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Universities and industrially relevant science: Towards measurement models and indicators of entrepreneurial orientation

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Abstract

Which university departments engaged in industrially relevant science are likely candidates to become entrepreneurial? At present, there are neither measurement models nor leading indicators that can answer such questions at an international comparative level. This paper introduces concepts, theory, and a measurement model for identifying (the early stages of) a university's enterpreneurial orientation within a quantitative analytical framework. This approach focuses specifically on university–industry interactions, in which the connectivity between academic science and industrial research is captured and measured empirically in terms of (1) public–private co-authored research articles, and (2) references ('citations') within corporate research articles to university research articles.

The paper examines a range of country-level and institutional determinants of industrially relevant science, across 18 research areas of significant industrial interest, and at two different levels of analysis: research systems of OECD countries, and large sets of research universities within those countries. The results of these large-scale analyses, along with those of a case study dealing with European universities active in the field of immunology research, suggest that many structural factors determine university–industry interactions and (the potential for) entrepreneurial orientation. The two connectivity indicators appear to be of minor significance compared to a university's country of location and the magnitude of its research activities in industrially relevant fields of science.

Keywords: University entrepreneurial orientation; Stage model; Knowledge spillovers; University–industry linkages; Research performance indicators

1. Introduction

This paper introduces a novel conceptual and analytical framework to conduct comprehensive and in-depth analyses of university's 'industrially relevant research' (IRR) in relation to the science-based entrepreneurial orientation (SEO) of university units. The scope of this paper is restricted to research-related activities, outcomes and impacts (thus excluding teaching, training, and consultancy activities with a commercial value). The earliest stages of SEO can be examined by looking at structural characteristics and abstract functions related to academic research activities, which are operationalised in terms of their research output, and their linkages and interactions with private-sector users of their research-based knowledge. The approach taken in this study focuses specifically on quantifiable information related to the production of codified research-based knowledge and its dissemination to science-dependent industrial R&D.[1]

[1] There are many kinds of knowledge-intensive spillovers (e.g. intentional transfers as well as unintended spillovers), each of which may flow through various dissemination and communication channels, and may take different routes to transform and materialise into shapes and

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The phenomenon of entrepreneurial universities has now become widespread within the advanced industrialised countries as well as developing countries, and has attracted increasing policy attention. So far, most of the policy debate and empirical analysis focused on economic outputs and impacts of entrepreneurial universities (such as patents, licenses and start-up firms), or their technology transfer mechanisms and facilities. The pervasive diffusion of this entrepreneurial orientation justifies larger-scale and more in-depth empirical studies focusing on enterpreneurial potential. The analytical framework introduced in this paper enables a systematic investigation of early 'upstream' knowledge-generating stages of entrepreneurial science and university/industry interactions, both within and across and fields of science, as well as across countries.

The remainder of paper is organised as follows: Section 2 presents a brief review of theoretical concepts, empirical studies and policy issues related to entrepreneurial science that may guide the development of an indicator-based comparative framework. Section 3 introduces the two key indicators of IRR, and describes the methodology and data sets that are applied in the statistical analyses. Section 4 presents the results of the analyses dealing with the aggregate levels of countries and research fields. In addition, the statistical relationships between IRR indicators and university-owned patents are investigated for a sample of European universities active within the field of immunology research. Finally, Section 5 summarises the main findings, observations and interpretations leading to tentative conclusions as to the limitations and relevance of this new approach.

2. Theoretical and empirical background

2.1. University–industry interactions and entrepreneurial orientation

Clark (1998, 2004) introduces, from a higher education system perspective, five necessary conditions for the creation of an 'entrepreneurial university'. Three of these are particularly relevant in the case of research-oriented entrepreneurial universities[2] in the advanced industrialised countries: 'expanded developmental periphery', 'stimulated academic heartland', and 'integrated entrepreneurial culture'. Entrepreneurial research universities are viewed as those that embrace the spirit of enterprise and innovation, promote an entrepreneurial culture, reach across the traditional academic-industry boundaries to form mutually beneficial relationships, and create a variety of functions to accommodate the transfer of knowledge and technologies across these boundaries, while integrating new managerial and market-related practices.[3] Many of these research universities with science and technology departments are now in this process of transition, in which an increasing number of units 'at the developmental periphery' take the form of interdisciplinary or transdisciplinary research centres focusing on societal problems and pursuing enterpreneurial science to meets the needs of business sectors. They have the stock of knowledge and expertise, the knowledge-generating capabilities, and the research facilities to engage in science-based enterpreneurial activities. As a result, many find themselves in an advantageous position to participate in the growth of the science-dependent industries and are tempted to cash in on their contributions.

Parallel to the internal push towards application-oriented university science, many research-oriented universities nowadays also experience an external pull forcing them to engage (more) actively in programmes of external financing, to conduct contract research that is outsourced by the corporate sector, and to participate in collaborative public–private research partnerships.[4]

added values that are deemed useful for intermediate users or end users of those inputs. These informational properties of science constitute a powerful analytical tool for studying the spillovers impacts and payoffs of publicly funded basic science (Dasgupta and David, 1994). This applies especially to codified research-based information.

[2] The term 'research-oriented university' (or 'research university') is used in a broad sense, i.e. including 'research active' universities with relatively low quantities of research papers in international peer-reviewed journals, as well as 'research intensive' universities that produce many research papers. University research activities may span the entire spectrum from curiosity-driven academic 'discovery' research to problem-driven to highly focused 'applied' research for specific (end) users, as well as intermediate forms of research such as generic, mission-oriented 'strategic' research or 'engineering research' dealing with general purpose technologies.

[3] A university's industrially relevant research activities and its entrepreneurial orientation are likely to depend very significantly on a range of cultural determinants. More specifically, these include the 'managerial culture' at research universities (e.g. incentive systems), and the 'governance culture' of the research and higher education sector at the regional or national level (e.g. legislative and regulatory frameworks, business-promoting measures), as well as the overarching socio-economic culture of a country (e.g. risk-aversion attitudes in welfare states).

[4] Such measures gave a significant boost to the adoption or further professionalisation of IPR-related procedures and policies, while contract research conducted at universities is increasingly viewed as an inherent part of the routine activities of today's universities (Etzkowitz, 1998; Branscomb et al., 1999; Van Looy et al., 2003).