate within the framework of one central university (The University of Texas). Both TTOs share common regulations of the commercialization process, such as mandatory reporting of innovation by scientists.

The model of cooperation in the commercialization process in the UT Health Science Center in San Antonio. The TTO in San Antonio leads adheres to traditional activities including: accepting innovation applications from researchers, evaluation of the commercialization potential and legal opportunities for commercialization, market analysis, preparation and implementation of patent applications, partner searching, preparing a business plan, identifying licensees, negotiations and license agreements. The whole process of commercialization is quite formalized, secret, and is done somewhat "behind the backs" of scientist. The developer of an innovation is not allowed to participate in conversations with business partners and does not affect the established conditions of the license sale and the value of royalties. Scientists, upon request, may obtain information on the negotiated terms but only after the conclusion of the agreement between the TTO and the buyer. Reporting of inventions and innovative research results is mandatory for the university and stems from the regulations of is dictated by the regulations for all university employees. Employee publications and abstracts sent to the press are also monitored by the PR department of the university for any innovative research results obtained. The TTO in the commercialization process attaches great importance to the value of innovation (commercializing only valuable inventions). The type of management in the TTO can be described as task management, firmly focused on the results of commercialization processes. These results contribute directly to the level of grants, the size of the research budget and financial rewards for the college. It can clearly be seen that in the case of the UT Health

Science Center in San Antonio, relationship marketing is of secondary importance in the process of commercialization.

The model of cooperation in commercialization processes in the UT Health Center in Houston.

In the case of the TTO in Houston, contacts with industry are mainly based on the relationship of individual researchers with companies. The University seeks to recruit scientists who have worked in industry, mainly in pharmaceutical companies, and have contacts there. In contrast to the TTO in San Antonio, here relationships with academic staff are being very intensively developed. The scientist is not only regarded as a "supplier" of innovation but also participates in the process of commercialization as a member of the team, moreover playing a decisive role. The commercialization process is flexible, adapted to the individual cases and the TTO plays more the role of mentoring, besides offering university resources, such as: incubators, laboratories, negotiation competency, searching for a CEO. The TTO sells an average of two licenses per month and participates in the formation of 1-3 new companies per year.

Comparison of both cooperation models

Despite similar external environments, a number of significant differences can be seen in the mode of action of both described technology transfer offices (Table 1). The TTO in San Antonio seems to pursue a model in which the main function of the center is to uphold the institution of intellectual property. The center focuses on the results, but in terms of their "representativeness" - it is not about the business results (large established companies, created jobs, etc.) but rather the number of licenses or the number of patents. These results are important for the institution as they increase the possibilities of obtaining funding for the university and build its prestige and good image. The UT Health Science Center in San Antonio is financed by the university and constitutes an expense for it. Houston TTO focuses more on business entrepreneurial results and presents a model in which the main objective of the center is to generate revenue for the university. The basis for this model is self-financing. Houston TTO not only covers the costs of its operations but also generates revenue for the university. In San Antonio, the commercialization process is highly bureaucratic and the researcher has no influence on the fate of their technology. This causes the relationship between the TTO and academic staff to remind one of a "bleeding wound"[3].

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[3] According to the words of a representative of the UT Health Science Center in San Antonio during an interview, which was part of the research project: “Integration and transfer of knowledge from scientific and research organizations to enterprises“. Project financed by the National Science Center on the basis of the decision number: DEC-2011/01/B/NS4/05200.

Table 1. Comparison of both cooperation approaches

UT Health Science Center in San Antonio TTO	UT Health Center in Houston TTO
The main role of TTO – uphold intellectual property	The main role of TTO – generate revenue for university
Funding from university – TTO generates costs	Self-financing – TTO covers own costs and generates revenue
Heavily bureaucratic process of commercialization	Flexible process of commercialization
Negligible role of researcher in the process of commercialization	Very important, decisive role of the researcher in the process of commercialization
Relationships with researchers – bleeding wound	Relationships with researchers – mentoring, motivating, promoting
Technological approach – institution and its technology is the most important, researcher is just a supplier of innovation.	Market and relationship approach – researcher is a very important partner in the process of wealth creation.

Source: Own research.

In Houston, the process is flexible and fully involves the scientist, giving him an important role. Houston TTO's activities are limited to motivating, encouraging and building relationships with employees, so that they notice not only the financial benefits from the sale of their research results but also explores the gain personal satisfaction.

In conclusion we can say that San Antonio TTO represents the technology institutional approach in the process of commercialization in which the institution (university) and the technology itself is the most important part. The scientist is treated objectively as a "supplier" of innovation. The aim is to sell innovation, sometimes even for a low price, not accepted by the creator of innovation. The Houston model is much closer to internal marketing assumptions. It can be described as an entrepreneurial market approach, where the researcher is an equal or even superior partner in the action aimed at generating revenue for the university.

Summary

It is difficult to capture the perfect model of a TTO, however, one can create a list of ideal components of a good one. This would include: professional management (a professional manager managing a results-oriented TTO), a critical mass of technology (access to such a number of technologies which allows enough transfer to prove self-financing), marketing across all channels of transfer and the creation of long term relationships and engagement. The belief that commercialization is a 'people business' is also supported in a growing body of literature. Authors like Hughes, Link, Abreu, Dooley and Kirk argue that the key to successful knowledge transfer is a process of continuous dialogue and a build-up of social networks [Nicolaou, Birley, 2003]. In particular, in the biotechnology industry the success factor often turns out to be human capital rather than technical or financial resources. The literature draws special attention to investment in human capital in the form of training, incentive systems, building confidence, close partnership relations of cooperation both in the individual teams as well as in systems with external partners.

In the described examples we can see two TTOs operating in south Texas, which is a biotechnology basin of the USA. In Houston the generated partnership has the potential to become long-term, and could be a crucial element in development and effectiveness. This success is a function of the development of strong personal (as opposed to institutional) relationships over time, which leads to the creation of trust (a key element in entrepreneurial activity) [Dooley, Kirk, 2007]. The example of San Antonio TTO shows that there is still much room for improvement, even in developed models. The relationship with researchers described as “a bleeding wound” can lead to a less effective processes of commercialization. Thus, in order to increase cooperation within the academics the academies/universities, TTOs should create a positive environment, communicate advantages, demonstrate best practice and establish a series of appropriate incentives and reward systems. Emphasis on people as a source of growth should be put first. The focus of activities to foster commercialization should be on researchers and teaching staff, the actual players of academia-business relationships, as cooperation is founded on an attitude or a mind-set and is driven by intrinsic and psychological elements (trust, mutual commitment, shared goals) rather than by rules.

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GOOD PRACTICES FROM ACADEMIA AND BUSINESS

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GOOD PRACTICES IN THE DEVELOPMENT OF E-LEARNING - EXEMPLIFIED BY THE UNIVERSITAT OBERTA DE CATALUNYA

Abstract

This paper attempts to show the impact and importance of good practice in higher education where development is linked with the introduction and intensification of innovative solutions based on knowledge and modern technologies. The key issue is to search for best practice based on the experiences of leading universities which apply good practices in didactic problem solving and initiate tools for the application of innovations. Attention is drawn to the innovative methods of gaining knowledge provided through e-learning techniques based on modern IT solutions. Universitat Oberta de Catalunya's projects serve as an example of good practice in the area of e-learning, regarding the university's level of innovation, IT support, knowledge transfer and communication in the educational process, which may inspire other scientific and educational institutions. The author presents the development and implementation of curricula based on new technologies to generate high quality educational programmes. The paper shows the way this on-line university introduced innovative activities regarded as good practice which can be followed by other universities.

The application of good practice and activities in the university environment for problem solving and instigation of progress has become a significant stimulant for the use of a university's potential in a greater beneficial manner. It also facilitates better adjustment to change, in particular, in the development of a modern networking society.

Keywords: good practice, innovations, new technologies, e-learning.

Introduction

The goal for applying good practice is to introduce and propagate innovative methods in problem solving. The priority for education is the vigorous search for resources that would overcome and solve existing problems. Good practice in the area of on-line study puts particular emphasis on IT tool application, not only in its functional and technical aspect but also in the area of the ability of distance learning to gain and propagate knowledge. Institutions responsible for the development of education should act in order to facilitate the introduction of modern methods to overcome problems and improve their operations and the quality of their educational process.

The main objective of this paper is to show the potential of education which uses e-learning to support innovation and integration of student groups as well as the capabilities of current and potential applications of social IT for the boosting of knowledge and changing the conditions in which people study, think, live and work, based on the achievements of the Universitat Oberta de Catalunya. The main focus is on the discovery of the new possibilities offered by e-learning in order to support innovative methods of learning and teaching. The ever changing conditions for educational activities, the increase in demand of students/consumers for educational services in their accessibility, rapid IT progress and intensification of competition on the education market, all call for an appropriate innovative solution. New generations of internet users have indispensable cognitive and technological skills in the area of ICT and are able to apply them practically (e.g. Internet navigation through information, electronic communication, building on-line networks with people of similar interests, increase of on-line usage, processing information, establishing on-line contacts, knowledge, obtaining knowledge and on-line cooperation.

E-learning is therefore the answer for the current market demands. Its objective is not only an applicable market solution but also the ability to propagate it. Good practice also means the skill to apply solutions. The examples of innovative solution application, mark the direction for the development of proposed implementations and ensure the credibility of their practical propagation.

The importance of good practice

The endeavour to improve one's own operations demands awareness of the best, most effective practices applied by innovation leaders who have already achieved market success. Looking for such solutions leads to the overcoming of one's own cultural limitations and stereotypical behaviour [Bogan, English, 2006]. Each stage of the operations may face a need or even a demand to reach for external experience/skills in order to obtain knowledge invaluable to continue reaching for the goals set [Mosińska, 2012]. In the rapidly changing environment, the examples of good practice allow us to view positive and leading solutions in various fields of socio-economic activities. The awareness of progress, along with the acquisition and implementation of best practice, fosters a climate to carry out significant improvements in the operations of all institutions [Bendell, Boulter 2000].

The features of good practice include:

- Innovativeness, or the ability to create new solutions or creative interpretation of solutions tested by other institutions. These solutions refer to both products (services) and processes (for example while project managing, in the methodology of monitoring and the assessment of the approach to publishing results), thereby benefiting interested parties
- Repeatability and transfer, or the ability to copy certain aspects of proposed conduct in other contexts and apply to solve different problems
- The appropriateness of the implemented framework, ensuring internal cohesion (in the area of activities, results and goals) and external (in reference to policy)
- Inclusion or the ability to adopt practices from other external or internal partners at various institutional levels within the integration of operations
- Access to clear, cohesive, trustworthy and concise information

All in all, good practice means all single or repeated undertakings which allow effective, economically viable implementation of tasks and achievement of targets [www.dobrepraktyki.utp.edu.pl, 2014]. Good practices are mainly innovative projects successfully implemented in various institutions, organisations and companies. Good practices have become fundamental skills, thanks to which employees show greater effectiveness and efficiency [Bogan, English, 2006]. They provide practical solutions for particular problems and generate concrete, positive results. It is necessary to make them universal, meaning having the ability to transfer solutions to other organisations. It is important to select and adjust knowledge in reference to new practices, namely an organisation's ability to recognise new values, information from external sources on organisational processes or technological solutions, their adoption and commercial applicability [Tidd, Bessant, 2013].

The collection of good practices may constitute a part of a basis of knowledge applied in order to support the decision making process and have an increasing importance in planning and management, which is why there is such importance attached to studying and presenting practices which are the leaders in solutions applied by companies and institutions in various aspects of their operations. It is about consistent actions geared towards the take up of good practice in any field and improving one's own solutions through learning from others and using their experience [Kowalczewski, Nazarko, 2006].

The main objective of propagating good practice is the improvement of operations in social institutions, companies and non-profit organisations through the copying of operational principles from other institutions, principles that are more effective and generate significant benefits. It is reasonable then to introduce innovative activities whose aim is to promote a new approach and to identify examples of good practice which may later be used to improve operations. The most significant part of the good practice adoption process is the establishment of methods of transfer of new concepts to a company, their improvement and implementation [Bendell, Boulter, 2000].

Simply, one can assert that the attitude to good practice relies on the interconnection of two basic groups, called institutions, which acquire knowledge on good practices, facilitating the improvement of their own operations, and institutions that are the source of inspiration for a potential improvement. Therefore, transfer of experience from such a source to another geographical area and/or sector are regarded as innovative.

Good practices are considered key, as they are assumed to play a paramount role in the achievement of higher effectiveness and efficiency of operations, and foster clearer convergence in the implementation of individual aims by a company in a particular economic sector.

They are also appreciated, as they contribute not only to the identification of more effective and innovative projects but also to integration. The ideas for change/improvement and development of new activities are proposed based on experience and identifying good practices and their propagation. The main features of good practice include innovativeness, transfer and repeatability.

It should be highlighted that, depending on the context, one can achieve targets using a variety of methods and techniques, which will not have the same result in all environments [Karwińska, Wiktor, 2008]. This is why one should consider the recipients of good practices, their needs and capabilities, the sector of their operations and conditions where the operations are to be implemented. The factors that make an adaptation successful also require recognition and consideration [Koczerga, 2011]. Identifying good practices for the development of institutions and companies remains a significant challenge, partly stemming from the great variety of implemented initiatives, including such areas as; entrepreneurship, training and skill development, environmental management, diversification of ventures, etc. It is also affected by the wide range of development targets that encompass various aspects of this development, such as; economic, social, long-term ability building, along with the various criteria which can be applied to assess success. The challenges faced by companies are also significant, as they may vary in a range of aspects (status and operation profile, liability to change over time). The endeavour for development requires therefore an individual approach that would consider local and sectorial features.

Good practice in e-learning

Good practices that carry a significant innovative potential are linked, among others, with the modernisation of educational processes at universities, based on modern IT technologies applied in distance and e-learning. The necessity to implement good practice in higher education, based on distance learning, facilitates communication, interaction and cooperation in an open and flexible e -learning context and is obseved by a range of universities [Hudson, 2005]. The ongoing development of communication and information technologies creates new opportunities for education, linked with access to and the possibility to use modern tools in the educational process and the propagation of information for educational purposes [Zrobek, Ratalewska, 2013]. Developmental tendencies of e-learning are more frequently based on technology and are significantly dependant on developments in IT techniques, including broadband internet access, Wi-Fi technologies and the range of cyber devices. E-learning is a technology base for study, within which mutual interaction, including the sending of study materials for students, takes place electronically via remote computer networks [Zhang, et al.]. Distance learning is a teaching method where the participants are widely spread, and in order to send information, apart from traditional forms of communication, modern audio-visual forms of technologies are also used. This is characterised by the ongoing blending of separate technologies into one integrated system, which combines micro-electronics, telecommunication, optoelectronics as well as computers [Castells, 2010].

Using the internet, tools of educational platforms, all the opportunities offered in the field of communication along with flexibility in choice and time and place, are attractive for both universities and students. Each of these methods can be applied in workshops using educational platforms, commonly known as e-learning. These technologies create new solutions, enabling a fuller perception of transferred information in the educational process. They also stimulate an individual to the independent acquisition and extension of competences, fostered by the relative ease and speed of access to the necessary materials and information [Dąbrowska et al.]. Innovation in science does not only refer to technologies in its strictest sense (acquainting the university community with a new tool), but also servicing the educational process (new manner of designing, management of education and training) as well as science (new approaches towards knowledge).

E-learning, on-line learning and distance learning are defined as using IT technologies to pass knowledge and to communicate in the educational process, whose objective is to boost the effectiveness of teaching/learning [Rosenberg, 2001]. They allow acquisition of knowledge through modern ways and resources. E-learning is a technology based science. Technology is a basic tool used in the implementation of teaching/learning strategy. Technological assistance facilitates the running of workshops, creating frameworks based on the creation and management of data concerning education and science, construction of knowledge as well as the approach towards knowledge.

Methods applied in e-education are diverse [Ratalewska, Zrobek, 2012], which makes it both universal and flexible. They are applied in e-learning, educational and training models in order to support a variety of downstream operations (in computer networks the direction of data transfer from server to customer), and upstream (in computer networks the direction of data transfer from customer to server); knowledge modelling, optimisation of teamwork, community of users, decision support, etc.. There are a number of classifications of such educational and training models that use the advantages of distance learning. The most general division of educational process models is the division into: synchronised (with the simultaneous participation of e-tutors and e-customers in e-classes) and asynchronised (where the educational process is planned in such a way that there is no longer a need for the simultaneous participation of students and tutors in e-classes). The time in which studying takes place is determined by other forms of e-teaching: self-study and blended learning.

Acquisition of knowledge via the internet has a wide range of advantages which include [Ratalewska, Zrobek, 2012]:

- Savings – reduced costs in comparison with traditional forms of studying eliminating of logistics costs, e.g. transportation and accommodation
- Flexibility and mobility – students study in various places and at various times (e.g. within working hours or afterwards), around the clock. They adjust the time and place of e-learning to their own preferences and possibilities
- The lack of obstacles connected to time and place – e-learning encompasses students from across the world, which, in the era of globalisation, boosts integration and exchange of experiences
- Effective work/time management – professional improvement studies following a set path of knowledge acquisition
- Application of new technologies – adjustment to the requirements of an IT society.

These advantages make this form of knowledge acquisition extremely beneficial, mainly thanks to the possibility of their practical application in any type of study and at an any site which may be contacted electronically, especially considering that universities participating in this network are capable of activating and establishing educational and developmental networks with other universities and institutions and adjusting their operations to the market needs for educational services [Castells, Himanen, 2009]. Combining the endeavour to get qualifications faster through the tools and opportunities offered by IT, significantly raises the effectiveness of the acquisition and development of knowledge and competences. Information technology and telecommunications have become tools for providing support for the modernisation of educational and training systems, they may also ensure easier access to a wider variety of services and educational material of a superior quality [Radkowska, Radkowski, 2012]. One should also note the universal aspect of e-learning technologies, which is so important when considering good practice, namely the ability to transfer applied solutions to other universities. It also considers the need to create and support the development of science and technologies, adjusted to a range of cultures, values and the coexistence of diverse communities, allowing problem solving on an international scale [Sakamoto, 2005].

Innovative e-learning practices, focusing on modern IT technologies, though relatively new for many universities, have attracted the interest of all science sectors. Technologies have the potential to transform all functional aspects of these institutions, from learning and teaching to administration services.

Examples of good practice can be identified and used to support forward-looking practical operations in this field. The applications highlight various usages for multiple social IT applications in the context of learning through wikis, blogs, podcasts, social bookmarks, network editing and creating instruments for drawing you into the online reality, network technologies, access, browsing, commenting and the creation of knowledge, cooperation, editing and publishing. The development of educational projects in virtual worlds deserves particular attention. In Second Life (SL), the largest virtual on-line world, the offer of educational services is being developed. This shows the significant opportunities for expansion of academic centres to run classes for international groups of students and auditors. Virtual worlds may therefore provide exceptional opportunities for communication and interaction with users from across the globe. Such an opportunity facilitates the exchange of good practices and the sharing of knowledge and information [Dąbrowski, 2008].

E-learning and its innovations will evolve into methods, thanks to which universities will be able to develop their own capabilities for distance learning and the application of innovative technologies. IT technologies carry the potential for the further transformation and improvement of university performance. Innovations will involve the introduction of something novel; devices, methods or ideas, leading to a breakthrough or change in current practices. Applying these technologies can still be labelled as innovative. The main benefits refer to the increase in the transferability of solutions, absorption, flexibility and rapid access to e-learning resources, direct communication, initiative stimulation and the engagement of participants.

It is significant to actively motivate students to study through the application of modern technologies, especially mobile and Wi-Fi ones. The challenge is to raise the awareness of those participating in education of the potential of innovative technologies, developing trust allowing the introduction of a new educational approach and the understanding of the possibility of achieving the desired benefits. Innovative practices in e-learning concentrate on the opportunity to find and utilise novel solutions that would extend and modernise participation in education. The role of these technologies is crucial, as they provide new possibilities in education.

Universitat Oberta de Catalunya, a case study

The presentation below highlights the benefits and obstacles which occur during operations introducing and supporting the development of distance learning when creating an IT society. Its objective is to show a number of good practices in the field of e-learning, based on projects carried out by Universitat Oberta de Catalunya, connected to the university's innovation level and to the support provided by IT during transfer of knowledge and interactions, which may be inspirational for other educational and science institutions[1].

At Universitat Oberta de Catalunya (UOC, Open University of Catalonia), students, lecturers and administrators cooperate according to the concept of the virtual vampus, forming a university community which uses the internet in order to create and propagate the opportunities to acquire knowledge. The objective of UOC, is to develop students' creativity, contribute to the development of society, promotion of specialised activities geared towards an open society based on knowledge through the establishment of cooperation with other universities and institutions across the World.

UOC is a novel institution, established by the Independent Regional Government of Catalonia (Generalitat de Catalunya) and has become a reference point for the entire World in the field of on-line education and electronic media (e-learning). It is worth emphasising that UOC bases its entire education on electronic learning, while most universities rely on traditional classroom teaching and perhaps blended or hybrid courses (distance learning is often a mixture of regular classroom study together with an on-line element). The objective of UOC is to introduce new initiatives, research and the spread of knowledge.

Universitat Oberta de Catalunya may be explained as follows:

- It is located in Catalonia, but covers the whole World
- Makes knowledge accessible to all, independent of time or place
- Adjusts lifelong education to an individual's needs
- Uses its own methodology of education
- Encourages innovation and research within a society, based on knowledge
- Establishes cooperation amongst universities through the formation of a metacampus
- Cooperates with the necessary institutions in order to achieve set goals
- Creates a new type of organisation for a new university concept
- Is ethically engaged in social development

UOC boasts a team of highly qualified professionals, who form an integrated and creative organisation, which is the universities strongest point. UOC's main objective is to achieve a high quality and effective level of activities.

[1] The information on Universitat Oberta de Catalunya was passed on by this university for the purposes of research.

In order to develop and propagate educational and research ventures, to transfer knowledge and technologies and to implement the most effective management and financial strategies, a structure has been introduced which is based on business initiatives, institutions supporting innovation and knowledge transfer as well as already established institutes, such as university and research institutes. Thanks to this structure, new challenges may be overcome easily and effectively and keep up with the rapid and far-reaching changes.

UOC is a virtual university and has no real campus. It is an on-line network university which pioneers an innovative educational model as well as the quality of the educational process. It provides access to life-long education, matching daily activities and personal circumstances with educational goals. The virtual campus, which is the main learning space, as well as student support, provides both students and tutors with access to university resources. This concept of a university pushes back the boundaries imposed by time and place and ensures education always and everywhere at the pace determined by the students themselves. Innovations in UOC's educational model and in their educational approach rely on flexibility and personalisation. Flexibility gives students an opportunity to manage their own pace of study and access all main elements of education at any time and place. Personalisation allows adjustment of content and the learning process to previously gained knowledge.

UOC's educational model uses IT and telecommunication technologies, based on a virtual world, which emphasises communication and interaction between individuals. It relies on an on-line teaching and management structure, which facilitates interactive communication between teachers and students, regardless of any timetable – an idea known as asynchrony. The virtual campus encompasses everything offered by a traditional university campus: teaching, research, knowledge transfer and services for students.

UOC offers and stimulates higher education at a high level along with an innovativeness geared towards the respect for the diverse requirements necessary on the educational market.

It offers a wide range of courses. For example at the time of writing it offered courses in:

- Law, Politics and Administration
- Psychology and Education
- Economy and Business
- Arts and Humanities
- IT and telecommunications
- Computers, Multimedia and Telecommunications
- Health and the Environment
- Tourism
- Asian studies

UOC courses are divided into university, masters and doctoral programmes designed according to the criteria in the Bologne Declaration of 1999 on European Higher Education.

Moreover, UOC offers companies and institutions services tailored to particular training programmes and cooperation projects. Companies and institutions can adjust and develop training programmes to suit their needs via the virtual campus of UOC and programmes are instigated from suggestions from the companies or institutions for training and the specific areas of knowledge offered by UOC. UOC cooperates with companies and institutions, running mutual projects promoting life-long learning in all areas of social life, especially with the application of new technologies, propagating significant changes in technology supporting education as well as learning and research in higher education. Thus, there is an ongoing ambition to modernise technological solutions of transfer and communication. Within the virtual campus, UOC strives to introduce new, more interactive and portable tools, such as iPad (Apple's tablet with a 9.7 inch touch screen and Multi-Touch technology allows the possibility of, amongst others, the viewing of films and photographs, use of an internet browser and compatibility with AppStore for iPhone and iPad applications). These relatively intuitive service tools with a mobile internet connection, such as Apple's tablet, are potentially beneficial for learning, as they allow a multitude of innovative solutions. UOC tries to enrich the experiences of learning, using a diversity and applicability of new mobile devices, with the aid of RSS technology, in order to ensure high quality connections in communication between students and tutors at this virtual university, as well as facilitating access to materials aimed at these groups and platforms.

The nature of Universitat Oberta de Catalunya, with its intense and varied application of IT and telecommunication technologies, also determines the goals of research programmes. It focusses on the research of the impact of ICT changes on people, companies and society, as well as the influence of ICT on changes in the deepening transformation from an industrial into a society based on IT and knowledge. The research is carried out on-line and is of an international and interdisciplinary nature, which encourages cooperation with researchers from other universities, institutions and companies.

The research may be:

- Basic and geared towards new knowledge acquisition
- Applied and geared towards new problem solving
- Connected with surveys on the perception of current operations

The university has participated in FP6 and FP7, LLP, CELTIC projects, with ministries (Spain) and regional government (Catalonia) in a variety of combinations and objectives connected to ICT, e-learning, platforms, mobiles, society, culture, etc. Some of them are: TECHNIPEDIA (national funding): INCLUSIVE

NAUKA (LLP); ALICE (7PR); MASELTOV (7PR); EUNOM (LLP); Up-to-USA (Celtic) and other international initiatives [www.b2mach.eu/ict2013].

Focused on the global range of its activities, UOC concentrates on finding channels for making the university available to a greater number of people, other universities and interested organisations abroad. There is a strong UOC international presence due to the strategy of establishing alliances with universities and research institutions in a wide number of countries, and a number of contracts of cooperation have been signed with universities in Europe and beyond. They look for opportunities for the transfer of solutions to other organisations, therefore joint ventures with foreign universities have been established for educational purposes as well as the exchange of information on technological capabilities and international contacts within this cooperation. There are a reasonable number of mutual programmes being carried out, e.g. Certificate UOC-UNM- mutual design and e- learning development based on cooperation between the Open University of Catalonia and University of New Mexico, USA, as is also the case in its cooperation with the e-University (HBMeU) of Dubai, which involves mutual scientific research and development, innovation and knowledge transfer projects along with other mutual activities. UOC also coordinates various international projects, such as the European ICT practical project, funded by The Lifelong Learning Programme, the objective of which is to train teachers in the field of ICT tools and creativity techniques. UOC also participates in the activities of the EU-USR research team in a scientific research project, conducted for the benefit of the mutual strategy of social responsibility among European universities. UOC cooperates in running doctoral studies with African universities such as; University of Duala in Cameroon, University of Ilorin in Nigeria, Kenyatta University in Kenia, Université des Sciences et Technologies du Benin, Université de Gaston Berger Saint-Louis Senegal and National University of Rwanda. In international cooperation, particular emphasis is placed on the application of new technologies in the transformation of higher education as well as offering participants of other universities the opportunity to exchange experiences, seeing similarities and analysing differences.

Universitat Oberta de Catalunya is a renowned leader in the quality of on-line classes and education, offering individuals, organisations and companies a range of programmes in established academic fields, geared towards the need of specialists, with a clear vision and direction. In order to do this, UOC uses intensively applied IT and communication technologies (ICT), which can erase the barrier of time and place and offer an educational model based on personalised and flexible cooperation with students.

Conclusions

Lifelong education has become a significant indicator of technological development and social progress. The deliberations presented here confirm the fact of the substantial capability generated by the use of distance learning techniques in lifelong learning. There are a number of reasons why one should expect an increase in the application of new technologies of learning, leading to the need for good practices allowing greater effectiveness in this area. Firstly, new information technologies are characterised by greater flexibility, creating the possibility of a wide choice of forms of education available around the clock. Secondly, the cost has been reduced through the method of scale, which cannot be applied in traditional methods of teaching. Thirdly, they allow rapid updating of content and, thanks to new interactive teaching methods, there is a shift from teaching to self-study. This is why it is important to introduce measures to promote this new approach and identify examples of good practice which may later be used to improve other universities' operations.

Acquisition and propagation of ways of knowledge transfer through e learning have become increasingly important, especially now that the current technologies of multimedia transmission, satellite and network technologies, as representatives of IT technologies, are developing at a pace. A modern, individualised education system can exist thanks to the application of network technology and data storage. Ground-breaking educational methods based on IT technologies play an important role in the support and propagation of modernisation in education. E-education, which relies on technologies, significantly affects ideas, forms, processes and methods of teaching as well as education management. It is important to create a framework which will foster diversity and innovativeness as well as support for universities in the exchange of ideas and material. Application of IT technologies in knowledge transfer has become a drive to continue innovative education. Subscribing to this modern theory of education, based on advanced IT technologies in the areas of design, development, application, assessment and management of educational processes, contribute to the successful development of education. Spreading modern educational technologies allows greater diversification and catchment. Mobile devices may enable accessibility to education and begin and spread a greater variety of educational operations. According to the idea of good practice, mobile devices support the widespread application of useful solutions in education. They also boost the engagement and motivation of student, as there are a range of needs concerning the form of lifelong learning. Modern educational technology also allows the shift from the traditional approach, towards a more varied method of teaching. Distance learning methods, individualised solutions, the various forms of mobile storage of courses, and individualised communication allow adjustment to the range of students' needs, clearly raising the effectiveness and efficiency of teaching, which is why there is such importance attached to recognition and adoption of novel products which have been successfully implemented at other universities.

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UNIVERSITY TECHNOLOGY ENTERPRISE NETWORK IN PORTUGAL: A BOTTOM-UP APPROACH TO IMPROVE REGIONAL INNOVATION ECOSYTEMS

Abstract

In the new paradigm of Open Innovation (OI), traditional cooperative research agreements or sponsored research are no longer effective enough to meet the needs of the system and the market. Today, any Innovation Ecosystem has a myriad of players, such as: big and small companies, start-ups, R&D institutions, brokers, and other intermediaries.

The UTEN (University Technology Enterprise Network) Program, launched in March 2007 by The University of Texas at Austin's IC² Institute to accelerate the development of a sustainable, globally competitive, professional technology transfer (TT) and commercialization network, was founded with the propose of improving the Portuguese international competitiveness in university–based science/technology commercialization. We argue that initiatives taken place in the project have gotten UTEN network presently run in OI fostered mostly by the TT Offices and their own networks and officers. This paper shows the actions taken to develop UTEN and improve the Portuguese Innovation Ecosystem. The data we offer in support of our argument is a collection of implementation that started with 14 Portuguese Universities and select international partners in a five-year program.

Our indicators show that UTEN has leveraged this growth by stimulating new competencies in international technology transfer and commercialization, and by facilitating industry access to the world's leading markets. This bottom-up approach contributed to building the necessary relationships between all actors within this innovation ecosystem by providing the necessary knowledge to play their roles. This case is evidence that critical mass and regional public policies are very important in the development of "high-tech" regions.

Keywords Portugal, technology commercialization, open innovation, university industry relationship, technology valorization, technology transfer office, innovation ecosystems.

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Introduction

Open Innovation (OI) is descriptive - it refers to the inbound and outbound of knowledge, ideas, and technologies in a "co-creative" environment that allows innovations to come to fruition and mature. The sources of external inputs and internal outputs are lavish in players, including: customers and suppliers, "competitors", university labs and research institutions (and their Technology Transfer Offices (TTOs)), public authorities, patent agents, public funding agencies, and mediating parties (i.e. technology consultants, media, conference organizers and the technology brokers).

Historically, universities have always practiced co-creation as a feature of their projects, and have primarily collaborated with their peers. OI is novel in the sense that the partners could transfer to other organizations outside of the academy, and the university's role is no longer restricted to the knowledge/technology provider.

As non-profit organizations, universities and their respective R&D institutions have different objectives and missions from for-profit companies. This also holds for an OI environment. By their nature, universities contribute to the early stages of an innovation process by producing novel technologies and not converting these technologies into products for sale in the marketplace. This reality underscores the crucial role of their TTOs in an OI environment. They need the TTOs to function as their "boundary spanners" (Rogers, 2003) that manage external relationships, matching the appropriate partners in a co-development environment. At the same time, TTOs are responsible for scouting the right "champions" [Rogers, 2003] on both sides of the partnership for a project, improving the ability of the R&D unit to be more aware and responsive to the final client goals and requirements.

In the following sections of this chapter we will demonstrate how UTEN (University Technology Enterprise Network) has applied a defined set of procedures to build a globally competitive and sustainable science and technology (S&T) transfer and commercialization network ready for the co-creative OI Ecosystem within its first five years of implementation. UTEN's focus has been the TTOs (a bottom-up approach) in association with universities, as the main agents capable of building and spreading the Portuguese regional innovation ecosystem. Obvious challenges from the start of this Program involved strengthening the existing Portuguese regional and national technology transfer (TT) academic-science-business cooperative networks and abilities in order to achieve needed critical competencies of required expertise to successfully take the best Portuguese S&T and entrepreneurial capabilities to commercial applications and international markets.

The chapter describes the success of the UTEN initiative (the methodology to collect data consisted of documental analysis, surveys, and interviews), and is organized as follows: Introduction; 2. Ecosystem and Actors; 3. Environment and Scenario; 4. Problem characterization; 5. The UTEN network; 6. Research Data and Discussion; 7. Final Notes; 8. Conclusions; and Acknowledges and References.

Ecosystem and Actors

Ever since the “competitive forces” of economies were defined [Porter, 1985], the global economy has changed with the expansion of strategies to improve those forces. Presently, intellectual capital expands the range of strategic management options so that organizations can play in the knowledge-based economy. OI follows this trend by establishing the adoption of “open” business models as the standard obligation for players. In this scenario, an organization could utilize this more competitive environment more efficiently by taking advantage of open and collaborative networks that can offer new ideas for business and provide resources to extend the development of outstanding opportunities.

One of the most important issues being raised today is that a technology can only offer value to the market when it is commercialized with a certain business model [Chesbrough, 2003]. The rise and decline of the dot-com era is a useful illustration on this concept. During this period a whirlwind of high-tech innovations without business models were unable to capture the potential value of the new technologies involved. Henry Chesbrough [2003a] states that an organization can capture value from innovations in three ways: using technology within your own existing businesses, licensing the technology to other partners, or launching a new business venture to use the technology. Because of the complexity of the environment, products, and markets in which an organization operates, it is very difficult to have individuals with expertise in all aspects of the organization's processes. The business model serves to connect aspects of business development with the economic output of the business, which provides more control over the risk inherent to technology commercialization. This leads to the conclusion that scientists and technical developers need to have an understanding of the business or join forces with business people, internally or externally.

Despite the variety of literature available on these topics, the human factor still remains unattended [Herzog and Leker, 2007]. Witzeman et al. [2006] argue that switching to the OI model requires that not only technological systems change. The more external innovation is sourced by organizations, the more systems, processes, values and culture also need to be modified. Witzeman et al. [2006] states that, “harnessing external technology for innovation requires a fundamental change in employee thinking. The «Not Invented Here» (NIH) syndrome is replaced with the «Invented Anywhere» approach." However, many organizations demonstrate their reluctance to change, showing strong path dependency [Menon and Pfeffer, 2003]. Therefore, the change of culture, attitudes and values in the organization should be implemented for opening up the organization boundaries. The values and attitudes of employees are often the consequence of strong mental models imposed by national culture. In the cultural dimension literature, "cultural values" are considered the most important explanatory variables of behaviour [Kluckhohn, 1951]. Certain cultural issues of Open Innovation have been mentioned in the literature, such as NIH and Not Sold Here (NSH) syndromes by Henry Chesbrough et al. [2006].

The development of a critical mass of technology transfer professionals (i.e. the human capital factor), occupies a central role in the UTEN project. For this reason, almost all initiatives taken place in the project have lead the UTEN network to adopt an Open Innovation (OI) model fostered mostly by the TTOs and their own networks and officers. The project changed culture, attitudes, and values in the network by applying a bottom-up approach to open up partner boundaries through its human resources. This opens up room to discussion the roles of actors in the ecosystem when they try to engage in a TT partnership.

The roles of the actors in technology transfer

Technologies are transferred through interpersonal networks [Rogers, 2002], which can offer a partial explanation for the presence of both effective and problematic cases. Everett Rogers [2002] discusses the reasons why the diffusion of innovations and TT types of communication are particularly difficult. For instance, TT involves heterophilous groups since technologies shift between different environments. It is useful to illustrate how the processes of TT can be analyzed from the point of view of the actor's individual roles in interpersonal networks within or between organizations. Rogers considers three types of roles of importance: "champions," "gatekeepers," and "boundary spanners." The champions are individuals in an organization who enthusiastically support new ideas [Rogers, 2003]. Within his work, Rogers describes the fundamental role of champions in introducing technological innovations. A champion can easily connect an innovation with an organizational problem and identify the needs of financial and human resources to implement and adopt the new idea. Champions act as great enthusiasts for technological innovations and their adoption. Robin Steele is a good example of a champion in TT: he was a young engineer from one of the companies of the corporate consortium MCC[3] in Austin (note that MCC

[3] Microelectronics and Computer Technology Corporation (Microelectronics and Computer Consortium - MCC) was the first, and - at one time - one of the largest, computer industry research and development consortia in the United States. In late 1982, several major computer and semiconductor manufacturers in the United States banded together and founded MCC under the leadership of Admiral Bobby Ray Inman, whose previous positions had been Director of the National Security Agency and Deputy Director of the Central Intelligence Agency as an American answer to Japan's Fifth Generation Project, a large Japanese research project aimed at producing a new kind of computer by 1991 (Gibson and Rogers 1994).

had twenty-two company members). For over a year, one week per month, Robin traveled from his office in Colorado Springs to the MCC in Austin, where he worked with a team of researchers to develop a computer program. Steele integrated this technology in a software product to be commercialized by his company, NCR Corporation. This young engineer showed great determination even in the face of numerous difficulties in bringing technology from the MCC to his company and commercializing the new product [Gibson and Rogers, 1994]. "Gatekeepers" are individuals who control the flow of messages in a communication channel [Rogers, 2003]. A gatekeeper can be someone on the top of the organization hierarchy (or near the top), such as a president or director who travels frequently and has a large social network, or someone at the operational level, such as a helpdesk employee that deals with customer service and complaints. Gatekeepers may play important roles in the TT processes. According with Gibson and Rogers [1994] each of the twenty-two electronics companies belonging to the MCC identified a key employee who travelled to Austin for monthly briefings on research findings. Some of these liaisons were more effective than others at applying technologies from the MCC to the relevant units in their corporation and reflecting their company's needs to guide the MCC research program [Gibson and Rogers, 1994]. The "boundary spanners", according to Everett Rogers [2002] (who cites various authors to illustrate this third type of role), are a particular type of gatekeeper whose function is to control the inflow and outflow of information across their system's boundary. They are individuals who link an organization with its environment. Thus, a boundary spanner provides openness across the boundaries of an organization by facilitating an information exchange, which alerts the system to new developments (both problems and solutions). Champions, gatekeepers, and boundary spanners are roles that some individuals on both sides of a TT relationship may have in their organization and whose importance in the process of technology transfer can be decisive. Nowadays, there are multiple cases of units/offices or organizations that are established to enhance the links between R&D units and other actors in the innovation ecosystem. The UTEN initiative has been actively involved in the improvement of these units/offices in Portugal.

In the United States, the offices of technology transfer that have been established in most research universities since the 1980's are boundary-spanning units. These organizational units help research universities become more actively involved in the technology transfer process [Rogers et al., 2000].

A particular skill set and information resources are required to efficiently manage co-creative projects, ideas, and innovations within the open innovation paradigm. Innovation brokers emerged in recent years in response to requests from companies who view co-creative projects in OI environment as a definite commitment to improve R&D efficiency and effectiveness. In this scenario, these innovation brokers have committed their most important resources on smart platforms of information systems to manage their customers' innovation projects (e.g. applications that enable the partner organizations to release and request internal and external information). Currently, these organizations act as services providers, or intermediaries that help other companies in their innovation processes. These companies are nodes of new networks that improve the global open innovation environments that intend to host the global scientific knowledge marketplaces of the future. Although these brokers maintain their business on the principles of open innovation, they differ in the approaches and adopted features. A good example is the Processes and structures of InnoCentive, Inc.[4] whose business model is centered on broadcasting science problems, connecting a global network of seekers (companies) and solvers (experts). This arrangement enables other companies to identify and hire the necessary skills to deal with their technical challenges.

Environment and scenario

Economic and cultural progress will be accelerated if advances in science and technology are adopted by companies and institutions through technology transfer [Novozhilov, 1991]. Technology transfer is complex: technological innovation is fast and continuous, companies are at a loss on how best to innovate and work with universities/R&D institutions, and the institutions themselves lack a full understanding of what companies need and when they need it [Rogers at al. 2001]. Therefore, while there is agreement that innovation will maintain and promote the competitiveness of companies, there are real hurdles in achieving such innovation [Etzkowitz et al., 2000]. TTOs are integral to these processes, yet they have received scant attention from policymakers and institutional leaders. They are the boundary spanners of their organizations and deserve significantly more attention now and in the future as important players in the OI ecosystems.

UTEN was launched in March 2007 with the mission of building a globally competitive and sustainable science and technology (S&T) transfer and commercialization network within five years. The vision of UTEN was that Portuguese companies, managed by highly trained TT professionals in close international collaboration, could benefit from a co-creative environment through the empowered links of the network. To fulfill this vision, UTEN has worked to create a critical mass of highly skilled professionals able to accelerate the international commercialization of Portuguese science and technology companies through the development of skills and professional competence and the leveraging of UTEN partnerships to foster international technology-based entrepreneurship and business development throughout the country.

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[4] InnoCentive is a Massachusetts-based open innovation company that accepts by commission research and development problems in a broad range of domains such as engineering, computer science, math, chemistry, life sciences, physical sciences and business and frames them as "challenge problems" for anyone to solve. It gives cash awards for the best solutions to solvers who meet the challenge criteria (Prizes for Solutions to Problems Play Valuable Role in Innovation. Wall Street Journal, 25 January 2007. Retrieved Sep 17, 2013).

When UTEN was initiated, Portugal had recently achieved an average OECD level in terms of the number of researchers per thousand workforce [Heitor and Bravo, 2010], and witnessed its highest increase in R&D expenditure: for the first time, expenditure represented more than 1.2% of its GDP (GERD reached 1,71% of GDP in 2009[5]), equaling or surpassing levels reached by Spain, Ireland, and Italy. The rise in R&D expenditure was matched overall by the business sector, which doubled such expenses in that period (having reached more than half of the R&D total expenditure).

This increase in R&D expenditure also reflected the policy priority for science and technology development, and was followed by a rapid increase in the number of researchers within the labor force from 3.8% in 2005 to 5% in 2007, (nearing the EU average) a ratio of one researcher per 200 employees.

The priority given to this rapid scientific and technological development was accompanied by a strong mobilization within the scientific community with visible results at an international level. Portugal's increasingly international scientific community is young and equally comprised of male and female researchers. This represented a highly productive period of clear growth. The national scientific output rose by 18% in a span of two years, measured in terms of the number of scientific publications in recognized journals. Among the five most cited scientific articles in the EU, two included collaboration with Portuguese authors.

At the same time, science- and technology-based entrepreneurship was increasingly seen as a key element of Portugal's ability to grow and prosper. Together with industrial liaison programs, research universities worked to foster a range of technology transfer and commercialization activities and offices, mostly devoted to fostering entrepreneurial environments, launching technology-based start-ups, and bringing ideas from the laboratory to the market. As part of this effort, UTEN was created to synergize the growth from research and stimulate new competencies in international technology transfer and commercialization with the aim of facilitating industry access to leading markets worldwide.

From Everrett Rogers's point of view [Rogers, 2002] together with the above discussion, we justify the procedures employed by UTEN. Rogers cites the following five strategies, "potentially the most important strategies" to the TT process:

- Create a boundary-spanning unit in an organizational structure that is responsible for technology transfer;
- Transfer personnel in order to transfer their technology;
- Form network relationships linking R&D organizations and receptor organizations;

[5] Eurostat 2010. Portugal: GPEARI / MCTES.

- Encourage the formation of high-tech spin-offs;
- Organize consensus-developing conferences to create shared practice guidelines concerning a technology (commonly accepted strategy in healthcare).

UTEN strategies follow the same rubric. In the following sections as support for the application of these strategies, we offer results from the evaluation phase.

Problem characterization - capacity Building

While it is clear that Portugal is climbing the charts in PhDs granted and R&D funding, IP protection, and licensing of technology to industry, it is also clear that these advancements are not sufficient alone (as witnessed in Portugal's current position in the global economy). In short, the significant challenges Portugal is currently facing center on 1) retaining the country's educated talent by developing high value jobs and careers, by 2) commercializing Portuguese S&T in global markets to the create new jobs for high talented nationals and on their own foster regional wealth across Portugal. Since its inception, UTEN's goal has been to enhance training and network building on an international scale, together with Portugal's technology transfer managers and staff and technology entrepreneurs, this effort is initiated under FCT's funding and leadership from the IC² Institute at The University of Texas at Austin.

UTEN's network includes 14 Portuguese universities and select technology parks and research centers. The Program focuses on capacity building for the accelerated commercialization of Portuguese S&T. UTEN is tightly linked with Portugal's program of international partnerships that focus on enhancing education and research excellence in targeted sectors at Portugal's leading research universities. Taken as a whole, these programs have been a substantial investment in financial and human resources devoted to enhancing Portugal's competitiveness in the knowledge-based global economy of the 21st century. The following are active programs furthering this goal:

The International Collaboratory for Emerging Technologies, CoLab (www.utaustinportugal.org) with The University of Texas at Austin

The MIT|Portugal Program in Engineering Systems, with the Massachusetts Institute of Technology (www.mitportugal.org)

The Information & Communication Technologies Institute, ICTI, with Carnegie Mellon University (www.cmu.edu/portugal)

The Harvard Medical School–Portugal Program in Translational Research and Information, (www.hmsportugal.org)

Fraunhofer Research Portugal (www.fraunhofer.pt) through FhP AICOS, the Research Center for Assistive Information and Communication Solutions.

Portugal has a unique worldwide in conceiving, launching, and continually assessing UTEN as an international program for capacity building with a focus on commercializing of academic S&T via business development and venture creation. These challenging tasks are key to wealth and job creation in emerging, developing, and developed economies, especially during the current global financial challenges. If it were easy to launch and build globally competitive national and international technology-based companies, then all nations would be doing it. It is not easy, and while Portugal has select examples of such successes, more needs to be done. The following pages demonstrate UTEN's unique proposal to address these challenges and to produce significant results.

UTEN has been in continuous development from 2007 through 2012 to provide much-needed training in technology transfer and commercialization and increase access to international networks. This is done in order to increase capacity building to bolster Portuguese academic-industry linkages, increase technology-based entrepreneurship, and accelerate firm growth nationally and globally. These capacity-building programs and activities over five years are reviewed and summarized in this working paper.

Taking the last mile

In networked systems that support many of today's critical services – roads, energy grids, telecommunication infrastructures, etc. – there is a well-known difficulty referred to as "the last mile problem." The [common] difficulty is bridging the gap from a local high-throughput distribution center to every single consumer home, equipment or individual, so that the service delivery point can actually (physically) meet the consumers, satisfying their needs and thereby producing value. The challenge is to feed the network with valuable content while providing it with the required capillarity to bridge the gap and avoid connectivity problems.

UTEN was born as a concept or a vision of a cooperative network aggregating entities and individuals in Portugal concerned with technology transfer, with a single major goal: improving and accelerating the transformation of science and knowledge into economically valuable, innovative solutions and addressing societal problems in a global context. With UTEN support such a network is being built on increasingly larger and more effective knowledge-producing nodes (laboratories, university research groups, tech-based companies) and on the new delivery links created through the technology transfer offices and professionals associated with those labs and universities – the "boundary-spanners".

In the OI environment, a boundary-spanner links the desired actors of an innovative project. The links (inbound or outbound links) with partners, brokers or any kind of organization or company participating in a project require management; this is the need boundary-spanners fulfill.

Because these links were initially created to interconnect the knowledge-producing nodes, they have trouble in effectively connecting with the knowledge-consuming nodes (the end-user companies and other licensees aiming at transforming and/or selling technology and technology-based products and services). This difficulty in effectively connecting to potential clients is the "last mile problem" of the technology transfer network.

With the application of all the capacity-building programs and activities over five years, the "last mile problems" of UTEN Portugal demonstrate their relevance through results presented in the next sections. We intend to show that the practices taken place in the UTEN program can improve and accelerate the transformation of science and knowledge of a region/country ecosystem into economically valuable innovative solutions as well as address their societal problems are adequate.

There is widely accepted (standard) method to systematically verify the performance of an innovation ecosystem—we do not know what an "adequate" performance by a player looks like, if it can be improved, and if improvements are possible. Furthermore, it is challenging to understand how to intervene to improve efficacy. Chapple at al. [2005], Debackere and Veugelers [2005], and Siegel et al., [2003] show many organizational practices that improve performance. Those practices are the same as those cited by Everett Rogers [2002]. We argue that in addition to the use of this information to improve individual institutions, thus information needs to be systematically normalized for the use of regional and national programs that utilize incentives and grants to enhance performances. In a time of reduced public expenditure, it is important to determine the best rate of return for every investment made [Resende et al., 2013].

In this chapter, we aim to achieve this last objective; however it is very important to analyze other success cases like UTEN in the future to further validate our conclusions. UTEN is a network, an OI Network, acting as a facilitator in the innovation ecosystem where it interplays.

The questions driving this analysis relating to the UTEN project are:

- There is a huge collection of variables conditioning the TT relationships, can we confirm that all processes, procedures, and structures in the UTEN network improved and accelerated, with relevant results, the transformation of science and knowledge of UTEN partners into economically valuable innovative solutions?
- Is it possible to characterize processes, procedures, and structures in the network and to identify their weight in the results?
- Is it possible to point out processes and critical procedures that are still weakly implemented?
- If we find and improve these weakly implemented processes and mechanisms, what performance increases (both efficiency and effectiveness) can we expect to achieve from intervening and rectifying existing problems?

Several other research projects have addressed issues of TT relationships - both cases in open innovation [Chesbrough et al., 2006; Carvalho, 2009] as driven by the triple helix [Etzkowitz et al., 2000; Fundación Cotec, 2003]. However, not all could be applied to the various scenarios and regions due to social, economic, and cultural specificities. In the following sections, we identify the steps necessary in our ultimate quest to improve technology transfer operations in an OI environment.

Research Methodology

The scientific domain of this research is the Management of Innovation and Knowledge and Technology Transfer, with a central subject of the relationships between the TTO, its host institution, companies, and other agents of innovation (who make Technology transfer one of its activities in an ecosystem under the OI paradigm.)

The research approach of this study is action research. According to Coughlan and Coghlan [2002] action research uses a scientific approach to study important social or organizational issues together with those who experience these issues directly. Action research has two goals: making the action happen and reflecting on what happens in order to contribute to the theory. This process involves collaboration between researchers and members of the organizational system. Action researchers are not just observing change, they are actively working to make it happen [Coughlan and Coghlan, 2002]. Action research is also self-evaluative. Researchers have to be aware of the impact they have on the situation [Remenyi et al., 1998].

Tharenou et al. [2007] argue that action research studies iteratively cycle through diagnosis and intervention until there is an understanding of the situation investigated. In this study, the action research is used to develop practice-based innovation processes in cooperation with the employees of case organizations.

The empirical research is based on various case studies. In fact, these case studies are all related to each other since the intention is to create a powerful network in the Portuguese innovation ecosystem. “Case study is a comprehensive inquiry, conduced in the field, into a single instance, event or setting” [Tharenou et al., 2007]. Case studies allow for the concentration on specific instances in order to provide a multidimensional view of the situation [Remenyi et al., 1998]. Although the results of a case study are difficult to generalize to other cases, the generalizability can be improved by using more than one case [Tharenou et al., 2007].

Action research always requires prior understanding of the organization’s environment, conditions of the business, as well as the structure and dynamics of the operating systems [Coughlan and Coghlan, 2002]. Therefore, a baseline data collection and metrics have been gathered in the first research phase.

The primary purpose of this first research phase has been to provide baseline data for key metrics on UTEN programs and activities as they relate to the performance of government programs, universities, and technology parks. In the Year 1 pilot program, national and EU comparative data was compiled from published research articles and combined with various studies and reports of the European statistics and economic agencies (this initial research report, "Select Baseline National Metrics Affecting Technology Commercialization in Portugal" in Jarrett and Ferreira 2007, contains data from the European Innovation Scorecard, OECD S&T and Industry Scorecard, and World Bank Indicators). In Jarrett and Teixeira [2011] additional data at the level of specific universities, incubators, and research parks was collected in cooperation with these Portuguese organizations.

The UTEN network – A case study

UTEN´s mission is to cultivate entrepreneurial attitudes and competitiveness of Portuguese science and technology assets in order to facilitate access to the OI market opportunities worldwide. UTEN strives to present new business opportunities to Portuguese scientific communities while also exploring opportunities for research projects with long-term industrial growth potential. Key UTEN activities include:

Strengthening and sustaining technology transfer networks and collaboration within Portugal and with international partners building the Portuguese Open Innovation Ecosystem;

Training Portuguese technology transfer managers and staff through value-added workshops and internships in select and diverse centers of expertise for "on-the-job" international competence building and enhanced network development;

Promoting both active support and mentoring for select and globally-competitive Portuguese business ventures as well as the national and international promotion of technology portfolios from Portuguese research centers and universities;

Enabling stakeholders to support leading-edge S&T commercialization practices including international patenting and globally networked entrepreneurship.

UTEN vision

The vision of the University Technology Enterprise Network was to build a network of highly trained professionals in science and technology (S&T) transfer and commercialization. The effort had already been taking place to establish TTOs in major universities across Portugal - UTEN was tasked with mobilizing this new resource. The UTEN network was to span Portugal and to intersect the globe; it was to become self-sustaining within five years. In pursuit of this vision, UTEN provided immersive training events to develop skills and professional competence at home, while introducing participants to international subject matter experts and industry contacts. The skills and the relationships that would result were to ground the UTEN network to, in turn, foster international technology-based entrepreneurship and business development throughout Portugal.

While most of its theoretical foundation consists of an understanding of entrepreneurial education, business incubation, regional development, and the power of positive policies to contribute to a knowledge economy – the UTEN program was of unique design, and introduced a "new angle of approach" for a program able to impact a nation's capacity for technology commercialization, and help launch technologies from university laboratories to global markets. This new trajectory has been agile in nature, with proactive response to program feedback. Thus, the program has evolved continually to meet new audiences with new events.

UTEN Strategy

UTEN's strategy has been to leverage programs and activities in a bottom-up approach that builds sustainable partnerships and networks among technology transfer and commercialization experts and centers across Portugal (UTEN Portugal), as well as with globally competitive international experts and offices of technology commercialization in order to:

- Strengthen Portuguese industry-science relations, intellectual property management, and technology transfer and commercialization competence for international markets
- Foster entrepreneurial vision and competence in Portuguese academia and business, and in civic organizations in a cooperative co-creative environment
- Provide productive international networking opportunities for Portuguese technology transfer managers and staff, technology-based companies, and start-ups
- Deepen Portugal's understanding of the challenges and opportunities of university-based technology transfer and commercialization nationally and globally
- Benefit from national and international experience and case studies which demonstrate how to promote regionally-based, globally-networked technology development and commercialization
- Brand Portugal as a creative, innovative nation that successfully attracts, educates, and retains world-class research and entrepreneurial talent.

UTEN was conceived as a cooperative network aggregating entities and individuals in Portugal concerned with technology transfer, with a single major goal: improving and accelerating the transformation of Portugal's science and knowledge into economically valuable innovative solutions as well as addressing societal problems in a global context.

Programs and activities

Since its inception, UTEN programs and activities have catalyzed sustainable, value-added partnerships and networks with key international partners while continually increasing its network reach within Portugal:

- Expanding the UTEN network by adding Portuguese institutional partners
- Expanding programs and activities to new international audiences
- Training an increasing number of Portuguese TTOs and associated entrepreneurs and professionals.

UTEN established new creative learning mechanisms with a focus on capacity building through innovative technology transfer practices, related know-how, commercialization skills, and development of both formal and informal national and international networks. UTEN programs and activities include:

- International Internships
- Specialized Training and Networking
- Technology Commercialization
- Observation and Assessment
- Institutional Building.

This chapter presents part of the Observation and Assessment. The central focus of UTEN's assessment effort is the continued observation and dissemination of lessons learned relating to challenges and successful projects and ventures to help assess and improve the performance of technology transfer and commercialization across Portuguese institutions. These efforts further the larger goal of the continued professionalization of Portuguese TT managers and staff. To this purpose UTEN conducts:

- In-depth program evaluations of international internships, international workshops, training weeks, in-situ training, and roundtables of leaders.
- Annual reports of the main activities and results of the Program with feedback from the stakeholders involved.
- Annual surveys of national TTOs, performed cooperatively with Portuguese and UT Austin researchers.
- Annual surveys administered to all UTEN partner institutions to help monitor the challenges and best practices of technology transfer and commercialization in Portugal.
- Case study development associated with Portuguese startups and university spin-offs.

Discussions and conclusions

The next discussion is a transcription of selected parts of the empirical research [UTEN, 2012] by James Jarrett, Senior Research Scientist, IC^2 Institute, The University of Texas at Austin, and Aurora Teixeira, Assistant Professor with Habilitation, School of Economy, University of Porto; Associate researcher of CEF.UP, INESC Porto & OBEGEF.

According to Coughlan and Coghlan [2002], the general phases of an action research process are: Planning, Taking action, Evaluating the action, and Further planning. This section explains the latter two phases with UTEN Program.

Context

The central mission of a TTO is to manage and operate TT activities [AUTM, 2005]. TTOs have been established to assure professional commercialization of the knowledge generated within the universities. These developments have received extensive attention worldwide with researchers initially focusing those efforts on the direct implications of licensing and patenting [Rothaermel et al., 2007]. Recognizing that TTOs are only a part (though an important one) of university knowledge spillover, [Shane 2004] the growing emphasis has been placed on university or Academic Spin Offs (ASOs) [Lockett et al., 2005]; [Wennberga et al., 2011]; [Lazzeretti and Tavoletti, 2005]. ASOs are firms whose products or services are based on scientific/technical knowledge generated within a university setting, where the founding members may (or may not) include the academic inventor [Steffensen et al., 1999]. In short, ASOs are firms created to exploit technological knowledge that originated within universities [Fini et al., 2011].

In what follows, we present summarized data of the main traits and dynamics of TTOs and ASOs in Portugal over the last decade. We argue that such trends, depicting TTOs and ASOs as key university related technology transfer mechanisms, might in large part be connected with the institutional changes observed in Portugal in this period, together with the creation of transnational programs, namely the University Technology Enterprise Network [Gibson and Naquin, 2011].

UTEN Survey of TTOs

In 2012 the third annual UTEN network survey of technology transfer offices was conducted to develop a more comprehensive view of technology transfer in Portugal. A short summary of key findings follows[6].

[6] The source of data is mainly from UTEN 2012 report. But it is important mention the following publications: Performance of Portuguese Academic Spin-offs: Main Determinants is the work of Aurora A. C. Teixeira with the research assistance of Marlene Grande. Previous related studies appear in the 2009-2010 UTEN annual report, Technology transfer and commercialization activities in Portugal: A quantitative overview, p. 52-55 and Portuguese Academic Spin-offs and the Role of Science and Technology Transfer Organizations, p. 55-61; and the 2011 UTEN annual report, Characters and Trends of Academic Spin Offs (ASOs) associated to UTEN partners, p.74.

The primary functions of TTO employees continue to be: writing grants and fund-raising (27%), assisting with the protection of intellectual property (18%), and supporting entrepreneurship/spin-outs (14%) with smaller amounts of time devoted to coordination, licensing, and industrial liaison;

On average, approximately half of the revenues received by TTOs are from grants, with another 20% from external fees and services; only one fourth of TTO revenues are provided by their institution.

Compared to last year, there was a substantial increase (42%) in the number of invention disclosures reported by the TTOs.

There are no clear trends with patent applications, while there has been an upward or stable trend over time for the three main types of patents granted. In the last two years, the impact of the economic crises in the use of patents seems clear.

Licenses, option agreements, and assignments in 2011 matched the strong number in 2010, and the trend over time continues to be positive.

Total license income increased once again in 2011, by about 6% over the prior year.

Research and development agreements were 38% higher in 2011 than in 2010. TTOs reported a large number of new companies established: 141 in 2011 compared to 95 in 2010.

Twenty offices were contacted, and responses were received from 18 TTOs as of late October. TTO directors were promised that only aggregate results would be released and that no responses from individual TTOs would be disseminated. Unlike the prior two years, this year UTEN Portugal implemented the survey with MERIT of Maastricht University, under the European Commission's Recommendation on Knowledge Transfer and supported by the European Council's Resolution on Knowledge Transfer. UTEN and MERIT surveys were merged to decrease the response burden on Portuguese TTOs and to overcome the lack of international comparable data. TTOs were contacted initially in late September 2012, and responses were tabulated in October 2012. A second survey was sent to a larger group of Portuguese institutions including polytechnic institutes, associated labs and private research centers, to access their technology transfer results for the year of 2011. The responses received are included in the results provided to MERIT integrating the sample for the technology transfer study commissioned by the European Commission.

Basic organizational structure

Basic organizational structure: most TTO respondents are an integral part of their institutions. Two TTOs are external organizations that provide technology transfer services to multiple institutions. Besides performing services for their universities, four TTOs serve government or non-profit research institutes, two serve incubators or a research institute, and two serve research parks.

Maturity of TTOs: Many of the TTOs are recently established with only two TTOs having been established for at least a decade. Others are more recent with one started in 2010 and another in 2012.

Employee duties: The number of full-time technical/professional employees ranges from 1 to 14 per office. Twelve of the 18 TTOs have five or fewer technical/professional employees. The offices that responded have a total of 81 technical/professional employees. Across the different TTOs, on average employees allocate their time to several key functions (Figure 1).

Budget expenditures: Expenditures vary considerably across the TTOs. At least four TTOs spent more than €200,000 and four others spent more than €100,000. Of the TTOs providing expenditure information, approximately 70% of funds were devoted to human resources, with nearly 20% allocated to patenting and the remaining funds spent on entrepreneurship.

Employees' backgrounds: More than half of the TTOs have employees with university qualifications in Management/Business Administration and Engineering/Natural Sciences. About one-fourth of the TTOs have employees with a background in Law. About one-fifth of the TTOs have employees with qualifications in Finance, and three TTOs (one-sixth) have staff with biomedical backgrounds.

Sources of revenues: As shown in Figure 1, grants and fund-raising are an important task for TTOs. Only one TTO in 2011 received all of its revenue from its home university. TTOs are in fact quite dependent on grants to perform their functions as nearly half of their revenues, on average, come from grants. In 2011, ten of the TTOs secured at least half of their revenue from grants, with three TTOs above 70%. Two other TTOs were entirely funded from external fees and services. On average in 2011, the TTOs received their revenues from sources as shown in Figure 1. Compared to the prior year, TTOs increasingly relied on external fees and services and grants, receiving a smaller proportion from their home institution.

Services provided: Despite the diversity among TTOs in their budget expenditures and revenue sources, there is considerable similarity in what services are being provided:

- Create or support start-up companies based on their institution's inventions
- Raise awareness/disseminate information on intellectual property rights and entrepreneurship
- Assess the patentability of inventions
- Manage material transfer or confidentiality agreements
- Apply for patents

(> 66% of TTOs)

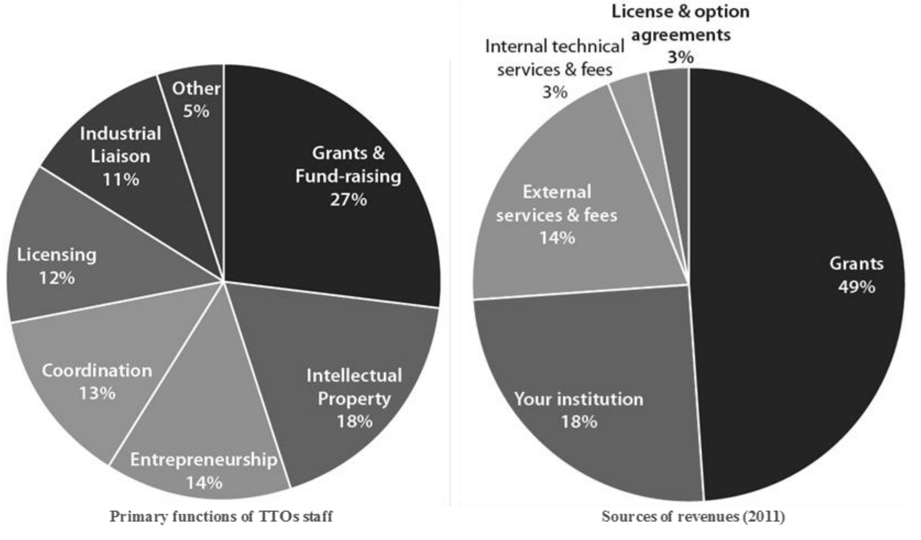
- Negotiate or arrange licenses
- Scout for new intellectual property and new technology
- Prepare grant proposals
- Provide training to faculty, researchers, or students

(>50% of TTOs)

- Negotiate government-sponsored research contracts/grants
- Coordinate with business angel networks.

In contrast, about one-third manage or coordinate an incubator facility and one in five manage a research/science and technology park. Other services noted by TTOs include: providing consultancy services, drafting non-disclosure agreements, business idea competitions, searching research and developing competencies, and acting as a liaison to industry.

Figure 1. Core functions and sources of revenues of the responders TTOs (UTEN 2012) Intellectual Property and Commercialization



Source: UTEN Portugal, 2007 – 2012: A Progress Report, Austin 2012.

Scope of patenting: In 2011, all but three of the 16 TTOs responding to this question performed at least 90% of the patent applications through their offices. One reported handling less than half of the applications, and two others do not undertake any patent applications.

Ownership of IP rights: The universities own IP rights in nearly all cases. In three, inventors own some rights depending on contract negotiations; in one, IP rights are owned by the schools.

Royalties: Seventeen TTOs provided information about royalties, and 15 reported that royalties are split between their institutions and the inventors in varying proportions. In eight of the institutions, royalties are split 50%-50%. In another seven institutions, the inventors receive 55% or more, this includes two institutions that provide 80% to inventors. One university alters the allocation depending on the total amount of royalties received—for smaller amounts, the inventor receives a higher percentage; for larger amounts, the university receives more and the organizational unit receives some proportion. Compared to last year, inventors now are receiving a larger share at a number of institutions.

Invention disclosures: During the UTEN program period, there was a substantial increase (42%) in the number of invention disclosures reported by the TTOs. As shown in Figure 2, invention disclosures in 2011 reached 282.

Patent applications (priority filings): The trend is less clear on patent applications as shown in Table 1. In one category (provisional), the trend is clearly upward, while in the other four categories there are no clear trends. In 2011, there was one application in Spain and another in India.

Patent Applications by Subject Area: More than half of the TTOs applied for some type of a biomedical (diagnostic, devices, pharmaceutical etc.) patent in 2011. Six of the TTOs applied for a patent related to computers or communication equipment, while four applied in the area of nanotechnology/new materials, and two in low or zero carbon energy technologies. Other areas in which TTOs applied for patents were agricultural sciences, life sciences, mechanics & electromechanics, and the food industry.

Patents Granted: The trends has been upward or stable over time for the three categories. In 2011, two TTOs reported receiving Canadian patents.

Active Patents: Compared to the year before, in 2011 there were more EPO patents (6%) and USPTO patents (26%) filed. PCT active patents declined by 5%. Because of changes in the data collection methodologies, the increase in the number of active Portuguese patents could not be determined precisely. The increase was a minimum of 56% and possibly as high as 85%. TTOs reported having active patents in Canada, France, Russia, Norway, Brazil, Japan, China, Australia, and South Africa.

Table 1. TTOs patents and applications, 2007-2011

TTOs	Patent Applications (Priority Filings)					*Patents Granted:* The trends has been upward or stable over time for the three categories				
	2007	***2008***	***2009***	***2010***	***2011***	***2007***	***2008***	***2009***	***2010***	***2011***
Provisional Filings	***4***	***23***	***66***	***80***	***100***					
Portuguese	***71***	***88***	***76***	***78***	***69***	***24***	***32***	***38***	***56***	***52***
EPO	12	13	12	4	6	4	5	5	7	8
USPTO	11	17	5	11	7	5	3	5	4	2
PCT	29	30	74	43	17					

Source: UTEN Portugal, 2007 – 2012: A Progress Report, Austin 2012

Licenses, Option Agreements, and Assignments: As in prior years, the large majority of the licenses, agreements, and assignments have been executed with Portuguese partners as shown in Figure 2. The total in 2011 nearly matched the very strong number in 2010, and the trend over the past five years continues to be positive. About an equal number of licenses and options were granted to start-up companies and firms with fewer than 250 employees. The remaining licenses and options, about 20%, were granted to companies with more than 250 employees.

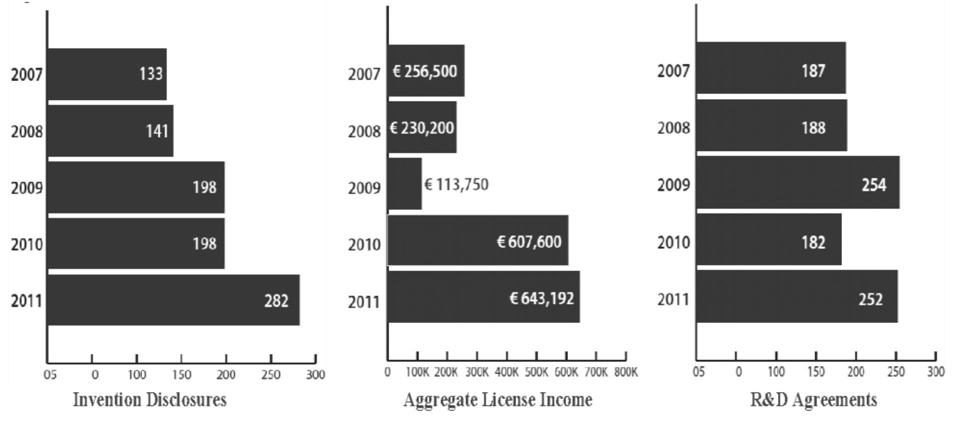
License Income: following the dramatic increase in 2010, the total amount of license income increased once again in 2011. Seven of the TTOs reported license income, with three TTOs reporting license income of at least €100,000 in 2011. Therefore the aggregate amount of nearly €650,000 is not due to a single transaction or single TTO. Three TTOs reported international license income.

Commercially Profitable Products: Eleven TTOs indicated that their institution's licensed technology or knowledge had resulted in commercially profitable products or processes in the past three years.

Research and Development Agreements: TTOs reported a dramatic increase in the number of executed agreements in 2011 (up 38% from the prior year). The number in 2011 essentially matches the strong performance in 2009 and surpasses the levels in 2007 and 2008 as shown in Figure 2.

Institutional Research Resources: For the first time in this series of surveys, TTOs were asked questions about their institution's research resources. The total number of research personnel (researchers, technicians, and administrative support personnel) at 14 institutions in 2011 was 22,377. Six TTOs reported more than 1,000 researchers each. The aggregate research budgets at nine institutions were €112,908,866, with two institutions accounting for three-quarters of the total. Privately funded research at institutions varied considerably. One TTO said 35% of total research expenditures came from private companies, a second TTO said that figure was 24% at their institution, and a third TTO reported 19%. One TTO each reported 12%, 11%, 10%, and 9%, while three TTOs reported 5%. Other TTOs did not provide a response.

Figure 2. Indicators – 2007 to 2011

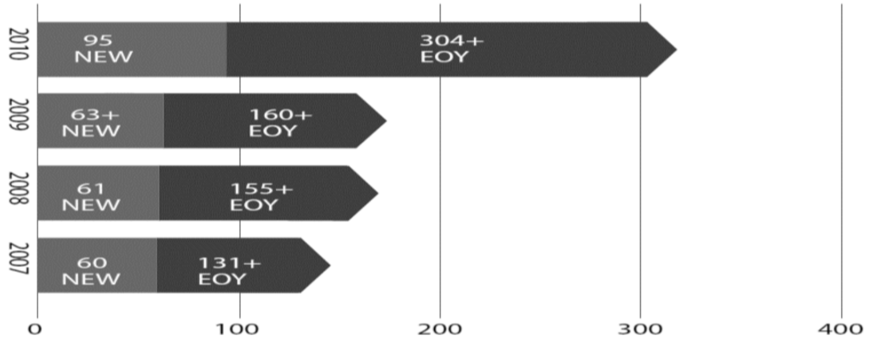


Source: UTEN Portugal, 2007 – 2012: A Progress Report, Austin 2012.

Spin-off & Start-Up Companies: Data from the TTOs show that a large number of new companies are being established. In 2011, TTOs reported 141 new companies were established, while nine companies from prior years ceased operations. The total number of new companies and the total number of active spin off and start-up companies until 2010 is shown in Figure 3.

We argue that UTEN program has improved not only the OI ecosystem but, more deeply, the co-creative relationships. The indicator is the number of ASOs that started selling earlier in the last years (Figure 4). In this case, one could state that the ecosystem "boot up" the user-driven innovation with some network actors.

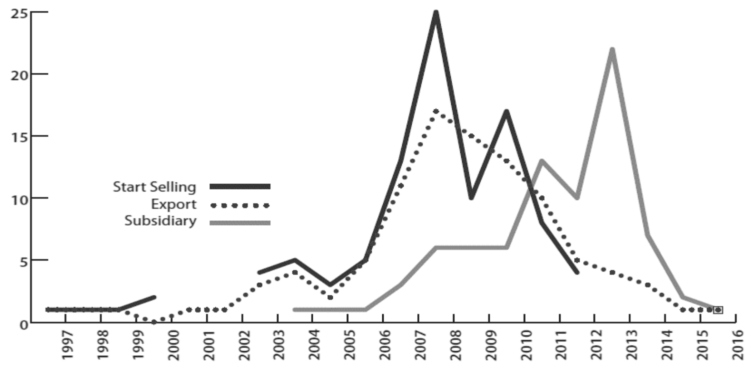
Figure 3. New and total Academic Spin Offs at end of years



Source: UTEN Portugal, 2007 – 2012: A Progress Report, Austin 2012.

In Portugal, national patent applications from universities have continuously increased between 2006 and 2009, with growth rates above 20% per year, as seen in Table 2. In 2010, it is possible to observe a slight decrease, partly recovered in 2011. The effects of the financial restrictions, resulting from the economic crisis, are visible in the in number of patents applied for, in these last years, namely after 2010 relationships. The indicator is the number of ASOs that started selling earlier in the last years (Figure 4). In this case, one could state that the ecosystem "boot up" the user-driven innovation with some network actors.

Figure 4. Beginning of the activity/sales/exports/subsidiary of ASOs



Source: UTEN Portugal, 2007 – 2012: A Progress Report, Austin 2012.

In general, the main applicant universities increased the number of patent applications over the last six years. On an individual level, between 2006 and 2011, University of Beira Interior (UBI) and University of Trás-os-Montes-and-Alto-Douro (UTAD) showed the most distinct growth. In 2006, these universities had the lowest number of patent applications. However, in 2011, UBI had the lead and the UTAD had the third highest number of patent applications. While Instituto Superior Técnico (IST), the country's largest Engineering school, has significantly decreased the number of patent applications in the last two years, it remains the university with the highest number of accumulated applications (194) in the period 2006-2011.

Table 2. University National Patent Applications, 2006-June 2012

	2006	2007	2008	2009	2010	2011	June 2012
University of Aveiro	12	5	19	21	17	12	9
University of Minho	8	12	13	12	14	12	11
University of Évora	3	4	1	5	2	1	1
University of Porto	12	8	12	11	3	10	9
University of Coimbra	2	1	1	9	7	9	4
University of Algarve	3	2	5	13	14	5	4
University Nova of Lisboa	3	13	13	11	3	2	0
University of Beira Interior	1	2	1	6	16	17	2
University of Trás-os-Montes and Alto Douro	1	8	6	7	7	13	5
Instituto Superior Técnico	35	43	54	38	9	15	6
Other	4	10	14	36	30	42	17
TOTAL	**84**	**108**	**139**	**169**	**122**	**138**	**68**

Source: Portuguese Institute of Industrial Property, UTEN Portugal, 2007 – 2012: A Progress Report, Austin 2012.

As shown in Table 3, except for the United States, the national and international (WIPO and EPO) patent applications have risen until 2009. In the last two years, the impact of the economic crises in the use of patents seems clear. There was a decline in the number of patent applications in all routes of protection. It was at national level that this effect was less visible; to a certain extent this can be explained by the fact that the protection in Portugal is the one which requires the lowest investment.

The number of patents applied for directly in the United States increased in 2007, but in the following years the level of applications has been more or less maintained. Moreover, it is interesting to observe that in 2010 there was even a rise in the applications in the United States contrary to the behavior in other routes/territories.

Table 3. National and international patent applications, 2006 – 2011

	2006	2007	2008	2009	2010	2011
Portuguese Institute of Industrial Property (INPI)	219	283	405	600	527	598
World Intellectual Patent Organization (WIPO)	68	93	100	163	117	96
European Patent Office (EPO)	78	70	84	112	81	77
United States Patent and Trademark Office (USPTO)	23	35	39	36	43	–

Source: Portuguese Institute of Industrial Property, UTEN Portugal, 2007 – 2012: A Progress Report, Austin 2012.

In 2011, EPO published 89 patents applications and WIPO published 185 applications in several technology areas, belonging to Portuguese enterprises, higher education and R&D institutions, and independent inventors. The majority of these applications came from enterprises, followed by universities and then by individuals. The U.S. Patent and Trademark Office (USPTO), in 2011, published 27 patents submitted by Portuguese entities while enterprises filed 23 of those patents, and universities filed the remaining 4.

Policy Implications

More opportunities for science and technology within increasingly globalized and specialized markets of OI have brought new challenges and opportunities to international technology transfer and commercialization. Our study shows improved indicators that lead to the conclusion that UTEN is a success case. This new network has worked the last five years with national and international partners to leverage existing professional technology transfer and commercialization know-how, to generate new knowledge for successful S&T co-creation and commercialization, and to promote Portuguese economic development in the global economy.

In recent years, public policies in Portugal have promoted a systematic development increase in competencies to manage TT and commercialization. UTEN was born as a top-down project that has been working with TTOs as a success case of a practical bottom-up approach.

Talent is everywhere, whether in large or small countries, or developed or developing economies. The pathway to success in which science meets the market to create economic impact is to uncover local talent and provide a country-wide ecosystem that is open to the world and promotes innovation and collaboration. One can conclude based on the evidence presented in this paper that for small countries such as Portugal to be competitive knowledge-generating moguls it is imperative to develop critical masses within the research community. We argue that an effective way to do this is through the establishment of partnerships like the UTEN program with leading international institutions with vast experience in the field will provide expertise and prestige to the local research entities. This principle also holds true for the technology commercialization process. The participation of formal global networks will trigger internal (informal) collaborative processes between local institutions that would otherwise not occur. If kept long enough, results will be generated as relationships evolve and confidence between peers solidifies. The role of federal governments is key for this transformation to occur. Not only through funding mechanisms (although crucial), public authorities should set the tone and develop policy that simulates excellence in research and development activities and the commercialization of scientific results. In doing so, these authorities function as a bridge between the research community and the private sector. By funding basic and applied research, keeping a culture of merit, and empowering the most promising institutions and individuals these organizations can cultivate the secret sauce for success.

The UTEN has considerably strengthened this movement. The UTEN network engages with scientific and academic institutions throughout Portugal to emphasize technology transfer and commercialization on an international scale. UTEN efforts have been made possible by the work of the IC^2 Institute at The University of Texas at Austin, the promotion and support of the Foundation for Science and Technology (FCT), working in close collaboration with the Portuguese Institute of Industrial Property (INPI), and since 2010, with the Council of Rectors of Portuguese Universities (CRUP).

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SOCIALLY RESPONSIBLE INNOVATIVENESS - GOOD PRACTICES AND THEIR EFFECTIVENESS EXEMPLIFIED BY KGHM

Abstract

The paper addresses the critical role played by corporate social responsibility and its measurement in the course of the development and implementation of new technologies as well as innovations in their broad sense. Particular attention is drawn to the practical applicability of stock exchange indices which assess the social responsibility of today's companies. The Respect Index, floated on the Warsaw stock exchange, and the innovative operations of KGHM Polska Miedź S.A serve as examples, revealing both the tight and beneficial interdependency between social responsibility, innovativeness and a company's financial results. Analysis of the literature on the subject is accompanied by the case study of good practices, drawn from KGHM Polska Miedź S.A.

Keywords: Corporate social responsibility, Respect Index, new technology, innovation, innovativeness, Warsaw Stock Exchange, WIG20.

Introduction

The rapid, dynamic, social, economic and technological changes of recent years have forced companies to constantly improve their operational strategies, which has led to all types of innovations being more and more regularly regarded as the key factor in a company's development, and even as a basis for the economic balance that leads to constant and sustainable growth. This gives innovations and the accompanying technological developments above average status - it is regarded as a chance for the future and perhaps even more. Aficionados of technology "regard innovations and technological development as the salvation of mankind from all possible plagues and suffering, the source of widespread felicity, peace, retention of eternal youth and beauty, boosting both physical and intellectual agility (…), a cure all for the whole planet and its economy" [Bokszańska, 2008]. Novelties, particularly those of a technological nature, bear the promise of making individuals better, wiser, increasing their effectiveness, improving happiness, ensuring safety, security, privacy and freeing people from sorrow while enriching them. This means they may be more productive than nature itself, giving the impression that our lives nowadays are governed directly by technology [Naisbitt, Naisbitt, 2003]. This is a blatant example of ‘technophilia’, namely a fascination with the latest technologies [Postman, 2004]. Trying to create and implement further innovative solutions, we regularly seem to forget the history and conditions of there creation and the purpose for which they were really created.

Sadly, technological advancement and the widespread scale of various innovations, not seen previously, also has a flip side. The range of new technology applications is constantly growing, while the ability to control them decreases [Pichlak, 2012]; [Cheasbrough, 2006]; [Lichtenhalter, 2011]. Innovative solutions turn up far more regularly, they may be controversial (e.g. innovations in genetics), have difficult to foresee side-effects (for employees, clients, local communities or the natural environment, etc.) and pose various risks (e.g. economic or health). The contemporary ‘technological’ civilisation has turned auto-destructive and self-harming as, “the competitive battle for buyers’ markets, the tendency to reduce production costs at any means, the inability to take collective action on an international scale (…) contribute to the increasing dangers for our civilization at a terrifying speed” [Hirsznowicz, 1988].

Under such conditions a company’s ethical values, such as trustworthiness or social responsibility, are of particular importance. Companies that have such features can afford to carry out innovative and non-standard operations with greater comfort and over a longer term. Long term relationships based on ethics, responsibility and trust, implemented with a wide range of partners, creates a unique atmosphere around the company, which builds its positive image, a so-called climate of trust. The skills, resources, knowledge, close loyalty-based business relationships, professionalism and honesty acquired at that time by cooperating parties, though often of an informal nature, build a unique, mutual ‘culture of trust’.

In many cases, thanks to responsibility and trust, which are widely appreciated qualities, organisations notice above average opportunities for transaction cost reduction, an increase in motivation to take business decisions, a readiness to undertake risky transactions, the stimulation of creative thinking processes, facilitation of information exchange, boosting a company’s ability to cope with crisis situations and a greater possibility for networking between organisations [Adamik, 2010], therefore greater competitiveness and risk taking.

The aim of this paper is to present the role of corporate social responsibility and its measurement in the processes of the development and implementation of new technologies and innovations in its broad sense, foremost, profitability and the effectiveness of companies today. The analysis of the literature on the subject is accompanied by a description of good company practices, which may consolidate success through innovativeness and social responsible attitudes.

The essence of corporate social responsibility

Each company operates within its environment, and its decisions, in both a direct and indirect way, impact and are important for both people and organisations. *Corporate Social Responsibility* (CSR) considers such issues. Its basic principle revolves around the impact of these decisions across all company operations. CSR is a concept which considers an organisation's responsibility for the results and influence of its decisions and operations on society and the environment through transparent and ethical actions. This is a business-specific contribution to the implementation of the policy of sustainable economic growth and to running a company whose priority is a balance between effectiveness, profitability and the public interest. Moreover, taking into account not only economic aspects (multiplying profits while boosting benefits for company cooperants in parallel) but also an ethical aspect (conduct not only in accord with legislation but also a moral standard), as well as an ecological aspect (operations respecting the natural environment and geared towards its protection) [Rojek-Nowosielska, 2006].

The economic aspect refers to, amongst others, economic operations according to accepted legislation, ensuring financial security for both employees and owners, fair competition and advertising and a constant improvement of product quality and management methods. The ethical aspect considers awareness of the results of decisions taken and accepting responsibility for them, being driven by respect for the welfare of society within generally accepted norms, as well as limiting profit-driven situations, which may lead to overstepping these boundaries. The ecological aspect includes mainly following the accepted rules and regulations on environmental protection, reduction of environmental damage in all operations, energy and natural resource efficiency, limiting the negative impact of products and company operations on the environment, and provision of all interested parties with information on production and products' environmental footprints in addition to ensuring the health and safety of staff in the working environment [Skalik, 2001].

In practice, such conduct is translated into [Tichy et al., 1998]:

- The ability to implement balanced development, considering society's health and welfare along with respect for the natural environment
- Taking into account in a company's operations the expectations of a wide range of stakeholders
- Acting in accordance with the law and coherence with international conduct norms (reflected in e.g. the Respect Index)
- The implementation of socially responsible solutions at all levels of company operations and a CSR approach within its whole zone of influence and its relationship with various types of stakeholders
- Sensitivity to affairs affecting the lives of people and organisations which you 'live with' and cooperate

- Striving to understand the conditions governing social life in order to affect it positively
- Consistent consideration of the social impact stemming from the organisation, investment, financial and non-business decisions which influence large groups of stakeholders (employees, clients, suppliers, cooperants, competitors, local communities and the natural environment)
- An increased awareness of not only 'what a company produces but how it is produced'

This is why the issue of effective and responsible management has been enjoying an increase in popularity. Companies more regularly widen the scope of their interests and, in the processes of opportunity and risk mapping, tend to identify and then eliminate its negative impact on social and environmental issues.

Due to the fact that strategic management and company responsibility enables long-term benefits, through for example opportunities for new, ecological, social and often innovative services and products as well as the more effective usage of pre-existing resources, particularly natural and intangible ones. CSR is becoming a sought after element of modern business strategies (in particular among raw material sector companies). A conscious and considered combination of CSR and business strategy not only facilitates company's setting long-term targets but also enables regular monitoring and assessment of the results of undertaken operations, which areas require particular attention and to which degree CSR targets support a company's development goals. CSR therefore is definitely a modern management strategy and approach to running a business, not merely a marketing or PR tool, as its opponents tend to present it.

Regardless of the definition of corporate social responsibility, and there are a number of them, this is a strategic and long-term approach leading to steady profit through particular conduct. Namely, product and service provision with particular attention to ethical values, law, due diligence, respect for the workforce and society in general, while being considerate to the natural environment. Overall, it comes down to a specific company's skills in the areas shaping its relationship with its close community and environment. It is also seen as a process within which companies gauge their relations with various stockholders who may have a real impact on a company's economic success. Therefore, it should be regarded as an investment, not a cost incurred [Paliwoda-Matiolańska, 2009]. It is even believed that social responsibility is becoming a sign of our times, a desired element in a company's image, a distinctive feature of advancement and adherence to standards reserved for the best companies, who attach great importance to multi-level partnerships in their operations [Pisz, 2010].

Seasoned investors, particularly those present on the Warsaw Stock Exchange (GPW), know that in order to achieve long-term success a company must have a mission and a plan for sustainable development, namely 'a backbone' which will facilitate its smooth operations and strengthen them. The strategy of corporate social responsibility is regarded by many as such a backbone. Namely, an approach that allows the company to be run in accordance with its business environment and not at its cost. The strategy builds trust towards a company and boosts its competitiveness. Thanks to this, companies achieve their economic goals while considering the public interest, meaning taking care of ethical principles, employee and human rights, society and the natural environment [Chudy, Nowodziński, 2007].

The key tasks for the management of modern organisations therefore include the search for methods and techniques which would enable an individual (an employee, client, cooperant, partner, neighbour, society, local community, etc.) to become the centre of a company's attention [Żemigała, 2007]. It also allows the design and implementation of a strategy of socially responsible activities which will follow the assumption that a company operates for the benefit of its environment and remains under its influence, that the environment conditions a company's operations, that only thanks to a smooth realisation of its needs, is it accepted by its environment, which enables its survival on the market, even when facing fierce competition [Adamczyk, 2009].

The design of CSR strategy should be carried out in accordance with the investment model concept, which regards socially responsible activities as tools and even investments indispensable for a company's survival in a competitive market. In Poland, the idea was pioneered by the ABB management, which conducted a formal dialogue with stockholders as early as 2002 or Elektrownia Opole (Opole Power) which implemented the social responsibility management standard SA8000 as early as in 2001 (The United Nations Development Programme). Nowadays, more and more organisations place their operations under public scrutiny, including social responsibility, hoping for general acceptance of their operations, particularly those of an innovative or investment nature. One such company, KGHM Polska Miedź S.A., serves as an example in this paper.

CRS – Aims and methods of measurement

In the contemporary world, responsible and balanced business seems not merely an idea but also an attitude towards management from extensive experience, personal methodology and established standards. One of these is the measurement and reporting of social actions. L. Zbiegień-Maciąg claims that the very idea of a company's social responsibility means that it is held morally responsible and its operations are certain to come under scrutiny by the law and society [Zbiegień-Maciąg, 1997].

Social responsibility reporting is today a dynamically developing trend, common among companies across the globe, especially in highly developed countries. It has been estimated that already over 10,000 companies worldwide release some kind of this report. In 2008, 197 companies from G250 Global Fortune 500 (a collection of the biggest and most advanced corporations worldwide) published individual reports on social responsibility. The most frequent and extensive reports of this type are carried out by companies of sectors which faced significant non-compliance or disasters, e.g. the petrochemical, pharmaceutical, FMCG and banking sectors [Roszkowska, 2011]. CSR monitoring assessment and reporting seems to be an investment linked to the creation of a company's positive potential. The selected reasons and benefits drawn from such activities are presented in Table 1.

Table 1. Reasons and benefits for reporting corporate social responsibility

Selected CSR reports - reasons	Selected benefits of CSR reports
Ethical reasons	Local community support
Economic reasons	Reduction of resource usage, emission of pollutants, operational costs (eco-effectiveness), income increase
Brand reputation	Boosting appeal for investors, improvement in a company's standing and image
Innovativeness, learning	Stimulating constructive changes in management of environmental and social issues
Employee motivation	Employee education, building loyalty, boosting productivity
Management risk reduction	Strengthening of business relations, limiting business risk
Strengthening links with suppliers	Raising competitive advantage in the supply chain, increasing customer trust
Access to capital, increasing shareholder value	Building trust and credibility among key stakeholder groups
Market share, competitive position	Boosting competitive advantage

Source: Own research.

Literature on the subject more and more frequently mentions the fact that thorough reporting (including CSR) enables companies in their financial, trade and social areas to construct a long-term and effective strategy which curbs risk and uncertainty in their operations as well as building not only its competitiveness and competitive advantage but also significant values for stakeholders (including innovativeness in its broad sense or technological solutions).

Various types of indices are used in measuring whether a company is a responsible one. The most common include; economic indices (e.g. investment, innovativeness or percentage of expenditure on R&D), ecological (e.g. CO_2 emissions, waste management, noncompliance with norms, investment in reducing harmful impacts, re-use of recycled material and emission effectiveness - emission/income), workforce (e.g. level and range of remuneration, training time per employee, number of redundancies, number affiliated to trade unions or vacancies created), safety (e.g. accident rate per employee, sick leave, number of accidents while travelling on company business), social engagement (e.g. resources allocated to social causes, level of taxes and local outgoings, subsidising local initiatives), or business relations (e.g. period of grace for payment, number of suppliers and complaints) [Bartkowiak, 2008]. There is also a growing interest by organisations and their potential partners, e.g. investors, in social responsibility stock exchange indices.

One of the oldest stock exchange indices that refers to socially responsible activities is Domini 400 Social Index, established in 1990. The most common indices at this time on this subject are presented in Table 2. It is worth mentioning that market participants have other, more specialized tools at their disposal such as the environmental indices FTSE CDP Carbon Strategy Index Series or religious ones like Dow Jones Islamic Market IndexSM.

Table 2. Review of the World's most popular CRS assessing indices

Index	Characteristics
RESPECT Index*	The current idea of the RESPECT Index project (RESPECT is an acronym of CSR keystones: Responsibility, Ecology, Sustainability, Participation, Environment, Community, Transparency) continues the activities of the Warsaw Stock Exchange, undertaken in 2009, whose effect was the establishment of the first index of responsible companies in Central and Eastern Europe. The aim of the RESPECT Index project is to highlight companies that are managed in a responsible and sustainable manner and to underline the investment attractiveness of those companies which can be characterised, among others, by reporting quality, level of investor relations and information governance. Thanks to the fact that the qualifying criteria considers the parameters of RESPECT Index liquidity, like other stock exchange indices, it has become a valued reference point for professional investors. The RESPECT Index, based on the verification of adherence to set criteria, includes exclusively those stock market companies which act in compliance with the highest management standards in the area of corporate governance, information governance and relations with investors as well as in the fields of ecological, social and employee factors.
Dow Jones Sustainability Index series (DJSI)	Established in September 1999 by Dow Jones, STOXX Limited and SAM Group – Sustainable Asset Management. Since when over a dozen wide ranging indices for World, region or sector have been established. DJSI bases its methodology on positive selection, and its aim is to choose companies which are 'best in class'. When selecting companies for the indices the main criterion taken into consideration is the analysis of three areas: The economy, environmental protection and social responsibility.
Calvert Social Index (CSI)	The Calvert index of investment funds has been calculated since March 2000 and measures the economic circumstances of American companies which have been labelled socially responsible. Analysis, in reference to their products (type of product), environment (protection and pollution), workplaces (adherence to regulations and norms) and business integrity, is conducted when selecting companies for the index.

Index	Characteristics
FTSE4GOOD series	Introduced by the London Stock Exchange and Financial Times in July 2001. At present it calculates the indices for the World as a whole, selected markets and regions. The selection of companies for the indices includes negative selection (it excludes companies involved in weapons manufacturing, addictive substances and those ignoring the principles of social equality) and positives (operations geared to environmental protection, development of positive relations with a company's environment, sustaining and developing human rights, combatting corruption). These indices are the only ones that have achieved special status granted by UNICEF.
FTSE Johannesburg Stock Exchange Socially Responsible Index (JSE SRI)	Introduced in May 2004 by Johannesburg Stock Exchange in cooperation with EIRIS, FTSE4GOOD – FTSE International Ltd. and KPMG. The main goal of this index is to introduce benchmarking for investors or indirect support and promotion of responsible management in the region of South Africa. Johannesburg Stock Exchange Socially Responsible Index was the first financial tool of its type introduced to developing markets. The main criterion for the selection of companies, aside from running a socially responsible business, is respect for human rights.
Sao Paolo Stock Exchange Corporate Sustainability Index (ISE)	Introduced by BOVESPA, Sao Paulo Stock Exchange in cooperation with the Center for Sustainability Studies of Fundaçao Getulio Vargas (CES-FGV) and IFC (International Finance Corporation) in December 2005. The creators of the index wanted to introduce benchmarking for investors interested in responsible investment and to promote CSR among Brazilian companies. The methodology is based on positive selection (ESG criteria).
KLD Global Sustainability Index Series (GSI)	Introduced by KLD Research & Analytics in October 2007. The Index is a benchmark based on ESG criteria in reference to 3 geographical areas: North America, Europe, Asia and The Pacific. The methodology is based on positive selection (ESG criteria).

Sources: www.odpowiedzialni.gpw.pl/opis_projektu; http://www.sustainability-index.com/; http://www.calvert.com/sri-index.html; 3http://www.ftse.com/Indices/FTSE4Good_Index_Series/index.jsp; http://www.jse.co.za/About-Us/SRI/Introduction_to_SRI_Index.aspx; http://www.bmfbovespa.com.br/Indices/download/ISE_ing.pdf; http://www.kld.com/indexes/gsindex/index.html.

In the Respect Index (RI), which is the most familiar to the authors, it is worth underlining the fact that there is a 3 stage, in-depth company assessment conducted within its framework [www.odpowiedzialni.gov.pl]. The aim of Stage 1 is to select groups of companies of the highest liquidity, namely those that are in the index portfolios: WIG20, mWIG40, sWIG80. Stage 2 covers the assessment of these companies in the areas of corporate governance, information governance and relations with investors, conducted by the Warsaw Stock Exchange in cooperation with the Polish Association of Listed Companies based on widely available reports published by the companies, accessible via their websites. Stage 3 is the assessment of the level and complexity of a company's activities geared towards stockholders, which are an expression of its social responsibility in its widely understood sense. The assessment is based on a questionnaire completed by companies and on the results of its verification carried out by Deloitte, Project Partner. The main criteria applied in the assessment process include the following categories:

1. Environmental:
    - Environmental management
    - Curbing environmental impact
    - Biodiversity
    - Environmental features of products and services
2. Social:
    - Health and safety
    - HR management
    - Relations with suppliers
    - Communication with stakeholders
    - Social reporting
3. Governance:
    - Strategic management
    - Code of conduct
    - Risk management
    - Fraud risk management
    - Internal audit and monitoring system
    - Customer liaisons

It seems that such multi-level analyses and the range of organisational activities of a company with a high RI index may inspire relatively high trust among potential business partners and a range of investors. For these strategic reasons it is worth striving for the highest rating in this respect, especially if a company is to be backed by the resources of external partners, and should be a standard in the economy based on cooperation between companies. On the other hand, it is worth remembering that observation and analysis of the company, including this and other indices, or other CSR monitoring tools, constitute a significant support in both the assessment processes and decision making, in particular, those referring to investment, consolidation and cooperation.

The respect index and its applicability

The respect index (RI) is a total return index where returns from dividends and right's issues are taken into account when calculating the RI. The index considers in its portfolio the companies that were positively verified by the Project Partner at the third stage of verification. The number of index participants fluctuates. A company's holdings in the index (weights) are the number of shares in the trade reduced by the number of shares introduced into the stock exchange trade. These are rounded up to full thousands. The shares of the largest companies in the index are limited to 25% when the index is less than 20 participants and to 10% when the number of participants is over 20 companies.

The index is calculated regularly at one minute intervals. The opening value of the index is published after the opening of the session when the companies' stock prices allow the valuation of at least 65% of the index portfolio at that session. The index's closing value is announced once the session has ended [www.odpowiedzialni.gpw.pl/opis_projektu].

At present, Warsaw Stock Exchange has registered 23 companies within the Respect Index. The last alteration took place on the 23 December 2013 when another 4 companies were added, thus forming the seventh new index group of responsible companies. 23 companies from the Main Market were positively verified in the area of corporate social responsibility and were placed in a new index portfolio. The updated index is presented in Table 3.

Table 3. Respect Index Companies

No.	**Company name**	**Accessed 23/12.2013**
1.	Apator S.A.	
2.	Bank BPH S.A.	
3.	Bank Handlowy w Warszawie S.A.	
4.	Bank Millennium S.A.	
5.	Bank Zachodni WBK S.A.	New company in the index
6.	Budimex S.A.	
7.	Elektrobudowa S.A.	
8.	GPW S.A.	New company in the index
9.	Grupa Azoty S.A.	
10.	Grupa LOTOS S.A.	
11.	ING Bank Śląski S.A.	
12.	Jastrzębska Spółka Węglowa S.A.	
13.	KGHM Polska Miedź S.A.	
14.	Netia S.A.	
15.	Pelion S.A.	
16.	Polska Grupa Energetyczna S.A.	
17.	Polski Koncern Naftowy ORLEN S.A.	
18.	Polskie Górnictwo Naftowe i Gazownictwo S.A.	
19.	Powszechny Zakład Ubezpieczeń S.A.	New company in the index
20.	RAFAKO S.A.	New company in the index
21.	Tauron Polska Energia S.A.	
22.	Telekomunikacja Polska S.A.	
23.	Zespół Elektrociepłowni Wrocławskich KOGENERACJA S.A.	

Source: www.finanse.egospodarka.pl

When analysing the index companies within RI, one may notice that they are among the unquestionable leaders in their fields of operations and among the most dynamically developing.

In order to emphasise the importance of the index and its interpretation it is worth understanding its constructed. The Formula is as follows [Indeksy, 2012]:

RESPECT Index (t) = M (t) / M(0) * K (t), (1)

where:

M(t) – is an index portfolio market capitalisation during t session,
M(0) – capitalisation of the index portfolio on base day,
K(t) – the value of adjustment coefficient during t session.

Adjustment coefficient is to ensure the continuity of the index value in case of its revision. The coefficient is determined by the formula:

K(t) = {[M(t) + Q(t) – Z (t)] * K(t')} / M(t), (2)

where:

M(t) – the capitalisation portfolio index before revision,
Q(t) – collective value of participants on the index list,
Z(t) – collective value of participants removed from the index,
K(t) – new value for the adjustment coefficient,
K(t') – earlier value for the adjustment coefficient.

When conducting analysis and description for investment needs, one cannot ignore an important element like the comparison of stock exchange indices. A key role is attached to their correlation (strength, direction or lack of it) with Respect Index. The index value is analysed over a period of time and the interpretation connected to social responsibility for the actions implemented may boost company image, its social responsibility and, last but not least, innovative activities in a variety of fields. The comparison of RI change and WIG20 index is presented in Figure 1.

Figure 1. Respoect Index vs. WIG20 (5-years)

Source: www.odpowiedzialni.gpw.pl.

As seen from the above, despite a clear drop in the WIG20 in the latter part of 2011, RI followed suit. However, this fall initiated a following upturn which was disproportionate in comparison to WIG20 and was 20-40% higher. One should observe that while the WIG20 index was generally falling RI, disproportionally higher, kept rising and is still growing. This mainly stems from the fact that companies which are socially responsible enjoy greater investor interest, particularly in turbulent, dynamic, unpredictable times. Therefore, one can assert that socially responsible companies are more resistant to stock exchange fluctuations. This results from the fact that the mentioned organisations are particularly focused on, amongst others, innovative activities as well as those that boost and stimulate the introduction of advanced technologies. One should emphasise the strong positive correlation between the occurrence of socially responsible activities and innovative activities in the group of companies analysed. Such a tendency gives hope for an organisation's responsible approach towards creative processes of new products, technologies and various forms of innovations even in the turbulent economic times.

Social responsibility as a constituent of modern technologies and innovation

Even rudimentary analysis of the term technology shows the opportunity for social responsibility, its creators and implementers. This is why technology encompasses, 'the whole knowledge on product (material or service) manufacturing methods or achieving a set result in manufacturing or services' [Santarek, 2008]. In order to achieve long-term customer loyalty and satisfaction, along with stockholders who cooperate with a company generating a particular technology, one requires not only knowledge on production techniques or a wide range of manufacturing methods, but also far-reaching knowledge. Which is to say, technology means, in practice, a particular process consisting of many operations, which include:

- A specifically determined manner (including ethical and social responsibility towards employees, clients, the natural environment and local communities participating in the creation and application of a particular technical solution)
- A specially determined sequence, as a result of which source material (resources, materials, intermediate products) are turned into the final product with specific features (e.g. customer-friendly, biodegradable, energy efficient, manufactured from natural materials) and adhere to customer needs (prestige, high quality, confidence in action, advancement, eco-friendliness, acceptable price, recyclability, long life, multi-functionality, etc.) [Gwarda-Gruszczyńska, 2013]. According to G. S. Day and P.J.H. Schomaker, technology is a set of skills within a discipline which are applied to a product, service, process or even contribute to the creation of a whole new sector [Day, Schomaker, 2000] (e.g. social dialogue). In order to manage technology fully within a company, it is necessary to manage operations, not only those of the technological process but also those referring to the appraisal of possessed technologies and processing, and the skills in the area of their creation and acquisition [Santarek, 2008]. These forms of appraisal may include assessment in the area of the social responsibility of the suggested solutions.

Without including the actions and tools for creating and monitoring a socially responsible organisation (CSR) in the processes of creating and exploitation of technologies, one cannot obtain full, long-term and effective technologies and the accompanying innovations [Jedynak, 2012]. Technology is not merely the pure application of scientific discoveries but is subject to social, cultural, economic and technical contexts which precede and shape it [Zakrzewska-Bielawska, 2011]; [Bijker, Law, 1992].

When considering responsible innovations, one may come across various opinions and contexts for this process. On one hand they come from the very nature of the innovations themselves, CSR, as well as the attitude of companies to the manner of the creation of socially responsible operations. On the other hand they are triggered by a company's features and its market, or even by decision makers. The above can be placed into two groups: (1) the process of the creation and commercialisation of innovations and CSRs and their relationship: (2) company features and the approach to CSR, innovations and stockholders. In-depth analyses points to the following problem areas: the dynamics of innovation and CSR, the attitude towards CSR and innovation in relation to the product or/and the service quality, company size, motivation of decision makers, expectation of results and external pressure.

Social responsibility is an inextricably linked and compulsory element of modern, in particular, highly advanced technologies. Companies should invest in this on multiple levels, develop it continuously, exploit the market opportunities and possibilities effectively (e.g. socially responsibly company image building, creation of pioneering, innovative, socially responsible or eco-friendly products, services and technical solutions). Bearing in mind the interests of stockholders, such an approach should be demanded from companies, which should be practically applied and constantly monitored if this social responsibility development is to be fully accepted among current and potential partners. The monitoring of social reporting and professional assessment of company activities in the area of CSR through socially responsible stock exchange indices, RESPECT Index or its counterparts, support the above activities.

The profitability of socially responsible investment measured by the Respect Index and published by the stock exchange, does not point to statistically significant differences in reference to the investment in the portfolio of the wider market, which is reflected in the WIG index. Assessing the effectiveness of socially responsible investment strategies[1], it has been concluded that it is higher than the effectiveness of the strategy of putting resources in WIG index. The research data available in the literature on the subject also point out that the higher the Respect Index the more attractive the company is to investors and the higher the introduction of innovations and actions whose aim is the implementation of advanced technologies and the more welcome by investors and management it is [Beabout, Schmiesing, 2003]; [Gerhard, 2010]; [Statman, 2006]. KGHM Polska Miedź S.A. may serve as an example of the above trend.

Responsible innovativeness in KGHM's experience

KGHM Polska Miedź S.A. is focused on the production of copper and silver. It is the largest producer of silver in the World along with being the largest mining producer of copper in Europe and is placed 8th largest World producer of mined copper. In 2012, KGHM produced roughly 566,000 tonnes of electrolyte copper

[1] Nowadays - apart from effectiveness, competiveness, efficiency, functionality and communication – morality has become a key category in the assessment of company operations.

and almost 427,000 tonnes of mined copper. In recent times the company has become the World leader in the production of silver. The high production of this precious metal brought KGHM, 1,274 tonnes in 2012, which was first place in the ranking of the World Silver Survey, carried out by Thomson Reuters GFMS [www.bankier.pl]. The copper, in the form of cathodes, produced by KGHM is registered on The London Metal Exchange and Shanghai Metal Exchange. The refined silver is certified through exchanges in London, Dubai and New York.

In 2012, thanks to the amicable takeover of the Canadian Quadra FNX Mining Ltd. (presently KGHM INTERNATIONAL LTD.), KGHM Polska Miedź S.A. went global, having assets on 3 continents with Sierra Gorda in Chile, one of the largest copper ore deposits in the World, as its key project, the production from which is expected to commence in 2014 [www.money.pl]. The value of its international transactions stood at 2.9 billion Canadian dollars and was the highest foreign transaction in Polish industry. The takeover of Canadian Quadra resulted in the building of its resource project portfolio and reduced the average operational cost. The experience gained during this transaction triggered the mutual initiative between KGHM and ICAN Institute creating the project Think Thank „POLAND, GO GLOBAL!", whose objective is to spread knowledge and experiences in order to make Polish companies international and to create a platform for cooperation and the exchange of best practices in the field of globalisation among Polish companies [http://www.raportroczny.kghm.pl].

Innovative activities have always been a strong point of KGHM Polska Miedź S.A.. Recent years have seen particular emphasis placed on the introduction of new technologies. Therefore, an intensive search for new, more efficient technologies are being carried out which is expected to reduce production costs, increase the extraction of copper and other accompanying metals along with more effective environmental protection.

Such tendencies comply perfectly with the new socio-economic reality and mean that this copper company is not just a regional but also a national innovative leader. Naturally, KGHM has become one of the key players in a consortium (a team selected by the Marshall (governor) of the region) in order to design the innovation strategy for the Lower Silesia region. The strategy aims to define scientific, research and support potential capabilities, namely, who, and how they can help in the implementation of the accepted projects and which companies may hold an interest in them. It is all about creating at a regional level a kind of 'innovativeness filter', which would accept or reject projects generated in industry or local governments. The aim of all this is to ensure the acquisition of E.U. structural funds in order to implement these projects. The management of KGHM do not hide the fact that it is interested in designing such a filter which will match the company's interests with the innovativeness strategy. These projects may include not only a technological aspect but also everything affiliated with it [http://www.kghm.pl/index.dhtml?category_id=21].

Since 2012, the company has been working intensively on a socially responsible innovative business venture, which is the introduction in a few years' time of the new technology of flash furnaces in the Głogów I copper smelter. This plant so far has based its production on shaft furnaces, an obsolete technology that has reached the end of its usefulness and is not supported by the E.U. As in the Głogów II smelter, KGHM wants to install a flash furnace, however with more advanced features. They have been working on an application which is to be sent to Finnish offset or to structural funds, as such an opportunity has also been recently opened to large companies. There is also a possibility to apply for further funds, e.g. environmental protection and water management, as the project also has an ecological objective – through cutting material and raw material usage. This new technology will not require refining further as it will be smelted without extra processing. [KGHM, Report CRS 2012]

Since 2010, biotechnologies have become one of the main priorities in the modernisation of production processes, and KGHM has drawn up plans for this objective. They refer to intermediate products which are applied in modern technology in mining and then mining and smelter flotation. It is about the more effective extraction of metals and the processing of difficult to process concentrates. There are certain bacterial strains which create more favourable conditions for extracting metals from ore. For example, if we had a crystal of chalcocite surrounded by quartz then, in the current process, it is difficult to extract the locked in metal. The bacteria that 'likes' silicon softens the case, thanks to which the metal is freed and the rate of its extraction is higher. Biotechnology will certainly not replace the current process, due to the production scale (KGHM produces 508,000 tonnes of copper from over a million tonnes of concentrate). It is even difficult to assume theoretically that the concentrate could be placed in containers to which bacteria can be added[2]. The World is already acquainted with this technology, the French BRGM or AngloAmerican are already applying it in order to extract precious metals – gold or platinum group metals. However, it should be pointed out that these concerns do not apply biotechnology in the course of everyday production but on slag stored on tailings. KGHM hopes to apply biotechnologies to process difficult to process concentrates which it cannot fully extract, for example valuable metal from copper-carrying shale. Through the Copper Research and Design Centre 'Cuprum' in Wrocław, the company filed an application along with other companies in a consortium partnership for the implementation of a Bio-shale project within the IV E.U. research programme.

Another novel, socially responsible idea linked with the technological process implemented after 2011 is the application of artificial intelligence in smelting, in particular neural networks, which are capable of learning through repetitive operations. Therefore, should there be a failure during a process, the control panel will be able to locate and fix the problem.

[2] http://www.kghm.pl/index.dhtml?module=articles&id=706&back=true

Since 2011, KGHM has been at the stage of formulating the theoretical basis for the utilisation of neural networks[3], which will hopefully lead to decision optimisation. This means the elimination of people from certain production processes. Imagine, the telephone call – ‘listen there is something wrong over there’ - will no longer be necessary. The system will learn to react to certain situations. ‘It seems as if we have reached the 5th generation achievement, as neural networks may even be applied when searching for fresh deposits – according to Mr. Wirth, a company director - (…). In the E.U., people are discussing not only intelligent smelting but also intelligent energy and mining. For a while, we also considered intelligent mining, namely an organisational structure which would mainly eliminate men from certain hazardous conditions, replacing them with remote controlled machinery’ [http://www.teberia.pl/sztuczna-inteligencja-w-podziemiach]. One of the features of an intelligent mine is not only the automation of the deposit extracting process under difficult conditions but also rapid transmission of information. An intelligent mine means also creating a secure permanent model of conduct. At present, KGHM does not have a mine model that would function along these lines but intends to introduce one. Innovative activities are also induced by the specifics of the deposit. Due to the World’s copper prices, the company must consider the issue of not over extracting ore of lower parameters. Underground machinery however allows exploitation which is profitable, namely adjusting exploitation to a particular, optimal layer. Such an approach is reflected in the reduction of indirect costs as less gangue is removed. In Miedz Polska mines, 28 million tonnes of rock is excavated, which then needs to be crushed, ground and floated, out of which only around 2% is usable metal, meaning 98% is considered waste material.

Another responsible and innovative solution from KGHM is the change in transportation of concentrate from the enrichment plant (ZWR) to the Głogów copper smelter, through replacing railway with hydro transport. The project commenced in 2009 and is expected to significantly reduce costs. Concentrate is pumped through pipes from ZWR directly to the smelter, thereby reducing costs of transportation by rail, saving energy used for concentrate drying in the process. The project seems extremely promising, however the copper company realises that due to the location of the hydro transport track and possible future demands from the landowners, it may be hard to implement [KGHM - Report CSR 2010-2011].

A problem which requires an unconventional approach is waste management, recognised by KGHM in 2000. In order to solve it, it is necessary to create an economically viable alternative to the present manner of waste storage (on the surface). Therefore, with the idea of using post flotation waste as a filler material, a team has been set up and the idea assessed in its technical, technological and economic aspects in rolling costs, meaning one which considers the costs at each

[3]http://www.biznes.newseria.pl/news/technologie/kghm_stawia_na,p1168193393

step of its functioning, environmental costs in particular. Today, in certain mines, the company uses natural materials, such as sand, as a back filler. The application of waste products for the back filler will cause a reduction in waste stored in the waste storage facility called 'Żelazny Most', which will increase the facility's longevity [KGHM, Raport CRS 2012].

The project of using post flotation waste as a hydraulic filler in KGHM mines was initiated by Dolnośląską Spółkę Inwestycyjną S.A. (DSI) in Lubin. The results are promising. Within DSI, there is a company whose goal is the recycling and utilisation of industrial waste, including hazardous material. It successfully applies its own technologies of waste solidification, namely its physio-chemical treatment, in order to make it environmentally safe.

The company invented their own technology for the production of so called Toflex which was received by the certification unit (Main Mining Institute) positively, approving its application as a component of filling mixtures. They also came up with their own technology for the application of Toflex and slag mixture in order to fill in and leakproof abandoned workings in mines.

The idea for storing hazardous waste is linked to the usage of salt excavations. Obviously this is not radioactive materials but waste that is expensive to store. The philosophy behind this venture relies on the fact that, in future, after the end of the commercial exploitation of salt, the workings can be filled with waste. Salt excavations are one of the major sites for waste deposits. These activities are at the pre-profitability stage. The first results point to the fact that the venture may become profitable and technically feasible, though challenging. Using salt deposits to store fuel and gas has also been considered, which in future could attract potential investors. KGHM is attempting to determine its clients as, after accession to the E.U., each state must have a 90 day reserve of liquid fuels. At present, Poland does not have such a reserve. Therefore, Polska Miedz intends to fill this gap by creating such underground storage.

Towards the end of September 2012, KGHM launched the Aggregate Production Company at the Głogów copper smelter. The venture was started by KGHM's division 'Metale'. Aggregate is produced from shaft slag, created during the production of copper. Metale intends to transform post copper slag into roughly one million tonnes of road aggregate[4]. KGHM is deeply rooted in the non-ferrous metals manufacturing industry. Its objective is foremostly products from copper and silver, Ammonium perrhenate, supply of post copper slag to produce Polgrit (used in abrasive blast cleaning), financial advice and supply logistics. Now the focus is on aggregate and the company offers a new high quality product, replacing, among others, such aggregates as: basalt, gabbro, melaphyre and aggregates from blast furnace slag. Material for the production of this aggregate is a by-product of smelting copper. Shaft slag in the form of a liquid is poured onto

[4] http://prtime.pl/biuro-prasowe/wiecej-lepiej-efektywniej/?lang=pl

tailings and cooled down under normal atmospheric conditions. The product obtained in such a manner is similar in its chemical composition to basalt and gabbro and is then crushed and granulated on advanced technological lines, designed using the knowledge and experience of the Roadway and Bridges Inspection Institute in Warsaw and its foreign partners. Among the features of the new product is excellent adhesiveness to bitumen which is then particularly resistant to abrasion, pressure and frost. Post copper rock is extremely resistant to the changeable conditions of central European climates. The product has received technical approval from the Roadway and Bridges Inspection Institute in Warsaw, authorised by the National Atomic Energy Agency and received approval from the Institute of Occupational Medicine. Post copper rocks can be used in the building of roads and highways, railway and tram tracks, forest and local roads, road banks and also in concrete constructions. [http://miedziowe.pl/content/view/66118/468/]

Another interesting socially responsible and innovative project that the company is considering refers to the production of a coagulant, an extremely desirable product which is used in water purification and sewage treatment. It is intended to be produced using sulphuric acid based on natural resources such as halloysite from deposits near the Legnica smelter. As a result of the reaction between this clay mineral and the acid, a ferrum clay and a waste product, a so called sorbent, which is highly prized in the ecological field, are created. The material is used in the treatment of oil leaks as well as other areas e.g. apple storage or the manufacturing of micro-sieves used in the treatment of used oil [KGHM – Raport CSR 2012].

KGHM is one of the initiators of a 2002 innovative idea to assess the possibilities of using biofuel for powering underground machinery. If biofuel were cheaper than that traditionally used then it would have an immediate effect. However, we need to bear in mind that burning biofuels results in the creation of certain compounds which are not produced when burning diesel fuels. The research aims to answer the question of whether biofuel can be safely used underground. German businessmen are particularly interested in this issue, which is why KGHM cannot stay idle. Biofuel use is not only connected to powering underground machinery but also those above ground, e.g. Pol-Miedź Trans has an extensive transportation base and cheaper fuel may generate substantial savings. It is worth noting that biofuel is one of the pro-eco projects of KGHM[5].

Another expression of KGHM's concern for its nearest environment is its water and sewage division. This company has been in operation since 2005 and is fully aware that the local boroughs are today economically inefficient and in debt, meaning that the financial capabilities of E.U. fund absorption is limited, which is why Dolnośląska Spółka Wodno-Ściekowa (DSWŚ) – a water treatment company - and also Zakład Gospodarki Wodnej – a water management company - act as a middleman in the implementation of the strategic objectives of responsibility

[5]http://ekologika.pl/energiabiomasy/54KGHM%20także%20zamirza%20wejść%20w%20biopaliwa.html.

for the environment. Where the borough is lacking or e.g. wants to make a contribution in kind, which would aid water and water waste management, DSWŚ will assist and set up mutual ventures within a Public Private Partnership (PPP) [http://www.kghm.pl/index.dhtml?category_id=269].

KGHM Polska Miedź S.A., through introducing the above selected along with many other socially responsible, innovative activities and advanced technologies, constantly improves its RI. These trends are shown in Figure 2.

Figure 2. Respect Index WIG20

Source: Source: www.odpowiedzialni.gpw.pl.

As the above shows, within the last 5 years, changes in RI for KGHM occur after the launch of socially responsible innovative activities. One can observe only a slight shift within 2 months. It is important that the trend of WIG20 change are exactly parallel to RI for KGHM. The clearly disproportionate quotation of KGHM shares is also important. For the first 5 years, up to mid2010, the WIG20 rate and RI for KGHM almost overlap. After this period the rate for WIG20 shares falls significantly whereas the RI for KGHM reaching minimum still does not reach the highest level for WIG20 in the analysed period. Since mid2012, one can observe a rising trend and assert that after the implementation of the above socially responsible innovative changes within RI for KGHM, the value of RI index dramatically increases, taking it to another, even higher level.

Summary

A company's social responsibility is one of the key challenges faced by those firms that operate in a rational manner, base their operations on the latest World trends and aim to be sector leaders. Introducing an innovation is not, in their case, a necessary evil nor a fad, as it should be highlighted that it is the socially responsible companies through the introduction of their own innovative ideas which are able to compete directly and more effectively than others on the highly demanding and competitive markets, which undergo regular, turbulent changes. Subscribing to a new paradigm, sustainable enterprises become the only way to lead a company with full awareness into the future [Grudzewski, Hejduk, Sankowska, 2010; Bakalarczyk, 2013]. Thus, it is done on the basis of a consistent assessment of the economic and social value of their technologies and other organisational activities. In this way, they use a kind of warning system which indicates the random, indirect and delayed factors which occur in the area of technology and can curtail or accelerate the development of the implemented technologies and innovations [Trzmielak, 2013].

After discussing the topic of a company's social responsibility in a theoretical context, analysis of the empirical research was conducted in order to exemplify the discussed phenomena. KGHM Polska Miedź S.A served as our example. Due to the indexing within the Respect Index and valuation on the open market on the Warsaw Stock Exchange, which increases access to information for analysis, the research used the method of purposive sampling of a company. Unfortunately, despite these facts, the researchers faced a number of limitations, including access to data published by the researched company, time limitations for the research and, equally important, quality values which are extremely difficult to translate into a company's results.

Taking into account the assumptions of the research programme, the analysis of the literature on the subject and their exemplification, one can reach conclusions referring to the individual analysed phenomena, both of a general and specific nature. The main general conclusion is that socially responsible companies have been and will continue to be a key factor in mature, developed economies. This arises mainly from the fact that they seem to have a higher resistance than other enterprises to fluctuations in share value, as shown in Figure 1.

In-depth conclusions can be drawn following the example of the researched company, KGHM Polska Miedź S.A.. Being a large player within the Respect Index, it introduces a number of activities in the area of innovation and the implementation of new technologies. Almost all implemented solutions post 2010 have been assessed as socially responsible. This example clearly shows that innovativeness and corporate social responsibility can go hand in hand successfully, even supporting one another. Their combination successfully boosts a company's image along with market standing and financial results.

Corporate social responsibility is not a short-lived fad at all but a strategic and forward-looking activity whose aim is to strengthen competitive advantage in the areas of innovation and innovativeness as well as the introduction of advanced technologies that are socially responsible. As the above empirical analysis reveals, KGHM Polska Miedź S.A is heading in this direction and, maturely, invests in its future and benefits from the socially responsible technological implementations and innovative activities already introduced.

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INTELLECTUAL PROPERTY MANAGEMENT – GOOD PRACTICE IN UNIVERSITY ENTERPRISE PARTNERSHIP

Abstract

Apart from its educational aspect, there is an opportunity for a university to build an innovative economy in its commercial operations. Responding to the growing need for channelling the conducted research towards the demands of the market, one may ask the question of how a university should manage its industrial property and whether academics should focus their attention on trading in research results. Perhaps outsourcing seems the solution to this problem. A new bill on higher education constitutes a guideline in this respect. According to the bill, universities may, and should, set up special purpose vehicle (SPV[1]). SPVs whose aim would be the commercialisation of university technologies. Moreover, the bill allows rectors to take decisions on commissioning SPVs, through agreements, to manage a university's industrial property. Is this a step in the right direction? What are the drawbacks and benefits of such a solution? Why are there so few SPVs across Poland? This paper attempts to answer the above. The operations of centres of technology transfer of Łódź University of Technology Ltd. will exemplify good practice in order to support the author's views.

Keywords: IP management, university enterprise.

Introduction

Educating the workforce on the need for a commercial aspect as well as scientific research are the main objectives of university operations. In this era of the constant search for stimulants for the Polish innovative economy, the expectations of universities are undergoing significant changes. Apart from education and research, one of the basic objectives of modern universities includes generating new technological solutions and their effective market implementation. Such a state of affairs has its reasons. Universities are perceived across the World as one of the key sources of innovations[2].

The position of Poland on the ICI Master Journal List shows the significant intellectual potential of Polish scientists, which, translated into actual economic

[1] SPV is named also, SPE – Special Purpose Entity or FVC – Financial Vehicle Corporation
[2] http://info.put.poznan.pl/system/files/Prezentacja%20-%20MNiSW.pdf (pobrane 20.10.2014).

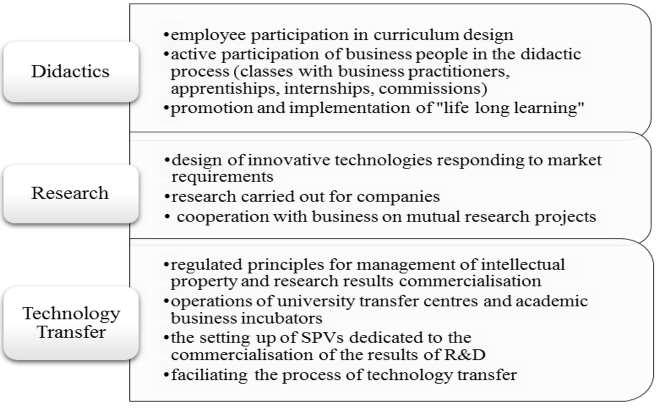
implementation, could boost the development of the national economy [Węgliński, 2010]. Poland is one of the leaders in the utilisation of E.U. funds. The value of financial resources designated for grants is on the increase and there is a growing number of patent applications. Despite this unequivocal potential, Polish innovative indices are alarming. The E.U. Innovation Scoreboard serves as an example, where Poland, in 2011, scores 5th last, and in 2012 it dropped to 4th from bottom, meaning it is classified as a moderate innovator and as the only E.U. state in the subcategory of slow growers. This European report accentuates Poland's strong point as human resources, whereas weak points include cooperation between business and science, entrepreneurship and innovativeness. The authors of the report highlighted the positive direction of reforms for science and business cooperation while underlining the lack of its visible effects to date [Innovation Union Scoreboard, 2014].

As a consequence of the above challenges, academics must find their feet in the reality that combines education and research (Humboldt's idea) and creative distraction (according to Szumpeter) [Matusiak, 2011]. Universities have to face the challenge of the management of their own knowledge resources.

Changes in the Polish Legal Context

The increasing growth in the role of universities in the construction of an innovative economy induces in-depth changes in higher education [Łobejko, 2008]. For the last few years, the active policy of the Polish Ministry for Science and Higher Education has been steadily introduced, whose aim is to open universities to closer cooperation with business, its environment and academic entrepreneurship [Kardas, 2012]. In order to prepare universities for these new challenges, the ministry established the direction of change which should be implemented in particular university operations. These stipulations are presented in Figure 1.

Figure 1. Changes in individual fields of university operations



Source: Own work.

One of the actions taken by the ministry in order to facilitate cooperation between universities and business was the introduction of certain legislative changes. The most significant of these were implemented in 2011, in the bill on higher education[3]. I'd like to cover just a few of them here [Ustawa, 2012]:
Rephrasing Art. 4 Paragraph 1 Subparagraph 4 in reference to the cooperation of universities with business

Retention of Art. 86, which enables universities to set up centres of technology transfer and academic business incubators (in the form of university institutions, trading companies or foundations), and the introduction of new legislation (Art. 86a) stipulating the setting up of SPVs dedicated to the commercialisation of scientific research results and development work

The obligatory introduction of a set of rules and regulations for intellectual, industrial and related property management (Art. 86c)
A change to Art. 90 Paragraph 1 Subparagraph 4, referring to the raising of the threshold market value of any item which is managed by a university from 50,000 to 250,000 Euros, above which the university is obliged to obtain permission from the Treasury to govern this asset.

The ministry justifies the introduced legislation as giving universities a chance to utilise better their potential in the implementation of the efficient management of intellectual property, attracting business, initiating academic entrepreneurship, dynamic and flexible commercialisation of research results, thereby obtaining an additional source of income.

Intellectual Property Management

Intellectual property involves generating intangible wealth, which is to say that it refers to all creativity from the human mind, thanks to which, unlike material sources, it is boundless. From such a viewpoint stems the increasingly popular slogan that the first million ought to be discovered in your own mind [Węgliński, 2010]. The term intellectual property is not unequivocally defined, neither by Polish or international legislation.

Obviously, the results of scientific and development work constitutes without doubt intellectual property. The results can be divided into 2 groups: those subject to protection – industrial property and any work governed by copyrights [MCBiR, 2013, Promińska, 2010]. And industrial property which stems from the legislation of a country or is international, conferring an exclusive monopoly including: inventions, utility models, industrial design, trademarks, geographical indications, integrated circuit topography[4].

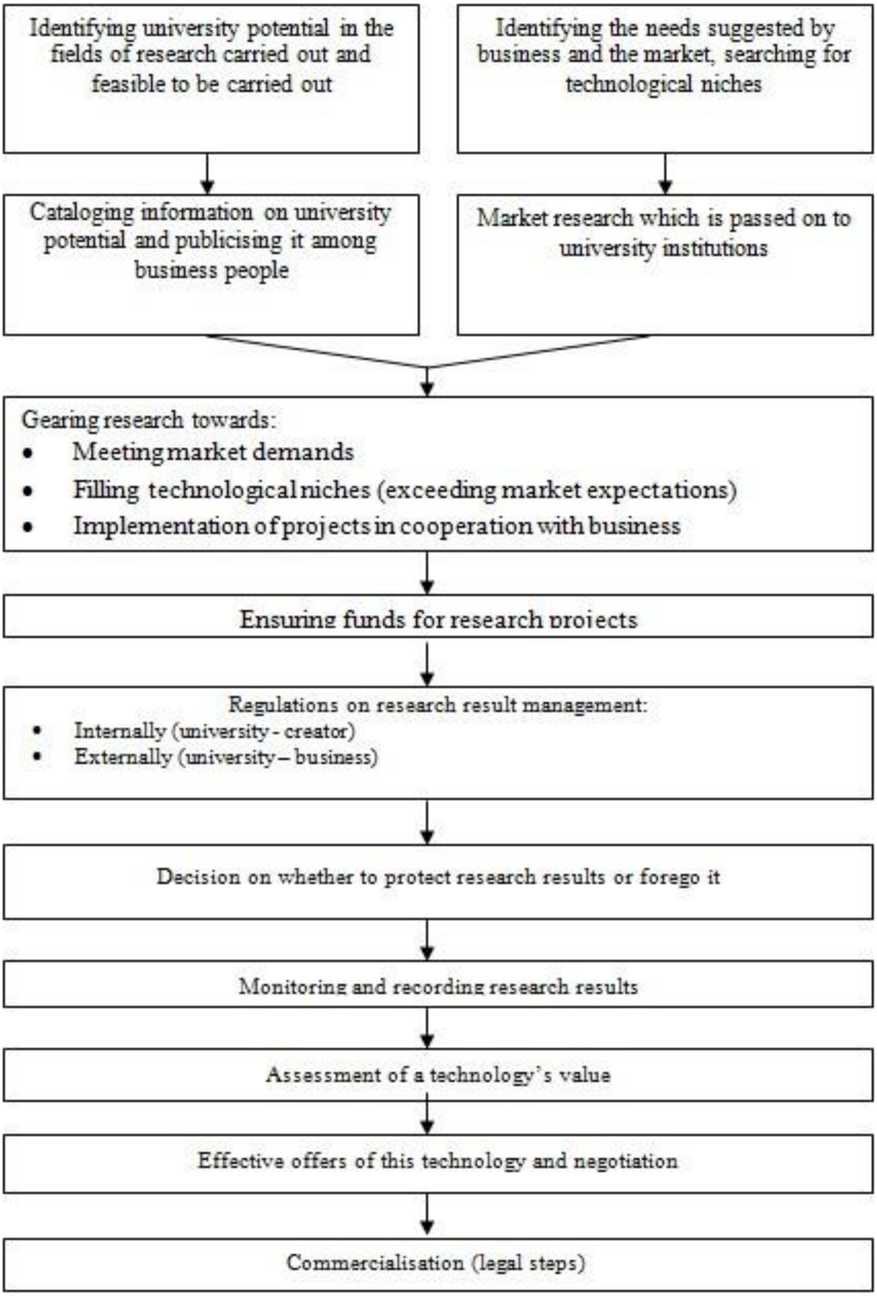
[3] http://www.bip.nauka.gov.pl/_gAllery/10/85/10859/20100910_UZASADNIENIE_na_RM.pdf (pobrane 21.10.2014).
[4] http://prawo.legeo.pl/prawo/ustawa-z-dnia-30-czerwca-2000-r-prawo-wlasnosci-przemyslowej/ (pobrane 20.05.2013)

According to the traditional definition of management by R.W. Griffin, management is, *a set of operations (including planning, decision making, organisation, leadership – namely managing the workforce and monitoring) geared at company resources (human, financial, material and information) and utilised in order to achieve a company's goals in a feasible and effective manner* [Griffin, 2005].

In the case of a university's industrial property, management should follow the analogy presented above. It focusses all of a university's operations to maximise its resources, namely industrial property, in order to implement research results effectively in the economy. How can this objective be achieved in the most successful manner? Foremost, industrial property management must be continual and cohesive. Many universities manage international property rights (IPR) only once it has been created, thereby limiting the management model to mere trade of ready solutions. Thereby leading to the omnipresent model of technology push [Matusiak, 2008]. However, the key to effective knowledge management with the intention of its marketing lies in the number of operations prior to the introduction of ready technology. Universities need to devise solutions that respond to the requirements of the market or even exceed them. Therefore, industrial property management should commence at the very moment of decision taking for the research itself. It is mainly the market which should provide the know-how that would direct research!

Figure 2 presents individual stages of IPR management from the stage of identifying market requirements to commercialisation.

Figure 2. The stages of research results and development work management – Technical University in Łódź practice



Source: Own work.

Commercialisation as one of the stage of IPR management. The term intellectual property management is frequently used instead of the term commercialisation. It is worth emphasising though that commercialisation is a narrower notion referring directly to research results and their legal transfer to companies [Trzmielak, 2013, Jasiński, 2011]. According to the handbook definition, commercialisation of R&D for practitioners means: "*making the right to particular R&D work results available to other institutions, mainly business, in order to gain financial benefits"*. This is why commercialisation is one of the final, albeit key, stages of management and is inseparable from economic benefits [Pomykalski, 2008; Pomykalski 2001]. This source also defines the main forms of commercialisation as:

Sales of rights to R&D results

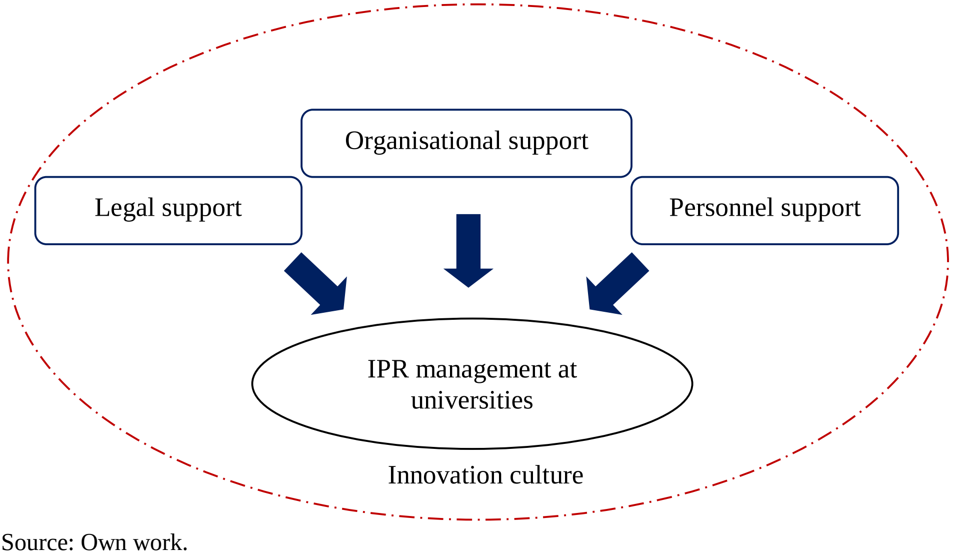
Granting of licences

Apportionment – meaning contribution in-kind of the results of research to commercial law company

Support for IPR management at universities

In order to manage intellectual property effectively, including the industrial property of a university, it is necessary to build support for pro-innovation policy [Chlebny, 2010]. It is vital to prepare the ground for a culture of innovation, which much have widespread awareness within companies as well as be understood, accepted and supported by the whole academic world [Bakalarczyk, Pomykalski, 2008; Baruk, 2006]. Figure 3 presents the support for effective IPR management.

Figure 3. Support for IPR management



Source: Own work.

Legal support refers to the introduction of legislation on intellectual property. These regulations should govern the principles of using research results, along with university infrastructure, rights and responsibilities of the creators and other external institutions engaged in research, principles of research results protection and confidentiality, principles of commercialisation and remuneration for the creators, the role and objectives of institutions supporting technology transfer and the principles of their cooperation. The problem of legislation may be solved by drawing up a sound set of rules and regulations governing copyrights, related rights, industrial property and principles of commercialisation [Rachoń, 2002].

Organisational support is the responsibility of the vice president, who is responsible for cooperation between universities and business, technology transfer and university institutions supporting commercialisation. In this case, the legislative body grants universities wide ranging freedom in selecting the appropriate institution. They can create technology transfer centres, academic business incubators, in the form of university institutions, foundations or commercial law companies. They may also decide to set up an SPV dedicated to the commercialisation of research results and development work.

The third element ensures competent staff in order to support IPR commercialisation at universities. It refers to the competencies of a university's governing body which is responsible for this sector of operations, as well as personnel of technology transfer institutions. People engaged in commercialisation should possess knowledge on intellectual property protection, market potential assessment of technologies, commercialisation methods and their optimal selection as well as legal, official and financial aspects of commercialisation. Interpersonal skills should not be overlooked, as these people will support not only the scientists but also conduct meetings and negotiations with business people.

Good practice exemplified by the SPV at Łódź University of Technology

Setting up SPVs

Among the institutions whose objective is to support technology transfer at universities are SPVs. It is defined in article 86a paragraph 1 on the bill on higher education in the following way: *In order to commercialise scientific research results and development work, a university sets up a company of limited liability or a joint stock company (hereafter called SPVs). SPVs are set up by the rector with the agreement of a board or other collective body (...)*. There is however a problem interpreting this definition as it raises the question of whether the term 'set up' means it can create, has to create or is a recommendation. Lawyers and technology transfer participants find it difficult to unequivocally interpret this entry, which triggers stormy debates. In the handbook, Commercialisation of

R&D for Practitioners 2013, the ministry dealt with this issue in the following way, "*(...) The standpoint of the Ministry for Science and Higher Education points to the obligatory nature of setting up SPVs in order to commercialise R&D research results".*

Irrespective of the obligation to set up an SPV or not, the key element is to determine a company's objectives in order to make it a sensible venture. The main objective of an SPV includes the management of a portfolio of shares in the newly formed companies to utilise research results. Within this objective, SPVs will both set up new companies along with taking over shares in already existing institutions. It may also get involves in so called direct commercialisation, namely, licencing and sale of rights to R&D research results.

Obstacles for SPVs

The first problem area is funding the set up and initial stages of the operations of SPVs. A university needs to allocate its own resources for the issued capital for this company and it is possible to initiate a company with a minimum outlay (5,000PLN). One should bear in mind that the company will generate fixed costs, which need not be high and cover the company's base, workforce, basic legal, accounting and financing services, this all means that issued capital must cover costs until the generation of the first income.

However, a crucial question needs to be asked, what will the SPV commercialise? This requires real assessment, not the number of inventions created at universities but their real value and market potential. Inadequacy of research results conducted by universities compared to the needs of the market is one of the main obstacles in setting up SPVs.

The idea fostered by the ministry favours the model of contribution in-kind of all rights to research results to SPVs. Such a situations eliminates the problem of a lack of products in an SPV and its issued capital. Tax and notary cost issues have not been considered in this context as this expenditure is only valid in the case of solutions which are successfully commercialised and generating income. Therefore, the approach of contribution in-kind to the company also remains unclear.

Outsourcing at universities – benefits of SPVs

Article 86a paragraph 2 of the bill provides the opportunity for commissioning SPVs with the management of university industrial property in order to commercialise it through contracts. From the point of view of management, such external commissioning to a specialised institution is considered outsourcing. Outsourcing supports prudent resource management which is goal-driven and performed by an institution to the best of its abilities, with other areas of the commission being delegated to specialised external institutions[5]. The main goal of SPVs is to generate profit through

[5] http://mfiles.pl/pl/index.php/Outsourcing (pobrane 20.05.2013).

commercialisation. Such a clear-cut and concrete target contributes to the fact that the institution will be dynamic, both at university level (searching for technologies), and on the market (searching for clients). This situation seems an opportunity to give a lie to the stereotype that technology transfer units specialise mainly in training. These companies will be active in establishing business contacts and market monitoring. As a consequence, SPVs attempt to offer and commercialise university technologies in the most effective way. They also have the chance to operate more efficiently than universities thanks to their organisational and financial independence. Being smaller in size than a university, with a flat organisational hierarchy, it has significantly greater flexibility when reacting to fluctuating market conditions. Setting up such a commercialisation-orientated company and granting it right to IPR management is a far-reaching solution, generating a range of new opportunities.

The SPV at Łódź University of Technology

The technology transfer centre at Łódź University of Technology Ltd. was established in 2009 with the intention of commercialising university technologies. Today, with four years of experience behind it, it is a shareholder in 2 spin-off companies, grants licences (for industrial property application, computer programmes, know-how) and sells rights to technologies.

The commercialisation principles of scientific research results and development work at Łódź University of Technology are governed by the regulations, *Rules and Regulations of Intellectual Property Rights Management along with Commercialisation Principles of Scientific Research Results and Development Work at Łódź University of Technology in 2013.* The fact that these rules and regulations force academics of Łódź University of Technology to commercialise technologies exclusively through a CTT company remains a great advantage. The company has a legal tool at its disposal which enables it to execute this right and prevents technology drain from university in a haphazard and unofficial manner. Moreover, since September 2012, the position of Vice-president for innovation has been established and the administrative structure under him includes: Technology Transfer Department, Patent Spokesperson, Quality Department, Career Office, and, due to ownership supervision, CTT, which is to say all departments involved in technology transfer. Technology transfer departmental proxies have been established in order to maintain ongoing information channels with individual departments and Technology. The CTT got the go ahead to operate and has university backing. Additionally, through an agreement signed by the CTT and Łódź Technical University in 2012, the SPV was assigned the task of managing university industrial property rights. The scope of the agreement gives the SPV the right enabling immediate response to the demands suggested by business. Such support for technology transfer fosters stable innovation culture building.

Summary

Recent years have seen a number of ventures whose objective was to bring Polish universities to the stage of effective cooperation between science and business. University research activities are considered a significant source of innovation for the Polish economy and as a 21st century generator of inventions and implementations. Such reforms however demand time as well as changes in the mindset and policies of universities. Legal regulations and tools offered to universities are to ensure the effective transfer of technologies. The demand for gearing research towards market demands forces universities to choose and implement intellectual property management. This management must become a cohesive system involving all the stages from targeting research to identified market demands to commercialisation of the results in the legal sense. Nevertheless, in the era of the battle over students and cost-cutting, it is hard to expect universities to abandon their current activities and concentrate on technology transfer. This is why technology transfer centres and similar university institutions provide support in this area. Due to the fact that the effectiveness of these centres is open to doubt it is worthwhile considering setting up SPVs and assigning them the task of managing university IPR. Outsourcing of this field of university activity to this company, despite a number of hurdles, may generate tangible results. Their main advantage is concentration of profit and the necessity to trade. Thanks to their organisational structure, SPVs may be equal partners for businesses, boasting speedy and effective operations. This requires however taking bold decisions and equipping SPVs with legal tools and technologies of marketable potential.

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