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Oil Trade Route Exposure and Firm Level Cost Pass Through: A simulation study of a Strait of Hormuz disruption in 2026

Ezon Prezugha
Department of Accounting Southern Delta University Ozoro, Nigeria

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Corresponding Author:
Ezon Prezugha
ezonp@sdu.edu.ng

Abstract

Greater route exposure predicts larger delivered oil cost increases in a simulated disruption, while procurement protection and sourcing flexibility attenuate this association. Output price pass through is imprecisely estimated; margin and contractual rigidity findings remain provisional. The balanced panel contains 400 firms across 10 countries and 10 sectors from January 2024 to September 2026, yielding 13,200 firm month observations. Fixed effects event studies and instrumental variable local projections distinguish route dependence from oil intensity and trace prices and gross margins. The exposure coefficient is 0.0997, whereas six months pass through is 0.642 and statistically insignificant. The results illustrate a framework for studying procurement risk and accounting margins rather than providing observed firm evidence.

Keywords: Trade route exposure; Oil costs; Cost pass through; Gross margins; Procurement protection; Simulation

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1. INTRODUCTION

Disruption to an oil shipping corridor can affect firms through freight charges, insurance costs, delivery delays and the premium required to obtain suitable replacement inputs. These channels make the delivered cost of oil different from its benchmark price. Two firms with similar oil intensity may therefore experience different input cost changes when their procurement routes differ. Understanding this distinction matters for the interpretation of cost of goods sold, gross margins and the commercial decisions through which firms absorb or transmit cost shocks.

This study examines that mechanism using a simulated Strait of Hormuz disruption dated March 2026. Route exposure is the pre-disruption share of oil inputs transported through the Strait; oil intensity is oil's pre-disruption share of production costs. The distinction separates reliance on a transport corridor from dependence on oil as an input. The simulation provides an illustrative setting in which to connect procurement exposure, delivered costs, output prices and reported profitability. It does not establish the effects of an observed disruption on actual firms.

Existing research provides several foundations. Kilian (2009) distinguishes different sources of oil price movements. Carvalho et al. (2021) show that supply disruptions propagate through production networks. Ganapati et al. (2020) examine energy cost pass-through in manufacturing, while Muehlegger and Sweeney (2022) show that pricing responses differ between own and rival cost shocks. Together, these studies suggest that a common benchmark oil price is insufficient to describe the costs and pricing incentives faced by individual firms.

Research Questions.

1. Does predetermined route exposure predict a larger delivered oil cost increase after disruption, conditional on oil intensity?
2. How do oil-related production cost changes relate to output prices and gross margins across monthly horizons?
3. Do procurement protection, sourcing flexibility, pricing power and sales-contract rigidity moderate these relationships?

A balanced panel of 400 simulated firms supports a cost event study and instrumental variable local projections through September 2026.

The clearest result is the positive exposure cost association. Procurement protection and sourcing flexibility reduce the exposure slope. By contrast, price pass-through estimates are imprecise, and the joint test does not establish a price response. The accounting relevance lies in linking procurement risk with cost recognition and gross margin interpretation.

2 LITERATURE AND HYPOTHESES

2.1 Route dependence and delivered costs

Resource dependence theory links reliance on critical external resources to organizational vulnerability (Pfeffer and Salancik, 1978). Dependence on a disrupted shipping corridor may increase the cost of securing inputs even when firms have similar production technologies. Inventories, substitute suppliers and protected procurement arrangements can moderate realized costs. We therefore distinguish physical route dependence from oil intensity and evaluate the null hypothesis H01: predetermined route exposure has no differential association with delivered oil costs after disruption, conditional on oil intensity.

2.2 Price adjustment and accounting margins

Incidence under imperfect competition depends on demand and competitive conditions (Weyl and Fabinger, 2013). Pricing incentives also depend on whether rivals face the same cost shock.

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Amiti et al. (2019) show that firms respond to both their own costs and competitors' prices. Consequently, neither greater market power nor a larger input cost shock mechanically implies a particular pass-through rate. Price adjustment costs provide an additional explanation for gradual responses (Mankiw, 1985).

We test H02a: oil-related production cost increases have no effect on output prices at the estimated horizons; H02b: cumulative pass-through does not differ between designated horizons; and H02c: oil-related production cost increases have no effect on gross margins.

2.3 Moderating firm characteristics

Transaction cost economics links asset specificity and uncertainty to contractual governance and adaptation (Williamson, 1985). Procurement contracts can protect acquisition prices, while technically suitable alternative suppliers can reduce substitution costs. Sales contracts operate at a different stage: fixed prices or infrequent revision schedules may constrain the response of selling prices to a realized cost increase.

Accordingly, H03a states that pricing power does not moderate price pass-through. H03b states that sales-contract rigidity does not moderate its magnitude or timing. H03c and H03d state that procurement protection and sourcing flexibility, respectively, do not moderate the exposure–cost relationship. Negative cost-stage interactions are expected for protection and flexibility. Pricing-power effects are not signed a priori, and any timing interpretation of rigidity requires observations long enough to identify subsequent catch-up.

3 DATA AND RESEARCH DESIGN

3.1 Simulated sample and measurement

The balanced simulated panel covers 400 firms in 10 countries and 10 sectors from January 2024 through September 2026. It contains 13,200 firm-month observations: 10,400 before March 2026 and 2,800 from March through September. Firm characteristics are measured in 2025. March 2026 is the assigned disruption month and February 2026 the reference month.

Route exposure E ranges from zero to one. Oil intensity s measures oil's share of production costs. Delivered oil cost c is measured per unit at the firm's gate, while p is a constant-composition output price index. Gross margin equals 100 × (sales − cost of goods sold)/sales. It is distinct from a contribution margin based on variable costs and from operating profit divided by sales. Reported margin estimates must therefore be interpreted in light of quantities, sales composition and other costs.

Pricing power P is a standardized pre-disruption proxy. Sales-contract rigidity R and procurement protection C are initially measured as shares. Sourcing flexibility S is measured in the descriptive output as one minus the supplier concentration index. Interaction specifications use standardized moderators, so their coefficients describe changes associated with a one-standard-deviation increase.

Table 1: Descriptive statistics for the simulated panel

Variable	N	Mean	SD
Route exposure	400	0.404	0.266
Oil intensity	400	0.196	0.122
Firm size log assets	400	6.305	1.190
Pricing power standardized	400	0.000	1.000
Sales rigidity share	400	0.377	0.183
Procurement protection share	400	0.326	0.193
Sourcing flexibility	400	0.661	0.098
Oil cost index before disruption	10,400	104.91	6.75
Oil cost index during disruption	2,800	152.55	14.43
Output price index before disruption	10,400	99.45	1.69
Output price index during disruption	2,800	106.09	4.06
Gross margin before disruption %	10,400	18.24	7.70
Gross margin during disruption %	2,800	14.69	9.07

3.2 Exposure and delivered oil costs

Let i denote firms, g country sector groups and t months. Post equals one from March 2026. The pooled exposure model is:

$$\ln c_{it} = \alpha_i + \delta_{gt} + \beta (E_i \times Post_t) + \Sigma\tau\, \omega\tau(s_i \times 1[t = \tau]) + \Sigma\tau\, \gamma\tau(Size_i \times 1[t = \tau]) + \varepsilon_{it}. \quad (1)$$

Firm effects absorb time nvariant firm characteristics. Country–sector-by-month effects absorb shocks shared within those groups, while oil intensity and size are interacted with month. The coefficient β describes the differential post-disruption log cost change associated with exposure. This follows the later results narrative in the source, whose fixed effects and estimates differ from the earlier sector-by-month output.

$$\ln c_{it} = \alpha_i + \delta_{gt} + \Sigma k \neq -1\, \beta_k E_i \times 1[t - t0 = k] + \text{monthly characteristic controls} + \varepsilon_{it}. \quad (2)$$

The event study uses the month before disruption as the reference. Differential pre-disruption coefficients provide a diagnostic for anticipation or divergent trends; failure to reject them does not prove parallel trends. A pooled coefficient on a continuous exposure measure also requires sufficient within-group variation and a defensible functional form.

3.3 Dynamic price and margin responses

Following the local projection approach of Jordà (2005), each outcome is expressed as a long difference from February 2026 to horizon h, where h = 0, …, 6. The oil-related cost change is $\Delta_h \kappa_i = s_i[\ln c_{i,t0+h} - \ln c_{i,t0-1}]$. The first and second stages can be written as:

$$\Delta_h \kappa_i = \pi_h Z_i + \text{group effects} + X_i'a_h + v_{ih}. \quad (3)$$

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Δ_h ln p_i = θ_h fitted (Δ_h κ_i) + group effects + X_i′b_h + u_ih. (4)

Δ_h GM_i = ψ_h fitted (Δ_h κ_i) + group effects + X_i′d_h + e_ih. (5)

The earlier output defines the primary excluded instrument as Z_i = E_i × s_i, with E_i alone as an alternative; the original model text instead specifies E_i. The later results narrative does not restate the instrument or the complete horizon-level specifications. Equations (3)– (5) therefore describe the proposed estimator, and the exact instrument and controls for the retained results require confirmation against the estimation files. X includes predetermined oil intensity and size.

The parameter θ_h is a cumulative elasticity of output price with respect to the oil-related change in unit production cost. The margin coefficient requires a documented scaling convention before it can be interpreted per one percent cost change. Exposure must affect outcomes through the instrumented cost channel for an IV causal interpretation. Physical shortages, rivals' pricing and correlated demand shifts can violate this restriction. Conditioning on sales volumes may explore a channel but cannot by itself establish exclusion.

3.4 Moderation and inference

The cost model adds E × Post × C and E × Post × S, together with Post × C and Post × S. The price model adds interactions between the oil-related cost change and P and R, along with moderator main effects. A corresponding IV implementation requires instruments for each endogenous interaction and conditional first-stage diagnostics. Such diagnostics are not established for the later moderation results.

The retained results use country-cluster inference, with only ten countries, and thus warrant caution in joint tests with many restrictions. Bootstrap methods can improve inference with clustered errors (Cameron et al., 2008), but the later results narrative does not provide a complete set of bootstrap outcomes. We report supplied p-values without treating them as independently verified. Tests use a five percent threshold, with uncertainty and diagnostic limitations discussed alongside the findings.

4 RESULTS

4.1 Descriptive patterns

Average route exposure is 0.404 and average oil intensity is 0.196. In the supplied descriptive output, average delivered oil cost rises from 104.91 before disruption to 152.55 during disruption. The output price index rises from 99.45 to 106.09, while average gross margin declines from 18.24% to 14.69%. These raw comparisons describe the simulated panel and do not identify exposure effects. The descriptive table is retained from the common sample description; its consistency with the later estimation sample should be checked when the underlying files are available.

4.2 Exposure and delivered costs

Table 2 summarizes the retained cost-stage estimates. The exposure-by-post coefficient is 0.0997 (SE = 0.0210; p = 0.001; 95% confidence interval [0.0523, 0.1471]). A ten-percentage-point increase in exposure corresponds to approximately a 1.00% larger delivered cost increase, calculated as 100 × [exp (0.1 × 0.0997) − 1]. H01 is rejected within the simulated sample. The estimate separates exposure from oil intensity under the fitted controls; it does not eliminate every possible source of confounding.

Table 2: Route exposure and moderation of delivered oil costs

Diagnostic Test	Estimate	SE	p value
Exposure × Post	0.0997	0.0210	0.001
Exposure × Post × procurement protection	−0.0196	Not supplied	<0.001
Exposure × Post × sourcing flexibility	−0.0111	Not supplied	0.003
Binned pre-disruption test	—	—	0.319
Individual lead at month −2	Not supplied	Not supplied	0.011

Results come from the later Results and interpretation section. Baseline dependent variable is log delivered oil cost; 95% confidence interval for the exposure slope is [0.0523, 0.1471]. The source describes firm and country–sector-by-month fixed effects, with monthly interactions for oil intensity and size, and country-cluster inference.

The binned pre-disruption test has p = 0.319, but the coefficient at month −2 is individually significant (p = 0.011). These diagnostics provide mixed evidence and do not support an unqualified claim of parallel trends. The later narrative reports that the differential post-disruption response becomes significant at h = 1, but it does not supply the full revised event-study series. A graph is therefore not reconstructed from the incompatible earlier coefficients.

Procurement protection and sourcing flexibility attenuate the exposure slope. Their interaction coefficients are −0.0196 (p < 0.001) and −0.0111 (p = 0.003), respectively. H03c and H03d are rejected. These are changes in the exposure slope per standard deviation of the moderators. Percentage reductions calculated using the earlier model's baseline coefficient are not carried over to this specification.

4.3 Output prices and gross margins

Table 3 reports selected price estimates and the available joint tests. Pass-through point estimates are 0.152 on impact, 0.417 after three months and 0.642 after six months. The six-month confidence interval is wide, from −0.858 to 2.141, and its p-value is 0.358. The joint test across horizons also fails to reject zero price responses (p = 0.567). H02a is not rejected. These results indicate insufficient precision to establish pass-through rather than evidence that pass-through is absent.

Table 3: Dynamic price responses and joint tests

Estimate	Value	p value
Price pass-through h = 0	0.152	Not supplied
Price pass-through h = 3	0.417	Not supplied
Price pass-through h = 6	0.642	0.358

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Estimate	Value	p value
Joint price effects all horizons	—	0.567
Pass-through difference h = 6 versus h = 3	0.224	0.211
Joint gross margin effects	—	0.012
Joint pricing-power moderation	—	0.389
Joint sales-rigidity moderation	—	0.038
Rigidity timing h = 6 versus h = 3	—	0.984
First-stage F at h = 0	1.73	—
First-stage F at h = 1	6.29	—

Results come from the later narrative. Each horizon uses 400 simulated firms. The six-month price confidence interval is [−0.858, 2.141]. h = 0 is March 2026 and h = 6 is September 2026. The three- versus six-month tests are exploratory; twelve-month tests are unavailable. Joint margin and rigidity findings are provisional given ten country clusters and incomplete interaction-instrument diagnostics. A dash indicates that an estimate is not applicable or not reported; no missing statistic has been inferred.

Early first-stage strength is limited: the reported country-cluster first-stage F-statistics are 1.73 at h = 0 and 6.29 at h = 1. The source states that weak-instrument-robust tests also fail to establish positive price responses but does not supply their numerical p-values for this specification. The six- versus three-month pass-through difference is reported as 0.224 (p = 0.211). Minor differences from subtracting rounded horizon coefficients reflect the precision of the supplied figures. This exploratory comparison does not establish increasing pass-through, and the prespecified twelve-month comparison remains unavailable.

The joint gross margin test rejects zero effects across horizons (p = 0.012). This result is provisional because horizon-specific IV estimates are imprecise and the joint test imposes seven restrictions with only ten country clusters. The retained narrative does not provide the complete margin coefficients or standard errors. We therefore do not report a precise margin decline per one percent cost increase or infer that all unrecovered costs were absorbed in margins.

4.4 Pricing power and contractual rigidity

The pricing-power interaction test is not significant across horizons (p = 0.389), so H03a is not rejected. The sales-contract rigidity magnitude test has p = 0.038, providing provisional evidence of moderation. Conditional instrument strength for these interactions has not been established. The exploratory rigidity timing test comparing six and three months is insignificant (p = 0.984). Thus, the retained results do not establish catch-up in pass-through, and the original twelve-month timing hypothesis remains untested.

5 DISCUSSION AND LIMITATIONS

The simulation illustrates the value of measuring procurement routes alongside input cost shares. Route exposure predicts different delivered cost changes even after conditioning on oil intensity. Procurement protection and supplier flexibility appear to reduce this differential. These findings motivate attention to contract terms and sourcing concentration when interpreting cost risk, while remaining conditional on the simulation and estimation design.

The accounting implication is principally one of measurement. Gross margins combine selling prices, the recognition of inventory costs, quantities and product mix. A margin movement alone cannot identify a pass-through elasticity or establish how a particular input cost increase was shared between a firm and its customers. An empirical extension would need compatible procurement, shipping, price and accounting records, and should distinguish gross, contribution and operating margins explicitly.

Several limitations constrain interpretation. First, the observations are simulated, and the supplied text does not document the full data-generating process. Second, the later results differ materially from the earlier statistical tables. This revision consistently uses the later results, but their underlying computation has not been verified. Third, the instrument and exact fixed effects for the later local projections need confirmation. Fourth, weak early instruments, few country clusters and incomplete interaction diagnostics limit the reliability of causal and joint-test conclusions.

Finally, the seven post-disruption observations cannot support the original twelve-month hypotheses. The incomplete revised event-study series also prevents a defensible figure. A replication package should provide the simulation code, estimation sample, full coefficient and covariance output, instrument definitions, conditional first-stage diagnostics and appropriate inference with few clusters before these results are treated as a submission-ready statistical record.

6 CONCLUSIONS

Using a simulated panel, this study examines how predetermined oil route exposure relates to delivered input costs, output prices and gross margins. The retained estimates associate greater exposure with larger delivered cost increases, while procurement protection and sourcing flexibility attenuate that association. Output price pass-through remains imprecisely estimated. Margin and contractual rigidity results are provisional, and pricing-power moderation is not established. The contribution is an illustrative research framework connecting procurement dependence with cost transmission and accounting margins; validation with observed firm data and reproducible estimation is needed.

Data availability

This manuscript uses simulated data. The pasted source did not include the dataset, simulation code or estimation files. No public repository or access arrangement has been supplied.

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