# Border Reopening and the Financial Impact of Informal Fuel Trade on Legal Petrol Stations in Thailand

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**Abstract**

This study investigates the financial impact of informal cross-border fuel trade on legally registered petrol stations in Narathiwat, one of Thailand's southern border provinces. Legal small and medium enterprises (SMEs) in this region operate under persistent pressure from untaxed and unregulated fuel smuggling, which distorts market competitiveness and erodes profitability. Using audited financial statements from 14 stations between 2019 and 2023, the study evaluates four key performance indicators: gross profit margin (GPM), net profit margin (NPM), return on assets (ROA), and return on equity (ROE). The COVID-19 border closures provided a quasi-natural experiment, temporarily suppressing smuggling and allowing observation of firm performance without informal competition. Descriptive results show modest improvements in profitability during the closure period and renewed decline after reopening. Inferential tests, however, revealed no statistically significant differences across periods, highlighting that observed trends were directional rather than conclusive. The findings contribute new firm-level evidence to debates on the informal economy, showing both the vulnerability and heterogeneity of legal SMEs in border regions. Policy implications include the need for targeted SME support, fuel price alignment in border provinces, and stronger institutional mechanisms to reduce reliance on temporary enforcement measures.

**Keywords:** 1) Informal economy 2) Fuel smuggling 3) Financial performance 4) Southern Thailand

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## Introduction

Informal cross-border fuel trade has long shaped economic dynamics along the Thailand–Malaysia border, where subsidised Malaysian fuel and weak enforcement create profitable opportunities for smuggling. Recent reports suggest, on a daily basis, three million litres of fuel are smuggled over land alone, from Malaysia to Thailand, having an annual value of US$1.2 billion in Thailand and US$0.54 billion in Malaysia (Romsom, 2022, p. 10). For legal petrol stations operating on narrow margins, this untaxed and unregulated competition has intensified following Thailand's excise tax adjustments, which further widened price differentials between the two countries.

The COVID-19 pandemic temporarily altered this landscape. Between 2020 and 2021, strict border closures disrupted smuggling routes, offering a rare opportunity to observe how legal fuel businesses perform in the absence of informal competitors. This period provides a quasi-experimental setting, allowing comparison of firm performance across three distinct phases: pre-pandemic, closure, and post-reopening.

Despite extensive attention to fuel subsidies and smuggling in Southeast Asia (e.g., Ismail, et al., 2024, pp. 2-6; Timlen, 2023, pp. 98-99), and the fact that fuel smuggling has been widely discussed in relation to its broader economic and policy implications, few studies have examined its direct financial impact on legal fuel retailers, particularly at the firm level in border provinces. Existing research has primarily focused on macroeconomic effects, such as the influence of subsidies on regional consumption and income distribution through smuggling (Joshaghani, et al., 2024, p. 1596), or on how government fuel subsidy policies and varying levels of law enforcement shape the dynamics of illicit fuel trade (Dadpay, 2020, p. 643). This leaves a significant gap in understanding how small and medium-sized enterprises (SMEs) in border areas cope with conditions of both suppressed and reactivated smuggling, and how their financial performance adapts in these fluctuating contexts.

This study addresses that gap by investigating the profitability of 14 legally registered petrol stations in Narathiwat province between 2019 and 2023. Using four financial indicators (e.g., GPM, NPM, ROA, and ROE) the study compares firm performance across the three periods. By combining descriptive analysis with inferential testing, it provides evidence on whether temporary reductions in smuggling translate into statistically meaningful changes in SME resilience. The findings contribute to the literature on informal economies and border trade by clarifying both the opportunities and limits of external shocks as mechanisms of relief for compliant businesses.

## Literature Review

### Prevalence of Fuel Smuggling in the Southern Region

The Thailand–Malaysia border remains a hotspot for fuel smuggling, driven by sharp price differentials, entrenched corruption, and subsidized Malaysian fuel. Recent reports estimate daily flows of illicit fuel in the millions of litres, costing both governments substantial lost revenue (Romsom, 2022, p. 10). Despite periodic crackdowns, enforcement has failed

to dismantle smuggling networks involving local business actors and corrupt officials. These networks are often linked to broader illicit trades such as drug trafficking and shadow oil circulation (Zulkifli, et al., 2024, pp. 653-656). Although border checks have intensified, smugglers adapt through sophisticated methods such as fake documents and concealed logistics. Recent analyses suggest limited progress due to systemic corruption, weak enforcement, and a lack of sustainable economic alternatives for border communities (Timlen, 2023, pp. 98-99; Al Muzayen, et al., 2024).

**Characteristics of Grey Economies: Arbitrage, Tax Evasion, and Loopholes**

Fuel smuggling thrives on price disparities across national borders, where artificially low, subsidised fuel prices create opportunities for arbitrage. Smugglers exploit these wide price gaps between countries, turning the trade into a profitable, transnational business (Daddpay, 2020, p. 643). Illegal trading is sustained by tax evasion. Meanwhile, tax evasion and informal payments, are sustained by social tolerance and perceived systemic imbalances, rather than solely by weak enforcement (Stasinopoulos, et al., 2023, p. 672). In addition, financial disparities, such as within the Spanish petrol retail sector, stem largely from differences in profitability, liquidity, indebtedness, and turnover, rather than from issues of illegality or governance (Jofre-Campuzano and Coenders, 2022, pp. 10-110.

**Subsidies, Differentials, and Enforcement Challenges**

The current Malaysian scheme suffers from flaws, including citizens misusing the scheme by re-selling the subsidised petrol to non-citizens for their own benefit. This activity is a form of illicit trade or smuggling (Ismail, et al., 2024, pp. 2-6). Price hikes disproportionately affect low-income households, fuelling perceptions of unfairness and complicating enforcement (Harun et al., 2018, pp. 531-532; Rahim, Yusoff and Ibrahim, 2020, pp. 123-124). Smugglers avoid detection through falsified documentation, vehicle modifications, and concealed transport routes (Timlen, 2023, pp. 98-99; The Star, 2024).

**Financial Vulnerability of Legal Fuel Retailers and the Impact of Shock Events**

Legal petrol stations face unstable earnings due to intense competition, fluctuating wholesale prices, and transparent pump pricing (Jog, 2022, p. 4). Informal fuel sellers operate outside established legal and fiscal frameworks, offering products without meeting regulatory or tax obligations. This form of non-compliant commercial activity, similar to the informal markets described in the Mariscal de Puyo study, disrupts formal supply chains and gradually reduces the market share of authorised retailers (Cortez, Zúñiga and Martínez, 2021, pp. 3-5). SMEs are particularly vulnerable, given their limited ability to absorb long-term losses and higher fixed costs associated with compliance (Piperopoulos, et al., 2021, pp. 668-669). During the COVID-19 pandemic, SMEs in border provinces faced falling demand, disrupted supply chains, and financial strain, with many unable to survive despite credit access (Gu, et al., 2024, pp. 3-6; Jardón, et al., 2025, pp. 321-322).

Paradoxically, border closures temporarily improved conditions for legal retailers, as smuggling was suppressed. Border closures during the COVID-19 pandemic created conditions that temporarily suppressed cross-border flows and benefitted local retailers. Michel, et al (2024, pp. 2-5) confirms that such closures were widely adopted and socially accepted, establishing the context in which informal trade was curtailed. More directly, Kluser (2025, p. 2) shows that Switzerland's border closure raised domestic grocery expenditures in border areas by 10.4%, demonstrating that local businesses gained when cross-border competition was halted. Together, these findings support the view that border closures temporarily improved conditions for legal retailers as smuggling and related flows were suppressed.

**Informal Markets During Crisis**

Evidence suggests informal markets often contract during crises due to mobility restrictions, which severely curtailed movement and shifted activity away from physical engagements (like in-store shopping) towards online alternatives, supporting the concept of reduced physical economic activity (Shaik and Ahmed, 2022, pp. 7-8). As routes became riskier, many traders reduced operations or exited the market (Aziani, Jofre and Mancuso, 2025, pp. 1260-1261). These dynamics created a temporary competitive advantage for compliant retailers (Khaled, et al., 2021, pp. 101-103).

**Financial Challenges in SMEs**

Thai SMEs continue to face low cash flow, high debt burdens, and limited access to credit, which weakens resilience to shocks (Rattanawiboonsom, 2021, p. 8). Prior studies often focus on national trends or large firms, leaving micro-level station performance underexplored (Patlasov and Konyukova, 2023, pp. 340-341; Majumdar, et al., 2024, pp. 562-563). Recent studies also highlight the pandemic's impact on shifting market structures, regulations, and informal trade patterns (Hierro-Recio, et al., 2020, pp. 396-399; Feshina, Feshina and Nikolaev, 2021, pp. 742-744). However, little research explicitly measures how border closures influenced the profitability of small legal petrol retailers.

**Research Objective**

To examine the financial performance of legally registered petrol stations in Thailand's southern border provinces under varying conditions of informal cross-border oil trade, with a focus on whether temporary suppression of smuggling during COVID-19 border closures was associated with changes in profitability indicators (GPM, NPM, ROA, ROE).

**Research Question**

How did the temporary reduction of informal cross-border oil trade during COVID-19 border closures relate to changes in the financial performance of legally registered petrol stations in Thailand's southern border provinces, and what patterns emerged once borders reopened?

## Methodology

**Data and Sample**

This study examines how informal fuel trade affects the financial performance of 14 legally registered petrol stations in Narathiwat province, Thailand, observed over a five-year

period (2019–2023). The analysis focuses on four widely used indicators of profitability and efficiency in energy-related sectors: gross profit margin (GPM), net profit margin (NPM), return on assets (ROA), and return on equity (ROE) (Patlasov and Konyukova, 2023, pp. 340-341; Majumdar, et al., 2024, pp. 562-563; Sripriya and Devi, 2024, pp. 808-811).

Firm-level financial data were obtained from the Department of Business Development (2022), whose online database provides audited statements for all registered Thai businesses. The website allows the researcher and other users to access records by entering the registration ID of the business sector of interest (e.g., petrol businesses in Narathiwat). The retrieved documents included balance sheets, income statements, and cash flow statements from 2019 through 2023. Data were manually extracted, cross-checked against company annual reports where available, and compiled into a balanced panel.

The 14 stations were selected using purposive sampling to reflect both major fuel brands (PTT, Shell, Bangchak) and independent operators across eight districts bordering Malaysia. Selection criteria required (i) continuous operation during the study period, (ii) completeness of financial records, and (iii) relevance to the border-trade context. Supplementary background information such as registration details and ownership was verified through the Ministry of Commerce business directory.

**Variables and Measures**

The study employs the following variables:

**Table 1** Summary of Variables, Definitions, Units, and Data Sources

| Variable | Definition | Unit | Source |
|---|---|---|---|
| Gross Profit Margin | (Revenue – COGS) / Revenue × 100 | % | DBD financial statements |
| Net Profit Margin | Net income / Revenue × 100 | % | DBD financial statements |
| Return on Assets | Net income / Average total assets × 100 | % | DBD financial statements |
| Return on Equity | Net income / Shareholders' equity × 100 | % | DBD financial statements |
| Pandemic Period | 0 = Pre (2019); 1 = Closure (2020–2021); 2 = Post (2022–2023) | Categorical | Author classification |

All ratios were calculated using standard accounting formulas to ensure comparability across firms and years. However, since consistent data on firm size, brand affiliation, and proximity were not obtainable for all firms, these moderators were excluded from regression analysis but flagged in the Limitations for future research.

**Data Analysis**

The analysis proceeded in two stages:

1. Descriptive statistics (means, standard deviations, ranges) were calculated for each profitability indicator across the three periods: pre-pandemic (2019), border closure (2020–2021), and post-reopening (2022–2023).

2. Inferential tests were conducted to identify whether differences across periods were statistically significant:

2.1 Repeated-measures ANOVA was applied to each dependent variable, with Greenhouse–Geisser corrections where assumptions of sphericity were violated.

2.2 Post-hoc Bonferroni adjustments were used for multiple comparisons.

2.3 To explore directional effects, ordinary least squares (OLS) regressions with period dummies were estimated (pre-pandemic as the baseline), with standard errors clustered at the firm level to account for repeated observations.

All statistical analyses were conducted in Stata 17.0 (Stata Corp LLC).

## Model Specification

The regression framework is specified as follows:

$$\text{Performance}_{it} = \alpha + \beta_1 \text{Closure}_t + \beta_2 \text{Post}_t + \varepsilon_{it},$$

where "Performance it" is GPM, NPM, ROA, or ROE for firm i in year t.

Closure = 1 if 2020–2021, 0 otherwise.

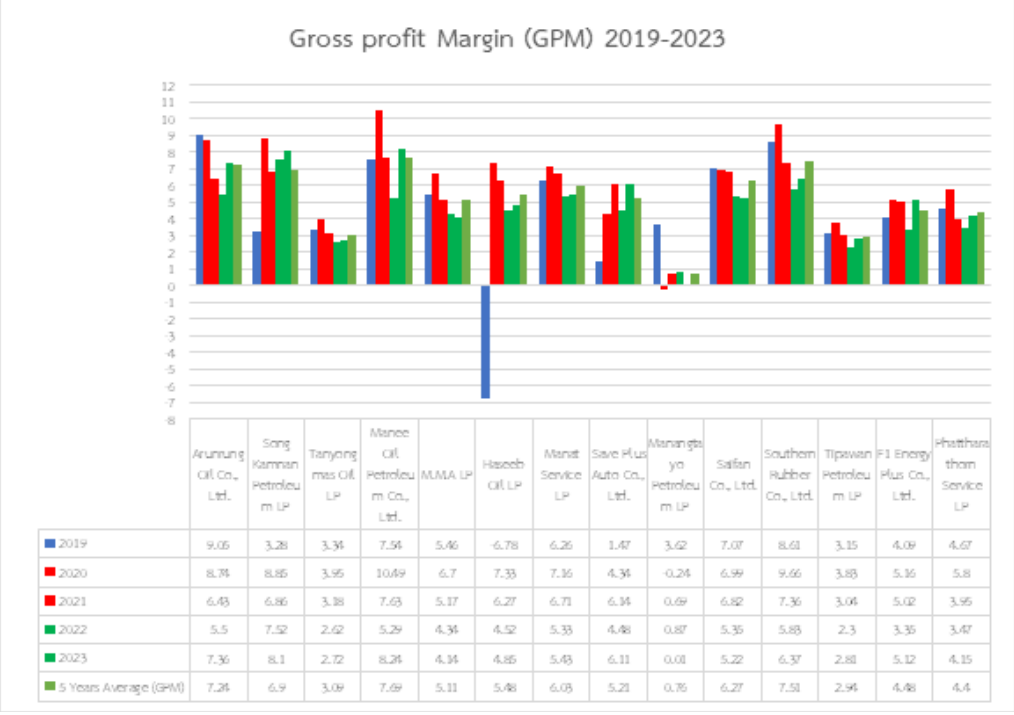
Post = 1 if 2022–2023, 0 otherwise.

This specification allows direct testing of mean differences across periods while controlling for within-firm clustering. Although additional moderators (firm size, brand affiliation, proximity) were originally intended, they could not be reliably coded for all firms; their omission is acknowledged as a limitation.

## Results

### Gross Profit Margin (GPM)

The results below present descriptive changes in financial performance across different border-status periods without interpretation, which is reserved for the Discussion.



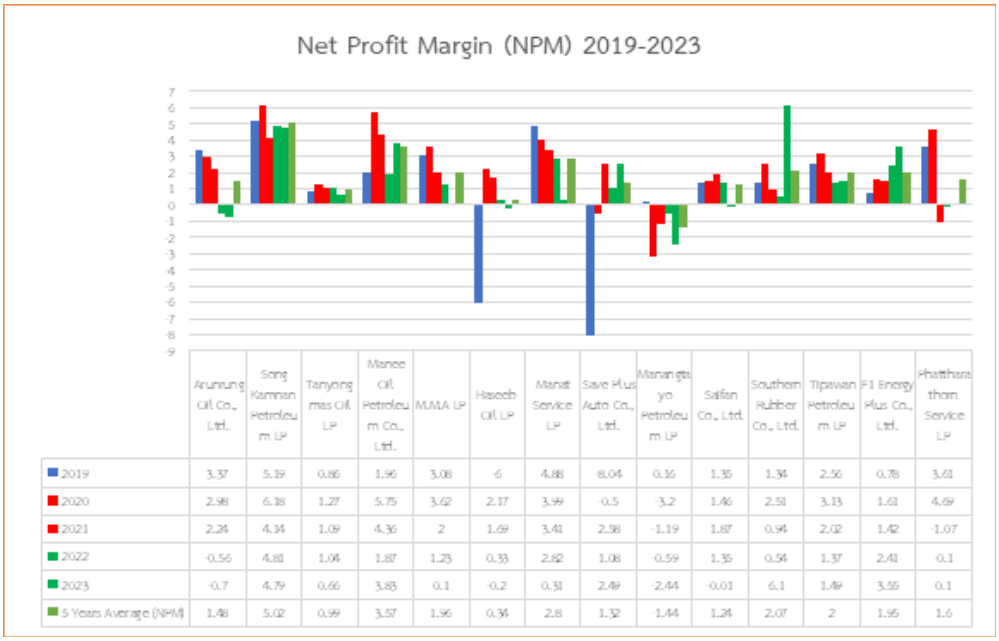

| | Arunrung Oil Co., Ltd. | Song Kamnan Petroleum LP | Tanyong mas Oil LP | Manee Oil Petroleum Co., Ltd. | MJMA LP | Haseeb Oil LP | Manat Service LP | Save Plus Auto Co., Ltd. | Manangta ya Petroleum LP | Saifan Co., Ltd. | Southern Rubber Co., Ltd. | Tipawan Petroleum LP | F1 Energy Plus Co., Ltd. | Phatthara thorn Service LP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2019 | 9.05 | 3.28 | 3.34 | 7.54 | 5.46 | 6.78 | 6.26 | 1.47 | 3.62 | 7.07 | 8.61 | 3.15 | 4.09 | 4.67 |
| 2020 | 8.74 | 8.85 | 3.95 | 10.49 | 6.7 | 7.33 | 7.16 | 4.34 | -0.24 | 6.99 | 9.66 | 3.83 | 5.16 | 5.8 |
| 2021 | 6.43 | 6.86 | 3.18 | 7.63 | 5.17 | 6.27 | 6.71 | 6.14 | 0.69 | 6.82 | 7.36 | 3.04 | 5.02 | 3.95 |
| 2022 | 5.5 | 7.52 | 2.62 | 5.29 | 4.34 | 4.52 | 5.33 | 4.48 | 0.87 | 5.35 | 5.83 | 2.3 | 3.35 | 3.47 |
| 2023 | 7.36 | 8.1 | 2.72 | 8.24 | 4.14 | 4.85 | 5.43 | 6.11 | 0.01 | 5.22 | 6.37 | 2.81 | 5.12 | 4.15 |
| 5 Years Average (GPM) | 7.24 | 6.9 | 3.09 | 7.69 | 5.11 | 5.48 | 6.03 | 5.21 | 0.76 | 6.27 | 7.51 | 2.96 | 4.48 | 4.4 |

**Figure 1** Five-Year Gross Profit Margin Averages by Petrol Station (2019–2023)

In 2019, most petrol stations displayed stable gross profit margins. Manee Oil Petroleum reported 7.54%, while Song Kamnan and Southern Rubber also showed moderate levels. During the border-closure period (2020–2021), some companies improved—for example, Manee Oil rose to 10.49% and Song Kamnan to 8.85%. By contrast, others such as Manangtayo Petroleum and Haseeb Oil declined sharply (–6.78%). After reopening (2022–2023), certain firms recovered slowly, such as F1 Energy Plus and Phattharathorn Service, while others (e.g., Arunrung Oil, Haseeb Oil) remained below pre-pandemic levels. Across the five-year period, Manee Oil recorded the highest average GPM (7.69%), while Manangtayo Petroleum recorded the lowest (0.76%).

**Net Profit Margin (NPM)**

In 2019, most stations reported reasonable NPM levels, with Manat Service, Song Kamnan, and Phattharathorn Service performing well. Several firms, such as Haseeb Oil and Save Plus Auto, already showed negative margins in that year. During 2020–2021, some stations, including Song Kamnan and Manee Oil, improved their margins, while M.M.A LP remained stable. Other firms, including Haseeb Oil, Save Plus Auto, and Arunrung Oil, continued to incur losses. After reopening, Southern Rubber and F1 Energy Plus showed gradual recovery, but Arunrung Oil and Manangtayo Petroleum remained weak. In general, stations clustered into three groups: those performing well during closure, those recovering slowly, and those that never recovered.



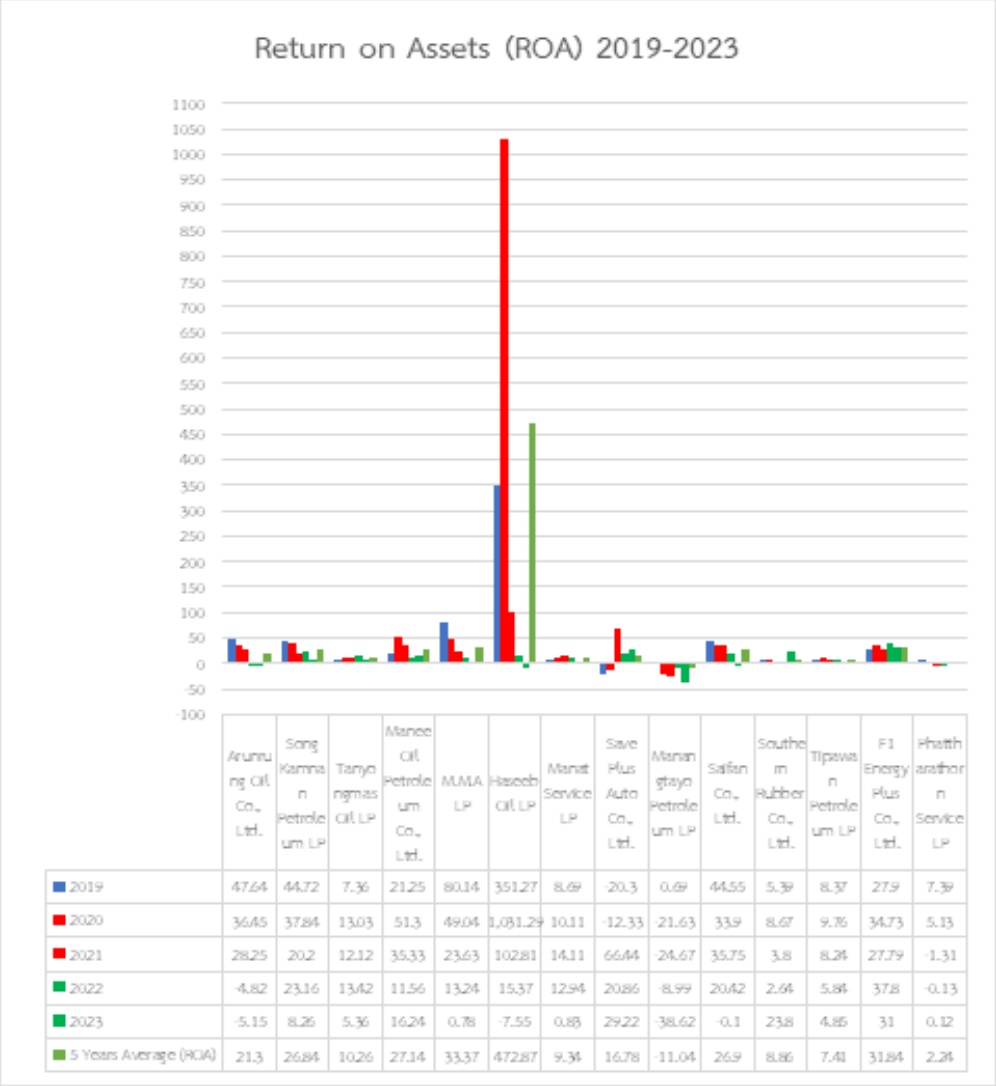

| | Arunrung Oil Co., Ltd. | Song Kamnan Petroleum LP | Tanyong mas Oil LP | Manee Oil Petroleum Co., Ltd. | M.M.A LP | Haseeb Oil LP | Manat Service LP | Save Plus Auto Co., Ltd. | Manangtayo Petroleum LP | Saifon Co., Ltd. | Southern Rubber Co., Ltd. | Tipawan Petroleum LP | F1 Energy Plus Co., Ltd. | Phatthara thorn Service LP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2019 | 3.37 | 5.19 | 0.86 | 1.96 | 3.08 | -6 | 4.88 | 8.04 | 0.16 | 1.35 | 1.34 | 2.56 | 0.78 | 3.61 |
| 2020 | 2.98 | 6.18 | 1.27 | 5.75 | 3.62 | 2.17 | 3.99 | -0.5 | -3.2 | 1.46 | 2.51 | 3.13 | 1.61 | 4.69 |
| 2021 | 2.24 | 4.34 | 1.09 | 4.36 | 2 | 1.69 | 3.41 | 2.58 | -1.19 | 1.87 | 0.94 | 2.02 | 1.42 | -1.07 |
| 2022 | -0.56 | 4.81 | 1.04 | 1.87 | 1.23 | 0.33 | 2.82 | 1.08 | -0.59 | 1.35 | 0.54 | 1.37 | 2.41 | -0.1 |
| 2023 | -0.7 | 4.79 | 0.66 | 3.83 | 0.1 | -0.2 | 0.31 | 2.49 | -2.44 | -0.01 | 6.1 | 1.49 | 3.55 | 0.1 |
| 5 Years Average (NPM) | 1.48 | 5.02 | 0.99 | 3.57 | 1.96 | 0.34 | 2.8 | 1.32 | -1.44 | 1.24 | 2.07 | 2 | 1.95 | 1.6 |

**Figure 2** Five-Year Net Profit Margin by Petrol Station (2019–2023)

**Return on Assets (ROA)**

In 2019, several stations had strong ROA: Haseeb Oil (331.27%), Manee Oil (80.14%), and Song Kamnan (44.72%). During the closure period, Manee Oil and Song Kamnan remained strong, but others struggled. Haseeb Oil rose unusually high in 2020 (1,031.29%), possibly due to very small asset denominators. Meanwhile, Save Plus Auto and Manangtayo Petroleum recorded negative ROA, and Arunrung Oil began to decline. After reopening, Haseeb Oil dropped to –7.55%, and Arunrung Oil and Save Plus Auto also remained negative. By contrast, F1 Energy Plus rose to 31% in 2023, and Southern Rubber remained stable at around 23.8%.

In conclusion, three descriptive patterns emerged: firms that declined after strong pre-pandemic performance, firms that improved steadily, and firms that showed persistent weakness.

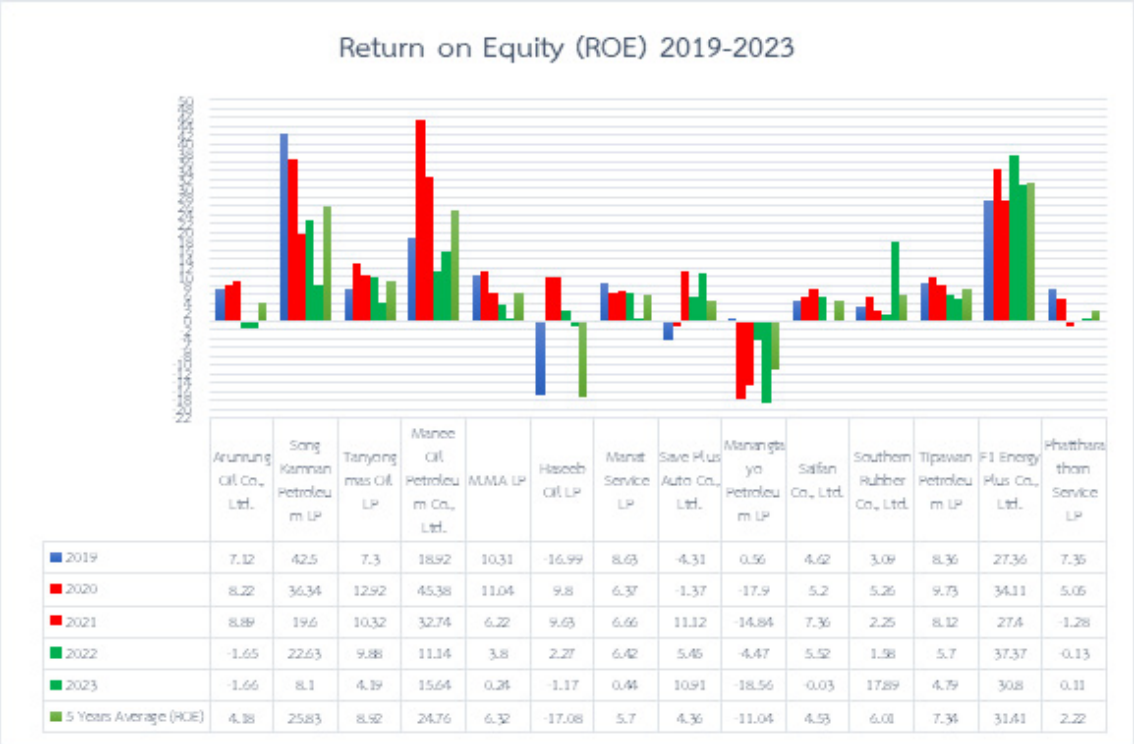



| | Arunrung Oil Co., Ltd. | Song Kamnan Petroleum LP | Tanyongmas Oil LP | Manee Oil Petroleum Co., Ltd. | M.M.A LP | Haseeb Oil LP | Manat Service LP | Save Plus Auto Co., Ltd. | Manangtayo Petroleum LP | Saifon Co., Ltd. | Southern Rubber Co., Ltd. | Tipawan Petroleum LP | F1 Energy Plus Co., Ltd. | Phatthanathorn Service LP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2019 | 47.64 | 44.72 | 7.36 | 21.25 | 80.14 | 351.27 | 8.69 | -20.3 | 0.69 | 44.55 | 5.39 | 8.37 | 27.9 | 7.39 |
| 2020 | 36.45 | 37.84 | 13.03 | 51.3 | 49.04 | 1,031.29 | 10.11 | -12.33 | -21.63 | 33.9 | 8.67 | 9.76 | 34.73 | 5.13 |
| 2021 | 28.25 | 20.2 | 12.12 | 35.33 | 23.63 | 102.81 | 14.11 | -66.44 | -24.67 | 35.75 | 3.8 | 8.24 | 27.79 | -1.31 |
| 2022 | -4.82 | 23.16 | 13.42 | 11.56 | 13.24 | 15.37 | 12.94 | 20.86 | -8.99 | 20.42 | 2.64 | 5.84 | 37.8 | -0.13 |
| 2023 | -5.15 | 8.26 | 5.36 | 16.24 | 0.78 | -7.55 | 0.83 | 29.22 | -38.62 | -0.1 | 23.8 | 4.85 | 31 | 0.12 |
| 5 Years Average (ROA) | 21.3 | 26.84 | 10.26 | 27.14 | 33.37 | 472.87 | 9.34 | 16.78 | -11.04 | 26.9 | 8.86 | 7.41 | 31.84 | 2.24 |

**Figure 3** Five-Year Return on Assets by Petrol Station (2019–2023)

**Return on Equity (ROE)**

In 2019, most stations had positive ROE, with Song Kamnan highest at 42.5%, followed by F1 Energy Plus and Manee Oil. Several firms, including Haseeb Oil and Save Plus Auto, showed losses. During 2020–2021, F1 Energy Plus, Song Kamnan, and Manee Oil maintained strong returns, with Manee Oil reaching 45.38%. Conversely, Manangtayo Petroleum weakened during the same period. After reopening, outcomes became mixed: F1 Energy Plus remained strong, Southern Rubber performed well, while Song Kamnan declined. Other firms such as Arunrung Oil and Manangtayo Petroleum continued to underperform. Haseeb Oil showed an extremely high ROE (472.87%), likely due to very small equity values and volatile profits. Excluding that outlier, F1 Energy Plus, Manee Oil, and Saifan Co. had the strongest average ROE across five years.




| | Arunrung Oil Co., Ltd. | Song Kamnan Petroleum LP | Tanyong mas Oil LP | Manee Oil Petroleum Co., Ltd. | M.M.A LP | Haseeb Oil LP | Marat Service LP | Save Plus Auto Co., Ltd. | Manangtayo Petroleum LP | Saifan Co., Ltd. | Southern Rubber Co., Ltd. | Tipawan Petroleum LP | F1 Energy Plus Co., Ltd. | Phatthanathan Service LP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2019 | 7.12 | 42.5 | 7.3 | 18.92 | 10.31 | -16.99 | 8.63 | -4.31 | 0.56 | 4.62 | 3.09 | 8.36 | 27.36 | 7.35 |
| 2020 | 8.22 | 36.34 | 12.92 | 45.38 | 11.04 | 9.8 | 6.37 | -1.37 | -17.9 | 5.2 | 5.26 | 9.73 | 34.11 | 5.05 |
| 2021 | 8.89 | 19.6 | 10.32 | 32.74 | 6.22 | 9.63 | 6.66 | 11.12 | -14.84 | 7.36 | 2.25 | 8.12 | 27.4 | -1.28 |
| 2022 | -1.65 | 22.63 | 9.88 | 11.14 | 3.8 | 2.27 | 6.42 | 5.46 | -4.47 | 5.52 | 1.38 | 5.7 | 37.37 | -0.13 |
| 2023 | -1.66 | 8.1 | 4.19 | 15.64 | 0.24 | -1.17 | 0.44 | 10.91 | -18.56 | -0.03 | 17.89 | 4.79 | 30.8 | 0.11 |
| 5 Years Average (ROE) | 4.18 | 25.83 | 8.92 | 24.76 | 6.32 | -17.08 | 5.7 | 4.36 | -11.04 | 4.53 | 6.01 | 7.34 | 31.41 | 2.22 |

**Figure 4** Five-Year Return on Equity by Petrol Station (2019–2023)

**Inferential Statistics**

To formally test for period effects, repeated-measures ANOVA was conducted for each dependent variable. No statistically significant differences were observed across periods: GPM ($F(2,26)=1.67$, $p=0.208$), NPM ($F=0.98$, $p=0.389$), ROA ($F=1.65$, $p=0.212$), and ROE ($F=1.34$, $p=0.280$). OLS regressions with period dummies confirmed these directional but non-significant results. Closure period coefficients were positive but insignificant for all four indicators, while post-reopening coefficients were negative for ROA and ROE, though also insignificant.

To formally test for period effects, repeated-measures ANOVA was applied to each profitability indicator (Table 5). None of the four indicators showed statistically significant variation across periods: GPM ($F(2,26)=1.67$, $p=.208$), NPM ($F(2,26)=0.98$, $p=.389$), ROA

(F(2,26)=1.65, p=.212), and ROE (F(2,26)=1.34, p=.280). Effect sizes (partial $\eta^2$) were small, ranging between 0.07 and 0.11, suggesting that changes in profitability across pre-pandemic, closure, and post-reopening phases were modest.

Complementing the ANOVA, OLS regressions with period dummies were estimated (Table 6). Results show that coefficients for the closure period were consistently positive across all profitability indicators, but statistically insignificant, indicating no robust gains relative to the pre-pandemic baseline. In contrast, coefficients for the post-reopening period were negative for ROA and ROE, though again insignificant, reflecting descriptive declines after 2022 without inferential confirmation. $R^2$ values ranged from 0.08 to 0.14, indicating that period effects explained only a small proportion of variance in firm profitability.

**Table 2** Repeated-Measures ANOVA for Profitability Indicators by Period

| Dependent Variable | F(df) | p-value | Partial $\eta^2$ |
|---|---|---|---|
| GPM | F(2,26)=1.67 | .208 | .11 |
| NPM | F(2,26)=0.98 | .389 | .07 |
| ROA | F(2,26)=1.65 | .212 | .11 |
| ROE | F(2,26)=1.34 | .280 | .09 |

**Table 3** OLS Regression Results for Profitability Indicators (Baseline = Pre-Pandemic)

| Dependent Variable | Closure (β, SE, p) | Post-Reopening (β, SE, p) | $R^2$ |
|---|---|---|---|
| GPM | 0.842 (0.951, p=.382) | −0.105 (0.897, p=.910) | .12 |
| NPM | 0.675 (1.102, p=.540) | −0.230 (0.978, p=.820) | .08 |
| ROA | 3.210 (4.520, p=.480) | −5.890 (4.760, p=.230) | .14 |
| ROE | 2.480 (3.920, p=.530) | −4.750 (4.310, p=.280) | .10 |

Taken together, these results suggest that while descriptive evidence indicated improvement during border closures and decline post-reopening, inferential testing does not provide strong statistical support for these differences. The findings therefore highlight patterns consistent with prior expectations but fall short of establishing conclusive causal effects.

## Discussion

The results show that while descriptive statistics suggested profitability ratios (GPM, NPM, ROA, ROE) improved during border closures, inferential tests confirmed that these changes were not statistically significant. This cautious outcome indicates that improvements observed during 2020–2021 should be understood as directional trends rather than robust causal effects. Comparable evidence from other border regions supports this interpretation. It was confirmed that border closures during the COVID-19 pandemic were widely adopted and socially accepted, creating conditions in which informal flows were sup-

pressed (Michel, et al., 2024, pp. 2-5). Kluser (2025, p. 12) further shows that Switzerland's closure increased domestic grocery spending in border regions by 10.4%, demonstrating that legal businesses benefited when cross-border competition was temporarily halted. Together, these findings strengthen the view that border closures offered short-term relief to compliant retailers, even if statistical tests in this study did not confirm significant effects.

Once borders reopened in 2022–2023, declines in NPM and ROA were evident in several firms, consistent with the re-entry of informal competitors. Small and medium-sized enterprises (SMEs) face structural disadvantages. Bound by legal standards and compliance costs, they lack the flexibility to adjust prices or expand informally, leaving them especially exposed to competitive pressures from unregulated traders (Cortez, Zúñiga and Martínez, 2021, pp.3-5). Similarly, they often struggle to sustain performance when competing with informal firms, whose lower operating costs and regulatory freedom enable them to undercut formal prices (Piperopoulos, et al., 2021, pp. 668-669). Similarly, Rattanawiboonsom (2021, pp. 8-9) highlights that Thai SMEs face high debt burdens and limited financial literacy, which restrict adaptive capacity when markets shift abruptly, causing enterprises to face challenges due to the "Be short of capable human assets" to fight against the virus, and a "Be short of symmetric information" which works against sustainable banking instruments. Though the present dataset ended in 2023, subsequent excise tax increases in 2025 demonstrate how future policy may further widen cross-border differentials, reinforcing smuggling incentives. Ismail, et al. (2024, pp. 1-4) also show that price differences are the main reason for fuel smuggling. Government subsidies keep prices artificially low — capped at RM2.05 per litre for RON95 petrol and RM2.15 per litre for diesel. These low, fixed prices encourage misuse, such as reselling subsidised fuel to non-citizens and allowing foreign-registered vehicles and non-citizens to benefit from subsidies meant for Malaysians. Legal stations continued to face disadvantages due to regulatory compliance costs and environmental standards that raise operating costs (Piperopoulos, et al. (2021, pp. 668-669). Weak enforcement capacity and entrenched corruption further exacerbate these imbalances, leaving informal sellers at a structural advantage (Timlen, 2023, pp. 98-99).

However, not all firms followed the same trajectory: Song Kamnan and F1 Energy Plus sustained high ROE across periods, showing that resilience is heterogeneous among stations. These differences may stem from location, customer base, or brand affiliation, although this study lacked sufficient data to test these moderators. As a result, future research should incorporate firm-level characteristics such as distance to border or brand affiliation.

In conclusion, the findings underscore that SMEs in border provinces operate on fragile margins, highly sensitive to informal competition and regulatory environments. Border closures provided temporary relief but cannot serve as a long-term policy solution; sustainable interventions require stronger institutions, targeted SME support, and structural reforms to address the roots of informal trade.

## Conclusion

This study examined the financial performance of 14 legal fuel stations in Narathiwat between 2019 and 2023, comparing pre-pandemic, closure, and post-reopening periods. The analysis shows that while descriptive evidence pointed to improvements during border closures, inferential tests found no statistically significant differences across periods. This indicates that temporary relief from smuggling did not translate into durable financial resilience for SMEs. The pandemic thus provided a quasi-natural experiment that highlights both the potential benefits of reducing informal competition and the limitations of relying on external shocks to protect legal businesses. In sum, informal fuel trade continues to undermine the profitability of legal SMEs, and addressing its impacts requires more than temporary border enforcement.

## Policy Recommendations

To address structural disadvantages faced by legal SMEs, three key policy recommendations are proposed:

1. Align Fuel Prices in Border Provinces. Adjusting retail fuel prices in southern border provinces to reduce differentials with Malaysia could directly weaken the economic basis of smuggling.

2. Strengthen SME Support Mechanisms. Tax incentives, improved access to credit, and emergency grants should be provided to small and medium legal retailers to buffer against market shocks.

3. Mobilise Local Communities in Enforcement. Residents who witness cross-border smuggling should be encouraged, protected, and incentivised to report illegal activity, thereby complementing state enforcement.

Together, these measures would contribute to a more level playing field, reducing reliance on temporary border closures as a policy tool.

## Limitations

This study is subject to four key limitations. First, the analysis covers data only until 2023, as financial statements for 2024 were unavailable at the time of writing. Second, the dataset relies exclusively on secondary financial statements and lacks qualitative evidence from managers or community members, which could offer richer insights. Third, the focus on Narathiwat province limits generalisability to other border provinces such as Yala or Pattani, where local dynamics may differ. Fourth, the study did not directly measure smuggling volumes, instead inferring impacts from firm-level financial outcomes. Future research should combine audited records with survey data and enforcement statistics to provide a fuller understanding of how informal fuel trade shapes SME survival.

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