

Who Benefits More from E-commerce? Resource-Endowment Heterogeneity in Grape Growers' Behavioral Upgrading in Yingkou City, Liaoning Province

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Abstract

Using survey data from 386 grape growers in Yingkou City, this article examines whether the behavioral effects of e-commerce participation vary across households with different resource endowments. Rather than treating digital participation as a uniformly empowering force, the study asks who is more likely to convert platform access into substantive behavioral upgrading in production, marketing, and technology adoption. Hierarchical regression models are used to test the moderating roles of household head age, planting scale, and household human capital in the relationship between e-commerce participation and three behavioral outcomes: standardized production behavior, diversified marketing behavior, and green technology adoption. The results show clear heterogeneity. Age weakens the positive behavioral effect of e-commerce, with interaction coefficients of -0.156, -0.163, and -0.151 across the three outcomes. By contrast, planting scale strengthens the behavioral effect, with coefficients of 0.172, 0.185, and 0.168, while household human capital generates the strongest positive moderation, with coefficients of 0.189, 0.201, and 0.182. Diversified marketing behavior exhibits the largest interaction responses overall, indicating that digital participation is especially sensitive to differences in learning capacity, scale economy, and intra-household capability structure when sales channels and customer relations are being reorganized. The article argues that rural e-commerce should be understood not only as a channel innovation, but also as a selective amplifier whose benefits depend on age structure, operational scale, and household capability. Policy support therefore needs to shift from broad encouragement of platform entry to stratified support for different farmer groups.

Keywords

Rural E-commerce; Grape Growers; Heterogeneity Effect; Planting Scale; Household Human Capital.

1. Introduction

Research on rural e-commerce has moved from asking whether farmers can access online markets to asking how digital participation changes business outcomes. However, the underlying assumption in many empirical studies is still that e-commerce produces a relatively uniform effect once producers enter the platform economy. That assumption is too strong for fresh agricultural products such as grapes, whose online commercialization requires continuous learning, quality stabilization, post-harvest coordination, customer interaction, and often multi-person household cooperation.[1]

In Yingkou City, Liaoning Province, e-commerce participation is increasingly embedded in the grape industry, yet growers do not benefit equally from it. Some households translate platform access into standardized production, diversified marketing, and stronger willingness to adopt green technologies; others participate only superficially and obtain much weaker behavioral

gains. The difference is not explained by platform access alone. It is closely tied to whether farmers have the age profile, operational scale, and household capability needed to absorb digital opportunities.[2]

Against this background, this article develops a dissertation-based heterogeneity analysis focusing on three moderators: household head age, planting scale, and household human capital. The contribution of the article is threefold. First, it isolates the conditional dimension of e-commerce effects rather than treating heterogeneity as a secondary robustness issue. Second, it compares moderator strength across three types of behavioral upgrading. Third, it translates the empirical results into a stratified policy logic showing why identical digital interventions may generate unequal behavioral returns.[3]

2. Theoretical Logic and Research Expectations

The behavioral effects of e-commerce participation are conditional because digital participation combines opportunity with capability requirements. E-commerce widens market reach and improves information flow, but it also imposes new demands in rule learning, platform operation, packaging coordination, and customer response. The effect of participation therefore depends on whether growers possess the resources needed to transform digital access into sustained behavioral change.

2.1. Age as a Negative Moderator

Age captures an important part of the rural digital divide. Younger and middle-aged household heads are generally more receptive to new technologies, more willing to experiment with livestreaming and short-video promotion, and better able to adapt to changing platform rules. Older growers may still participate in e-commerce, but the learning costs of operating digital tools, interpreting online feedback, and coordinating new marketing formats are usually higher. Therefore, the positive effect of e-commerce participation on behavioral upgrading is expected to weaken as the age of the household head increases.[4]

2.2. Planting Scale as a Positive Moderator

Planting scale reflects whether the household can spread the fixed costs associated with packaging improvement, cold-chain coordination, branding, and standardized management. Large-scale growers are more capable of stabilizing product supply and investing in complementary assets that make e-commerce effective. Small-scale growers may enter online markets, but the benefits of participation are more easily diluted by unstable volume, fragmented labor input, and weaker bargaining power. E-commerce participation is therefore expected to have stronger behavioral effects in larger-scale operations.[5]

2.3. Household Human Capital as a Positive Moderator

Household human capital includes the educational attainment, training experience, non-farm exposure, and digital ability available inside the family. These resources shape whether information from platforms can be understood, filtered, and converted into action. In households with stronger human capital, e-commerce signals are more likely to be translated into production adjustment, marketing innovation, and experimentation with green technology. Hence, household human capital is expected to amplify the marginal effect of e-commerce participation.[6]

2.4. Empirical Framework

Figure 1 presents the heterogeneity framework used in this article. E-commerce participation remains the core explanatory variable, but the strength of its relationship with standardized production behavior, diversified marketing behavior, and green technology adoption is allowed to vary with age, planting scale, and household human capital. The analytical emphasis is not

only whether e-commerce works, but who is more capable of converting participation into behavioral upgrading.

3. Data, Variables, and Methods

The empirical analysis uses the dissertation survey of 386 grape growers drawn from the major grape-producing areas of Yingkou City, including townships in Gaizhou and Dashiqiao. The dataset combines offline field interviews and supplementary online questionnaires. In the dissertation, the e-commerce participation index was measured through breadth, depth, and operational intensity. The dependent variables were standardized production behavior (SPB), diversified marketing behavior (DMB), and green technology adoption (GTA).

To test heterogeneity, hierarchical regression was applied. For each moderator, the main effect model was estimated first, followed by a second-step model including the interaction term between e-commerce participation and the moderator. All models controlled for the standard background variables used in the dissertation. A significant interaction term indicates that the slope of e-commerce participation differs across households with different resource endowments.

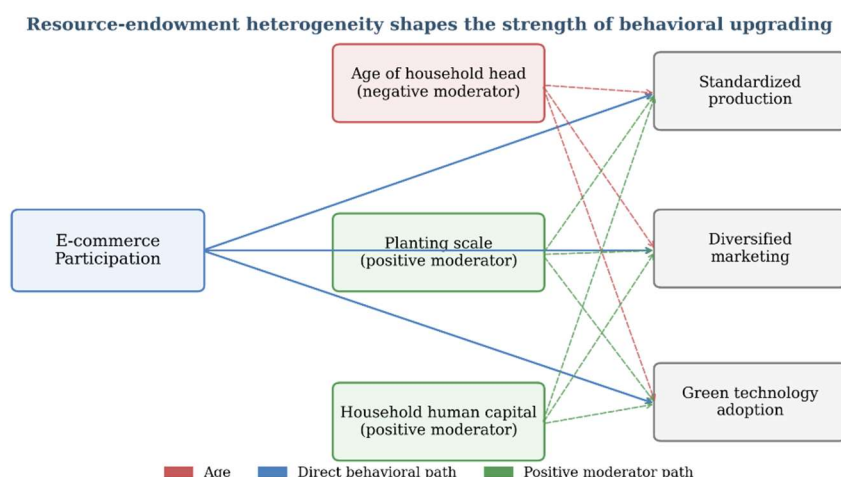


Figure 1. Resource-endowment heterogeneity in the behavioral effects of e-commerce participation.

Table 1. Key heterogeneity-related sample profile.

Dimension	Category	Frequency (n)	Percentage (%)
Age of household head	Younger and middle-aged (<=50)	176	45.6
Age of household head	Middle-aged and older (>50)	210	54.4
Planting scale	Small scale (<=5 mu)	142	36.8
Planting scale	Medium scale (5-20 mu)	189	49.0
Planting scale	Large scale (>20 mu)	55	14.2
Farm household e-commerce participation	Participates in e-commerce	199	52.1
Farm household e-commerce participation	Does not participate in e-commerce	187	47.9

Note: Household human capital was measured through the multi-item scale reported in the dissertation, covering family educational resources, training, and non-farm experience.

4. Results

The regression results show that the behavioral effect of e-commerce participation is clearly heterogeneous. Age weakens the positive effect, while planting scale and household human capital strengthen it. The interaction terms are statistically significant across all three dependent variables, demonstrating that e-commerce is not a uniformly empowering force across the sample.

The negative interaction between e-commerce participation and age is observed for standardized production behavior (-0.156), diversified marketing behavior (-0.163), and green technology adoption (-0.151). This means that although participation remains beneficial overall, the behavioral return to participation declines with age. The strongest dampening effect appears in diversified marketing, which is also the most operation-intensive digital behavior.

Table 2. Summary of moderating effects across the three behavioral outcomes.

Moderator	SPB interaction	ΔR^2	DMB interaction	ΔR^2	GTA interaction	ΔR^2	Overall direction
Household head age	-0.156**	0.023	-0.163**	0.025	-0.151**	0.022	Negative moderator
Planting scale	0.172***	0.031	0.185***	0.033	0.168***	0.031	Positive moderator
Household human capital	0.189***	0.036	0.201***	0.037	0.182***	0.036	Positive moderator

Note: SPB = standardized production behavior; DMB = diversified marketing behavior; GTA = green technology adoption. ΔR^2 is the increase in R-squared from Step 1 to Step 2 after adding the interaction term.

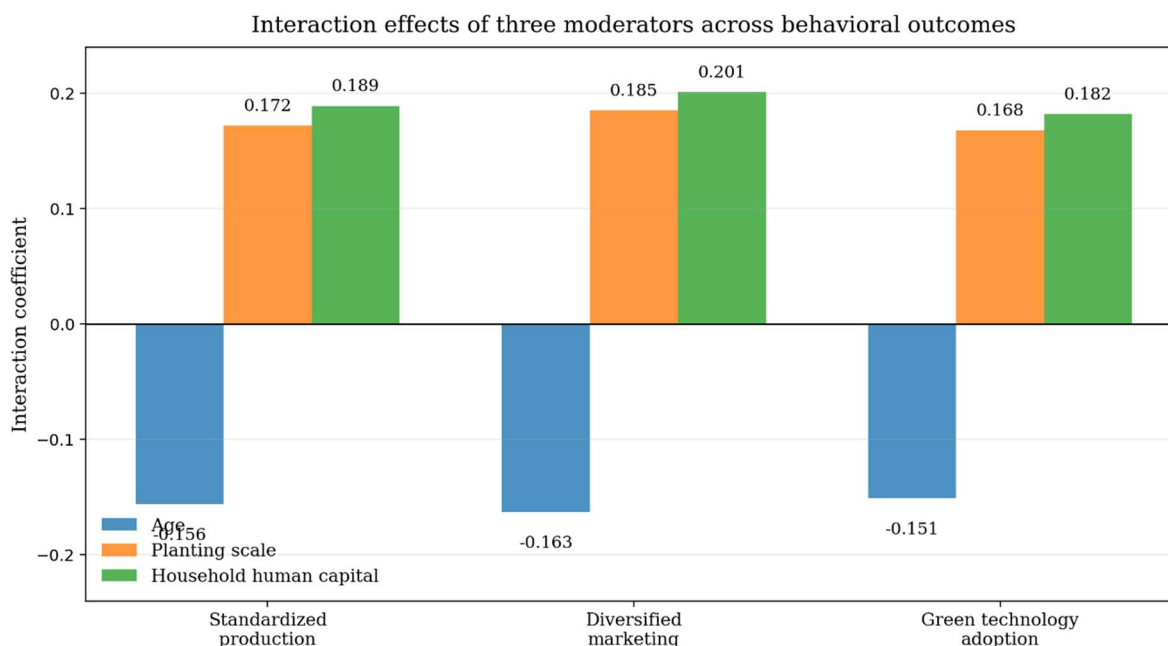


Figure 2. Comparative interaction coefficients of age, planting scale, and household human capital.

By contrast, planting scale amplifies the behavioral effect of e-commerce. Interaction coefficients reach 0.172 for standardized production, 0.185 for diversified marketing, and 0.168 for green technology adoption. The pattern indicates a coupling effect between scale economy and digital participation. Larger growers are better positioned to absorb packaging, logistics, and branding costs, and thus can extract more behavioral value from e-commerce participation.

Household human capital produces the strongest positive moderation among the three moderators. The interaction coefficients are 0.189 for standardized production, 0.201 for diversified marketing, and 0.182 for green technology adoption. This finding suggests that intra-household capability is especially important when farmers need to interpret market signals, maintain multiple channels, and continue learning under platform uncertainty.

5. Discussion

The results reveal that heterogeneity is not a side issue in rural e-commerce; it is a core part of the mechanism through which digital participation translates into behavioral change. Age reflects differences in digital receptiveness and learning costs. Planting scale reflects whether households can complement platform participation with logistics, packaging, and volume stability. Household human capital reflects the family's internal ability to process information, divide labor, and sustain learning.

A notable pattern is that all three moderators exert their strongest effects on diversified marketing behavior. Compared with standardized production and green technology adoption, diversified marketing requires more frequent platform interaction, stronger content adaptation, faster response to consumer feedback, and greater coordination across online and offline channels. This makes it especially sensitive to differences in age profile, scale, and household capability.

These findings help reinterpret the meaning of digital inclusion. Access to the internet or an e-commerce platform does not automatically equal equal benefit. In practice, e-commerce behaves as a selective amplifier: households with stronger complementary resources gain more from participation, whereas those with weaker endowments may still participate but find it harder to convert participation into durable behavioral upgrading.

6. Policy Implications and Conclusion

The article reaches three main conclusions. First, the positive effect of e-commerce participation on growers' behavior is significantly moderated by resource endowments. Second, age weakens the behavioral payoff of e-commerce participation, while planting scale and household human capital strengthen it. Third, diversified marketing is the behavioral dimension most sensitive to heterogeneity, indicating that digital channel reorganization depends heavily on farmer capability.

These conclusions imply that policy should move beyond universal encouragement of online selling. Older growers require sustained and practical digital assistance rather than one-off training. Small-scale growers need organizational support, shared logistics, and cooperative service platforms that reduce the fixed costs of participation. Households with lower human capital need targeted support in rule interpretation, information screening, and household-based skill accumulation. In this sense, the future of rural e-commerce development depends not only on expanding platform access, but also on reducing the capability gap that determines who can genuinely benefit from digital participation.

Table 3. Interpretation of heterogeneity patterns and stratified support directions.

Moderator	Empirical pattern	Behavioral mechanism	Support direction
Age	Negative moderation across all outcomes.	Higher learning cost and slower rule adaptation.	Provide continuous local assistance and simplified operating guidance.
Planting scale	Positive moderation across all outcomes.	Scale absorbs packaging, logistics, and branding costs.	Offer shared logistics and cooperative services for smaller growers.
Household human capital	Strongest positive moderation.	Better information processing and family labor division.	Develop tiered training and household capability building.

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