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AICGSPOLICYREPORT

THE NEW ROLE OF UNIVERSITIES IN THE TWENTY-FIRST CENTURY: UNIVERSITIES AS ENGINES OF INNOVATION AND ENTREPRENEURIAL HUBS

Andreas Pinkwart

AMERICAN INSTITUTE FOR CONTEMPORARY GERMAN STUDIES THE JOHNS HOPKINS UNIVERSITY

American Institute for Contemporary German Studies

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FOREWORD

"Innovation" is the buzzword for the twenty-first century. How can our economies stay competitive? How can our industries grow? How will our work forces adapt to new demands? Universities pay a distinct role in answering these questions, and can be a driving force for innovation. As companies have adjusted to new economic realities, universities have adjusted, too. Rather than competing for the best ideas, universities and companies are partnering to encourage innovation and entrepreneurial ideas among students and researchers.

In this Policy Report, Prof. Dr. Andreas Pinkwart analyzes the changes underway within the innovation systems in the United States and Germany. He looks at how modern universities have changed in the twenty-first century, and cites requirements for those universities looking to better integrate in the innovation system. He then discusses how universities can transition from being "ivory towers" to "entrepreneurial universities," and how businesses can encourage university innovation and entrepreneurship through partnerships and campus companies.

This publication is part of AICGS' broader efforts to examine the various aspects of innovation in the United States and Germany, and our emphasis on providing solutions to current business and policy challenges. AICGS is grateful to Prof. Dr. Andreas Pinkwart for his insights and to Jessica Riester for her work on this report. This Policy Report, together with a conference in June 2011 on "The New Role of Universities in the Twenty-first Century: Universities as Engines of Innovation and Entrepreneurial Hubs," was made possible by a generous grant from the Stifterverband für die Deutsche Wissenschaft.

Jack Janes
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01 PREFACE

PREFACE

The degree of interaction between universities and companies as two main institutes in any society has attracted a considerable amount of research over the past decades. Nevertheless, more research is always needed to optimize the way in which they can best cooperate in the process of knowledge transfer for the welfare of global societies.

Historically, the traditional school of thought viewed universities as a typical "production machine" of human resources. Students pass through the different levels of a university education and according to their potential, obtain a Bachelor's degree, a Master's degree, and even a Doctorate. Later on, companies enter the picture when they recruit competent graduates to work for them or when qualified students seek jobs in the departments of Research and Development (also referred to as R&D) of large reputable companies. After a few years, these companies have developed huge R&D departments, in which many researchers are working on relatively similar tasks with a low degree of efficiency and specialization. Traditionally, ideas are developed in these central facilities and then transferred to the development of a product or service.

Now companies have shifted to a more project-oriented and open-innovation approach, where research activities are divided and spread across several sites not only within the company's headquarters, but also worldwide. The interest in a large R&D center has seriously declined.

Alongside the changes within companies, universities have changed, too. Earlier trends led universities to seek cooperation with nearby companies and national firms. However, recent trends have encouraged a global network of cooperation between universities and firms working at an international level. Central research units within universities have transitioned into joint-venture research laboratories (i.e., university-industry collaborations), which are close to becoming an emerging company. In the late twentieth century we witnessed an academic revolution. Universities began to contribute to society not only through their research and teaching, but also by contributing to the economic development of society. This trend began in the United States in the 1970s and in various western European countries during the 1980s and 1990s.[1]

The role of universities as engines of innovation is in the first place due to the education and qualification of undergraduate students, doctoral students, and postdocs. The students are the creative disrupters, the catalysts, and the future entrepreneurs. This is the traditional function of universities, which is much more valued in the current world of sciences than it was in the past.

What is really new in principle, however, is that the best skilled people are developing their innovative ideas and inventions more often during their time at universities than in the laboratories of the research-oriented companies, as was the case in the past. Therefore, the universities must not only educate their students, but they must organize the shift of knowledge from the university labs to the markets.

The teaching and research in the area of entrepreneurship, which deals with the discovery of new business opportunities by individuals as well as the creation of appropriate organizational structures,[2] has increased almost exponentially. Whereas in Germany there were serious reservations about this new research and study for a long time,[3] in the United

States, somehow the pioneer in the field of entrepreneurship, this discipline from the beginning was facing serious pressure to explain itself compared to the traditional perspectives and disciplines taught at business schools until the early 1990s.[4]

The same reservations could be witnesses in the area of technology transfer and the role of universities as think-tanks seeking patents and licenses. In 1980, the Bayh-Dole Act was enacted to enhance the patent applications from universities and to intensify the application-oriented research cooperation between universities and industry in the U.S. Lagging behind about twenty years, Germany amended the Employee Invention Act in 2002 to eliminate the so-called "*Hochschullehrerprivileg*"[5] or university teacher privilege, and to set up publicly-funded patent exploitation agencies.

These initiatives were spurred by the impressive success gained at MIT and Stanford University beginning in the early 1960s and 1970s in producing highly innovative, fast growing companies as well as in the acquistion of outstanding research laboratories through close cooperation between universities and industry. Universities in developed countries, especially in the United States and Germany, have taken on additional functions within the innovation process over the past decades. More quantitative as well as qualitative participation in the national and international innovation ecosystem[6] is taking place.

In addition to this multifunctional nature within universities, they are also magnets for the best skilled immigrants. This is especially true in the United States. There is a rapidly growing proportion of foreign-born PhDs in the United States: 15 percent of the age group of 66-70, and over 40 percent in the age group of 26-30. Universities in the United States are not only engines of innovation for the American population, but also for the global market. On the other hand, because their universities are magnets for the best students, American universities can import the best talent and attract those with the qualifications necessary for growth and employment through innovation.

In the following Policy Report, the changing uses of universities in the twentieth and twenty-first centuries are discussed. After highlighting some explanations for the new role of universities in the innovation process, the requirements for modern universities in the innovation society will be addressed, as well as different paths of development within modern universities. One of the focal points of this report is the comparison of universities' contributions to the innovation system. Possible strategies to find sustainable transitions from being that of an "ivory tower" to an "entrepreneurial university" are also highlighted. With all due respect for the universities and research institutions focused on the strengthening of regional and national innovation forces in recent years, there has been an increase in criticism worldwide with regard to their untapped innovation opportunities. Further details, with a special focus on the United States and Germany, will be discussed.

Also included are the results of a conference conducted by AICGS and supported by the Stifterverband in Washington on 9 June 2011. The author thanks the conference participants, as well as his partners at American universities and research institutions for their important contributions and suggestions. Special thanks go to the staff at AICGS, led by its director, Dr. Jack Janes, for their hospitality and support during the research stay in Washington. In particular, the author would like to thank Jessica Riester and Kirsten Verclas. In Germany, special thanks go to the team at the Leipzig Graduate School of Management (HHL) consisting of Nagwan Abu El-Ella, Christian Koch, and Dr. Tim Metje, as well as to Heather Metcalfe for their careful and dedicated participation in conducting the conference and in the preparation of this report.

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THE CHANGING ROLE OF UNIVERSITIES

THE CHANGING ROLE OF UNIVERSITIES AS INNOVATION ENGINES AND ENTREPRENEURIAL HUBS

The Changing Uses of Universities in the Last Decades

The importance of the quality of knowledge for the welfare of nations can be illustrated by a simple example. Although the physical weight of the United States' annual exports has not changed significantly over the last hundred years, the real value of its exports has increased twenty-fold. It is the knowledge that goes into the goods and services and the processes required to produce them that determine the value of the exports and their competitiveness in world markets.[8]

Anyone wishing to keep up in the global scientific community must acquire new and enhanced knowledge from institutional arrangements, creativity, and existing knowledge. They must then innovate and transfer this knowledge into money. If these knowledge creation processes could be arranged earlier in a largely consecutive order, with the knowledge being transferred via the next generation of graduates, then there would be a faster global availability of knowledge. This would result in an extremely dynamic sequence of knowledge generation and knowledge exploitation.

Although universities may not appear to be much different than their earlier predecessors, in recent decades dramatic changes have been taking place. The changes taking place behind their impressive façades, the scale of which is greatly underestimated, is leading to future consequences that have not even been remotely recognized. Universities are pioneers and drivers of the information revolution. Yet, they themselves have to undergo fundamental changes as a result of new technologies. Just as the invention of the printing press five hundred years ago increased the number of universities and the productivity of their work, the second wave of the information revolution is creating a profound change in universities and the way in which they operate.

All over the world people are using new media to create their own ways of acquiring knowledge. They then create new knowledge that crosses national and cultural boundaries. Talented people are moving around the globe to the sites where knowledge can best be acquired and implemented and in doing so, the funding available for research and best teaching is not the only thing that attracts them.

Universities have a special role to play in the development of new methods and measuring instruments. The focus on providing students and society with a special tool kit that allows others to better evaluate, understand, and cope with similarities and differences will be crucial. Also important is the selection of information that firms need to know. In an era where information overload has replaced information scarcity, it must become the task of universities to enable others to maximize their learning with an abundance of materials.[9] People are also attracted by the expanded scale of networking, which allows them to meet the best in their respective fields to achieve new scientific breakthroughs, the benefits of which can be used for the good of social development by being transferred directly into practice.

As universities shift in their role from a provider of human resources to an innovation engine and entrepreneurial hub, they provide regional and national knowledge-based development.[10] Academic knowledge is transferred to new products and processes through many different channels such as the patenting and the licensing of inventions, business development, or university-industry collaborations. Although there is evidence of the increase in the commercialization of academic knowledge, less is known about whether the commercialization of research takes place in universities in a form that companies can also replicate.[11]

Given the simultaneous changes within companies (see Section 3) to more modularization and decentralization, as well as the widespread integration of customers and suppliers into the innovation process, it can be said that the boundaries between firms and entrepreneurially-active universities are becoming increasingly blurred.

Different Models for Explaining the Research Systems and Knowledge Transfer Mechanisms

Three models have been proposed for the study of knowledge-based innovation systems: 1. the distinction of "Mode 2" knowledge production as opposed to disciplinary knowledge production in "Mode 1"[12]; 2. the model of national systems of innovation in evolutionary economics[13]; and 3. the Triple Helix model of university-industry-government relations.[14] These three models differ in the degree of integration and the differentiation among its systems components.

THE MOVE FROM MODE 1 (DISCIPLINARY) TO MODE 2 (TRANSDISCIPLINARY) OF KNOWLEDGE PRODUCTION

The shift from Mode 1 to Mode 2 was a great change in the concept of knowledge production. According to Michael Gibbons, Founding Director of the Program of Policy Research in Engineering Science and Technology and Director of Research and Technology Transfer at the University of Manchester and former Secretary General of the Association of Commonwealth Universities, and his co-authors, Mode 1 is all about the traditional knowledge created within a discipline in a primarily cognitive context.[15] Mode 2 knowledge is created in a broader transdisciplinary social and economic context and is sometimes referred to as a "socially distributed knowledge production system." Therefore, it made sense when talking about Mode 1 to refer to science and scientists, whereas Mode 2 refers more to practitioners.

The nature of the transformation from Mode 1 to Mode 2 has been elaborated in different fields (i.e., humanities, social sciences, technology, etc). One field in particular was within universities and the change within the higher education systems. Since World War II, all industrialized countries have encountered a rapid expansion of people pursuing higher education. This trend has helped the rapid growth in both education and research, as well as prompted the shift from Mode 1 to Mode 2, especially in research. In Mode 1, research is considered an elite activity even when carried out by a large number of people. Table 1 summarizes the different kinds of shifts in universities resulting from the increase of people taking part in research and education.[16]

However, one must not forget that Mode 2 is an outgrowth of Mode 1. The bigger manifestation of the expansion of the role of universities is clear in the Triple Helix approach.

THE TRIPLE HELIX OF UNIVERSITY-INDUSTRY-GOVERNMENT RELATIONS

The Triple Helix approach integrated universities as major players in the innovation process in knowledge-based societies. As the name suggests, it is the combined effort of a society's main three institutions—universities, industries, and government agencies—that overlays the network of knowledge sharing. This approach added a third task to the understood main tasks of a university—education and research—that is the direct contribution to industry by knowledge and technology transfer.

The Triple Helix approach has passed through three main stages. First there was Triple Helix I, in which the state directs relations between academia and industry (e.g., in the former Soviet Union). Triple Helix II consists of several institutional spheres with borders (e.g., in Sweden and the United States). Triple Helix III generates a knowledge infrastructure in terms of overlapping spheres, each taking the role of the other and with hybrid organizations emerging at the interfaces.

Over the last five to ten years, most countries have been trying to attain some form of Triple Helix III. Their main goal is to attain an "innovative environment consisting of university spin-offs, tri-lateral initiatives for knowledge-based economic development, and strategic alliances among firms (large and small, operating in different areas, and with different levels of technology), government laboratories, and academic research groups. These arrangements are often then encouraged, but not controlled by the government."[17]

Evaluations of the various regional initiatives show that the expectations of the Triple Helix approach were not met, particularly where technology transfer was designed as a purely linear process (see Section 4) and no strategic partnerships with major international companies exist.[18]

CAMPUS COMPANIES AS PROMOTERS OF ACADEMIC START-UPS

In Germany, there are the "An-Institute" (associated institutes) and other kinds of so-called campus companies, which foster innovation systems.[19] These transfer institutions are legally independent entities founded next to universities. They are owned

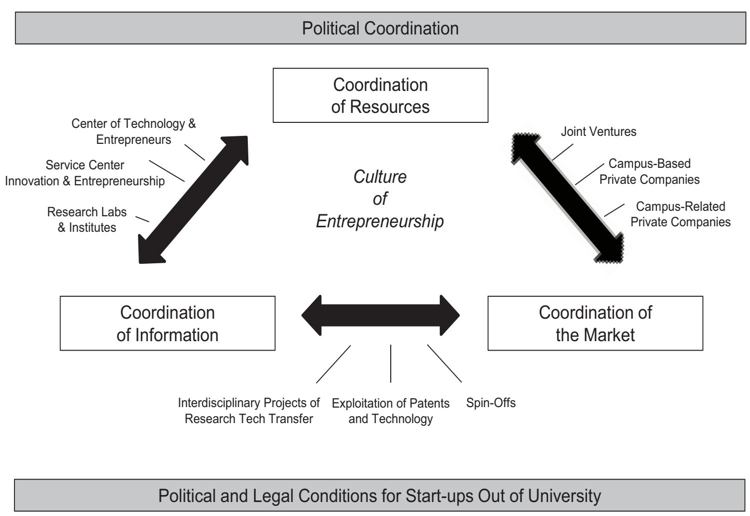
Table 1: Main Distinctions between Mode 1 and Mode 2

Area of Change	From Mode 1 to Mode 2
Functions inside a university	Diversification of functions that range from specialized research to intensive training.
Teaching and research tension	Subjects were not entirely dominated by arts and sciences (Mode 1), some changed for educating professionals and training.
Research style	Transition from free inquiries approach to a problem solving-oriented research approach.
Accountability	University teachers have become part of a larger and denser network of knowledge institutions, which extends to industries and sometimes governments (therefore called the "extended university").
Sources of funding for higher education	Increased dramatically with the widening of university networks.
Technology transfer in knowledge production	Linear transfers of knowledge have shifted to interactive transfers of knowledge.
Organizational development	Faculties have transitioned from being intellectual centers to becoming largely administrative. The real academic unit is the research team.
Social profile of student populations	An increase in the number of students seeking a university education caused growth in the old elite universities and thus the roles of universities have been transformed.

by different combinations of players including states, universities, industry leaders, and other supporting groups. These institutes cooperate very closely with universities. Often the head of the institute is a professor within the university. In addition, an An-Institute or a public-private lab on the campus is closely connected to industrial investors, as it receives a very small part of its budget from public funds. Thus, An-Institutes and other kinds of campus companies promote strategic partnerships between public universities and industrial companies. They are established for a limited period of time with the goal of combining research and resources in order to learn from each other. The different forms can be modeled as a continuum of institutional arrangements between science and industry. Figure 1 illustrates the different contribution of each different type of campus companies to reduce the information, resource, and market-related transaction costs. As in the Triple Helix model already shown, policy in addition to science and industry has its own role as a coordinator.

Campus companies are comparable to some of the university-industry research centers that are very successful in the United States, although the financial and organizational conditions are different. The focus is on the transaction costs from the start-up of and process of innovation. Starting from Israel M. Kirzner's, a former professor of economics at New York University, idea of the resourceful entrepreneur,[20] there are three different transaction cost-reducing contributions of campus companies.[21] First, it is the bringing together of different knowledge fragments to produce innovative solutions in terms of an invention. Second, campus companies contribute by coordinating the process of bringing together resources (technology, management expertise, personnel, financial and physical capital), which helps reduce costs incurred throughout innovation. Finally, they open the appropriate market by revealing potential arbitrage opportunities and help realize them through internal performance.[22]

Figure 1: Supporting Functions of Campus Companies for Academic Start-up[23]



The prominent role of campus companies within the process of promoting academic innovative performances and spin-offs can be seen in the United States at the Langer Lab of MIT[24] and in Germany at the RWTH Aachen.

In Aachen, one of Europe's biggest campus complexes is under construction. After substantial completion of the first major phase of construction with an area of 473,000m^2, RWTH Aachen University is currently working on expanding further to include another 325,000m^2. What will be created is a total of nineteen integrated clusters to connect science and industry. Within these clusters more than 10,000 jobs will be created and an investment of approximately €2 billion is to be expected.

Different Innovation Management Systems

Innovation systems can be defined in many ways focusing either on their functional or on their territorial aspects. However, they all involve the creation, diffusion, and use of knowledge. Different innovation systems have been presented; the main innovation systems seen are national,[25] sectoral,[26] and regional.[27]

National systems of innovation can be defined in a "narrow" or in a "broad" sense. "The narrow definition would include organizations and institutions involved in searching and exploring—such as R&D departments, technological institutes, and universities. The broad definition which follows from the theoretical perspective presented above includes all parts and aspects of the economic structure and the institutional set-up affecting learning as well as searching and exploring—the production system, the marketing system and the system of finance present themselves as sub-systems in which learning takes place."[28] The elements of the national system are naturally located within the borders of a nation state.

However, the concept of national systems of innovation does not cancel other concepts, such as regional/local systems of innovation and global systems of innovation. According to Bengt-Åke Lundvall, a professor at the Department of Business Studies at Aalborg University and at Sciences-Po in Paris, it results in a multi-level hierarchy of different innovation systems that mutually influence each other.[29]

On the other hand, a sectoral system of innovation and production, "is composed by the set of heterogeneous agents carrying out market and non-market interactions for the generation, adoption and use of (new and established) technologies and for the creation, production and use of (new and established) products that pertain to a sector ('sectoral products')."[30]

The agents in a sectoral innovation system are individuals and organizations. These organizations may be firms, universities, financial institutions, industry associations, government agencies, or even R&D departments. The main components of a sector in this model are "knowledge and technology," "actors and networks," "institutions," and "demand."[31] In terms of "knowledge base," the sectoral innovation system model assumes that often more than one technology exists in a sector and, usually, we face a Technology-Product matrix in any sector. These technologies are interdependent and complementary and for innovative activities, knowledge should be accumulated over time. This view believes that the main indicator for determining the boundaries of sectors is "the common knowledge base" and it can explain the differences between sectors in terms of "appropriation," "opportunity," and "accumulativeness."[32]

Regions differ with respect to their R&D and innovation capabilities as well as innovation performance. Philip N. Cooke and his co-authors define an Regional System of Innovation (RSI) as a system "in which firms and other organizations are systematically engaged in interactive learning through an institutional milieu characterized by embeddedness."[33] Bjorn Asheim and Arne Isaksen add that "a regional innovation system consists of a production structure (techno–economic structures) and an institutional infrastructure (political–institutional structures)."[34] Firms, institutions, knowledge infrastructures, and innovative policy are in general the main elements comprising an RSI.

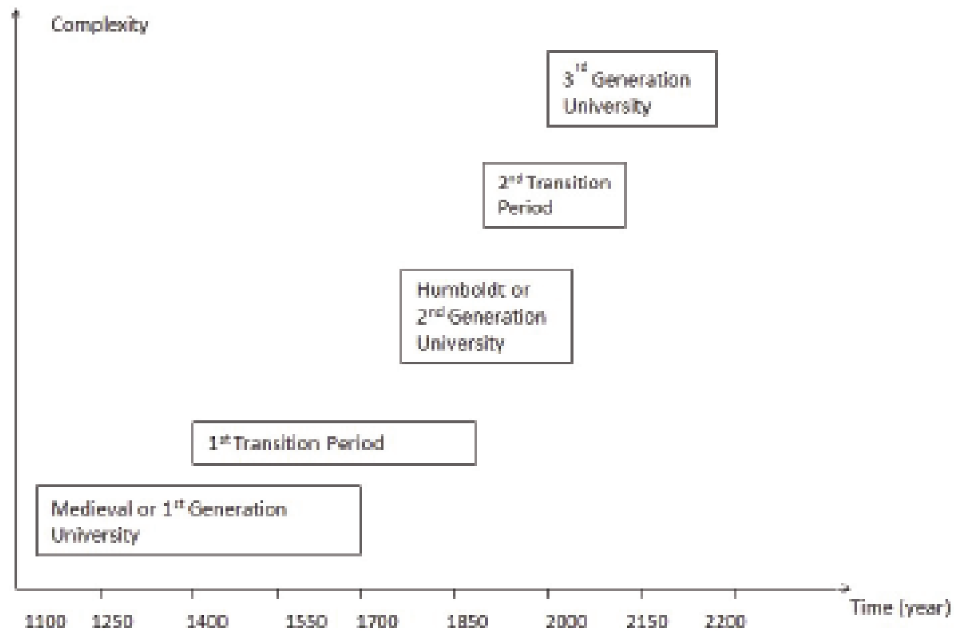
Universities Becoming Main Parts of the Innovation System

Universities are changing in a tremendous way, moving from the science-based model to becoming "third generation" universities. To be able to talk about the main trends that drive this change, an overview of the history of universities should first be displayed.

THE DEVELOPMENT OF UNIVERSITIES

Wissema has made an extensive overview on each stage of the development of universities.[36] Kerr also made a great review with special emphasis on the idea of multiversity.[37] First, a short review of history. The medieval universities, or the first generation universities, stem from Latin schools in the early Middle Ages and the inheritance of Plato's Academia and Aristotle's Lyceum. They were strong organizations that enjoyed protection from the state and the

Figure 2: Development of Universities[35]



church. However, the main goal of these universities was not to obtain new knowledge, but rather to protect the past and obey the religious rules of the church. Individual lectures, which were allowed to be given to the public, were the first trigger for universities, some of which were the ancestors of the University of Paris. In the Middle Ages, many of a university's current features were developed such as a name, a central location, and even an administrative structure.

By the end of the eighteenth century, European universities became like introverted castles, until the rebirth of the university took place in Germany. This dramatic change occurred with the establishment of the University of Berlin by Wilhelm von Humboldt in 1809, which was a second generation university. It emphasized philosophy and science, research, freedom of professors, and graduate instruction. Its effect spread quickly throughout Germany with the two new forces of science and nationalism.[38]

At the same time, the United States had already founded a number of colleges developed on the models of Oxford and Cambridge. However, the real development of modern American universities came with Professor George Ticknor at Harvard in 1825. Then came the founding of Johns Hopkins University in 1876. It was the first institution to develop a graduate school, which focused on research with high academic standards. Harvard then followed suit and became a university with its focus on the areas of professional school, graduate school, and research.

Then comes the third generation university (3GU). The 3GU is a multicultural, cosmopolitan, networked university, operating in a competitive international market, with an interdisciplinary approach to research, an exploitation of know-how, and a decreasing reliance on state regulation (second generation) university.[39] Wissema identified several key factors in the shift from second generation to third generation universities. These include: pressures on quality following a significant increase in student numbers from the 1960s; the need for changes in governance in light of this swelling of numbers; globalization; the emergence of interdisciplinary research and the challenges this poses to traditional forms of faculty organization; the increased costs associated with top level research; the growth of research institutes outside universities; government demands for a stronger focus on technology-based economic growth; and the emergence of new opportunities for collaboration with industry and the development of academic entrepreneurship.[40]

No doubt, the second generation had its strengths at the time, but should not be romanticized, as “the role of universities was limited to scientific research and education; it was considered wise not to bother them with the application of what they invented.”[41]

The idea of “Multiversity” is that of an inconsistent institution comprised of several communities even when they have conflicting interests.[42] There are the communities of the undergraduates, the graduates, the humanists, the scientists, and even that of the administrators. The university has boundaries while the multiversity does not. How great institutes in different societies within globalizing forces coordinate and develop under one horizon is at the core of our discussion.

03 THE CORRESPONDING CHANGES IN INDUSTRY

THE CORRESPONDING CHANGES IN INDUSTRY

Research companies have already reacted to this development. The time when research-oriented companies primarily developed their ideas and inventions in their own central research laboratories, where the best ideas moved along the innovation funnel into development, production, and finally sales, has changed due to the information revolution.

Albach has marked the informational revolution based on the products that he named "Scienceware," in contrast to traditional hardware and software. They can be described using the following four characteristics: First, products contain an increasing proportion of research and development services. Second, relatively small businesses have access to the world market through their easy access to information and logistics networks. Third is the fact that the development, manufacture, and integration of the products can actually occur anywhere in the world. Fourth, the complex integration of technological capabilities on the user side leads to increased information asymmetry.[43]

The far advanced modularization and decentralization of business activities as part of the information revolution and its flexibility in outsourcing in collaboration with more or less virtual networks is also reflected in the research and development area. A strong approach to the customer, as well as to universities and other research institutions, makes companies better able to work without borders or limits.[44]

Instead, research is increasingly being seen in terms of integrated technology management. Research is a function covering the entire innovation process, collaborating closely and continuously with all stages of the internal innovation process, as well as with external cooperative partners.[45] In addition to this, the various R&D activities are being spread more frequently across several sites worldwide. Many of these departments work closely together with professors, research institutes, and faculties. Technological knowledge is therefore increasingly becoming a commercially tradable resource.

Or as DeVol and Bedroussian put it, research and innovation are increasingly shifting away from the corporate lab and back to where they began in the university campus. As the global economy grows increasingly dependent on the enhancement and dissemination of knowledge, universities are seen as natural partners for both business and government.[46]

Due to its ability to integrate international students and researchers, different disciplines and stakeholders, academia commercializes knowledge and research in ways that companies cannot replicate.[47] They therefore strive to integrate their specific expertise through networks into globally aligned innovation processes.

Directing to Open Innovation System

Companies are constantly working on their innovation processes, seeking new and different approaches. This need is driven by high competition, increased R&D investments, and shortened life cycles of many products worldwide, as well as the limitedness of resources. The various well-known innovation systems comprise different combinations of institutions and relationships that take place at the national, regional, and sectoral levels.

When Henry Chesbrough introduced the concept of Open Innovation, emphasizing the interdependent nature of the innovation processes,[48] he argued that the increased number of producers of knowledge and the increased mobility of knowledge workers make it more difficult for firms to appropriate and control their R&D investments. Thus, the advantage of having an internal R&D department has declined. In connection, the boundary between a company and its environment is now porous due to the open innovation process. This leads a company to become embedded in loosely connected networks of different players, collectively and individually, all working toward commercializing new knowledge.[49]

Thus, we will find that open innovation stresses on the fact that while some companies are busy erecting solid boundaries to protect their information secrecy, their competitors are jumping to the market faster. This is due to compaines' wide networks composed of various stakeholders of industrial and academic partners and the continuous inflow and outflow of knowledge, which results from this network.

Some statistics have shown that companies that use external sources in their innovation processes gain more patents and own more intangible assets than companies that do not conduct exploratory search. Among these corporations are Cisco Systems, DuPont, IBM, Intel, Lucent, Procter & Gamble, Philips, and Sun Microsystems.

IBM: A REAL SUCCESS CASE OF ADOPTING OPEN INNOVATION

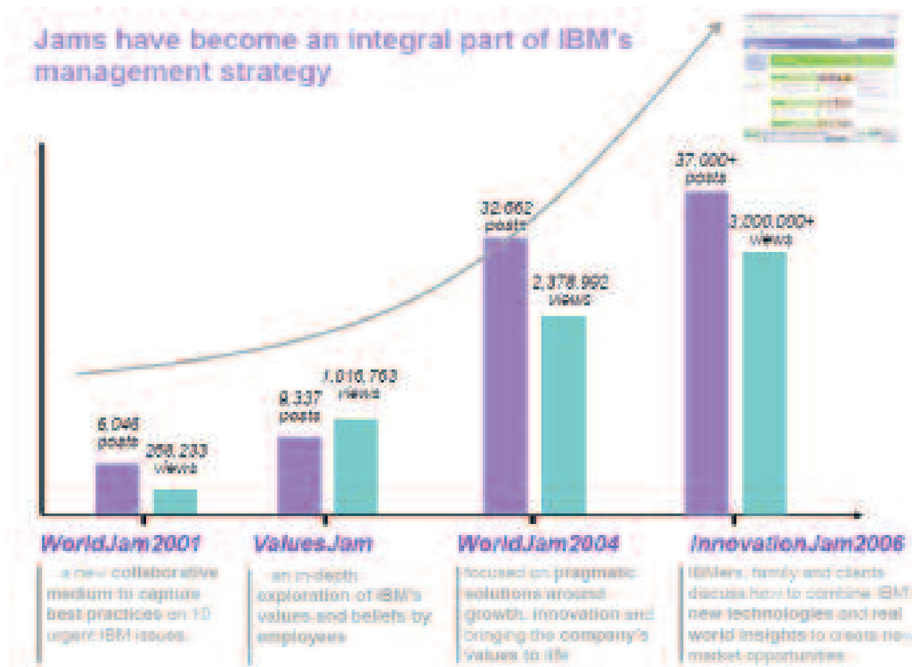
The American multinational company IBM is said to have innovation in its blood. It is the top established and fastest growing company in the information technology (IT) market. IBM long ago realized that the influence of information and communication technology would spread into traditional disciplines such as medicine, pharmacy, and others. Thus, they led a highly dynamic industry for some years. IBM was different than the others as it did not solely focus on investments in R&D, but also in expanding its networks and opening up its innovation processes to have a better view of the market, as well as of consumer demand.

Figure 3: Open Collaboration in IBM[50]

Since 2001, IBM has been holding "Innovation Jams." These jams refer to online discussions for audiences ranging in size from a few hundred to hundreds of thousands,[51] and jams have captured many ideas about critical business issues.

Out of these jams, ten ideas were identified to receive further funding for the development of incubator businesses. IBM funded these ideas with $100 million, all of which were chosen through these discussions. They include the following: Big Green Innovations, a new business unit in IBM focusing on applying the company's expertise and technologies to emerging environmental opportunities, such as advanced water modeling and efficient solar power systems; Integrated Mass Transit Information System, systems for integrating, managing, and disseminating real-time data for all of a municipality's or region's transit

Figure 4: Jams as a Major Open Innovation Tool[52]



systems; 3D Internet, developed to build the next platform for global commerce and business operations. Five of the ten ideas now make up IBM's "Smarter Planet," which is a company-wide initiative to make the world's systems "smarter."

So the highly and openly innovative system at IBM depends on the following stages: Ideation; Mobilize Interest & Collaborate; Incubate, Prototype & Validate; and Implement & Take to Market.[53] In the approximately eight research labs that focus on basic research and long-term development, and the thirty development labs oriented toward short and middle-term projects, approximately 400,000 people are employed in approximately 170 different branches of IBM worldwide.

Employees comprise a huge part of the widespread decentralized network of innovation and cooperation. Innovation Jams and other recent techniques bring together employees to freely discuss their ideas, as long as they are not releasing proprietary information. There is no IBM corporate blog but rather many internal blogs to support the "be yourself" concept for more innovative results.

According to Lichtenthaler et al., the implementation of open innovation systems is often resisted by many employees who favor internal innovation.[54] To overcome this attitude, managers in innovative companies must work hard on communicating the open innovation strategy throughout the whole company. In addition, they should establish suitable incentive systems and design their organizational structures to ease the opening of innovation. Furthermore, managers need to institutionalize open technology transfer attitudes in the corporate culture.

04

DIFFERENT PATHS OF DEVELOPMENT

DIFFERENT PATHS OF DEVELOPMENT OF MODERN UNIVERSITIES IN THE UNITED STATES AND GERMANY

As reported by the OECD, higher education and training schools are essential for innovation, because they attract and produce the players within innovation. In more open systems of innovation, they also connect the players on a larger scale, such as businesses, governments, and countries. They contribute to the local quality of life, help to attract the highly skilled from around the globe, and can be the anchor for clusters of innovative activity. According to the report, "[t]he major policy challenge is to recognize the essential role of universities in the innovation enterprise rather than view them, as is all too commonly the case, simply as providers of essential public goods. This [though] requires a greater focus of policy makers on ensuring independence, competition, excellence, entrepreneurial spirit and flexibility in universities."[55]

In addition to this multiversity, universities are also magnets for the best skilled immigrants. This is especially seen within the United States. There is a rapidly growing proportion of foreign-born doctorates in the United States from 15 percent in the age group of 66-70 to over 40 percent in the age group of 26-30. Universities in the United States are not only engines of innovation for the American population, but also for the global market. On the other hand, because their universities are magnets for the best students, they can import the best talent and attract those with the qualifications necessary for growth and employment through innovation. Although German universities are able to attract a relatively high share of the international student market, it is not comparable with the role of U.S. universities.

This is a very important and current point of discussion, which we have to resolve. We must better understand the influence of immigration on innovation and entrepreneurship, as well as the role universities do and can play to meet these challenges. Perhaps German universities have to learn how to financially profit from the work of foreign students, as well as support them in remaining in Germany where they can find employment after their exams. This is needed to fill a gap within Germany's demography, which will be much deeper in Germany than in the United States.

The U.S. system of higher education has long been familiar with a much greater entrepreneurial orientation because of the often private ownership of individual universities and their large capital base. Yet not until recently has the legal and financial framework of the German universities changed considerably. Higher education has especially been altered due to liberal legislation. The legislation demonstrated a clear commitment to excellence and an interdisciplinary environment, as well as significantly increased the funding of universities, for example by the Excellence Initiative.

The German Excellence Initiative

In June 2005, after several months of political discussions, the federal and state governments of Germany decided to pool their resources in a new common research initiative, which was called "The Excellence Initiative." The German Research Foundation and the German Council of Science and Humanities conduct this initiative. Two stages of the competitive support program have already been completed and the third one is to be finished in 2012.[56]

New challenges in a globalized world call for new efforts in promoting high-level research. Jamil Salmi, coordinator of Tertiary Education at the World Bank, emphasizes that nowadays, "economic growth and global competitiveness are increasingly driven by knowledge" and that universities can play a major role in achieving it.[57] He suggests that there are different strategies to gain a good position in what the author Ben Wildavsky calls the "Brain Race."[58] One of the strategies that Salmi presents is that of "picking winners." Here only a small group of already successful universities would be supported by lots of public resources, in order to improve them. The German Excellence Initiative is following this strategy to give a selection of German universities the chance to close the gap with the top flight of research universities worldwide.

To understand why following this strategy is a dramatic change for the German science system it is important to know that concentrating on just a few universities would have been unthinkable in Germany for many decades. Public financial support for science very often tried to include every university, so focusing on just a small group of them could be understood as leaving the others behind. Yet the federal and state governments in Germany recognized that a new approach was necessary if the country and its universities still wanted to be competitive in the "Brain Race" with the rest of the world.

The Excellence Initiative is driven by the idea of promoting cutting-edge scientists and their research by creating outstanding conditions at their universities. The results should enhance the international image and visibility of German research universities and improve their positioning within prestigious international university rankings. Increasing third party funds and the number of appointments of scientists with excellent international reputation were also aims of the initiative.

The ambitious goals of the initiative cannot be reached by all universities. The program clearly aimed at supporting a limited number of excellent projects. As stated earlier, this new culture of inequality and elites within the scientific community meant a departure from one of Germany's basic values about science and politics. The second major change along with the Excellence Initiative was the idea of setting up a competition between universities. Every university that wanted to participate had to apply for financial support and face up to the concepts of other universities. There are three lines of funding universities could apply for:

■ Thirty-nine graduate research schools were chosen within the Excellence Initiative to be supported with an average of €1 million per year. Each of these graduate schools was established to give young doctoral students the chance to improve their careers by benefiting from a network of young academics and experienced scientists. Researching at one of these graduate schools is an attractive opportunity for broad minds and means a powerful alternative to one of the highly recognized graduate schools abroad.

■ In addition to the graduate schools, the Excellence Initiative supported thirty-seven Clusters of Excellence with an average funding of €6.5 million per year over the period of five years. The Clusters furthered the idea of concentrating and focusing the research potential of German universities, so as to increase their international scientific visibility in one specific area of their research. This approach encouraged universities to concentrate on auspicious forward-looking priorities within their research activities, as well as connected them to industrial partners and non-university researchers from the four important German research associations (Max-Planck, Helmholtz, Leibnitz, and Fraunhofer). Systematic scientific networking beyond the frontiers of their own department or university broadened the horizon of many researchers and provided them a real benefit for their work.

■ The most noted part of the funding initiative was the Institutional Strategies, which aimed to strengthen a small number of universities as a whole to improve their international competitiveness. Nine universities have now been supported with up to €13.5 million per year. German media soon called them "Elite Universities," which is a label not chosen by governments or any scientific organization. The label nevertheless became very popular and is recognized as an honorable reward for scientific excellence. All universities that gained this status had to present a long-term strategy on how to compete with top-ranking international universities. Existing strengths were to be improved upon so the universities would become more attractive for young, promising, and already established cutting edge researchers.

At the end of the two rounds, in October 2006 and October 2007, the scientific and political community together selected 85 institutions. To sum it up: 39 graduate schools for the training of young, high performing scientists and researchers; 37 Clusters of Excellence, in which universities, non-university research institutions, and often business and industry work together on particularly promising topics of the future; and the 9 so-called Institutional Strategies that universities draw up to advance their development as a whole. The impressive number and extensive range of research concepts, which were submitted in hopes of support from the initiative, exceeded the expectations of politicians and scientists.

RESULTS OF THE INITIATIVE

After a relatively short period of three years since the initiative began, the first results demonstrating the success of the Excellence Initiative were published by DFG & Wissenschaftsrat in the first substantiated report.[59] The Initiative for Excellence has triggered a number of structural and profile-building developments within German universities by spending almost €2 billion during the two first rounds. It has created research-friendly structures. It has promoted interdisciplinary cooperation within universities and between universities, as well as among universities, non-university research institutions, and the private sector.

The numbers show that young scientists in particular have benefited from the Initiative for Excellence. The Initiative has also promoted equal opportunities for male and female scientists and measures to help balance work and family life. Moreover, the Initiative for Excellence has made an important contribution to the internationalization of German universities and increased their attractiveness to students and scientists from Germany and abroad. Approximately 4,200 scientists and 300 professorships have been recruited in the funded projects with about 25 percent of them coming from outside Germany. These scientists did not only improve research, but also played a major role in advancing teaching within the universities.

In addition to the scientific results of the Excellence Initiative there is also a remarkable economic factor that further demonstrates its success: Over 4,000 new jobs in science have been created as a direct effect of the financial support. This is a strong signal for private employers to invest in new jobs as well.

FUTURE PROSPECTS

Even during the financial and economic crisis in 2009, federal and state governments decided to start the third round of the Excellence Initiative with increased financial support. The applications of this round are being reviewed and the winners will be announced in June 2012. The entire program will be continued through 2017. There is €2.7 billion of financial support available to successful universities. If one looks at the success of the Excellence Initiative it is hard to imagine that it will not be continued further. There will be additional stages of competition between universities, which have already been supported, as well as universities who also are trying to reach this goal. While the first group will try to achieve a continuation of their status, the second group will do its best to gain support. This kind of competition is one of the keystones for the advancement of the whole German scientific system.

05 THE CONTRIBUTIONS OF UNIVERSITIES

THE CONTRIBUTIONS OF UNIVERSITIES TO THE INNOVATION SYSTEMS OF THE UNITED STATES AND GERMANY

Universities in the United States and Germany have always played an important role within innovation systems. In both countries universities produce high numbers of students with valued degrees every year. Young adults with Bachelor's, Master's, and PhDs spend several years at universities improving their skills and enhancing their knowledge. This greatly benefits not only themselves, but their future employers as well. These graduating students become highly trained employees who contribute to the financial well-being of our societies. In addition, their studies at a university build a great foundation for further education in a demanding job. Some graduates even team up to start their own companies, which can be a model for other students as well.

However, universities do not just produce personnel; they produce ideas. Universities produce ideas that move innovation systems forward. They produce auspicious new ideas. The research of professors, their staffs, and their students is critical for a smooth transfer of knowledge between science and economy. Scientific publications, patents, prototypes, and business models push the economy and help to speed up developments in numerous sectors. Moreover, universities act as entrepreneurs. Universities develop promising companies on their own, as well as in cooperation with industrial partners.

In both the United States and in Germany, society realizes the importance of universities within the innovation system. Universities, however, need to better understand the ecosystem they work in, and communicate within it. By doing so, universities can enhance their role within innovation systems. To explore this, some indicators of input and output of the universities in each country, differences, as well as best practices will be further discussed.

Indicators of Innovation

INPUT SIDE

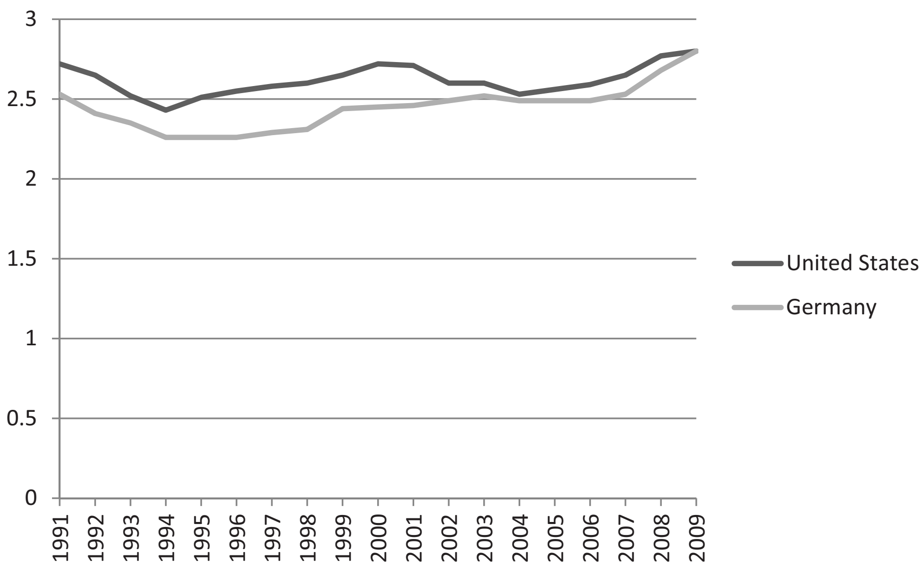
The following figure (Figure 5) shows a comparative analysis of innovation input indicators in Germany and in the United States.

There are two input coefficients that are important indicators of the value placed on universities within an innovation system. First of all, the funds spent for R&D in comparison to gross domestic product (GDP). In 2009, Germany spent €67 billion on R&D, which equates to 2.8 percent of its GDP. In 2008, the United States spent $268 billion on R&D, which also equates to 2.8 percent of its GDP. Thus, Germany and the United States use the same amount of their economic power to promote research and development.

Looking at the timeline, it can be seen clearly that there used to be a significant gap between the funds allocated for R&D in Germany and the United States until Germany closed the gap in the last few years. There is also evidence that the German quota has risen due to the GDP slump caused by the economic crisis. In recent years, research in Germany made a jump with regard to resources, autonomy, increased competitiveness, and degrees of national and international cooperation.

Another important indicator is the number of professors. In Germany, only 1 in 2,000 inhabitants is a professor; in the United States, this number is approximately ten times higher. However, this does not mean that Germany is scientifically underdevel-

Figure 5: Development R&D/GDP in Germany and the U.S.



oped. If we look at the number of people working in R&D, we see there are 500,000 German scientists compared to 1.4 million American scientists. With populations of 82 and 309 million people, respectively, the German number is above average.

However, if we look at how much money each country spends on universities, we will see a difference. Germany spent €10 billion on universities in 2010 which equates to 0.41 percent of its GDP. The United States spent $55 billion, which is 0.57 percent of its GDP. This fact demonstrates the difference in value placed on universities within each country.

OUTPUT SIDE

We will first examine the output indicator of the number of students, together with their age group. Due to an expansion of college and university attendance in Germany and the introduction of a Bachelor/Master system, the percentage of undergraduate students has risen to 46 percent in 2010. The comparable number in the U.S. is 68 percent.

Overall there are also more academics in the United States than in Germany. According to a 2008 OECD survey, 16 percent of 25-64 year old Germans have an academic degree, while 27 percent of the same age group in the United States do. The significantly smaller percentage of academics in Germany can be explained due to its long tradition of non-university professional education in a dual system. The numbers are also different if we look at the PhDs granted in both countries per year. In the United States there are 42,000 doctorates. In Germany, there are 25,000 doctorates, although there are significantly fewer students pursuing such degrees.

Patents are another output indicator worth examining. The IEEE Spectrum, a magazine edited by the Institute of Electrical and Electronics Engineers, publishes an interesting yearly survey on new patents in the United States and their origin. They analyze not just the number of patents, but also create an index, the “Adjusted Pipeline Power,” which indicates the “Patent Prowess” of companies and universities. If we sum up the numbers you can see that the top ten U.S. universities, according to their “Patent Prowess,” have applied for 3,600 patents. If we add up the number of the top ten patenting automotive companies worldwide, we see there were 4,500 patents. This is an amazingly small difference between the numbers of patents coming out of universities versus those coming out of the global automotive industry.

When comparing patents filed by universities in the United States against their counterparts in Germany, the United States is in the lead. In 2009, American universities filed approximately 3,400 patents. In Germany, universities filed approximately 700 patents. However, statistics indicate these numbers are shifting. If we compare these numbers to 2004, we can see that the number of patents coming out of German universities has risen from 500 to 700. In contrast, the number of patents coming out of American universities has decreased; for example, in 2004, 3,700 patents were applied for.

There are two possible explanations for this. The slight American decrease could be the result of slower progress in biotechnologies after many years of groundbreaking new inventions and a trend of intense patenting in this field, whereas the rising number of German university patents could be the result of legislative change. In 2003, when German universities gained the right to patent the inventions of employed professors at their facilities, the number of applications submitted by professors for patents decreased.

A further output indicator is by looking at how U.S. universities serve as incubators for start-up companies. According to the Association of University Technology Managers (AUTM) network in 2009, 596 U.S. start-ups were developed using intellectual property licensed from American universities. According to the report for the year 2010, this number increased to 651.[60] Unfortunately there is no comparable German statistic on this topic.

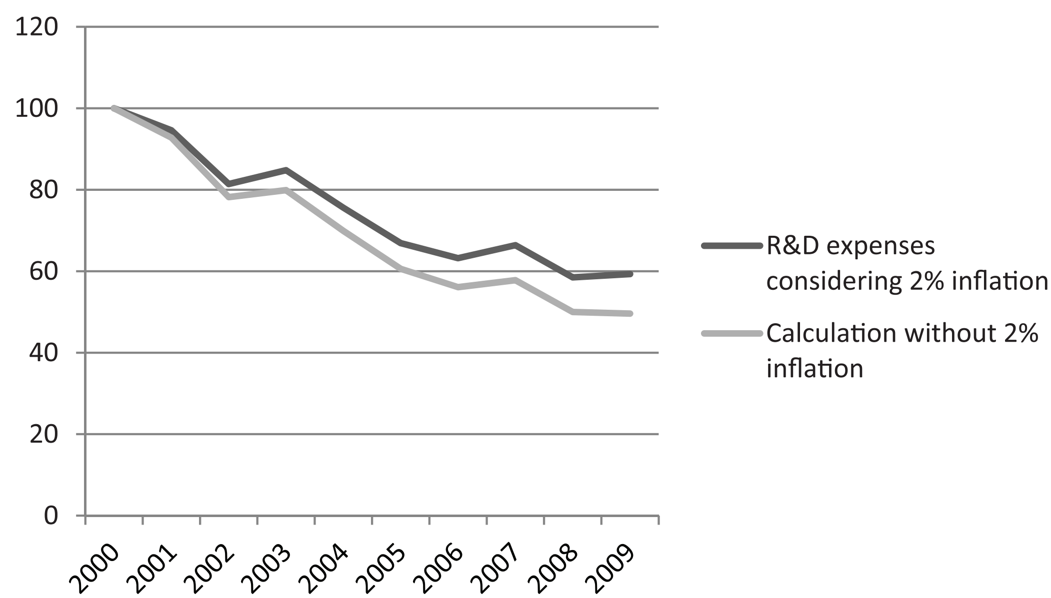
PRODUCTIVITY OF THE UNIVERSITY-DRIVEN INNOVATION SYSTEM (FACTS & FIGURES)

Now that we have looked at different inputs and outputs of universities, we can further explore the role of universities within an innovation system and how we might enhance our role within the system. To do this, we are going to focus on the recent AUTM report for the year 2010, which shows more interesting facts on the impact of innovation in the United States. (The respective figures for 2009 are also listed in parenthesis, in order to reflect the short-term changes caused by the financial crisis.) Here are some highlights from this report, which demonstrate the importance of universities within the U.S. innovation system:

- In the year 2010, there were 658 (657) commercial products launched by universities. 4,284 (4,374) licenses were submitted. A total of 651 (596) start-up companies were founded.

- The total sponsored research expenditures equate to $59.1 ($53.9) billion. The federal government funded $39.1 ($33.3) billion. Industry contributed $4.3 ($4) billion.

Figure 6: The Development of Patent Activity by U.S. Universities



■ There was a total income from licensed property of $2.4 ($2.3) billion. This is 4.06 percent (4.27 percent) of the total expenses for R&D. Running royalties in the year 2010 resulted in $1.4 ($1.6) billion. The cashed-in equity is $63.4 ($24.4) million and other incomes amount to $452.3 ($262) million.

With these high dollar amounts based on intellectual property, one would think that more universities would increase their number of patent applications. On the contrary, although the amount of public funding going to universities is increasing drastically, universities are not filing more patents. In fact, there are even less patents filed by universities.

Figure 6 shows the development of patent activity by U.S. universities, visualized by the number of patents filed between the years of 2000 to 2009. The vertical axis shows the number of patents in relation to R&D expenses. Even by assuming a 2 percent inflation rate putting the R&D expenses into perspective, the decrease in output can be seen despite an increase in public funds.

The fact that a higher number of employees are working full time in this area also seems to have no effect. Thus, there is not a problem of lack of funds or personnel, but rather a problem in putting these efforts into patents. Obviously, innovative ideas are being fostered in that there are high numbers of non-disclosure agreements being signed in the same period, compared to the R&D expenses.

If we have a further look at 2009 and 2010, years that were affected by the global economic crisis, we see how economic influences can affect the knowledge-related incomes of universities. The license earnings of U.S. universities decreased in comparison to 2008 from $3.4 billion dollars to $2.3 billion in 2009. There is a small increase in 2010 with $2.4 billion being earned via licenses. Running royalties decreased from $2.3 billion to $1.6 billion in 2009 and further decreased to $1.4 billion in 2010. Only the cashed-in equities, which were almost cut in half from $44.4 to $24.4 million in 2009 had a significant increase to $63.4 million in 2010. On top of this, there was a decrease of 31.5 percent of revenue from licensed property in 2009.

Another AUTM statistic shown in the above mentioned report shows that a small number of “high flyers” can have enormous effects on the whole system: “Interestingly, total license income for 2008 excluding one-time payments received by Northwestern University, Children’s Hospital of Philadelphia, Sloan Kettering Institute for Cancer Research and City of Hope National Medical Center and Beckman Research Institute was around 2.13

Figure 7: Effects of the Economic Crisis

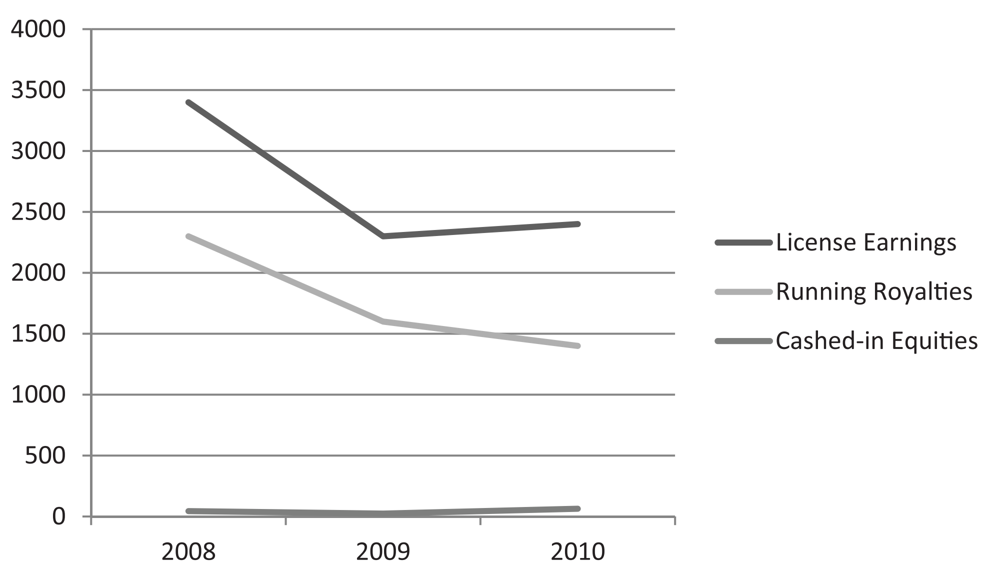
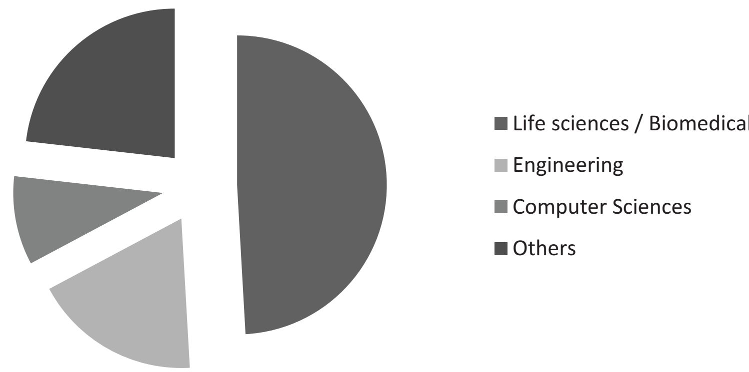


Figure 8: Distribution on Academic Disciplines: Non-Disclosure Agreements



billion dollars." This is a huge amount if compared to the total income, which was $3.4 billion.

Another special feature is noticeable when looking at non-disclosure agreements and their distribution on different academic disciplines. There were 13,376 non-disclosure agreements signed in 2009. Forty-nine point one percent were for life sciences or biomedical research, 9.6 percent related to computer science research, and 18.1 percent were relevant to the research of engineering. I will draw my conclusions on these facts later, as it could be one of the explanations for the decrease in output of patents.

A group of renowned researchers compiled an international comparison of thirty-eight indicators for innovation and summed it up in a recent report.[61]

The analysis shows that Germany has improved its innovative performance over the past fifteen years (see Figure 9). After being ranked tenth in 2005, the country is now in fourth place. Obviously public investments in science and public research have contributed significantly to this improved position. Thus, Germany has survived the economic crisis in research, development, and innovation much better than other countries. Germany is seen as an example for the group of countries that attach greater importance to R&D in order to raise their competitiveness.

In contrast, the United States has lost its high ranking over the past years. After being ranked in second or third place for the last fifteen years, the United States dropped to ninth place in 2010. "As this development results from structural problems, the USA threatens to remain permanently in the midfield, if not to slide down even further."[62] The researchers conclude that the United States could be more dynamic and spend more on R&D. Furthermore there is an enormous trade deficit. The United States imports "40 percent more high technology" than they export.[63]

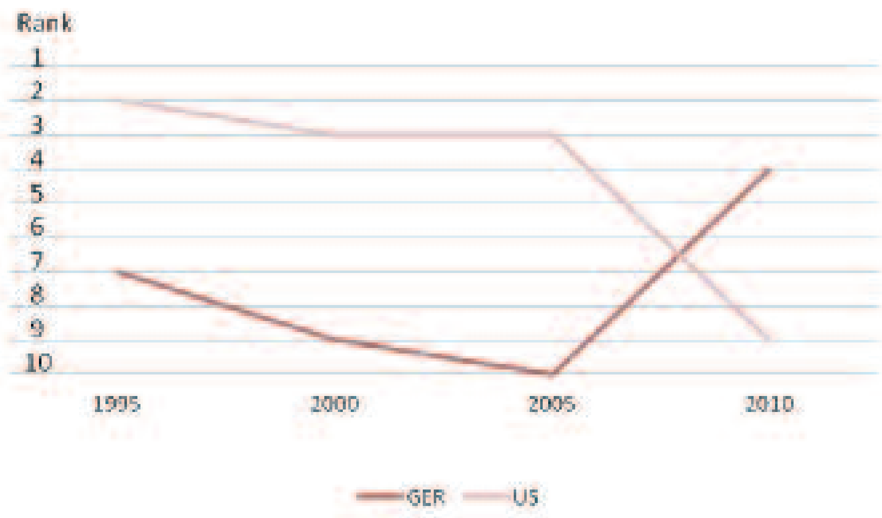
Strengths and Weaknesses within German and U.S. Systems of Innovation

Given the similar challenges faced by the United States and Germany, the analysis of their innovation systems shows that Germany was able to improve its position in the past decade, while the United States has lost its edge. The numbers presented reveal that even though the United States spends more money on research and development, it spends the same percentage of its GDP as Germany. Germany has closed the gap due to the impacts of the economic crisis. We have to wait for more recent data to see whether this trend continues.

Therefore, it is not surprising that during discussions on the effectiveness of the success of previous innovation policy, there is a strong opinion that American universities should become more entrepreneurial.[64] At the same time, there is an intense debate focusing on innovation systems within other industrialized countries to examine their future development.

However, even though Germany in the last ten years has tried to meet the standards set by American universities in the 1980s and 1990s, there are still significant structural differences within the science

Figure 9: Innovation Indicator, U.S. and Germany 1995-2010



and innovation systems of both countries. A closer inspection on the specifics of the science and transfer system could clarify recommendations for future development activities. Below is a cursory overview of some key structural differences presented in an effort to encourage further research and discussion.

- Research at universities plays a much bigger role in the United States. Germany is more focused on research in companies and non-university research institutions. While German universities are able to spend €10 billion per year on research, in reality they spend only €7.9 billion on it.

- The United States previously had a higher number of undergraduate students than Germany. The ongoing restructuring process of the German academic system has led to a notable increase of undergraduates. The percentage of PhDs in Germany is much higher because many recipients are not focused on university research, but transfer the knowledge into companies and research institutions. Thus, a PhD does not lead one exclusively to an academic career. This theory also explains why the percentage of university professors in the United States is higher and emphasizes the value of research at universities in the United States.

- The percent of foreign PhDs in the United States has risen to 33 percent, and the number of foreign postdocs has risen to 50 percent. Many of these individuals remigrate when their research projects are finished. In Germany, PhDs more often choose to join a research company within the country. This can be regarded as a strength of the German system because it demonstrates that universities invest in the ecosystem that surrounds them. It is a more sustainable strategy to invest in the economy and in the qualification of teachers, and to cooperate with schools. If we interpret universities as engines they can only perform as strong as the fuel that society provides them. In the German context, one must also keep in perspective that the number of PhDs and postdocs from abroad who are allowed to study in Germany's high-level research institutions has been expanded by the German government. This is to be expected, as Germany has a decreasing population and needs highly skilled immigrants to preserve its economic and scientific strength.

- University chairs in Germany have to do research as well as teach. Thus, they stay in close contact with the economy, which makes them small campus companies and serves the innovation transfer.

- U.S. universities make better use of patents, which are filed by researchers on their campuses. The Bayh-Dole Act was enacted in 1980, while a comparable German legislation was not enacted until 2003. Still, both countries should not be satisfied by the number of patents. Research funds are increasing and the number of university patents remains static or decreases.

■ The United States may be too focused on the top universities, disregarding a broad intermediate group that work in a more use-oriented way. Germany has shown some success in dedicating a part of its funding to applied universities and research institutions, which are dedicated to use-inspired basic and applied research, like Fraunhofer.

■ In Germany, it has proven successful to designate different research institutions to different parts of Stoke's "Pasteur's Quadrant." Some do pure basic research like Max Planck, some do pure applied research, and some cover Pasteur's Quadrant. Supported by federal initiatives like the Excellence Initiative and the Top-Cluster Strategy, these institutions have deepened their cooperation with universities and companies in recent years.

■ The transfer agencies have to become technology hubs, which actively seek new possibilities in cooperation. The system does not work well if universities and companies have to push their ideas and demands. There has to be a technology pull that is forcefully driven by the agencies.

■ The focus of research in the United States has been relocated from engineering to life sciences, thus leading to two dramatic impacts. First, universities lose some of their most important transnational researchers and, second, the growing importance of life sciences leads to a major change in the U.S. innovation system. Research and approval needs more time. One has to face a much higher entry barrier. More expensive and elaborate procedures in marketing and logistics must be fulfilled. This may have led to a kind of deceleration.

■ University chairs have more often become open to researchers from other disciplines, as well as researchers from the industrial sector. There is nothing wrong in having external labs on the campus to establish a dialogue between theory and practice.

■ The assessment of risks in Germany and the United States is very different. This difference is not mainly rooted in the personality of the founder, but in his or her opportunities to organize, share, or limit the risks. The conditions in the United States favor risky decisions and limit the personal risks so a prospective founder is more likely to realize his or her plan.

■ The risk bearing ability in the United States is much higher because business angels and venture capitalists are easier to acquire. This makes the realization of a project potentially more plausible. However, it should be noted that the availability of venture capital in the United States in the past decade has decreased considerably. The level, however, is still well above that found in European countries, including Germany.

■ A first conclusion that can be drawn here: Innovation is not just to be administrated but can be configured by setting positive framing conditions and connecting universities to their surrounding ecosystems. Following this path will enable them to become strong engines of the innovation system.

06

FROM THE IVORY TOWER TO THE ENTREPRENEURIAL UNIVERSITY

FROM THE IVORY TOWER TO THE ENTREPRENEURIAL UNIVERSITY

How Much Untapped Potential for Innovation is Still in Our Universities?

Heaton et al. discussed the following six types of tensions and conflicts. “Not all of these conflicts exist at all American research universities, but university presidents and other administrators often must deal with them and find some balance between competing objectives.”

- The long existing tension between teaching and research among managing professors.

- The conflicting goals of professors including: starting a company, engaging in external entrepreneurship, teaching, and academic research.

- The challenge of maintaining objectivity and credibility when a university helps an individual company via university research projects.

- Engaging in local economic development versus non-local activities in university technology transfer offices.

- How the desire for political support competes with the risk of over-promising what universities can contribute to the overall economic growth.

- A university’s decision to support economic and social development at a local level, versus applying its efforts at a global level.[65]

New Ideas and Faster Ways from the Laboratory to the Marketplace

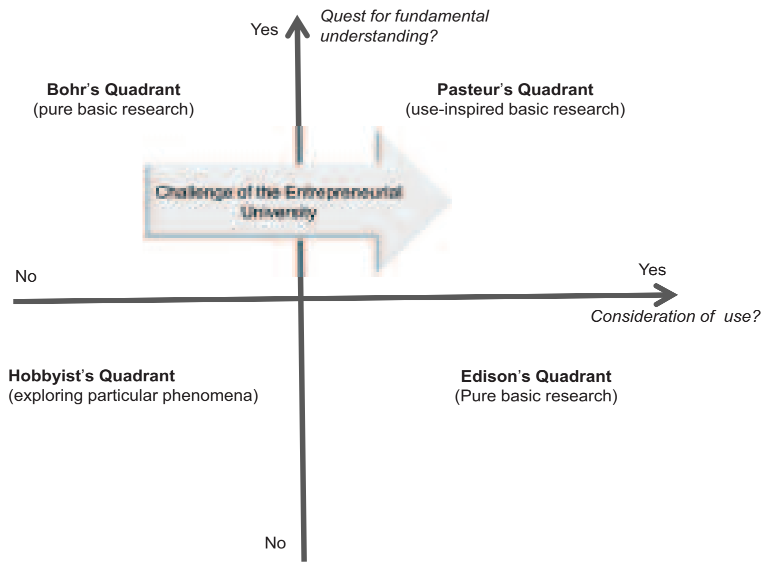
A remaining question is how the stagnating number of patents in spite of increased funding for R&D can be explained. Perhaps the potential for further growth is exhausted; thus, additional expenses fail to lead to more output. Another explanation may be that universities do excellent basic research but could put more emphasis on applied research. A simple graphic gives the opportunity to bridge the gap (between basic and applied research): From Bohr’s to Pasteur’s Quadrant (Figure 10).

As Stokes points out in his book about Pasteur’s Quadrant,[66] the postwar paradigm of scientific research has been transformed from the simple one-dimensional “basic” to “applied” spectrum to a modification of linear model. This was done by recognizing the time needed for the application of basic research depending on national objectives on research, which could be more tactical (it has to be immediately applicable) or strategic or, in a highly abstract way, pure research.

This modification of the linear model was replaced at the beginning of the 1990s when Nathan Rosenberg pointed out, “Everyone knows that the linear model of innovation is dead.”[67] Before this, the OECD countries worked more than twenty years on the task of how official reporting categories can be modified in a way that helps to clarify the relationship between “understanding” and “use” as goals of research. At the end the paradigm of research has been transformed from a one to a two dimension model, which Stokes identified as the Pasteur’s Quadrant.[68]

The author has learned through interviews with leading personnel in U.S. transfer agencies that university researchers and departments concentrate too much on research, which is located in the field of the so-called Bohr’s Quadrant. Stokes called it Bohr’s Quadrant in view of how clearly Niels Bohr’s

Figure 10: Bridging Stoke's Quadrants[69]



quest of a model atomic structure was a pure voyage of discovery, however much his ideas later remade the world. Universities also are conducting pure basic research.

If universities would aim for more use-inspired basic research like Pasteur did, they could become much stronger in making use of their knowledge. They could do this without losing their demanding standards, which would happen if they concentrated on pure applied research, as was called the "Edison Quadrant" by Stokes who stated, "in view of how strictly this brilliant inventor kept his co-workers at Menlo Park, the first industrial research laboratory in America, from pursuing the deeper scientific implications of what they were discovering in their headlong rush toward commercially profitable electric lighting."[70] The lower left hand quadrant is not empty. This quadrant includes research, which is inspired neither by considerations of use nor by the goal of fundamental understanding. It is research focused on exploring particular phenomena and can be therefore named the "Hobbyist's Quadrant."

Stokes discussed and developed this new two-dimensional model not only in a static, but also in a more dynamic version. He argued that "a clearer understanding of the links between the dual but semi-autonomous trajectories of basic scientific understanding and technological know-how" is needed. The interaction of pure basic research and purely applied R&D "includes the role that new research technologies at times play in the creation of operational technologies and the importance that the availability of commercialized measurement methods may have in supporting new fundamental science."[71] Stokes has showed this in the revised Dynamic Model (Figure 11).

How Universities Can Benefit from their Innovation Performance

Universities need to better understand the ecosystem they work in and communicate with it. Innovation and entrepreneurship is about people interacting with people. As Thorp & Goldstein wrote, "Innovation is almost always driven by somebody (typically an entrepreneur)." They continue, "Entrepreneurship is not a subject or a discipline, but a practice or a way of thinking that can increase the impact of innovation ... Innovation is not characterized solely by an 'a-ha moment', but rather a series of actions and decisions that translate a good idea into reality." Which means in their interpretation: "The revolutionary idea is important for innovation, but it is not sufficient."[73]

Furthermore, Peter Drucker once presented a remarkably simple but true catchphrase: "Entrepreneurs innovate."[74] Universities have to put their efforts on trying to generate excellent researchers, keep them tied to their university and region, as well as encourage them to be entrepreneurs. Stanford, for example, began designating areas next to the campus for alumni to found their start-ups in the middle of the twentieth century. Another aspect that should be mentioned is the establishment of technology transfer agencies between universities and the economy. These agencies were erected to become a link so as to make technology transfer faster and easier for both sides. Universities in the United States and Germany have had good and bad experiences with these agencies.

The bad experiences often result from wrong perspectives. Universities and researching professors often see the agencies as a contact point for their ideas and concepts. They deliver their ideas or let it be. Conversely, companies that would like to invest in seminal projects see the agencies as a kind of bulletin board, a place to be informed about recent academic research. If both sides interpret the agencies in this way they can easily become useless, because there is not enough exchange due to a lack of direct transfer of offers and demands.

To make the work of transfer agencies more efficient it is necessary to change the perspective and concept of these agencies. It is not sufficient to wait passively until universities and companies come to them. The transfer agencies must be active scouts for innovation. They must contact universities and professors directly, as well as ask for the demands of companies. Figure 12 is a simple visualization that displays this change of perspective.

Looking at the transfer agencies in the first case, one sees the agencies wait until they are delivered with ideas and demands. In the second case, the agencies actively seek ideas and demands, which is the more successful way—as many examples prove. The German Max Planck Society has established a Drug Delivery Center in Dortmund that even does clinical pre-testing of scientific ideas to raise the chances of getting a medical patent ready for marketing. Harvard Medical School acts in a very similar way. Boston University has even changed the whole team of its transfer agency to fit the needs of an actively seeking innovator.

Concerned about the slow pace at which new treatments are being developed by big pharmaceuticals, the National Institutes of Health (NIH) has opened a new drug development center. The move, which comes after months of planning and study, would collect more than $700 million in projects already underway at various NIH institutes. The decision reflects a growing concern that the pharmaceutical industry is finding it difficult to deliver on new break-

Figure 11: Dynamic Model of the Interaction of Science and Technology[72]

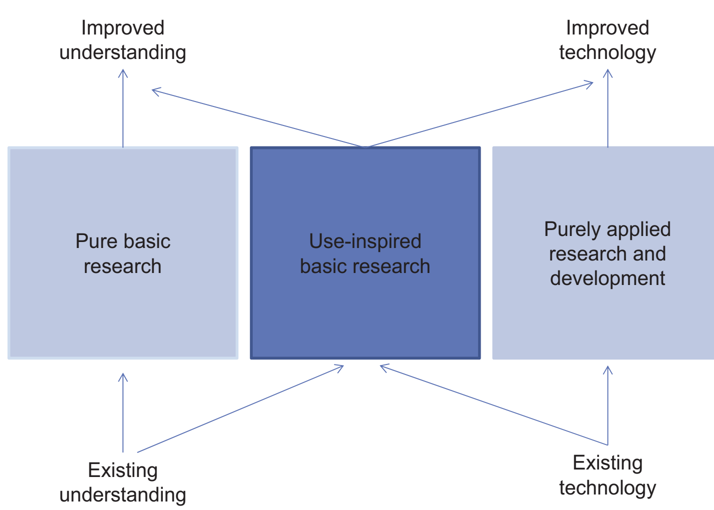
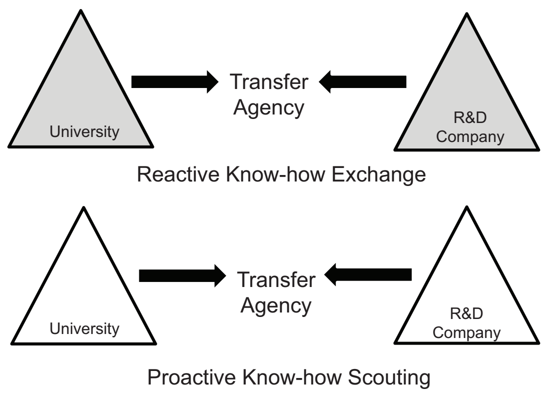


Figure 12: Changing Role of Transfer Agencies



throughs, while at the same time continuing to scale down research efforts in hopes of saving money. However, the Director of the NIH has recently offered a new innovation prize that could be a sign of rethinking the problem.

One of the great challenges universities face is making themselves transparent to potentially interested outside parties who would like to identify expertise within the institution. Large research universities typically have one thousand or more faculties with as many separate areas of expertise. To outsiders, such as technical staff members of companies, universities can be overwhelmingly complicated, confusing, and unresponsive. To overcome this problem, universities have adopted a number of strategies, some of which are discussed above. They are also attempting to create searchable databases of faculty expertise that are open to the public, generally through the internet. They are encouraging faculty to post their curriculum vitae, including full publication lists and research interests, on the public website so that they will appear in the results of internet searches. Most universities post their faculty and staff directories on the internet, including individual email addresses and telephone numbers. All this is done in part to help market the university and its faculty to the world.

In summary, we find that American universities are actively engaged in marketing themselves and their capabilities through a variety of mechanisms. While most university websites only appear in English, this is not a major barrier to their engagement to the world's scientific and technical community, of which English is typically a second language. Marketing activities of the sort reviewed here are not inexpensive. They require dedicated professional staff to design programs, collect information, update websites, organize activities, as well as to write, edit, and publish magazines and other materials. Nonetheless, in the United States today, marketing of this sort is routine for all research universities.

07 RESULTS

RESULTS

Science, research, education, and technology are crucial components of the transatlantic partnership. The future of the societies in both countries will depend on how they advance education, science, and technology. The United States and Germany both emphasize these subjects, and the two countries are striving to excel in these fields in an effort to increase their competitiveness and remain “nations of innovation.” It must be a bilateral commitment for the two countries to coordinate internationally and to set similar standards for the future so that colleges and universities can be more productive. Sharing know-how and resources through international cooperation is the key in this respect. The United States and the EU account for half of the world’s GDP and must stay ahead of the curve in setting international standards.

There is a growing need for cooperation between experts across a multitude of fields in order to provide effective solutions to the issues facing Germany and the United States, as well as the global community. Specifically, there must be a focus on bringing scientists, engineers, and academics into the conversation with business leaders and policymakers with regard to transforming new ideas into tangible products for society. In order to achieve this, countries like Germany and the United States must focus their efforts on better fostering an environment that welcomes such cooperation. This begins with a greater willingness on both sides of the Atlantic to create policies that push research and development to even greater levels. Otherwise, we will continue to see an unacceptable number of new ideas lost in the so-called “Valley of Death,” the place between concept creations and obtaining necessary venture capital for universities to continue to be pioneers and drivers of the information revolution. Yet, they themselves have to undergo fundamental changes due to the new technologies.

The same can be observed in international companies that have long organized their activities around global research, production, and distribution networks. The more universities apply these standards, the smoother the transition between the research companies and entrepreneurial universities will be. This creates new opportunities for synergies, which can increase cooperation in research. New institutional arrangements such as campus companies or new forms of technology transfer can be the solution.

In the face of such demand for cooperation and better development of research, it seems that universities are the ideal setting for the future of innovation. In no other company or institution, aside from universities, can one find the needed diversity to reach solutions to complex issues under one roof. Universities need to use their strength and potential as drivers of innovation and entrepreneurship.

The benefits to innovation produced by universities are immense in both countries. Universities turn out increasing numbers of well-educated students with a wide range of academic degrees that can be later utilized by future employers. Universities, with their vast diversity of knowledge, are also essential contributors to the breadth of ideas entering the innovative system each year. Finally, universities hold a strong entrepreneurial presence in the innovation markets of Germany and the United States through both the start-up of companies, as well as the cooperation with private business in research and development. However, despite these incredible numbers produced by our universities, much can still be done to improve their effectiveness.

One characteristic of universities that tends to obstruct their productivity is their inability to fully grasp the environments they work in. Often times, it seems, universities do not properly seek to understand the product needs of businesses and markets. Therefore, despite increased funding for research and development in universities, a proportionate rise in university patents was not seen in the last decade. Here, the technology transfer agencies designed to match universities with businesses looking to conduct research must be more proactive.

Universities in both Germany and the United States must also focus on bringing a stronger entrepreneurial aspect into their research. In doing so, universities will better understand the relationships they carry with businesses on idea incubation and, hopefully, lead to more efficient development.

Finally, universities must focus on keeping researchers involved in work tied to their communities. This will foster a long-term commitment, a necessary step to understanding where the needs for stronger research lie. For universities to realize their full potential and to impact innovation systems, they must look to widen their spectrum of study and begin to better understand the needs of a changing market and society.

Universities act as anchors of innovation, as well as serving the role of conveners and developers, both of campus and neighborhood infrastructure and of initiatives that support innovation, partnerships, and new research proposals. Therefore, by increasing their interconnectedness with governments, businesses, and other organizations that comprise regional economies and communities, the development of new ideas beyond the "Valley of Death" can be improved. Indeed, the financial success of a university is inseparable from that of its community and, thus, it is in the long term best interests of the university to contribute to the economic vitality of its region.

The transformation of ideas into tangible products relies heavily on the investment of venture capital firms. However, the level of investment in new ideas and potential start-ups today is a fraction of what it was roughly one decade ago. Therefore, universities must focus on boosting the transfer of students to companies and organizations, as well as a more general boost in research and development of start-ups and spin-offs. They must seek out a balanced combination of public funding and support from academia as well as private funding and support from industry.

The university sector is becoming increasingly competitive, which is forcing many universities to seek out new ways to innovate and stay ahead of the curve. They are being pushed to expand the spectrum of education and formulate multiple approaches to solving the important issues of today's world. Nevertheless, despite their ever-evolving approaches, universities are still losing out to businesses in many areas of research and innovation. Due to many of the internal structures in place in the universities that seem to hinder the capabilities of faculty members, many leave to do work in an industry setting.

To curb this exodus to the commercial world, universities must look to take more risks in terms of new ideas and innovation. They must cultivate a stronger entrepreneurial atmosphere within the university setting. They must also focus on new models for the partnerships they engage in for research and development by becoming more transparent in their capabilities. By doing so, companies will have a better understanding of which university best fits their needs and, therefore, be more willing to enter into a long-term relationship for innovative enterprises. These steps will go a long way in maintaining a competitive aspect for universities in the field of innovation.

APPENDIX

Summary of the Conference: "The New Role of Universities in the Twenty-first Century. Universities as Engines of Innovation and Entrepreneurial Hubs," held on 9 June 2011, Washington, DC

The conference began with keynote remarks by the Honorable Klaus Scharioth, Ambassador of the Federal Republic of Germany to the U.S. Ambassador Scharioth stressed that the conference was taking place at a good time, as Chancellor Angela Merkel had been on an official visit including a state dinner to Washington only two days earlier to meet with President Barack Obama. The visit underscored the importance of German-U.S. cooperation; both Merkel and Obama remarked that science, research, education, and technology are crucial components of the transatlantic partnership. The Ambassador pointed out that the future of our societies depends on how we advance education, science, and technology. The German government is therefore committed to increasing overall spending on research to 3 percent of GDP and spending on education to 7 percent of GDP, the Ambassador explained. He underlined that the U.S. and Germany both place emphasis on these subjects and the two countries are striving to excel in these fields in an effort to increase their competitiveness and remain "champions of innovation." Sharing know-how and resources through international cooperation is key in this respect. Universities need to use their strength and potential as drivers of innovation and entrepreneurship. In Germany, for example, universities must target their research to support the transition to the age of renewable energies, while it ceases its use of nuclear energy by 2022. The Ambassador highlighted that this conference offers an outstanding opportunity to exchange ideas and experiences and to learn from each other.

The Honorable Bart Gordon took the podium next, stating that Germany and the U.S. both have to become "nations of innovations." It must be a bilateral commitment for the two countries to coordinate internationally and to set similar standards for the future so that colleges and universities can be more productive. He also illustrated there is a need for research and development cooperation between the U.S. and Germany as well as throughout Europe. That the National Institute for Science and Technology needs more international outreach in order to align standards among major nations, namely within the European Union. The U.S. and the EU account for half of the world's GDP and must stay ahead of the curve in setting international standards.

After the morning keynote speakers, Prof. Dr. Andreas Pinkwart (Leipzig Graduate School of Management) presented the contributions made by universities to innovation in Germany and the U.S. In both countries, the benefits to innovation produced by universities are immense. Universities turn out increasing numbers of well-educated students with a wide range of academic degrees that can be later utilized by future employers. For instance, the U.S. and Germany respectively, award 42,000 and 25,000 doctorates annually. Universities are also essential contributors to the breadth of ideas entering the innovative system each year due to their vast diversity of knowledge. In 2009, 3,400 patents were filed by universities in the U.S. with an additional 700 patents filed by German universities. Finally, universities hold a strong entrepreneurial presence in the innovation markets of Germany and the U.S. through both the start-up of companies, as well as the cooperation with private business in research and development. In 2009 alone, U.S. universities launched 596 start-ups and 658 commercial products. However, despite these incredible numbers produced by our universities, much can still be done to improve their effectiveness.

One characteristic of universities that tends to obstruct their productivity is their inability to fully grasp the environments they work in. Often times, it seems, universities do not properly seek to understand the product needs of businesses and markets. Therefore, despite increased funding for research and development in universities, we do not see a proportionate rise in university patents. Therefore, the technology transfer agencies designed to match universities with businesses looking to conduct research must be more proactive. Universities can no longer afford to simply wait until a proposal falls into their hands. Universities in both Germany and the U.S. must also focus on bringing a stronger entrepreneurial aspect into their research. In doing so, universities will better understand the relationships they have with businesses regarding idea incubation. Hopefully, this will lead to more efficient development. Finally, universities must focus on keeping researchers involved in work tied to their communities. This will foster a long-term commitment, a necessary step to understanding where the needs for stronger research lie. For universities to realize their full potential and to impact innovation systems, they must look to widen their spectrum of study and begin to better understand the needs of a changing market and society.

Following Prof. Dr. Pinkwart's presentation was the first of three panel discussions looking into the role of universities for the future of innovation. Panel speakers Mr. Robert Cresanti (SAP America, Inc.), Mr. Burton B. Goldstein (University of North Carolina), and Mr. Peter Hoffman (Boeing) addressed the growing need for cooperation between experts across a multitude of fields in order to provide effective solutions to the issues facing Germany and the U.S., as well as the global community. Specifically, there must be a focus on bringing scientists, engineers, and academics into the conversation with business leaders and policymakers in regards to transforming new ideas into tangible products for society. In order to achieve this, countries like Germany and the U.S. must focus their efforts on better fostering an environment that welcomes such cooperation. This begins with a greater willingness on both sides of the Atlantic to create policies that push R&D to even greater levels. Otherwise, we will continue to see an unacceptable number of new ideas lost in the so-called "Valley of Death," the place between concept creation and obtaining necessary venture capital funding to go into production.

In the face of such demand for cooperation and better development of research, it seems that universities are the ideal setting for the future of innovation. In no other company or institution, aside from universities, can one find the needed diversity under one roof, which will allow the finding of solutions to complex issues. Furthermore, based on the fact that 70 of the 85 major institutions still around from the year 1550 are universities, it could be safely assumed that their impact will be long-term. The question is how do we increase this impact in the field of innovation?

Following the first panel was the luncheon keynote address given by Dr. Luis M. Proenza, President of the University of Akron. Drawing on the initiatives taken by the University of Akron, widely known as the "Akron Model," Dr. Proenza outlined the importance of linking our universities to our communities at a local, regional, and even global level. He further asserted we should be thinking of our universities in broad terms that allow them to serve as a robust platform for economic development. Universities act as anchors of innovation, as well as fulfill the role of conveners and developers. They do this both on campus and within a neighborhood infrastructure, with regards to initiatives that support innovation, partnerships, and new research proposals. Therefore, by increasing their interconnectedness with governments, businesses, and other organizations that comprise our regional economies and communities, we can improve the development of new ideas beyond this "Valley of Death." This interconnectedness involves a greater level of cooperation pertaining to the economic vitality of our society, as well as a vested interest by universities in the strategies of our communities. Indeed, the financial success of a university is inseparable from that of its community and thus, it is in the long-term best interests of the university to contribute to the economic vitality of its region. In this sense, according to Dr. Proenza, it is no longer solely the government's responsibility to strengthen our communities. Instead, businesses and universities must look to play an integral role. Universities, in particular, must utilize a more entrepreneurial approach than ever before by offering a place of incubation for new ideas and start ups. Through the organization of greater involvement of entrepreneurial talent at the university level, we can increase both the productivity and relevance of universities as they begin to function as broad based “tool chests” of economic development.

The second panel of the conference featured Dr. Bert Klebl (Lead Discovery Center), Prof. Dr. Thomas Martinetz (University of Lübeck), Mr. Michael Pratt (Boston University), and Mr. Daniel Zimmermann (Wilmer Hale LLP), who discussed ways to more effectively bring new ideas into the market. The transformation of ideas into tangible products relies heavily on the investment of venture capital firms. However, the level of investment in new ideas and potential start-ups today is a fraction of what it was roughly one decade ago. So, what course of action can be taken to fuel the development of new ideas?

One major aspect of the strategy proposed by the panelists involves encouraging universities to actively seek out new ideas for research initiatives. It must be the job of the university to target an idea and then play a major role in overseeing research and development. However, in doing so, universities must look to make a long-term commitment in the projects they undertake. By allowing these ideas the proper setting and timeframe with which to grow in, universities are helping to introduce more fully developed, less risky products to potential investors. Universities must also look to make the transfer of technology and knowledge an integral part of their mission. They must focus on boosting the transfer of students to companies and organizations, as well as a more general boost in the R&D of start ups and spin offs. We can no longer afford a system in which new ideas are chosen solely on their perceived potential for success. Instead, we must encourage our universities to take in all ideas and offer them some level of support if we wish to see the full potential of each idea being reached. To achieve all of this, universities must seek out a balanced combination of public funding and support from academia on the one hand, as well as private funding and support from industry on the other.

The third, and final, panel of the conference, included Dr. Carlo J. De Luca (Boston University), Prof. Dr. Ursula Gather (TU Dortmund University), and Dr. Volker Meyer-Guckel (Deutscher Stifterverband) and addressed the necessary steps universities must take to maintain relevance and competitiveness in innovation. The university sector is becoming increasingly competitive, which is forcing many universities to seek out new ways to innovate and stay ahead of the curve. They are being pushed to expand the spectrum of education and formulate multiple approaches to solving the important issues of today’s world. Nevertheless, despite their ever-evolving approaches, universities are still losing out to businesses in many areas of research and innovation. Due to many of the internal structures in place in the universities that seem to hinder the capabilities of faculty members, many leave to do work in an industry setting. For instance, in the U.S. alone, there are more Ph.D.s carrying out research for companies than for universities.

To curb this exodus to the commercial world, universities must look to take more risks in terms of new ideas and innovation. They must cultivate a stronger entrepreneurial atmosphere within the university setting. They must also focus on new models for the partnerships they engage in for research and development by becoming more transparent in their capabilities. By doing so, companies will have a better understanding of which university best fits their needs, and therefore be more willing to enter into a long term relationship for innovative enterprises. These steps will go a long way in maintaining a competitive aspect for universities in the field on innovation.

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