

Entrepreneurial University Metrics: State of the Art and Future Directions

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PART 1. Background and Conceptual Framework

1.1 Towards a definition of the Entrepreneurial University

Education, research and entrepreneurship are being synthesized into an academic model that is becoming as potent in its influence in the early 21st century as the late 19th century Humboldtian synthesis of research and education. The rise of the entrepreneurial university is part of the transition from an industrial society based on the production of things to a knowledge-based society based upon the creation of ideas (Drucker, 1985). The transition to an entrepreneurial university is a fundamental transformation of the university from departments of individual scholars to a collectivity of research groups and centres, with conjoint theoretical and practical objectives.

The university is a capacious institution, with the ability to periodically reinvent itself and incorporate multiple missions that enhance each other even as they persist in a creative tension. The 1st Academic Revolution in the 19th century transformed the university from an educational institution to one with dual missions of research and teaching (Jencks and Riesman, 1968). The seed for the second academic revolution was planted in the U.S. in the latter part of the 19th century with the passage of the Morrill Acts which created a system of land-grant universities which formalized an explicit mission service and outreach initially for agriculture development. Over the decades the ethos embodied in the land-grant university has spread across academic units and universities. This Second Academic Revolution is making economic and social development an academic mission, further broadening the university's research and teaching focus. As each new mission

becomes part of the university, it provides a new source of support for the previous mission and influences how it is carried out.

The stages of entrepreneurial academic development usually occur in the order of Education-> Research->Entrepreneurship, but they may also take place in any sequence or even virtually simultaneously as the university turns its intellectual resources towards creation of economic results from knowledge as well as knowledge for its own sake. Although they were identified as taking place sequentially in the development of the Massachusetts Institute of Technology (one of several private land-grant universities), non linear and even reverse sequences may be identified, for example, in the experience of the *Blekinge Institute of Technology* in Sweden which took off from phase three. Thus, the transition to the entrepreneurial university can also take off from a teaching as well as a research-oriented school.

Table 1. Expansion of University Missions

Teaching	Research	Entrepreneurial
Preservation and dissemination of knowledge	1 st Academic Revolution	2 nd Academic Revolution
New missions generate conflict of interest controversies→	Two Missions: teaching and Research	Third Mission: economic and social development; old missions continued

The Entrepreneurial University model may be expressed as four interrelated propositions:

Proposition 1: *Interaction*. The entrepreneurial university interacts closely with the industry and government; it is not an ivory tower university isolated from society.

Proposition 2: *Independence*. The entrepreneurial university is a relatively independent institution; it is not a dependent creature of another institutional sphere.

Proposition 3: *Hybridization*. The resolution of the tensions between the principles of

interaction and independence are an impetus to the creation of hybrid organizational formats to realize both objectives simultaneously.

Proposition. 4: *Reciprocity*. There is a continuing renovation of the internal structure of the university as its relation to industry and government changes and of industry and government as their relationship to the university is revised.

Propositions One and Two may also be institutional principles of a research and teaching university; it is the confluence of all four elements that make for a full-fledged entrepreneurial university.

1.2 Impetuses to academic entrepreneurship

The first step toward an academic entrepreneurial ethos is increased sensitivity to the practical potential of knowledge, whether scientific or humanistic, followed by a willingness to participate in the realization of this potential. Knowledge has multiple characteristics: it is theoretical and practical, publishable and patentable, at one and the same time. A polyvalent epistemological model lowers barriers between university and industry expressed in the formula, “let the university be the university; let industry be industry.”

When a university first gets involved in entrepreneurial activities it may be due to realization that an important discovery, made on campus, that might have been patented was not, “the big fish that got away” or at the request of a local firm, industry association or government requesting assistance in solving a production or governance problem. In a second stage, an organization is created to arrange relationships in a more systematic way, whether through an industrial liaison office to introduce firms to the university or a technology transfer office to seek an outlet for inventions made on campus.

Several models have been set forth in recent years to articulate the role of the university in economic and social development. An entrepreneurial university model, holds for academic transformation to an entrepreneurial mode in which the university directly

engages in economic activities (Etzkowitz, 1983). This model has also been called “innovation U.” in other analyses (Tornatzky, Waugaman, Gray, 2002; Tornatzky & Rideout, 2014). A civic university model, also promotes enhanced university engagement in society, but is largely limited to an extension of existing teaching and research roles, keeping traditional boundaries intact (Goddard, 2009). An entrepreneurial university in a non-economic format, views the transition of the government-sponsored university to a more independent status (Clark, 1998).

1.3 Stages and phases of academic entrepreneurship

These different conceptions of the university within the larger socio-economic system may also be viewed as stages and phases in the development of the university as an entrepreneur, with each modality building upon the other, in a usual but by no means necessary order. The stages and paths to development can vary significantly based on differences in national or even regional innovation system in question. Even very industrialized countries, their institutions of higher education can be in very different phases of development toward an entrepreneurial university. For instance, in large part due to the creation of land grant universities and their spin-offs and the very decentralized structure of higher education, some U.S. universities have been operating as entrepreneurial universities for many decades (Gray, 20xx). However, as the case studies presented in *Innovation U. and Innovation U. 2.0* demonstrate, this does not mean that such universities can rest on their laurels.

In countries where the precedent for the entrepreneurial university are not well established the development of such universities can be much more fluid. In an initial phase (*University Entrepreneur One*) the academic institution takes a strategic view of its direction and gains some ability to set its own priorities, either by raising its own resources through donations, tuition fees and grant income or through negotiations with resource providers. European universities, that formerly received almost their entire income by government subvention, are undergoing the painful process of diversification,

forming alumni associations to connect with their graduates and establishing fund raising offices, long a staple of US academia.

A prerequisite for the university taking the role of entrepreneur is the ability to set its own strategic direction. The ability to take independent initiatives is based on the premise that the university is not a subordinate element of a hierarchical administrative structure such as a Ministry of Higher Education. If a university system operates as it formerly did in Sweden where the Ministry of Higher Education decided how many students would be admitted each year to each discipline, there is hardly a possibility to have sufficient autonomy on which to base an entrepreneurial university. Universities in France did not have an independent existence until the 1970's devolution that occurred as a side effect of reforms made in response to the student protest movements of the 1960's. Until quite recently, the various faculties were directly linked to the National Ministry and universities hardly had an organizational framework, let alone autonomy (Musselin, 2001).

A facilitative legal framework is a necessary but not sufficient condition of creating an entrepreneurial university. France changed its laws in 1999, legalizing academic entrepreneurship. Previously it was illegal for a faculty member to participate in spinning off an enterprise from their research. Indeed, the Innovation law went much further and provided significant resources to encourage technology transfer and firm formation. However, a study of a new university, established in a declining industrial region found that these incentives were insufficient to create an entrepreneurial university in an inhospitable setting (Laperche, 2002). Not every research university, even those setting their strategic direction is an entrepreneurial university; some remain ivory tower institutions.

The ability to set a strategic direction is only the first step toward an entrepreneurial university, the necessary but not the sufficient condition. The second step is a commitment to seeing that the knowledge developed within the university is put to use, especially in its local region. This can take a variety of forms, including developing

internal capabilities for technology transfer and commercialization of research to playing a collaborative role in establishing a strategy for knowledge-based regional economic development and participation in initiatives to implement that strategy. The entrepreneurial university presumes a considerable degree of independence from government, industry and ecclesiastical sponsors, on the one hand, while maintaining a high degree of involvement with other societal actors from this independent standpoint. An orientation to seeking out the practical as well as theoretical implications of research and organizational mechanisms to assist technology transfer and firm formation fills out the picture. Next, training programs to introduce students to entrepreneurship are required when it is not already a part of the academic culture. Finally, the introduction of organizational formats such as centers to encourage the generation of research with theoretical and practical relevance completes a virtuous circle. As suggested above, the sequence in which these elements appear may differ from country to country and from institution to institution.

1.4 Commercialization of research

In a second phase (*University Entrepreneur Two*) the academic institution takes an active role in commercializing the intellectual property arising from the activities of its faculty, staff and students. In this phase, a university typically establishes its own technology transfer capabilities, in-sourcing them from firms to which they may have been contracted, such as the Research Corporation in the US, or through devolution of system-wide offices as in the State University of New York and the University of California to individual campuses. Universities with significant intellectual property potential, like Stanford, received an immediate boost in income from having their own staff in more direct contact with the faculty. Similarly, research powerhouses, like Oxford, Cambridge and Imperial, in the UK, very quickly, became leaders in technology transfer and firm-formation once they turned their minds to it. Universities with fewer research resources to commercialize, not surprisingly, take a longer time to ramp up. However, some schools with modest resources, like Arizona State and the University of Utah, that have made tech

transfer and firm formation an equal priority with education and research, have achieved higher rates of valorization than many of their resource rich competitors.

1.5 The university's role in regional renewal

In a third phase (University Entrepreneur Three), the academic institution takes a proactive role in improving the efficacy of its regional innovation environment, often in collaboration with industry and government actors. In this stage, a university wishes to build upon these relationships, raise its profile, and play a strategic role in encouraging innovation in its region. Leadership can be very critical in success at this stage. This typically occurs through local actors from academia, industry and government, coming together, at the invitation of a respected person with convening power, to formulate and implement a strategy to promote regional development via a “High-tech Council” or “Knowledge Circle,” often supported by governmental initiatives. Political leaders, industrialists, university administrators, and citizens increasingly view universities as focal points of economic development for regional economies, with economic legitimating themes becoming as important as cultural ones. (Peters, 1989). A great deal of the recent success of U.S. entrepreneurial universities has been attributable to attempts by state, regional and local governments to provide funding and programmatic structures for universities to get involved in technology-based economic development efforts (Plosila, 20xx).

The scientific and technological innovation produced by universities is widely recognized as a contributor to both regional and national economic growth. Stated another way, universities play a role in national and regional “innovation systems,” and a significant body of literature investigates this role. Researchers studying this subject have used a variety of methods to measure the economic impact that universities have on regions (Drucker and Goldstein). Universities play a role in “regional innovation systems” through a variety of mechanisms that go beyond the transfer of intellectual property from academia to industry (Mowery & Sampat, 2016). Such mechanisms may include, straightforwardly, the spin-off of new firms, or more indirectly, the cultivation of cultural norms that help foster innovation (Genasekara), perhaps through the participation of

university employees in local and regional governance as they serve on boards and councils (Chatterton and Goddard, p. 481).

Significantly, the Triple Helix model conceptualizes the interactions between these regional entities (universities, local industry, and governments) not as a linear flow (where knowledge production is handed off from universities to industry for economic development) but as recursive networks of interaction, where individuals may take on roles in each sector, and the roles of each sector overlap (Genasekara, p. 141). While the transfer of intellectual property in the form of patent licenses represents the most well known mode of engagement, patents usually account for only a small fraction of the total revenue universities receive from entrepreneurial activity, and also represent only a fraction of overall knowledge flow and even technology transfer (Mowery et al., p. 5; Perkmann et al., p. 424). However, academic involvement in regional development has taken a broader entrepreneurial focus beyond legal transfer of intellectual property rights to firms.

1.6 Concluding remarks

A series of organizational innovations in teaching and research encouraged the development of academic entrepreneurship. The key elements include (1) the organization of group research, (2) the creation of a research base with commercial potential, (3) the development of organizational mechanisms to move research out of the university as protected intellectual property, (4) the capacity to organize firms within the university and (5) integration of academic and business elements into new formats such as university-industry research centres. The first two elements are within the framework of the Research University; the third is part of the transition from the research to entrepreneurial academic models; fourth and fifth elements are special features of the Entrepreneurial University. Since there can be numerous institutional, cultural and other obstacles to addressing all of these issues in a particular national system, leadership also becomes a core issue to address.

An entrepreneurial science model, combining basic research and teaching with technological innovation, is displacing the “ivory tower” of knowledge for its own sake. U.S. land grant universities, MIT and Stanford took up entrepreneurship early on as part of their institutional DNA setting in motion an entrepreneurial academic dynamic that led other universities to replicate the process. Indeed the OECD has created a scoring mechanism, allowing schools to evaluate how far they have proceeded in the transition to an entrepreneurial university model. Once peculiar to a few schools, the entrepreneurial academic paradigm has spread to virtually everywhere where universities are found or may be founded for this purpose (Wong, 2007; Caspar, 2007).

PART 2: Measurement, Metrics and Performance Indicators

2.1 An economic perspective

In our globalized and competitive world, knowledge and innovation are increasingly seen as the key to industrial competitiveness, economic growth and wealth creation. Moreover, public bodies and funding agencies in advanced societies are challenging the traditional university model to contribute more to the generation of knowledge for the good of society. Facing demands for new professions and qualifications, an increasing number and variety of students, and the growing complexity and speed of knowledge, universities are also expected to contribute to commercialization and innovations for economic growth and new jobs. If 21st century universities are to remain in preminent leadership positions they need better structures for engaged scholarship and research, more efficient technology transfer mechanism, robust and sustainable partnerships with industry, and an institutionally embedded culture of entrepreneurship.

Universities of Technology and Entrepreneurial Universities are at the forefront of linking knowledge production and knowledge transfer to entrepreneurship and commercial activities. But what exactly is the contribution of their research and development investments, science-based teaching and training programs, entrepreneurship course,

research intensity and innovation activities to technological change and its impact on economic productivity? We can examine these questions and explain those links, by closely examining the their inputs, processes, outputs and impacts that constitute this value chain. The direct return this can bring in terms of greater prestige, income or productivity in that university or university system (private rate of return). However the benefits can also ‘spill-over’ across organizations, socioeconomic sectors, regions and countries, impacting positively on economic growth and contributing to societal welfare. This is particularly so for knowledge and skills generated from research, which is usually a public good, and therefor open to all (it is less so for scientific discoveries and new technologies that are protected by patents). There is a lot of evidence demonstrating that this ‘social rate of return’ from these investments is substantially higher than the private rate of return. Public knowledge can be reused extensively and, subject to the ‘absorptive capacity’ of potential users and adopters, applied in new environments and situations. A single research output could have a wide range of significant impacts and therefore create significant economic ‘spill overs’ (potential).

The challenge now is to move beyond case studies to assess the contributions of entrepreneurial universities to economic growth in a larger-scale, systemic manner that allows fair and valid comparisons across universities, regions and countries. For that we need measurement models and frameworks. What are the key information gaps in our understanding, and which of those are amenable to measurement? What is the best evidence we can draw upon right now?

2.2 Measures and metrics: the need for more and better

Despite general agreement on connections between scientific research and economic growth, in practice this is difficult to demonstrate let alone to measure unambiguously. Studies have used correlations between macro-econometric inputs and outputs at the economy level to model and measure the effect of particular variables (such as investment in research and development). An extensive series of econometric case studies have been used to study the link between particular inputs and outcomes.

Focusing specifically on entrepreneurial universities, some empirical work has been done during the last decade across individual universities and countries (e.g. Tijssen, 2006), but there is certainly no consensus yet on “best measures” or “key performance indicators” to capture relevant features in a reliable and comparative fashion. Let alone on how to apply metrics to develop a convincing classification of entrepreneurial universities worldwide for institutional benchmarking. The currently available World University Ranking systems, each covering between 500 and 1 000 universities, do not specify the type of university.

What is clear that there are many “pathways to entrepreneurial impacts”. Institutional metrics and indicators are needed due to the long lag time between research and impact, which could take a decade or more. Impacts are often highly skewed, where only a small proportion of activities and projects will translate into measurable impacts over the long term. We will have to identify “modes of interaction” between the university and its external environment. There are many challenges: what to measure, how to measure, and when to measure?

Some data is collected in-house by universities but remains confidential; some information can be extracted from the international surveys of university technology transfer offices (AUTM in the USA; ASTP in Europe) or from bibliometric data from research publications and patents. The USA has two research programs on related issues: STAR METRICS and UMETRIC. These sources suggest the following non-exhaustive list of possibly relevant metrics:

- income from private sources;
- industry-sponsored research as a percentage of research expenditures;
- students enrolled in entrepreneurship courses;
- university staff with dual appointments in the private sector;
- joint research publications with industry partners;
- citations from patents to research publications;
- downloads of research publications by business enterprises and private sector;
- number of staff employed by TTOs;
- number of invention disclosures;
- number of patents;

- share of patents co-owned with industry;
- license income from patents;
- number of spin-off companies.

Several other measurement options exist, often customized derivatives or modifications of the above. For reasons of cross-institutional comparisons (notably to correct for institution size differences) various ways exist to ‘normalize’ these quantities, usually in terms of expenditure or income, research workforce numbers, or research publication output numbers.

Although the above list may suggest otherwise, on the whole we face a soaring lack of high-quality comparative empirical information on links between universities and industry and, more in general, on the ‘broader impact’ of universities. Major information gaps among the present metrics are: (local/regional) employment of graduated students in the private sector; student internships at business enterprises, and number of industry (co-)funded PhDs.

2.3 Extracting metrics out of case studies

Complementary information will have to be data-mined in of existing secondary sources (e.g. on industry-sponsored research) or collected from scratch through from dedicated surveys that still need to be developed.

To create and test these data gathering tools, we need to learn from a variety of ‘Entrepreneurial university’ cases, in varying contexts, using different levels of analysis. Starting from a general description of the entity, such as “an Entrepreneurial University is an organization that adopts an entrepreneurial management style, with members (faculty, students, and staff members) who act entrepreneurially, and that interacts with its outside environment in an entrepreneurial manner”, we could divide our attention between ‘Research and Science’; ‘Teaching and Training’; ‘Services and Societal engagement’ (third mission); ‘Governance’. Our analysis of institutional determinants could focus on ‘Culture’; Strategic Orientation’; ‘Management’; ‘Support mechanisms’.

Research questions that could help guide us in this learning process are:

- What distinguishes a ‘traditional university’ from an ‘entrepreneurial university’?
- What is the role of Entrepreneurial Universities as drivers and/or contributors to entrepreneurial contexts of development? Which of their activities are directly linked to regional/national development?
- Which parts of the Entrepreneurial University are technology transfer drivers (patents, spin-offs and start-ups) and which are entrepreneurship drivers (providing leadership for creating entrepreneurial thinking, actions, institutions, and commercialization capital)?
- What is the role of research orientation, university-industry collaboration, knowledge diffusion and incentive systems in research structures in order to raise entrepreneurial awareness within the university?
- What are the environmental factors (i.e., formal: policies, incentives & informal: attitudes, culture) and internal factors (i.e., resources and capabilities), that affects the development of Entrepreneurial Universities?
- How are Entrepreneurial Universities adapting to meet the demands of the emerging knowledge and entrepreneurial society?
- What is the role of financing, strategy, leadership, and culture in governance structures in order to develop an entrepreneurial culture in the university?
- What is the most effective mix of Entrepreneurship and Innovation in an Entrepreneurial University to meet local societal needs and for positive regional impact?
- What is the relationship between research and teaching at Entrepreneurial Universities?
- How can the effectiveness of support mechanisms employed by Entrepreneurial Universities in regional development (technology transfer, science parks, business incubators, etc.) be measured?

Reference list

[to be done]