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Tripartite Game Evolution and Stabilization Strategies in Artificial Intelligence-Empowered Science & Technology Journals

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ABSTRACT

Currently, the cognitive synergy between artificial intelligence and human editors will become an important direction to promote the development of scientific and technical journals. The purpose of this paper is to illustrate the evolutionary game dynamics between multiple stakeholders in the intelligent transformation of the publishing industry, reveal the behavioural rationality and strategic decisions of each participant, and explore the optimal coping strategies under the interaction between AI technology and human resources. In order to deeply study the dynamic interaction between technology and human resources under the framework of co-construction of AI and science and technology journals, we divided the relationship between each stakeholder. We established a game relationship model, taking the government and ethical regulators, the editorial boards of scientific and technical journals, and research groups as game participants. Then, we addressed the stabilisation strategy problem and examined the strategic choice dilemmas faced by these three parties. We identified four stabilisation points and studied the evolutionary game through four stages of technology, early stage, development phase, surge phase and maturity phase respectively. Based on the results of the game analysis, the coping strategies of gradient adaptation of technology embedding and business process, capacity cultivation of human capital and organisational development, value reconstruction of academic ecology and scientific research culture, precise insight of user needs and cognitive behaviours, and globalisation and regional differences are proposed from the perspectives of governmental and ethical regulators, editorial boards of science and technology journals, and scientific research groups, respectively. The human-machine collaborative editing model, by integrating human creativity and the efficient processing capability of AI, will achieve a double rise in quality and efficiency in the fields of content review, intelligent proofreading, editing and processing, precise pushing, and knowledge dissemination.

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Introduction

The swift advancement of artificial intelligence technology has influenced the evolution of organizations and economic growth across multiple sectors both domestically and internationally. Simultaneously, with the extensive advancement and utilization of data, alongside the progressive evolution of AI technology, its influence on various sectors will become increasingly profound, significantly empowering diverse industries [1]. In 2023, Nature published a report indicating that scientific researchers have commenced utilizing ChatGPT and other generative AI tools to aid in paper composition, the generation of review comments, literature summary compilation, and related tasks. Additionally, the editorial boards of scientific and technical journals are experimenting with the integration of AI technology into the publishing process to enhance publishing efficiency and manuscript review [2]. This trend has engendered significant apprehension within the academic community regarding the merging of 'AI+scientific and technical journal' and has also introduced new challenges to the ethical standards and governance framework of academic publishing.

The widespread use of AI in technology publishing and the problems that come with it are making people pay more attention to what governments and ethical regulators do. On February 11,

2025, the AI Action Summit took place in Paris, France. There, 58 countries, including China, India, and the European Union, all agreed to and signed a declaration for AI that is inclusive and sustainable. The statement lays out basic ideas like making AI more accessible and closing the digital divide; encouraging open, honest, safe, and trustworthy AI; stopping the concentration of AI development in a few companies to encourage innovation; improving job outcomes; making sure AI lasts; and promoting international cooperation and governance [3].

With the help of government rules, the progress of journal editors, and the hard work of many researchers, the scientific and technical publication system is quickly moving towards a major change that will be marked by intelligence and automation. Researchers are gathering relevant information. For example, Xie Hejia et al. used qualitative thematic analysis to group the science and technology ethics content shared by publishing institutions Yang Lin and Li Zhiqi not only summarised the main points of the policy but also used the BER Topic model to look at the themes of papers in the AI field, making it easier to find themes, track how they change over time, and build possible thematic relationship Pan Xue et al. investigated the role of science and technology journals in the advancement of intelligent and automated publication, as well as the motivations behind these journals' efforts to enhance their communication efficacy in the AI era, analyzing the various factors that impede this development [4-6]. These results show that the digital transformation of scientific and technological journals is an inevitable trend and provides a strong theoretical basis for their innovation development.

Currently, most of the relevant studies only look at things from a static and macro point of view. They don't take into account how different entities coexist and interact in the real world and how that changes over time. This means they don't fully explain the competitive relationship between technology and human resources in academic publishing. The goal of this paper is to explain game theory, look at how artificial intelligence and scientific journals are related from a dynamic point of view, find the hidden value in academic data, fix the problems with previous research, improve the theoretical framework that governs the evolution of scientific journals through digital intelligence, and give academic research more targeted support [7].

Model Construction and Assumption

Model Construction

Science and technology constitute the primary productive force, while innovation serves as the foremost catalyst for development. Artificial intelligence and academic creation share a reciprocal relationship characterized by mutual influence, forming a cyclical and reinforcing process [8]. In the realm of science and technology journals, the principal entities are authors and publishing institutions, which engage in the generation and distribution of academic findings and other significant connections, respectively. Consequently, this study identifies the government and ethical regulators, the editorial board of science and technology journals, and the scientific researcher community as the triadic participants in the evolutionary game model. Here, the government and ethical regulators specifically denote the ethical overseers pertinent to science and technology, such as those related to artificial intelligence.

The government and ethical regulatory bodies consult ethical regulatory agencies and pertinent government departments for science and technology, including AI, to uphold academic integrity; the editorial department of scientific journals engages with relevant organizations to review and publish manuscripts; and the scientific researcher group comprises scholars who have produced academic work and results. Initially, we developed a three-party evolutionary game model based on the interest relationships among the participants and examined the strategic stability of each participant, as well as the impact of various elements on strategy selection. Subsequently, we performed a stability analysis on the pure and mixed strategy equilibrium points of the replication dynamics system, identifying combinations of evolutionary stable strategies under varying conditions [9]. Finally, we proposed diverse countermeasures and recommendations for AI-enabled scientific and technical journals derived from the study's conclusions. Various countermeasures and recommendations are presented.

Model Assumption

Based on the relationship between the elements of the constructed three-way evolutionary game model, the following assumptions are made here:

H1: Strategy Assumptions of Three Parties

The government and ethical regulatory bodies, the editorial boards of science and technology journals, and the group of scientific researchers are all boundedly rational participants. Through trial-and-error learning, they adjust their strategies until reaching optimal ones [10]. Their decisions are influenced by current payoffs and the distribution of strategies across groups. The strategy choices of the government and ethical regulators are denoted as F = (F1, F2) = (strict supervision, loose supervision), with a probability $x \in [0, 1]$ of choosing F1 and $1 - x$ of choosing F2. The strategy choices of editorial boards are H = (H1, H2) = (high-level digital integration, low-level digital integration), with a probability $y \in [0, 1]$ of choosing H1 and $1 - y$ for H2. The strategy choices of scientific researchers are K = (K1, K2) = (deep reliance on AI, active avoidance of AI), with a probability $z \in [0, 1]$ of choosing K1 and $1 - z$ for K2. Here, x, y, and z are all functions of time t.

H2: Technological Efficiency and Ethical Risks

Artificial intelligence possesses formidable data processing and analytical capabilities, enabling scientific and technical journal editorial boards to operate with heightened efficiency and achieve significant digital integration. The benefits and costs associated with high-level digital integration are denoted as E1 and C1, respectively, while those of low-level digital integration are E2 and C2, respectively, where $E1 > E2$. However, due to the opaque and black-box nature of AI algorithms, accurate assessment of content originality and reliability is difficult, leading to risks even among high-value outputs.When digitalization remains low, editorial boards may be unable to detect academic misconduct such as forgery or plagiarism, resulting in the publication of unethical work. This can trigger public backlash and be interpreted as a dereliction of editorial duty. In such cases, responsibility may be transferred to government and ethical regulators. Conversely, effective dissemination of high-quality research enhances the impact of science and technology journals.Moreover, the widespread implementation of technology improves the reputation of the government and ethical regulators among editors and authors, increasing their benefit E4.

H3: Regulatory Strategies and Technological Subsidies

Cost and benefit when the government and ethics regulator strictly regulates are C5 and E5 respectively, the government and ethics regulator can detect academic misconduct in time, while adopting a lax regulatory strategy will lead to regulatory failure, and when

the editorial office flows out the problematic journals resulting in serious academic misconduct, the government and ethics regulator faces the amount of pursuing and administrative punishment from the higher authorities is R3; At the same time, the government and ethical regulators have to spend the cost of rectifying the field of scientific and technological journals in order to protect the stable order of the academic world and safeguard the legitimate rights and interests of the relevant authors as C4. The government and ethical regulators encourage and support the deep application of artificial intelligence, big data and other technologies to various fields, and the subsidies given to them as E6.

H4: Ethical Risks and Reputational Impact for Scientific Researchers

The current norms for the use of AI in different regions of the academic session are not consistent, increas- ing the risk of AI-related ethics in science and technology. The likelihood of science researchers violating ethics in science and technology is affected by the strength of external regulation and technological strategies. The probability of violating ethics in science and technology when the community of science researchers is deeply dependent on AI is Wα (when α = 1, 2, 3 refer to the probability of violating ethics when the (F1, H1) strategy, the (F1, H2) or the (F2, H1) strategy, (F2, H2) strategy, and W3 > W2 > W1.

Here it is assumed that the authors will not be involved in academic ethics when actively avoiding AI), the scientific researcher community faces recourse to science and technology ethics as well as a loss of reputation as R4, and the scientific researcher community's reputational gain after their academic work is successfully approved for acceptance is E7.

The main parameters and their meanings in the evolutionary game model are shown in Table 1.

Based on the above assumptions, a tripartite game payoff matrix is constructed for the government and ethical regulators, the editorial boards of scientific and technical journals, and the scientific researcher community, as shown in Table 2.

Table 1: Key Parameters and Their Meanings in the Evolutionary Game Model

Stakeholder	Parameter	Meaning
Government and	E_4	Reputation/image benefit from high-level digitalization
Ethical Regulators	E_5	Benefit of strict supervision strategy
	E_8	Benefit of lenient supervision strategy
	C_4	Cost of managing public ethical backlash due to dereliction
	C_5	Cost of enforcing strict supervision
	R_2	Reputation loss from holding journals accountable
	R_3	Administrative penalty from higher authorities
Editorial Boards of	E_6	Subsidies to editorial boards for digital integration
	E_1	Benefit of high-level digital integration
Journals	E_2	Benefit of low-level digital integration
	C_1	Cost of high-level digital integration
	C_2	Cost of low-level digital integration
	E_3	Impact factor gain per accepted paper
	R_1	Loss due to algorithmic bias under high digitalization
Scientific Researcher	R_4	Reputational damage due to ethical violation
Community	Wα	Probability/weight of ethical violation when AI is deeply used
	1 −Wα	Probability/weight of ethical compliance when AI is deeply used
	C_6	Cost of deeply relying on AI
	C_7	Cost of actively avoiding AI
	N_1	Number of accepted papers under deep AI use
	N_2	Number of accepted papers under AI avoidance
	E_7	Reputation gain per accepted paper

Table 2: Tripartite Game Payoff Matrix

Strategy	Government and Ethical Regulators	Editorial Boards of Journals	Scientific Researcher Community
F_1, H_1, K_1	$E_5 - C_5 + E_4 - E_6$	$E_1 - C_1 + (1 - W_1)N_1E_3 - R_1 + E_6$	$(1 - W1)N_1E_7 - C_6$
F_1, H_1, K_2	$E_5 - C_5 + E_4 - E_6$	$E_1 - C_1 + N_2E_3 - R_1 + E_6$	$N_2E_7 - C_7$
F_1, H_2, K_1	$E_5 - C_5$	$E_2 - C_2 + (1 - W_2)N_1E_3 - W_2R_2$	$(1 - W_2)N_1E_7 - C_6 - W_2R_4$
F_1, H_2, K_2	$E_5 - C_5$	$E_2 - C_2 + N_2E_3$	$N_2E_7 - C_7$
F_2, H_1, K_1	$-E_6 + E_4 + E_8$	$E^1 - C_1 + (1 - W_2)N_1E_3 - R_1 + E_6$	$(1 - W_2)N_1E_7 - C_6$
F_2, H_1, K_2	$-E_6 + E_4 + E_8$	$E_1 - C_1 + N_2E_3 - R_1 + E_6$	$N_2E_7 - C_7$
F_2, H_2, K_1	$-W_3C_4 - W_3R_3 + E_8$	$E_2 - C_2 + (1 - W_3)N_1E_3 - W_3R_2$	$(1 - W_3)N_1E_7 - C_6 - W_3R_4$
F_2, H_2, K_2	E_8	$E_2 - C_2 + N_2E_3$	$N_2E_7 - C_7$

Solution to the Tripartite Evolutionary Game Model

Evolutionary Game Theory

Originating from biological evolution theory, evolutionary game theory emphasizes concepts like Evolu- tionarily Stable Strategy (ESS) and replicator dynamics [11]. Unlike classical game theory, it rejects the assumption of perfect rationality and thus offers greater explanatory power for real-world scenarios. It is particularly useful in modeling the strategic development of science and technology journals.

An ESS represents a strategy that stabilizes over time through bounded rational learning, imitation, and adaptation. Replicator dynamics is a differential equation that tracks the change in frequency or proportion of a given strategy within a population.

Based on the stability conditions of differential equations, a point is defined as an evolutionarily stable equilibrium (ESS) if it satisfies:

$$F(x) = \frac{dx}{dt} = 0, \quad \text{and} \quad F'(x) = \frac{dF(x)}{dx} < 0$$

The general form of the replicator dynamics equation is:

$$\frac{dx_i}{dt} = x_i\,[u_i(x) - \bar{u}(x)]$$

Here, xi denotes the proportion of the population adopting pure strategy i, ui(x) is the fitness (or expected utility) of strategy i, and $\bar{u}(x)$ is the average fitness across all strategies. In this study, Ei j denotes the expected payoff for player i choosing strategy j, where i = m refers to the government and ethics regulators, i = s to the editorial board, and i = l to the scientific research community; j = 1, 2 corresponds to their two respective strategic choices.

Government and Ethical Regulators' Strategy

The expected payoffs for the government and ethical regulators under strict and lenient regulation are as follows:

$E(x) = yz(E_5 - C_5 + E_4 - E_6) + (1 - y)z(E_5 - C_5) + y(1 - z)(E_5 - C_5 + E_4 - E_6) + (1 - y)(1 - z)(E_5 - C_5)$ $E(1 - x) = yz(E_8 + E_4 - E_6) + (1 - y)z(E_8 - W_3C_4 - W_3R_3) + y(1 - z)(E_8 + E_4 - E_6) + (1 - y)(1 - z)E_8$

The average payoff $\bar{E}m$ for the regulator is:

$\bar{E}m = xEm_1 + (1 - x)\,Em_2$

$\bar{E}m = x\,(E_5 - C_5 - E_6z) + (1 - x)\,[E_8 + yE_4 - yE_6 - z\,(1 - y)\,W_3(C_4 + R_3)]$

The corresponding replicator dynamic equation for strategy x is:

$F(x) = x\,(1 - x)\,[(E_5 - C_5 - E_8) + zW_3(C_4 + R_3)\,(1 - y)]$

Editorial Board Strategy

The expected payoffs for selecting high-level (y) or low-level (1 − y) digital integration are:

$E(y) = xz\,[E_1 - C_1 + (1 - W_1)\,N_1E_3 - R_1 + E_6] + (1 - x)\,z\,[E_1 - C_1 + N_2E_3 - R_1 + E_6]$
$+ x\,(1 - z)\,(E_2 - C_2 + N_2E_3) + (1 - x)\,(1 - z)\,(E_1 - C_1 + N_2E_3 - R_1 + E_6)$

$E\,(1 - y) = xz\,[E_2 - C_2 + (1 - W_2)\,N_1E_3 - W_2R_2] + (1 - x)\,z\,[E_2 - C_2 + (1 - W_3)\,N_1E_3 - W_3R_2]$
$+ x\,(1 - z)\,(E_2 - C_2 + N_2E_3) + (1 - x)\,(1 - z)\,(E_2 - C_2 + N_2E_3)$

The average payoff $\bar{E}s$ for the editorial board is:

$\bar{E}s = E_1y\,(1 - x + xz) + E_2[yx(1 - z) + (1 - y)]$
$- C_1y\,(1 - x + xz) - C_2[yx\,(1 - z) + (1 - y)]$
$+ N_1E_3[xz(y\,(1 - W_1) + (1 - y)\,(1 - W_2)) + (1 - y)\,(1 - x)\,z\,(1 - W_3)]$
$+ N_2E_3[y\,(1 - xz) + (1 - y)\,(1 - z)]$
$- R_1y\,(1 - x + xz) - R_2(1 - y)\,[xzW_2 + (1 - x)\,z\,W_3]$
$+ E_6y\,(1 - x + xz)$

The replicator dynamic equation for strategy y is:

$F(y) = y\,(1 - y)\,A$

Where:

$A = (E_1 - C_1 - R_1 + E_6)\,(1 - x + xz) - (E_2 - C_2)\,(1 - x + xz)$
$+ N_1E_3[xz(W_2 - W_1) + (1 - x)\,z\,(W_3 - W_2)]$
$+ N_2E_3(1 - z) - R_2z\,[W_2x + W_3(1 - x)]$ (1)

Scientific Researcher Community Strategy

The scientific researcher community chooses between two strategic options: deeply relying on AI or actively avoiding AI. The expected payoffs for each are defined as follows:

$E(z) = xy\,[(1 - W_1)\,N_1E_7 - C_6] + x\,(1 - y)\,[(1 - W_2)\,N_1E_7 - C_6 - W_2R_4]$
$+ (1 - x)y\,[(1 - W_2)N_1E_7 - C_6] + (1 - x)(1 - y)[(1 - W_3)N_1E_7 - C_6 - W_3R_4]$ $E(1 - z) = xy(N_2E_7 - C_7) + x(1 - y)(N_2E_7 - C_7)$
$+ (1 - x)y(N_2E_7 - C_7) + (1 - x)(1 - y)(N_2E_7 - C_7)$

The average payoff for the researcher community is expressed as:

$\bar{E}l = xE_1l + (1 - x)El_2$

After simplification, the average payoff becomes:

$\bar{E}l = E_7N_1\,xy(z(1 - W_1) + (1 - z)\,N_2) + (x(1 - y) + (1 - x)y)\,(z(1 - W_2) + (1 - z)\,N_2)$
$N_1 \qquad N_1$
$+(1 - x)(1 - y)(z(1 - W) + (1 - z)\,N2)$
$N1$
$- zC_6 - (1 - z)C_7 - zR_4\,[W_2x(1 - y) + W_3(1 - x)(1 - y)]$

Thus, the replicator dynamic equation describing the evolution of strategy z in the scientific researcher community is:

$F(z) = z(1 - z) \cdot B$

Where:

$B = N_1E_7\,[(1 - W_1)xy + (1 - W_2)(x(1 - y) + y(1 - x)) + (1 - W_3)\,(1 - x)(1 - y)]$
$- (N_2E_7 - C_7) - C_6 + R_4\,[W_2x(1 - y) + W_3(1 - x)(1 - y)]$ (2)

Stability Analysis of the Evolutionary Game Model

To determine the evolutionarily stable strategies (ESS), we first identify the equilibrium points of the evolutionary game. This is done by setting F(x) = 0, F(y) = 0, and F(z) = 0, indicating that the system is at rest and strategies are not changing. Solving these equations yields eight equilibrium points for the dynamic system. Stability is evaluated using the eigenvalue method based on the Jacobian matrix. If all eigenvalues of the Jacobian at a given equilibrium point are negative, the point is an evolutionarily stable strategy (ESS). If at least one eigenvalue is positive, the point is considered unstable.

We compute the partial derivatives of F(x), F(y), and F(z) with respect to the variables x, y, and z, respectively, to form the Jacobian matrix

$$J = \begin{bmatrix} J_1 & J_2 & J_3 \\ J_4 & J_5 & J_6 \\ J_7 & J_8 & J_9 \end{bmatrix} = \begin{bmatrix} \frac{\partial F(x)}{\partial x} & \frac{\partial F(x)}{\partial y} & \frac{\partial F(x)}{\partial z} \\ \frac{\partial F(y)}{\partial x} & \frac{\partial F(y)}{\partial y} & \frac{\partial F(y)}{\partial z} \\ \frac{\partial F(z)}{\partial x} & \frac{\partial F(z)}{\partial y} & \frac{\partial F(z)}{\partial z} \end{bmatrix}$$

Calculated and analysed to produce Table 3

Based on the parameter assumptions and an analysis informed by real-world data, the evolutionary game model involving the three stakeholder groups yields four Evolutionarily Stable Strategy (ESS) points under different parameter configurations and ESS criteria [12]. These stable points are identified as (0, 0, 0), (0, 0, 1), (0, 1, 1), and (1, 1, 1).

Table 3: Stability Analysis of Equilibrium Points

Equilibrium point	λ_1	Jacobian matrix eigenvalue λ_2	λ_3
$E_1(0, 0, 0)$	$-C_1 + C_2 + E_1 - E_2 + E_3N_2 + E_6 - R_1$	$-C_5 + E_5 - E_8$	$-C_6 + C_7 - E_7N_1W_3 + E_7N_1 - E_7N_2 + R_4W_3$
$E_2(1, 0, 0)$	$-C_6 + C_7 - E_7N_1W_2 + E_7N_1 - E_7N_2 + R_4W_2$	$C_5 - E_5 + E_8$	E_3N_2
$E_3(0, 1, 0)$	$-C_5 + E_5 - E_8$	$-C_6 + C_7 - E_7N_1W_2 + E_7N_1 - E_7N_2$	$C_1 - C_2 - E_1 + E_2 - E_3N^2 - E_6 + R_1$
$E_4(0, 0, 1)$	$-C_1 + C_2 + E_1 - E_2 - E_3N_1W_2 + E_3N_1W_3 + E_6 - R_1 - R_2W_3$	$C_4W_3 - C_5 + E_5 - E_8 + R_3W_3$	$C_6 - C_7 + E_7N_1W_3 - E_7N_1 + E_7N_2 - R_4W_3$
$E_5(1, 1, 0)$	$-C_6 + C_7 - E_7N_1W_1 + E_7N_1 - E_7N_2$	$-E_3N_2$	$C^5 - E_5 + E_8$
$E_6(1, 0, 1)$	$-C_1 + C_2 + E_1 - E_2 - E_3N_1W_1 + E_3N_1W_2 + E_6 - R_1 - R_2W_2$	$-C_4W_3 + C_5 - E_5 + E_8 - R_3W_3$	$C_6 - C_7 + E_7N_1W_2 - E_7N_1 + E_7N_2 - R_4W_2$
$E_7(0, 1, 1)$	$-C_5 + E_5 - E_8$	$C_1 - C_2 - E_1 + E_2 + E_3N_1W_2 - E_3N_1W_3 - E^6 + R_1 + R_2W_3$	$C_6 - C_7 + E_7N_1W_2 - E_7N_1 + E_7N_2$
$E_8(1, 1, 1)$	$C_1 - C_2 - E_1 + E_2 + E_3N_1W_1 - E_3N_1W_2 - E_6 + R_1 + R_2W_2$	$C_5 - E_5 + E_8$	$C_6 - C_7 + E_7N_1W_1 - E_7N_1 + E_7N_2$

Table 4 summarizes the stability conditions for all equilibrium points, highlighting the aforementioned four ESS points. The specific parameter configurations that give rise to these four ESS points are detailed in Table 5.

Table 4: Stability Conditions of Equilibrium Points

Equilibrium Point	Stability Conditions
$E_1(0, 0, 0)$	$C_1 + E_2 + R_1 > C_2 + E_1 + E_3N_2 + E_6$
	$C_5 + E_8 > E_5$
	$C_6 + E_7N_1W_3 + E_7N_2 > C_7 + E_7N_1 + R_4W_3$
$E_2(1, 0, 0)$	Unstable Point
$E_3(0, 1, 0)$	$C_5 + E_8 > E_5$
	$C_6 + E_7N_1W_2 + E_7N_2 > C_7 + E_7N_1$ $C_2 + E_1 + E_3N_2 + E_6 > C_1 + R_1 + E_2$
$E_4(0, 0, 1)$	$C_1 + E_2 + E_3N_1W_2 + R_1 + R_2W_3 > C_2 + E_1 + E_3N_1W_3 + E_6$
	$C_5 + E_8 > C_4W_3 + E_5 + R_3W_3$
	$C_7 + E_7N_1 + R_4W_3 > E_7N_1W_3 + E_7N_2 + C_6$
$E_5(1, 1, 0)$	$C_6 + E_7N_1W_1 + E_7N_2 > C_7 + E_7N_1$
	$E_5 > C_5 + E_8$
$E_6(1, 0, 1)$	$C_1 + E_2 + E_3N_1W_1 + R_1 + R_2W_2 > C_2 + E_1 + E_3N_1W_2 + E_6$
	$C_4W_3 + E_5 + R_3W_3 > C_5 + E_8$
	$C_7 + E_7N_1 + R_4W_2 > E_7N_1W_2 + E_7N_2 + C_6$
$E_7(0, 1, 1)$	$C_5 + E_8 > E_5$

	$C_2 + E_1 + E_3N_1W_3 + E_6 > C_1 + E_2 + E_3N_1W_2 + R_1 + R_2W_3$
	$C_7 + E_7N_1 > E_7N_1W_2 + E_7N_2 + C_6$
$E_8(1, 1, 1)$	$C_2 + E_1 + E_3N_1W_2 + E_6 > C_1 + E_2 + E_3N_1W_1 + R_1 + R_2W_2$
	$C_5 > E_5 + E_8$
	$C_7 + E_7N_1 > E_7N_1W_1 + E_7N_2 + C_6$

Scenario-Based Analysis by Development Stage

Early Stage of Technology Development

The current mean point is (0, 0, 0), and the chosen decision is (F2, H2, K2). This means that the government and ethical regulators take a hands-off approach to regulation, the editorial boards of scientific and technical journals keep a low number of digital integration, and the scientific research community takes a proactive approach to avoiding AI.

AI technology is still in its early stages, and its functions and areas of use are still fairly limited. The government and ethical regulators take a relaxed approach to regulation, which could mean they don't know about the risks of AI or are waiting to see what happens. They haven't yet set clear rules and limits for regulation. There isn't much digital integration in the editorial boards of scientific and technical journals right now because it's still early and the costs are high. Because of this, digital tools are not fully used in the processes of reviewing and publishing manuscripts.

Table 5: Parameter Settings for Each Equilibrium Point

Equilibrium Point	E_1–E_8	C_1–2,C_4–7	N_1, N_2	W_1,W_2,W_3, R_1–R_4
$E_1(0, 0, 0)$	all 1	5, 2, 1, 2, 3, 2	1, 1	all 1
$E_4(0, 0, 1)$	all 1	5, 2, 1, 2, 4, 2	1, 1	all 1
$E_7(0, 1, 1)$	all 1	2, 4, 1, 2, 2, 4	1, 1	all 1
$E_8(1, 1, 1)$	4, 1, 2, 1, 5, 2, 2, 2	5, 3, -1, 2, 0, 5	3, 1	1, 2, 1, 1, 1, -1, 1

During this time, the scientific research community is worried about AI and mostly chooses not to use it. Researchers are not sure if AI tools are reliable, are worried about ethical problems, and are cautious about possible violations of academic standards. These worries are made worse by a lack of real-world experience and good ways to deal with them.

At this point, AI applications haven't made a big impact on academic research yet because the technology is still new and not fully developed. Because of this, there aren't many big ethical or regulatory issues. The quality and quantity of scientific research still depend a lot on traditional methods, which helps keep the academic ecosystem stable and balanced.

Figure 1: illustrates the evolutionary trajectory of this stage in the tripartite game model, highlighting the dynamics and interactions among the three strategic agents during the early phase of AI integration.

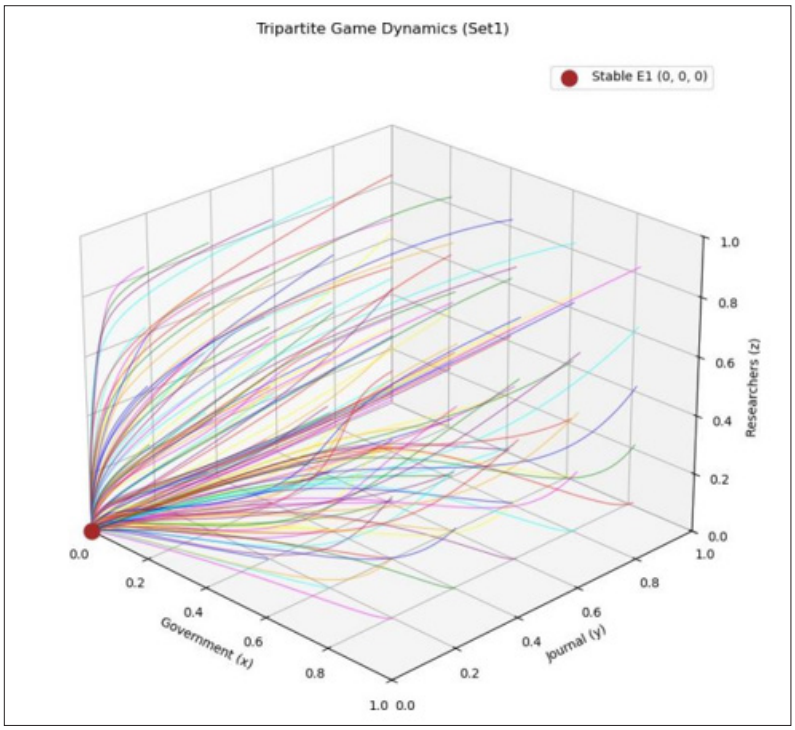

Figure 1: Early Stage Evolutionary Game Path

Technology Development Phase

The current mean point is (0, 0, 1), and the chosen decision is (F2, H2, K1). This means that the government and ethical regulators use lenient rules, the editorial boards of scientific and technical journals don't use many digital tools, and the scientific research community relies heavily on the AI strategy. AI technology is getting better and better during this phase, and the costs of running it are going down. The scientific research community is also starting to see and use the potential benefits of AI.

Even though the government and ethical regulators are still being lenient and there aren't any clear rules for how to use digital tools in scientific and technical journals, the editorial boards of these journals still don't fully use digital tools in their work. They mostly use simple online platforms. But the scientific research community has slowly changed its approach, relying more and more on AI tools to help with data analysis, text optimisation, and content creation. This reliance has made research outputs much more efficient, plentiful, and high-quality. Still, the lack of clear rules and not enough digitalisation in editorial practices create moral and ethical problems with AI-generated content. This means that some publications may have problems with quality or misconduct that go unnoticed.

This strategic setup has encouraged academic innovation, but it also shows the possible risks of not having enough rules and not using technology properly. These worries mean that regulatory standards need to be gradually raised and journal editorial frameworks need to be made stronger to make sure that AI is used responsibly.

Figure 2 illustrates the evolutionary game path during this development phase.

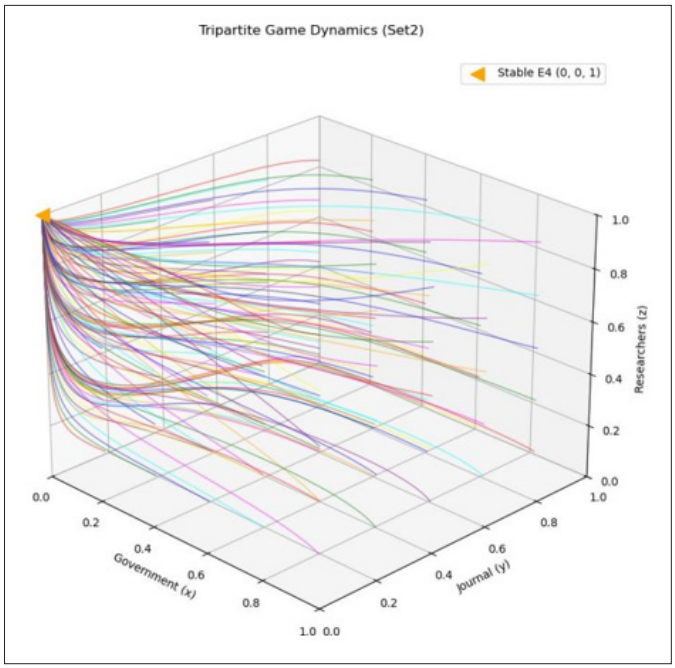

Figure 2: Technology Development Phase Evolutionary Game Path

Technology Surge Phase

The mean point is now (0, 1, 1), and the chosen decision is (F2, H1, K1). This means that the government and ethical regulators use lenient rules, the editorial offices of scientific and technical journals use a lot of digital tools, and the scientific research community relies heavily on AI strategies.

At this point, the costs of putting AI into use go down even more. Editorial boards of scientific and technical journals have made their digital integration much better by using more advanced technologies in the review and publication of manuscripts. This makes academic communication and operations much more effective.

Still, the government and ethical regulators keep taking a lenient approach to regulation and don't put in place strict oversight systems, which makes for a relatively permissive governance environment. At the same time, scientists are using AI more and more for things like analysing data, processing text, and making scientific content. This makes research a lot more productive and innovative.

Journals can now better find and fix problems with AI-generated content thanks to the advanced digitisation of editorial work. But without strict outside rules, there may still be ethical issues and arguments about academic standards. This strategic setup encourages short-term activity and innovation in the academic field, but it also means that regulatory responses may not keep up with the speed of technological progress.

So, all stakeholders need to gradually become more aware of ethics and set up stronger systems for monitoring and working together to govern.

Figure 3 illustrates the evolutionary dynamics in this phase, highlighting the strategic interplay under conditions of accelerated technological adoption and weak regulation.

Technological Maturity Phase

At this point, the mean point is (1, 1, 1) and the chosen decision is (F1, H1, K1). This means that the government and ethical regulators put in place strict rules, the editorial office of scientific and technical journals uses a lot of digital technology, and the scientific research community chooses to rely heavily on AI.

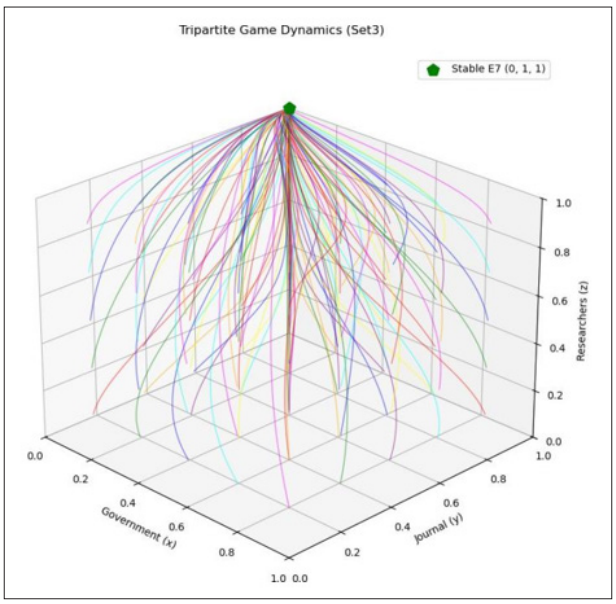

Figure 3: Technology Surge Phase Evolutionary Game Path

The government and ethical regulators set strict rules and give targeted subsidies to help scientific and technical journals go digital. These efforts help editorial departments reach a high level of digital integration, which keeps them up to date with new technologies and makes them more competitive.

In this stage, scientists and researchers support the smart and effective use of AI technologies. More and more research is being done in a legal and compliant way, which makes it possible to use AI responsibly to greatly increase productivity and open up new areas of scientific research. This leads to a dynamic and stable balance between the three areas of governance, editorial oversight, and research innovation.

To keep this balance, it is important for the government and ethical regulators to keep improving regulatory frameworks and standards; for editorial boards of scientific and technical journals to enforce strict review processes and use standardised operational procedures; and for the scientific research community to become more aware of ethics and better at what they do.

To reduce new risks and problems, these three stakeholders must work closely together and communicate with each other. This will help scientific progress and ethical governance grow together [13]. Also, as technological systems become more advanced and society becomes more stable, the system may go back to the decision configuration (F2, H2, K1) when a new technological paradigm appears. This would show that equilibrium has been restored at the point (0, 0, 1).

Figure 4 depicts the evolutionary game trajectory for this phase, highlighting the convergence of strategic decisions under high maturity and regulation.

Pathways For Optimizing the Co-Construction Mechanism Gradient Adaptation Strategy for Technology Embedding

The gradual development and introduction of artificial intelligence should proceed incrementally in close coordination with prevailing conditions, lest it fails not only to contribute to greater efficiency but even causes a decline in effectiveness. Integration in its initial phase requires a heavy investment in technological development research, with a significant amount of data allocation, yet incremental expenditure is predicted sequentially to decline as subsequent development stages unfold. While manual editing would uncover relative ineffectiveness in some parts of the process, it adds a qualitative element of customization with a human element, vindicating its importance to the journal. Editorial sections in journals on science and technology can devise a specific plan for AI integration depending on their specific disciplinary nature and development context, within whose bounds they should judiciously distribute technological as well as human resources in order to ensure smooth operations for digital transformation. Medical science and technology journals typically include huge clinical trial data, case studies, and medical research outcomes demanding high data integrity, as well as security. Therefore, in AI integration, an automated proofread system would be introduced in its preliminary stage in order to scrupulously check for accuracy in medical terminology, pharmaceutical names, and similar information. In the mid-term, attention would be focused on devising an intelligent recommendation system capable of suggesting relevant medical literature as well as research outcomes consistent with specialties as well as interests of medical professionals and researchers. Finally, in its development stage, feasibility would be explored for using writing techniques generated from it for medical reviews as well as for writing case reports, provided there is strict compliance with prevailing standards within the context of medical research application. The application of generative writing in the domain of medication reviews and case reports requires more research; however, maintaining medical ethics while following regulatory requirements rigorously is essential. This gradient adaptation method can exploit artificial intelligence technologies for publication in scientific and technical journals of various fields, improving the quality and competitiveness of such publications.

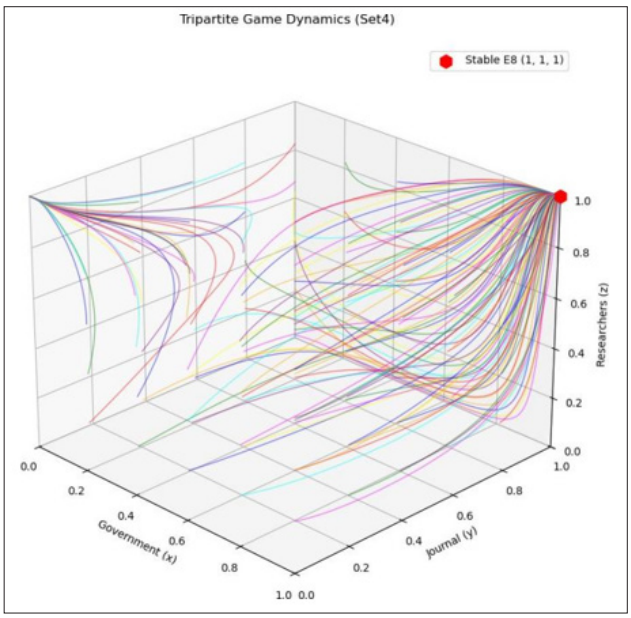

Figure 4: Technological Maturity Phase Evolutionary Game Path

Cultivating New Capabilities in Human Capital

In order to counteract the gradual introduction of artificial intelligence into scientific and technological literature, it is crucial to enhance digital skills within professionals working in the academic environment [14]. The basic program should include technical skills, operational requirements, and potential applications, amongst other aspects. At the same time, it is recommended to collaborate with the technical team for undertaking cooperative projects, hiring skilled editorial members, and participating in project plan- ning, hence creating a relationship between technical and editorial sections for ensuring interdisciplinary digital application skills in practice. Therefore, with AI algorithms skillfully implemented in varied stages within the editorial process, editorial members can attain required technical skills, hence curbing negative impacts resulting from organizational resistance, digital barriers, and other impediments hindering digital transformation in the editorial department.

Also, more research institutions should be willing to hold seminars focused on scientific journals enabled by developments in digital technology. The aim is to enhance scholars' knowledge regarding artificial intelligence technologies coupled with ethical aspects, making them capable of regulating their application adequately on their own [15]. Eventually, this project aims to enhance its research output while, at the same time, facilitating scientific and technological journal development. At the same time, in scientific and technical publications' editorial departments, artificial intelligence is moving from an initial digital integration phase into a more evolved phase.

Moreover, Government and ethical regulator should supervise strictly to be able to respond to ethical risk and academic misconduct. An extensive framework is necessary to stimulate stability in the academic environment. This kind of stability is important for the development of scientific journal [16].

Value Reconstruction of Academic Ecology and Culture

Using (F1, H1, K1) as a strategy, the tripartite evolutionary

game reaches a stable state at (1,1,1). This creates a new kind of equilibrium with more digital integration and better regulatory control. This change is a major shift in the academic world, and it requires a full re-evaluation of its basic ideas. To keep research integrity risks from relying too much on new technologies, the academic community should clearly define the roles of artificial intelligence in research and editorial procedures. Editorial boards should set strict rules for how AI can be used so that authors, reviewers, and editors are all held accountable for how much AI they use. We need to stress working together with AI and moving away from relying only on AI technologies to smart augmentation, where we weigh the benefits of increased productivity against the need to protect academic integrity and critical review. As AI becomes more common, the academic community needs to change its ethical frameworks and cultural values at the same time as it calls for responsible innovation, fairness, and trust in scholarly communication to continue.

Precision Insight into User Needs and Behavioral Trends

Throughout the evolutionary trajectory—from the early state (F2, H2, K2) to the mature state (F1, H1, K1)-the behavioural patterns and anticipations of primary users (readers, authors, and reviewers) undergo substantial evolution. As AI changes how editorial work is done, it's important to set up a system that uses data to gather user preferences. Editorial boards should use AI to analyze submission patterns, reviewer skills, and reading habits. This would make it easier to make personalised recommendations and offer flexible services. Authors can get help with formatting that is specific to their needs, and viewers can get content recommendations made by AI. During the development phase (F2, H2, K1), editorial boards don't have enough digital capacity to find wrongdoings in AI-generated content. As a result, using smart assistants like AI chatbots and semantic search engines can fix service problems and make things more clear. Scientific journals can better meet changing user expectations and become more important in the digital scholarly ecosystem by making users happier and more responsive.

Coordinated Response to Globalization and Regional Differences

The evolutionary game phases (0, 1, 1) and (1, 1, 1) show how new technologies make it easier for scientists all over the world to work together. Still, there are differences between regions in how quickly they adopt artificial intelligence and regulatory bodies. Journal publishers have to make sure that their global plans fit with what's going on in each country. AI-powered tools like translation and search algorithms could help lessen the effects of language barriers, which would encourage international exchange and raise the profile of Chinese scholarly journals around the world. Conversely, customized solutions are necessary for developing countries, particularly where data infrastructure is weak. For example, AI models that don't need a lot of resources could help these areas go through digital transformation at a low cost. In addition, journals in rich countries could help a lot by providing important technical tools and ways to run things. AI's use in scientific publishing around the world has to deal with different legal requirements and cultural norms, which means that there needs to be a unified but adaptable ethical framework. This joint effort makes sure that progress and inclusion happen at the same time.

Future Outlook

As AI technology keeps getting better, it is expected that AI's role in helping researchers with editing will become an even more collaborative and reliable partnership in the near future. This change will have a big effect on the progress of scientific and technological writing. AI is great at analysing and processing data, so it can quickly look at, analyse, and combine huge amounts of information. Human editors, on the other hand, have a natural understanding of the subject matter, the ability to make informed decisions, and the ability to think creatively. The two working together brings together AI's ability to do maths and researchers' ability to think creatively and analytically, which benefits both sides. In the end, this partnership should make academic publishing better and more efficient. Finally, it's important to have good rules and regulations in place to make sure that this growth happens in a responsible and thoughtful way.

Declaration

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