Evidence-Based Procurement Based on Three-Party Evolutionary Game Theory

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Abstract

Purpose/Significance: High-quality resource construction is the foundation of library services. Current mainstream procurement models, such as bulk purchasing and patron-driven acquisition, exhibit certain limitations. This paper focuses on evidence-based acquisition—an emerging procurement paradigm—to investigate the interactions among relevant stakeholders and promote its development. Method/Process: Through a systematic review of evidence-based acquisition, this study constructs a tripartite evolutionary game model encompassing libraries, users, and resource vendors. The model analyzes replicator dynamic equations and evolutionary stable strategies, conducts simulation experiments via MATLAB, examines the influence of various parameters on facilitating the evolution of evidence-based acquisition, clarifies the interactive and associative relationships among relevant entities, and illuminates the driving forces behind evidence-based acquisition. Results/Conclusion: The model identifies two evolutionary stable strategies. Based on the game-theoretic outcomes and practical realities, recommendations are proposed for advancing evidence-based acquisition.

Full Text

Evidence-Based Acquisition from a Tripartite Evolutionary Game Perspective

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Abstract

[**Purpose/Significance**] High-quality collection development is fundamental to library services. Current mainstream acquisition models, such as the "big deal" and Patron-Driven Acquisition (PDA), suffer from inherent limitations. This paper focuses on Evidence-Based Acquisition (EBA)—an emerging acquisition model—and examines the interactions among its key stakeholders to promote EBA development. [**Method/Process**] By systematically reviewing EBA, this study constructs a tripartite evolutionary game model involving libraries, users, and resource providers. We analyze the replicator dynamic equations and Evolutionarily Stable Strategies (ESS), conduct simulation experiments using MATLAB, dissect the impact of various parameters on EBA evolution, clarify the interactive relationships among stakeholders, and gain insights into the driving forces behind EBA. [**Result/Conclusion**] The model identifies two evolutionary stable strategies. Based on the game outcomes and practical considerations, we propose recommendations for advancing EBA.

Keywords: Evidence-Based Acquisition; Evolutionary Game; Collection Development

Introduction

With the development of digital technology, electronic collections have become an essential component of collection development for libraries worldwide. Compared to print books, e-books offer shorter publication cycles, diverse formats, environmental benefits, larger storage capacity, and easier retrieval, making them increasingly popular among users. During the COVID-19 pandemic, when students and faculty could not access campus library spaces or physical resources, the importance of digital resources that support remote teaching, research, and learning became particularly prominent. A Choice white paper survey found that three-quarters of academic libraries planned to purchase more e-books due to COVID-19 [1]. In this context, e-book acquisition has become increasingly important.

In recent years, global economic growth has slowed continuously. Since 2020, most libraries have experienced budget cuts, with significant uncertainty surrounding financial recovery post-pandemic. On March 25, 2021, China's Ministry of Education announced its departmental budget for 2021, with a general budget of 13,420,942 million RMB—a reduction of 673,589 million RMB (4.77%) from 2020 [2]. High-quality collection development is fundamental to library services. However, the mainstream e-book acquisition model—the "big deal"—has gradually become misaligned with library development. Its annual price increases and bundled deals result in resource waste, creating considerable challenges for budget-constrained libraries. To mitigate the impact of big deals, the industry has begun exploring new e-book acquisition models.

Patron-Driven Acquisition (PDA), which emerged in the late 1990s and early 2000s, has become a popular e-book acquisition model. PDA provides libraries

with greater flexibility from publishers and satisfies user needs, reducing the problem of zero-use collections [3]. However, PDA practice has revealed numerous defects: PDA projects often exhaust budgets too quickly, require librarians to pre-select titles, limit package sizes, and may not be more cost-effective than big deals—Liverpool University modeling found PDA was not necessarily more cost-effective than big deals [4]. Additionally, strict digital rights management, imbalanced collection development, and low user participation rates constrain PDA's development. Long-term optimization of library e-book acquisition models remains necessary.

2.1 Evidence-Based Acquisition

Collection development has always been a core library function, with book circulation and utilization being longstanding research subjects. Current mainstream e-book acquisition models can be categorized by time rights (subscription vs. perpetual ownership) or quantity (single-title subscription vs. package purchase), and also include Patron-Driven Acquisition and Evidence-Based Acquisition (EBA). Traditionally, librarians and subject specialists played crucial roles in collection development, selecting titles from vendor-provided lists based on experience and disciplinary expertise. However, tightening education budgets, low collection utilization rates, high interlibrary loan costs, and modern information technology developments have challenged these traditional acquisition models [5].

EBA is an emerging library acquisition model developed from PDA. It involves negotiations between libraries and resource providers, where libraries make an upfront payment and vendors provide access to an e-book pool. At the project's conclusion (typically after one year), libraries use the prepayment to purchase titles based on their own criteria, usually grounded in usage data [6]. Unlike traditional acquisition based solely on librarian experience or PDA based exclusively on usage quantity, EBA combines librarian expertise, user needs, and library development goals. It pursues high-quality evidence and ensures collection distinctiveness and rationality while meeting user needs [7]. EBA also effectively addresses library budget crises by securing maximum resource access within budget constraints to meet diverse disciplinary needs, free from digital rights restrictions. After the agreement period, libraries can permanently acquire e-books based on multiple selection criteria including usage data and expert review. EBA provides a solution to conflicts among user needs, library budgets, and vendor interests.

In international EBA research, Andrew Booth [8] argues that question formulation is fundamental to evidence-based practice, as questioners often stimulate experienced practitioners to challenge long-held assumptions. Helen Partridge et al. [9] used semi-structured interviews to explore differences in how library and information professionals experience evidence-based practice and proposed a conceptual framework. In domestic research, Zhou Yi [10] posits that evidence-based practice emphasizes value orientation combining evidence, theory, and

practice, integrating application subjects, contexts, and evidence. Dang Hongli [11] introduced EBA concepts, impacts, and implications, examining practices at the University of British Columbia Library and other institutions to inform domestic libraries. Hou Jingli [12] analyzed EBA practices in the Orbis Cascade Alliance and Colorado Alliance of Research Libraries from a consortium perspective. Ma Chen et al. [13] conducted a SWOT analysis of EBA, critically examining its advantages and disadvantages and proposing application strategies. While EBA has been applied internationally and in Hong Kong, Macau, and Taiwan for years, it remains a new collection development model for mainland Chinese libraries with limited large-scale implementation.

Recent representative EBA projects include: The Orbis Cascade Alliance, comprising 39 academic libraries across Idaho, Oregon, and Washington, used DDA from 2011-2015. In 2015, it re-evaluated DDA and investigated EBA. Compared to DDA, EBA offered fixed expenditures, no DRM restrictions, larger title pools, and comparable costs to short-term loans and DDA. Considering these benefits, the Alliance launched EBA with Wiley in May 2016. Due to positive outcomes, it discontinued DDA after 2017 and expanded EBA to multiple publishers [12], [14].

Stony Brook University piloted an EBA program for STEM e-books. In 2019, two publishers participated: Publisher A offered a general engineering and computer science package with 969 titles, while Springer provided 3,186 e-books—2,271 more than Publisher A. Publisher A's price was $6,789.20 higher than Springer's. Stony Brook partnered with Springer for a 12-month EBA in engineering and science. During this period, 361 e-books were used 6,810 times, with download spikes in November 2019, April 2020, and September 2020. November 2019 saw 1,045 downloads when the project launched, while April 2020 reached 970 downloads due to COVID-19 online instruction increasing demand for digital resources. The most-used category comprised 8 conference proceedings. Stony Brook's evaluation found the 361 e-books cost 36% of their average retail price. As the pilot occurred during the pandemic, the EBA pool became an important supplement to online collections [15].

The Chinese Academy of Sciences Documentation and Information Center launched an EBA project with Elsevier in 2017. The first three-year contract featured modest prepayment increases while Elsevier's offered e-books grew annually, reaching 28,463 titles by end-2019. Users accessed 20,366 titles, and the library permanently acquired 1,271 titles based on list prices and subscription fees at contract end. In July 2020, cooperation continued with an 18-month agreement. By September 2021, the pool expanded to 38,478 titles with 19,050 used titles, and average costs decreased significantly from the previous cycle.

2.2 Evolutionary Game Theory

Evolutionary game theory combines biological evolution theory with economic game theory. Unlike traditional game theory, it assumes incomplete information and bounded rationality, where players achieve equilibrium through continuous comparison, learning, and imitation. Evolutionary game theory examines populations of participants that change over time, aiming to understand group evolution dynamics and explain why and how groups reach their current states [16]. Its characteristics help investigate problem complexity and dynamics [17]. Domestic applications of evolutionary game theory have proliferated in recent years, particularly in economics. Its core concepts—replicator dynamics and Evolutionarily Stable Strategies—provide modeling foundations for analyzing dynamic evolution mechanisms and identifying optimal strategy combinations [18].

Current EBA remains exploratory with many unresolved issues. However, given budget reductions and the pandemic's continuation, EBA development benefits library resource model innovation and aligns with precision collection goals. This paper introduces evolutionary game theory to EBA, constructing a tripartite model of libraries, users, and resource providers from stakeholder interest perspectives. We analyze evolutionary path selection and stability factors among EBA participants and propose recommendations.

3.1 Game Player Analysis

Resource Providers: Resource providers include publishers and aggregators who are essentially "economic agents" whose behaviors are determined by economic interests, driving them to monopolize e-book copyrights and compress library business scopes [19]. In EBA projects, resource providers must cooperate with libraries. After agreeing on prepayment terms, they provide MARC records for library discovery systems, eliminate usage, download, and concurrency restrictions, and deliver usage statistics reports throughout the project. The applicability, accuracy, and detail of usage statistics are critical criteria for final e-book selection. Additionally, resource quality, variety, service capacity, service levels, and prior cooperation history are important factors in library vendor selection.

Libraries: In the EBA chain, libraries must identify suitable vendors, negotiate for optimal budget utilization, serve users, attract user participation, ensure engagement, meet user needs, and select e-books based on multiple criteria including usage data. Libraries act as both practitioners and managers, making them crucial players in this game.

Users: As resource users, patrons are essential library constituents. Libraries initiate EBA to meet user needs, and usage data serves as important evidence for acquisition. Resource acquisition without user usage is meaningless. EBA represents another exploration to enhance resource utilization rates.

[Figure 1: see original paper]

3.2 Model Assumptions and Parameter Definitions

Assumption 1: In EBA, libraries have two choices (cooperate, not cooperate), users have two choices (high utilization, low utilization), and resource providers have two choices (high prepayment, low prepayment). Let x, y, z represent the probabilities of choosing cooperation, high utilization, and high prepayment respectively; (1-x), (1-y), (1-z) represent the probabilities of choosing non-cooperation, low utilization, and low prepayment respectively.

Assumption 2: When resource providers choose high prepayment, their revenue is u_{31} with human/material costs c_{31}. If libraries cooperate at this time, library revenue is u_{11} with cost c_{11}. Library-vendor cooperation benefits collection development and enhances library brand effect v_{1}. Given recent budget constraints, high prepayment may disrupt future cooperation, causing long-term loss s_{31} to vendors. Under high prepayment, if libraries choose non-cooperation, they incur loss B_{11} from seeking other vendors while the vendor experiences zero profit/loss.

Assumption 3: When resource providers choose low prepayment, revenue is u_{32} with cost c_{32}. If libraries cooperate, library revenue is u_{12} with cost c_{12}. Long-term cooperation may establish friendly relations, generating additional vendor benefit s_{32}. Under low prepayment, library non-cooperation causes zero vendor profit/loss but library loss B_{12}.

Assumption 4: When users utilize EBA resources, their benefit is u_{2} with search time cost c_{2}. When resources match needs, high utilization yields satisfaction v_{2}. User utilization rates create risks for libraries and vendors under different conditions: high utilization with high prepayment creates risk B_{31} for vendors; high utilization with low prepayment creates risk B_{32} for vendors. Low utilization from unmet needs or unawareness causes user loss s_{21} and library risk r_{1} from inefficient budget use. If library-vendor cooperation fails, users incur additional effort s_{22} seeking resources elsewhere. Library non-cooperation under high utilization causes user loss B_{21}; under low utilization causes loss B_{22}.

4.1 Model Construction

Based on the above analysis, the evolutionary game payoff matrix for libraries, users, and resource providers is as follows:

4.2 Utility Function Construction

Based on the payoff matrix, we derive the expected utility and average utility functions for each party.

(1) Library Expected Utility and Average Utility Functions

Library's utility from cooperating:

$$E_{11} = yz(u_{11}-c_{11}+v_1)+y(1-z)(u_{12}-c_{12}+v_1)+z(1-y)(u_{11}-c_{11}+v_1-r_1)+(1-z)(1-y)(u_{12}-c_{12}+v_1-r_1)$$

Library's utility from not cooperating:

$$E_{12} = yz(-B_{11}) + y(1-z)(-B_{12}) + (1-y)z(-B_{11}) + (1-y)(1-z)(-B_{12})$$

Library's average utility:

$$E_1 = xE_{11} + (1-x)E_{12}$$

(2) User Expected Utility and Average Utility Functions

User's utility from high utilization:

$$E_{21} = xz(u_2-c_2+v_2)+x(1-z)(u_2-c_2+v_2)+(1-x)z(-s_{22}-B_{21})+(1-x)(1-z)(-s_{22}-B_{21})$$

User's utility from low utilization:

$$E_{22} = xz(u_2-c_2-s_{21})+x(1-z)(u_2-c_2-s_{21})+(1-x)z(-s_{22}-B_{22})+(1-x)(1-z)(-s_{22}-B_{22})$$

User's average utility:

$$E_2 = xE_{21} + (1-x)E_{22}$$

(3) Resource Provider Expected Utility and Average Utility Functions

Resource provider's utility from high prepayment:

$$E_{31} = xy(u_{31} - c_{31} - s_{31} - B_{31}) + x(1-y)(u_{31} - c_{31} - s_{31})$$

Resource provider's utility from low prepayment:

$$E_{32} = xy(u_{32} - c_{32} + s_{32} - B_{32}) + x(1-y)(u_{32} - c_{32} + s_{32})$$

Resource provider's average utility:

$$E_3 = xE_{31} + (1-x)E_{32}$$

4.3.1 Library Strategy Stability Analysis

The library's replicator dynamic equation is:

$$F(x) = x(1-x)[z(u_{11}-c_{11}+v_1-r_1+B_{11})+(1-z)(u_{12}-c_{12}+v_1-r_1+B_{12})+yr_1]$$

Stability requires $F(x) = 0$ and $dF(x)/dx < 0$. The derivative is:

$$\frac{dF(x)}{dx} = (1-2x)[z(u_{11}-c_{11}+v_1-r_1+B_{11})+(1-z)(u_{12}-c_{12}+v_1-r_1+B_{12})+yr_1]$$

Let $G(y) = z(u_{11} - c_{11} + v_1 - r_1 + B_{11}) + (1-z)(u_{12} - c_{12} + v_1 - r_1 + B_{12}) + yr_1$. Since $\partial G(y)/\partial y > 0$, $G(y)$ is increasing in y. When $y^* = -\frac{z(u_{11}-c_{11}+v_1-r_1+B_{11})+(1-z)(u_{12}-c_{12}+v_1-r_1+B_{12})}{r_1}$, $G(y) = 0$ and $dF(x)/dx = 0$. When $y > y^*$, $G(y) > 0$, making $x = 1$ the ESS. When $y < y^*$, $G(y) < 0$, making $x = 0$ the ESS. When $y = y^*$, the ESS is indeterminate.

[Figure 2: see original paper]

Conclusion 1: The library's probability of choosing cooperation increases with user high utilization probability and decreases with low utilization probability. This indicates that whether libraries adopt EBA depends on whether vendor resources match user needs.

4.3.2 User Strategy Stability Analysis

The user's replicator dynamic equation is:

$$F(y) = y(1-y)[x(v_2 + s_{21}) + (1-x)(B_{22} - B_{21})]$$

The first derivative is:

$$\frac{dF(y)}{dy} = (1-2y)[x(v_2 + s_{21}) + (1-x)(B_{22} - B_{21})]$$

Let $H(x) = x(v_2 + s_{21}) + (1-x)(B_{22} - B_{21})$. Since $\partial H(x)/\partial x > 0$, $H(x)$ is increasing. When $x^* = \frac{B_{21}-B_{22}}{v_2+s_{21}+B_{21}-B_{22}}$, $H(x) = 0$ and $dF(y)/dy = 0$. When $x > x^*$, $H(x) > 0$, making $y = 1$ the ESS. Conversely, when $x < x^*$, $H(x) < 0$, making $y = 0$ the ESS.

[Figure 3: see original paper]

Conclusion 2: User high utilization probability increases with library cooperation probability and decreases with non-cooperation probability. This shows that when libraries select user-appropriate resources and promote EBA programs effectively, higher e-book utilization reduces library risk, encouraging EBA renewal. This enables libraries to build better collections and fulfill their service mission.

4.3.3 Resource Provider Strategy Stability Analysis

The vendor's replicator dynamic equation is:

$$F(z) = z(1-z)[xy(B_{32} - B_{31}) + x(u_{31} - c_{31} - s_{31}) - x(u_{32} - c_{32} + s_{32})]$$

The first derivative is:

$$\frac{dF(z)}{dz} = (1-2z)[xy(B_{32} - B_{31}) + x(u_{31} - c_{31} - s_{31}) - x(u_{32} - c_{32} + s_{32})]$$

Let $J(y) = xy(B_{32} - B_{31}) + x(u_{31} - c_{31} - s_{31}) - x(u_{32} - c_{32} + s_{32})$. When $J(y) = 0$, $y^{**} = \frac{(u_{32}-c_{32}+s_{32})-(u_{31}-c_{31}-s_{31})}{B_{32}-B_{31}}$. $J(y)$ is increasing in y. When $y > y^{**}$, $J(y) > 0$, making $z = 1$ the ESS. When $y < y^{**}$, $J(y) < 0$, making $z = 0$ the ESS.

[Figure 4: see original paper]

Conclusion 3: The vendor's probability of choosing high prepayment increases with user high utilization probability. This indicates that increased user utilization threatens vendor interests, prompting them to raise prices to offset losses from higher usage.

4.4 System Equilibrium Stability Analysis

Setting $F(x) = 0$, $F(y) = 0$, $F(z) = 0$ yields meaningful system equilibrium points. Solving the replicator dynamic equations simultaneously gives: $E_1(0,0,0)$, $E_2(0,0,1)$, $E_3(0,1,0)$, $E_4(0,1,1)$, $E_5(1,0,0)$, $E_6(1,0,1)$, $E_7(1,1,0)$, $E_8(1,1,1)$.

The Jacobian matrix of the tripartite evolutionary game is:

$$J = \begin{bmatrix} \frac{\partial F(x)}{\partial x} & \frac{\partial F(x)}{\partial y} & \frac{\partial F(x)}{\partial z} \\ \frac{\partial F(y)}{\partial x} & \frac{\partial F(y)}{\partial y} & \frac{\partial F(y)}{\partial z} \\ \frac{\partial F(z)}{\partial x} & \frac{\partial F(z)}{\partial y} & \frac{\partial F(z)}{\partial z} \end{bmatrix}$$

$$= \begin{bmatrix} (1-2x)[z(u_{11} - c_{11} + v_1 - r_1 + B_{11}) + (1-z)(u_{12} - c_{12} + v_1 - r_1 + B_{12}) + yr_1] & x(1-x \\ y(1-y)[v_2 + s_{21} - B_{22} + B_{21}] & (1-2y)[x(v_2 + s_{21}) + (\\ z(1-z)[y(B_{32} - B_{31}) + (u_{31} - c_{31} - s_{31}) - (u_{32} - c_{32} + s_{32})] & z(1-z)[x(B_3 \end{bmatrix}$$

According to Lyapunov's first method, an equilibrium is unstable if at least one Jacobian eigenvalue is positive, asymptotically stable if all eigenvalues are negative, and critical if all real parts are non-positive with some zero eigenvalues. Stability analysis of equilibrium points is shown below:

Conclusion 4: When $u_{12}-c_{12}+B_{12} > r_1$, $u_{11}-c_{11}+B_{11} > r_1$, $u_{31}-c_{31}-s_{31} > u_{32}-c_{32}+s_{32}$, and $B_{32}-B_{31}+u_{31}-c_{31}-s_{31} > u_{32}-c_{32}+s_{32}$, the EBA system has only one equilibrium point $E_8(1,1,1)$. This indicates that when user low-utilization risk is low or user utilization is high, library net benefits from EBA are high, and non-cooperation losses are substantial, while vendor long-term losses from high prepayment are small and long-term benefits from low prepayment are also low, the strategy combination evolves to (Cooperation, High Utilization, High Prepayment). In this scenario, strong user demand and effective library promotion drive high participation, maximizing budget efficiency. Even with high prepayment, libraries are willing to renew contracts.

Conclusion 5: When $u_{12} - c_{12} + B_{12} + v_1 < r_1$, $u_{11} - c_{11} + B_{11} + v_1 < r_1$, $u_{31}-c_{31}-s_{31} < u_{32}-c_{32}+s_{32}$, and $B_{32}-B_{31}+(u_{31}-c_{31}-s_{31}) < (u_{32}-c_{32}+s_{32})$,

the system has two critical points $E_1(0,0,0)$, $E_2(0,0,1)$ and one stable point $E_7(1,1,0)$. When vendor potential losses from high prepayment are large but low prepayment yields greater long-term benefits, and the risk gap between high and low prepayment under high utilization is small, vendors will choose low prepayment, stabilizing at (Cooperation, High Utilization, Low Prepayment).

5 Numerical Simulation Analysis

To validate the stability analysis, we assign parameter values based on real-world conditions and expert advice, conducting simulations using MATLAB 2018b. **Parameter Set 1**: $u_{11} = 100$, $c_{11} = 100$, $v_1 = 10$, $r_1 = 0$, $B_{11} = 20$, $u_{12} = 100$, $c_{12} = 80$, $B_{12} = 30$, $v_2 = 10$, $s_{21} = 10$, $B_{22} = 5$, $B_{21} = 10$, $B_{32} = 20$, $B_{31} = 15$, $u_{31} = 150$, $c_{31} = 50$, $s_{31} = 40$, $u_{32} = 65$, $c_{32} = 50$, $s_{32} = 40$. This satisfies conditions . To analyze r_1's impact, we set $r_1 = 0, 50, 100$. The replicator dynamics over time are shown in Figure 5 [Figure 5: see original paper].

Conclusion 6: The figure shows that reduced user low-utilization risk accelerates library cooperation strategy evolution. As r_1 decreases, library cooperation probability increases, and vendor high prepayment probability also rises. This indicates that adequate library budgets and high user utilization reduce resource inefficiency risks, encouraging EBA adoption.

To examine vendor prepayment revenue effects, we set high prepayment revenue $u_{31} = 150, 140, 130$, keeping other parameters constant. Results are shown in Figure 6 [Figure 6: see original paper].

Conclusion 7: With other parameters unchanged, reduced high prepayment revenue u_{31} decreases vendor high prepayment probability. When user low-utilization risk remains low, library cooperation probability increases. Figures 5 and 6 demonstrate that user utilization is critical to EBA success. Libraries develop collections based on user needs, but with limited budgets and unlimited resources, libraries must leverage decision-making and negotiation skills to maximize benefits when vendors' demands are excessive.

Next, we assign $s_{32} = 40, 80, 120$. Simulation results are shown in Figure 7 [Figure 7: see original paper].

Conclusion 8: Figure 7 shows that greater vendor long-term benefits from low prepayment increase low prepayment strategy selection. As low prepayment probability rises, libraries increasingly favor cooperation. Reasonably optimizing digital resource pricing to achieve supply-demand coordination benefits both parties and enables symbiotic development.

Parameter Set 2 ($u_{11} = 100$, $c_{11} = 100$, $v_1 = 10$, $r_1 = 10$, $B_{11} = 20$, $u_{12} = 100$, $c_{12} = 80$, $B_{12} = 30$, $v_2 = 10$, $s_{21} = 10$, $B_{22} = 5$, $B_{21} = 10$, $B_{32} = 20$, $B_{31} = 15$, $u_{31} = 150$, $c_{31} = 50$, $s_{31} = 40$, $u_{32} = 70$, $c_{32} = 50$, $s_{32} = 40$) satisfies condition . **Parameter Set 3** (same as Set 2 but $s_{32} = 60$) satisfies condition .

Simulating 50 iterations yields results shown in Figures 8 [Figure 8: see original paper] and 9 [Figure 9: see original paper].

Figure 8 shows the system converging to the sole ESS (Cooperation, High Utilization, High Prepayment), consistent with Conclusion 4. Figure 9 shows the system converging to ESS (Cooperation, High Utilization, Low Prepayment), consistent with Conclusion 5. Simulation and stability analyses align, providing practical guidance for EBA implementation.

The crux of EBA lies in user utilization, library commitment to the model, and vendor benefit protection. Users and libraries mutually influence each other: higher utilization increases library EBA adoption likelihood, while EBA programs positively impact utilization. Users and vendors have no direct contact, but usage intensity creates vendor risk, affecting vendor strategies. Library-vendor negotiation is key to sustainability. Libraries enrich collections and build reputation through EBA, while reasonable vendor pricing enables long-term cooperation. EBA continuity requires tripartite collaboration. As the pivot of e-book acquisition, libraries should select appropriate vendors, promote resources actively, and prevent resource unavailability. EBA demands significant librarian time and effort. To maintain good vendor relations, libraries must enhance staff competencies, decision-making abilities, and negotiation skills to ensure proper budget allocation and broaden funding channels. EBA is a win-win approach requiring continuous adjustment and planning to satisfy all stakeholders.

6 Conclusions and Recommendations

EBA is nascent in China. The Chinese Academy of Sciences Documentation and Information Center adopted EBA for Elsevier e-books, while Shanghai Jiao Tong University implemented five EBA projects from 2017-2019. Vendors like Cambridge University Press, JSTOR, and De Gruyter actively promote EBA. While processes are generally consistent across publishers, each has unique features. Cambridge University Press supports customized EBA deals and employs dedicated marketing teams to promote EBA to researchers and students via email campaigns [20], establishing successful partnerships with the University of Johannesburg and the University of Bath, who consider it simple and cost-effective [21]. JSTOR provides access to over 67,000 high-quality e-books from 100+ publishers, collaborating with ProQuest and EBSCO to manage demand-driven acquisition and combining it with EBA to help libraries control costs [22]. While EBA helps libraries innovate collection development, challenges remain. Based on our evolutionary game analysis and existing practices, we offer the following recommendations:

(1) Select appropriate vendors for targeted acquisition. With limited budgets, effectively meeting most user needs is challenging. EBA's broad resource pool addresses both user needs and budget constraints. Vendor resource variety, quality, and service levels must align with library goals. Rich and diverse vendor resources improve EBA success rates. Libraries should consider:

whether vendors offer EBA; appropriate prepayment amounts [23]; detailed, authentic usage reports; resource quality, quantity, and variety; seamless integration with library systems [24]; user concurrency limits; and timely, regular MARC record delivery [25]. User-need-oriented collection development that integrates institutional goals with suitable vendors and effective acquisition plans upgrades traditional collections.

(2) Enhance promotion and integrate technical tools. Usage data is central to EBA acquisition decisions. Low utilization creates library risk and budget inefficiency—vendors leverage this to promote new acquisition models promising better ROI [25]. Increasing utilization is key to EBA success. Current domestic EBA practice lacks promotion, leaving users uninformed. Libraries can leverage user "footprint" data to build user profiles and recommendation systems based on information needs, preferences, and search habits [26], enabling intelligent resource scheduling that reduces information gaps, encourages unrestricted usage, increases user loyalty, and multiplies EBA knowledge value.

(3) Improve librarian competencies for efficient acquisition. EBA promotion and process control require skilled staff. Librarians' market understanding, budgeting, decision-making, and negotiation skills are critical for effective communication and balanced interests. Staff quality directly affects EBA efficiency and effectiveness. Libraries should organize regular training, clarify career development plans, send staff to experienced libraries for training, participate in online courses and conferences, and institutionalize training systems [27]. Recruiting professionals and maximizing talent value are also crucial. Standardizing procurement processes, strengthening departmental collaboration, and improving efficiency are essential for EBA development.

(4) Establish EBA standards for sustainable development. EBA operation depends on tripartite participation. While resource acquisition is sustainable for libraries and vendors, it only works within budget constraints and with vendor cooperation. Pricing must sustain vendor income and publishing while remaining acceptable to libraries. Standards can balance interests, promote reasonable pricing, prevent risks from blind purchasing, save time and effort, maintain market balance, and ensure smooth operation. Standardized EBA development also facilitates e-resource management, requiring comprehensive project parameter planning and interdepartmental coordination. From negotiation to acquisition to evaluation, standardized processes enable libraries to seize opportunities in collection development transformation.

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Author Contributions

Zhang Di: conceptualization, writing; Zhu Jiang: revision and supplementation; Pan Ting: data collection.

Note: Figure translations are in progress. See original paper for figures.