The Impact of Agricultural Product Quality Upgrades on Regional Brand Performance in the Greater Bay Area

Gongliang Zhang, Haoen He, Weitan Lu

College of Management, Zhongkai University of Agriculture and Engineering, Guangzhou 510000, China

Abstract: *This study explores how agricultural product quality influences the success of regional brands in the Greater Bay Area (GBA). Using game theory, it examines the interactions between government regulators, businesses, and consumers. The findings suggest that when authorities enforce strict quality standards, businesses are more likely to enhance product quality, which strengthens consumer trust and ultimately boosts brand performance. On the other hand, weak regulatory oversight may lead companies to cut corners, resulting in declining consumer confidence and a weaker market presence. By combining theoretical analysis with real-world implications, this research provides valuable insights into the role of quality improvements in strengthening regional brand competitiveness.*

Keywords: Agricultural product quality, Regional brand performance, Greater Bay Area, Game theory.

1. Introduction

As global agriculture continues to evolve, improving product quality has become an essential factor in advancing modernization and strengthening market competitiveness. Consumers today place greater emphasis on food safety, premium quality, and environmental responsibility, prompting businesses to enhance their standards. Beyond meeting consumer expectations, these improvements also contribute to stronger business performance and regional economic growth. Studies suggest that raising product standards can enhance export success by increasing brand credibility, particularly for companies competing in international markets where quality serves as a decisive factor (Zhu & Tomasi, 2020). Furthermore, sourcing superior raw materials from more developed economies has been shown to improve export quality, reinforcing global market positioning (Fiankor et al., 2021).

The Greater Bay Area (GBA) plays a crucial role in driving China's economic growth, with a strong market foundation and a rapidly evolving business landscape. However, its agricultural sector continues to face challenges, particularly in securing premium pricing, expanding brand influence, and improving global competitiveness. While the region benefits from abundant resources, technological advancements, and a sizable consumer base, it has yet to fully capitalize on these strengths within the agricultural industry. As consumer demand for high-quality agricultural products continues to grow, regional brands have a unique opportunity to strengthen their market position. In response, improving product quality has emerged as a key strategy for enhancing brand success. Research indicates that higher quality standards can significantly improve market performance, increase consumer trust, and enhance brand recognition (Liu & Wang, 2023).

The role of agricultural product quality in strengthening regional brand performance has drawn increasing interest from both researchers and industry professionals. While past studies establish a link between product quality and brand trust, there remains a lack of in-depth analysis on how these improvements directly impact brand performance, particularly in relation to branding strategies. This issue is especially pressing in the Greater Bay Area (GBA), where businesses face ongoing challenges in leveraging quality enhancements to build stronger brand value. Existing literature emphasizes that premium-quality products play a crucial role in regional brand development by fostering consumer trust and enhancing market competitiveness (Fan & Chee, 2023). This study seeks to address two critical questions: To what extent do agricultural product quality improvements contribute to better market performance for regional brands in the GBA? And what strategies are most effective in utilizing quality enhancements to drive brand growth?

Beyond addressing these questions, this research aims to broaden the theoretical understanding of how quality management in agriculture influences brand success. While previous studies have explored the effects of product quality on consumer trust and purchasing behavior, there is still a gap in understanding how regional branding efforts interact with quality improvements (Medina, 2022). This study will examine how elevating product quality enhances brand positioning, providing new insights into regional brand development. Practically, the findings will offer actionable recommendations for agricultural enterprises and policymakers in the GBA, helping them formulate strategies to strengthen brand premiums, increase competitiveness, and support long-term regional economic sustainability (Bannor & Abele, 2021).

To explore the impact of quality improvements on regional brand success, this study adopts a game theory approach, analyzing the strategic interactions among agricultural producers, brand managers, and consumers. By simulating different decision-making scenarios, this research aims to provide a clearer picture of how quality upgrades influence brand performance. The findings will contribute both theoretical insights and practical guidance on enhancing product quality and strengthening regional brand development in the GBA.

2. Model Construction and Analysis

This chapter introduces a tripartite game model designed to explore the effects of agricultural product quality improvements on the performance of regional brands in the Greater Bay Area (GBA). The model examines the strategic interactions among three major stakeholders—government regulators, agricultural enterprises, and consumers—highlighting how their decisions influence one another and shape overall brand success (Fan et al., 2023).

Government agencies, as the primary regulatory authority, set and enforce agricultural quality standards, creating the framework within which businesses operate. In response, agricultural enterprises weigh both regulatory requirements and market incentives when deciding whether to invest in quality upgrades. Meanwhile, consumers, as the ultimate beneficiaries, react to these improvements by adjusting their purchasing behavior, which in turn affects demand and brand perception (Wang & Xu, 2022).

By simulating different regulatory approaches and business strategies, this tripartite model reveals how varying levels of government enforcement and enterprise commitment to quality upgrades lead to different market outcomes. The analysis uncovers key feedback loops between product quality, consumer trust, and brand competitiveness. These insights offer strategic guidance for agricultural enterprises seeking to optimize their quality improvement decisions in the highly competitive GBA market, while also helping policymakers refine regulatory frameworks to support the sustainable growth of regional agricultural brands (Liu et al., 2021).

2.1 Model Assumptions

2.1.1 Participants

This model considers three key participants:

1) Government Regulatory Agency (G): The government oversees agricultural product quality, setting the standards and enforcing regulations. Its main goal is to protect public welfare by ensuring businesses meet minimum quality expectations. The government decides how strict or flexible its oversight should be—ranging from strict penalties for non-compliance to more relaxed policies that give companies some leeway. The level of enforcement directly affects how businesses approach quality improvements and influences the overall market landscape.

2) Agricultural Enterprise (E): These businesses are responsible for producing and selling agricultural products. They must decide whether to invest in higher quality, which comes with added costs but can also lead to stronger brand recognition, consumer trust, and better sales. Companies weigh two key factors: potential profits from better quality and government regulations that push them toward compliance. Those that choose to improve quality may attract more loyal customers, stand out from competitors, and enhance their market position.

3) Consumer (C): Consumers make the final purchasing decisions, basing their choices on product quality, price, and

brand reputation. In this model, they are assumed to act rationally, choosing products that offer the best balance of quality and cost. If a product meets their expectations, they are more likely to buy it, increasing demand. Since consumers don't always have complete product information, they often rely on external cues like brand reputation and certifications to assess quality. Their collective purchasing habits significantly impact market trends and brand success.

2.1.2 Basic Assumptions

To develop a clearer understanding of the model, we make the following key assumptions:

1) Market Structure: The agricultural market operates under monopolistic competition, where multiple businesses sell similar but slightly differentiated products. These differences may come from branding, production techniques, or product quality, all of which shape consumer choices and market trends (Goryunov, Kokovin, & Tabuchi, 2021). Unlike markets that compete solely on price, this environment allows room for innovation, where enterprises can improve product quality to stand out.

2) Information Asymmetry: Consumers often lack complete knowledge about the quality of agricultural products, making them reliant on external signals such as certification labels, government regulations, and brand reputation. This information gap can create inefficiencies, as lower-quality products may still perform well if marketed effectively. Because of this, regulatory oversight plays a crucial role in ensuring fair competition and protecting consumer interests (Yekimov, Sokoly, & Iarova, 2021).

3) Rational Decision-Making: All participants—government agencies, businesses, and consumers—are assumed to make rational choices aimed at maximizing their own benefits. Policymakers try to balance public interest with market efficiency by designing effective regulations. Agricultural enterprises focus on profit growth, sometimes choosing to invest in quality improvements to enhance their competitive edge. Meanwhile, consumers base their purchasing decisions on price, perceived quality, and brand reputation, looking for the best value (Han & Liu, 2020).

4) Sequential Decision-Making: The interactions between these participants occur in a step-by-step sequence, following the principles of dynamic game theory. The government initiates the process by setting quality standards and enforcing regulations. Enterprises then respond, deciding whether to invest in quality upgrades based on both market conditions and regulatory requirements. Finally, consumers adjust their buying behavior according to how they perceive product quality and the credibility of regulations. This cycle creates a feedback loop where product quality, consumer confidence, and brand success are continuously shaped by earlier decisions (Laussel, Van Long, & Resende, 2020).

2.1.3 Game Sequence

The game proceeds as follows:

1) First Stage: The government regulatory agency (G) decides

on the intensity of regulation, choosing between strengthening regulation (S) or loosening regulation (L).

2) Second Stage: The agricultural enterprise (E), after observing the government's regulatory strategy, decides whether to upgrade product quality, choosing between upgrading (U) or not upgrading (N).

3) Third Stage: Consumers (C), based on the enterprise's quality strategy and market information, decide whether to purchase the product, choosing between buying (B) or not buying (NB).

2.2 Model Construction

2.2.1 Strategy Spaces

The strategy spaces for each participant are as follows:

1) Government Regulatory Agency(G): $\{S, L\}$
   S: Strengthen regulation
   L: Loosen regulation

2) Agricultural Enterprise(E): $\{U, N\}$
   U: Upgrade quality
   N: Do not upgrade quality

3) Consumer(C): $\{B, NB\}$
   B: Buy the product
   NB: Do not buy the product

2.2.2 Parameter Definitions

To establish the payoff functions, we define the following parameters:

P: Base price of the product.

α: Brand premium brought by quality upgrading, where $\alpha > 0$

Q: Product sales, which is related to consumer purchase decisions

C_U: Cost of quality upgrading for the enterprise, where $C_U > 0$

F: Penalty amount imposed if the product is found to be non-compliant with quality standards ($F > 0$)

θ: The probability of the enterprise being caught under strict government regulation, where $0 < \theta \leq 1$. This reflects the likelihood that the company will be penalized for failing to meet quality standards. Under relaxed government regulation, the probability of being caught is approximately zero.

V: The intrinsic value of the product, which is positively correlated with quality.

β: Consumer preference coefficient for high-quality products ($\beta > 0$)

γ: The negative utility from purchasing low-quality products (e.g., health risks, where $\gamma > 0$)

W: Social welfare, which is positively correlated with both product quality and market transaction volume.

C_S: The cost of enforcing stricter regulation ($C_S > 0$)

δ: The social welfare loss caused by relaxed regulation ($\delta > 0$)

2.3 Payoff Functions

2.3.1 Payoff Function of Agricultural Enterprises

The enterprise's payoff depends on the product price, sales volume, cost of quality upgrading, and potential fines.

1) When the enterprise chooses to upgrade quality (denoted as U):

$$\Pi_E^U = (P + \alpha) \times Q - C_U \tag{1}$$

Where Q represents the product sales, which depend on consumer purchase decisions.

2) When the enterprise chooses not to upgrade (N):

Under strict government regulation (S), the probability of being fined is θ (where, $0 < \theta \leq 1$), and the expected profit is:

$$\Pi_E^{N,S}, S = P \times Q - \theta F \tag{2}$$

Under relaxed government regulation (L), the probability of being fined is approximately zero, and the expected profit is:

$$\Pi_E^{N,L} = P \times Q \tag{3}$$

2.3.2 Consumer utility function

The utility of consumers comes from the value of product quality minus the price paid and the negative utility caused by potential quality risks.

When consumers purchase an upgraded product (the enterprise chooses U):
$$U_C^B = V + \beta - (P + \alpha) \tag{4}$$

When consumers purchase a non-upgraded product (the enterprise chooses N):
$$U_C^{B'} = V - P - \gamma \tag{5}$$

When consumers do not purchase the product (NB):
$$U_C^{NB} = 0 \tag{6}$$

2.3.3 Government regulatory agency's utility function

The government's utility reflects social welfare gains minus the costs of regulation.

1) When choosing strict regulation (S):
$$U_G^S = W - C_S + \theta F \tag{7}$$

Where θF represents the income from fines.

2) When choosing relaxed regulation (*L*):

$$U_G^L = W - \delta \qquad (8)$$

3. Model Solution

To identify the equilibrium strategies in this game, we employ the method of backward induction. This approach involves analyzing the game starting from the final stage and working backwards to determine the optimal strategies for each participant at every stage. By evaluating the decisions of consumers, enterprises, and the government in reverse order, we can systematically derive the strategies that lead to equilibrium outcomes for all involved.

3.1 Third Stage: Consumer Decision

In the final stage, consumers make purchasing decisions based on the enterprise's chosen quality strategy. Their goal is to maximize their utility, which is influenced by the perceived quality of the product and its price. If the enterprise has opted for quality upgrading, consumers may view the product as more reliable and worth the price, leading to a higher likelihood of purchase. Conversely, if the product quality remains low, consumers might choose not to buy, reducing the overall market demand.

3.1.1 When the Enterprise Chooses Quality Upgrading (*U*)

When the enterprise conducts quality upgrading, the consumer's utility is U_C^B (see Equation (4)). The consumer compares this utility with the utility of not purchasing $U_C^{NB} = 0$:

$$U_C^B \geq U_C^{NB} \qquad (9)$$

That is:

$$V + \beta - (P + \alpha) \geq 0 \qquad (10)$$

If Inequality (10) holds, the consumer will choose to purchase (*B*); otherwise, they will choose not to purchase (*NB*).

3.1.2 When the Enterprise Chooses Not to Upgrade (*N*)

When the enterprise does not conduct quality upgrading, the consumer's utility is $U_C^{B\prime}$ (see Equation (5)). The consumer compares this utility with the utility of not purchasing:

$$U_C^{B\prime} \geq U_C^{NB} \qquad (11)$$

That is:

$$V - P - \gamma \geq 0 \qquad (12)$$

If Inequality (12) holds, the consumer may choose to purchase (*B*); otherwise, they will choose not to purchase (*NB*).

3.2 Second Stage: Enterprise Decision

In the second stage, the enterprise determines whether to invest in quality upgrading, considering the government's regulatory strategy and anticipating consumer purchasing behavior. The enterprise's goal is to maximize its payoff by weighing the costs and benefits of improving product quality.

3.2.1 Under Government Strengthening Regulation (*S*)

When the government enforces stricter regulations (*S*), the enterprise must compare the potential payoffs of upgrading product quality (*U*) versus maintaining the current quality (*N*). Quality upgrading may increase operational costs but can lead to higher sales through enhanced consumer trust and compliance with regulatory standards. On the other hand, choosing not to upgrade may save costs in the short term but could result in penalties from the government and a loss of consumer confidence, ultimately harming long-term profitability. The enterprise will choose the strategy that provides the greatest overall payoff, considering both regulatory pressures and market conditions.

Choosing Quality Upgrading (*U*): When the enterprise opts for quality upgrading, its payoff is represented by Π_E^U (see Equation (1)). This payoff considers the additional operational costs incurred from upgrading product quality, balanced against the potential gains from increased consumer trust, higher sales, and compliance with stricter government regulations. If the benefits from improved consumer demand and avoiding penalties outweigh the costs, the enterprise's overall payoff will increase.

Choosing Not to Upgrade (*N*): If the enterprise decides not to upgrade product quality, its payoff is represented by $\Pi_E^{N,S}$ (see Equation (2)). In this case, the enterprise avoids the immediate costs of quality improvement, leading to lower short-term operational expenses. However, this decision may result in penalties from the government and a loss of consumer confidence, which can reduce sales and hurt the enterprise's long-term profitability.

Enterprise's Decision Condition:

The enterprise compares the payoffs of the two strategies:

$$\Pi_E^U \geq \Pi_E^{N,S} \qquad (13)$$

Substituting the respective payoff functions, we get:

$$(P + \alpha) \cdot Q_U - C_U \geq P \cdot Q_N - \theta F \qquad (14)$$

Since after quality upgrading, consumers are more inclined to purchase, the sales volume Q_U is greater than Q_N. The enterprise needs to balance brand premium, increased sales volume, quality upgrading costs, and the risk of fines.

3.2.2 Under Government Loosening Regulation (*L*)

The enterprise similarly needs to compare the payoffs of the two strategies.

Choosing Quality Upgrading (*U*): The enterprise's payoff remains Π_E^U (see Equation (1)).

Choosing Not to Upgrade (*N*): The enterprise's payoff is $\Pi_E^{N,L}$ (see Equation (3)).

Enterprise's Decision Condition:

The enterprise compares the payoffs:

$$\Pi_E^U \geq \Pi_E^{N,L} \qquad (15)$$

That is:

$$(P + \alpha) \cdot Q_U - C_U \geq P \cdot Q_N \qquad (16)$$

In the case of loosened regulation, the risk of fines is reduced, and the enterprise is more likely to choose not to upgrade to save costs. However, it needs to consider that consumers may reduce purchases due to quality concerns, leading to a decrease in sales volume Q_N.

3.3 First Stage: Government Decision

In the first stage, the government determines the intensity of regulation by considering the expected reactions of both enterprises and consumers. The government's goal is to maximize social welfare while taking into account the costs of regulation and potential revenue from fines. Striking the right balance between enforcing strict quality standards and maintaining a cost-effective regulatory framework is critical to achieving this objective.

Government's Decision Condition: The government weighs the potential outcomes of choosing strict regulation (S) versus a more relaxed regulatory approach (L). It must compare the payoffs from imposing stringent regulations, which may increase social welfare through higher product quality, against the lower regulatory costs and possible short-term economic flexibility associated with a looser approach. In making this decision, the government aims to select the regulatory strategy that optimizes the overall benefits to society, factoring in compliance costs, consumer trust, and the long-term sustainability of the agricultural market.

$$U_G^S \geq U_G^L \qquad (17)$$

Substituting the government's payoff functions (Equations (7) and (8)), we obtain:

$$W - C_S + \theta F \geq W - \delta \qquad (18)$$

Simplifying:

$$\theta F + \delta \geq C_S \qquad (19)$$

If Inequality (19) holds, the government will choose to strengthen regulation (S); otherwise, it will choose to loosen regulation (L).

3.4 Equilibrium Strategy Analysis

Combining the above analysis, we can obtain the equilibrium strategy combinations of the game.

3.4.1 Case 1: Government Chooses to Strengthen Regulation (S)

Enterprise's Decision: If Inequality (14) holds, that is: $(P + \alpha) \cdot Q_U - C_U \geq P \cdot Q_N - \theta F$. The enterprise will choose quality upgrading (U).

Consumer's Decision: The consumer's purchasing decision is influenced by the enterprise's choice to engage in quality upgrading (U). When the enterprise opts for quality enhancement and the condition represented by Inequality (10) is satisfied, the consumer will rationally choose to make a purchase (B). This choice stems from their perception of a better product, where the balance between price and quality appears more favorable. As a result, consumer confidence in

both the product and the brand strengthens, reinforcing their willingness to buy. Over time, this trust fosters repeat purchases and brand loyalty, further benefiting the enterprise.

Enterprise's Outcome: When an enterprise invests in product quality improvements, it stands to gain from enhanced consumer confidence, which often translates into higher demand. As more consumers actively choose the upgraded product, sales volumes rise, leading to immediate profit growth. Beyond short-term financial gains, this commitment to quality helps strengthen the enterprise's market reputation and fosters long-term customer loyalty. Over time, these factors contribute to a stronger competitive position, not only in domestic markets but also in potential international expansions, where quality standards play a crucial role in market access and brand differentiation.

Government's Outcome: By enforcing stricter quality regulations, the government plays a critical role in protecting public welfare and ensuring consumer trust in the market. Effective regulatory oversight compels enterprises to maintain higher standards, reducing the prevalence of subpar products and fostering a more transparent, consumer-friendly marketplace. Additionally, penalties for non-compliance serve as both a deterrent and a source of revenue, further reinforcing adherence to quality standards. More importantly, regulatory actions promote overall social welfare by guaranteeing that consumers have access to safer, higher-quality goods. This intervention helps mitigate market inefficiencies, particularly those arising from information asymmetry, where consumers may otherwise struggle to assess product quality accurately.

3.4.2 Case 2: Government Chooses to Loosen Regulation (L)

Enterprise's Decision: If Inequality (16) does not hold, that is: $(P + \alpha) \cdot Q_U - C_U < P \cdot Q_N$, which means the cost of upgrading product quality exceeds the expected benefits, the agricultural enterprise may decide not to invest in quality improvements (N). Without strong regulatory pressure from the government and lacking sufficient market incentives, the enterprise might choose to prioritize short-term profits by avoiding the costs associated with upgrading quality. This decision can be seen as rational from the enterprise's perspective, as quality upgrading in this case does not guarantee a corresponding increase in sales or market premiums due to weak consumer demand for quality or insufficient regulatory enforcement.

Consumer's Decision: When an enterprise opts not to enhance product quality, consumer reactions hinge on their perceived value of the product. If Inequality (12) is not satisfied, implying that product quality does not align with their expectations, consumers may refrain from making a purchase (NB). Under such circumstances, weakened government regulations, combined with the enterprise's inaction on quality improvements, could heighten consumer skepticism. This erosion of confidence prompts a decline in demand, as individuals either turn to alternative products or abstain from purchasing altogether.

Enterprise's Outcome: The enterprise faces diminished sales as consumer willingness to buy decreases. This decision to

forgo quality enhancement not only reduces immediate revenue but also jeopardizes future market standing. Without the added value of improved quality, the enterprise struggles to maintain consumer trust, which could ultimately impact long-term brand reputation and competitive positioning. The short-term cost savings from avoiding quality upgrades may thus be outweighed by the broader financial and reputational consequences.

Government's Outcome: A regulatory relaxation strategy, while potentially aimed at reducing business constraints, might inadvertently lower social welfare. Weak oversight increases the risk of market inefficiencies, leaving consumers with products that fail to meet expectations. Additionally, diminished regulatory control may contribute to negative externalities, such as public health and safety concerns, further straining consumer confidence and economic stability. In the long run, insufficient regulation can undermine trust in the market and compromise overall welfare.

4. Conclusion

This study applies backward induction to analyze the relationship between improved agricultural product quality and regional brand performance in the Greater Bay Area. The findings demonstrate that stricter government regulations encourage agricultural businesses to enhance product quality. Higher standards allow companies to avoid penalties, boost consumer confidence, and increase brand value. As consumer trust grows, sales improve, benefiting regional economic performance and overall social welfare.

Conversely, lenient regulations may encourage companies to compromise product quality. Such compromises create uncertainty among quality-sensitive consumers, weakening their willingness to purchase. This reduces sales and negatively impacts regional brand strength and social welfare. Ultimately, weak regulation undermines the competitiveness of the agricultural sector and threatens long-term economic growth. This research highlights the significant influence of regulatory policies on business behavior and market outcomes. Ensuring rigorous quality standards is essential for fostering consumer trust, maintaining brand strength, and supporting sustainable development in the regional agricultural industry.

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