

Article

Enhancing Rural Revitalization in China through Digital Economic Transformation and Green Entrepreneurship

Ying Wang¹ and Daoliang Ye^{2,*}¹ Keyi College, Zhejiang Sci-Tech University, Hanzhou 310018, China; wy201@zstu.edu.cn² School of Marxism, Shanghai University of Finance and Economics, Shanghai 200433, China

* Correspondence: ye_daoliang@stu.sufe.edu.cn

Abstract: Over the past few years, rural revitalization has become a focal point of interest in the discourse of sustainable development. However, there exists a gap in understanding the factors that foster economic sustainability in rural settings. The current study seeks to investigate the influence of digital economic transformation on rural revitalization in the context of China by employing a serial mediation model encompassing green entrepreneurship and green innovation. Data were collected from rural entrepreneurs using a stratified sampling method, with strata identified based on geographical and socioeconomic factors, which allowed for a comprehensive examination of various business sizes and stages across sectors. The authors analyzed the structural paths using multivariate analytical techniques by utilizing SmartPLS-SEM. The empirical findings provide support to the hypothesized relationships that: (1) digital economic transformation significantly promotes green entrepreneurship, which in turn, cultivates green innovation; and (2) green entrepreneurship and green innovation serially mediate the association between digital economic transformation and rural revitalization. Our study provides a holistic model that can inform regulatory frameworks and governmental strategies to support sustainable rural development in China.

Keywords: rural revitalization; digital economic transformation; serial mediation model; green entrepreneurship; green innovation; sustainable economic growth; China



Citation: Wang, Y.; Ye, D. Enhancing Rural Revitalization in China through Digital Economic Transformation and Green Entrepreneurship. *Sustainability* **2024**, *16*, 4147. <https://doi.org/10.3390/su16104147>

Academic Editor: Libang Ma

Received: 11 March 2024

Revised: 30 April 2024

Accepted: 9 May 2024

Published: 15 May 2024



Copyright: © 2024 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

1. Introduction

Given the escalated gravity of interest in exploring rural revitalization in the contemporary development discourse, researchers have recognized the pivotal role that rural areas play in national economies, ecological sustainability, and social fabric [1]. It is argued that rural revitalization's significance extends beyond the mere enhancement of agricultural productivity to encompassing the wider objectives of economic diversification, poverty alleviation, and environmental conservation [2]. There is growing consensus that warrants empirical scrutiny on the subject of rural revitalization due to the multifaceted challenges that the rural communities face such as economic underdevelopment and environmental degradation [3,4]. Thus, the imperative of rural revitalization is not only an economic necessity, but also a social and environmental need. In addition to this, sustainable rural revitalization (e.g., inclusive economic growth, sustainable agriculture, and resilient communities) can contribute significantly to achieving the United Nations' Sustainable Development Goals (SDGs) [3]. From this perspective, recent research has identified the integration of digital technologies and green development practices as crucial elements for transforming rural economies and promoting environmental sustainability [5]. Nevertheless, the authors conducted an exploratory study of the interplay between digital technologies and rural development and paved the way to empirically assess the linkage between digital economic transformation and rural revitalization. Hence, empirical investigation of the antecedents of rural revitalization is not just about addressing the disparities between urban and rural areas; rather our study harnesses the potential of rural regions as engines of sustainable development, innovation, and cultural preservation.

According to Nosova et al. [6] (p. 659), digital economic transformation represents “the saturation of business processes with digital technologies leads to the digital transformation of the economy” and leverages digital technologies to drive efficiency, innovation, and inclusivity [7]. This transformation is particularly critical for rural areas, where the digital divide has historically impeded economic growth and integration into broader markets. The rationale for linking digital economic transformation as an antecedent to rural revitalization lies in its transformative potential to overcome geographic isolation, enhance access to information and markets, and foster entrepreneurial initiatives. This is further substantiated by Rijswijk et al. [8], who argued that digital platforms can enable rural businesses to reach broad markets and yield higher revenue streams. In addition, agricultural practices can be significantly improved through digital tools and services (e.g., precision farming, market access, and supply chain efficiency) [1]. As a result, digital economic transformation might offer avenues for rural areas to move beyond traditional agriculture-based livelihoods to include sustainable services and digital entrepreneurship. Thus, the integration of digital economic transformation is essential for fostering sustainable development in rural areas.

Building on the foundational role of digital economic transformation in fostering sustainable development within rural areas, the concept of green entrepreneurship has emerged as a significant pathway that bridges digital innovation with rural revitalization. Green entrepreneurship refers to “the continuous commitment of enterprises to ethical behavior that promotes economic development and improves the quality of life of the labor force, families, local and global communities, and future generations.” [9,10] (p. 413). Furthermore, green entrepreneurship leverages the transformative capabilities provided by digital advancements to offer business solutions that are not only economically viable, but also environmentally responsive [11]. The intermediary role of green entrepreneurship offers an opportunity to address the environmental challenges linked to economic growth, thereby augmenting rural revitalization. Thus, the emphasis on green entrepreneurship in the context of digital transformation highlights a nuanced pathway through which rural economies can develop inclusive and environmentally responsible growth.

Following the exploration of green entrepreneurship in the nexus between digital economic transformation and rural revitalization, green innovation has ascended as a transformative progression from green entrepreneurship to elevated rural revitalization. Green innovation involves the development and implementation of new products, processes, or services that minimize environmental impacts, conserve natural resources, and promote the use of sustainable materials [12]. Tseng et al. [13] (p. 72) categorized green innovation into four main categories: “managerial innovation, product innovation, process innovation, and technological innovation”. Furthermore, Yang and Liu sanctioned that green innovation transforms the principles of green entrepreneurship into tangible practices and technologies that can significantly enhance environmental sustainability within rural economies. Taken together, the study proposes a serial mediation model that digital economic transformation promotes green entrepreneurship, which in turn, leads to green innovation, thus contributing to rural revitalization. By examining the serial mediation role of green entrepreneurship and green innovation into the relation of digital economic transformation and rural revitalization, this study presents a more nuanced understanding of the factors that impact sustainable development in rural settings.

While recent studies have highlighted the transformative potential of digital economic transformation and green entrepreneurship in rural revitalization efforts [14–16], there remains a gap in empirical research examining the interplay between these factors and their impact on rural revitalization. Specifically, there is a need for studies that empirically assess the relationship between digital economic transformation, green entrepreneurship, green innovation, and rural revitalization within the context of the Sustainable Development Goals. Therefore, this study aimed to address this gap by exploring the serial mediation role of green entrepreneurship and green innovation in the relationship between digital economic transformation and rural revitalization. The research questions guiding this study are as follows:

1. *To what extent does digital economic transformation influence green entrepreneurship in rural areas?*
2. *How does green entrepreneurship mediate the relationship between digital economic transformation and green innovation in rural settings?*
3. *What is the serial mediation effect of green entrepreneurship and green innovation on the relationship between digital economic transformation and rural revitalization?*

These research questions guide the empirical investigation into the antecedents of rural revitalization, providing insights into the mechanisms through which digital economic transformation and green entrepreneurship contribute to sustainable development in rural regions.

2. Digital Economic Transformation and Rural Revitalization

Digital economic transformation has been a major factor in the past few years in the upheaval of regions [5] and the production of significant effects in the rural area [1]. According to preliminary research [17], the process of digitization can have an effect on rural sectors in general as well as agriculture specifically (e.g., defining new and richer services, helping to efficient use of resources). The production side of the agrifood industry has been affected by the digital revolution because new technologies provide customers with full visibility and traceability of the production process. This has resulted in significant changes to consumer behavior and business models of agricultural product companies.

Digital economic transformation provides new tools for local agrifood sectors and rural areas to modify their strategies and actions in real-time [18]. Additionally, it fosters cooperation amongst various stakeholders engaged in agrifood tourism and rural revitalization, serving as catalysts for the fostering of relationships in settings where social cohesion precludes the ad hoc formation of networks. In rural areas, where there are often many small-scale producers with little coordination or rare cooperation among themselves, leading to ineffective development of the rural tourism industry, digitalization can play a supportive role [1]. According to this viewpoint, the difficulty of rural revitalization that builds on the agrifood and food-tourism sectors is included in the requirement to link the various players in the value chain, concentrating on the abilities and customs that each of them employs to define the uniqueness of the region. The increasing demand for communication between the various parties involved in rural revitalization may be met by digital technologies.

3. Green Entrepreneurship

Entrepreneurship has historically been researched, examined, and applied as a means of creating a type of self-employment that can yield financial gains [19] or as a means of creating jobs [20]. In another way, entrepreneurship has traditionally been seen as a means of promoting economic development [21], while social and environmental concerns have been disregarded [22]. However, as governments, NGOs, researchers, and businesses place more emphasis on environmental issues, and as the idea of green development gains traction [4], a number of scholars [22] have asserted that entrepreneurship should not be limited to making money. Furthermore, some academics contend that entrepreneurship is a means of guiding economic sectors toward sustainable growth [23].

According to Baker and Welter's [24] theory, entrepreneurship ought to concentrate on undertakings that address the demands of the modern economy by serving commercial, social, and environmental goals. Furthermore, Corbett and Montgomery [25] contend that business owners must incorporate and modify sustainability into their business plans if they hope to build a profitable company that advances development. As a result, during the past several years, businesses and entrepreneurs have been more interested in learning about the true effects of their ventures on society and the environment. Thus, the conventional definition of entrepreneurship, which emphasizes value creation in terms of financial gains, has also been expanded to include nonfinancial advantages [11].

The notion of “green entrepreneurship”, also known as “greenopreneurship” [26], has emerged as a result of some researchers’ increased focus on the relationship between green development and entrepreneurship. According to Gu et al. [27], green entrepreneurship is founded on and associated with the triple bottom line (TBL), which consists of three main aspects: (1) environmental, which considers long-term protection and a reduction in negative effects; (2) social, where attention is given to the customers, stakeholders, partners, workers, and community; and (3) economic, which is dependent on economic performance. Accordingly, green entrepreneurs are now seen as change agents who are dedicated to achieving a balance between social welfare, environmental preservation, and economic viability.

In the context of rural revitalization [28], green entrepreneurship holds particular significance as a catalyst for sustainable economic development in rural areas. Rural communities often face unique challenges including limited access to resources, economic diversification, and environmental sustainability [29]. Green entrepreneurship offers a promising avenue to address these challenges by fostering innovation [30], creating new employment opportunities [31], and promoting environmentally responsible business practices [32]. By leveraging digital technologies and green development principles, rural entrepreneurs can not only enhance the economic viability of their ventures, but also contribute to the preservation of natural resources and the well-being of local communities [33,34]. Thus, green entrepreneurship has emerged as a vital driver of rural revitalization efforts, aligning with broader goals of promoting inclusive and environmentally sustainable development [35–37].

4. Research Hypotheses

4.1. Impact of Digital Economic Transformation on Green Entrepreneurship

Digitalization is the integration and utilization of digital technologies like cloud computing, artificial intelligence, 3D printing, and mobile computing by governments, industries, or organizations [14]. The distinctive characteristics of digital technologies provide new opportunities for action in specific user contexts that can be utilized by actors like entrepreneurs [25]. Digital transformation results in new institutional arrangements that introduce new values, practices, and structures that challenge the existing rules and present logic systems [7]. These arrangements consist of widely acknowledged and adaptable digital modules like ERP systems as well as standard digital infrastructures that coordinate the interaction of players such as product platforms and blockchain technology. Significantly, these powerful digital developments also impact business models [26]. Scholars contend that the digital capabilities that come with digital structures and components expand the possibilities and generate new avenues for producing, distributing, and gaining value [27], even at the discourse of sustainable production and offerings [38]. We propose that incorporating a digital logic based on these concepts can introduce new practices into the range of viable logics that shape business models.

Building on this foundation, we propose a linkage between digital economic transformation and green entrepreneurship. It is evident that digital technological advancements equip green entrepreneurs with the necessary tools and processes for implementing and executing sustainable solutions [5]. Furthermore, Saura et al. [39] substantiated that the application of digital technologies in green ventures facilitates circular economy practices by leveraging the optimization of resource re-use and the enhancement in energy efficiency. This is also endorsed by Kayikci et al. [40], whereby blockchain technology offers enhanced transparency and traceability, which result in improved operational efficiency and sustainable practices. In addition, the research by Bickley et al. [41] identified AI and big data analytics as positive predictors of sustainable entrepreneurship. Hence, we contend that digital economic transformation not only reshapes business models, but also serves as a catalyst for green entrepreneurship by offering transformative and innovative ways to address environmental challenges. Therefore, the above arguments render support to propose our first hypothesis:

H1. *There is a positive association between digital economic transformation and green entrepreneurship.*

4.2. *Impact of Green Entrepreneurship on Green Innovation*

Scholars view green innovation as the crucial element for the success of green entrepreneurship [42]. While green entrepreneurship is closely associated with green innovation, companies who implement green entrepreneurship principles may not necessarily be proficient in achieving green innovation; green innovation demands greater exertion compared to traditional innovation [43]. From this perspective, Soomro et al. [30] investigated the correlation between green innovation and green entrepreneurship in their study and found a statistically significant association between green innovation and economic success, considering the influence of green entrepreneurship. The study concluded that adopting green entrepreneurship can help companies enhance their financial performance. Furthermore, green entrepreneurship is viewed as a lucrative and inventive endeavor that has a good influence on the local community, the regional economy, and the environment in the vicinity [11]. Entrepreneurship, as stated in the literature, allows companies to develop innovation either through direct or indirect means [13]. It is also argued that companies that engage in green entrepreneurship can manage resource utilization to minimize their environmental impact and explore green opportunities for innovation, development, organization, and the efficient use of primary resources [10]. The primary strategic goal of green entrepreneurship is to motivate companies to establish organizational dynamics that allow them to create and offer sustainable products and services. This orientation can become even more stable and effective if firms retain a business orientation, which induces a higher level of innovation, risk taking, and initiatives [44]. When organizations are highly motivated to engage in green entrepreneurship, they can showcase environmentally responsible management and innovation in several aspects of their business [45]. Therefore, these companies will ultimately and effectively create environmentally friendly innovation. Moreover, green entrepreneurs find it easier to accomplish green innovation and economic benefits compared to firms focusing only on the financial benefits and profitability [46]. Subsequently, green entrepreneurship, despite being rooted in enhancing technology and cutting expenses, can foster green innovation. Based on the above arguments we propose that:

H2. *There is a positive association between green entrepreneurship and green innovation.*

4.3. *Impact of Green Innovation on Rural Revitalization*

Many studies have been conducted on green innovation, with the majority focusing on countries in the West and Europe [47–49]. It is surprising how little research has been conducted in emerging countries, so more investigation is required. This is a good reason to acknowledge the regional dynamics of green innovation, as it is difficult, if not impossible, to generalize studies from one country to another due to significant differences in national innovation systems, business maturity, consumer demand for eco-products, organizational size, and culture [50]. Specifically, research carried out in the Chinese environment up to this time has not resulted in a comprehensive adoption roadmap for green solutions, especially in the context of rural areas. Green innovation, characterized by the development and implementation of new products, services, or processes that reduce environmental impacts and promote sustainability [45], has a profound impact on rural revitalization. According to Monda et al. [5], rural areas can experience enhanced economic growth and environmental sustainability by integrating eco-friendly practices and technologies. This is further supported by a recent study conducted by Li et al. [51], who argued that green innovation significantly contributes to the economic empowerment of regional areas as they create novel and sustainable business opportunities in sectors such as renewable energy [52], sustainable agriculture [53], and eco-tourism [54]. Furthermore, green innovation engenders sustainable practices that enhance biodiversity, conserve water, and minimize pollution [55]. The trickle-down effects of these factors can be translated into mitigating the impacts of climate change and environmental degradation. In addition, prior research

has also linked green innovation to improved societal well-being and resilience [56]. This is further deliberated by Zhang et al. [57], who found the influence of eco-technology innovation on eco-well-being performance, which refers to the effectiveness of transforming natural resources into human well-being while minimizing environmental degradation, rather than solely focusing on the increase in traditional GDP. This concept emphasizes the enhancement of human well-being as the primary objective of green innovation. Consequently, rural areas can efficiently improve the living standards of their communities by invoking green innovation. Therefore, the following hypothesis is put forth:

H3. *There is a positive association between green innovation and rural revitalization.*

4.4. Serial Mediating Impacts of Green Entrepreneurship and Green Innovation

Combining the arguments pertaining to the linkage between digital economic transformation and green entrepreneurship (hypothesis 1) and green innovation and rural revitalization (hypothesis 2), we further infer the mediating impact of green entrepreneurship in the relationship between digital economic transformation and green innovation. As discussed above, digital economic transformation leverages rural entrepreneurs to embark upon enhanced tools and technologies that can enable them to incite sustainable solutions [5] catered to the diversified needs of rural areas. As a result, sustainable solutions may be culminated into enhanced levels of green innovation. This inference is supported by prior research, for instance, Kayikci et al. [40] contended that through utilizing blockchain, big data analytics, and AI, entrepreneurs can invoke sustainable solutions through advancements in technology, which can result in improved operational efficiency in the course of sustainable ventures.

In addition, the amalgamation of hypothesis 2 with the relationship between green innovation and rural revitalization (hypothesis 3) led us to deduce the mediating role of green innovation in the relationship between green entrepreneurship and rural revitalization. That is to say, through the utilization of advanced green technologies and practices, the influence of green entrepreneurship is not confined to the economic benefits for the firm itself [43], but rather, its cascading effects extend beyond sustainable innovation and culminate into elevated impacts on ecological sustainability in rural contexts [11]. Therefore, green innovation mediates the relationship between green entrepreneurship and rural revitalization.

Taken together, the influence of digital economic transformation on green innovation through green entrepreneurship and the direct impact of green innovation in eliciting rural revitalization (hypothesis 3), we anticipate a serial mechanism pathway that facilitates the culmination of digital economic transformation on green innovation through green entrepreneurship, and then rural revitalization. Therefore, the above arguments render support to hypothesize the mediation and serial mediation hypothesis:

H4. *Green entrepreneurship mediates the relationship between digital economic transformation and green innovation.*

H5. *Green innovation mediates the relationship between green entrepreneurship and rural revitalization.*

H6. *The relationship between digital economic transformation and rural revitalization is serially mediated by green entrepreneurship and green innovation.*

4.5. Conceptual Model

Figure 1 illustrates the conceptual model between digital economic transformation and rural revitalization through the serial mediation effects of green entrepreneurship and green innovation.

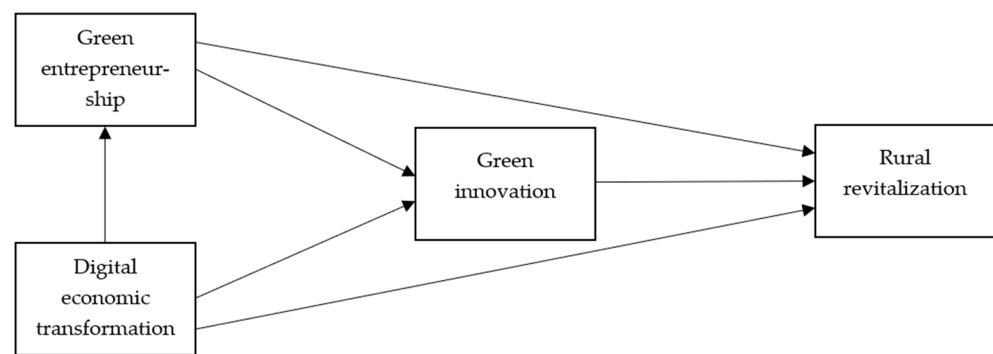


Figure 1. Conceptual model.

5. Research Methodology

5.1. Sampling and Data Collection

In order to examine the relationship between digital economic transformation and rural revitalization, the authors conducted a cross-sectional survey with the help of questionnaires collected through a stratified sampling technique. The survey was administered to the target respondents across different sectors such as renewable energy, sustainable agriculture, and eco-friendly product manufacturing. Strata were identified based on geographical and socioeconomic factors, allowing for the inclusion of various business sizes and stages such as startups as well as established enterprises. Within each stratum, a systematic random sampling approach was utilized to select participants. By employing the stratified sampling technique [58], the researchers were able to include various business sizes and stages such as startups as well as established enterprises. The researchers administered the survey questionnaires to the target respondents across different sectors, ensuring that participants from each stratum were proportionally represented in the sample. This approach enabled the researchers to capture the perspectives and experiences of entrepreneurs from various business backgrounds, contributing to the comprehensiveness of the study's findings.

The study used the stratified sampling technique to reach a sample of 350 for this study. Out of 350 participants partaking in the study, 324 respondents successfully returned the responses. However, 15 surveys were poorly filled out and/or carried incomplete information. Thus, the authors screened out 309 finalized questionnaires to be available for empirical analysis. As the study collected data from the target respondents using a cross-sectional, self-rated research design, there were chances that the study may have been affected by the issues with respect to common method biases (CMBs). For this purpose, we first checked the collinearity assessment using the variance inflation factor (VIF), and all values below 3.3. ensured that the study was free from the effects of CMBs. Results of this analysis are reported in Appendix A. In addition, the authors conducted Harman's single-factor test to assess the potential presence of common method bias. The analysis revealed a variance of 32.647%, indicating no significant threats from common method bias in our study.

The demographic profiles of the participants were as follows: approximately 41% and 59% of the respondents were female and male entrepreneurs, respectively. The age distribution of the participants revealed that the majority, around 62%, were between the ages of 30 and 50 (standard deviation: 5.690). Regarding educational background, about 68% of the entrepreneurs reported having at least a Bachelor's degree. The businesses represented in the study spanned several sectors, with 28% in sustainable agriculture, 26% in renewable energy, 22% in eco-friendly product manufacturing, and the remaining 25% distributed among various other green services and technologies. Demographic profiles of the respondents are illustrated in Appendix B.

5.2. Measurement Variables

The study measured the variables of digital economic transformation, green entrepreneurship, green innovation, and rural revitalization by using a Likert scale with a range of five values, with 1 showing a complete disagreement and 5 manifesting a complete agreement. To ensure the face and content validity of the measurement scales used in the study, the authors implemented several steps. First, they conducted expert reviews of the scales to assess their relevance and comprehensiveness in the context of the study. Experts in the field provided feedback on the appropriateness of the items and their alignment with the research objectives. Second, the authors ensured that the scales were culturally adapted and validated for the context of China. This involved translating the scales into the local language and conducting a validation study to assess their psychometric properties in the target population. The scale items for measuring digital economic transformation (five items) [5,18,29], green entrepreneurship (five items) [45,46], green innovation (five items) [45,47], and rural revitalization (five items) [1,27] were borrowed from previous studies. The details of these items are described in Appendix C.

6. Data Analysis

The study examined the proposed relationship between digital economic transformation and rural revitalization through the serial mediating role of green entrepreneurship and green innovation by utilizing the SmartPLS software version 3.3.

6.1. Utilization of PLS-SEM

Partial least squares structural equation modeling (PLS-SEM) is a statistical technique widely employed in social sciences and business research for modeling complex relationships among latent variables [59]. Unlike traditional covariance-based SEM, PLS-SEM is particularly suited for studies with small sample sizes, non-normal data, and complex models [60]. SmartPLS enables researchers to examine the structural equation model (SEM) in two stages: (i) measurement model, and (ii) structural model [59–61]. Prior to data analysis, the authors conducted outlier removal and normality testing to ensure the quality of the data. Outliers were identified and removed from the dataset to prevent them from unduly influencing the results. Normality testing was performed to assess the distribution of the data and ensure that the assumptions of PLS-SEM were met. Subsequently, the first stage involved assessing the reliability and validity of the measurement model by utilizing techniques such as factor analysis and reliability tests. Upon validation, the second stage involved testing hypotheses about the direct and indirect effects of one construct on another by assessing the path coefficients and bootstrapping techniques. Details of these analyses are elaborated below.

6.2. Measurement Model

The evaluation of reflective measurement models encompasses three key components: average variance extracted (AVE) for convergent validity, individual indicator reliability, and composite reliability for internal consistency. Discriminant validity is another aspect of reflective measurement model assessment. To assess discriminant validity, researchers can utilize the Fornell–Larcker criterion, cross-loadings, and particularly the heterotrait–monotrait (HTMT) ratio of correlations [59]. Initially, the internal consistency reliability was evaluated using the Cronbach’s alpha and composite reliability. Our findings yielded values above the threshold level of 0.70 for these metrics to qualify for internal consistency. Alongside indicator reliability, the measurement model also tested the convergent validity using the indicator reliability metric (i.e., outer loadings as well as average variance extracted (AVE)). The AVE values reported in Table 1 indicate that the study adhered to the convergent reliability capability of the proposed model, as all of the values were above 0.50. In addition, the outer loading values are illustrated in Appendix C, which underpin this examination.

Table 1. Construct reliability and validity.

	Cronbach's Alpha	Composite Reliability (rho_a)	Composite Reliability (rho_c)	Average Variance Extracted (AVE)
Digital economic revitalization	0.909	0.916	0.932	0.733
Green entrepreneurship	0.888	0.893	0.918	0.691
Green innovation	0.886	0.892	0.916	0.687
Rural revitalization	0.916	0.918	0.937	0.749

According to Hair et al. [59], the degree to which a construct is genuinely different from other constructs based on empirical standards is known as discriminant validity. A construct must be distinct and able to capture phenomena that other constructs in the model are unable to capture in order to demonstrate discriminant validity. We tested the discriminant validity using cross-loadings (values are reported in Appendix D, surpassing the minimum threshold as well as ensuring distinctiveness), Fornell–Larcker, and the heterotrait–monotrait (HTMT) ratio. Fornell–Larcker contrasts the correlations between the latent variables and the square root of the AVE values. To be more precise, every construct's AVE square root needs to exceed its maximum correlation with any other construct [59]. The results shown in Table 2 validate the discriminant validity using the Fornell–Larcker criterion.

Table 2. Fornell–Larcker.

	Digital Economic Revitalization	Green Entrepreneurship	Green Innovation	Rural Revitalization
Digital economic revitalization	0.856			
Green entrepreneurship	0.644	0.831		
Green innovation	0.637	0.640	0.829	
Rural revitalization	0.517	0.574	0.738	0.865

In addition, according to [62], evaluating the heterotrait–monotrait ratio (HTMT) is suggested to validate the discriminant validity. The ratio of within-trait correlations to between-trait correlations is known as HTMT. The maximum threshold value for the HTMT ratio is 0.85, and our analysis, reported in Table 3, yielded values below this threshold, further ensuring the discriminant validity.

Table 3. Heterotrait–monotrait (HTMT) ratio.

	Digital Economic Revitalization	Green Entrepreneurship	Green Innovation	Rural Revitalization
Digital economic revitalization				
Green entrepreneurship	0.712			
Green innovation	0.702	0.712		
Rural revitalization	0.561	0.630	0.809	

6.3. Structural Model

Our study proposed the indirect relationship between digital economic transformation and rural revitalization through the serial mediating roles of green entrepreneurship and green innovation. Therefore, after successfully validating the measurement model, this study assessed the structural model. Specifically, the structural paths were tested alongside significance metrics using the PLS algorithm and bootstrapping approach [57]. For this reason, the direct and indirect effects were examined to assess the proposed model. The analysis showed that there was a positive association between digital economic transformation and green entrepreneurship, as the path coefficient value of $\beta = 0.644$ indicated a significant effect ($p < 0.01$; $t > 1.96$), therefore hypothesis 1 was confirmed. Furthermore,

there was a positive association between green entrepreneurship and green innovation, as the path coefficient value of $\beta = 0.393$ indicated a significant effect ($p < 0.01$; $t > 1.96$), therefore hypothesis 2 was confirmed. Likewise, there was a positive association between green innovation and rural revitalization as the path coefficient value of $\beta = 0.623$ indicated a significant effect ($p < 0.01$; $t > 1.96$), therefore hypothesis 3 was confirmed. In addition, the analysis also reported a significant positive impact of digital economic transformation on green innovation ($\beta = 0.383$; $p < 0.01$; $t > 1.96$) and green entrepreneurship on rural revitalization ($\beta = 0.166$; $p < 0.01$; $t > 1.96$). However, the direct impact of digital economic transformation on rural revitalization ($\beta = 0.014$; $p > 0.01$; $t < 1.96$) was insignificant.

Similarly, the indirect relationships were also confirmed by the empirical analysis, with a resample of 5000 bootstrapping techniques (bias-corrected and accelerated). The analysis showed that green entrepreneurship significantly mediates the relationship between digital economic transformation and green innovation, as the analysis yielded a path coefficient value of $\beta = 0.253$ with a significant effect ($p < 0.01$; $t > 1.96$). Furthermore, green innovation significantly mediates the relationship between green entrepreneurship and rural revitalization, as the analysis yielded the path coefficient value ($\beta = 0.245$) with a significant effect ($p < 0.01$; $t > 1.96$). Finally, the study confirmed the serial mediation roles of green entrepreneurship and green innovation in the relationship between digital economic transformation and rural revitalization, as the analysis yielded the path coefficient value of $\beta = 0.158$ with a significant effect ($p < 0.01$; $t > 1.96$). In addition, the Figure 2 and Table 4 shows that the direct relationship between digital economic transformation and rural revitalization is insignificant, indicating the indirect-only mediation in the model.

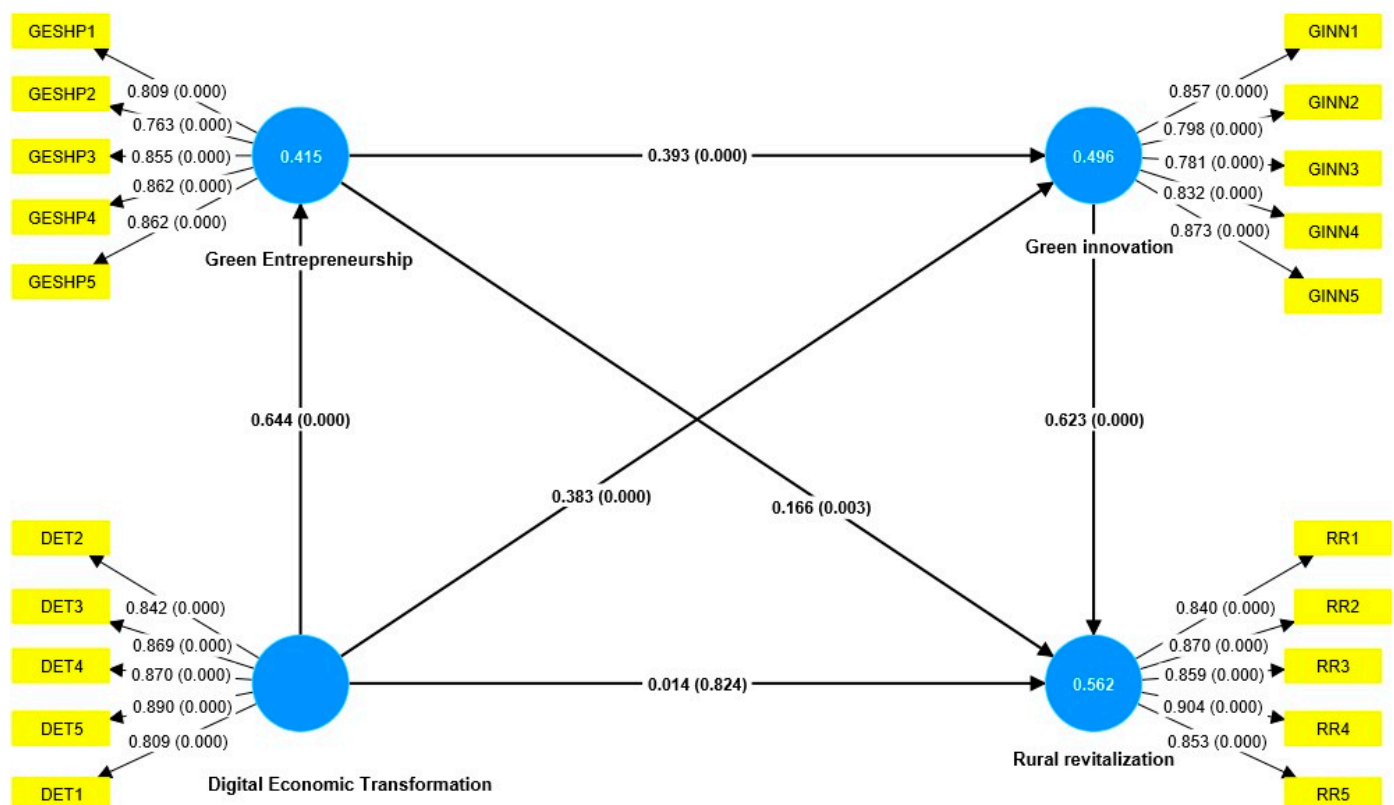


Figure 2. Structural paths (5000 bias-corrected and accelerated: BCa bootstrapping).

Finally, the authors also examined the effect size and predictive relevance of the proposed model. Appendix E illustrates the medium- to large-effect sizes of these relationships, whereas Appendix F yielded Q^2 values > 0 , which indicates the strength in the predictive capability of the proposed model.

Table 4. Path coefficients.

	B	p-Value	t-Value	Confidence Intervals
Direct effects				
Digital economic transformation → green entrepreneurship	0.644 **	0.000	16.151	[0.563, 0.721]
Digital economic transformation → green innovation	0.383 **	0.000	6.341	[0.262, 0.498]
Digital economic transformation → rural revitalization	0.014 (n.s.)	0.824	0.222	[−0.106, 0.141]
Green entrepreneurship → green innovation	0.393 **	0.000	6.899	[0.282, 0.502]
Green entrepreneurship → rural revitalization	0.166 **	0.003	2.972	[0.056, 0.277]
Green innovation → rural revitalization	0.623 **	0.000	0.689	[0.489, 0.740]
Indirect effects				
Digital economic transformation → green entrepreneurship → green innovation	0.253 **	0.000	6.091	[0.176, 0.337]
Green entrepreneurship → green innovation → rural revitalization	0.245 **	0.000	6.031	[0.167, 0.327]
Serial mediation effect				
Digital economic transformation → green entrepreneurship → green innovation → rural revitalization	0.158 **	0.000	5.407	[0.104, 0.219]

** indicates significant and n.s. indicates not significant.

7. Discussion of Findings and Their Implications

This study examined the impact of digital economic transformation on rural revitalization and investigated how green entrepreneurship and green innovation mediate the relationship between digital economic transformation and rural revitalization. Our findings demonstrate that digital economic transformation does not have a direct impact on rural revitalization. However, its influence primarily operates indirectly through green entrepreneurship and green innovation, accounting for 15.8% of their impact on rural revitalization. Our results align with earlier studies. For instance, Ref. [63] discovered that the degree of entrepreneurial orientation played a mediating role in the impact of big data analytics capabilities on the business model. In addition, Zameer et al. [64] determined that there was no significant correlation between the business analytics and green environmental orientation. They also found that green innovation completely underpinned the impact of business analytics on competitive advantage.

The findings further indicate that green entrepreneurship plays a role in mediating the link between digital economic transformation and green innovation. Utilizing digital applications such as AI, IoT, and big data analytics enhances understanding, resulting in improved entrepreneurial pursuits, and consequently enhanced ecological innovation [38]. Additionally, according to Bickley et al. [41], obtaining big data analytics capabilities and AI integration can bolster the efforts of green entrepreneurs in creating environmentally friendly business solutions. Furthermore, Industry 4.0 technology has facilitated firms in enhancing green entrepreneurship through improved planning, execution, and forecasting [65]. Subsequently, green innovation serves as a mediator in the relationship between green entrepreneurship and rural revitalization. Academics concur that implementing digital technologies enhances both the innovative performance of an enterprise and contributes to ecological sustainability [66]. Nevertheless, there is a scarcity of research that has examined the comprehensive influence of green entrepreneurship and green innovation and rural revitalization [67]. The results of our research align with other studies by Yin et al. [68] that validate the influence of green innovation on rural revitalization. Furthermore, our study showed that the green innovation variable is the most important factor in the impact of digital economic transformation and rural revitalization and plays a crucial role in establishing sustainability. This is consistent with the findings of Shahzad et al. [69],

as it acknowledges the function of green innovation in mediating the association between technology adoption and environmental sustainability.

The link between digital economic transformation and rural revitalization is mediated sequentially by green entrepreneurship and green innovation. The impact of green innovation is significant, with both direct and indirect effects. However, the indirect influence through green entrepreneurship is more significant. Green entrepreneurship plays a crucial role in facilitating the transition to sustainable solutions [46]. The results are corroborated by the research conducted by Cen et al. [70], which investigated the influence of Industry 4.0 technologies on the capacity of industrial upgrading to enhance rural revitalization.

Specifically, our research expands the extant body of knowledge in the wider research spectrum of the technological sphere such as digital economic transformation, big data analytics, AI, Industry 4.0, and IoT [38,65,69], among others. Since the inception of Industry 4.0 and machine learning, there has been a growing academic and practical interest in exploring the antecedents and consequences of digital transformation [65]. However, there has been little research that has explored the influence of digital economic transformation on rural revitalization. By examining the association between digital economic transformation and rural revitalization, our research extends the existing literature and contributes to the broader literature on technology and sustainability. Furthermore, our research found that the connection between digital economic transformation and rural revitalization is not direct, rather, there exists some intermediary paths through which the relationship is cultivated. Subsequently, linking green entrepreneurship as a mediating factor enriches the extant scholarly works on entrepreneurship, sustainable entrepreneurship [44], and most specifically, rural entrepreneurship [71]. This addition to the current academic debate substantially advances the theoretical, empirical as well as practical implications of our proposed model. In addition, our study further found that the relationship between digital economic transformation is further facilitated through the inculcation of green innovation as a crucial sequel. Accordingly, these insights were translated as well as empirically validated in a serial mediation mechanism such as green entrepreneurship, and green innovation sequentially mediates the relationship between digital economic transformation and rural revitalization. Afterward, our research represents the inaugural exploration of the indirect association between digital economic transformation and rural revitalization through a serial mediation path by employing green entrepreneurship and green innovation.

8. Conclusions

The current study explored a serial mediation model encompassing green entrepreneurship and green innovation as the sequential mediators of the indirect effects of digital economic transformation on rural revitalization. The study examined the proposed model by employing multivariate analytical techniques and rendered empirical support to the hypothesized relationships. Our findings confirm the relationships between (1) digital economic transformation and green entrepreneurship; (2) green entrepreneurship and green innovation; and (3) green innovation and rural revitalization. Furthermore, our study confirms (a) the mediating role of green entrepreneurship between digital economic transformation and green innovation; (b) the mediating role of green innovation between green entrepreneurship and rural revitalization; and (c) the serial mediating roles of green entrepreneurship and green innovation between digital economic transformation and rural revitalization. Finally, our study presents numerous noteworthy theoretical and practical implications.

8.1. Practical Implication of Research

The practical implications of this study extend significantly into various sectors, particularly in enhancing the effectiveness of green entrepreneurship and innovation within rural revitalization efforts. By demonstrating the critical role of digital economic transformation as a catalyst for green entrepreneurship and green innovation, this research provides a blueprint for stakeholders on how to leverage technology for sustainable development. For

policymakers, the findings underscore the necessity of creating supportive environments that encourage the adoption of digital technologies in rural areas. Efforts may be invested in broadband infrastructure, providing training programs to improve digital literacy, and offering incentives for businesses that integrate sustainable practices into their operations.

For entrepreneurs and businesses, the study highlights the potential of utilizing digital tools to drive sustainability initiatives and develop eco-friendly products and services. Our findings suggest that integrating Industry 4.0 technologies can lead to greater operational efficiencies, improved planning and execution, and innovative solutions to environmental challenges. Consequently, businesses that prioritize sustainability can not only contribute to rural revitalization, but also tap into new markets and consumer segments that value eco-conscious products.

Furthermore, the research points to the need for collaboration between governments, industries, and educational institutions to foster an ecosystem that nurtures green entrepreneurship and innovation. For instance, there may be initiatives such as public–private partnerships to fund green startups, competitions that encourage sustainable innovations, and curriculum development that incorporates elements of digital literacy and sustainability. By acting on these practical implications, stakeholders can collectively work toward a more sustainable and prosperous future for rural communities, aligning with broader global objectives such as the United Nations’ Sustainable Development Goals.

8.2. Limitations and Future Research

The study has several limitations. First, the data collection was conducted on Chinese respondents, thereby limiting the study’s scope across various cultural contexts. Second, data were collected by employing measurements based on the perceptions of our respondents. Therefore, there may be issues related to CMBs in our study. Although we tested the collinearity assessment to mitigate these issues, caution should be taken when generalizing the findings. Third, our research design was based on a cross-sectional method rather than a longitudinal one.

We suggest future studies to incorporate and analyze additional variables that might also influence the relationship between digital economic transformation and rural revitalization. For instance, confounding variables should be treated and analyzed to gauge any potential effects of these variables on the proposed relationships. Furthermore, we expect that digital economic transformation engenders the facilitation of tacit knowledge, however, there should be some intermediary path that translates such tacit knowledge into entrepreneurial green ventures. Thus, future research should focus on this limitation, which was not addressed in our study. Additionally, mixed methodology and longitudinal research designs could be employed to generalize the findings of this study.

Author Contributions: Y.W. and D.Y. take equal responsibility and contributed in every aspect of preparing and submitting this article. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Obtained from the relevant institutions.

Informed Consent Statement: Not applicable.

Data Availability Statement: Data are contained within the article.

Conflicts of Interest: The authors declare no potential conflicts of interest.

Appendix A. Collinearity Statistics (Variance Inflation Factor: VIF)

	Digital Economic Revitalization	Green Entrepreneurship	Green Innovation	Rural Revitalization
Digital economic revitalization		1.000	1.709	2.000
Green entrepreneurship			1.709	2.016
Green innovation				1.984
Rural revitalization				

Appendix B. Demographic Profiles

Demographic Profile	Percentage
Gender	
Mae	41%
Female	59%
Age	
20–30	18%
30–40	35%
40–50	27%
Above 50	20%
Education	
Bachelor’s	68%
Master’s	21%
Other	11%
Business sector	
Sustainable agriculture	28%
Renewable energy	26%
Eco-friendly product manufacturing	22%
Other	25%

Appendix C. Outer Loadings

	Loadings
Digital economic transformation	
“The community frequently uses digital platforms for local business operations.”	0.842
“There is a significant presence of digital payment systems in the local market.”	0.869
“Local businesses often utilize digital marketing to reach their customers.”	0.870
“Digital training programs are readily available for the rural workforce.”	0.890
“The use of digital technology in agriculture is becoming increasingly common.”	0.809
Green entrepreneurship	
“Local entrepreneurs are actively involved in businesses that promote environmental sustainability.”	0.809
“Start-ups focusing on eco-friendly products or services are emerging in the area.”	0.763
“Entrepreneurs receive support for initiatives that reduce environmental impact.”	0.855
“There is a growing interest in sustainable agricultural practices among local business owners.”	0.862
“Renewable energy sources are preferred by new and existing businesses.”	0.862

	Loadings
Green innovation	
“Innovations that reduce waste and pollution are being implemented by local businesses.”	0.857
“There is an adoption of eco-friendly technologies in production processes.”	0.798
“Local enterprises are innovating in water conservation techniques.”	0.781
“Sustainable packaging solutions are being developed and used by local producers.”	0.832
“Energy efficiency improvements are a common goal for business innovations.”	0.873
Rural revitalization	
“The standard of living in rural areas is improving.”	0.840
“There is an increase in employment opportunities in rural regions.”	0.870
“Rural infrastructure, such as roads and internet connectivity, is being enhanced.”	0.859
“Local culture and traditions are being preserved while promoting economic development.”	0.904
“There is a noticeable improvement in the accessibility of educational and healthcare services in rural areas.”	0.853

Appendix D. Cross Loadings

Items	Digital Economic Revitalization	Green Entrepreneurship	Green Innovation	Rural Revitalization
DET1	0.809	0.550	0.468	0.374
DET2	0.842	0.495	0.512	0.374
DET3	0.869	0.515	0.554	0.441
DET4	0.870	0.589	0.544	0.467
DET5	0.890	0.600	0.631	0.536
GESHP1	0.513	0.809	0.528	0.494
GESHP2	0.454	0.763	0.475	0.360
GESHP3	0.584	0.855	0.522	0.507
GESHP4	0.546	0.862	0.563	0.476
GESHP5	0.568	0.862	0.568	0.530
GINN1	0.559	0.568	0.857	0.621
GINN2	0.551	0.613	0.798	0.697
GINN3	0.520	0.411	0.781	0.485
GINN4	0.440	0.503	0.832	0.575
GINN5	0.557	0.527	0.873	0.647
RR1	0.413	0.420	0.621	0.840
RR2	0.481	0.501	0.593	0.870
RR3	0.501	0.526	0.658	0.859
RR4	0.450	0.561	0.675	0.904
RR5	0.392	0.466	0.641	0.853

Appendix E. Effect Size (F-Square Matrix)

	Digital Economic Revitalization	Green Entrepreneurship	Green Innovation	Rural Revitalization
Digital economic revitalization		0.709	0.171	0.000
Green entrepreneurship			0.180	0.031
Green innovation				0.446
Rural revitalization				

Appendix F. Predictive Relevance (Q-Square)

	SSO	SSE	Q ² (=1 – SSE/SSO)
Digital economic transformation	1545.000	1545.000	0.000
Green entrepreneurship	1545.000	1109.227	0.282
Green innovation	1545.000	1035.056	0.330
Rural revitalization	1545.000	905.080	0.414

References

1. Yang, J.; Yang, R.; Chen, M.H.; Su, C.H.J.; Zhi, Y.; Xi, J. Effects of rural revitalization on rural tourism. *J. Hosp. Tour. Manag.* **2021**, *47*, 35–45. [\[CrossRef\]](#)
2. Chen, M.; Zhou, Y.; Huang, X.; Ye, C. The integration of new-type urbanization and rural revitalization strategies in China: Origin, reality and future trends. *Land* **2021**, *10*, 207. [\[CrossRef\]](#)
3. Geng, Y.; Liu, L.; Chen, L. Rural revitalization of China: A new framework, measurement and forecast. *Socio-Econ. Plan. Sci.* **2023**, *89*, 101696. [\[CrossRef\]](#)
4. Xu, G.; Hou, G.; Zhang, J. Digital Sustainable Entrepreneurship: A digital capability perspective through digital innovation orientation for social and environmental value creation. *Sustainability* **2022**, *14*, 11222. [\[CrossRef\]](#)
5. Monda, A.; Feola, R.; Parente, R.; Vesci, M.; Botti, A. Rural development and digital technologies: A collaborative framework for policy-making. *Transform. Gov. People Process Policy* **2023**, *17*, 328–343. [\[CrossRef\]](#)
6. Nosova, S.; Norkina, A.; Makar, S.; Fadeicheva, G. Digital transformation as a new paradigm of economic policy. *Procedia Comput. Sci.* **2021**, *190*, 657–665. [\[CrossRef\]](#)
7. Shkarlet, S.; Dubyna, M.; Shtyrkhun, K.; Verbivska, L. Transformation of the paradigm of the economic entities development in digital economy. *WSEAS Trans. Environ. Dev.* **2020**, *16*, 413–422. [\[CrossRef\]](#)
8. Rijswijk, K.; Klerkx, L.; Bacco, M.; Bartolini, F.; Bulten, E.; Debruyne, L.; Dessein, J.; Scotti, I.; Brunori, G. Digital transformation of agriculture and rural areas: A socio-cyber-physical system framework to support responsabilisation. *J. Rural Stud.* **2021**, *85*, 79–90. [\[CrossRef\]](#)
9. Zhang, X.N.; Qu, M. Impact of Environmental Regulation on Scientific and Technological Competitiveness of Resource-Based Cities in China—Based on Panel Data of 33 Resource-Based Cities. *Int. J. Environ. Res. Public Health* **2020**, *17*, 9187. [\[CrossRef\]](#) [\[PubMed\]](#)
10. Zeng, J.; Ren, J. How does green entrepreneurship affect environmental improvement? Findings from 293 enterprises. *Int. Entrep. Manag. J.* **2022**, *18*, 409–434. [\[CrossRef\]](#)
11. Speckemeier, L.; Tsvirikos, D. Green entrepreneurship: Should legislators invest in the formation of sustainable hubs? *Sustainability* **2022**, *14*, 7152. [\[CrossRef\]](#)
12. Ji, X.; Zhang, S.; Lu, Y. Does an Environmental Management System Affect Green Innovation: The Role of Green Financing in China's Tourism Sector in a Circular Economy. *Sustainability* **2023**, *15*, 6411. [\[CrossRef\]](#)
13. Tseng, M.L.; Wang, R.; Chiu, A.S.; Geng, Y.; Lin, Y.H. Improving performance of green innovation practices under uncertainty. *J. Clean. Prod.* **2013**, *40*, 71–82. [\[CrossRef\]](#)
14. Yang, J.; Wu, R.; Yang, H. Digital transformation and enterprise sustainability: The moderating role of regional virtual agglomeration. *Sustainability* **2023**, *15*, 7597. [\[CrossRef\]](#)
15. Jiang, Z.; Zhang, X.; Zhao, Y.; Li, C.; Wang, Z. The impact of urban digital transformation on resource sustainability: Evidence from a quasi-natural experiment in China. *Resour. Policy* **2023**, *85*, 103784. [\[CrossRef\]](#)
16. Criveanu, M.M. Investigating Digital Intensity and E-Commerce as Drivers for Sustainability and Economic Growth in the EU Countries. *Electronics* **2023**, *12*, 2318. [\[CrossRef\]](#)
17. Ma, R.; Lin, B. Digital infrastructure construction drives green economic transformation: Evidence from Chinese cities. *Humanit. Soc. Sci. Commun.* **2023**, *10*, 1–10. [\[CrossRef\]](#)
18. Qin, T.; Wang, L.; Zhou, Y.; Guo, L.; Jiang, G.; Zhang, L. Digital technology-and-services-driven sustainable transformation of agriculture: Cases of China and the EU. *Agriculture* **2022**, *12*, 297. [\[CrossRef\]](#)
19. Audretsch, D. Entrepreneurship research. *Manag. Decis.* **2012**, *50*, 755–764. [\[CrossRef\]](#)
20. Hisrich, R.D.; Peters, M.P.; Shepherd, D.A. *Entrepreneurship*; McGraw-Hill Education: Berkshire, UK, 2017.
21. Naudé, W. *Entrepreneurship in Economic Development*; The United Nations University World Institute for Development Economics Research (UNU-WIDER): Helsinki, Finland, 2008.
22. Vedula, S.; Doblinger, C.; Pacheco, D.; York, J.G.; Bacq, S.; Russo, M.V.; Dean, T.J. Entrepreneurship for the public good: A review, critique, and path forward for social and environmental entrepreneurship research. *Acad. Manag. Ann.* **2022**, *16*, 391–425. [\[CrossRef\]](#)
23. Neumann, T. The impact of entrepreneurship on economic, social and environmental welfare and its determinants: A systematic review. *Manag. Rev. Q.* **2021**, *71*, 553–584. [\[CrossRef\]](#)
24. Baker, T.; Welter, F. *Contextualizing Entrepreneurship Theory*; Routledge: London, UK, 2020; p. 188.
25. Corbett, J.; Montgomery, A.W. Environmental entrepreneurship and interorganizational arrangements: A model of social-benefit market creation. *Strateg. Entrep. J.* **2017**, *11*, 422–440. [\[CrossRef\]](#)

26. Prayitno, M.A.; Lutfianasari, U.; Nugroho, D.E. The Effectiveness of Greenpreneurship Course for Students' Communication Ability and Entrepreneurial Interest. *THABIEA J. Nat. Sci. Teach.* **2020**, *3*, 141–150. [\[CrossRef\]](#)
27. Gu, W.; Wang, J.; Hua, X.; Liu, Z. Entrepreneurship and high-quality economic development: Based on the triple bottom line of sustainable development. *Int. Entrep. Manag. J.* **2021**, *17*, 1–27. [\[CrossRef\]](#)
28. Zhang, Q.; Kim, E.; Yang, C.; Cao, F. Rural revitalization: Sustainable strategy for the development of cultural landscape of traditional villages through optimized IPA approach. *J. Cult. Herit. Manag. Sustain. Dev.* **2023**, *13*, 66–86. [\[CrossRef\]](#)
29. Chen, J.; Zeng, H.; Gao, Q. Using the sustainable development capacity of key counties to guide rural revitalization in China. *Int. J. Environ. Res. Public Health* **2023**, *20*, 4076. [\[CrossRef\]](#) [\[PubMed\]](#)
30. Soomro, B.A.; Moawad, N.F.; Saraih, U.N.; Abedelwahed, N.A.A.; Shah, N. Going green with the green market and green innovation: Building the connection between green entrepreneurship and sustainable development. *Kybernetes* **2024**, *53*, 1484–1504. [\[CrossRef\]](#)
31. AlQershi, N.A.; Saufi, R.B.A.; Yaziz, M.F.B.A.; Ramayah, T.; Muhammad, N.M.N.; Yusoff, M.N.H.B. The relationship between green entrepreneurship, human capital and business sustainability in Malaysian large manufacturing firms: An empirical study. *Technol. Forecast. Soc. Chang.* **2023**, *192*, 122529. [\[CrossRef\]](#)
32. Yasir, N.; Babar, M.; Mehmood, H.S.; Xie, R.; Guo, G. The environmental values play a role in the development of green entrepreneurship to achieve sustainable entrepreneurial intention. *Sustainability* **2023**, *15*, 6451. [\[CrossRef\]](#)
33. Heredia, J.; McIntyre, J.R.; Rubiños, C.; Santibañez, E.; Flores, A. A configuration approach to explain corporate environmental responsibility behavior of the emerging economies firms at industry 4.0. *J. Clean. Prod.* **2023**, *395*, 136383. [\[CrossRef\]](#)
34. Mondal, S.; Singh, S.; Gupta, H. Green entrepreneurship and digitalization enabling the circular economy through sustainable waste management-An exploratory study of emerging economy. *J. Clean. Prod.* **2023**, *422*, 138433. [\[CrossRef\]](#)
35. Manjon, M.; Aouni, Z.; Crutzen, N. Green and digital entrepreneurship in smart cities. *Ann. Reg. Sci.* **2022**, *68*, 429–462. [\[CrossRef\]](#)
36. Polas, M.R.H.; Kabir, A.I.; Soheli-Uz-Zaman, A.S.M.; Karim, R.; Tabash, M.I. Blockchain technology as a game changer for green innovation: Green entrepreneurship as a roadmap to green economic sustainability in Peru. *J. Open Innov. Technol. Mark. Complex.* **2022**, *8*, 62. [\[CrossRef\]](#)
37. Xu, L.; Zhao, H.; Chernova, V.; Strielkowski, W.; Chen, G. Research on Rural Revitalization and Governance from the Perspective of Sustainable Development. *Front. Environ. Sci.* **2022**, *10*, 168. [\[CrossRef\]](#)
38. Makhoulfi, L. Do knowledge sharing and big data analytics capabilities matter for green absorptive capacity and green entrepreneurship orientation? Implications for green innovation. *Ind. Manag. Data Syst.* **2023**, *124*, 978–1004. [\[CrossRef\]](#)
39. Saura, J.R.; Ribeiro-Soriano, D.; Palacios-Marqués, D. Adopting digital reservation systems to enable circular economy in entrepreneurship. *Manag. Decis.* **2022**. [\[CrossRef\]](#)
40. Kayikci, Y.; Gozacan-Chase, N.; Rejeb, A. Blockchain entrepreneurship roles for circular supply chain transition. *Bus. Strat. Environ.* **2024**, *33*, 197–222. [\[CrossRef\]](#)
41. Bickley, S.J.; Macintyre, A.; Torgler, B. Artificial intelligence and big data in sustainable entrepreneurship. *J. Econ. Surv.* **2021**, *1*–43. [\[CrossRef\]](#)
42. Ebrahimi, P.; Mirbargkar, S.M. Green entrepreneurship and green innovation for SME development in market turbulence. *Eurasian Bus. Rev.* **2017**, *7*, 203–228. [\[CrossRef\]](#)
43. Skordoulis, M.; Kyriakopoulos, G.; Ntanos, S.; Galatsidas, S.; Arabatzis, G.; Chalikias, M.; Kalantonis, P. The mediating role of firm strategy in the relationship between green entrepreneurship, green innovation, and competitive advantage: The case of medium and large-sized firms in Greece. *Sustainability* **2022**, *14*, 3286. [\[CrossRef\]](#)
44. Muangmee, C.; Dacko-Pikiewicz, Z.; Meekaewkunchorn, N.; Kassakorn, N.; Khalid, B. Green entrepreneurial orientation and green innovation in small and medium-sized enterprises (SMEs). *Soc. Sci.* **2021**, *10*, 136. [\[CrossRef\]](#)
45. Guo, Y.; Wang, L.; Chen, Y. Green entrepreneurial orientation and green innovation: The mediating effect of supply chain learning. *SAGE Open* **2020**, *10*, 2158244019898798. [\[CrossRef\]](#)
46. Shehzad, M.U.; Zhang, J.; Latif, K.F.; Jamil, K.; Waseel, A.H. Do green entrepreneurial orientation and green knowledge management matter in the pursuit of ambidextrous green innovation: A moderated mediation model. *J. Clean. Prod.* **2023**, *388*, 135971. [\[CrossRef\]](#)
47. Aldieri, L.; Carlucci, F.; Cirà, A.; Ioppolo, G.; Vinci, C.P. Is green innovation an opportunity or a threat to employment? An empirical analysis of three main industrialized areas: The USA, Japan and Europe. *J. Clean. Prod.* **2019**, *214*, 758–766. [\[CrossRef\]](#)
48. Apak, S.; Atay, E. Global competitiveness in the EU through green innovation technologies and knowledge production. *Proc. Soc. Behav. Sci.* **2015**, *181*, 207–217. [\[CrossRef\]](#)
49. Asad, A.I.; Çera, E.; Pavelková, D.; Matošková, J. The management of green technology innovation: A comparative analysis of the global west and the v4 economies. In Proceedings of the 17th Annual International Bata Conference for Ph.D. Students and Young Researchers, Zlin, Czech Republic, 27 September 2021; p. 30.
50. Wang, C.H. How organizational green culture influences green performance and competitive advantage: The mediating role of green innovation. *J. Manuf. Technol. Manag.* **2019**, *30*, 666–683. [\[CrossRef\]](#)
51. Li, H.Y.; Liu, Q.; Ye, H.Z. Digital development influencing mechanism on green innovation performance: A perspective of green innovation network. *IEEE Access* **2023**, *11*, 22490–22504. [\[CrossRef\]](#)

52. Hermawati, W.; Ririh, K.R.; Ariyani, L.; Helmi, R.L.; Rosaira, I. Sustainable and green energy development to support women's empowerment in rural areas of Indonesia: Case of micro-hydro power implementation. *Energy Sustain. Dev.* **2023**, *73*, 218–231. [\[CrossRef\]](#)
53. Farooq, M.; Pisante, M. (Eds.) *Innovations in Sustainable Agriculture*; Springer International Publishing: Berlin/Heidelberg, Germany, 2019.
54. Tyagi, P.K.; Nadda, V.; Bharti, V.; Kemer, E. (Eds.) *Embracing Business Sustainability through Innovation and Creativity in the Service Sector*; IGI Global: Hershey, PA, USA, 2023.
55. Zhang, Y.-J.; Zhao, J.-N.; Wang, H.; Tan, B.-C.; Zhang, H.-F.; Liu, H.-M.; Wang, L.-L.; Wang, N.; Liu, R.-L.; Yang, D.-L.; et al. Innovative integration and demonstration of green and efficient agricultural technology in Danjiangkou water conservation area: Pattern design, technology integration, and mechanism innovation. *J. Agric. Resour. Environ.* **2020**, *37*, 301–307.
56. Nguyen Dang, H.A.; Khan, A.; Doan, A.T.; Ibbett, N. The social impact of green innovation: Towards a conceptual framework. *Int. J. Public Adm.* **2022**, *45*, 399–411. [\[CrossRef\]](#)
57. Zhang, Y.; Mao, Y.; Jiao, L.; Shuai, C.; Zhang, H. Eco-efficiency, eco-technology innovation and eco-well-being performance to improve global sustainable development. *Environ. Impact Assess. Rev.* **2021**, *89*, 106580. [\[CrossRef\]](#)
58. Singh, R.; Mangat, N.S.; Singh, R.; Mangat, N.S. Stratified Sampling. In *Elements of Survey Sampling*; Springer: Berlin/Heidelberg, Germany, 1996; pp. 102–144.
59. Hair, J.F.; Risher, J.J.; Sarstedt, M.; Ringle, C.M. When to use and how to report the results of PLS-SEM. *Eur. Bus. Rev.* **2019**, *31*, 2–24. [\[CrossRef\]](#)
60. Hair, J.F., Jr.; Hult, G.T.M.; Ringle, C.M.; Sarstedt, M.; Danks, N.P.; Ray, S. *Partial Least Squares Structural Equation Modeling (PLS-SEM) Using R: A Workbook*; Springer Nature: Cham, Switzerland, 2021.
61. Ringle, C.M.; Sarstedt, M.; Mitchell, R.; Gudergan, S.P. Partial least squares structural equation modeling in HRM research. *Int. J. Hum. Resour. Manag.* **2020**, *31*, 1617–1643. [\[CrossRef\]](#)
62. Henseler, J.; Ringle, C.M.; Sarstedt, M. A new criterion for assessing discriminant validity in variance-based structural equation modeling. *J. Acad. Mark. Sci.* **2015**, *43*, 115–135. [\[CrossRef\]](#)
63. Ciampi, F.; Demi, S.; Magrini, A.; Marzi, G.; Papa, A. Exploring the impact of big data analytics capabilities on business model innovation: The mediating role of entrepreneurial orientation. *J. Bus. Res.* **2021**, *123*, 1–13. [\[CrossRef\]](#)
64. Zameer, H.; Wang, Y.; Yasmeen, H.; Mubarak, S. Green innovation as a mediator in the impact of business analytics and environmental orientation on green competitive advantage. *Manag. Decis.* **2022**, *60*, 488–507. [\[CrossRef\]](#)
65. Gupta, H.; Mondal, S.; Singh, S.; Kharub, M. Industry 4.0 and Green Entrepreneurship for Environmental Sustainability: Exploring Barriers from an Indian SME Perspective. In *The International Workshop on Best-Worst Method*; Springer Nature: Cham, Switzerland, 2023; pp. 77–108.
66. Zhao, X.; Qian, Y. Does digital technology promote green innovation performance? *J. Knowl. Econ.* **2023**, 1–20. [\[CrossRef\]](#)
67. Li, X.; Ma, L.; Ruman, A.M.; Iqbal, N.; Strielkowski, W. Impact of natural resource mining on sustainable economic development: The role of education and green innovation in China. *Geosci. Front.* **2023**, *15*, 101703. [\[CrossRef\]](#)
68. Yin, X.; Chen, J.; Li, J. Rural innovation system: Revitalize the countryside for a sustainable development. *J. Rural Stud.* **2022**, *93*, 471–478. [\[CrossRef\]](#)
69. Shahzad, M.; Qu, Y.; Rehman, S.U.; Zafar, A.U. Adoption of green innovation technology to accelerate sustainable development among manufacturing industry. *J. Innov. Knowl.* **2022**, *7*, 100231. [\[CrossRef\]](#)
70. Cen, T.; Lin, S.; Wu, Q. How does digital economy affect rural revitalization? The mediating effect of industrial upgrading. *Sustainability* **2022**, *14*, 16987. [\[CrossRef\]](#)
71. del Olmo-García, F.; Domínguez-Fabián, I.; Crecente-Romero, F.J.; del Val-Núñez, M.T. Determinant factors for the development of rural entrepreneurship. *Technol. Forecast. Soc. Change* **2023**, *191*, 122487. [\[CrossRef\]](#)

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.