

## ENTREPRENEURIAL UNIVERSITY SCALE (ENTRE-U) VALIDATION AT CHINESE UNIVERSITIES

DOI: 10.5937/EMC26041T

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### ABSTRACT

The rapid rise of Chinese universities in global research rankings has raised important questions regarding the entrepreneurial orientation (EO) of engineering and research-intensive academic institutions in China. This study examines the EO of Chinese universities using the Entre-U scale and investigates its relationship with innovation performance. Data were collected from department heads and academic administrators across engineering, computer science, natural sciences, and related disciplines at Chinese universities. The findings confirm that the Entre-U scale is a reliable instrument for measuring entrepreneurial orientation within the Chinese higher education context. However, the results indicate that EO does not have a strong direct relationship with university performance when measured by patents and faculty-led startup activity. Among the four EO dimensions, only Industry Collaboration demonstrated a modest positive association with performance outcomes. The study suggests that traditional commercialization metrics may not fully capture the broader contributions of Chinese engineering departments to technological innovation and economic development. The findings highlight the need for more comprehensive measures of entrepreneurial university performance within engineering and technology-focused institutions.

**Key Words:** Entrepreneurial Orientation, Entre-U Scale, Engineering Departments, Chinese Entrepreneurial Universities, University Innovation

### INTRODUCTION

The Centre for Science and Technology Studies (CWTS) at Leiden University published the Leiden Ranking Open Edition 2025, which evaluates universities worldwide based on their scientific publications and review output between 2020 and 2023. In the 2025 rankings, Chinese universities occupied the leading positions, surpassing many historically dominant American research institutions. Zhejiang University ranked first with 37,457 points, followed by Shanghai Jiao Tong University with 35,373 points, while Harvard University fell to third place. These rankings, which assessed the scientific performance of more than 1,500 universities globally, highlight China's growing influence in research productivity, engineering innovation, and technological development.

The prominence of Chinese universities in the CWTS rankings reflects decades of strategic national investment in higher education, advanced engineering research, industrial modernization, and innovation ecosystems. Engineering faculties and technology-oriented departments have played a particularly critical role in this transformation by contributing to scientific breakthroughs, patents, technology transfer, and startup development. Consequently, the rise of Chinese universities represents not only an academic achievement but also a broader shift in global technological leadership and industrial competitiveness.

The latest CWTS rankings have generated significant international attention and raised important questions regarding the entrepreneurial orientation of Chinese universities, particularly within engineering and applied science disciplines. Specifically, to what extent do engineering departments

within Chinese universities demonstrate entrepreneurial characteristics that support high-impact research and innovation? Furthermore, how effectively do research activities within these departments contribute to technological commercialization, intellectual property generation, and startup creation that support China's economic development and industrial competitiveness?

The remainder of this article is organized as follows. First, a review of the literature on Entrepreneurial Orientation (EO) and the development of the Entre-U scale is presented, with particular attention to its relevance for engineering and technology-focused academic units. This is followed by the research methodology and empirical results. The final section discusses the implications of the findings, identifies limitations of the study, and proposes future research directions for understanding entrepreneurial orientation within engineering-intensive higher education institutions.

## **LITERATURE REVIEW FOR ENTREPRENEURIAL ORIENTATION AND ENTRE-U SCALE**

### **Entrepreneurial Orientation**

Entrepreneurial Orientation (EO) is a foundational construct within entrepreneurship and strategic management research that explains how organizations adopt entrepreneurial behaviors to enhance innovation capability, technological competitiveness, and organizational performance (Miller, 1983). Miller (1983) characterized entrepreneurial organizations as those that engage in product-market innovation, undertake risk-oriented initiatives, and proactively introduce innovations ahead of competitors.

Building upon this foundational framework, Covin and Slevin (1989) conceptualized EO as a strategic posture characterized by innovativeness, risk-taking, and proactiveness, and subsequently developed one of the most influential measurement scales for empirical EO research. These three dimensions became central to early EO scholarship. Later, Lumpkin and Dess (1996) expanded the construct into a five-dimensional framework by incorporating competitive aggressiveness and autonomy. This multidimensional interpretation has become widely accepted because it enables researchers to evaluate EO either as an integrated construct or through its individual dimensions depending on the organizational context.

A substantial body of empirical research has demonstrated a positive relationship between EO and organizational performance. Firms exhibiting stronger entrepreneurial orientation frequently achieve superior growth, enhanced innovation output, and sustained competitive advantage (Rauch, Wiklund, Lumpkin, & Frese, 2009; Wiklund & Shepherd, 2005). More recent research has extended EO into contexts such as digital entrepreneurship, corporate entrepreneurship, and technology-intensive industries. Scholars argue that EO strengthens an organization's capacity to identify emerging technological opportunities, respond to dynamic market conditions, and maintain strategic flexibility in rapidly evolving innovation environments (Covin & Wales, 2019).

Within engineering and technology-oriented academic environments, EO is particularly relevant because engineering departments serve as primary generators of applied research, patents, technological innovation, and university-industry collaboration. Engineering faculties often operate at the intersection of scientific discovery and industrial application, making them critical contributors to technology transfer and entrepreneurial ecosystems within universities. Consequently, examining EO within engineering departments provides valuable insight into how universities transform scientific knowledge into economic and technological value.

### **Entre-U Scale**

The transformation of traditional universities into entrepreneurial institutions has received extensive attention in the literature on innovation systems and higher education. Early theoretical frameworks emphasized the interaction among universities, industry, and government as a catalyst for innovation

and economic development (Etzkowitz & Leydesdorff, 2000). Within this framework, entrepreneurial universities were conceptualized as institutions that strategically adapt their organizational structures, funding models, and institutional cultures to promote innovation, commercialization, and entrepreneurial activities (Clark, 1989).

Although these foundational studies established important theoretical perspectives, they did not provide standardized quantitative instruments for assessing the entrepreneurial orientation of universities. To address this limitation, Todorovic et al. (2011) developed the Entre-U scale, which has since become one of the most widely utilized instruments for measuring entrepreneurial orientation in higher education institutions.

The Entre-U scale evaluates four principal dimensions of university entrepreneurial orientation: Research Mobilization, Unconventionality, Industry Collaboration, and University Policies. These dimensions are especially relevant to engineering and applied science departments, where research commercialization, interdisciplinary collaboration, and industry partnerships frequently drive innovation outcomes. Engineering faculties, in particular, depend heavily on effective industry engagement and supportive institutional policies to facilitate technology transfer, patent generation, and startup creation.

Subsequent studies have applied the Entre-U scale across diverse cultural and institutional settings to examine the relationship between university entrepreneurial orientation and performance outcomes. Building on this body of research, the present study applies the Entre-U scale within the Chinese higher education context to investigate the entrepreneurial orientation of engineering-focused university departments and its relationship with innovation performance.

## **METHODOLOGY**

### **Measures**

This study adopted the Entre-U scale developed by Todorovic et al. (2011) to assess the entrepreneurial orientation (EO) of Chinese universities, with particular emphasis on engineering as well as other technology-oriented departments. The Entre-U scale consists of 23 items measuring four dimensions of university EO: Research Mobilization (6 items), Unconventionality (8 items), Industry Collaboration (5 items), and University Policies (4 items). All items were measured using a seven-point Likert scale ranging from 1 (“Strongly Disagree”) to 7 (“Strongly Agree”).

Given that the study was conducted within the Chinese higher education context, the original English-language instrument was translated into Chinese by a bilingual Chinese graduate student proficient in both English and Chinese academic terminology. To ensure linguistic equivalence and conceptual accuracy, the Chinese version was subsequently back-translated into English following the procedures recommended by Brislin (1970). The back-translation process was completed by a bilingual professor based in the United States.

To improve the reliability and contextual appropriateness of the survey instrument, the Chinese questionnaire was pre-tested with a small group of faculty members and prospective respondents from engineering and science-related departments. Feedback regarding wording clarity, contextual relevance, and interpretability was incorporated into the final version of the survey instrument.

University performance was assessed through self-reported measures provided by departmental respondents. Performance indicators focused specifically on entrepreneurial and innovation-related outcomes generated within academic departments during the preceding three years. In particular, the survey measured the number of patents, intellectual property outputs, and faculty-led spin-offs or startup ventures originating from the department. These indicators were selected because they are especially relevant to engineering and technology-oriented disciplines, where applied research,

commercialization activities, and industry-driven innovation represent critical measures of institutional impact.

### **Sampling and Data Collection Method**

Data collection for the study was conducted through an online survey administered to academic leaders across Chinese universities. Survey invitations containing the questionnaire link were distributed electronically to targeted respondents. The sampling frame primarily consisted of department heads and senior academic administrators from engineering, natural sciences, biochemistry, computer science, health sciences, aeronautical and astronautical sciences, and agricultural sciences. Particular emphasis was placed on engineering and technology-intensive departments because of their central role in research commercialization, innovation development, and university-industry collaboration within China's higher education system.

A total of 130 universities were selected based on the 2014 university rankings published by the Chinese University Alumni Association. The sample included the top 100 universities as well as an additional 30 universities selected from the lower range of the top 600 institutions in China. This sampling strategy enabled the study to capture variation in institutional prestige, research capacity, and entrepreneurial orientation across different tiers of Chinese universities.

The target population consisted of 4,578 academic administrators and department leaders. Engineering departments represented the largest proportion of the sample, reflecting their dominant role in Chinese research and innovation activities. Specifically, the sampling frame included 1,919 individuals from engineering disciplines, 715 from natural sciences, 724 from biochemistry, 404 from computer science, 662 from health sciences, 78 from aeronautical and astronautical sciences, and 76 from agricultural sciences.

Among the identified respondents, 1,013 individuals could not be reached because of invalid or inaccessible email and telephone contact information. During the data collection period, two reminder emails were distributed to improve participation rates. The first reminder was sent one week after the initial invitation, while the second reminder was distributed three weeks following the initial contact.

A total of 593 responses were received, yielding a response rate of 16.63%. Following data screening procedures, 253 responses were excluded because they contained substantial missing data, defined as more than 20% missing values across study variables. Subsequent outlier analysis resulted in the removal of an additional five observations, leaving a final sample of 335 valid responses for statistical analysis.

The demographic profile of respondents indicates substantial administrative and academic experience among participants. Of the final sample, 83.8% of respondents were male and 16.2% were female. Only one respondent was younger than 30 years of age, while 48.1% were 46 years or older. In addition, 81.2% of respondents had served as department chairs or academic administrators for three years or longer, suggesting a high degree of familiarity with departmental research activities, innovation initiatives, and institutional policies.

Engineering departments accounted for the largest proportion of respondents (43.6%), followed by biochemistry (18.8%), natural sciences (15.2%), health sciences (10.4%), and computer science (9%). The strong representation of engineering-related disciplines aligns with the study's objective of examining entrepreneurial orientation within research-intensive and innovation-driven academic environments.

Potential non-response bias was evaluated by comparing the mean responses of the earliest 25% of respondents with those of the latest 25% of respondents. The analysis revealed no statistically significant differences between the two groups, suggesting that non-response bias does not represent a major concern in the present study.

## RESULTS

### Confirmatory Factor Analysis

Amos was used to analyze the data. Confirmatory Factor Analysis was conducted to test the first-order model with four latent factors, and all latent factors are correlated. The preliminary results show that the factor loadings of UC8 and IC5 have factor loadings less than .5. The two items were dropped for further analysis. After dropping the two items, the confirmatory factor Analysis was conducted. The reliability analysis shows that all measures in the measurement model achieve good reliability. The model fit indices also show that the measurement model is acceptable (CFI=.841, RMSEA=.106).

Table 1: Reliability Analysis

| Research Mobilization               |                                     | Unconventionality                    |                                     | Industry Collaboration               |                                     | University Policy                    |                                     |
|-------------------------------------|-------------------------------------|--------------------------------------|-------------------------------------|--------------------------------------|-------------------------------------|--------------------------------------|-------------------------------------|
| Items                               | Standardized Regression Coefficient | Items                                | Standardized Regression Coefficient | Items                                | Standardized Regression Coefficient | Items                                | Standardized Regression Coefficient |
| RM1                                 | 0.565                               | UC1                                  | 0.696                               | IC1                                  | 0.788                               | UC1                                  | 0.725                               |
| RM2                                 | 0.648                               | UC2                                  | 0.547                               | IC2                                  | 0.669                               | UC2                                  | 0.75                                |
| RM3                                 | 0.756                               | UC3                                  | 0.717                               | IC3                                  | 0.794                               | UC3                                  | 0.825                               |
| RM4                                 | 0.784                               | UC4                                  | 0.736                               | IC4                                  | 0.696                               | UC4                                  | 0.577                               |
| RM5                                 | 0.709                               | UC5                                  | 0.756                               |                                      |                                     |                                      |                                     |
| RM6                                 | 0.677                               | UC6                                  | 0.71                                |                                      |                                     |                                      |                                     |
|                                     |                                     | UC7                                  | 0.676                               |                                      |                                     |                                      |                                     |
| CR=.846; AVE=.481;<br>$\alpha$ =.85 |                                     | CR=.866; AVE=.482;<br>$\alpha$ =.861 |                                     | CR=.827; AVE=.546;<br>$\alpha$ =.819 |                                     | CR=.813; AVE=.525;<br>$\alpha$ =.805 |                                     |

### Relationship between EO and Performance

Using the number of IPs and the number of startups as performance measures, SEM was submitted to AMOS for analysis. The model fit indices show the model has a good fit to the data (CFI=.844, RMSEA=.096). The correlations between the four dimensions of EO and performance show that only industrial collaboration has a significant impact on performance at the .1 level. The other three dimensions do not have a significant impact on performance.

## DISCUSSION AND FUTURE RESEARCH DIRECTIONS

The study examines the entrepreneurial orientation (EO) of Chinese universities, with a focus on engineering and technology-intensive environments, using the Entre-U scale. Results confirm that the scale is valid in the Chinese context, with its four dimensions—Research Mobilization, Unconventionality, Industry Collaboration, and University Policies—relevant for assessing university entrepreneurship in engineering-focused institutions.

However, EO shows little direct relationship with performance when measured by patents, intellectual property, and startup creation. Only Industry Collaboration exhibits a modest positive effect. This suggests that EO does not straightforwardly translate into commercialization outcomes in Chinese universities.

A key explanation is that China's centralized, policy-driven innovation system and strong emphasis on research output and rankings may weaken the direct impact of EO on entrepreneurial results. Engineering departments may produce high levels of innovation while still facing structural barriers to commercialization and technology transfer.

Moreover, conventional indicators such as patents and startups may underrepresent the broader contributions of engineering faculties, including industry collaboration, technology diffusion, infrastructure development, and talent formation.

Overall, the study highlights the need for broader performance measures and more context-sensitive approaches to understanding university entrepreneurship. While Chinese engineering universities demonstrate clear entrepreneurial characteristics, their impact on innovation outcomes is complex and not fully captured by traditional metrics.

## REFERENCES

- Brislin, R. W. (1970). Back-Translation For Cross-Cultural Research. *Journal of Cross-Cultural Psychology*, 1(3), 185-216. doi:10.1177/135910457000100301
- Clark, B. (1989). *Creating Entrepreneurial Universities: Organizational Pathways Of Transformation*: Oxford: IAU Press/Pergamon.
- Covin, J. G., & Slevin, D. P. (1989). Strategic Management Of Small Firms In Hostile And Benign Environments. *Strategic Management Journal (Wiley-Blackwell) - 1980 to 2009*, 10(1), 75-87. doi:10.1002/smj.4250100107
- Covin, J. G., & Wales, W. J. (2019). Crafting High-Impact Entrepreneurial Orientation Research: Some Suggested Guidelines. *Entrepreneurship: Theory & Practice*, 43(1), 3-18. doi:10.1177/1042258718773181
- Etzkowitz, H., & Leydesdorff, L. (2000). The Dynamics of Innovation: From National Systems and "Mode 2" to a Triple Helix of University-Industry-Government Relations. *Research Policy*, 29(2), 109-123. Retrieved from <https://research.ebsco.com/linkprocessor/plink?id=7fcf0a78-a18e-3f39-9955-b01996a4e509>
- Lumpkin, G. T., & Dess, G. G. (1996). Clarifying The Entrepreneurial Orientation Construct And Linking It To Performance. *The Academy of Management Review*, 21(1), 135-172. doi:10.2307/258632
- Miller, D. (1983). The Correlates Of Entrepreneurship In Three Types Of Firms. *Management Science (INFORMS)*, 29(7), 770-791. doi:10.1287/mnsc.29.7.770
- Rauch, A., Wiklund, J., Lumpkin, G. T., & Frese, M. (2009). Entrepreneurial Orientation and Business Performance: An Assessment of Past Research and Suggestions for the Future. *Entrepreneurship: Theory & Practice*, 33(3), 761-787. doi:10.1111/j.1540-6520.2009.00308.x
- Todorovic, Z., McNaughton, R. B., & Guild, P. (2011). ENTRE-U: An entrepreneurial orientation scale for universities. *Technovation*, 31(2/3), 128-137. doi:10.1016/j.technovation.2010.10.009
- Wiklund, J., & Shepherd, D. (2005). Entrepreneurial orientation and small business performance: a configurational approach. *Journal of Business Venturing*, 20(1), 71-91. doi:10.1016/j.jbusvent.2004.01.001