https://doi.org/10.51408/issi2025_188

Delayed Recognition of Novel Ideas: Initially Underestimated, Ultimately Rewarded

Tao Zhiyu[1], Liu Xiaoping,[2], Liang Shuang[3], Li Hanxi[4]

[1]*taozhiyu@mail.las.ac.cn*, [2]*liuxp@mail.las.ac.cn*
National Science Library, Chinese Academy of Sciences, Beijing (China)
Department of Information Resources Management, School of Economics and Management, University of Chinese Academy of Sciences, Beijing (China)

[3]*liangs1998@126.com*
Department of Information Management, Peking University, Beijing (China)

[4]*lihanxi24@mails.ucas.ac.cn*
School of Economics and Management, University of Chinese Academy of Sciences, Beijing (China)

Introduction

Groundbreaking research challenging established paradigms often sparks debate, yet its growth dynamics and long-term impact are underexplored. Using SciSciNet data, we measure research novelty with the atypical combination index, assess long-term impact via the WSB model, and gauge recognition time with the beauty coefficient. Applying OLS regression, we analyze how innovation strategies influence recognition speed and impact. Findings show that bolder knowledge combinations take longer to gain recognition but yield greater impact. Paradigm-shifting innovations require the longest recognition time but achieve the highest impact, highlighting the rewards of high-risk research. The results revealed by this study have rich implications for innovation polices.

Research Design

To investigate the recognition timeline and impact of novel ideas, we employ the beauty coefficient (SB_B) introduced by Ke et al. (2015), to assess the duration required for a study to gain recognition. Additionally, we apply the WSB model (Wang et al., 2013) to evaluate the ultimate impact of research and the atypical combination indicator (AC) (Uzzi et al., 2013) to quantify research novelty. By incorporating control variables that may affect research impact and using ordinary least squares (OLS) regression, we quantitatively analyze the relationships between dependent and independent variables to elucidate the growth dynamics and long-term impact of novel idea.

The Dependent Variables

We introduce two dependent variables:

(1) The SB_B index, which quantifies the time required for a study to gain peer recognition, defined as follows:

$$SB\_B_i = \sum_{t=0}^{t_m} \frac{\frac{c_{t_m} - c_0}{t_m} \cdot t + c_0 - c_t}{\max\{1, \ c_t\}} \quad (1)$$

In this equation, B = 0 for papers with $t_m = 0$. Papers with citations growing linearly with time ($c_t = \ell_t$) have B =0, B is the nonpositive for papers whose citation trajectory c_t is a concave function of time.

(2) WSB model is introduced to quantify the ultimate impact one paper may have in the future, which enable papers to move beyond current impact, which can be defined as:

$$UI_i^{\infty} = m\left(e^{\lambda_i} - 1\right) \quad (2)$$

Where the UI predicts that the total number of citations acquired by a paper during its lifetime, which depends on the relative fitness λ of each paper.

The Independent Variables

Our study investigates how novel ideas shape their ultimate impact and recognition timeline. We utilize the atypical combination (AC) indicator to assess idea novelty and examine its influence on recognition time and impact. The AC is calculated as follows:

$$z = \frac{obs - \mu}{\sigma} \tag{3}$$

Where obs is the observed frequency of the journal pair in the actual WOS, while the μ is the mean and σ indicate the standard deviation. Frequently, the 10th percentile and median z-score are used to describe the novelty of paper from different perspectives.

The Control Variables

Drawing on prior research, we identify variables that simultaneously affect ultimate impact and recognition time, potentially introducing endogeneity with our variable. We include citation count (CC), reference count (RC), funding (FD), atypical combination pairs (AP), and team size (TS) as control variables, with publication year as a fixed effect.

The Evaluation Model

Based on the previous analysis, we design the regression model to implement further evaluation:

$$DV_i = \alpha_i + \beta_1 * AC\_10_i + \beta_2 * AC_{M_i} + \beta_4 * CONTROL_i + Y_t + F_i + \varepsilon_i \tag{4}$$

In this equation, DV_i is the dependent variables employed in this study, Y_t is the fixed effect for the publication year, F_i is the fixed effect of the discipline, and the ε_i indicates the random error.

Empirical Study

Data Source and Preprocessing

We leverage the comprehensive SciSciNet dataset, spanning all disciplines. However, due to challenges in data quality, disciplinary heterogeneity, document-type variability, and the need for sufficient citation history, not all data are suitable for analysis. We thus focus on physics, a well-studied field, analyzing 733,648 records from 1892 to 2011.

Main Results

Novel ideas are more prone to delayed recognition (Fig. 1). Analysis of Fig. 1 reveals that 59.15% of highly delayed papers are novel, compared to only 38.44% of instantly recognized papers. This suggests novel ideas face greater delays in recognition, whereas conventional studies are more likely to gain immediate recognition.

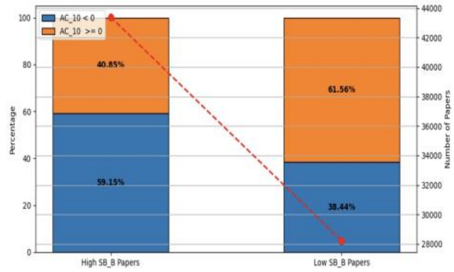

Figure 1. The distribution of SB_B and novelty.

Novel ideas tend to achieve greater ultimate impact. Figure 2 shows that novel ideas have higher impact, with moderately novel research (AC_7) exhibiting a greater likelihood of high impact compared to the most radical ideas (AC_1 and AC_2).

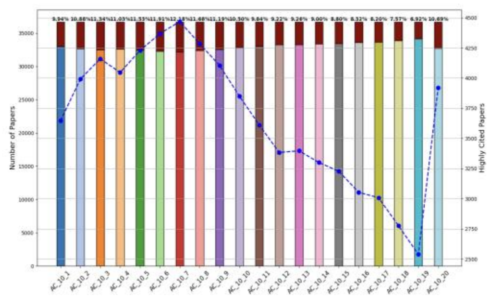

Figure 2. The distribution of novelty and UI.

Research with high ultimate impact is more likely to experience delayed recognition. Figure 3 shows that 33.42% of highly cited papers face significant delays in recognition, whereas low-cited papers rarely exhibit delayed recognition, suggesting that impactful ideas may face initial challenges but ultimately gain substantial recognition.

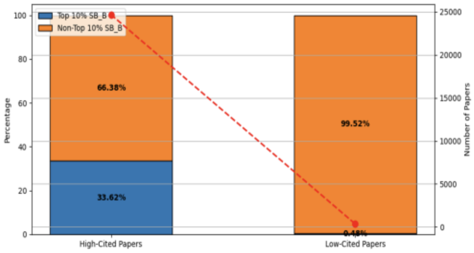

Figure 3. The distribution of SB_B and impact.

We classify innovations into four quadrants based on AC_10 and AC_M. Figure 4 reveals that paradigm-shifting ideas (top 5% AC_M, not top 5% AC_10) exhibit significantly greater ultimate impact than other innovation types but are most likely to experience delayed recognition. This suggests that high-impact ideas, which propose novel explanations for existing problems, often challenge established paradigms, facing resistance from mainstream adopters and resulting in prolonged recognition timelines.

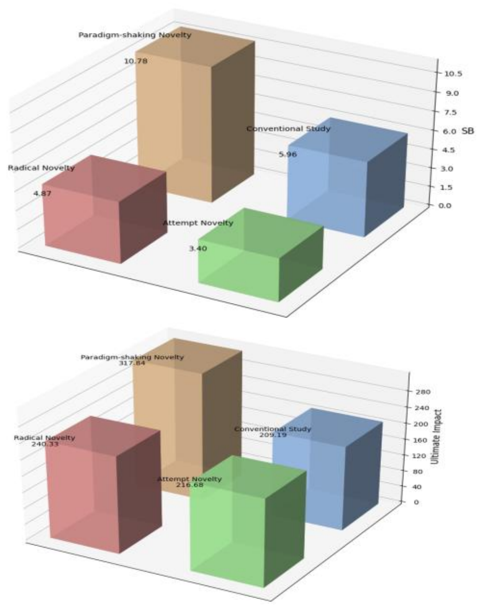

Figure 4. Four types of research and its SB and UI.

Conclusion

By analyzing extensive publication data, our study reveals: (1) Novel research typically experiences longer recognition times and is more likely to be a "sleeping beauty" than conventional research. (2) Moderately novel ideas have the highest probability of achieving high impact compared to highly radical or conventional research. (3) Most high-impact research faces delayed recognition, suggesting that the path to success can be challenging. Further, we derive the following insights: (1) Research evaluation should extend beyond immediate impact to consider long-term scientific contributions. (2) The academic community should foster greater inclusivity toward novel, paradigm-shifting ideas that challenge mainstream theories, as breakthroughs often stem from bold innovations.

References

Ke, Q., Ferrara, E., Radicchi, F., & Flammini, A. (2015). Defining and identifying Sleeping Beauties in science. *Proc Natl Acad Sci U S A*, *112*(24), 7426-7431.

Uzzi, B., Mukherjee, S., Stringer, M., & Jones, B. (2013). Atypical combinations and scientific impact. *Science*, *342*(6157), 468-472.

Wang, D., Song, C., & Barabási, A.-L. s. (2013). Quantifying Long-Term Scientific Impact. *Science*, *342*(6154), 127-132.