Government Leadership and Market Participation: A Collaborative Development Model for the Cultural Ecosystem Services of Nature Reserves

Yue Song
Zhonghe Zhang
Wenjia Liu
Meng Lin

Abstract

Natural protected areas possess abundant cultural ecosystem services (CESs), requiring integrated efforts from both government and market for development; however, disagreements and debates regarding respective development boundaries are ongoing. This study establishes a theoretical framework for observation and analysis using protected areas in state-owned forest regions of NE China as a case study. Data were collected from multiple stakeholders. The research results show the following. (1) Protected areas in NE China's state-owned forests contain at least five types of CES. Among these, scientific research (mean = 3.877), education (mean = 3.907), and psychological benefits (mean = 3.930) were rated higher than spiritual values (mean = 2.908) and recreation (mean = 2.898). (2) Government intervention and market demand not only directly improve the quality and efficiency of CES development but also leverage the foundational advantages of resource endowment and development level to indirectly enhance CES outcomes. (3) In the development of CES in protected areas, the government focuses on ecological conservation and restoration, whereas the market prioritizes economic value. This study constructs a framework for understanding the complex causal relationships between CES development approaches and their effectiveness. It also clarifies the development boundaries between government and market roles in protected areas.

The Millennium Ecosystem Assessment Report raises a question crucial for the 21st century: What are our options for ensuring the sustainable use of ecosystems? Regarding protected areas, this becomes a pressing governance issue. Despite 17.6 percent of global terrestrial ecosystems being protected as of 2024, institutional barriers still hinder ecological service provision and community well-being in these areas. Cultural ecosystem services (CESs), vital for linking ecological and human well-being, are key for intergenerational equity in protected areas. However, a major challenge is that CESs, as public goods, need government intervention to correct market failures and market mechanisms to boost resource allocation efficiency. Yet, the boundaries and interaction pathways between government and market in CES development remain unclear.

In recent years, China has established numerous nature reserves, offering rich cases for exploring CES development models. The 2017 Regulations on Nature Reserves clarified the basis for construction and management, ensuring orderly CES development. In 2020, China launched the National Protected Areas Integration and Optimization Initiative to enhance protected area integrity and clarify CES development boundaries. For example, Heilongjiang

The authors are, respectively, Doctor, Northeast Forestry University, Harbin (daisysongyue@foxmail.com); Master, Heilongjiang University, Harbin (2240013@s.hlju.edu.cn); Doctor, Shanghai Customs University, Shanghai (2005400@shcc.edu.cn [corresponding author]); and Associate Professor, Heilongjiang University, Harbin (imlinmeng@hlju.edu.cn [corresponding author]), P. R. China. This paper was received for publication in May 2025. Article no. 25-00028.

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Province completed this process in 2023, reducing the number of protected areas from 464 to 339, and shifted CES development from government-dominated to a multi-stakeholder model with government leadership and market regulation.

Existing research has reached several consensuses on the necessity, key challenges, and ideal models for CES development. CES refers to the non-material benefits that people derive from ecosystems through spiritual satisfaction, cognitive development, reflection, recreation, and aesthetic experiences; it serves as an essential link between ecosystems and human well-being. Developing CESs can translate ecosystem functions into human welfare (Gladkikh et al. 2019; Nie et al. 2025). Moreover, a key challenge in CES development lies in overcoming the non-excludability issue. For instance, direct sensory experiences based on biodiversity cannot exclude non-paying groups, potentially causing welfare loss. Similarly, government intervention and market regulation can be used to alleviate non-excludability and enhance the quality and efficiency of CES development.

The current governance paradigm faces a dilemma. On one hand, government-led models can ensure the scale effect of CES supply through policy tools but cannot avoid the inefficiency trap in public governance and interest distribution imbalance (Huang et al. 2019; Wang et al. 2022). On the other hand, market mechanisms can activate community participation but face commodification distortion because of difficulties in measuring non-material values (Kirby et al. 2003; Masozera et al. 2006). Although the academic community advocates collaborative governance between government and the market, unresolved key scientific issues are still found (Benjamin 2008). First, the way in which the heterogeneous nature of CES affects the effectiveness of governance tool selection must be determined. Existing classification frameworks fail to deconstruct the essential differences in value sources, beneficiary groups, and intergenerational sustainability across different CES types. Second, knowledge of how to build a Pareto improvement path for multi-stakeholder collaboration must be established. Existing research has not revealed the coupling mechanism between government regulation and market incentives. Therefore, it is necessary to study the combined effects of government intervention and market regulation.

Further research shows that the perceptual sensory dimensions of urban green spaces significantly affect cultural service supply. Optimizing a green space design can boost cultural services and promote ecological sustainability (Chen et al., 2023). Cultural services are also vital for regional sustainable development and ecological restoration. For instance, studies on the Yellow River Basin indicate that cultural services can enhance ecosystem functions and community well-being. Additionally, ecological restoration research on the Yongding River reveals that public satisfaction greatly contributes to the total value of ecosystem services (Wu et al. 2024; Yu et al. 2024).

Prioritizing cultural services can guide resource allocation and policymaking; however, the realization of cultural service value is influenced by various factors, including ecological endowments, transportation, and marketing strategies (Isaias et al. 2022; Lin et al. 2025). Sociocultural values, land-use changes, degree of public participation, and types of urban infrastructure also significantly affect the realization of cultural service value (Raymond et al. 2009; Kaymaz et al. 2024). Different regions have varied focuses on cultural service value realization because of factors such as natural landscapes and protected areas. Therefore, in the joint-intervention process of government and market, it is necessary to consider the development level, resource endowments, geographical environment, and other factors of the region.

Using this information, this study explores designing a collaborative mechanism of government intervention and market regulation to boost CES development efficiency and quality. It builds a comprehensive theoretical framework that integrates CES, government intervention, market regulation, and other factors (e.g., development level, resource endowments, geographical environment). The study also collects multi-source data from the government, enterprises, universities, and consumers and uses structural equation models for fitting to form appropriate CES development paths. Moreover, it contrasts and discusses CES development models in other countries and regions and summarizes theoretical findings that reveal the coupling mechanism of government regulation and market incentives. Through this research, this study provides potential contributions on theoretical and practical levels. Theoretically, it constructs a causal chain between CES heterogeneous characteristics and governance tool compatibility. Practically, it proposes a dynamic optimization path for combined governance, providing a system design blueprint for global-protected areas to achieve the Millennium Ecosystem Assessment–proposed supply and value equilibrium goals.

Materials and Methods

Model specification

To identify optimal application scenarios for the two primary development approaches—government intervention and market demand—this study constructs a theoretical framework (Fig. 1). The theoretical framework adopts a directed acyclic graph structure to analyze three core components: CES origins, development approaches, and final outputs. This formalism is chosen because directed acyclic graphs effectively disentangle the complex causal relationships between government interventions, market forces, and CES outcomes across varying contexts in protected areas (Colombo et al. 2012).

The final CES typology adopts the Millennium Ecosystem Assessment classification system, encompassing five service categories: spiritual, scientific, educational, psychological, and recreational services provided by ecosystems (Millennium Ecosystem Assessment 2005). Spiritual services are delivered through natural and cultural heritage assets (Ryfield et al. 2019). It provides indigenous communities with symbolic representations of local knowledge, traditional practices, and ecological beliefs (Chaudhary et al. 2019). Moreover, spiritual services progressively incorporate contemporary popular culture elements through temporal evolution (Coscieme 2015). Scientific services use ecosystems as natural laboratories and data sources, enhancing human benefits in scientific research, technological innovation, and ecological monitoring (Friess et al. 2020). Educational services employ ecosystems as knowledge platforms and living classrooms, fostering environmental literacy and ecological ethics through immersive landscape

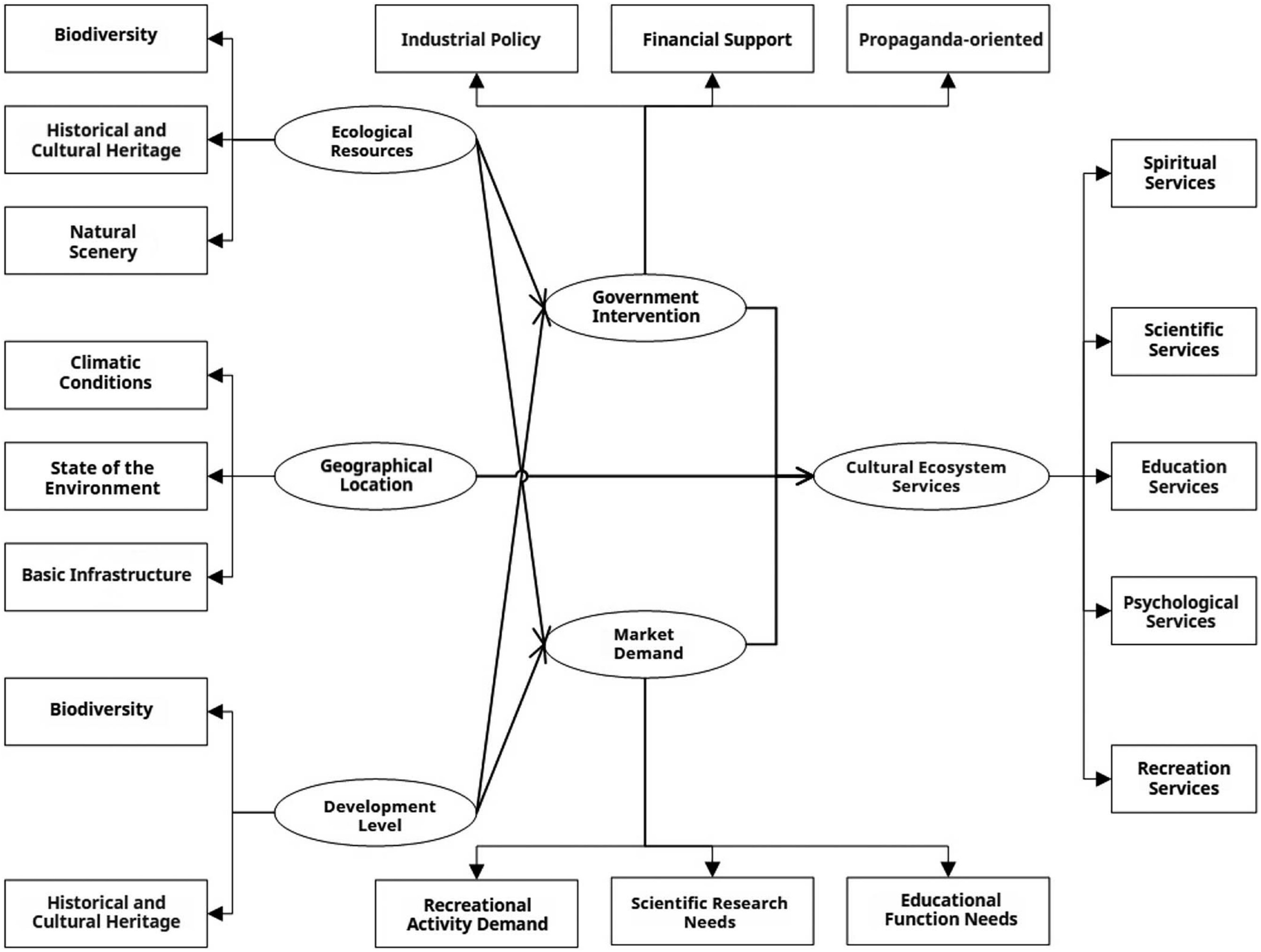

Figure 1.—Theoretical analytical framework for cultural ecosystem service development models.

experiences, thereby bridging scientific knowledge and public understanding (Mocior et al., 2016). Psychological services originate from sensory stimulation by ecosystems. Proximity to or visits to ecosystems maintain mental well-being. A Beijing case study demonstrates dual mechanisms: urban green spaces directly provide psychological benefits for elderly residents, which indirectly enhance mental health by enabling physical exercise (Guo et al. 2023). Recreational services are supported by ecosystem landscapes, providing humans with leisure activities and aesthetic experiences. These services demonstrate significant development potential (Moseley et al. 2018). For instance, recreational services account for approximately one-third of the economic benefits generated by European forests; however, both their scale and return rates remain lower than timber provisioning services, thus indicating substantial potential for enhancement (Lovrić et al. 2025).

Despite their capacity to deliver multiple critical CESs, these services remain significantly understudied in academic research and largely neglected in management practices. Educational and scientific services are typically perceived as non-excludable public goods (Mocior et al., 2016; Friess et al. 2020). Spiritual and psychological services are systematically excluded from mainstream assessment frameworks in most studies (Garrett et al. 2023). Therefore, targeted development requires embedded government intervention or market regulation. Government intervention encompasses three approaches: formulating ecological policies and development plans; implementing ecological engineering projects with corresponding investments; and promoting public participation in CES conservation and use through awareness campaigns. Market regulation operates by aligning supply with demand for CESs. Specifically, recreation, scientific research, and educational services demonstrate clearly identifiable demand entities. Government approaches to CES development exhibit significant diversification. High-quality CES development necessitates synergistic integration of governmental and market forces. This rationale generates two testable research hypotheses.

Hypothesis 1: Government intervention exerts a positive effect on the CES value in protected areas.

Hypothesis 2: Market demand demonstrates a positive causal relationship with the CES valuation in protected areas.

The quantity and quality of CES are fundamentally determined by their originating sources. Ecological resources, geographical location, and social development constitute the three primary sources of CESs (Goodness et al. 2016). Among these, ecological resources serve as the direct provisioning source for CESs. Biodiversity provides essential study subjects for educational and scientific services (Schaich et al. 2010; Blake et al. 2021). Natural landscapes and cultural heritage constitute the direct value sources for recreational, spiritual, and psychological services (Plieninger et al. 2014). Geographical location fundamentally determines ecosystem dynamics and development potential.

When an ecosystem is situated in a location with favorable climatic conditions, a superior environmental baseline, and well-developed infrastructure, it not only exhibits strong ecological resilience but also ensures accessibility for human activities (Al-Assaf et al. 2016). The level of development enables the exploitation of CESs. A region with advanced economic development and high technological capacity can attract a significant influx of tourists and researchers, thereby enabling the substantial realization of CES value (Wang et al. 2019). This leads to the formulation of three research hypotheses:

Hypothesis 3: Geographic environment exerts a positive influence on the CES value of protected areas.

Hypothesis 4: Resource endowment has a positive effect on the CES value of protected areas.

Hypothesis 5: Development level positively affects the CES value of protected areas.

Moreover, a close relationship occurs between resource endowment and development level. Abundant natural resource endowment can provide raw materials for industrial production, reduce production costs, and promote industrial development. For instance, the Middle East has developed into a globally significant energy supply center thanks to its rich oil resources. The growth of the oil industry has driven rapid local economic expansion and enabled the region to attain a relatively high level of economic development in a short period. Similarly, the advantage of resource endowment often attracts the clustering of related industries, forming industrial clusters and generating scale economic effects, which further propel economic development (Raymond et al. 2009). Resource development and use can also create several job opportunities and boost residents' income levels, thereby promoting consumption, stimulating domestic demand, and promoting a virtuous economic cycle (Chen et al., 2012).

Moreover, resource-abundant regions may overly depend on resource-based industries, neglecting the development of other industries. This leads to a monolithic industrial structure and unsustainable economic development. When resources are exhausted or resource prices fluctuate, the economy can easily fall into difficulty. Abundant resource endowment may cause enterprises and local governments to develop path dependence, lacking the motivation and pressure to innovate, which is against technological progress and industrial upgrading (Liu et al. 2008).

The degree of market mechanism perfection and quality of the institutional environment can affect the efficiency of transforming resource endowment into economic development advantages. In areas with well-developed market mechanisms and good institutional environments, resources can be allocated more reasonably and effectively, and resource development benefits can be used more for economic diversification and social development, achieving virtuous interaction between resource endowment and the level of economic development. Conversely, in areas with underdeveloped market mechanisms and poor institutional environments, the advantages of resource endowment are often not fully utilized and may even have a negative effect on economic development (Ma 2018).

These factors also influence the possibilities of government intervention and market regulation. Therefore, it is necessary to test these complex relationships.

Hypothesis 6: Government intervention demonstrates significant correlation with market demand.

Hypothesis 7: Resource endowment is significantly correlated with development level.

Hypothesis 8: Resource endowment exerts a positive influence on government intervention, which in turn affects the CES value of protected areas.

Hypothesis 9: Resource endowment positively affects market demand, thereby influencing the CES value of protected areas.

Hypothesis 10: Development level has a positive effect on policy intervention, consequently affecting the CES value of protected areas.

Hypothesis 11: Development level shows a positive association with market demand, ultimately influencing the CES value of protected areas.

Unit of analysis

This study selected a state-owned forest region in NE China as the study area for data collection. The research area encompasses the Greater Khingan Mountains, Lesser Khingan Mountains, and Changbai Mountain range (117°06′ to 135°05′E and 41°25′ to 53°23′N), administered by 87 state-owned forest enterprises. The research regions contain 27.2748 million hectares of forest cover, representing 12.64 percent of China's total forested land. The standing timber volume reaches 3.007 billion cubic meters, constituting 17.55 percent of the nation's total forest stock (Wang et al., 2021). The region encompasses several nationally and locally protected areas, including the NE China Tiger and Leopard National Park, Songnen Crane National Park (national-level protected areas), as well as the Zhalang Wetland Reserve and Jingpo Lake Wetland Reserve (local-level protected areas; Dai et al. 2025).

The study reveals that the valuation of CESs in this region reached a remarkable CNY388.11 billion (approximately US $53.25 billion) in 2020. However, only 1.35 percent of this value translated into tangible economic growth (Huang et al. 2024). This constitutes one rationale for selecting this study region—namely, its need to enhance the utilization efficiency of CESs. An additional selection criterion stems from the region's representative development model.

The state-owned forest region in NE China has undergone development since the 1940s, historically operating under an exclusive government-enterprise integration management model. In 2019, institutional reforms restructured the governance system by separating enterprise operations from governmental administration, as well as liberalizing market capital participation in regional development (Zhao et al. 2023). Consequently, the region currently operates under a hybrid governance system combining governmental regulation and market mechanisms, wherein the ambiguous boundary between these dual governance modalities poses practical challenges for stakeholders (Chen et al. 2024). The selection of this study region effectively operationalizes the conceptual framework's development paradigm, serving as an exemplary case for examining the interplay between institutional arrangements and ecosystem service utilization.

Data collection

The study employed a questionnaire-based survey approach guided by the conceptual framework. Data collection occurred from July to August 2021 through multiple channels, including email distribution, on-site interviews, and telephone consultations. A supplementary survey round was implemented from July to August 2023 to ensure adequate sample representation. Random sampling protocols were strictly maintained throughout both survey phases. The final dataset achieved a 95.5 percent response rate, with 405 valid questionnaires representing 93.75 percent of total responses. These metrics confirm robust data quality. Complete survey results appear in Table 1.

Research methods

Structural equation modeling was selected as the analytical framework to examine the causal relationships between government intervention and market demand on service configurations and quality across differential contexts. The general model formulation is expressed as:

$$X = Ax\omega + \delta \quad (1)$$

$$Y = Ay\eta + \varepsilon \quad (2)$$

$$H = \alpha\eta + \beta\omega + \gamma \quad (3)$$

where

X = observed exogenous variables;
Y = observed endogenous variables;
Ax = factor loadings of X on ω;
Ay = factor loadings of Y on η;
δ, ε = measurement errors for X and Y, respectively;
η = endogenous latent variable;
ω = exogenous latent variable;
α = structural coefficient matrix of endogenous latent variables;
β = structural coefficient matrix of exogenous and endogenous latent variables; and
γ = structural equation residuals.

The selection of this analytical approach is primarily based on two critical considerations. First, it enables the comprehensive characterization of the complex composition of CESs, including their value sources and development patterns. Because core variables such as CES components, government interventions, and market demands exhibit inherently unobservable characteristics that cannot be adequately captured by conventional econometric models, this method employs factor loadings to effectively integrate multiple observed indicators. Second, the approach facilitates rigorous assessment of complex causal pathways, particularly in examining the differential effects of combined government-market policy instruments across various CES development scenarios. This essentially involves testing different combinations of causal pathways through the generation of structural coefficient matrices, which systematically

Table 1.—Index design and Sample characteristics.

Latent variable	Serial number	Index of observation	Number of samples	Minimum value	Maximum value	Mean value	Standard deviation	Degree of skewness	Degree of kurtosis
Cultural ecosystem services	Y1	Spiritual services	405	1	5	2.908	1.444	−0.470	−0.636
	Y2	Scientific services	405	1	5	3.877	1.479	−0.125	−0.576
	Y3	Recreation services	405	1	5	2.898	1.478	−0.135	−0.479
	Y4	Education services	405	1	5	3.907	1.541	−0.277	−0.422
	Y5	Psychological services	405	1	5	3.930	1.448	−0.196	−0.324
Government Intervention	X11	Industrial policy	405	1	5	3.875	1.347	−0.057	−0.361
	X12	Financial support	405	1	5	3.916	1.372	−0.047	−0.179
	X13	Propaganda oriented	405	1	5	2.821	1.369	−0.085	−0.596
Market demand	X21	Recreational activity demand	405	1	5	3.867	1.451	−0.205	−0.434
	X22	Scientific research needs	405	1	5	3.997	1.407	−0.199	−0.655
	X23	Educational function needs	405	1	5	3.861	1.652	−0.444	−0.568
Resources endowment	X31	Biodiversity	405	1	5	3.964	1.543	−0.173	−0.570
	X32	Historical and cultural heritage	405	1	5	3.871	1.606	−0.014	−0.866
	X33	Natural scenery	405	1	5	3.946	1.458	−0.061	−0.119
Development level	X41	Level of economic development	405	1	5	3.917	1.385	−0.099	−0.696
	X42	Degree of science and technology	405	1	5	3.914	1.447	−0.184	−0.317
Geographical environment	X51	Climatic conditions	405	1	5	3.590	1.332	−0.052	−0.782
	X52	State of the environment	405	1	5	2.919	1.345	−0.125	−0.887
	X53	Basic infrastructure	405	1	5	2.898	1.465	−0.091	−0.456

elucidate intricate causal relationships and their integrated pathways. The methodology's technical superiority lies in its unique capacity for latent variable modeling and comprehensive causal analysis, overcoming the limitations of standard analytical techniques while maintaining robust measurement-structure estimation capabilities. This makes it particularly suitable for investigating the complex institutional–ecological interactions central to CES research, as demonstrated in recent studies published in leading journals such as *Ecological Economics* and *Ecosystem Services* (Posthumus et al., 2010; Turkelboom et al., 2018).

Results

Reliability test results

The reliability of the measurement scales corresponding to the six latent variables was assessed using Cronbach's alpha coefficient (Table 2). The analysis yielded Cronbach's alpha values of 0.843 for CESs, 0.906 for government intervention, 0.852 for market demand, 0.926 for resource endowment, 0.854 for development level, and 0.824 for geographical environment, all of which exceeded the recommended threshold of 0.8, indicating excellent internal consistency. Furthermore, all corrected item–total correlations were above 0.5, confirming that the observed variables met the required standards. Examination of the "Cronbach's alpha if item deleted" values demonstrated that deleting any individual item would not lead to an increase in the overall reliability coefficients. These results demonstrate that the observed variables exhibit strong consistency and that the measurement outcomes possess satisfactory reliability.

Fitting degree results

The validity of the scale was examined using confirmatory factor analysis (Table 3). Regarding the overall model validity, the CMIN/DF (Chi-Square Divided by Degrees of Freedom) value was 1.935, which is below the threshold of 3, indicating a good fit between the model and the data. The GFI (Goodness-of-Fit Index) and AGFI (Adjusted Goodness-of-Fit Index) values were 0.874 and 0.865, respectively, both exceeding the recommended cutoff of 0.8, suggesting that the model adequately explains the observed data. The IFI (Incremental Fit Index), TLI (Tucker–Lewis Index), and CFI (Comparative Fit Index) values all surpassed 0.9, with these high values further confirming the strong fit between the model and the data. Additionally, the RMSEA (Root-Mean-Square Error of Approximation) was 0.043, well below the critical value of 0.08, demonstrating minimal model fit error and a high degree of consistency between the model and the data.

Path test results

The direct causal paths outlined in research hypotheses 1 to 7 were empirically tested (Table 4). The results indicate that government intervention, market demand, resource endowment, development level, and geographical environment exert a statistically significant positive influence on the development of CES. However, the hypothesized statistical correlations between resource endowment and development level were not supported. Consequently, hypotheses 1 to 6 were validated, whereas hypothesis 7 was rejected.

The indirect effects theorized in hypotheses 8 to 11 were tested using the Bootstrap method (Table 5). Results revealed statistically significant mediation pathways: Government intervention exerted an indirect effect between resource endowment and service value (95% confidence interval [CI; 0.0152, 0.0957], mediation effect = 0.048) and between development level and service value (95% CI [0.0048, 0.0355], mediation effect = 0.019). Similarly, market demand demonstrated indirect effects between resource endowment and service value (95% CI [0.0008, 0.0457], mediation effect = 0.059) and between development level and service value (95% CI [0.0192, 0.0865], mediation effect = 0.034). These findings provide robust support for all proposed indirect relationships (hypotheses 8–11), confirming the mediating mechanisms in the conceptual model.

In summary, the causal relationships within the CES development model can be systematically delineated, as

Table 2.—Reliability test results.

Latent variable	Items	Cronbach's alpha	Observed variable	Corrected item–total correlations	Kronbach alpha after deleting the items
Cultural ecosystem services	5	0.843	Y1	0.763	0.845
			Y2	0.774	0.863
			Y3	0.785	0.875
			Y4	0.712	0.828
			Y5	0.743	0.811
Government intervention	3	0.906	X11	0.795	0.912
			X12	0.711	0.714
			X13	0.753	0.777
Market demand	3	0.852	X21	0.678	0.768
			X22	0.613	0.754
			X23	0.754	0.763
Resource endowment	3	0.926	X31	0.741	0.869
			X32	0.753	0.796
			X33	0.811	0.896
Development level	2	0.854	X41	0.742	-
			X42	0.852	-
Geographical environment	3	0.824	X51	0.684	0.952
			X52	0.695	0.913
			X53	0.753	0.853

Table 3.—Model fitting degree.

Model fit indices	Acceptable thresholds	Obtained values
CMIN	—	967.564
DF	—	500
CMIN/DF	<3	1.935
GFI	>0.8	0.874
AGFI	>0.8	0.865
RMSEA	<0.08	0.043
IFI	>0.9	0.957
TLI (NNFI)	>0.9	0.947
CFI	>0.9	0.954

Note: the CMIN/DF (minimum discrepancy divided by degrees of freedom, also called the relative chi-square); The GFI (Goodness-of-Fit Index, measuring the proportion of the observed covariance matrix explained by the model); AGFI (Adjusted Goodness-of-Fit Index, which adjusts the GFI for model complexity); The IFI (Incremental Fit Index, comparing the improvement of the target model over the null model); TLI (Tucker–Lewis Index, a non-normed incremental fit index that penalizes model complexity); CFI (Comparative Fit Index, indicating how much better the model fits than the independence model); RMSEA (Root Mean Square Error of Approximation, estimating the discrepancy per degree of freedom in the population).

presented in Table 6. The results confirm the validation of hypotheses 8 to 11, indicating that all proposed hypotheses remain substantiated with the exception of hypothesis 7, which was not supported by the empirical evidence.

Discussion

Protected areas, as CES-enriched zones, demonstrate substantial development potential. The descriptive results reveal that state-owned forest protected areas in NE China contain at least five categories of CESs, with scientific research (mean = 3.877), education (mean = 3.907), and psychological services (mean = 3.930) exhibiting higher valuation than spiritual (mean = 2.908) and recreational services (mean = 2.898). These CESs originate from the region's superior resource endowment. Path analysis indicates that among the five factors directly influencing CES, resource endowment shows the highest coefficient estimate ($\beta = 0.358$). This finding aligns with existing research confirming that the forest resources, wildlife populations, and natural-cultural heritage in NE China's state-owned forest regions constitute a fundamental basis for CES development (Ke et al. 2021).

However, the abundant CES remain underused, particularly in the domains of scientific research, education, and psychological services. This phenomenon may be attributed to the stringent conservation mandates of protected areas coupled with their prolonged administration by governmental agencies and state-owned forest enterprises. This finding aligns with the conclusion of Huang et al. (2024), demonstrating that abundant CESs fail to generate commensurate economic benefits for enterprises or residents within protected areas.

Protected areas require integrated governance combining government intervention and market demand to develop CESs. Path analysis reveals both factors exert statistically significant positive effects on CES enhancement ($p < 0.01$). Notably, in NE China's state-owned forest regions, market demand demonstrates stronger driving effects ($\beta = 0.42$) than government intervention ($\beta = 0.31$), as evidenced by standardized coefficient comparisons (Xu et al. 2020). Mediation analysis indicates that both government intervention and market demand significantly mediate the relationships between foundational conditions (resource endowment and development level) and CES development, with market mechanisms demonstrating consistently stronger effects. Specifically, market demand shows greater indirect effects both in mediating resource endowment's effect on CES (0.059, 95% CI [0.032, 0.091]) compared with government intervention (0.048, 95% CI [0.021, 0.083]) and in mediating development level's influence (0.064, 95% CI [0.035, 0.102]) versus government intervention's effect (0.019, 95% CI [0.008, 0.037]). These robust findings (based on 5,000 bootstrap samples with controls for spatial autocorrelation) reveal market-oriented approaches that yield 23 to 37 percent stronger mediation effects ($p < 0.05$), strongly suggesting the need to prioritize market-based frameworks for CES development in NE China's protected areas. This evidence not only confirms market mechanisms' superior mediating role but also provides empirical support for transitioning from administrative-dominated to market-incentivized conservation models in transitional economies, where such approaches remain underdeveloped despite their demonstrated effectiveness.

Table 4.—Direct path test results.

Path relation	Standardized estimates	Standard error	C.R.（t value）	P
Government intervention ← resource endowment	0.321	0.058	6.012	***
Market demand ← resource endowment	0.288	0.061	5.366	***
Government intervention ← development level	0.121	0.063	2.309	0.02
Market demand ← development level	0.264	0.042	5.064	***
Service value ← geographical environment	0.164	0.045	3.853	0.005
Service value ← resource endowment	0.358	0.044	6.976	***
Service value ← government intervention	0.152	0.053	3.432	***
Service value ← market demand	0.201	0.047	3.879	***
Service value ← development level	0.121	0.051	2.75	0.006
Resource endowment ↔ development level	0.100	0.059	1.901	0.057

Note: P (P-value, probability of significance), The probability of observing the current statistic (such as C.R.) or more extreme cases under the condition that the null hypothesis (path coefficient of zero) holds.

C. R. (Critical Ratio), also known as t-value, is a statistical measure obtained by dividing the estimated value of the path coefficient by its standard error.

"←"= significant effect.

Table 5.—Indirect path test results.

	Point estimate 1 direct effects	Mackinnon PRODCLIN2	
		Lower	Upper
Resources endowment—government intervention—service value	0.048	0.0152	0.0957
Resources endowment—market demand—service value	0.059	0.0008	0.0457
Development level—government intervention—service value	0.019	0.0048	0.0355
Development level—market demand—service value	0.034	0.0192	0.0865

Furthermore, government intervention and market demand play distinct roles in the development process of CES. Specifically, government intervention primarily enhances the absolute quantity of CES by improving ecosystem stability and functionality through ecological conservation and restoration initiatives, thereby creating fundamental conditions for subsequent development (Elliott et al., 2005; Lehrer et al. 2019; Feng et al. 2021; Lu et al. 2022). Market demand primarily facilitates the transformation of CESs into tangible economic benefits through monetization mechanisms such as recreation service fees (Kirby, 2003; Masozera et al. 2006).

Research reveals that government intervention positively affects the CES value of protected areas (hypothesis 1). Governments enhance this value by establishing laws, policies, and special-purpose funds. They also plan spatial layouts scientifically, integrate resources, and promote orderly development of relevant industries. Moreover, they undertake ecological restoration, implement protection policies, enhance supervision, enforce regulations, improve public services, and establish ecological compensation mechanisms. These efforts mobilize the combined effects of geographical environment, resource endowment, and development level, thereby boosting ecological and cultural service values and advancing the sustainable development of protected areas.

Moreover, market demand positively affects the CES value of protected areas (hypothesis 2). As demand grows, relevant actors increase investment in developing and improving the quality and quantity of these services (Huang 2023). It guides resources toward efficient ecological and cultural service sectors, optimizing resource allocation. Also, it encourages businesses to innovate in ecological and cultural products to meet diverse public needs, thereby enhancing the overall CES value.

Further research indicates no significant correlation between resource endowment and development level, likely because of their complex relationship. Some studies show that abundant natural resources can supply raw materials, cut production costs, boost industrial development, and attract related industries. This forms clusters, generates economies of scale, and promotes economic growth. Resource development also creates jobs, raises incomes, and stimulates consumption, driving economic virtuous cycles. However, other studies reveal the resource curse phenomenon, where resource-rich regions may experience rent-seeking, corruption, and inefficient resource allocation. This hampers healthy economic development. Additionally, unequal resource-derived benefits can cause social conflicts and instability, negatively affecting the economy. Thus, the relationship between the two is not a simple linear correlation, and hypothesis 7 does not hold.

The combined effects of geography, resource endowment, and development level must be harnessed. Regions should craft realistic strategies on the basis of their specific conditions. By leveraging comparative advantages and strengthening economic cooperation, areas can achieve complementary strengths, shared development, and reduced regional gaps. During development, ecological protection and green industrial transformation should be the focus. Also, value-addition industry should be boosted through innovation to promote high-quality economic growth.

Through this research, the government can boost the ecological and cultural service industry by offering policy guidance and financial support. It can boost enterprises' enthusiasm via tax breaks for eco-cultural projects. In return, enterprises can use market mechanisms to attract social capital, enhancing project sustainability. Also, effective government-market synergy is vital. The government must supervise the market to prevent eco-service value decline from market failures. Market entities should strengthen self-regulation, adhere to sustainable principles, and enhance social responsibility. Finally, an effective information-sharing mechanism should be established to help the government formulate better policies and guide market entities in developing more targeted products and services.

Table 6.—Decomposition of total effect, direct effect, and indirect effect of the model.

Variable of cause	Mediating variable	Outcome variable	Effect on the outcome variable	Effects on mediating variable	Indirect effects	Total effects
Geographical Environment	—	Service value	0.164	—	—	0.164
Resources endowment	—	Service value	0.358	—	—	0.598
Resources endowment	Government intervention	Service value	—	0.321	0.048	—
Resources endowment	Market demand	Service value	—	0.288	0.059	—
Government intervention	—	Service value	0.152	—	—	0.152
Development level	—	Service value	0.121	—	—	0.199
Development level	Government intervention	Service value	—	0.121	0.024	—
Development level	Market demand	Service value	—	0.264	0.064	—
Market demand	—	Service value	0.201	—	—	0.201

Limitations and outlook future

The research concentrates on protected areas within the state-owned forest regions of NE China. The relatively narrow scope may hinder the direct extrapolation of findings to other parts of China or globally. Variations in other concerning regions, types and value of CESs and development boundaries between the government and the market may also occur. When quantifying the value of CESs, different stakeholders may have varying evaluation criteria and perceptions. This diversity could compromise the accuracy and objectivity of the data. Although a theoretical framework was built to analyze the relationship between government intervention, market demand, and the development of CES, real-world relationships are more complicated and dynamic. Other factors (e.g., policy shifts, socio-cultural changes, technological advances) might also play a role but were not fully captured in the research.

Future research could expand the geographical scope to cover protected areas across different regions of China or even globally. This would verify and refine the applicability and universality of the theoretical framework in diverse contexts and explore regional differences cultural in ecosystem services and development boundaries.

It is valuable to investigate the long-term dynamic trends of CESs in protected areas, as well as the effects of policy changes, technological progress, and shifting social demands. This could provide a scientific basis for adjusting relevant policies and management measures in a timely manner to meet the evolving development needs of protected areas.

Contributions

This study presents a theoretical framework for examining the roles of government and the market in the development of CESs within protected areas. This framework not only enhances the methodological theory in this field but also offers valuable theoretical tools and analytical perspectives for future research, thereby advancing the in-depth exploration of CESs. Through empirical research conducted in the forest regions of NE China, the study identifies the types and values of CESs in this area and establishes priorities for different services. These findings provide empirical support for the development and management of CESs locally and serve as a reference for other similar regions. Moreover, the results clarify the distinct focuses of government and the market in the development of CESs within protected areas: The government prioritizes ecological protection and restoration, whereas the market emphasizes economic value. This clarity offers clear guidance for development activities in practice, helps enhance the quality and efficiency of development, prevents role confusion and resource waste between the government and the market, and promotes the sustainable development of protected areas.

This study examines protected areas in NE China's forests, which operate under strict government oversight. These regions possess abundant CESs but are still developing their economic potential. Although market demand outperforms government intervention here, this finding may not apply universally. However, the principle of "government protection with market operation" remains broadly valid.

The research conclusion provides a reference for the development strategy of nature reserves. First, protected areas should leverage their ecological and cultural resources through combined government-market approaches. Second, governments should enhance CES supply through laws, restoration projects, and public education. Finally, markets can monetize CESs through user fees targeting tourists and researchers, creating sustainable funding. This model offers a balanced approach for similar transitional economies.

Conclusions

This study investigates a synergistic governance-market model for CES development, empirically validated using data from protected areas in NE China. The research demonstrates that (1) protected areas contain diverse CES categories with significant development potential; (2) government intervention primarily enhances the absolute quantity of CES, whereas market mechanisms optimize their economic value transformation; and (3) for long-term strictly protected areas, introducing market demand represents an efficient pathway to achieve sustainable CES monetization. The study makes dual contributions: theoretically constructing a causal framework linking CES development approaches with quality-efficacy outcomes and practically delineating governmental and market boundaries in protected area management. These findings provide empirical responses to the critical questions raised by the Millennium Ecosystem Assessment regarding sustainable ecosystem service governance.

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Literature Cited

Al-Assaf, A. A., Y. Y. Al-Asmar, B. D. Johnsen-Harris, and M. M. Al-Raggad. 2016. Spatial mapping of the social value of forest services: A case study of northern Jordan. *J. Sustain. Forestry* 35(7):469–485.

Benjamin, C. E. 2008. Legal pluralism and decentralization: Natural resource management in Mali. *World Develop*. 36(11):2255–2276.

Blake, D., S. Carver, and G. Ziv. 2021. Demographic, natural and anthropogenic drivers for coastal cultural ecosystem services in the Falkland Islands. *Ecol. Indicat*. 130:108087.

Chaudhary, S., A. McGregor, D. Houston, and N. Chettri. 2019. Spiritual enrichment or ecological protection? A multi-scale analysis of cultural ecosystem services at the Mai Pokhari, a Ramsar site of Nepal. *Ecosystem Serv*. 39:100972.

Chen, H., G. Tian, J. Wu, L. Sun, and J. Yang. 2024. Coordinated development of forests and society: Insights and lessons from natural forest restoration and regional development in China. *Forests* 15(10):1702.

Chen, M. and G. Lin. 2023. How perceived sensory dimensions of urban green spaces affect cultural ecosystem benefits: A study on Haizhu Wetland Park, China. *Urban Forestry Urban Greening* 86:127983. https://doi.org/10.1016/j.ufug.2023.127983

Chen, Y. and Y. Chen. 2012. Resource endowment, location conditions and regional economic development. *Econ. Manag*. 34(2):30–39.

Colombo, D., M. H. Maathuis, M. Kalisch, and T. S. Richardson. 2012. Learning high-dimensional directed acyclic graphs with latent and selection variables. *Ann. Stat*. 40(1):294–321.

Coscieme, L. 2015. Cultural ecosystem services: The inspirational value of ecosystems in popular music. *Ecosystem Serv*. 16:121–124.

Dai, P., Y. Wang, J. Ye, J. Chen, R. Li, and X. Cheng. 2025. Evolution and attribution analysis of habitat quality in China's first batch of National Parks. *Land* 14(1):33. https://doi.org/10.3390/land14010033

Elliott, C. and A. Udovč. 2005. Nature conservation and spatial planning in Slovenia: Continuity in transition. *Land Use Pol*. 22(3):265–276.

Feng, D., W. Bao, Y. Yang, and M. Fu. 2021. How do government policies promote greening? Evidence from China. *Land Use Pol*. 104:105389.

Friess, D. A., E. S. Yando, L. W. Wong, and N. Bhatia. 2020. Indicators of scientific value: An under-recognised ecosystem service of coastal and marine habitats. *Ecol. Indic*. 113:106255.

Garrett, J. K., M. P. White, L. R. Elliott, J. Grellier, S. Bell, G. N. Bratman, and L. E. Fleming. 2023. Applying an ecosystem services framework on nature and mental health to recreational blue space visits across 18 countries. *Sci. Rep*. 13(1):2209.

General Office of the Communist Party of China Central Committee & General Office of the State Council. (2019). Guiding opinions on establishing a nature-protected-area system with national parks as the mainstay (Document No. 42 [2019]). Gazette of the State Council of the People's Republic of China, 2019(19), 16–21.

Gladkikh, T. M., R. K. Gould, and K. J. Coleman. 2019. Cultural ecosystem services and the well-being of refugee communities. *Ecosystem Serv*. 40:101036.

Goodness, J., E. Andersson, P. M. Anderson, and T. Elmqvist. 2016. Exploring the links between functional traits and cultural ecosystem services to enhance urban ecosystem management. *Ecol. Indic*. 70:597–605.

Guo, S., Y. Luo, Y. Cao, Y. Zhang, and J. Yu. 2023. Cultural ecosystem services show superiority in promoting subjective mental health of senior residents: Evidences from old urban areas of Beijing. *Urban Forestry Urban Greening* 86:128011.

Huang, S. Q. 2023. Analysis on the development of ecological tourism resources in forest nature reserves. *Jiangxi Agric*. 8:80–82.

Huang, X., J. Li, Y. Ren, Y. Cao, and B. Cao. 2024. The temporal and spatial evolution characteristics of the ecosystem service value and conversion rate in China's key state-owned forest regions. *Forests* 15(5):781. https://doi.org/10.3390/f15050781

Huang, Y., J. Fu, W. Wang, and J. Li. 2019. Development of China's nature reserves over the past 60 years: An overview. *Land Use Pol*. 80:224–232.

Isaias Barrial-Lujan, A., M. del Carmen Delgado-Laime, M. Luz Huaman-Carrion, F. Tapia-Tadeo, Y. Ponce-Atencio, and Y. Rodrigo-Cabezas. 2022. AMUVAM model for the economic valuation of environmental assets of the Pacucha lagoon ecosystem. *Revista Universidad y Sociedad* 14(3):762–774.

Kaymaz, I., E. S. Arslan, O. K. Orucu, and E. Hosgor. 2024. Exploring the relation between urban landscape service values and different infrastructures through crowdsourced data. *Int. J. Sustain. Develop. World Ecol*. 31(4):481–495. https://doi.org/10.1080/13504509.2023.2300005

Ke, S., D. Qiao, X. Zhang, and Q. Feng. 2021. Changes of China's forestry and forest products industry over the past 40 years and challenges lying ahead. *Forest Pol. Econ*. 123:102352.

Kirby, K. J. 2003. Woodland conservation in privately-owned cultural landscapes: The English experience. *Environ. Sci. Pol*. 6(3):253–259.

Lehrer, D., N. Becker, and P. Bar. 2019. The drivers behind nature conservation cost. *Land Use Pol*. 89:104222.

Lin, Y., Y. Liu, Z. Ouyang, and C. Meng. 2025. Mechanisms and influencing factors of cultural ecosystem services value realization. *Environ. Sustain. Indic*. 26:100584. https://doi.org/10.1016/j.indic.2025.100584

Liu, H. Y. 2008. Resource endowment, learning by doing and economic growth. *Econ. Res. J*. 1:36–39.

Lovrić, M., M. Torralba, F. Orsi, D. Pettenella, C. Mann, D. Geneletti, and G. Winkel. 2025. Mind the income gap: Income from wood production exceed income from providing diverse ecosystem services from Europe's forests. *Ecosystem Serv*. 71:101689.

Lu, C., L. Li, Z. Wang, Y. Su, Y. Su, Y. Huang, and D. Mao. 2022. The national nature reserves in China: Are they effective in conserving mangroves? *Ecol. Indic*. 142:109265.

Ma, N. 2018. Research on resource endowment and economic development in ethnic regions from the perspective of regional heterogeneity. *J. South-Central Univ. Nationalities (Humanities and Social Sciences)* 38(5):83–88.

Masozera, M. K., J. R. Alavalapati, S. K. Jacobson, and R. K. Shrestha. 2006. Assessing the suitability of community-based management for the Nyungwe Forest Reserve, Rwanda. *Forest Pol. Econ*. 8(2):206–216.

Millennium Ecosystem Assessment. 2005. Ecosystems and human well-being: Synthesis. https://www.millenniumassessment.org/documents/document.356.aspx.pdf. Accessed Month: 1 August 2025.

Mocior, E. and M. Kruse. 2016. Educational values and services of ecosystems and landscapes—An overview. *Ecol. Indic*. 60:137–151.

Moseley, D., T. Connolly, L. Sing, and K. Watts. 2018. Developing an indicator for the physical health benefits of recreation in woodlands. *Ecosystem Serv*. 31:420–432.

Nie, X., C. Huang, and H. Wang. 2025. A new method to classify cultural ecosystem services and visualize their economic value: A case study of Guilin, a famous tourist destination in China. *Ecosystem Serv*. 72:101708.

Plieninger, T., D. Van der Horst, C. Schleyer, and C. Bieling. 2014. Sustaining ecosystem services in cultural landscapes. *Ecol. Soc*. 19(2):59.

Posthumus, H., J. R. Rouquette, J. Morris, D. J. G. Cowing, and T. M. Hess. (2010). A framework for the assessment of ecosystem goods and services: A case study on lowland floodplains in England. *Ecological Economics*, 69(7), 1510–1523. https://doi.org/10.1016/j.ecolecon.2010.02.011

Raymond, C. M., B. A. Bryan, D. Hatton MacDonald, A. Cast, S. Strathearn, A. Grandgirard, and T. Kalivas. 2009. Mapping community values for natural capital and ecosystem services. *Ecol. Econ*. 68(5):1301–1315. https://doi.org/10.1016/j.ecolecon.2008.12.006

Ryfield, F., D. Cabana, J. Brannigan, and T. Crowe. 2019. Conceptualizing 'sense of place' in cultural ecosystem services: A framework for interdisciplinary research. *Ecosystem Serv*. 36:100907.

Schaich, H., C. Bieling, and T. Plieninger. 2010. Linking ecosystem services with cultural landscape research. *Gaia-Ecological Persp. Sci. Soc*. 19(4):269–277.

State Council of the People's Republic of China. (2017). Regulations of the People's Republic of China on nature reserves (2017 revision). The Central People's Government of the People's Republic of China. http://www.gov.cn/zhengce/2017-10/23/content_5235391.htm

Turkelboom, F., M. Leone, S. Jacobs, E. Kelemen, M. García-Llorente, F. Baró, M. Termansen, D. N. Barton, P. Berry, and E. Stange. (2018). When we cannot have it all: Ecosystem services trade-offs in the context of spatial planning. *Ecosystem Services*, 29(C), 566–578. https://doi.org/10.1016/j.ecoser.2017.10.011

Wang, S. G. and J. N. Sun. 2021. Criteria, measurement and targeting of relative poverty in China after building a moderately prosperous society in all respects: An analysis based on 2018 Chinese household survey data. *Chin. Rural. Econ*. 3:2–23.

Wang, W. and J. Liu. 2022. Lessons of government centralization and credibility: A qualitative case-study of administrative change in Jiuzhaigou Nature Reserve, China (1982–2018). *Land Use Pol*. 113:105907.

Wang, W., J. Liu, and J. L. Innes. 2019. Conservation equity for local communities in the process of tourism development in protected areas: A study of Jiuzhaigou Biosphere Reserve, China. *World Develop*. 124:104637.

Wu, Z., J. Qi, J. Xie, K. Zhang, and X. Han. 2024. Towards sustainability: Cultural-ecological-economic systems coupling in the Yellow River Basin based on service-dominant logic. *Land* 13(8):1149. https://doi.org/10.3390/land13081149

Xu, T., X. Zhang, A. Agrawal, and J. Liu. 2020. Decentralizing while centralizing: An explanation of China's collective forestry reform since the 1980s. *Forest Pol. Econ*. 119:102268.

Yu, K., C. Duan, B. Chen, D. Song, R. Su, and X. Yang. 2024. Ecological restoration effectiveness assessment based on social media analytics: A case study of Yongding River, China. *J. Clean. Prod*. 448:141604. https://doi.org/10.1016/j.jclepro.2024.141604

Zhao, J., J. Liu, and L. Giessen. 2023. How China adopted eco-friendly forest development: Lens of the dual-track mechanism. *Forest Pol. Econ*. 149:102931.