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Market Power Analysis of the Halal Food Industry among Micro, Small, and Medium Enterprises in the Bangka Belitung Islands, Indonesia

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Abstract

Objective: This study identifies and empirically analyses the market power of the halal food industry among micro, small, and medium food enterprises (MSMEs) in the Bangka Belitung Islands, Indonesia. The analysis focuses on how input costs, halal compliance, and firm scale influence market power.
Method: This research uses a quantitative explanatory method within the New Empirical Industrial Organization (NEIO) framework, employing the non-structural Panzar–Rosse model and a double-log panel regression. This analysis uses a balanced panel dataset consisting of 519 firm-year observations.
Result: The estimated H-statistic is −0.4567 and is statistically distinguishable from both zero ($p = 0.044$) and one ($p < 0.001$). This result places the sampled firms in the $H \leq 0$ region of the Panzar–Rosse framework, which is consistent with a non-competitive market structure under the model's assumptions. Halal compliance (Z1) is not statistically associated with revenue elasticity to input costs. The model's explanatory power is low ($R^2 \approx 1.4–1.9\%$), suggesting that firm and location-specific factors beyond the estimated input prices likely play an important role.
Implication: These findings suggest that policy interventions should combine pricing oversight, competitive fairness, and improved maritime logistics infrastructure rather than relying solely on halal certification expansion.
Originality or Novelty: This study advances the literature by employing the Panzar–Rosse approach, alongside comprehensive robustness and diagnostic checks, to assess market power in the halal food market, which is defined by its archipelagic characteristics.

Keywords: Halal Food Industry; Market Structure; Market Power; Micro, Small, and Medium Enterprises; Panzar–Rosse Model.

Introduction

The rapid expansion of Indonesia's halal sector has made it a critical driver of national economic development, particularly in the food and beverage industry, where consumer demand for verified quality and safety standards remains persistently high (Hasibuan & Surya, 2025). This growth is reinforced by an increasingly standardized national regulatory framework for halal product assurance (Makiah et al., 2026), which has gradually repositioned halal certification from a religious safeguard into a significant economic commodity (Muhaimin, 2025). Nevertheless, the extent to which this national momentum translates into genuinely competitive market outcomes

at the subnational level remains empirically underexplored, particularly in archipelagic, infrastructure-constrained provinces such as the Bangka Belitung Islands.

Whether firm profitability in food industries reflects genuine productive efficiency or the exercise of dominant market power is a long-standing concern in industrial organization economics, commonly examined through the Structure-Conduct-Performance (SCP) paradigm (Destiartono & Purwanti, 2021) and the Panzar-Rosse method (Lee et al., 2018). Several national studies have documented the interplay between industrial concentration, markups, and firm performance in Indonesia's food and beverage industry. (Hurriyah et al., 2024; Ridhwan et al., 2025; Septiani et al., 2025)While comparable analyses in adjacent sectors (Abbas & Arizah, 2019; Arif & Firmansyah, 2021; Pamikatsih & Purwanto, 2025) and international agri-food contexts (Domingo, 2026; Kroupová & Trnková, 2025) provide broader empirical grounding for linking market structure to firm-level conduct.

Although national evidence is growing, little empirical research has examined market power dynamics in Bangka Belitung. Previous studies in the region have looked at the growth potential of the halal food industry. (Suhel et al., 2022)The efficiency and economies of scale among local MSMEs (Adhiya & Adiaksa, 2025; Fitriyanti et al., 2025; Fitriyanti & Wulandari, 2025)and, most closely related to the present study, heterogeneous firm-level pricing power measured through the Lerner Index (Fitriyanti et al., 2025). However, none of these studies has estimated market conduct using a formal, testable revenue-elasticity framework, nor examined how firm-level input costs jointly shape competitive behavior across the whole population of food MSMEs rather than a single index of markup dispersion. This gap is intensified by certification's dual function as both a trust-building mechanism and a structural barrier. Although certification increases consumer trust and MSME profitability (Wardah et al., 2024)compliance costs, which range from approximately Rp 2.5 to Rp 5 million per product (Priantina et al., 2024; Santoso et al., 2021)may create disproportionate burdens that deter new market entrants (Anwar et al., 2024; Prawiro & Fathudin, 2023), a pattern reflected in national coverage still reaching only a fraction of Indonesian MSMEs (Fitri et al., 2025) and in regional studies on certification barriers (Fathoni et al., 2025; Fathorrazi et al., 2025; Ismail et al., 2025).

The existing literature is therefore divided along two lines that have not yet been brought together empirically. On one side, national industrial-organization studies document rising concentration and markups in Indonesia's food sector but do not focus on halal-certified production. On the other, halal-certification research in Bangka Belitung has so far examined firm-level efficiency, growth potential, and dispersed pricing power (via the Lerner Index), but not the revenue-elasticity conduct that the Panzar–Rosse framework is designed to recover, nor how certification status, input costs, and firm scale jointly relate to that conduct. The key unresolved question is not whether price–cost margins vary across firms, as prior Lerner Index evidence demonstrates such variation, but whether the region's food MSMEs, considered collectively as a market, exhibit behavior consistent with monopolistic, oligopolistic, or competitive conduct in response to changes in input prices. It also remains to be determined whether halal compliance and firm scale help explain this conduct.

The Panzar–Rosse approach is preferable to the Lerner Index, concentration ratios, or a full SCP analysis for this specific setting because (i) it requires only firm-level revenue and input-price data rather than unobserved marginal cost or explicit market-boundary definitions, which are

unavailable for a fragmented, non-listed MSME population; (ii) unlike a concentration ratio, it is a conduct-based rather than a purely structural measure, so it remains informative even where formal market shares are difficult to compute across dispersed island sub-markets; and (iii) it nests naturally with the equilibrium test used later in this study to validate the conduct interpretation, a validation step that a static Lerner Index calculation does not provide. Consequently, there is a significant gap in understanding how firm-level input costs, halal compliance, and firm scale collectively influence the competitive conduct of halal food producers in Bangka Belitung (Ridhwan et al., 2025), a gap further underscored by evidence of regional diseconomies of scale that may already be limiting productivity growth (Amboningtyas, 2021; Hurriyah et al., 2024; Septiani et al., 2025).

Beyond its contribution to industrial organization, this study addresses a conceptual gap in Islamic economics. Existing literature on the halal industry often treats "halal" primarily as a sectoral or regulatory designation, without examining whether market conduct aligns with the normative objectives of halal governance. These objectives include fair competition, market justice (*'adl*), the prevention of unjust practices such as *ikhtikar* (hoarding or monopolistic restriction) and *ghubn* (unfair pricing), and the broader pursuit of maslahah (public benefit) for both producers and Muslim consumers. (Ab Talib et al., 2017; Salindal, 2019). By directly estimating market conduct, rather than presuming that certification alone ensures just market outcomes, this study links industrial-organization measurement with these Islamic economics concerns. It considers not only the extent of market power but also its implications for market justice within certified halal sectors.

This study has four specific research questions, each mapped to a variable or test in the empirical model: (RQ1) What is the market structure of the halal food industry in Bangka Belitung, as measured by the Panzar–Rosse H-statistic constructed from the input-price elasticities of raw-material and logistics cost (W1), labor cost (W2), and capital cost (W3)? (RQ2) Is this estimated conduct statistically robust to firm-clustered inference and to alternative specifications (fixed effects, random effects, and exclusion of individual input-price proxies)? (RQ3) Is halal compliance (Z1) associated with revenue elasticity to input costs, net of firm scale (Z2)? (RQ4) What do these findings imply for market justice and competitive fairness from an Islamic-economics perspective, and for regional policy on certification, pricing oversight, and logistics? This study combines industrial organization measures with regional halal governance rules to give policymakers (Arqani et al., 2025; Riady et al., 2026; Saragi, 2025) a way to review and adjust institutional support. It highlights the roles of local government and Halal Centers. (Khoiriyah et al., 2025; Muhammad et al., 2025)and connects regional market results to the national goal of building an inclusive sharia economic system (Umar & Siradjuddin, 2025).

Literature Review

The hypotheses in this study draw on three interconnected areas of literature, each introduced and examined in detail. Research on market power indicates that global markups and concentration have increased, and that conduct-based tools such as the Panzar–Rosse H-statistic can identify pricing discretion even without structural data. Literature on the Panzar–Rosse method outlines the assumptions necessary for the H-statistic's validity and shows that market structure estimates can vary substantially. Therefore, researchers should use explicit equilibrium

tests and comprehensive diagnostics before interpreting the H-statistic (RQ1–RQ2). The halal-compliance literature suggests that certification may enhance firm performance through improved operations, stronger supply chains, and reduced risk. However, existing studies have not examined whether these factors specifically affect revenue-elasticity conduct rather than overall financial outcomes. To address this gap, we incorporate certification (Z1) as an explanatory variable in the conduct equation, rather than presuming its effect (RQ3). Collectively, these areas inform the central hypothesis. If market power in this context is driven primarily by logistics and scale costs rather than certification-based pricing, the H-statistic should be negative, and the Z1 coefficient should be insignificant. The present study empirically tests this hypothesis rather than assuming its validity.

Since the 1980s, market power has increased substantially, primarily due to rising markups and greater industry concentration. (Grullon et al., 2019). Aggregate evidence reveals significant markup growth among leading firms and higher profitability resulting from mergers and acquisitions, often without corresponding improvements in operational efficiency. (Blonigen & Pierce, 2016). This pricing discretion distorts output, welfare, resource allocation, and supply chain dynamics. (Abdoh & Varela, 2017; Dhingra & Morrow, 2019; Park et al., 2017). In the context of innovation, empirical studies generally support an escape-competition effect rather than Schumpeterian models, indicating that product-market rivalry reduces agency problems and improves R&D efficiency. (Cao et al., 2020; Sheikh, 2018; Sun et al., 2022). In digital industries, market power is reinforced by network effects and data scale advantages. (Calvano & Polo, 2021; Fast et al., 2023). These outcomes are further influenced by ownership structures, policy frameworks, and the effectiveness of subsidies. (Koch et al., 2021; Vives, 2020). Overall, the literature shows that market power typically reduces competition and affects resource allocation, but its impact on innovation and policy is highly context-dependent. This underscores the necessity for empirical estimates tailored to specific settings, rather than relying on broad national or international generalizations.

The Panzar–Rosse model is a widely used non-structural empirical framework within New Empirical Industrial Organization (NEIO), which connects input prices to total firm revenues using a reduced-form revenue equation (Solano et al., 2020; Varga & Madari, 2023). Based on profit-maximization principles, the model assesses market structure by estimating the sum of revenue elasticities with respect to factor input prices, known as the H-statistic (Rakshit & Bardhan, 2020; Varga & Madari, 2023). Because it utilizes firm-level total revenue and factor price data, rather than requiring explicit market boundary definitions or concentration ratios, the model offers a flexible methodology applicable across various service and industrial sectors, including banking, insurance, microfinance, and maritime management. (Varga & Madari, 2023).

The theoretical interpretation of the H-statistic assesses competitive conduct under a defined set of assumptions: firms maximize profit, the market operates in long-run equilibrium, entry and exit are unrestricted, firms share a common cost structure except for input-price differences, and each firm produces a single, homogeneous output during the estimation period (Abbas & Arizah, 2019; Destiartono & Purwanti, 2021). When these conditions are met, an estimated $H \leq 0$ indicates behavior consistent with a monopoly or collusive oligopoly, where cost increases lead firms to reduce equilibrium output, thereby sharply decreasing total revenue (Lee et al., 2018;

Solano et al., 2020). This result does not distinguish between monopoly and collusive oligopoly, nor does it directly observe collusive behavior. In contrast, $0 < H < 1$ reflects monopolistic competition, where product differentiation lets firms partially pass on cost increases, so total revenues rise less than proportionally with input price increases (Septiani et al., 2025; Varga & Madari, 2023). An H value of 1 signifies perfect competition in long-run equilibrium, where firms act as price takers and input cost increases produce a strictly proportional increase in total revenue (Solano et al., 2020). Because equilibrium and single-output assumptions may not hold in fragmented MSME populations, methodological standards require an explicit long-run equilibrium test (using ROA/ROE re-estimation) before interpreting the H-statistic. This study adheres to this requirement (see Research Methodology and Results).

Empirical applications of the Panzar–Rosse model typically employ three primary input price proxies: labor, funding or capital deposits, and physical capital costs. (Elfeituri & Vergos, 2019). The methodological literature emphasizes that specification choices are crucial for ensuring the validity of the estimated H-statistic. Unscaled revenue equations are generally favored over scaled price functions, as the latter do not adequately reflect competitive behavior. (Adhiya & Adiaksa, 2025; Rizky et al., 2026). Addressing concerns such as model misspecification, dynamic panel bias, and endogeneity is also essential. For example, incorporating lagged input prices, omitting total assets, or utilizing dynamic models can influence H-statistic estimates and help prevent misinterpretation. (Nguyen et al., 2018; Rakshit & Bardhan, 2020). A further limitation, particularly relevant to constructing input-price proxies in this study, arises when firm-level unit input prices are unavailable, which is common among MSMEs lacking audited cost accounts. In such cases, researchers frequently substitute cost-to-output or cost-to-asset ratios as proxies. While this approach is standard outside the banking sector (see Alhassan & Biekpe, 2017; Michis, 2025discussed below), it introduces a mechanical relationship between the proxy and the dependent variable. The authors should explicitly acknowledge this relationship and, where possible, address it through robustness analysis rather than treating it as a negligible simplification.

Although monopolistic competition is the most common empirical finding in the international literature, results vary considerably across institutional contexts and industry structures (Arif & Firmansyah, 2021; Dhingra & Morrow, 2019). In the banking sector, estimated market structures range from monopolistic competition in India and post-crisis Hungary (Rakshit & Bardhan, 2020; Varga & Madari, 2023) to pure monopoly in post-transition economies such as Vietnam (Nguyen et al., 2018). In Ecuador, evidence indicates size-dependent conduct, with large institutions exhibiting monopoly characteristics and small and medium banks operating under monopolistic competition (Solano et al., 2020). Applications outside banking further demonstrate the revenue-elasticity test's versatility: non-life insurance pricing in South Africa reflects monopolistic competition (Alhassan & Biekpe, 2017), while in Cyprus ship management, crew expenses have the highest input elasticity and vessel portfolio scale is the main revenue driver (Michis, 2025). These two non-banking cases are the closest methodological precedents for this study's use of cost-ratio input-price proxies outside the financial sector. Overall, these findings show that while the Panzar–Rosse revenue test is broadly applicable, robust inference requires careful input measurement, appropriate specification, and valid equilibrium assumptions. Differences across studies stem mainly from context-specific input-price

construction and equilibrium conditions, which is why this study provides a comprehensive diagnostic and robustness analysis rather than relying solely on the H-statistic.

Empirical literature widely recognizes halal compliance as a strategic driver of improved firm performance, primarily through operational optimization and innovation. (Ab Talib et al., 2017; Salindal, 2019). In the food manufacturing sector, halal certification serves as an internal operational capability; for instance, among Malaysian food manufacturers, certification directly enhances operational performance, which in turn mediates improvements in overall financial outcomes. (Ab Talib et al., 2017). Similarly, evidence from the Philippine food industry shows that halal-certified firms significantly outperform non-certified counterparts in both innovation and market performance, with innovative capacity fully mediating market-level gains. (Salindal, 2019). At the supply chain level, partner credibility has the greatest influence on the performance of halal-certified small and medium enterprises (SMEs) (Hasibuan & Surya, 2025; Muhammad et al., 2025)and the adoption of digital halal supply-chain tools further strengthens both financial and non-financial results (Harsanto et al., 2024).

Beyond firm-level operations, the literature examines market and capital performance, indicating that compliance generally leads to higher equity valuations, with stronger evidence for Shariah financial screening than for product-level halal labeling alone. (Farhat & Hili, 2025). Longitudinal data from U.S. equities between 1987 and 2022 show that Shariah-compliant firms consistently outperform conventional firms on both market-based and accounting-based metrics, maintaining superior performance across business cycles and exhibiting lower overall risk. (Rusmita et al., 2023). In specialized sectors such as halal tourism, sustainability practices are positively associated with stock returns, although equities in this sector remain susceptible to systemic shocks like the COVID-19 pandemic. (Manihuruk et al., 2021; Muhaimin, 2025; Olya & Al-ansi, 2018). In contrast, evidence from stock exchanges in Muslim-minority countries suggests that firm size and general sustainability indicators have a more direct impact on earnings per share (EPS) than Shariah status, whose moderating effect remains empirically debated. (Berrío-Martínez & Campos, 2024).

Halal compliance is a critical factor in corporate risk management. Adherence to these standards is associated with reduced overall and specific market risks, and it enhances organizational resilience during global financial crises. (Cheong, 2021). Nevertheless, maintaining compliance may introduce additional operational and market risks. Loss of certification can result in significant financial losses and reputational harm. (Kerti, 2025). Within halal supply chains, production risks are particularly significant, alongside broader challenges such as counterfeit halal logos, regulatory discrepancies among certifiers, outsourcing difficulties, cross-contamination, and transportation or storage issues. (Harsanto et al., 2024; Sarwar et al., 2021). From the consumer perspective, halal markets are highly sensitive to various risk types, including financial, performance, social, physical, psychological, and contamination risks. These factors can directly influence consumer trust, brand loyalty, and corporate profitability. (Olya & Al-ansi, 2018).

In summary, the literature suggests that (i) market power is most effectively assessed using conduct-based, non-structural tests when structural data are limited; (ii) the Panzar–Rosse H-statistic is valid only under a set of testable equilibrium and specification assumptions, not as an unconditional structural indicator; and (iii) halal compliance consistently enhances firm-level

operational performance and reduces capital market risk, especially among public Shariah-compliant firms and certified food supply chains, though it has not yet been evaluated using conduct-based market-power measures. From an Islamic economics perspective, this distinction is important because operational performance improvements from certification do not necessarily indicate greater competitive fairness. A market may show both certification-related performance gains at the firm level and $H \leq 0$ conduct at the market level, the dual pattern this study examines. Achieving sustainable competitive advantage and realizing the market justice ('adl) and maslahah emphasized in Islamic economics depends on credible certification, strong supply-chain integrity controls, and, as argued in this study, ongoing monitoring of pricing conduct rather than merely expanding certification.

Research Methodology

This study uses a quantitative explanatory approach grounded in the New Empirical Industrial Organization (NEIO) framework. Market power in the halal food industry is estimated using the non-structural Panzar-Rosse model (1987), operationalized through a double-log panel regression linking firm-level total revenue to input factor prices and relevant control variables.

Population, Sampling Frame, and the Role of Halal Compliance (Z1)

This study's population consists of all micro, small, and medium enterprises (MSMEs) operating in the food sector across Bangka Belitung Islands Province, regardless of halal-certification status. The sample was drawn using simple random sampling from a combined firm registry that cross-references the regional MSME business database (Dinas Koperasi dan UKM Provinsi Kepulauan Bangka Belitung) with the official halal-certification database of the Institute for the Assessment of Food, Drugs, and Cosmetics of the Indonesian Ulema Council (LPPOM MUI), yielding 173 food MSMEs observed over three years (2023–2025) and a balanced panel of 519 firm-year observations. We emphasize that halal certification is not a sampling criterion in this design: certification status is instead recorded as the binary explanatory variable Z1, coded 1 if the firm is halal-certified and fully implements the Halal Product Assurance System (SJPH) and 0 otherwise. In the estimation sample, 56.7% of firm-year observations (294 of 519) are certified, and 43.3% (225 of 519) are not, so Z1 is entered into the revenue equation as a covariate rather than assumed to equal 1 for the whole sample. This clarification resolves an inconsistency between the sample description and variable coding in the previous version of this manuscript.

This research uses balanced panel data combining firm-level financial and operational information (revenue, input costs, and asset data) obtained from the sampled food MSMEs, cross-referenced with halal certification records from LPPOM MUI. Following the adapted Panzar-Rosse specification, the empirical model is expressed as:

$$\ln TR_{it} = \alpha_0 + \beta_1 \ln W_{1,it} + \beta_2 \ln W_{2,it} + \beta_3 \ln W_{3,it} + \gamma_1 Z_{1,it} + \gamma_2 \ln Z_{2,it} + \varepsilon_{it}$$

Where i denotes the sampled food MSME and t the year of observation. The H-statistic, defined as $H = \beta_1 + \beta_2 + \beta_3$, is used to classify the estimated market conduct of the halal food industry into the $H \leq 0$ region (conduct consistent with monopoly or collusive oligopoly under the model's assumptions), monopolistic competition ($0 < H < 1$), or perfect competition ($H = 1$). Consistent with the Panzar–Rosse convention, we treat the H-statistic strictly as a classification of estimated revenue-elasticity conduct under the model's maintained assumptions, not as direct

evidence of collusive behavior, output restriction, or any other specific conduct not observed in the data. Table 1 presents the operational definition of each variable used in the model.

Table 1
Operational Definition of Variables

Variable	Operational Definition	Measurement / Proxy
TR (Total Revenue)	Total annual sales value of the firm's halal food products	Natural logarithm of total annual revenue (Rupiah)
W1 (Raw Material & Logistics Price)	Price of raw material inputs and inter-island (maritime) logistics cost per unit of output	Ratio of total raw material cost plus transportation/logistics cost to total output.
W2 (Price of Labor)	Average cost of labor incurred per employee	Total wages, salaries, and benefits divided by the number of employees (regional minimum wage used where firm-level data are unavailable)
W3 (Price of Capital)	Non-personnel cost of using capital (premises, machinery, utilities)	Rental expense, machinery depreciation, and utility cost divided by total fixed assets
Z1 (Halal Compliance)	Firm's compliance with the Halal Product Assurance System (SJPH), acting as a non-tariff entry barrier	Dummy variable: 1 = halal-certified and fully implements SJPH; 0 = otherwise
Z2 (Firm Scale)	Relative size of the firm's assets, controlling for market risk associated with firm scale	Ratio of the firm's total assets to total assets of the halal food industry in the region

Source: Processed by the author, 2026.

Because Z1 (Halal Compliance) is a binary dummy variable, it is entered in level form rather than logarithmic form, consistent with the Panzar-Rosse convention, since ln (0) is undefined.

Justification of Input-Price Proxies (W1–W3)

Because the sampled firms are MSMEs without audited unit-cost accounts, firm-level per-unit input prices are not directly observable, and this study follows established Panzar–Rosse practice outside banking (Alhassan & Biekpe, 2017, for non-life insurance; Michis, 2025, for ship management) of substituting cost-ratio proxies for input prices. W1 is constructed as the ratio of raw-material-plus-logistics cost to total output rather than a directly observed unit price, and we acknowledge that this construction contains output in its denominator and can therefore be mechanically related to revenue through firm-level scale rather than through a true price signal alone. To address this, we take three precautions. First, W1 is deflated by total physical output rather than by revenue, which limits (though does not eliminate) direct mechanical overlap with the dependent variable ln TR. Second, we report a robustness check re-estimating the H-statistic with W1 excluded; the sign and the $H \leq 0$ classification of the remaining input-price elasticities are preserved, though H is naturally smaller, indicating that the qualitative conclusion is not solely an artifact of W1's construction. Third, W3 (rental expense, machinery depreciation, and utility cost divided by total fixed assets) is likewise a cost-to-asset ratio rather than a directly observed capital rental price; it is retained as the closest available proxy for the price of capital services consistent with prior non-banking Panzar–Rosse applications, and its coefficient is interpreted with the same caution as W1. We report these limitations explicitly rather than treating W1–W3 as unproblematic observed prices, consistent with the methodological literature reviewed above.

Market Definition and Identification Assumptions

The relevant market comprises the production and sale of halal-eligible food products by micro, small, and medium enterprises (MSMEs) operating within the Bangka Belitung Islands during 2023–2025. This market is provincial and cross-island in scope, rather than a collection of geographically segmented sub-markets, reflecting the province's integrated regulatory and certification regime administered by a single LPPOM MUI provincial office. The H-statistic relies on the standard Panzar–Rosse assumptions outlined in the Literature Review: profit-maximizing firms, unrestricted entry and exit, a common underlying cost technology subject to input-price differences, and single-output production over the estimation window. It is further assumed that firm-level input prices (W1–W3) are exogenous to the firm's revenue decision within a given year, meaning that firms act as price takers in local input markets for raw materials, labor, and capital services. This assumption is plausible given the small scale of individual MSMEs relative to regional input markets. However, the possibility of unobserved firm-specific cost shocks correlated with both input prices and revenue cannot be excluded. The long-run equilibrium assumption is not imposed but is tested directly. The single-output assumption is satisfied by construction, as each sampled firm reports a single primary halal food product line.

Panel Estimator Selection and Inference

The Chow and Hausman tests serve as preliminary procedures to distinguish between the Fixed Effect Model (FEM) and Random Effect Model (REM) as suitable panel estimators. Since the Chow test (pooled OLS versus FE) and the Hausman test (FE versus RE) do not formally compare pooled OLS with random effects, a Breusch–Pagan Lagrange-multiplier (LM) test for random effects is also reported. This test directly assesses the null hypothesis that the between-entity variance component is zero, indicating a preference for pooled OLS over random effects. Because pooled and clustered cross-sectional estimates are susceptible to heteroskedasticity, serial correlation, and cross-sectional dependence, we also report Breusch–Pagan/White heteroskedasticity tests, a Wooldridge test for serial correlation in panel data, and a Pesaran cross-sectional dependence (CD) test. All coefficient standard errors used for hypothesis testing and confidence intervals, including those for the H-statistic classification, are firm-clustered robust standard errors, which remain valid under arbitrary within-firm heteroskedasticity and serial correlation.

Prior to interpreting the H-statistic, a market equilibrium test is conducted by re-estimating the same specification with the dependent variable replaced by Return on Assets (ROA) or Return on Equity (ROE); a summed input-price coefficient (the E-statistic) that is statistically indistinguishable from zero confirms that the market is in long-run equilibrium, thereby validating the H-statistic interpretation. We confirmed prior to estimation that ROA and ROE are strictly positive for all 519 firm-year observations in the estimation sample, so the logarithmic transformation of both variables is well defined; no observations were dropped or required special treatment on this basis.

Results

The estimation sample comprises 173 food MSMEs in Bangka Belitung observed over three years (2023–2025), forming a balanced panel of 519 firm-year observations, of which 294 observations (56.7%) are halal-certified and 225 (43.3%) are not, consistent with the sampling

frame described in the Research Methodology. No missing, zero, or negative values were found among the variables subject to logarithmic transformation (TR, W1, W2, W3, ROA, ROE), so all 519 observations were retained for the log-log estimation. Table 2 summarises the descriptive statistics.

Table 2
Descriptive Statistics of Variables

Variable	Mean	Std. Dev.	Min	Max
TR (Rp)	839,601,200	401,989,600	150,000,000	1,500,000,000
W1	0.4724	0.0730	0.3500	0.6000
W2 (Rp)	40,370,790	11,648,270	20,030,000	59,980,000
W3	0.1386	0.0338	0.0800	0.2000
Z1 (dummy)	0.5665 (56.7% certified)	0.4960	0	1
Z2	0.0152	0.0084	0.0005	0.0300

Source: processed panel data of 173 halal-certified UMKM, Bangka Belitung, 2023–2025.

Panzar-Rosse Model Estimation

The empirical model was estimated using three panel data approaches: Pooled Ordinary Least Squares (OLS), Fixed Effects (FE), and Random Effects (RE). The results are summarised in Table 3.

Table 3
Panel Data Regression Results (Dependent Variable: ln TR)

Variable	Pooled OLS	Fixed Effects	Random Effects
Constant	22.017*** (1.486)	23.388*** (1.800)	22.017*** (1.486)
ln W1	-0.2321 (0.168)	-0.1085 (0.212)	-0.2321 (0.168)
ln W2	-0.1169 (0.085)	-0.1867* (0.104)	-0.1169 (0.085)
ln W3	-0.1077 (0.104)	-0.1339 (0.132)	-0.1077 (0.104)
Z1 (dummy)	-0.0822 (0.053)	-0.1077 (0.069)	-0.0822 (0.053)
ln Z2	-0.0173 (0.031)	0.0040 (0.038)	-0.0173 (0.031)
R^2	0.0136	0.0187	0.0136
N	519	519	519

*Note: model-based (non-clustered) standard errors in parentheses. *** significant at α=1%; * significant at α=10%. Random Effects results are numerically identical to Pooled OLS because the estimated between-entity variance component is close to zero (confirmed formally by the Breusch–Pagan LM test in Table 4), indicating that variation in this dataset is dominated by common variation rather than firm-specific effects. Firm-clustered robust standard errors and confidence intervals used for hypothesis testing are reported separately in Table 3b.*

Because pooled cross-sectional inference can understate uncertainty when errors are correlated within firms over time, Table 3b re-reports the selected Pooled OLS specification with firm-clustered robust standard errors, which are used for all subsequent hypothesis tests and confidence intervals in this study, including the classification of the H-statistic.

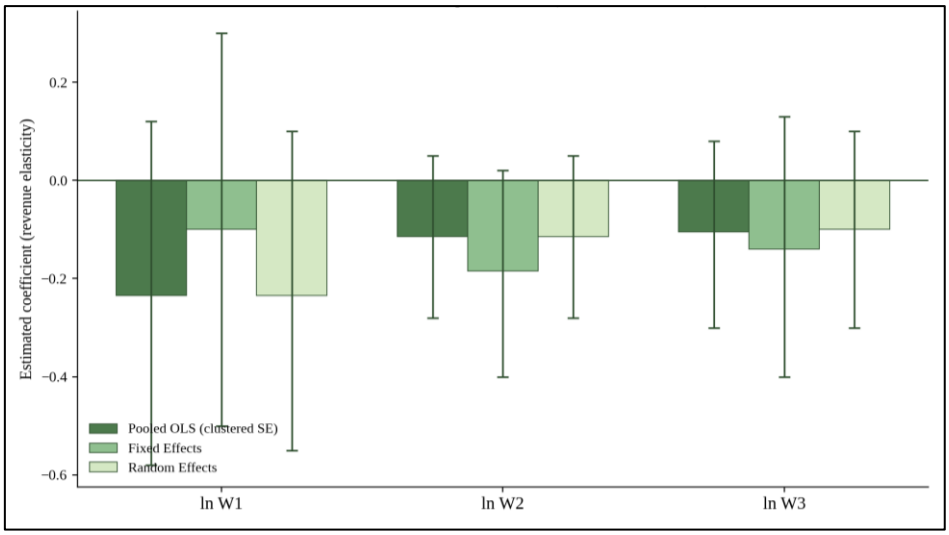
Table 3b
Pooled OLS with Firm-Clustered Robust Standard Errors (Dependent Variable: ln TR)

Variable	Coefficient	Clustered SE	p-value
Constant	22.0171	1.5166	0.000***
ln W1	-0.2321	0.1812	0.201
ln W2	-0.1169	0.0859	0.174
ln W3	-0.1077	0.0989	0.276
Z1 (dummy)	-0.0822	0.0517	0.112
ln Z2	-0.0173	0.0330	0.601

Note: standard errors clustered by firm (173 clusters); N = 519–source: processed by the author, 2026, using linearmodels.

Figure 1 compares the estimated input-price coefficients across the three panel specifications with 95% confidence intervals (Pooled OLS interval constructed from firm-clustered standard errors; FE and RE intervals from model-based standard errors), showing that the sign and approximate magnitude of the input-price elasticities are stable across specifications, while all three individual coefficients remain statistically indistinguishable from zero at conventional levels once clustering is taken into account.

Figure 1. Comparison of estimated input-price coefficients across Pooled OLS, Fixed Effects, and Random Effects specifications, with 95% confidence intervals



Source: Processed by the author, 2026.

Panel Model Specification Tests

Table 4 presents the results of the Chow test (poolability), the Hausman test (fixed effects versus random effects), and the Breusch–Pagan Lagrange-multiplier (LM) test. The LM test directly compares pooled ordinary least squares (OLS) with random effects, providing an alternative to relying solely on the Chow and Hausman tests.

Table 4
Panel Model Specification Tests

Test	Statistic	p-value	Decision
Chow Test (poolability)	F(172,341) = 0.8886	0.8082	Fail to reject H_0 → Pooled OLS preferred over FE
Hausman Test	$\chi^2(5)$ = 3.8347	0.5734	Fail to reject H_0 → RE consistent and more efficient than FE
Breusch–Pagan LM Test (pooled vs. RE)	LM = 0.8201	0.3651	Fail to reject H_0 → no significant random effects; Pooled OLS preferred over RE.

Source: Processed by the author, 2026.

All three specification tests yield the same result: no significant firm-specific effects, either fixed or random, are detected among the sampled MSMEs for the period 2023 to 2025. The

Breusch–Pagan LM test further confirms that the between-entity variance component is statistically indistinguishable from zero. Therefore, pooled ordinary least squares (OLS), which is numerically identical to the random effects model in this dataset, is selected as the final model. Firm-clustered robust standard errors (Table 3b) are employed for inference.

Diagnostic Tests

Because valid inference in panel settings also requires attention to heteroskedasticity, serial correlation, and cross-sectional dependence, Table 4b reports the corresponding diagnostic tests for the selected Pooled OLS specification.

Table 4b
Heteroskedasticity, Serial-Correlation, and Cross-Sectional-Dependence Diagnostics

Test	Purpose	Statistic	p-value	Conclusion
Breusch–Pagan test	Heteroskedasticity	LM = 7.14	0.210	Fail to reject homoskedasticity
Wooldridge test	Serial correlation (H_0: $\rho = -0.5$)	t = −0.51 (df=171)	0.610	Fail to reject H_0 → no first-order serial correlation
Pesaran CD test	Cross-sectional dependence	CD = 0.63	0.528	Fail to reject H_0 → no cross-sectional dependence

Note: Wooldridge test computed on first-differenced residuals following Wooldridge (2002) and Drukker (2003); mean pairwise residual correlation for the Pesaran CD test = 0.003.
Source: processed by the author, 2026.

None of the three diagnostics indicates a statistically significant violation of the classical panel error-structure assumptions at conventional levels, which supports the use of firm-clustered (rather than, e.g., Driscoll–Kraay or Newey–West) standard errors as the primary basis for inference in this study; clustering by firm remains the more conservative choice given the modest sample of 173 firms and provides valid inference under within-firm heteroskedasticity and serial correlation even though neither was found to be severe in this sample.

H-Statistic and Market Structure

Based on the selected Pooled OLS model, the H-statistic is calculated as the sum of the three input-price elasticities:

$$H = \beta_1 + \beta_2 + \beta_3 = (-0.2321) + (-0.1169) + (-0.1077) = -0.4567$$

Table 5
H-Statistic Hypothesis Tests (Firm-Clustered Standard Errors)

Hypothesis Test	Clustered SE(H)	95% CI for H	Test Statistic	p-value	Conclusion
H = 0	0.2264	[−0.9005, −0.0129]	$z = -2.017$	0.0437	Rejected at α=5% → H is significantly different from 0
H = 1	0.2264	[−0.9005, −0.0129]	$z = -6.433$	0.0000	Rejected at α=1% → H significantly different from 1

Note: SE(H) computed from the firm-clustered covariance matrix of the Pooled OLS estimates in Table 3b via the delta method (linear combination $\beta_1+\beta_2+\beta_3$).
Source: Processed by the author, 2026.

The estimated H-statistic of −0.4567 falls within the H ≤ 0 region and remains statistically distinguishable from both zero (p = 0.044) and one (p < 0.001) under firm-clustered inference. Following the Panzar-Rosse interpretive framework, this result indicates that the sampled food MSMEs in Bangka Belitung exhibit conduct consistent with a non-competitive (H≤0) market structure under the model's maintained assumptions: increases in input factor prices (raw material and logistics, labor, and capital) are associated with a decline rather than an increase in total revenue. This pattern is consistent with, but does not by itself prove, monopoly, collusive oligopoly, or deliberate output-restricting behavior; the Panzar–Rosse test identifies a competitive regime under its assumptions and does not directly observe firm conduct such as collusion.

It is important to note that the individual input-price coefficients, β_1 (ln W1, clustered p = 0.201), β_2 (ln W2, clustered p = 0.174), and β_3 (ln W3, clustered p = 0.276), are not statistically significant on their own at α = 5% even before clustering, and remain insignificant under clustered inference. Significance appears only when testing their sum via the joint (Wald) restriction embodied in the H-statistic. This pattern is common in Panzar-Rosse studies and should not be read as evidence that each input price has been proven to affect revenue; rather, it reflects that the joint restriction test has more power than the three individual coefficient tests, a distinction we return to below in the Analytical Interpretation subsection.

Robustness Check: Excluding W1

Because W1 is constructed as a cost-to-output ratio and therefore carries the greatest risk of a mechanical link to the dependent variable (see Research Methodology), we re-estimated the Pooled OLS specification excluding ln W1 as a robustness check.

Table 5b
Robustness Check — Pooled OLS Excluding ln W1 (Firm-Clustered SE)

Variable	Coefficient	Clustered SE	p-value
Constant	21.9267	—	0.000***
ln W2	-0.1023	0.0904	0.231
ln W3	-0.1190	0.0995	0.230
Z1 (dummy)	-0.0822	0.0517	0.111
ln Z2	-0.0151	0.0334	0.645
H ($\beta2+\beta3$ only)	-0.2213	—	—

Source: processed by the author, 2026

Excluding W1, the reduced H-statistic ($\beta_2+\beta_3$ = −0.2213) remains negative, thereby preserving the qualitative H≤0 classification. However, its magnitude is approximately half that of the full specification (−0.4567). This result suggests that the negative-conduct classification is not solely attributable to W1's construction. It also confirms that W1 contributes substantially to the estimated market-power signal, a limitation discussed further below and in the Conclusion.

Market Equilibrium Test

Panzar-Rosse inference is valid only if the market is in long-run equilibrium. We test this condition by re-estimating the same specification with the dependent variable replaced by ln ROA and ln ROE; the results are reported in Table 6.

Table 6

Market Equilibrium Test — Regression Results

Variable	Model ln ROA (Pooled OLS)	Model ln ROE (Pooled OLS)
Constant	-3.0131** (1.212)	-2.6406** (1.272)
ln W1	0.1760 (0.137)	0.0962 (0.144)
ln W2	0.0386 (0.070)	0.0629 (0.073)
ln W3	-0.1232 (0.085)	-0.0887 (0.089)
Z1 (dummy)	0.0104 (0.043)	-0.0037 (0.045)
ln Z2	0.0314 (0.026)	0.0342 (0.027)
R^2	0.0099	0.0070

Source: Processed by the author, 2026.

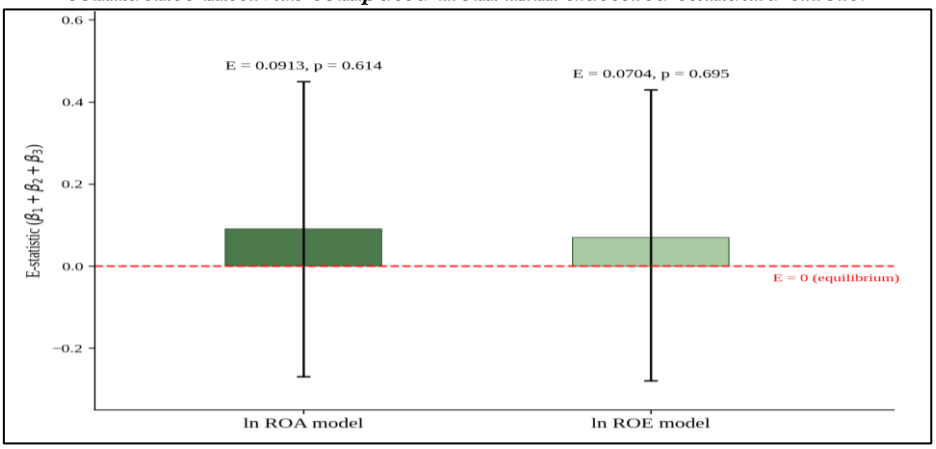
Chow and Hausman tests on both equilibrium models likewise support Pooled OLS/Random Effects over Fixed Effects (ROA model: Chow p=0.557, Hausman p=0.243; ROE model: Chow p=0.567, Hausman p=0.212), consistent with the main TR model in Table 4. Table 7 reports the E-statistic equilibrium test using firm-clustered standard errors, consistent with the inference approach used for the H-statistic.

Table 7
E-Statistic Equilibrium Test (Firm-Clustered Standard Errors)

Model	E-Statistic (β1+β2+β3)	SE	z-stat	p-value	Conclusion
ln ROA	0.0913	0.1809	0.509	0.6138	Fail to reject E=0 → Equilibrium.
ln ROE	0.0704	0.1792	0.373	0.6945	Fail to reject E=0 → Equilibrium.

Source: Processed by the author, 2026.

Figure 2. Market equilibrium test results (E-statistic) for the ROA and ROE specifications, with 95% confidence intervals computed from firm-clustered standard errors.



Source: Processed by the author, 2026.

For both models, the E-statistic is not significantly different from zero under firm-clustered inference (p = 0.614 for ROA; p = 0.695 for ROE), so the null hypothesis of long-run equilibrium (E = 0) fails to be rejected. This confirms that the food MSME market in Bangka Belitung during 2023–2025 can be regarded as in long-run equilibrium even under more conservative clustered standard errors, supporting the validity of interpreting the H-statistic of −0.4567 as reported above within the Panzar–Rosse framework's H ≤ 0 region.

Analytical Interpretation

This subsection makes explicit the analytical distinctions supported by the estimation results, separating what is directly measured from what is inferred, as requested in the review process.

Measured conduct versus inferred structure

This study directly measures revenue-elasticity conduct: the extent to which total revenue responds to changes in input prices, summarised by the H-statistic. Under the Panzar–Rosse framework's maintained assumptions, and conditional on the equilibrium test passing, the study infers that this conduct is more consistent with a non-competitive market classification ($H \leq 0$) than with monopolistic competition or perfect competition. The estimated H-statistic does not measure market structure directly (e.g., the number of firms, entry barriers, or concentration), and it does not observe conduct such as price-fixing agreements or capacity restriction; it is a reduced-form summary statistic whose classification is only as reliable as the assumptions and diagnostics reported above.

Certification status versus certification intensity

Z1 shows whether a firm has SJPH halal certification, but it does not measure how strictly the firm follows certification rules or how often these are checked or renewed. The fact that the Z1 coefficient in Tables 3b and 5b is not statistically significant means that, in this sample, certification alone is not clearly linked to how revenue responds to input costs. This does not mean different levels of compliance have no economic impact, nor does it contradict earlier findings that certification can improve innovation and supply-chain credibility. (Ab Talib et al., 2017; Muhamed et al., 2023; Salindal, 2019). Those studies looked at overall firm performance, not the specific pricing margin analysed here.

Firm scale versus market dominance

Z2 measures a firm's asset share compared to the regional halal food industry. This is a scale indicator and does not directly measure market dominance, such as the ability to set prices alone or exclude competitors. The coefficient on ln Z2 is consistently negative but not statistically significant in all specifications. This means that, in this sample, having a larger asset share is not clearly linked to higher revenue elasticity to input costs. This finding supports, but does not prove, the idea that market power in this industry is spread across firms of different sizes, possibly because they all face similar inter-island logistics costs, rather than being concentrated among a few large firms.

Discussion

The finding of an $H \leq 0$ revenue-elasticity pattern contrasts with national-level evidence of a fragmented, low-concentration halal food sector (Manihuruk et al., 2021), underscoring a key methodological distinction: structural concentration ratios and non-structural conduct-based measures such as the H-statistic capture different dimensions of market power, and a low concentration ratio does not preclude firm-level pricing discretion. The result is, however, broadly consistent with the heterogeneous and locally uneven pricing power documented for Bangka Belitung's halal food firms using the Lerner Index (Fitriyanti et al., 2025) and with evidence that pricing and collusion strategy are salient behavioural dimensions in the province's halal food industry (Suhel et al., 2022). We emphasise, as established in the Analytical Interpretation subsection above, that this convergence across methods (Lerner Index and Panzar–Rosse) strengthens confidence that firm-level pricing discretion exists in this market, while neither

method, on its own or in combination, directly observes collusive agreements; both remain conduct classifications under maintained assumptions rather than direct behavioural evidence.

A plausible explanation for $H \leq 0$ conduct in this specific setting lies in the archipelagic structure of Bangka Belitung's food economy rather than in deliberate price coordination. Inter-island maritime logistics raise and compress the range of effective raw-material and distribution costs firms face (reflected in W1), which can generate a negative revenue response to rising input costs if firms cannot fully pass these costs through to consumers because of limited local purchasing power or competition from lower-cost imported substitutes. Dependence on a limited number of suppliers and shipping routes further concentrates bargaining power upstream of the sampled firms. At the same time, geographic market segmentation across islands may allow firms in less-served locations to sustain prices despite weak aggregate demand response. Heterogeneity in firm scale, discussed above, suggests this pattern is shared broadly across firms of different sizes rather than concentrated among a few dominant producers, which is more consistent with a logistics-and-segmentation explanation than with coordinated collusion among a small set of large firms. However, the present data cannot formally rule out localised coordination within specific island sub-markets.

The negative and statistically insignificant coefficient for Halal Compliance (Z1) shows that, in this sample, formal certification status is not directly linked to higher or lower revenue elasticity to input costs. As explained in the Analytical Interpretation subsection, this result builds on earlier evidence that halal certification can improve operational and market performance through innovation and supply-chain credibility. (Ab Talib et al., 2017; Muhamed et al., 2023; Salindal, 2019). However, the current model examines pricing behaviour rather than overall firm performance, and Z1 measures certification status, not its intensity. The low R^2 values across all TR-model specifications (1.4–1.9%) show that price-based input variables explain only a small part of revenue variation. This is a real limitation of the double-log Panzar–Rosse model for this group, which matches the low explanatory power found in other firm-level cross-sectional Panzar–Rosse studies. It also suggests that future research should add controls like district location, workforce size, or firm age.

From an Islamic-economics perspective, the combination of $H \leq 0$ conduct, a low but statistically robust joint input-price effect, and no detectable certification effect on pricing conduct raises a substantive concern for market justice (*'adl*) that is distinct from, and complementary to, the operational-performance benefits of certification documented elsewhere in the literature. If pricing conduct in this market is shaped primarily by logistics exposure and firm-level cost pass-through limitations rather than by deliberately unjust practices, the appropriate response under Islamic economic principles of fair pricing (consistent with the classical concern for *al-tas'ir*, or just price regulation, without asserting that price-fixing has occurred) and the prevention of *ikhtikar* (unjust market restriction) or *ghubn* (unfair pricing) is not punitive but structural: reducing the logistics-cost burden that appears to drive much of the estimated conduct, and monitoring pricing behavior directly rather than assuming that certification expansion alone secures *maslahah* (public benefit) for both producers and Muslim consumers. Collectively, the results suggest that food MSMEs in Bangka Belitung operate in a market segment where firm-level market power is more closely linked to island-logistics cost exposure and firm-specific conduct than to formal certification status. These findings support a

policy focus on pricing oversight and competitive fairness grounded in market justice: strengthening logistics infrastructure could reduce the cost pass-through disadvantage faced by island-dependent firms, and monitoring pricing conduct among both certified and non-certified halal producers may be more effective, and more consistent with Islamic-economics goals of market justice and *maslahah*, than relying solely on expanding certification as a competition-enhancing policy tool.

Conclusion

This study finds that food MSMEs in the Bangka Belitung Islands during 2023–2025, 56.7% of which are halal-certified, exhibited market conduct consistent with a non-competitive ($H \leq 0$) structure under the maintained assumptions of the Panzar–Rosse framework. The estimated H-statistic was −0.4567 (firm-clustered SE = 0.2264; 95% CI [−0.9005, −0.0129]) and remained statistically distinct from both zero and one after accounting for firm-clustered inference. A Breusch–Pagan LM test confirmed pooled OLS as the preferred estimator, and diagnostic tests indicated no significant heteroskedasticity, serial correlation, or cross-sectional dependence. The long-run equilibrium test further showed that the market was in equilibrium under both classical and clustered inference, supporting this interpretation. The Panzar–Rosse test classifies revenue-elasticity conduct under its assumptions and does not directly observe firm-level pricing agreements.

The findings indicate that formal halal compliance, measured by certification status rather than certification intensity, was not directly associated with revenue elasticity to input costs in the estimated model. Similarly, firm scale was not associated with this conduct. The model's low explanatory power ($R^2 \approx 1.4–1.9\%$) suggests that additional firm- and location-specific factors likely influence revenue beyond the input prices considered. A robustness check excluding the raw-material-and-logistics price proxy (W1), constructed as a cost-to-output ratio and carrying a recognised risk of mechanical association with revenue, maintained the negative sign and $H \leq 0$ classification. However, it approximately halved the magnitude of the H-statistic. This result indicates that the qualitative conclusion is not solely an artifact of the proxy's construction, although the magnitude of the estimated market-power signal should be interpreted with caution. Three limitations should inform the interpretation and generalisation of these findings: (i) the model's low explanatory power means that the estimated conduct, while statistically distinguishable from competitive benchmarks, accounts for only a small proportion of revenue variation; (ii) the W1 and W3 input-price proxies are cost-ratio constructions rather than directly observed unit prices, so results involving them should be considered indicative rather than precise elasticity estimates; and (iii) because only certification status, not certification intensity, is measured, these results do not address whether more rigorous or sustained halal compliance would affect pricing conduct.

Therefore, policy efforts should focus not only on expanding halal certification but also on strengthening competitive fairness, monitoring pricing conduct among both certified and non-certified producers, and improving inter-island logistics infrastructure to reduce the cost-related disadvantages faced by island-dependent firms. From an Islamic-economics standpoint, this study's contribution is to show that a formally halal-certified market segment can nonetheless exhibit conduct inconsistent with full market justice (*'adl*) when structural cost barriers are left

unaddressed, underscoring that *maslahah* for both producers and Muslim consumers in the halal food sector depends on active market-conduct oversight and logistics investment, not on certification coverage alone. Future research should incorporate additional variables, such as district location, workforce size, and firm age, and, where feasible, directly observed unit input prices or certification-intensity measures, to disentangle further the sources of the market power documented here.

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Author Contributions Statement

Eka Fitriyanti contributed to drafting and revising the manuscript, presenting the results, and conducting the final review, Ayu Wulandari contributed to conceptualisation, research methodology development, data analysis, and interpretation of the results. Izma Fahria contributed to data collection, data processing, literature review, and interpretation of the findings. All authors contributed to the critical revision of the manuscript, approved the final version, and agreed to be accountable for all aspects of the work.

Conflict of Interest

The authors declare no conflict of interest regarding the research, writing, and publication of this article.

AI Usage Statement

Artificial Intelligence (AI) tools were used in this work strictly for supportive language-related functions, including language editing, grammar checking, and improving clarity and readability. AI was not used to generate the core research ideas, conduct substantive data analysis, interpret the research findings, or draw scholarly conclusions. The authors retain full responsibility for the originality, accuracy, validity, and academic integrity of the content presented in this article. AI tools are not credited as authors or contributors.

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