

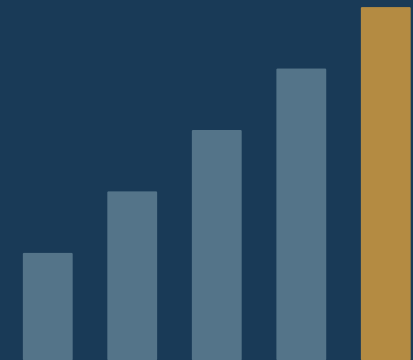
A Changing Cedi

Different Effects on Importers, Exporters and Domestic Producers

Costs. Margins. Competition. Currency liabilities.

Commissioning institution: Institute of Development and Economic Research (IDER)

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INFORMATION CUT-OFF
23 SEPTEMBER 2026

FX history: Jan 2019–Aug 2026
Fuel extension: Apr 2019–Apr 2023

About this publication

Independent research • transparent evidence • reproducible calculations

TITLE AND SERIES

A Changing Cedi: Different Effects on Importers, Exporters and Domestic Producers

IDER's Ghana Macroeconomic Policy and Business Intelligence Briefings

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RESPONSIBILITY AND INTERPRETATION

The analysis and interpretations are those of the author and IDER. This is not a World Bank or IMF publication; source citation does not imply endorsement. Reproducible calculations do not convert conditional scenarios into causal national estimates.

DATA, CODE AND ENQUIRIES

The companion evidence package contains source-labelled inputs, calculation code, figure data, model documentation and verification records. For research, corrections or reuse enquiries: info@iderafrica.com.

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Page numbers match the printed folios and the PDF page count; all entries are clickable in the master file.

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NAVIGATION Running headers identify sections. Source IDs link to references; model IDs link to the equation catalogue in the editable master.

How to interpret the evidence

Read the evidence status, measurement boundary and assumptions before interpreting a number.

SOURCE-REPORTED / CONTEXTUAL

Official records, survey indicators and issuer disclosures retain their own dates, populations and definitions. A source observation is not automatically a complete national estimate.

ESTIMATED ASSOCIATION

Regression coefficients describe historical co-movement in observed samples. HAC and HC3 adjust uncertainty; they do not by themselves establish exogenous exchange-rate treatment.

CONDITIONAL BUSINESS MODEL

Enterprise profiles are assumed annual archetypes. Results depend on declared cost shares, pricing behaviour, quantities, debt service and working-capital rules.

PROSPECTIVE / NOT ESTIMATED

The firm-level causal design specifies what future data must identify. No fitted firm-panel treatment effect, standard error or representative national loss is reported.

UNITS AND ROUNDING

Scenario money is GHS per GHS100 of baseline annual revenue unless stated otherwise. Calculations use full precision before display rounding.

SIGNS AND QUOTATIONS

A higher GHS/USD rate denotes cedi depreciation. A +20% GHS/USD move is not the reciprocal of a -20% movement in the cedi's dollar value.

RANGES AND MISSINGNESS

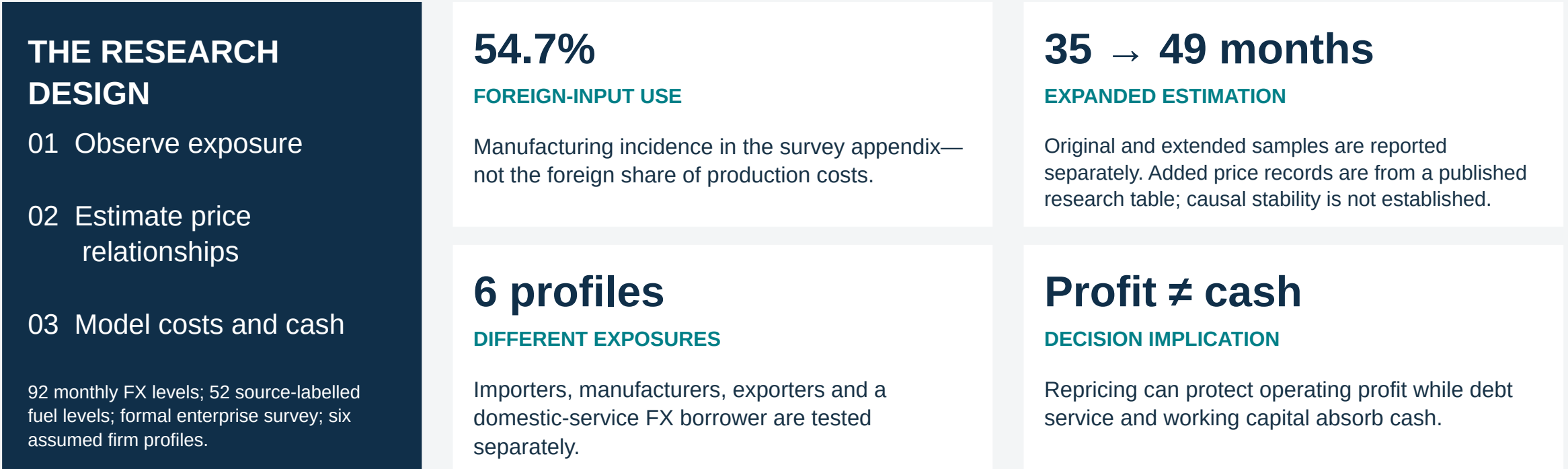
Confidence intervals, sensitivity ranges and scenario grids answer different questions. Missing firms, missing invoices or absent records are not treated as zero.

SOURCES AND MODELS

Source IDs identify records; figure and model IDs identify executed outputs. Historical associations, conditional accounting and prospective causal designs remain separate.

One currency movement. Several business consequences.

Research question: how do exchange-rate changes reach costs, margins, competition and currency obligations?



Sources: BoG: monthly FX; IMF/FRED: Brent; BoG: petrol; World Bank ES; Hesse et al. (2026), Table 1; IDER calculations. [\[S01\]](#) [\[S02\]](#) [\[S03\]](#) [\[S04\]](#) [\[S12\]](#) [\[S11\]](#)

Note: Historical associations and model scenarios are not Ghana-wide causal effects or representative firm profit estimates.

Assess the net exposure—not the business label

The business question is not simply whether the cedi strengthened or weakened. It is which cash flows changed.

IMPORTER / DOMESTIC SALES

-4.00 → +10.11

Importer A's operating profit at +20% FX is -4.00 with fixed pricing, or +10.11 with assumed repricing and demand response. Capacity or procurement limits reduce the adaptive gain; neither number is a surveyed importer outcome.

EXPORTER / FOREIGN SALES

+35.00 vs +22.00

Under fixed quantities and local costs, low-import exporter D earns 35.00 versus 22.00 for import-intensive exporter E. Their baseline profits differ: 20.00 and 15.00.

CASH / LIABILITY MATCH

-0.63

Importer A's adaptive result still gives a -0.63 transition cash proxy after FX service and incremental working capital, before tax and capital expenditure.

Sources: World Bank ES; Amiti et al. (2014); Gopinath et al. (2020); IDER calculations. [\[S04\]](#) [\[S07\]](#) [\[S08\]](#) [\[S11\]](#)

Note: All +20% enterprise examples below are conditional; +20% means an increase in GHS per USD, not a 20% reciprocal loss.

A 90-day implementation path for enterprise FX intelligence

Proposed sequence begins when authorised data access and participating-firm approval are secured.

DAYS 0–30 MAP Treasury + procurement + sales Create a currency-by-date exposure register. Separate committed invoices, forecast purchases, export receivables and debt. Reconcile all material balances to supporting records.	DAYS 31–60 TEST Finance + operations + risk Run appreciation, depreciation and joint input-price scenarios. Quantify repricing delays, financing needs and hedge coverage. Test every payment date, not just year-end profit.	DAYS 61–90 USE Management + IDER + reviewer Approve firm-specific tolerances and release a reproducible dashboard. Keep unresolved source gaps visible. Track realised invoice rates and errors against the previous planning vintage.
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Source: IDER calculations. [\[S11\]](#)

Note: Targets are proposed operating controls, not achieved coverage, legal minimums or instructions to choose a currency position.

Abbreviations and reading terms

Definitions support the existing analysis; source-specific measurement rules remain controlling.

BoG	Bank of Ghana.	pp / log pp	Percentage points / 100 x natural-log change.
Cedi / GHS	Ghana cedi; domestic reporting currency in this briefing.	RMSE / MAE	Root mean squared error / mean absolute error.
DFI / MSME	Development finance institution / micro, small and medium enterprise.	ES	World Bank Enterprise Surveys; contextual firm evidence with population limits.
DSO / DIO / DPO	Receivable days / inventory days / payable days used in the working-capital proxy.	FRED / IMF	Federal Reserve Bank of St. Louis data interface / International Monetary Fund source series.
FX / GHS/USD	Foreign exchange; Ghana cedis per US dollar. A higher rate denotes depreciation.	GSE	Ghana Stock Exchange source for listed-company annual reports.
HAC / HC3	Serial-correlation-robust covariance / leverage-adjusted heteroskedasticity covariance.	Pass-through	Price response to FX or input-cost changes; not assumed universal.
IDER	Institute of Development and Economic Research.	Scenario profile	Declared analytical archetype; not a sampled average firm.
NWC	Net working capital; a funding proxy, not a verified dated cash ledger.	Transition cash proxy	Operating profit less FX service and incremental NWC; excludes tax, capex and opening cash.
OLS	Ordinary least squares; an estimator, not a causal design.	Source exception	A documented source-access, definition or reconciliation limitation.

Terminology: source-specific definitions in S01-S13 and model entries M01-M19 / D01 remain controlling.

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M02 Joint cost conversion	Executed accounting	101		F07 Year exclusion diagnostic	Influence / stability	105	
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F05 Lag-only model and loss	Estimated association / pseudo-OOS	103		M03 Own and competitor prices	Conditional model	108	
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Family IDs are stable; evidence status, assumptions and interpretation boundaries appear in the model catalogue.

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The percentage change depends on the quotation convention

Exact arithmetic; the scenario driver is the change in GHS per USD.

Table 2. The percentage change depends on the quotation convention

GHS/USD movement	Cedi value in USD	Unchanged USD invoice	Interpretation
+20.0%	−16.7%	GHS cost rises 20.0%	A 20% increase and a 20% decrease are not reciprocal moves.
−20.0%	+25.0%	GHS cost falls 20.0%	Restoring the original exchange rate requires a 25% rise from the lower rate.
+10.0%	−9.1%	GHS cost rises 10.0%	Always report the numerator, denominator and start/end dates.

Source: IDER calculations. [\[S11\]](#)

Note: Exchange-rate effects here hold the foreign-currency invoice, taxes and other charges fixed; actual contracts can differ.

The cedi path contains reversals that annual averages can conceal

92 month-end observations, January 2019–August 2026; GHS per USD.

Figure 1. The cedi path contains reversals that annual averages can conceal



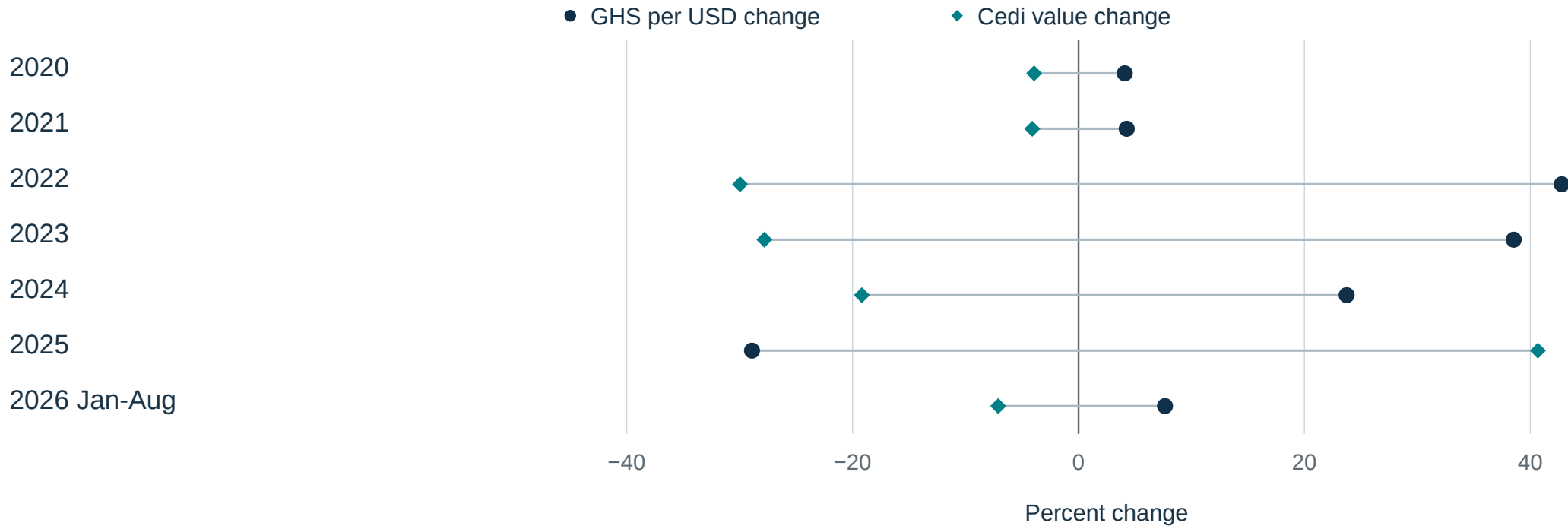
Source: BoG: monthly FX. [\[S01\]](#)

Note: Original archived BoG series retained; it is not a retail customer quote or a continuous intramonth price path.

The same endpoints produce different—but consistent—percentages

December-to-December comparisons; 2026 is December 2025 to August 2026 only.

Figure 2. The same endpoints produce different—but consistent—percentages



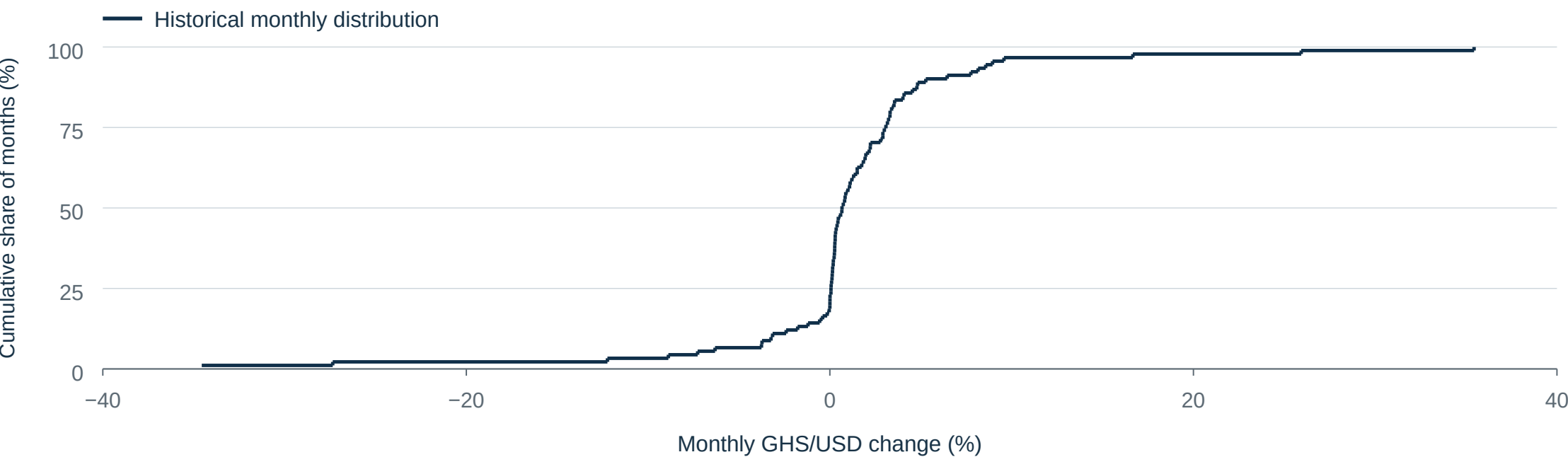
Source: BoG: monthly FX. [\[S01\]](#)

Note: The two series use reciprocal quotation conventions; neither is a portfolio total return.

Large movements occur in the historical record—but are not probabilities

Empirical cumulative distribution of 91 one-month GHS/USD changes.

Figure 3. Large movements occur in the historical record—but are not probabilities



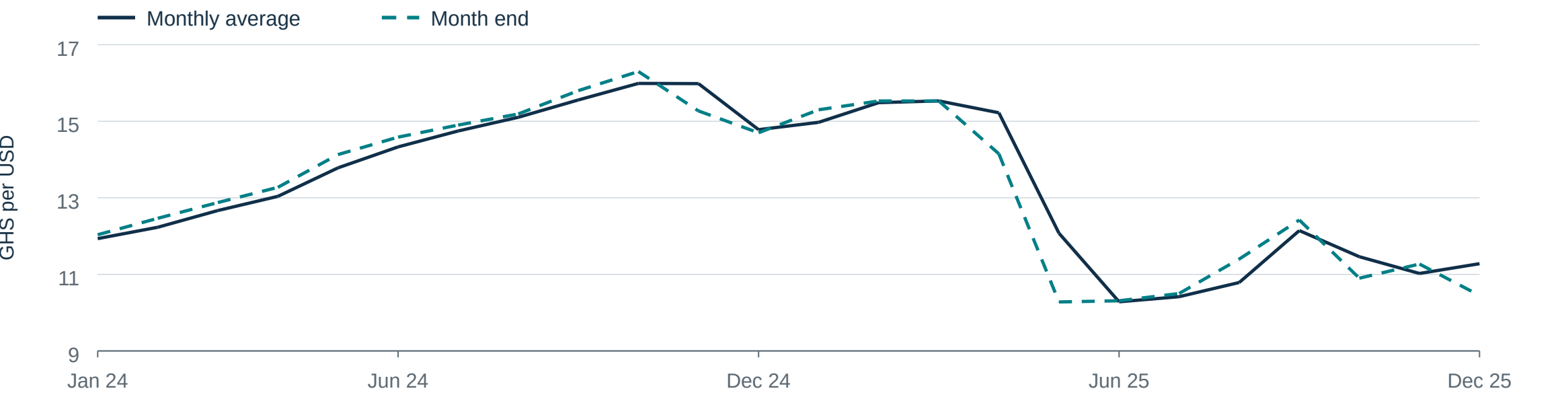
Sources: BoG: monthly FX; IDER calculations. [\[S01\]](#) [\[S11\]](#)

Note: Historical quantiles are descriptive. Dependence, regime shifts and future policy responses prevent a forecast-VaR interpretation.

Operating conversion rates and closing valuation rates can diverge

Monthly-average and month-end GHS/USD, January 2024–December 2025.

Figure 4. Operating conversion rates and closing valuation rates can diverge



Source: BoG: monthly FX. [\[S01\]](#)

Note: Published monthly averages do not reproduce a firm’s transaction-weighted conversion rate; actual cash conversion requires its own ledger.

Reference-rate updates do not replace invoice-level dealing quotes

Ghana Association of Banks schedules; each published rate and date is retained.

Table 3. Reference-rate updates do not replace invoice-level dealing quotes

Period / statistic	GHS per USD	Purpose	Boundary
December 2025 monthly mid	11.3194	Reference average	Archived BoG monthly average is 11.2784; the difference is not reconciled.
31 December 2025 mid	10.4500	Dated closing reference	Not the December monthly average.
August 2026 monthly mid	11.3558	Separately dated monitoring	Not a full-year 2026 outturn or September execution rate.
31 August 2026 mid	11.2500	Dated closing reference	Customer spreads, fees, amount and value date remain contract-specific.

Sources: BoG: monthly FX; GAB: monthly FX. [\[S01\]](#) [\[S05\]](#)

Note: Do not average conflicting source conventions into a synthetic quote. No current trading recommendation is made.

The enterprise survey is informative—but it is not all Ghanaian businesses

Ghana 2023 Country Profile: 713 interviews, February 2023–February 2024.

Table 4. The enterprise survey is informative—but it is not all Ghanaian businesses

Coverage dimension	Included / measured	Outside the inference boundary
Firm size	Formal firms with at least five employees	Microbusinesses with fewer than five workers.
Economic activity	Manufacturing and selected services, including construction and trade	Agriculture, fishing, mining, public utilities, financial services and other excluded sectors.
Ownership / status	Registered establishments with private participation	Informal firms and entirely state-owned firms.
Survey inference	Published country-profile point estimates	No survey microdata, design-based standard errors or 2026 reweighting are estimated here.

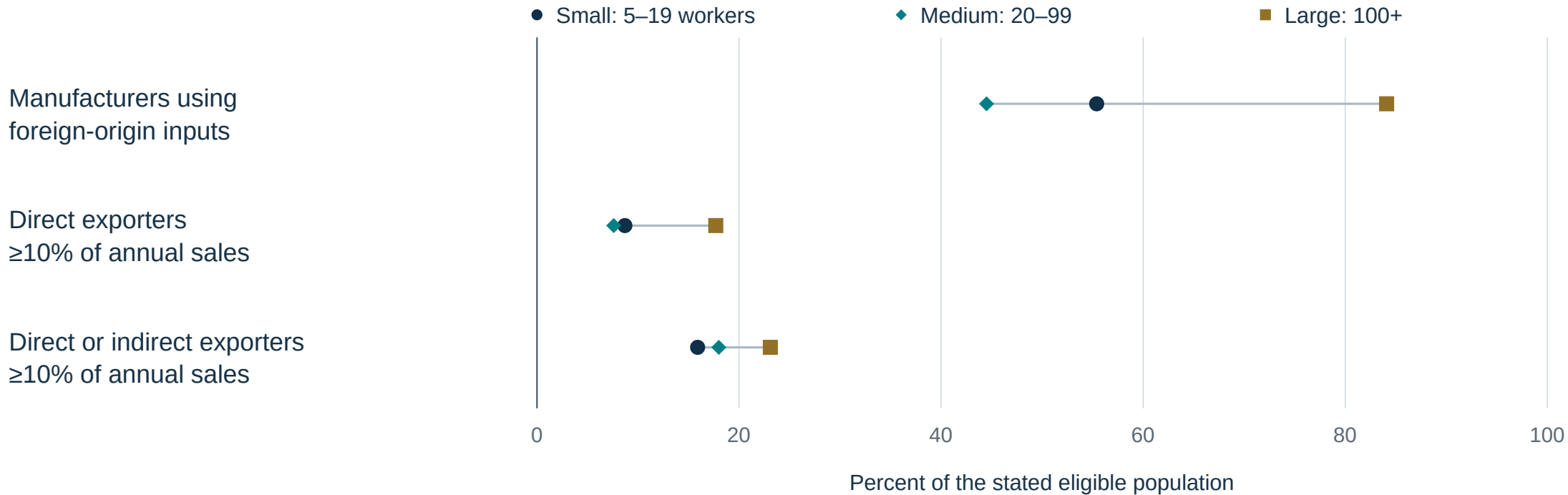
Source: World Bank ES. [\[S04\]](#)

Note: The survey is contextual evidence; it does not supply the cost shares or elasticities of the six business-model profiles.

Foreign inputs matter to domestic producers as well as direct importers

Detailed survey appendix, not its inconsistent summary graphic; point estimates only.

Figure 5. Foreign inputs matter to domestic producers as well as direct importers



Source: World Bank ES. [\[S04\]](#)

Note: The foreign-input indicator covers manufacturers; exporter indicators cover eligible firms. Denominators are different.

A currency shock can also become a financing constraint

Ghana Enterprise Survey appendix; percentages retain their original denominators.

Table 5. A currency shock can also become a financing constraint

Indicator	All	Small	Medium	Large
Investment financed internally	76.0	77.7	74.8	70.8
Investment financed by banks	5.0	3.2	5.7	13.3
Firms using banks to finance investment	14.1	10.0	16.6	28.5

Source: World Bank ES. [\[S04\]](#)

Note: “Investment financed by banks” is a financing share; “firms using banks” is an incidence measure. Differences are not significance tests.

Do not conceal inconsistencies inside a polished graphic

Primary PDF page images were inspected; these differences exceed simple display rounding.

Table 6. Do not conceal inconsistencies inside a polished graphic

Indicator	Summary graphic	Detailed appendix	Treatment
Manufacturers using foreign inputs	67%	54.7%	Use appendix; no cost-share inference.
Export customs clearance	9 days	7.5 days	Use appendix; conditional population and source limitations remain.
Import customs clearance	22 days	20.6 days	Use appendix; do not average the two figures.

Source: World Bank ES. [\[S04\]](#)

Note: An unresolved source conflict is not a sampling confidence interval. An official reconciliation was not obtained.

Five channels explain why the net effect differs

The analysis tracks the contract currency and the timing of adjustment—not only the direction of the exchange rate.

OPERATING COST AND REVENUE

Imported inputs and foreign-currency sales translate directly. Local suppliers may also pass through their own imported costs. A high export share does not imply a large net FX surplus.

PRICING AND COMPETITION

Own prices, competing import prices and customer demand can adjust at different speeds. Dollar invoicing can weaken the link between a bilateral exchange rate and export market share.

BALANCE SHEET AND CASH

Foreign-currency debt, trade credit, collateral, inventory and receivables create additional exposure. A translation gain or loss is not identical to a settlement cash flow.

Sources: Amiti et al. (2014); Gopinath et al. (2020); IDER calculations. [\[S07\]](#) [\[S08\]](#) [\[S11\]](#)

Note: The literature motivates the channels; foreign-country coefficient estimates are not imposed as Ghana elasticities.

FX and foreign supplier prices multiply—not simply add

A fixed foreign-currency quantity with unchanged freight, duties and other costs.

Figure 6. FX and foreign supplier prices multiply—not simply add

	USD price –20%	Unchanged	USD price +20%
GHS/USD –20%	–36.0	–20.0	–4.0
GHS/USD unchanged	–20.0	0.0	20.0
GHS/USD +20%	–4.0	20.0	44.0

Change in GHS input cost (%)

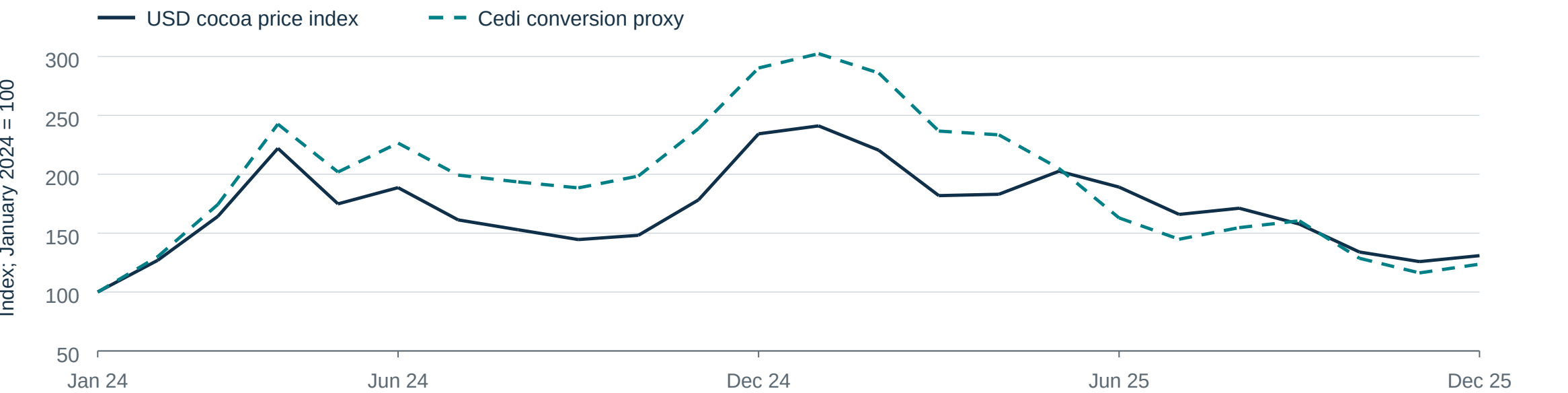
Source: IDER calculations. [\[S11\]](#)

Note: A +20% GHS/USD move combined with a +20% USD unit-price move raises the GHS invoice by 44%, not 40%.

Dollar commodity prices and cedi conversion can move differently

Cocoa benchmark: January 2024 = 100; monthly-average FX × monthly USD price.

Figure 7. Dollar commodity prices and cedi conversion can move differently



Sources: BoG: monthly FX; IMF/FRED: cocoa. [\[S01\]](#) [\[S10\]](#)

Note: The converted series is a benchmark product of averages—not a farmgate price, realised exporter revenue or margin.

The historical estimation uses a narrow, clearly defined price outcome

Fuel is a traded-input illustration; the model does not estimate all consumer or producer prices.

Table 7. The historical estimation uses a narrow, clearly defined price outcome

Variable	Definition / source	Window / treatment
Indicative petrol price	GHS/litre; BoG commodity-price table	36 levels, Jan 2020–Dec 2022. Official-domain cached transcription; direct retrieval failed.
Exchange rate	BoG month-end GHS per USD	Monthly log changes and lags. Month-end timing differs from indicative monthly pricing.
Global oil benchmark	IMF Brent monthly average, USD/barrel, via FRED	Contemporaneous and lagged log changes; foreign input-price covariate.
Estimation sample	35 monthly petrol-price changes	Feb 2020–Dec 2022. Pre-sample FX and oil observations supply regressor lags.

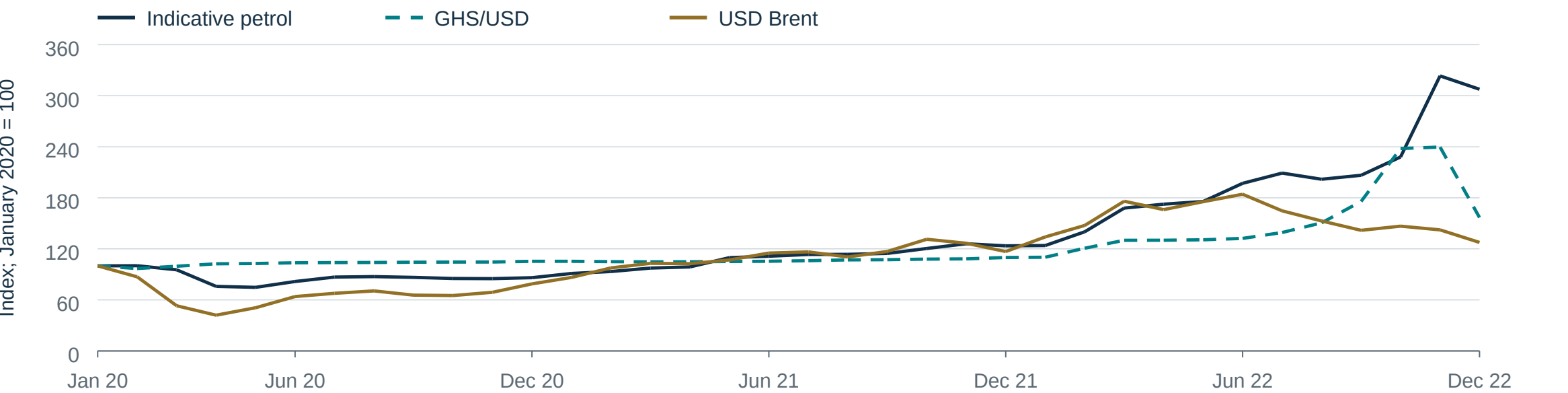
Sources: BoG: monthly FX; IMF/FRED: Brent; BoG: petrol. [\[S01\]](#) [\[S02\]](#) [\[S03\]](#)

Note: Original sample retained for traceability. The separate 49-month extension adds source-labelled records; no observations are imputed, winsorised or manufactured.

Retail fuel and its traded-input benchmarks have different paths

Indices normalised to January 2020 = 100; 36 observed monthly levels.

Figure 8. Retail fuel and its traded-input benchmarks have different paths



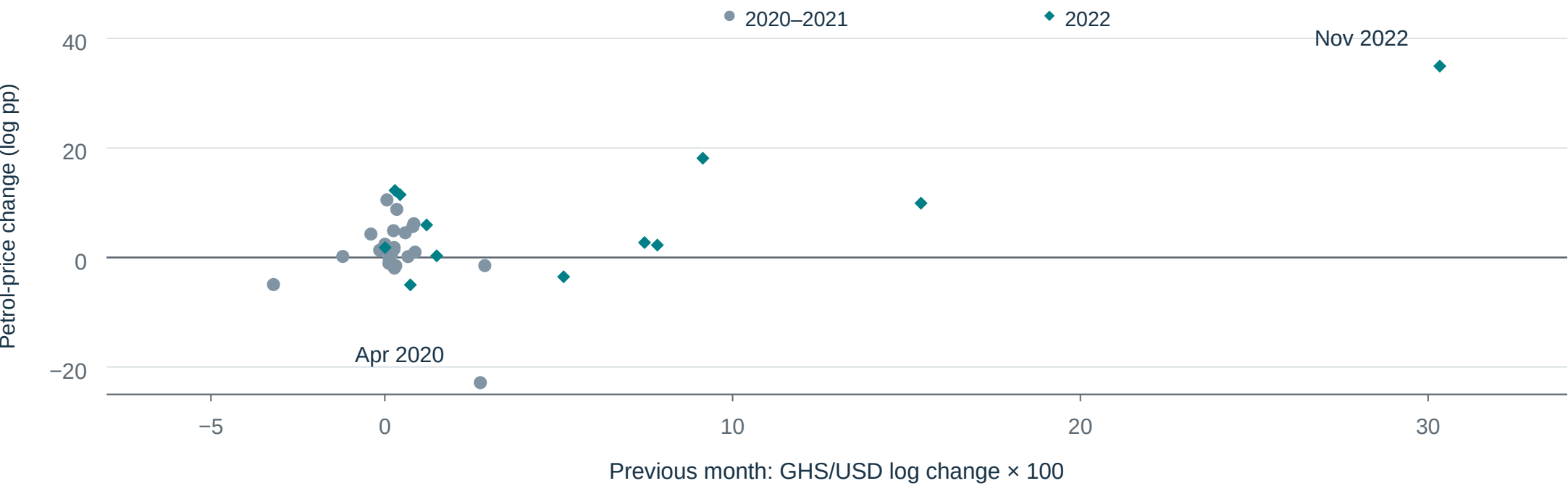
Sources: BoG: monthly FX; IMF/FRED: Brent; BoG: petrol. [\[S01\]](#) [\[S02\]](#) [\[S03\]](#)

Note: Differences also reflect taxes, margins, refining/freight costs, stocks and adjustment timing—not only the exchange rate.

The high-variation 2022 months materially influence the relationship

Lagged GHS/USD log change versus current indicative petrol-price log change.

Figure 9. The high-variation 2022 months materially influence the relationship



Sources: BoG: monthly FX; BoG: petrol. [\[S01\]](#) [\[S03\]](#)

Note: Scatter points do not control for Brent or concurrent shocks. They illustrate support and influence, not a causal dose response.

Estimate changes and lags—not a regression between trending levels

F02: one lag of FX and Brent log changes; OLS with Bartlett HAC(3) covariance.

Table 8. Estimate changes and lags—not a regression between trending levels

Regressor	Coefficient	HAC s.e.	95% interval	p-value
Intercept	0.005	0.007	[−0.009, 0.019]	0.477
FX change, current	0.048	0.063	[−0.081, 0.176]	0.455
FX change, lag 1	0.912	0.154	[0.598, 1.226]	<0.001
Brent change, current	0.086	0.081	[−0.079, 0.251]	0.295
Brent change, lag 1	0.364	0.073	[0.215, 0.513]	<0.001

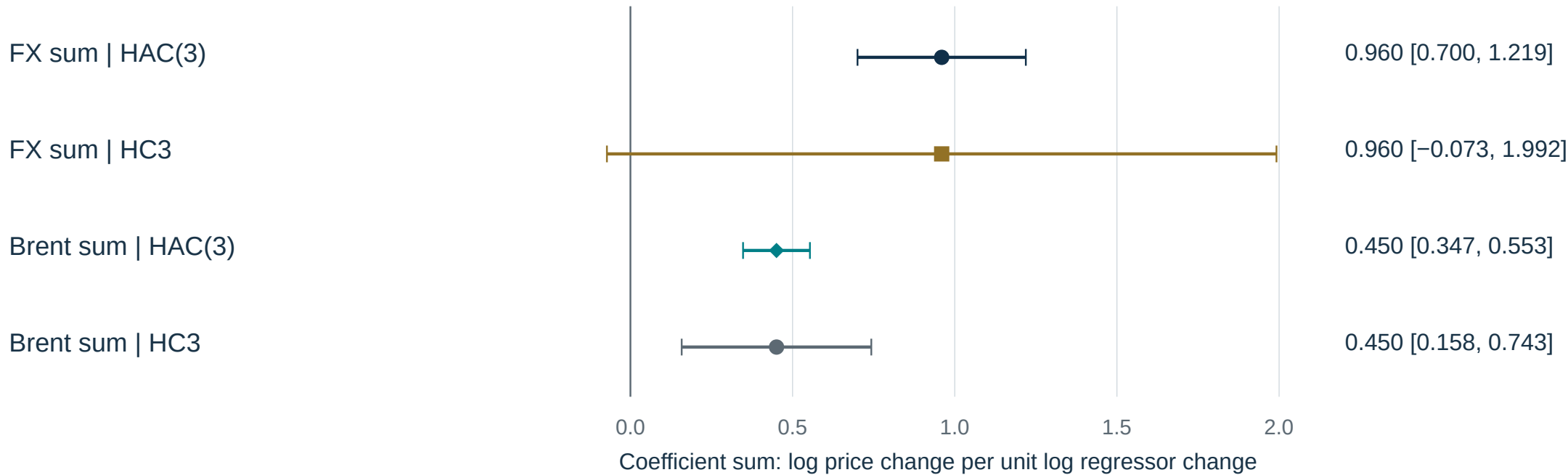
Sources: BoG: monthly FX; IMF/FRED: Brent; BoG: petrol; statsmodels documentation; IDER calculations. [\[S01\]](#) [\[S02\]](#) [\[S03\]](#) [\[S09\]](#) [\[S11\]](#)

Note: n=35; residual df=30; R²=0.781. Approximate t-based intervals do not address omitted variables, leverage fragility or transcription errors.

The FX confidence statement changes under leverage-adjusted inference

Sums of current and lag-1 coefficients; 95% approximate intervals.

Figure 10. The FX confidence statement changes under leverage-adjusted inference



Sources: BoG: monthly FX; IMF/FRED: Brent; BoG: petrol; statsmodels documentation; IDER calculations. [\[S01\]](#) [\[S02\]](#) [\[S03\]](#) [\[S09\]](#) [\[S11\]](#)

Note: HAC allows short serial dependence; HC3 adjusts for leverage but not serial dependence. Neither is a causal-identification remedy.

Lag structure matters more than a single headline elasticity

All estimates use observed data; specifications differ in timing and dynamic feedback.

Table 9. Lag structure matters more than a single headline elasticity

Specification	n	FX coefficient sum	Brent coefficient sum	R ²
F01 DL0	35	0.167	0.250	0.196
F02 DL1 primary	35	0.960	0.450	0.781
F03 DL2	35	0.754	0.389	0.796
F04 DL1 + AR1	34	0.972	0.477	0.801
F05 lag-only	35	0.820	0.350	0.790

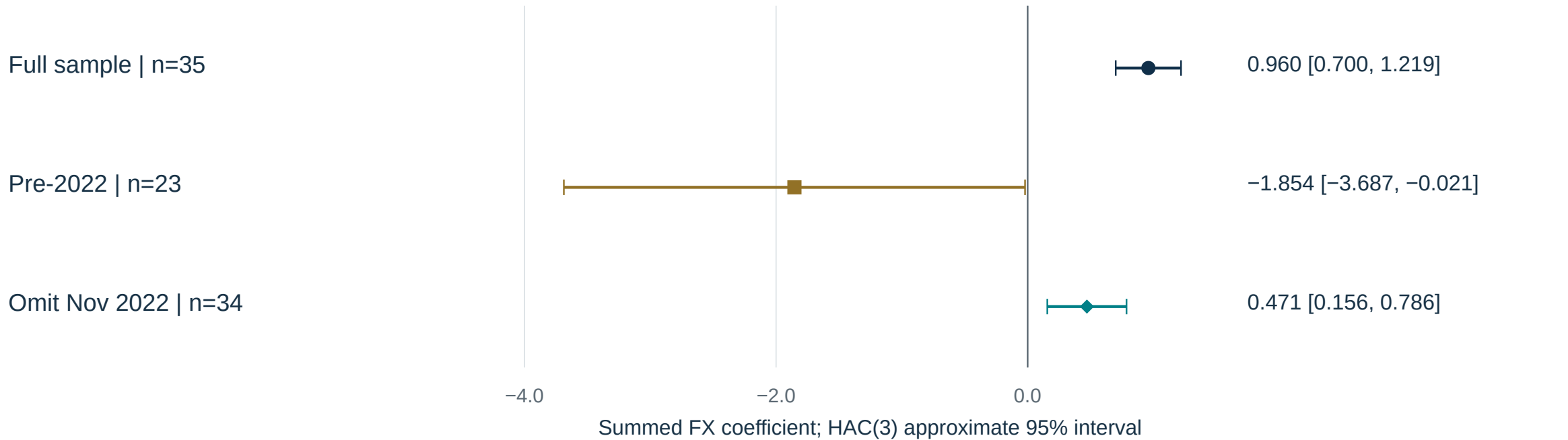
Sources: BoG: monthly FX; IMF/FRED: Brent; BoG: petrol; IDER calculations. [\[S01\]](#) [\[S02\]](#) [\[S03\]](#) [\[S11\]](#)

Note: For F04, sums cover direct regressor terms only; lagged petrol-price feedback is not included. These are not comparable long-run causal multipliers.

The pre-2022 estimate reverses sign; stability is not established

Same F02 regressor structure; selected historical windows and an influential-month diagnostic.

Figure 11. The pre-2022 estimate reverses sign; stability is not established



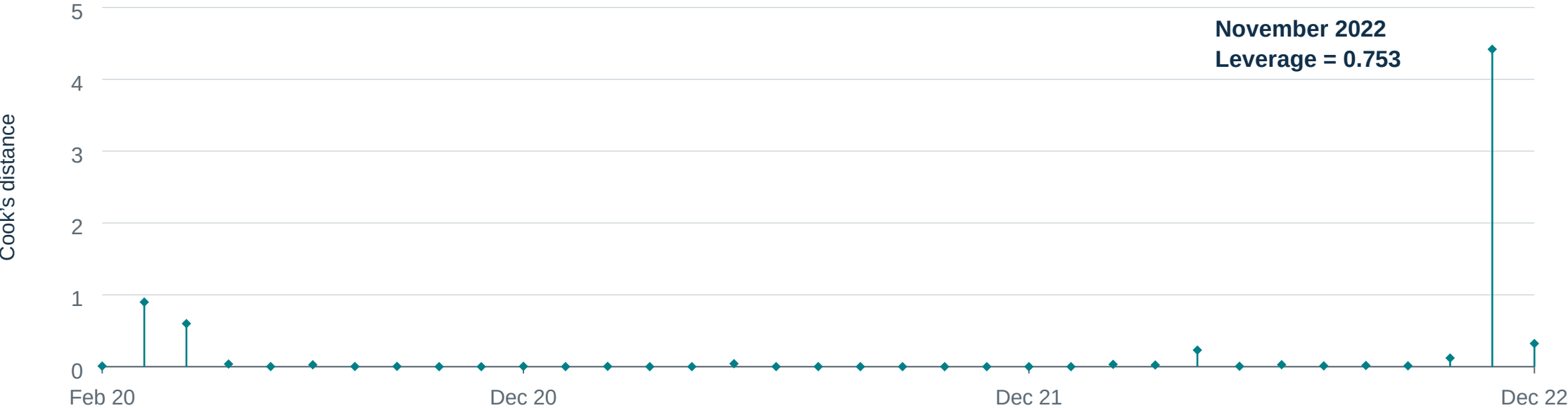
Sources: BoG: monthly FX; IMF/FRED: Brent; BoG: petrol; IDER calculations. [\[S01\]](#) [\[S02\]](#) [\[S03\]](#) [\[S11\]](#)

Note: Deleting November 2022 is a diagnostic, not a preferred replacement sample. The full set of observations remains in the main result.

One observation has unusually high leverage and influence

Cook’s distance for the F02 estimation sample; 35 monthly observations.

Figure 12. One observation has unusually high leverage and influence



Sources: BoG: monthly FX; IMF/FRED: Brent; BoG: petrol; IDER calculations. [\[S01\]](#) [\[S02\]](#) [\[S03\]](#) [\[S11\]](#)

Note: Influence is a diagnostic signal, not a licence to discard valid observations. Leave-one-out FX sums span 0.471–1.042.

Non-rejection of a diagnostic null does not validate causality

The main residual diagnostics are reported alongside substantive specification risks.

Table 10. Non-rejection of a diagnostic null does not validate causality

Check	Observed result	Interpretation
Residual serial correlation, lag 3	Ljung–Box p=0.234	Does not reject this diagnostic null; low power and specification dependence remain.
Heteroskedasticity	Breusch–Pagan p=0.383	Does not establish constant variance; leverage-sensitive HC3 inference is shown.
HAC bandwidth sensitivity	FX sum interval: HAC1 [0.659, 1.261]; HAC6 [0.719, 1.201]	Bandwidth variation does not address influential episodes or confounding.
Regressor support	FX log-change SD: 1.13 pp pre-2022; 16.73 pp in 2022	The episode comparison has sharply different variation and cannot establish structural invariance.

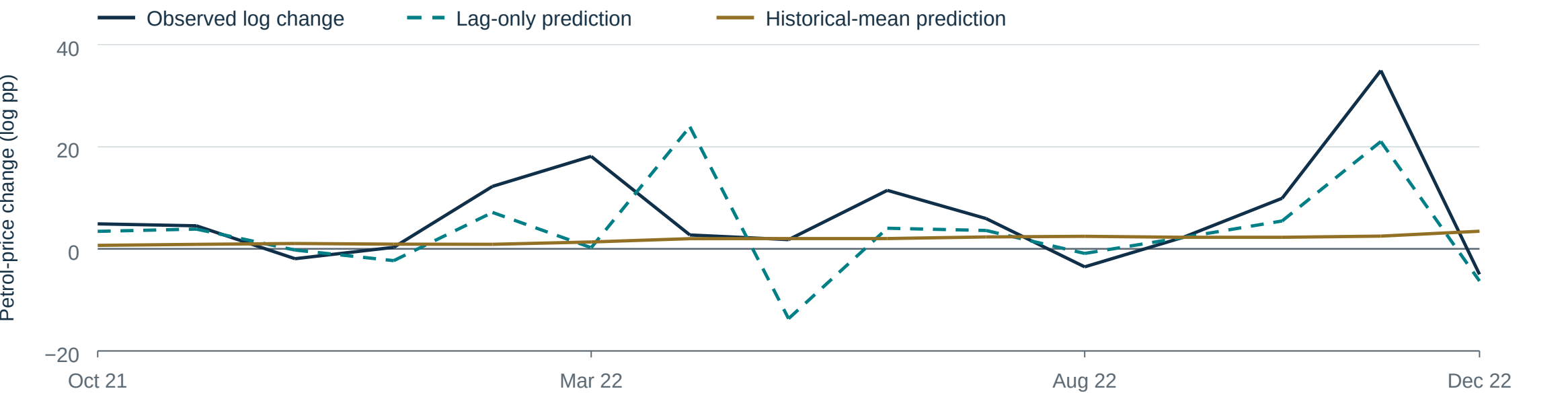
Sources: BoG: monthly FX; IMF/FRED: Brent; BoG: petrol; statsmodels documentation; IDER calculations. [\[S01\]](#) [\[S02\]](#) [\[S03\]](#) [\[S09\]](#) [\[S11\]](#)

Note: Diagnostics are descriptive specification checks. No test of source accuracy, instrument validity or a causal exclusion restriction is claimed.

A lag-only model is tested without using future observed prices

Fixed-vintage expanding-window exercise: 20 initial observations; 15 subsequent monthly outcomes.

Figure 13. A lag-only model is tested without using future observed prices



Sources: BoG: monthly FX; IMF/FRED: Brent; BoG: petrol; IDER calculations. [\[S01\]](#) [\[S02\]](#) [\[S03\]](#) [\[S11\]](#)

Note: This is pseudo-out-of-sample: historical data revisions and original publication lags are not reconstructed.

Smaller historical errors are not a guarantee of future forecast accuracy

Evaluation over the same 15 held-out monthly outcomes; loss measured in log percentage points.

Table 11. Smaller historical errors are not a guarantee of future forecast accuracy

Predictor	RMSE	MAE	Interpretation
Lag Only	9.41	6.54	Lagged FX/oil covariates only; not a current operational forecast.
Historical Mean	10.87	7.21	Mean fitted on the expanding training sample.
Zero Change	11.73	7.97	Fixed zero-change benchmark; no coefficient is fitted.

Sources: BoG: monthly FX; IMF/FRED: Brent; BoG: petrol; IDER calculations. [\[S01\]](#) [\[S02\]](#) [\[S03\]](#) [\[S11\]](#)

Note: With 15 dependent forecast errors, no formal claim of model dominance or stable out-of-sample superiority is made.

Statistical adjustment does not isolate an exchange-rate policy effect

The causal target must distinguish a currency shock from the events that generated it.

COMMON CAUSES

Global oil and dollar conditions, domestic price-setting rules, freight, demand, taxes and policy responses can affect both FX and fuel prices. Brent controls alone do not isolate these channels.

TIMING AND FEEDBACK

Month-end FX and indicative monthly prices may embed different timing. Firms and authorities react to expected costs. Lagged regressors reduce contemporaneous overlap, not necessarily endogeneity.

RELEASE BOUNDARY

The report releases conditional historical associations. It does not use gold prices, oil prices or lagged exchange rates as automatically valid instruments, and it does not claim a national causal pass-through rate.

Sources: Amiti et al. (2014); Gopinath et al. (2020); statsmodels documentation; IDER calculations. [\[S07\]](#) [\[S08\]](#) [\[S09\]](#) [\[S11\]](#)

Note: HAC, HC3, differencing and predictive validation address specific statistical concerns; none proves exogenous treatment assignment.

A firm-level causal extension needs exposure, timing and a comparison design

Prospective design only; no enterprise panel or valid external instrument was obtained for this edition.

Table 12. A firm-level causal extension needs exposure, timing and a comparison design

Requirement	Data / design	Release condition
Target outcome	Invoice input cost, export contribution margin, volume and dated cash shortfall	Specify currency, firm population, horizon and treatment increment.
Pre-shock exposure	Import content, invoice currency, export mix, debt maturity and hedge commitments	Use exposure measured before the shock; do not control away post-shock mediators.
Assignment / comparison	Product–firm panel, common shocks and defensible differential exposure or an external instrument	Assess parallel counterfactual paths or exclusion; placebo tests alone are insufficient.
Selection and attrition	Full eligible roster; failed, delayed, exited and non-reporting firms retained	Weight or impute only with defensible missingness and overlap; otherwise report bounds.

Source: IDER calculations. [\[S11\]](#)

Note: The six illustrative profiles below cannot replace representative enterprise microdata or support significance tests between business types.

The extension adds observations—not a new claim of causal identification

52 source-labelled monthly petrol levels; 49 common model outcomes after lag alignment.

Table 13. The extension adds observations—not a new claim of causal identification

Evidence layer	Completed verification	Remaining boundary
Original petrol inputs	36 levels: Jan 2020–Dec 2022. Preserved unchanged.	The original direct BoG HTML retrieval remains unavailable.
Additional published observations	12 months in 2019 and Jan–Apr 2023: Hesse et al. Table 1, PDF p.14.	A research-table reproduction attributed to BoG, not a newly downloaded raw official series.
Overlap reconciliation	All 36 overlapping values agree exactly with the retained CSV.	Agreement between copies is not an independent audit of original price collection.
Common comparison sample	Apr 2019–Apr 2023: 49 monthly outcomes for all five extended specifications.	Earlier observations supply lags. No gaps are interpolated; no duplicate month enters twice.

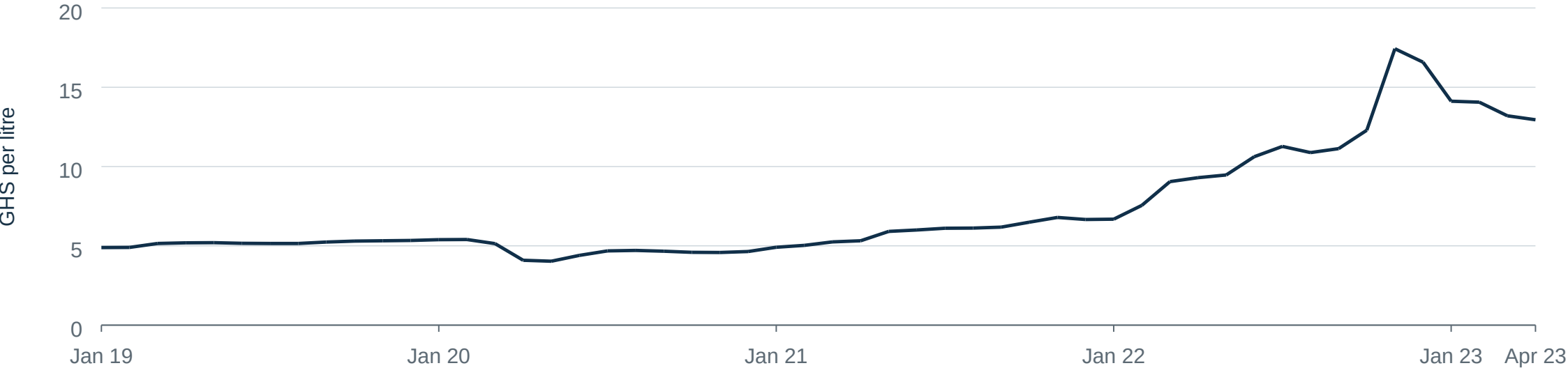
Sources: BoG: monthly FX; IMF/FRED: Brent; Hesse et al. (2026), Table 1; IDER calculations. [\[S01\]](#) [\[S02\]](#) [\[S12\]](#) [\[S11\]](#)

Note: Only the article’s displayed input observations are used. Its ARIMA model, pandemic attribution and reported causal estimates are not adopted.

The extended record includes the post-2022 price reversal

Indicative petrol price, January 2019–April 2023; published monthly observations.

Figure 14. The extended record includes the post-2022 price reversal



Sources: BoG: monthly FX; IMF/FRED: Brent; Hesse et al. (2026), Table 1; IDER calculations. [\[S01\]](#) [\[S02\]](#) [\[S12\]](#) [\[S11\]](#)

Note: The final four observations are January–April 2023—not a complete 2023 year. This is one aggregate fuel-price outcome, not a firm survey.

The common-window estimate is materially below the original estimate

X01-DL1: current and one lag of FX and Brent log changes; Bartlett HAC(3), small-sample scalar correction.

Table 14. The common-window estimate is materially below the original estimate

Regressor	Coefficient	HAC s.e.	95% interval	p-value
Intercept	0.007	0.005	[−0.003, 0.017]	0.179
FX change, current	0.147	0.031	[0.085, 0.209]	<0.001
FX change, lag 1	0.491	0.156	[0.177, 0.804]	0.003
Brent change, current	0.118	0.065	[−0.012, 0.248]	0.074
Brent change, lag 1	0.323	0.059	[0.204, 0.443]	<0.001

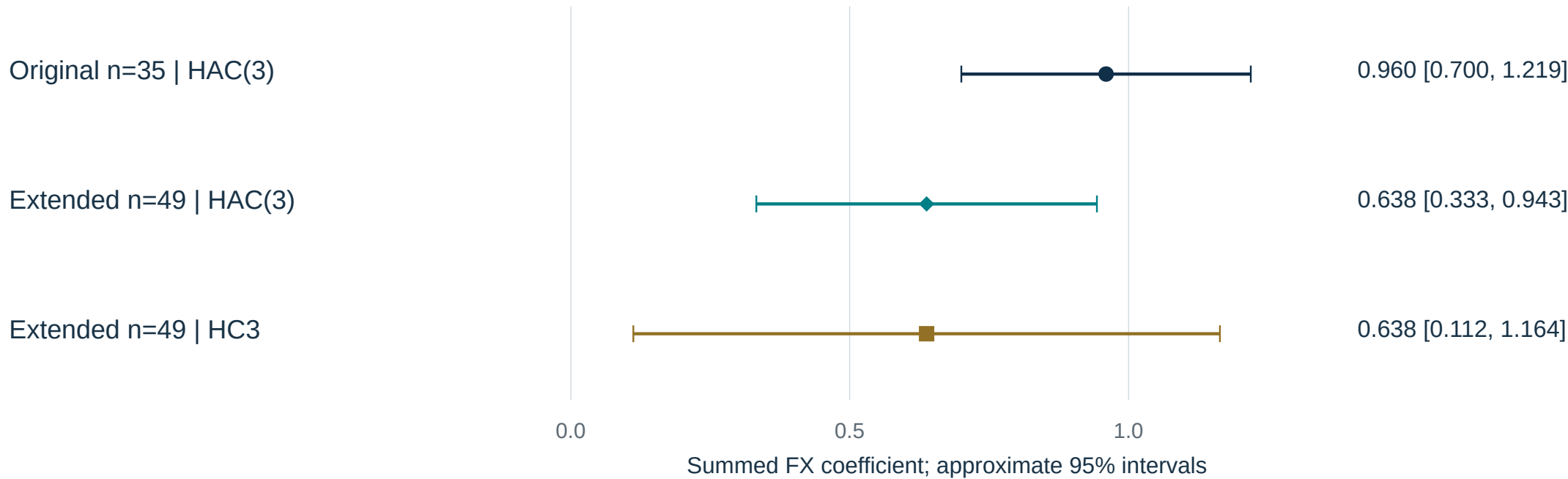
Sources: BoG: monthly FX; IMF/FRED: Brent; Hesse et al. (2026), Table 1; IDER calculations. [\[S01\]](#) [\[S02\]](#) [\[S12\]](#) [\[S11\]](#)

Note: n=49; residual df=44; R²=0.647. The t-based intervals are approximate; they exclude source-transcription and causal-identification uncertainty.

A positive extended association is not a stable universal pass-through rate

Current-plus-lag-1 FX coefficient; same units across two samples and two covariance choices.

Figure 15. A positive extended association is not a stable universal pass-through rate



Sources: BoG: monthly FX; IMF/FRED: Brent; Hesse et al. (2026), Table 1; IDER calculations; statsmodels documentation. [\[S01\]](#) [\[S02\]](#) [\[S12\]](#) [\[S11\]](#) [\[S09\]](#)

Note: HAC addresses short serial dependence; HC3 addresses leverage-sensitive heteroskedasticity. Neither removes unmeasured confounding.

Lag comparisons now hold the observation window constant

All five models use the same 49 monthly outcomes: April 2019–April 2023.

Table 15. Lag comparisons now hold the observation window constant

Specification	n	FX coefficient sum	Brent coefficient sum	R ²
DL0	49	0.039	0.247	0.134
DL1	49	0.638	0.442	0.647
DL2	49	0.955	0.416	0.703
DL1 AR1	49	0.717	0.419	0.675
lag-only	49	0.625	0.304	0.629

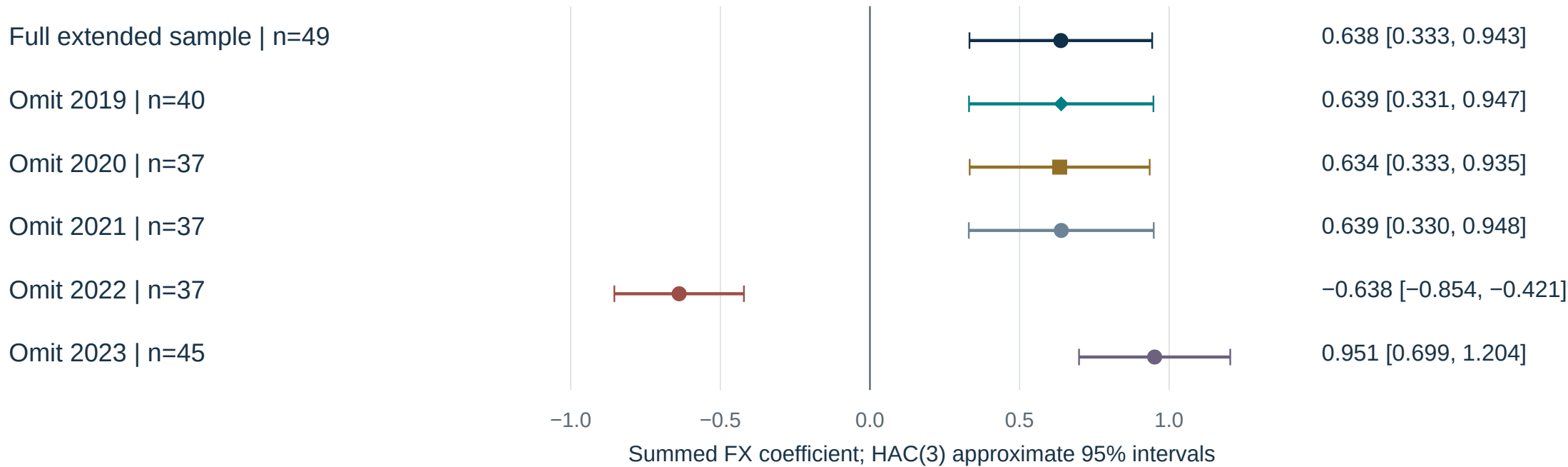
Sources: BoG: monthly FX; IMF/FRED: Brent; Hesse et al. (2026), Table 1; IDER calculations. [\[S01\]](#) [\[S02\]](#) [\[S12\]](#) [\[S11\]](#)

Note: The AR1 row reports direct coefficient sums only, not a total dynamic multiplier. These exploratory alternatives were not preregistered.

Removing 2022 reverses the extended FX coefficient

Whole-year exclusions use actual remaining calendar gaps in the HAC calculation.

Figure 16. Removing 2022 reverses the extended FX coefficient



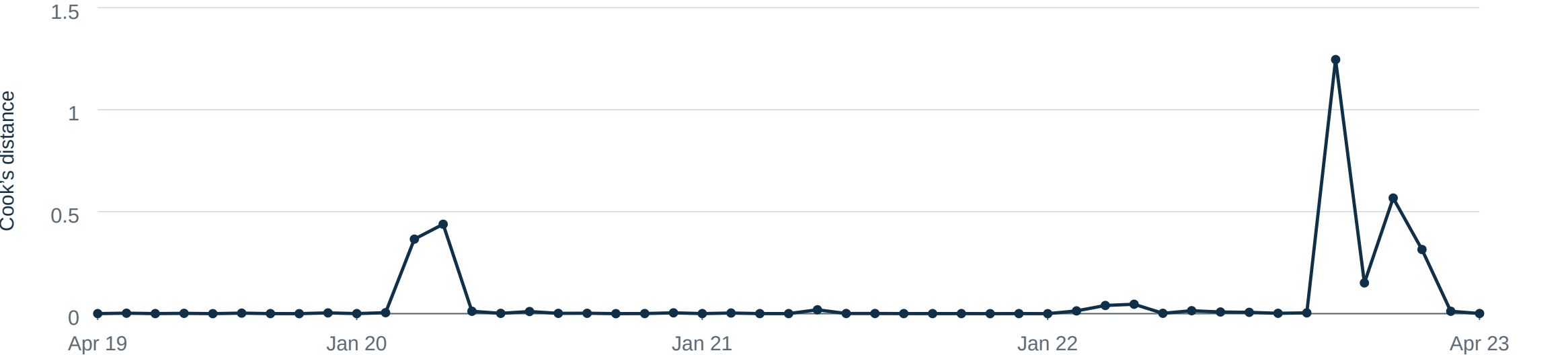
Sources: BoG: monthly FX; IMF/FRED: Brent; Hesse et al. (2026), Table 1; IDER calculations. [\[S01\]](#) [\[S02\]](#) [\[S12\]](#) [\[S11\]](#)

Note: All exclusions are sensitivity diagnostics, not preferred replacement samples. The 2023 comparison omits only four months; support differs across exclusions.

The largest-leverage month remains influential after extension

Cook’s distance across the 49-observation common sample.

Figure 17. The largest-leverage month remains influential after extension



Sources: BoG: monthly FX; IMF/FRED: Brent; Hesse et al. (2026), Table 1; IDER calculations. [\[S01\]](#) [\[S02\]](#) [\[S12\]](#) [\[S11\]](#)

Note: Largest leverage = 0.634. Leave-one-month-out FX sums range 0.428–0.744; deleting valid observations is not a method for selecting a preferred result.

The extended data expose additional specification risk

Report rejections and non-rejections together; a diagnostic pass is not a validity certificate.

Table 16. The extended data expose additional specification risk

Diagnostic	Extended result	Treatment and interpretation
Serial correlation: Breusch–Godfrey, 3 lags	p=0.026	Residual serial dependence is detected by this exploratory check. HAC bandwidth sensitivity is retained; this does not repair an incorrect mean model.
Heteroskedasticity: Breusch–Pagan	p=0.002	Constant error variance is rejected. Present both HAC and leverage-adjusted HC3 inference instead of homoskedastic intervals.
RESET squared fitted term, HC3	p=0.720	Non-rejection is not evidence that all omitted nonlinearities or common shocks are absent.
Influence and sample support	Leverage 0.634; Cook's D 1.246	Retain the full sample, report deletion and episode sensitivity, and avoid fixed-parameter national forecasts.

Sources: BoG: monthly FX; IMF/FRED: Brent; Hesse et al. (2026), Table 1; IDER calculations; statsmodels documentation. [\[S01\]](#) [\[S02\]](#) [\[S12\]](#) [\[S11\]](#) [\[S09\]](#)

Note: Diagnostic p-values are exploratory and not multiplicity-adjusted. BG/RESET assumptions and limited sample size constrain their interpretation.

Quantify how much omitted-variable association could move the coefficient

Point-estimate sensitivity after an exact reparameterisation of the current-plus-lag FX contrast.

Table 17. Quantify how much omitted-variable association could move the coefficient

Sample	FX sum	Partial R ² of target	Equal-strength R ² to zero
Legacy n35	0.960	63.9%	71.3%
Extended n49	0.638	38.4%	53.7%

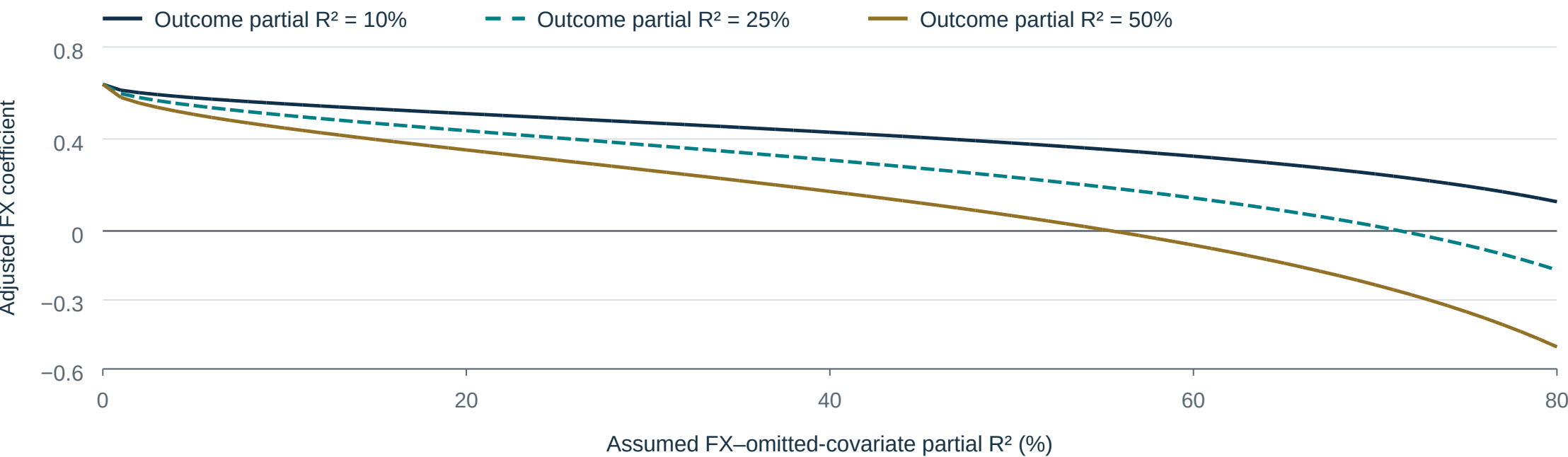
Sources: BoG: monthly FX; IMF/FRED: Brent; Hesse et al. (2026), Table 1; IDER calculations; Cinelli and Hazlett (2020). [\[S01\]](#) [\[S02\]](#) [\[S12\]](#) [\[S11\]](#) [\[S13\]](#)

Note: The two strength parameters concern an omitted covariate’s residual association with FX and petrol. This is a point-estimate tipping calculation—not a probability, p-value or proof of exogeneity.

The direction and strength of omitted associations matter

An adversarial omitted covariate moves the extended 0.638 coefficient towards and beyond zero.

Figure 18. The direction and strength of omitted associations matter



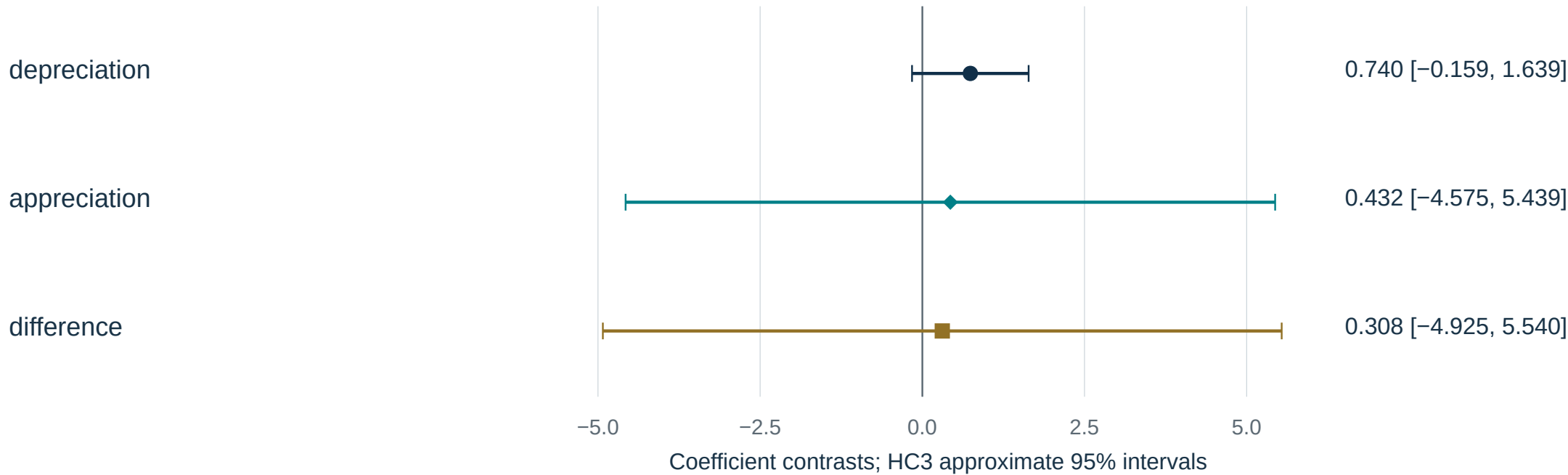
Sources: BoG: monthly FX; IMF/FRED: Brent; Hesse et al. (2026), Table 1; IDER calculations; Cinelli and Hazlett (2020). [\[S01\]](#) [\[S02\]](#) [\[S12\]](#) [\[S11\]](#) [\[S13\]](#)

Note: The curves impose confounding strengths; they do not estimate an omitted variable. OLS standard error is an algebraic scale here, not HAC/HC3 uncertainty.

Appreciation and depreciation effects are not separately pinned down

Signed FX increases and decreases enter separately at current and lag-1 horizons; 49 observations.

Figure 19. Appreciation and depreciation effects are not separately pinned down



Sources: BoG: monthly FX; IMF/FRED: Brent; Hesse et al. (2026), Table 1; IDER calculations. [\[S01\]](#) [\[S02\]](#) [\[S12\]](#) [\[S11\]](#)

Note: The difference test has HC3 $p=0.906$ (HAC $p=0.254$). Failure to reject symmetry is not proof of equal responses; the appreciation interval is very wide.

A future-FX term is a diagnostic—not an instrument

Add next-month FX change to the extended DL1 model; do not use this specification for advance prediction.

Table 18. A future-FX term is a diagnostic—not an instrument

Covariance	Lead coefficient	95% interval	p-value
HAC	−0.214	[−0.438, 0.010]	0.061
HC3	−0.214	[−0.930, 0.501]	0.549

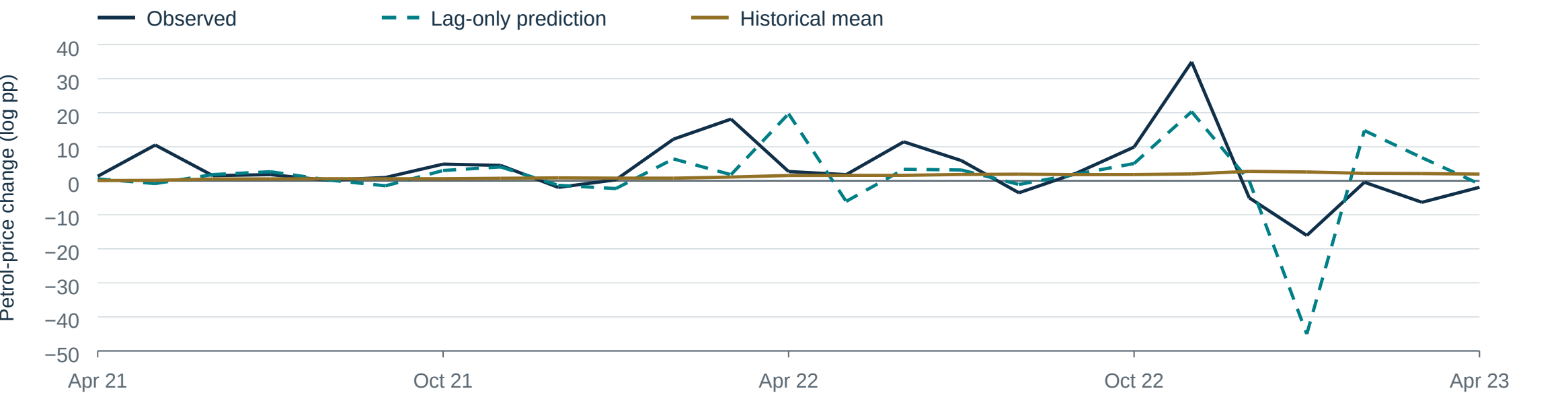
Sources: BoG: monthly FX; IMF/FRED: Brent; Hesse et al. (2026), Table 1; IDER calculations. [\[S01\]](#) [\[S02\]](#) [\[S12\]](#) [\[S11\]](#)

Note: A non-significant future term cannot verify no anticipation, reverse causation or omitted common causes. The source timing mismatch remains unresolved.

A longer held-out period tests the earlier predictive impression

Fixed lag-only model; 24 initial observations and 25 expanding-window test months, April 2021–April 2023.

Figure 20. A longer held-out period tests the earlier predictive impression



Sources: BoG: monthly FX; IMF/FRED: Brent; Hesse et al. (2026), Table 1; IDER calculations. [\[S01\]](#) [\[S02\]](#) [\[S12\]](#) [\[S11\]](#)

Note: Only lagged covariates enter the predictor. This remains a fixed-vintage retrospective exercise; publication lags and historical data revisions are not reconstructed.

The earlier error advantage does not persist across this evaluation

All predictors are assessed against the same 25 held-out outcomes; losses are log percentage points.

Table 19. The earlier error advantage does not persist across this evaluation

Predictor	Test months	RMSE	MAE
Lag Only	25	9.76	6.58
Historical Mean	25	9.74	6.33
Zero Change	25	9.97	6.42

Sources: BoG: monthly FX; IMF/FRED: Brent; Hesse et al. (2026), Table 1; IDER calculations. [\[S01\]](#) [\[S02\]](#) [\[S12\]](#) [\[S11\]](#)

Note: Lag-only RMSE 9.76 versus historical-mean 9.74 is a descriptive comparison, not a statistically significant ranking. The zero-change benchmark is fixed at zero, not fitted.

Different selection problems require different remedies

No single weighting or imputation procedure can make all of these data representative.

Table 20. Different selection problems require different remedies

Evidence layer	Selection / coverage risk	Implemented safeguard
Monthly price model	One indicative product series and an uneven crisis-era distribution of FX changes.	Publish all months and common windows; preserve outliers; show episode exclusions and support. Do not claim retail-station or enterprise representativeness.
Formal enterprise survey	Coverage excludes informal and sub-five-worker firms; detailed microdata and design weights were not obtained.	Retain published population definitions. No fabricated weights, standard errors, cost shares or national extrapolation.
Selected listed manufacturer	Issuer disclosure is purposively selected, not a random corporate sample.	Treat as a dated case study. Retain currency units and source discrepancies; do not use it as a population average.
Six business profiles	Parameters are assumed; no observation probabilities or firm weights exist.	Report conditional model results and parameter-grid ranges. Do not report standard errors or national loss totals for the archetypes.

Sources: BoG: petrol; World Bank ES; Guinness FY2025 / GSE; IDER calculations; Hesse et al. (2026), Table 1. [\[S03\]](#) [\[S04\]](#) [\[S06\]](#) [\[S11\]](#) [\[S12\]](#)

Note: More rows or a stronger-looking p-value do not resolve endogenous exposure, sample selection or missing reporting universes.

The stronger evidence is a more qualified business conclusion

The extension is deliberately not a search for a preferred significant coefficient.

WHAT THE DATA ADD	WHAT IS NOW QUANTIFIED	WHAT IS NOT IDENTIFIED
The common-window FX association is positive, but the estimate changes with lag structure and the 2022 episode. Expanded predictive validation does not support a stable advantage over a simple historical mean.	Episode sensitivity, leverage, residual specification risk and omitted-variable tipping strengths are reported. The added observations and all comparison samples have explicit source and date records.	The analysis still does not isolate a policy-driven FX shock or estimate heterogeneous causal profit effects across Ghanaian firms. The corporate model therefore uses disclosed assumptions—not the fuel coefficient as a calibration.

Sources: BoG: monthly FX; IMF/FRED: Brent; Hesse et al. (2026), Table 1; IDER calculations. [\[S01\]](#) [\[S02\]](#) [\[S12\]](#) [\[S11\]](#)

Note: The original n=35 results remain in the report for comparison. The 49-month extension is separately source-labelled and cannot validate the authors’ causal attribution.

Operating exposure, financing exposure and valuation are distinct

Each model starts from annual baseline revenue of 100 and an explicitly defined cost and funding structure.

OPERATING PROFIT

Revenue minus imported inputs, local variable costs and fixed operating costs. Export and import flows are converted once. Fixed and adaptive cases answer different questions.

FINANCING AND CASH

FX interest and principal are deducted from a separate cash proxy. Incremental working capital is a transition funding need. Taxes, capital expenditure and unrestricted opening cash are outside that proxy.

BALANCE-SHEET VALUE

The translated FX debt stock changes with the exchange rate even before repayment. This stock revaluation must not be added again as a second cash outflow when the same principal is settled.

Source: IDER calculations. [\[S11\]](#)

Note: Model operating costs are treated as cash expenses; no depreciation is modelled. No full statutory profit, cash-flow statement or default probability is reconstructed.

Six business types are modelled—not sampled or population-weighted

Annual baseline revenue = 100; all costs are GHS per 100 baseline revenue.

Table 21. Six business types are modelled—not sampled or population-weighted

Profile	FX sales (%)	Imported cost	Local variable	Fixed cost	Operating profit
A Import distributor	0	70	10	10	10
B Import-intensive manufacturer	10	50	25	10	15
C Local-input producer	5	15	55	15	15
D Low-import exporter	90	15	50	15	20
E Import-intensive exporter	90	55	20	10	15
F Domestic-service FX borrower	5	10	50	20	20

Source: IDER calculations. [\[S11\]](#)

Note: Illustrative parameters are not estimated from the enterprise survey. The profiles are analytical archetypes, not average Ghanaian businesses.

Repricing, competition and local-cost feedback are imposed explicitly

Elasticities apply to normalised GHS/USD; export USD prices and export quantities remain fixed in the central cases.

Table 22. Repricing, competition and local-cost feedback are imposed explicitly

Profile	Own domestic price α	Competitor price γ	Relative-demand η	Local cost φ	Fixed cost ψ
A	0.70	0.90	1.20	0.10	0.10
B	0.50	0.90	1.00	0.15	0.15
C	0.20	0.90	0.80	0.15	0.10
D	0.20	0.50	0.60	0.10	0.10
E	0.20	0.50	0.60	0.10	0.10
F	0.10	0.20	0.50	0.10	0.10

Source: IDER calculations. [\[S11\]](#)

Note: These are assumed elasticities, not fitted coefficients. Positive relative demand requires capacity and customer substitution; aggregate demand is tested separately.

Funding exposure is measured independently of imported operating inputs

Annual baseline revenue = 100; day counts are fixed planning assumptions.

Table 23. Funding exposure is measured independently of imported operating inputs

Profile	Receivable days	Inventory days	Import payable days	FX debt stock	FX interest / principal
A	30	45	30	20	2.0 / 5.0
B	45	60	30	25	2.5 / 5.0
C	30	45	15	10	1.0 / 3.0
D	60	45	30	20	2.0 / 5.0
E	60	60	30	30	3.0 / 6.0
F	45	15	15	80	8.0 / 8.0

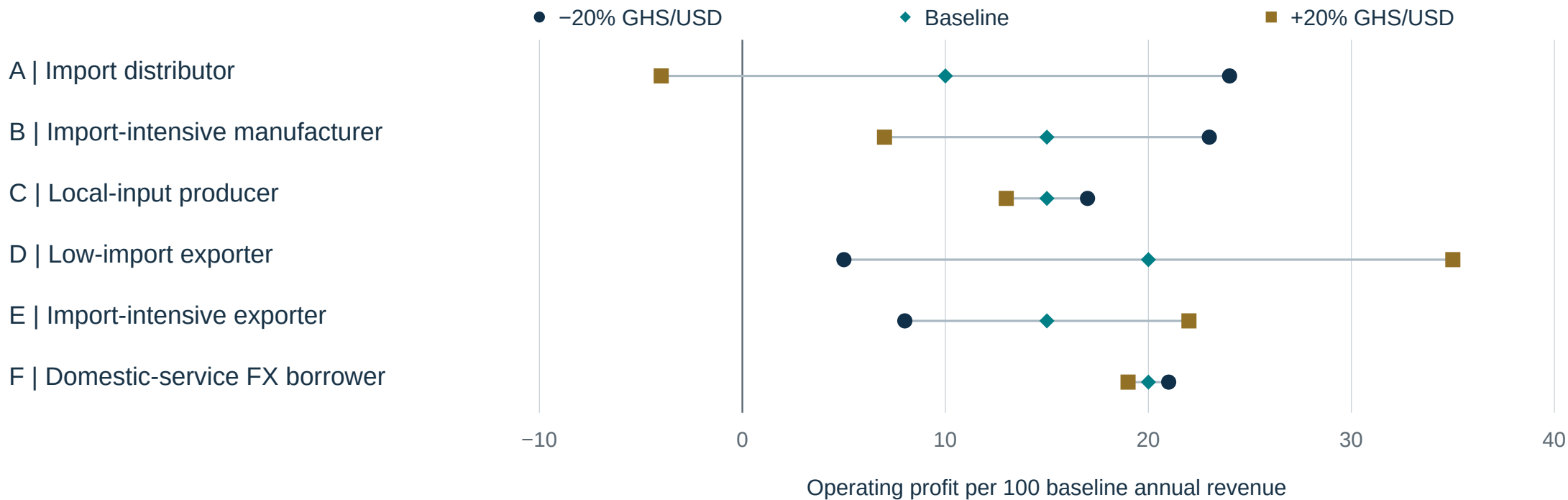
Source: IDER calculations. [\[S11\]](#)

Note: The NWC proxy uses annual revenue, variable production cost and import payables on a 365-day convention; actual timing requires an invoice ledger.

The same FX change shifts operating profit in opposite directions

Fixed quantities, domestic prices and local costs; only FX-converted sales and inputs change.

Figure 21. The same FX change shifts operating profit in opposite directions



Source: IDER calculations. [\[S11\]](#)

Note: Levels are normalised operating profit, not percent changes or measured Ghana firm outcomes.

Net operating FX exposure determines the immediate arithmetic

Seven imposed FX movements; no repricing, volume or local-cost response.

Figure 22. Net operating FX exposure determines the immediate arithmetic

	-30%	-20%	-10%	0%	+10%	+20%	+30%
A Import distributor	31.0	24.0	17.0	10.0	3.0	-4.0	-11.0
B Import-intensive manufacturer	27.0	23.0	19.0	15.0	11.0	7.0	3.0
C Local-input producer	18.0	17.0	16.0	15.0	14.0	13.0	12.0
D Low-import exporter	-2.5	5.0	12.5	20.0	27.5	35.0	42.5
E Import-intensive exporter	4.5	8.0	11.5	15.0	18.5	22.0	25.5
F Domestic-service FX borrower	21.5	21.0	20.5	20.0	19.5	19.0	18.5

Operating profit per 100 baseline revenue

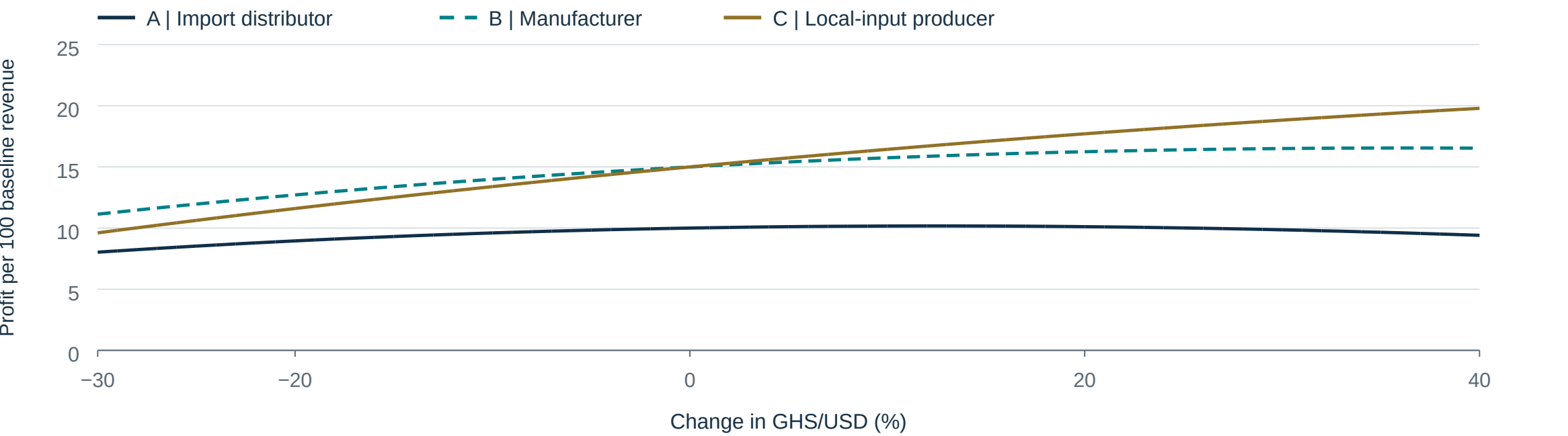
Source: IDER calculations. [\[S11\]](#)

Note: Read each row against its own baseline. Colour distinguishes positive/negative profit; it is not a business rating or a scenario probability.

Repricing can offset input pressure—but the model assumptions do the work

Conditional responses of prices, competitor prices, domestic quantities and local costs.

Figure 23. Repricing can offset input pressure—but the model assumptions do the work



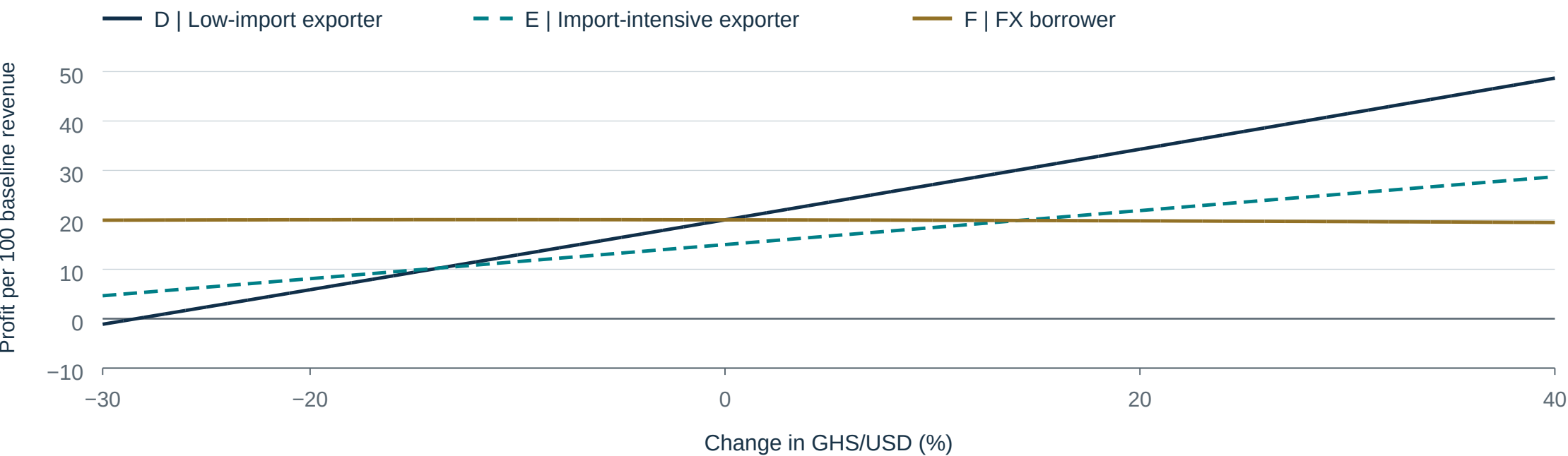
Source: IDER calculations. [\[S11\]](#)

Note: Export quantities and USD prices are fixed. The curves do not include capacity limits, credit rationing or a general-equilibrium demand response.

Export receipts and operating inputs create different profit sensitivities

Conditional responses of prices, competitor prices, domestic quantities and local costs.

Figure 24. Export receipts and operating inputs create different profit sensitivities



Source: IDER calculations. [\[S11\]](#)

Note: Export quantities and USD prices are fixed. The curves do not include capacity limits, credit rationing or a general-equilibrium demand response.

Stable profit does not imply a stable profit margin

Adaptive model at +20% GHS/USD; each row is compared with its own baseline.

Table 24. Stable profit does not imply a stable profit margin

Profile	Baseline profit	Scenario profit	Baseline margin (%)	Scenario margin (%)
A Import distributor	10.00	10.11	10.00	8.52
B Import-intensive manufacturer	15.00	16.24	15.00	13.76
C Local-input producer	15.00	17.71	15.00	15.38
D Low-import exporter	20.00	34.29	20.00	28.88
E Import-intensive exporter	15.00	21.88	15.00	18.43
F Domestic-service FX borrower	20.00	19.80	20.00	19.10

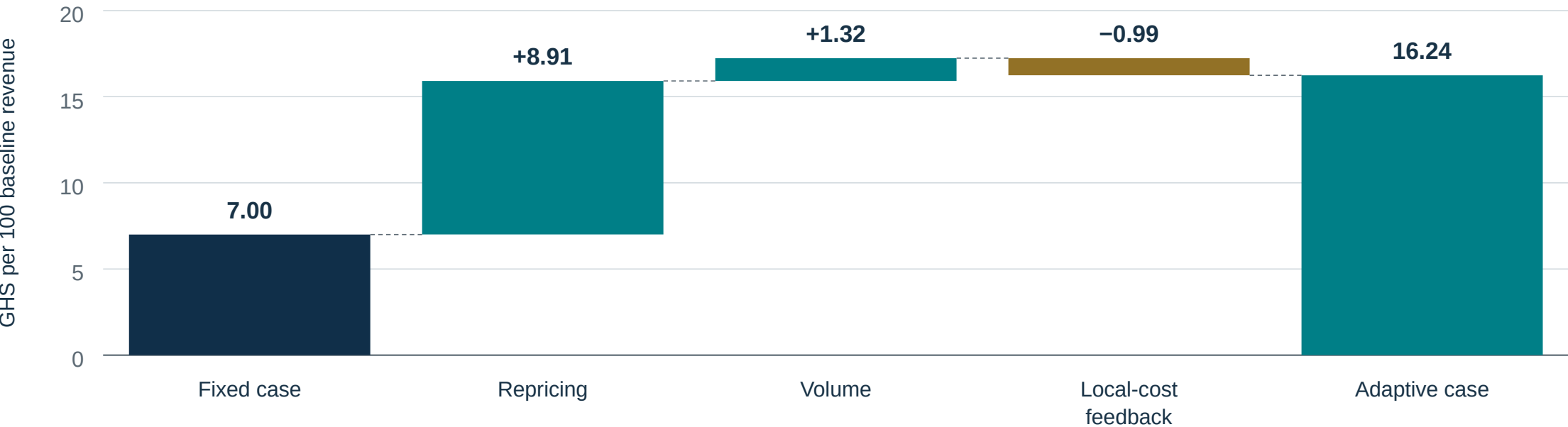
Source: IDER calculations. [\[S11\]](#)

Note: For importer A, profit rises slightly while the margin falls from 10.00% to 8.52%, because revenue and variable-cost bases both increase.

The manufacturer’s adaptive gain can be traced to three channels

Shapley allocation averages all six orderings of price, volume and local-cost changes.

Figure 25. The manufacturer’s adaptive gain can be traced to three channels



Source: IDER calculations. [\[S11\]](#)

Note: This is order-independent accounting within the declared model—not identified causal contributions in Ghana.

The importer's central vulnerability is a repricing-and-cash mismatch

Illustrative importer: no export sales; imported cost 70; local variable and fixed costs 10 each.

NO REPRICING

At +20% GHS/USD, imported cost rises from 70 to 84. Operating profit falls from 10 to -4. Holding the original profit at fixed quantity requires a 14% domestic price increase.

ASSUMED ADAPTATION

The model's own-price elasticity is 0.70 and competitor-price elasticity 0.90. Relative demand increases under the assumed capacity and substitution conditions. Operating profit is 10.11, but margin is 8.52%.

FUNDING CONSEQUENCE

FX service and incremental NWC absorb the operating buffer. The transition cash proxy is -0.63 before tax and capital expenditure. Quote validity, repricing dates and cash-facility headroom matter together.

Source: IDER calculations. [\[S11\]](#)

Note: These calculations are not a forecast for a named importer. Reduced customer demand or tighter trade credit can materially worsen the result.

A manufacturer may recover profit while still needing additional finance

Illustrative profile B: 10% FX sales, imported cost 50, local variable cost 25 and fixed cost 10.

COST AND SALES EXPOSURE The fixed-case net operating FX exposure is –40 per 100 revenue. A +20% GHS/USD movement reduces operating profit from 15 to 7 before repricing or demand adjustment.	PRICE AND VOLUME RESPONSE With the stated adaptive assumptions, operating profit is 16.24. The Shapley bridge allocates +8.91 to repricing, +1.32 to volume and –0.99 to local-cost feedback.	CASH AND COMPETITIVENESS Incremental NWC is 3.78. The transition cash proxy is 3.46, not the 16.24 operating profit. Supplier terms, energy intensity, imported packaging and spare parts need separate records.
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Source: IDER calculations. [\[S11\]](#)

Note: No sector-wide capacity, credit availability or wage response has been estimated. The central case is conditional on the declared parameters.

Import competition gains can be offset by local-supplier cost feedback

Local-input producer C at +20% GHS/USD; vary demand responsiveness and local variable-cost elasticity.

Figure 26. Import competition gains can be offset by local-supplier cost feedback

	$\eta = 0.0$	$\eta = 0.4$	$\eta = 0.8$	$\eta = 1.2$	$\eta = 1.6$
Local-cost $\varphi = 0.0$	16.3	17.8	19.4	21.1	22.9
Local-cost $\varphi = 0.1$	15.2	16.7	18.3	19.9	21.6
Local-cost $\varphi = 0.2$	14.2	15.6	17.1	18.7	20.4
Local-cost $\varphi = 0.3$	13.2	14.5	16.0	17.5	19.1
Local-cost $\varphi = 0.4$	12.1	13.4	14.8	16.3	17.8

Operating profit per 100 baseline revenue; larger η means stronger relative-price substitution

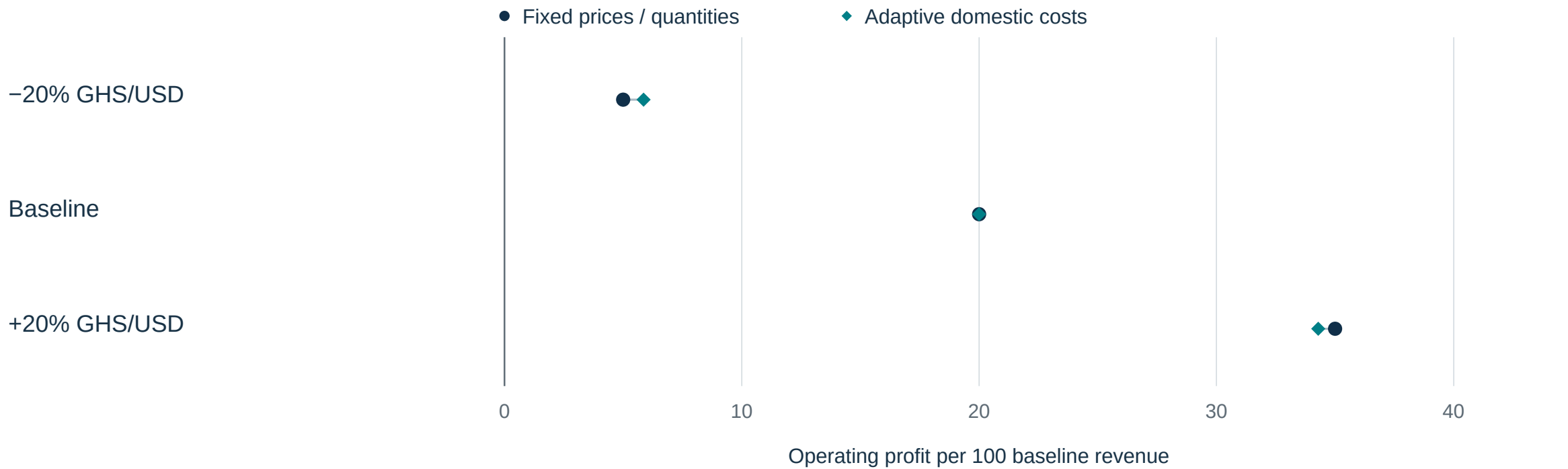
Source: IDER calculations. [\[S11\]](#)

Note: Baseline profit is 15.00. The grid is a sensitivity exercise, not a confidence region or a population distribution.

An exporter’s local-currency margin can contract during appreciation

Profile D: FX sales 90; imported cost 15; baseline operating profit 20.

Figure 27. An exporter’s local-currency margin can contract during appreciation



Source: IDER calculations. [\[S11\]](#)

Note: Foreign-currency export prices and quantities are held fixed. No automatic volume gain from depreciation is assumed.

A weaker cedi does not guarantee a stronger export margin

Profile E at +20% GHS/USD; independently vary foreign supplier and export unit prices.

Figure 28. A weaker cedi does not guarantee a stronger export margin

	Export price -20%	Export price +0%	Export price +20%
USD input price -20%	13.5	35.1	56.7
USD input price +0%	0.3	21.9	43.5
USD input price +20%	-13.0	8.6	30.2

Operating profit per 100 baseline revenue; baseline before all shocks = 15.00

Source: IDER calculations. [\[S11\]](#)

Note: At each grid point, the FX-driven quantity index is held at its central +20% value. Commodity-price shocks are imposed jointly, not causally attributed to FX.

Low imported-input use does not imply low foreign-currency risk

Profile F earns only 5% of sales in FX but has an FX debt stock of 80 per 100 baseline revenue.

Table 25. Low imported-input use does not imply low foreign-currency risk

Adaptive-model metric	–20% GHS/USD	Baseline	+20% GHS/USD
Operating profit	20.02	20.00	19.80
FX interest + principal due	12.80	16.00	19.20
Translated FX debt stock	64.00	80.00	96.00
Post-service cash proxy	7.22	4.00	0.60
Transition cash proxy after Δ NWC	7.79	4.00	0.09

Source: IDER calculations. [\[S11\]](#)

Note: The translated debt stock is not added as another cash outflow. Interest and due principal are already deducted once.

Required price adjustment is a break-even condition—not a forecast

Domestic price change needed to preserve baseline operating profit at fixed quantities and local costs.

Table 26. Required price adjustment is a break-even condition—not a forecast

Profile	FX +10%	FX +20%	FX +30%
A Import distributor	7.00%	14.00%	21.00%
B Import-intensive manufacturer	4.44%	8.89%	13.33%
C Local-input producer	1.05%	2.11%	3.16%

Source: IDER calculations. [\[S11\]](#)

Note: Export revenue also adjusts in B and C. Demand losses, competitor pricing, taxes and credit constraints are excluded from this fixed-quantity threshold.

A break-even exchange rate is conditional on the operating model

Exact fixed-price profit boundary; all other costs and quantities are held constant.

Table 27. A break-even exchange rate is conditional on the operating model

Profile	Boundary: GHS/USD move	Inside central –30% to +30% grid?	Interpretation
A Import distributor	+14.29%	Yes	Profit reaches zero without repricing.
B Import-intensive manufacturer	+37.50%	No	Extrapolated static boundary, not a planning forecast.
D Low-import exporter	–26.67%	Yes	Appreciation compresses the assumed net export contribution.
E Import-intensive exporter	–42.86%	No	Extrapolated static boundary; strong assumptions dominate.

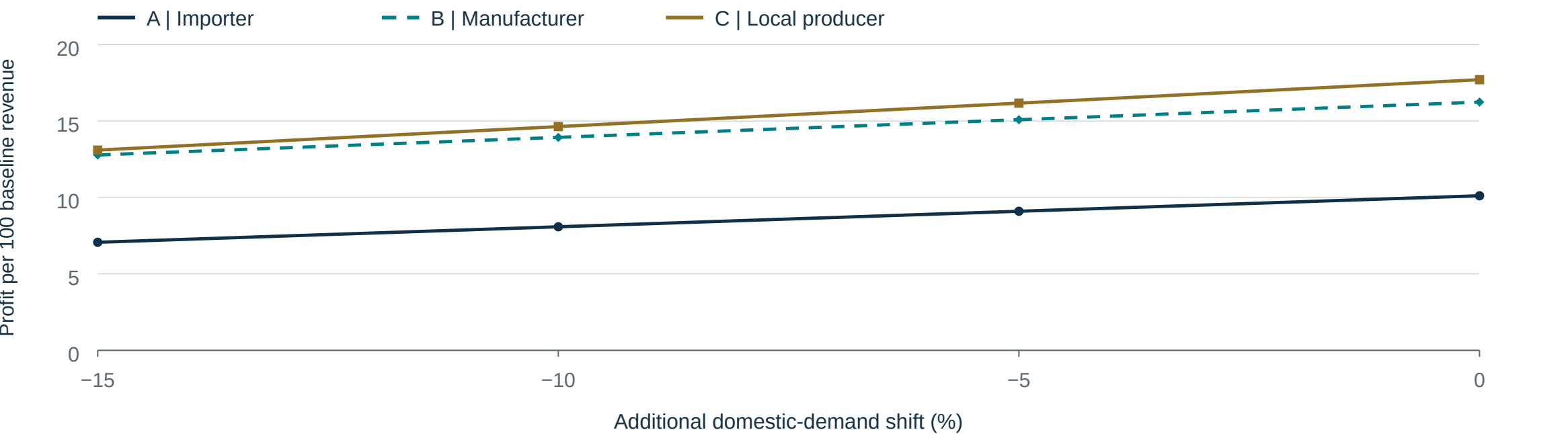
Source: IDER calculations. [\[S11\]](#)

Note: Profiles C and F have much more distant static operating-profit boundaries; cash-service constraints can bind long before operating profit reaches zero.

Relative-price substitution does not protect against all demand shocks

Adaptive +20% FX case plus an independently imposed domestic-demand contraction.

Figure 29. Relative-price substitution does not protect against all demand shocks



Source: IDER calculations. [\[S11\]](#)

Note: Export volume remains fixed. The additional demand shock is not estimated or attributed to the exchange-rate movement.

Local procurement can still contain imported costs

The legal residence of the supplier does not identify the currency sensitivity of the input.

DIRECT EXPOSURE

Trace imported ingredients, packaging, fuel, equipment, spare parts and foreign technical services. Separate transaction currency from origin country and distinguish committed from forecast purchases.

INDIRECT EXPOSURE

A local supplier may import its feedstock or face FX-linked transport and equipment costs. Supplier-specific cost shares or input–output links are needed; blanket “local content” assumptions can miss these channels.

MEASUREMENT RULE

Avoid adding direct and indirect import content twice. The current model imposes local-cost feedback elasticities as sensitivity parameters, rather than presenting an unobserved national input–output matrix.

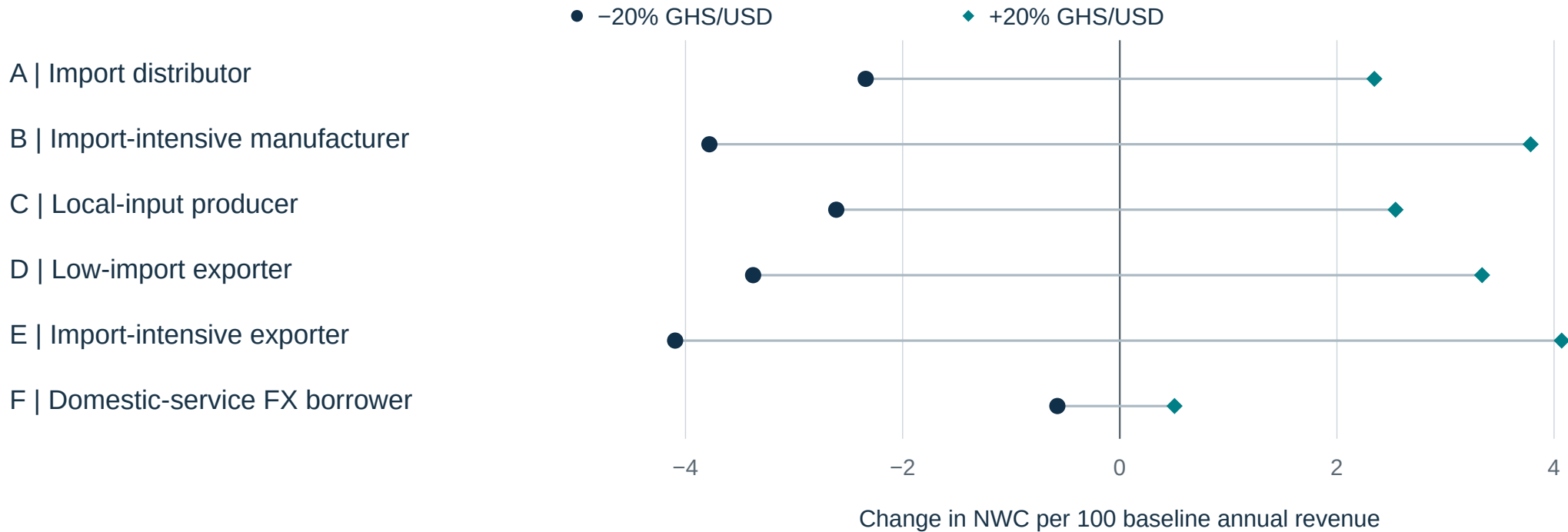
Sources: Amiti et al. (2014); IDER calculations. [\[S07\]](#) [\[S11\]](#)

Note: The sensitivity parameters are not estimates of local inflation, wage indexation or upstream pass-through in Ghana.

The funding requirement can rise even when profit is protected

Adaptive case: change in the NWC proxy relative to each profile’s baseline.

Figure 30. The funding requirement can rise even when profit is protected



Source: IDER calculations. [\[S11\]](#)

Note: NWC uses constant turnover-day assumptions. Positive values are additional funding needs, not operating expenses or realised losses.

Operating profit is only the first line in a financing decision

Adaptive +20% GHS/USD; amounts per 100 baseline annual revenue.

Table 28. Operating profit is only the first line in a financing decision

Profile	Operating profit	FX service	Incremental NWC	Transition cash proxy
A	10.11	8.40	2.35	-0.63
B	16.24	9.00	3.78	3.46
C	17.71	4.80	2.54	10.37
D	34.29	8.40	3.34	22.55
E	21.88	10.80	4.07	7.01
F	19.80	19.20	0.50	0.09

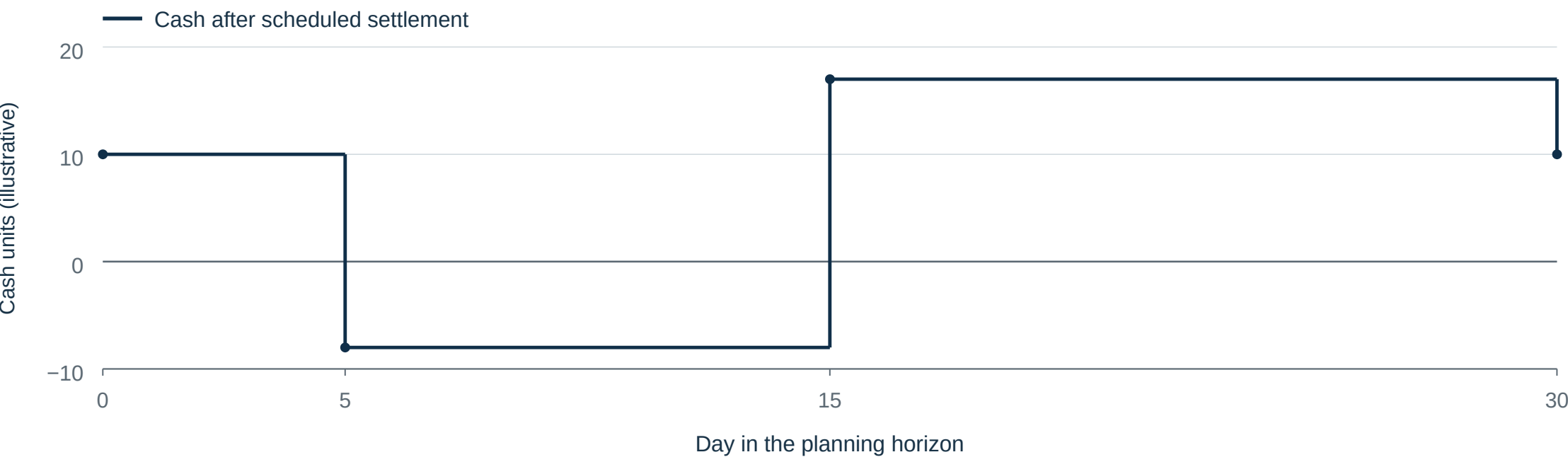
Source: IDER calculations. [\[S11\]](#)

Note: Transition cash = operating profit – FX service – ΔNWC, calculated before rounding. Tax, capex, opening cash and other financing are outside this proxy.

A positive closing balance can conceal an earlier payment gap

Synthetic cash schedule: opening 10; day-5 payment 18; day-15 receipt 25; day-30 payment 7.

Figure 31. A positive closing balance can conceal an earlier payment gap



Source: IDER calculations. [\[S11\]](#)

Note: Negative balances denote an unmet payment in this no-overdraft example; they are not authorised financing.

Historical-cost profit and replacement-cost funding can diverge

An appreciation or depreciation affects existing stock, replacement purchases and unpaid supplier invoices differently.

STOCK ALREADY PAID

Inventory purchased earlier may still enter reported cost at its historical basis. A new spot rate does not automatically change the cash already spent. Selling prices may nevertheless respond to current competitors.

STOCK NOT YET PAID

An unpaid foreign-currency invoice carries monetary exposure until settlement. The purchase, payable and payment need linked identifiers so that the same FX effect is not counted twice.

REPLACEMENT ORDER

At fixed USD cost, a 20% GHS/USD rise makes an imported replacement order of 70 cost 84. Even a profitable sale of old stock may fail to fund the next order without repricing or additional finance.

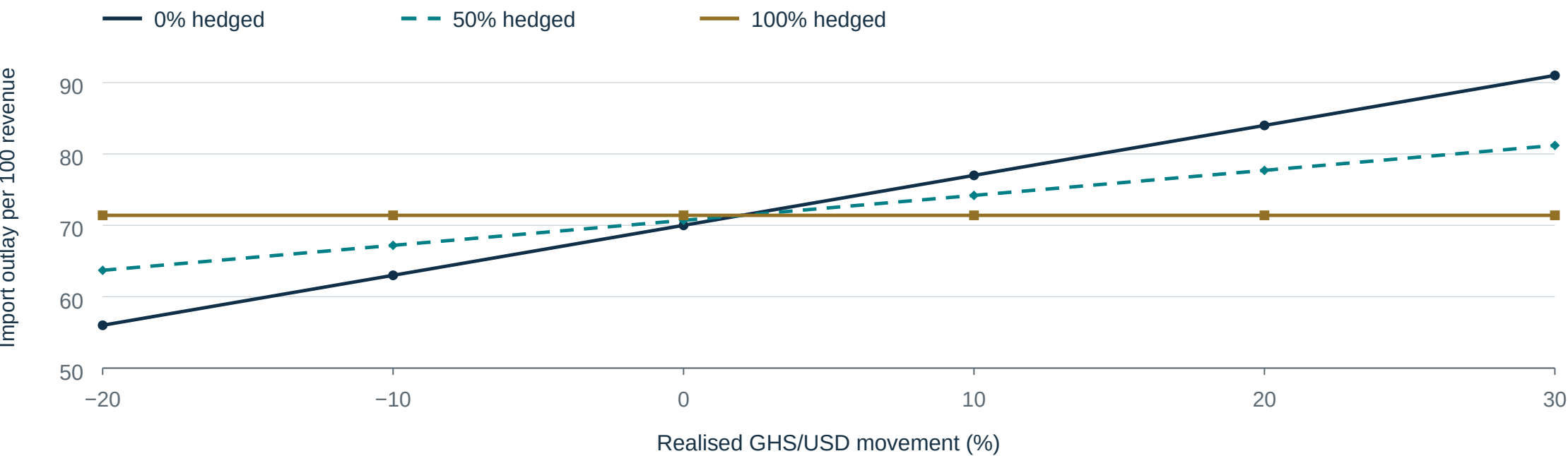
Source: IDER calculations. [\[S11\]](#)

Note: The example illustrates economic cash exposure. It is not a substitute for the entity's applicable accounting policy or inventory valuation requirements.

A forward changes the cash exposure—but has a cost and a quantity limit

Fixed importer-A input basket; assumed forward rate = 1.02 × opening spot.

Figure 32. A forward changes the cash exposure—but has a cost and a quantity limit



Source: IDER calculations. [\[S11\]](#)

Note: The 2% premium is illustrative, not a market quote. The hedge has no assumed margin calls, fees, credit limit or default.

A hedge is only as reliable as its currency, amount and date match

Currency receipts are not automatically available when a liability falls due.

NATURAL MATCH

Offset documented export receipts against operating payments in the same currency and value-date bucket. Netting a euro receivable against a dollar payable still leaves conversion and basis risk.

CONTRACT MATCH

Separate committed exposures from uncertain forecasts. A cancelled import order can leave a forward outstanding. A hedge of a variable quantity can become an unintended speculative position.

LIQUIDITY MATCH

Confirm settlement conditions, collateral calls, credit lines and counterparty capacity. A favourable mark-to-market value does not guarantee that cash is available before an invoice must be paid.

Sources: Gopinath et al. (2020); IDER calculations. [\[S08\]](#) [\[S11\]](#)

Note: Instrument choice, suitability and contractual treatment require the firm's authorised treasury and professional advisers; no universal hedge ratio is recommended.

A listed producer can hold cash and still have net FX payables

Guinness Ghana FY2025 disclosure, as at 30 June 2025; transaction-currency thousands.

Table 29. A listed producer can hold cash and still have net FX payables

Currency	Bank balances	Trade payables	Related-party payables	Net monetary exposure
EUR	2,196	−3,380	−1,779	−2,963
USD	6,223	−2,280	−9,997	−6,054
GBP	961	−254	−16,677	−15,970

Source: Guinness FY2025 / GSE. [\[S06\]](#)

Note: Amounts in different currencies must not be summed without conversion. This selected issuer is not a representative sample of Ghanaian producers.

Published sensitivity amounts need a reproducible reconciliation

Same issuer note: stated $\pm 7.5\%$ currency sensitivity versus a mechanical check of displayed inputs.

Table 30. Published sensitivity amounts need a reproducible reconciliation

Currency	Reported absolute sensitivity	Net $\times$ closing rate $\times$ 7.5%	Unreconciled difference
EUR	3,516.00	2,697.81	818.19
USD	6,605.00	4,699.42	1,905.58
GBP	22,612.00	16,984.10	5,627.90

Sources: Guinness FY2025 / GSE; IDER calculations. [\[S06\]](#) [\[S11\]](#)

Note: GHS thousands. The check applies a linear change in GHS per currency unit; issuer shock and valuation conventions may differ. No statement is amended.

Demand that cannot be financed or produced is not realised output

At +20% GHS/USD, impose transparent constraints on the existing adaptive demand model.

Table 31. Demand that cannot be financed or produced is not realised output

Constraint	Implementation	Interpretation boundary
Installed output capacity	Scale planned domestic and export quantities proportionately until total output is no greater than its baseline index of 1.00.	Prices and fixed costs stay at their scenario values. No investment, substitution or priority allocation is optimised.
Fixed procurement budget	Cap the GHS imported-input outlay at its baseline amount M0; proportionately scale all planned output when the cap binds.	This assumes a binding upfront procurement budget. It is not a measured bank facility, trade-credit limit or national financing shortage.
Profit and cash reconciliation	Recalculate sales, variable costs and working capital at served quantities; deduct FX interest and principal once.	Lost sales may free NWC while reducing profit. A cash-proxy improvement does not mean greater productivity or a preferred policy.

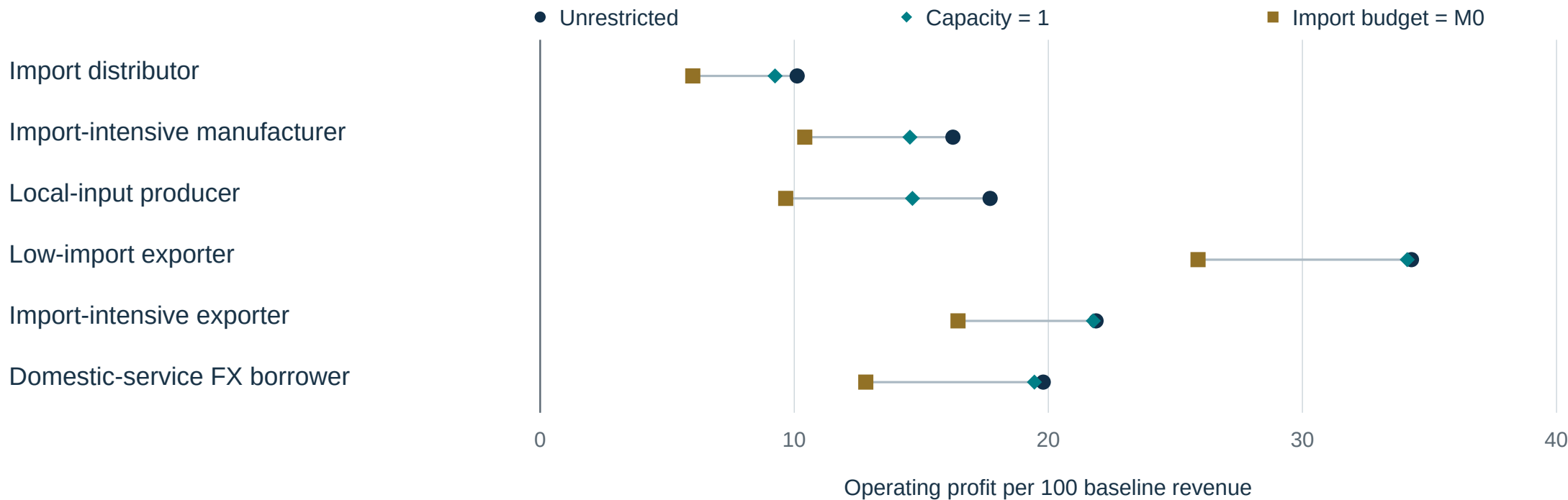
Source: IDER calculations. [\[S11\]](#)

Note: The unconstrained case is reproduced exactly. Export quantities are no longer fixed when a capacity or procurement constraint binds.

Capacity limits remove some assumed gains from domestic substitution

Operating profit per 100 baseline revenue; same +20% GHS/USD change across three cases.

Figure 33. Capacity limits remove some assumed gains from domestic substitution



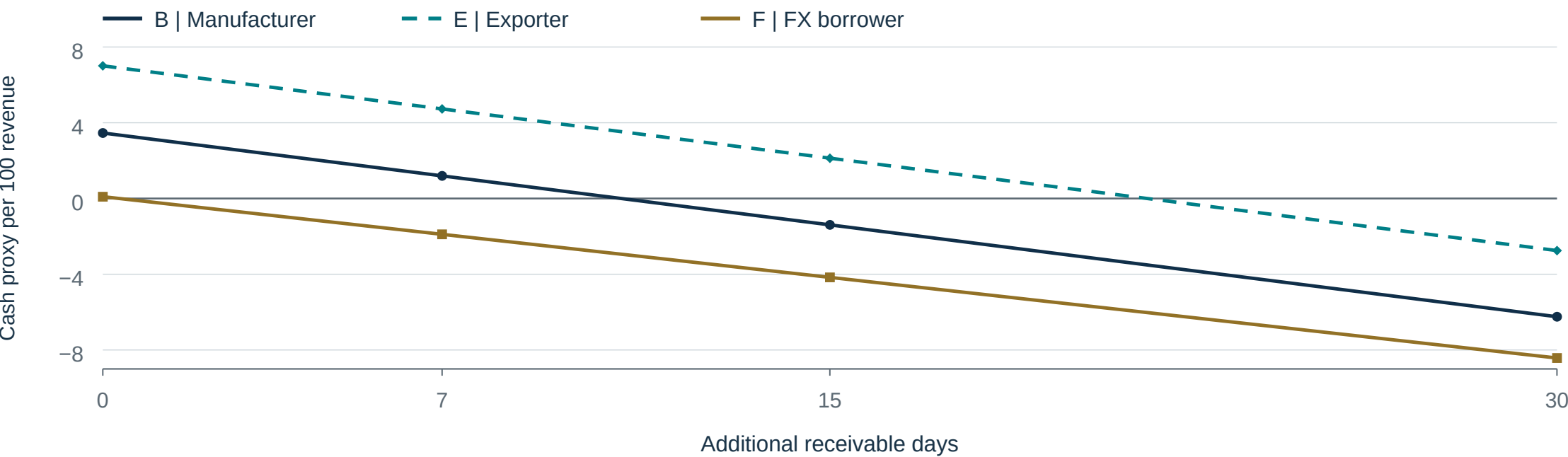
Source: IDER calculations. [\[S11\]](#)

Note: For producer C, operating profit is 17.71 unconstrained but 14.65 under the capacity ceiling. Baseline profit is 15.00; the difference is conditional, not an observed firm loss.

Small cash cushions can disappear before operating profit changes

Additional collection days raise receivables while operating prices, quantities and costs remain fixed.

Figure 34. Small cash cushions can disappear before operating profit changes



Source: IDER calculations. [\[S11\]](#)

Note: Only the receivable timing assumption changes. The model excludes opening cash, tax, capex and new financing; its zero crossing is not a default prediction.

A cash-proxy threshold is more specific than a currency headline

Adaptive +20% FX case; hold all other assumptions fixed and solve for additional collection delay.

Table 32. A cash-proxy threshold is more specific than a currency headline

Profile	No additional delay	With 15 extra days	Delay reaching zero proxy
A	-0.63	-5.51	Already below zero
B	3.46	-1.39	10.70 days
C	10.37	5.64	32.87 days
D	22.55	17.68	69.34 days
E	7.01	2.13	21.54 days
F	0.09	-4.16	0.33 days

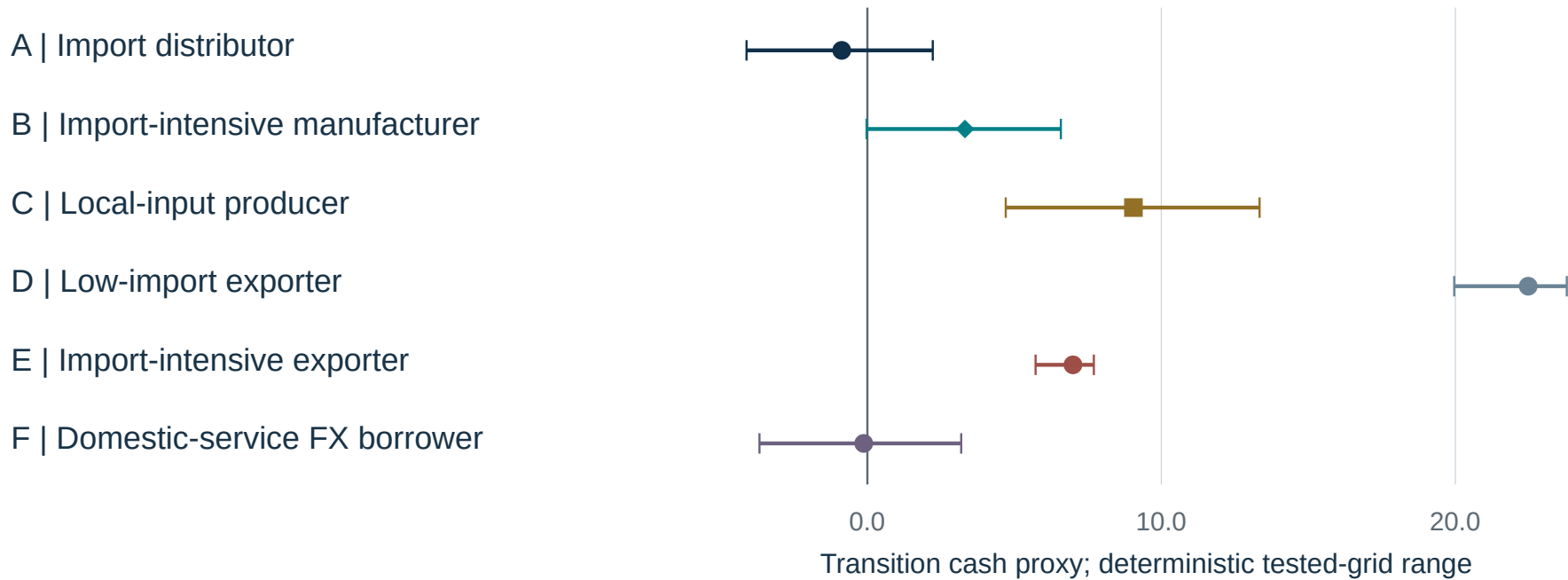
Source: IDER calculations. [\[S11\]](#)

Note: For F the zero crossing is 0.33 additional days. This is a model threshold relative to its assumed annual flows—not its actual liquidity tolerance.

Central scenario results are not invariant to behavioural assumptions

Finite 81-point grid per profile; own/competitor pricing, relative demand and local-cost feedback vary jointly.

Figure 35. Central scenario results are not invariant to behavioural assumptions



Source: IDER calculations. [\[S11\]](#)

Note: Dots use the central capacity-constrained model; ranges are the minimum and maximum tested grid outcomes. They are not confidence intervals, probabilities or global continuous bounds.

Lending and valuation should use net, dated enterprise exposure

The report supports due diligence and scenario testing—not an asset-price target or credit rating.

Table 33. Lending and valuation should use net, dated enterprise exposure

User	Decision-relevant evidence	What a headline FX view misses
Banks / credit teams	Net currency cash flows; matched debt service; committed liquidity; collateral and hedge terms	An operating-margin gain may not cover principal, NWC or an early cash deficit.
Fund and asset managers	Revenue currency, imported input content, net debt and sensitivity reconciliation	Export status alone does not measure the earnings or valuation effect.
DFIs / institutional investors	Project import schedule, local-cost escalation, funding currency and repayment profile	Long-term project returns and short-term settlement capacity are different.
Corporate executives	Quote validity, repricing authority, inventory turnover and forecast error	A single annual budget rate cannot represent all contracts and time horizons.

Source: IDER calculations. [\[S11\]](#)

Note: Security-specific valuation requires additional cash-flow, discount-rate, governance and liquidity evidence not estimated in this report.

Translate the model into a manageable operating record

A practical exposure ledger can improve decisions before a sophisticated forecast is available.

FOR THE BUSINESS

Record invoice amount, currency, due date, bank quote, fees, paid status and expected customer collection. Show the next replacement order separately from the stock already bought.

FOR THE ASSOCIATION

Collect comparable anonymised indicators on imported inputs, settlement delays and repricing frequency. Keep the reporting frame explicit; successful or surviving members alone are not a representative population.

FOR RESEARCH PARTNERS

Use simple error and completeness checks, then investigate missing creditors and delayed invoices. Never replace missing amounts with zero or report an assumed scenario as a measured national SME loss.

Source: IDER calculations. [\[S11\]](#)

Note: The formal enterprise survey excludes firms below five workers and informal establishments; separate coverage is needed for these groups.

Asset currency and spending currency must be considered together

Currency exposure includes the goods and services financed by future liabilities—not only the label on the asset.

LIABILITY HORIZON

Match expected payouts and liquidity needs by date and currency. A long-duration asset gain may not finance an immediate payment, and a reference FX rate is not an executable liquidation price.

PURCHASING POWER

Cedi-denominated spending can contain imported food, medicines, transport or equipment. Inflation and exchange rates are related but distinct; this report does not estimate each household's cost-of-living index.

PORTFOLIO INTERPRETATION

Assess concentration, counterparty risk, liquidity and currency mismatch jointly. The findings do not imply that retirees, insurers or pension funds should universally hold dollars, cedis, gold or a named security.

Source: IDER calculations. [\[S11\]](#)

Note: No personalised allocation advice, expected investment return or institution-specific regulatory compliance conclusion is provided.

Useful policy analysis separates mechanisms, coverage and trade-offs

Analytical questions for MoF, BoG, regulators and development partners; no policy ranking is assigned.

Table 34. Useful policy analysis separates mechanisms, coverage and trade-offs

Analytical option	Information it can provide	Trade-off / evidence requirement
Linked enterprise FX reporting	Connect imported inputs, export receipts, debt and payment timing	Reporting burden, confidentiality and informal-sector coverage.
More transparent price-cost data	Separate FX, world prices, freight, taxes, margins and timing	Comparable definitions and revisions; avoid disclosure of sensitive firm pricing.
Trade-finance and settlement diagnostics	Identify cash timing, documentation and currency-funding constraints	Additional credit can add leverage; realised repayment and access must be evaluated.
Competitiveness analysis	Distinguish input-cost relief from output-market competition and capacity	General-equilibrium demand, productivity and distributional effects remain unmeasured.

Source: IDER calculations. [\[S11\]](#)

Note: Modelled firm gains and losses cannot be aggregated into a national welfare conclusion without firm weights, spillovers and fiscal effects.

Condition the response on the exposure that actually binds

Actions below are analytical controls, not instructions to speculate on the currency.

Table 35. Condition the response on the exposure that actually binds

Observed condition	Decision test	Required record
High import bill; limited repricing	Can margins and replacement orders survive adverse FX and supplier-price moves?	Costed bill of materials; price-reset dates; stock and payables.
High FX sales; high FX input cost	What remains after imported inputs, commissions, debt and collection delays?	Net currency contribution and dated receivables.
Domestic sales; FX debt	How does debt service change relative to collectible operating cash?	Amortisation, interest resets, covenants and natural hedges.
Appreciation with cheaper imports	Will lower replacement cost be offset by lower selling prices or lost market share?	Competitive prices, customer mix, inventory age and sales volumes.

Source: IDER calculations. [\[S11\]](#)

Note: Evaluate both appreciation and depreciation. A one-direction budget stress can miss the exposure that matters for a particular enterprise.

Define deliverables, owners and observable completion criteria

Proposed 90-day pilot for consenting firms; the baseline is to be measured at inception.

Table 36. Define deliverables, owners and observable completion criteria

Period / proposed owner	Deliverable	Proposed acceptance criterion
Days 0–30 finance + data lead	Currency-by-date ledger and source-linked baseline	100% of known material commitments recorded; missing universe and unverified balances listed separately.
Days 31–60 treasury + operations	Firm-specific stress tests and a 13-week cash schedule	All material currency buckets tested; no known duplicate invoice or principal deduction; pricing and quantity assumptions disclosed.
Days 61–90 management + reviewer	Reproducible dashboard and exception review	All changes versioned; previous forecast errors shown; unresolved material differences visible before use.

Source: IDER calculations. [\[S11\]](#)

Note: These are proposed control targets, not achieved national coverage or a claim that all reporting firms have adopted the system.

Measure exposure, adjustment and execution—not only the spot rate

Suggested internal dashboard indicators; firm-specific thresholds require management approval.

Table 37. Measure exposure, adjustment and execution—not only the spot rate

Indicator	Definition	Frequency / owner
Net committed FX	Contracted currency inflows minus outflows by value date	Weekly treasury
Price-reset lag	Days from supplier-cost revision to effective customer price change	Monthly commercial + procurement
NWC pressure	Receivables + variable-cost inventory – import payables	Weekly / monthly finance
Cash shortfall window	Minimum dated cash balance by currency under each scenario	Weekly treasury + risk
Hedge alignment	Matched committed amount / gross exposure; separately show forecast hedges	Weekly authorised treasury
Data exceptions	Unmatched items, missing balances, source conflicts and duplicate IDs	Each release data steward

Source: IDER calculations. [\[S11\]](#)

Note: A threshold breach is a prompt for review, not an automatically estimated default event or policy intervention trigger.

Register the empirical question before expanding the data model

A transparent next-stage study can distinguish measurement improvement from causal inference.

DESIGN AND COVERAGE

Define the firm population, treatment, comparison, outcome and horizon. Include importers that also export, closed firms and failed settlements where relevant. Conduct power analysis using actual dependence and sample structure.

ESTIMATION AND ROBUSTNESS

Prespecify main outcomes, lag structure, exposure timing and inference. Test overlap, pre-trends, alternative windows and source revisions. Use design-appropriate weights and clusters rather than mechanically selecting a familiar estimator.

RELEASE AND REPLICATION

Provide source-labelled inputs or approved aggregates, code and a disclosure register. Separate planned from executed methods. Publish null or unstable findings alongside commercially relevant positive results.

Source: IDER calculations. [\[S11\]](#)

Note: No firm-level causal model or experiment is claimed. The extended tests quantify instability and confounding sensitivity; they do not remove all endogeneity.

What the report establishes—and what remains conditional

The evidence is stronger when the unresolved issues are visible rather than hidden in one summary coefficient.

ESTABLISHED IN THIS EDITION	NOT IDENTIFIED	PRINCIPAL DATA GAPS
Currency-conversion identities, observed source comparisons, executed historical regression diagnostics and reproducible model outcomes. The accounting and scenario outputs can be recalculated from supplied inputs.	A stable Ghana-wide causal pass-through rate, the national distribution of enterprise profit effects, an actual default probability, optimal hedge ratios, or the effect of a named policy on business welfare.	Matched invoice-level firm panels; sampling and non-response information; exact price components and release vintages; current firm cash ledgers; and official reconciliation of identified source inconsistencies.

Source: IDER calculations. [\[S11\]](#)

Note: The report is scientifically useful without presenting unobserved quantities as estimates. Additional data may change both signs and magnitudes.

Quotation and joint input-cost arithmetic

Exact identities; each source retains its own rate, date and pricing convention.

M01 | Exchange-rate transformations

EXECUTED ACCOUNTING

$$d = e_1/e_0 - 1; \quad v = e_0/e_1 - 1 \tag{M01a}$$

$$r_t = \ln(e_t) - \ln(e_{t-1}) \tag{M01b}$$

e is GHS per foreign-currency unit; d is its proportional change; v is reciprocal cedi-value change. r is a log change.

Assumptions / boundary: Positive rates; matched currency and observation dates. Log changes are not exact percentage changes.

M02 | Joint cost conversion

EXECUTED ACCOUNTING

$$C_1/C_0 = (1 + d)(1 + u) \tag{M02}$$

C is local-currency cost of a fixed quantity; d is FX change; u is the foreign-currency unit-price change.

Assumptions / boundary: Quantity, freight, duty and other charges are fixed or separately recorded. The cross term d×u cannot be omitted.

Source: IDER calculations. [\[S11\]](#)

Note: Every model entry records its status and limits; an executed accounting model is not an identified causal effect.

Executed fuel-price regression family: current and lagged changes

All regressions use observed log changes; the maintained linear specification is not a verified structural model.

F01–F03 | Finite distributed lags

ESTIMATED ASSOCIATION

$$\Delta \ln P_t = a + \sum_j b_j \Delta \ln e_{t-j} + \sum_j c_j \Delta \ln B_{t-j} + u_t \tag{F01–F03}$$

P: indicative petrol GHS/litre; e: GHS/USD; B: USD Brent. F01 uses j=0; F02 j=0,1; F03 j=0,1,2. n=35.

Assumptions / boundary: Interpretation as causal requires conditional exogeneity that is not established. Logs require positive levels; lag terms use existing pre-sample data.

I01 | Linear contrast and interval

EXECUTED STATISTICAL INFERENCE

$$b_\Sigma = \sum_j b_j; \text{ se}^2 = r' V r \tag{I01a}$$

$$CI = b_\Sigma \pm t_{n-k,0.975} \times \text{se} \tag{I01b}$$

r selects FX coefficient terms; V is HAC or HC3 covariance. Reported two-sided p-values use residual degrees of freedom.

Assumptions / boundary: Approximate sampling uncertainty, not source, parameter-selection or causal-identification uncertainty. A coefficient sum is not an unconditional long-run multiplier.

Sources: BoG: monthly FX; IMF/FRED: Brent; BoG: petrol; statsmodels documentation; IDER calculations. [\[S01\]](#) [\[S02\]](#) [\[S03\]](#) [\[S09\]](#) [\[S11\]](#)

Note: Every model entry records its status and limits; an executed accounting model is not an identified causal effect.

Alternative dynamics and the historical prediction test

Executed specifications; no local-projection impulse response or instrumental-variable model is claimed.

F04 | Additional price-growth lag

ESTIMATED ASSOCIATION

$$\Delta \ln P_t = \text{F02 terms} + \rho \Delta \ln P_{t-1} \tag{F04}$$

F04 adds one lag of petrol-price growth to the F02 regressor set; n=34. Published sums cover the direct FX and Brent terms.

Assumptions / boundary: Dynamic feedback is excluded from the displayed sums. Stability, weak dependence and absence of omitted confounding are not proven by fit.

F05 | Lag-only model and loss

ESTIMATED ASSOCIATION / PSEUDO-OOS

$$\Delta \ln P_t = a + \sum_{j=1,2} (b_j r_{t-j} + c_j z_{t-j}) \tag{F05a}$$

$$\text{RMSE} = \sqrt{\text{mean}[(100y_t - 100\hat{y}_t)^2]} \tag{F05b}$$

r=Δln e; z=Δln B. Fit n=35. Fixed-vintage expanding training starts at n=20; evaluate 15 remaining outcomes.

Assumptions / boundary: No contemporaneous future price enters predictions. Original data-release timing and subsequent revisions are not reconstructed.

Sources: BoG: monthly FX; IMF/FRED: Brent; BoG: petrol; statsmodels documentation; IDER calculations. [\[S01\]](#) [\[S02\]](#) [\[S03\]](#) [\[S09\]](#) [\[S11\]](#)

Note: Every model entry records its status and limits; an executed accounting model is not an identified causal effect.

Covariance and influence checks are part of the estimate

The code uses calendar distance for HAC when an observation is omitted; the remaining months are not compressed.

I02 | Bartlett HAC covariance

EXECUTED INFERENCE DIAGNOSTIC

$$V = c(X'X)^{-1} S (X'X)^{-1} \tag{I02a}$$

$$S = \sum_t g_t g_t' + \sum_l w_l \sum_t (g_t g_{t-l}' + g_{t-l} g_t') \tag{I02b}$$

$g_t = x_t u_t$ uses OLS residuals u_t ; $w_l = 1 - l / (L + 1)$; $c = n / (n - k)$. Main $L = 3$; sensitivity $L = 1$ and 6 . Dates determine lag pairs.

Assumptions / boundary: Asymptotic approximation with a small-sample scalar correction. Weak dependence and an adequate mean specification remain maintained conditions.

I03 | HC3 and leave-one-out

EXECUTED INFERENCE DIAGNOSTIC

$$S_{HC3} = \sum_t x_t x_t' [u_t / (1 - h_t)]^2 \tag{I03a}$$

$$b_{\sum, (-t)} = \text{FX sum after omitting month } t \tag{I03b}$$

h_t is diagonal leverage. $V_{HC3} = (X'X)^{-1} S_{HC3} (X'X)^{-1}$, without the HAC scalar correction. Same OLS estimate; all 35 deletions retained.

Assumptions / boundary: HC3 does not model serial dependence. Deletion results diagnose influence; they are not selective replacements for the full-sample estimate.

Sources: statsmodels documentation; IDER calculations. [\[S09\]](#) [\[S11\]](#)

Note: Every model entry records its status and limits; an executed accounting model is not an identified causal effect.

Adaptive pricing and output quantities

Executed hypothetical model; all exposure and elasticity parameters are disclosed in the input tables.

M03 | Own and competitor prices

CONDITIONAL MODEL

$$p_D = e^\alpha; \quad p_C = e^\gamma \tag{M03}$$

e is the FX rate relative to baseline (baseline=1). α is own domestic-price elasticity; γ is competitor-price elasticity. Prices are indices.

Assumptions / boundary: Coefficients are imposed, not estimated. No price ceilings, contract resets or strategic equilibrium are solved.

M04 | Relative-price demand

CONDITIONAL MODEL

$$q_D = (p_D/p_C)^{-\eta} \tag{M04a}$$

$$Q = (1-x)q_D + xq_X; \quad q_X = 1 \tag{M04b}$$

x is baseline FX-sales share; q_D and q_X are quantity indices. η is an imposed relative-price elasticity. Q weights the output basket.

Assumptions / boundary: Baseline domestic/export unit costs are common within a profile. No capacity ceiling; export quantity stays fixed. Independent demand compression is separate.

Sources: Amiti et al. (2014); Gopinath et al. (2020); IDER calculations. [\[S07\]](#) [\[S08\]](#) [\[S11\]](#)

Note: Every model entry records its status and limits; an executed accounting model is not an identified causal effect.

Revenue, costs and operating profit

Baseline annual revenue is 100; all model money values use that normalisation.

M05 | Revenue by currency

CONDITIONAL MODEL

$$R_D = 100(1-x)p_{DqD} \tag{M05a}$$

$$R_X = 100xe\,p_X^*q_X; \, R = R_D + R_X \tag{M05b}$$

p_X^* is a foreign-currency export-price index. Central case $p_X^*=1$; separate joint scenarios change it by -20%, 0 or +20%.

Assumptions / boundary: No foreign-currency volume response or change in destination mix is assumed. Conversion is not itself an economic margin.

M06 | Operating cost and profit

CONDITIONAL MODEL

$$M = M_0\,e(1+u)Q; \, V = V_0\,e^\varphi Q \tag{M06a}$$

$$F = F_0\,e^\psi; \, \Pi = R - M - V - F \tag{M06b}$$

M: imports; V: local variable cost; F: fixed cost; u: USD input-price shock. φ and ψ are local-variable and fixed-cost elasticities.

Assumptions / boundary: Fixed case: domestic prices, quantities and local-cost indices stay at 1. Costs are cash operating costs. Interest, principal, tax, depreciation and capex are outside Π .

Source: IDER calculations. [\[S11\]](#)

Note: Every model entry records its status and limits; an executed accounting model is not an identified causal effect.

Financing exposure and the working-capital bridge

Cash-service and stock-valuation entries are separate to prevent double counting.

M07 | FX debt and service

CONDITIONAL ACCOUNTING

$$D = eD_0; \quad I = eI_0; \quad A = eA_0 \tag{M07a}$$

$$C_{\text{preWC}} = \Pi + H - I - A \tag{M07b}$$

D is the FX debt stock translated to GHS; I interest; A principal due; H hedge cash payoff. C_preWC is a simplified cash proxy.

Assumptions / boundary: Fixed foreign-currency debt balances and payments. D is not deducted again as cash; omitted taxes, capex and other financing are not zero in reality.

M08 | NWC and transition cash

CONDITIONAL ACCOUNTING

$$\text{NWC} = [R \cdot \text{DSO} + (M + V) \cdot \text{DIO} - M \cdot \text{DPO}] / 365 \tag{M08a}$$

$$C_{\text{transition}} = C_{\text{preWC}} - (\text{NWC}_1 - \text{NWC}_0) \tag{M08b}$$

DSO: receivable days; DIO: inventory days; DPO: import-payable days. Inputs are annual flows and fixed day assumptions.

Assumptions / boundary: Only import payables offset NWC here. The transition change is deducted once; this is not the minimum of a verified dated cash path.

Source: IDER calculations. [\[S11\]](#)

Note: Every model entry records its status and limits; an executed accounting model is not an identified causal effect.

Hedge payoffs and reverse operating thresholds

Executed fixed-basket illustrations; no optimal hedge strategy or future exchange rate is estimated.

M09 | Fixed-notional import hedge

CONDITIONAL ACCOUNTING

$$H = M_0 h[e - (1+f)] \tag{M09a}$$

$$\text{Effective import outlay} = M - H \tag{M09b}$$

h is the hedged share of baseline import notional; f is the assumed forward premium, 2% in the illustration. $e_0=1$.

Assumptions / boundary: Same currency, amount and date; fees, collateral and credit effects excluded. Under variable volumes the baseline hedge does not automatically scale.

M10 | Static break-even conditions

EXECUTED REVERSE STRESS

$$\Pi(e) = \Pi_0 + (100x - M_0)(e - 1) \tag{M10a}$$

$$e_{\text{break}} = 1 - \Pi_0 / (100x - M_0) \tag{M10b}$$

x is baseline FX-sales share; M_0 is imported cost. Π_0 is baseline profit. Positive admissible roots and the tested range are reported.

Assumptions / boundary: Fixed quantities, domestic prices and local costs; no endogenous business response. Far-out roots are extrapolations, not forecasts.

Source: IDER calculations. [\[S11\]](#)

Note: Every model entry records its status and limits; an executed accounting model is not an identified causal effect.

Order-independent attribution and source-disclosure arithmetic

Model attribution is exact within its assumptions; reported issuer sensitivities remain distinct from the diagnostic.

M11 | Shapley decomposition

EXECUTED CONDITIONAL ACCOUNTING

$$\varphi_j = \text{mean}_{\text{orderings}}[V(S \cup \{j\}) - V(S)] \tag{M11a}$$

$$\sum_j \varphi_j = \Pi_{\text{adaptive}} - \Pi_{\text{fixed}} \tag{M11b}$$

Three switches: repricing, domestic quantity and local-cost feedback.
Average marginal contributions over all 3!=6 orderings.

Assumptions / boundary: Same +20% FX scenario, same baseline firm. No path-dependent sequencing is selected to create a preferred explanation.

M12 | Monetary exposure check

EXECUTED DISCLOSURE DIAGNOSTIC

$$N_c = \text{Cash}_c - \text{Payables}_c - \text{Related}_c \tag{M12a}$$

$$\text{Linear sensitivity}_c = |N_c| \times e_c \times 0.075 \tag{M12b}$$

N_c is native-currency thousands; e_c is the issuer’s displayed GHS per currency unit. Output is GHS thousands.

Assumptions / boundary: The linear quote-change convention may differ from the issuer’s shock or valuation definition. The reported sensitivity is not silently corrected.

Sources: Guinness FY2025 / GSE; IDER calculations. [\[S06\]](#) [\[S11\]](#)

Note: Every model entry records its status and limits; an executed accounting model is not an identified causal effect.

Observed distribution and conversion benchmarks

These transformations describe a retrieved historical vintage; they do not assign future probabilities.

M13 | Empirical FX distribution

EXECUTED DESCRIPTION

$$F(r) = (1/n) \sum_t 1(r_t \leq r) \tag{M13}$$

r_t is a historical simple percentage FX change; $n=91$ for one-month observations. Quantiles use the code’s linear interpolation convention.

Assumptions / boundary: The record is serially dependent and spans different regimes. No stationarity-based forecast risk distribution is asserted.

M14 | Monthly conversion proxy

EXECUTED ACCOUNTING

$$G_t = \bar{e}_t \times P_t^*; \text{ index}_t = 100G_t/G_0 \tag{M14}$$

$\bar{e}$ is a monthly-average reference FX rate; P^* a monthly USD commodity price. Means of these products are reported separately.

Assumptions / boundary: A product of two monthly averages is not the average of daily products, a contract-weighted conversion or an observed firm margin.

Sources: BoG: monthly FX; IMF/FRED: Brent; IMF/FRED: cocoa; IDER calculations. [\[S01\]](#) [\[S02\]](#) [\[S10\]](#) [\[S11\]](#)

Note: Every model entry records its status and limits; an executed accounting model is not an identified causal effect.

Required pricing and every-date cash feasibility

An accounting threshold is neither a behavioural forecast nor a guarantee of payment execution.

M15 | Dated cash balance

EXECUTED ILLUSTRATION

$$B_c(t) = B_c(0) + \sum \text{Receipts}_c(\tau) - \sum \text{Payments}_c(\tau), \tau \leq t \tag{M15}$$

For each currency c , the minimum balance is $\min_t B_c(t)$. The illustrative ledger starts at 10 and reaches -8 before closing at 10.

Assumptions / boundary: No overdraft, borrowing or unrecorded support is assumed. Negative balance denotes unmet funding. Use unique IDs and actual within-date ordering.

M16 | Required domestic price

EXECUTED REVERSE STRESS

$$p_{D,\text{hold}} = [\Pi_0 + M_0e + V_0 + F_0 - 100xe] / [100(1-x)] \tag{M16}$$

$p_{D,\text{hold}}$ is the domestic-price index preserving baseline profit Π_0 . The reported percentage change is $100(p_{D,\text{hold}}-1)$; $x < 1$.

Assumptions / boundary: Fixed quantity, local costs and USD export prices. A feasible accounting price is not necessarily accepted by customers or permitted by contracts.

Source: IDER calculations. [\[S11\]](#)

Note: Every model entry records its status and limits; an executed accounting model is not an identified causal effect.

Prospective firm-panel design and its identifying restrictions

The following model has not been estimated; it formalises what additional data would need to identify.

D01 | Pre-shock exposure interaction

PROSPECTIVE ONLY

$$\Delta \ln y_{it} = a_i + \lambda_t + \beta(X_{i0} \times \Delta \ln e_t) + \Gamma W_{it} + u_{it} \quad (\text{D01})$$

y is a matched positive firm outcome; X_{i0} is pre-shock exposure; a_i and λ_t are firm and time effects. Common FX effects are absorbed by λ_t.

Assumptions / boundary: Differential counterfactual paths must be credible. Baseline exposure can be endogenous; selected controls, missing firms and spillovers require design-specific treatment.

Source: IDER calculations. [\[S11\]](#)

Note: Every model entry records its status and limits; an executed accounting model is not an identified causal effect.

Extended-sample estimation and directional checks

Executed exploratory specifications; all comparison windows, transformations and covariance settings are recorded.

X01 | Common-window finite distributed lags

ESTIMATED ASSOCIATION

$$\Delta \ln P_t = a + \sum_j b_j r_{t-j} + \sum_j c_j z_{t-j} + u_t \tag{X01}$$

r=FX log change; z=Brent log change. Apr 2019–Apr 2023, n=49; j=0, 0–1 or 0–2. AR1 and lag-only variants are separate.

Assumptions / boundary: The added petrol rows are research-table reproductions. Common windows remove a composition difference, not confounding. HAC/HC3 intervals are approximate.

X02 | Asymmetry and future-term diagnostic

ESTIMATED ASSOCIATION / DIAGNOSTIC

$$r^+ = \max(r,0); r^- = \min(r,0) \tag{X02a}$$

$$\text{Difference} = \sum b^+_j - \sum b^-_j \tag{X02b}$$

Replace current/lag FX with signed positive and negative parts. A separate diagnostic adds r_{t+1} to DL1; it is not used for forecasts.

Assumptions / boundary: The tests are exploratory, not preregistered. Sparse directional support and common shocks limit inference. A future term is not an instrument.

Sources: BoG: monthly FX; IMF/FRED: Brent; statsmodels documentation; IDER calculations; Hesse et al. (2026), Table 1. [\[S01\]](#) [\[S02\]](#) [\[S09\]](#) [\[S11\]](#) [\[S12\]](#)

Note: Every model entry records its status and limits; an executed accounting model is not an identified causal effect.

Omitted-variable sensitivity of the summed FX coefficient

Exact sample linear-regression algebra; no inference that the omitted covariate actually exists at the assumed strength.

I04 | Reparameterised target

EXECUTED ALGEBRA

$$b_0r_t + b_1r_{t-1} = b_0(r_t-r_{t-1}) + \tau r_{t-1} \tag{I04a}$$

$$\tau = b_0 + b_1 \tag{I04b}$$

Set $D=r_{t-1}$; controls include r_t-r_{t-1} , current/lag Brent and an intercept. The coefficient on D equals the original FX sum.

Assumptions / boundary: FWL and QR calculations verify equality. Only a change of coordinates is made; no new shock or identifying instrument is generated.

I05 | Partial- R^2 omitted-variable tipping point

CONDITIONAL POINT-ESTIMATE SENSITIVITY

$$|Bias| = s_{OLS} \sqrt{[df \times R^2Y \times R^2D/(1-R^2D)]} \tag{I05a}$$

$$\tau_{adjusted} = \tau - sign(\tau)|Bias| \tag{I05b}$$

R^2D relates omitted Z to D given controls; R^2Y relates Z to petrol given D and controls. Equal-strength R^2 sets $R^2D=R^2Y$.

Assumptions / boundary: s_{OLS} is an algebraic residual scale, not robust inference. Report point shifts only; serial-dependence-adjusted p-values are not derived from this formula.

Sources: IDER calculations; Cinelli and Hazlett (2020). [\[S11\]](#) [\[S13\]](#)

Note: Every model entry records its status and limits; an executed accounting model is not an identified causal effect.

Capacity and collection constraints in the business model

Executed conditional calculations; these extra constraints are assumed, not estimated from Ghanaian enterprise microdata.

M17 | Proportionate output rationing

CONDITIONAL CONSTRAINED MODEL

$$z = \min(1, Q_{cap}/Q_{plan}, K/M_{plan}) \tag{M17a}$$

$$\Pi = z(R_{plan} - M_{plan} - V_{plan}) - F \tag{M17b}$$

z is the served share. Q_cap=1 in the capacity case; procurement K=M0 in the funding case. Non-binding limits are infinite.

Assumptions / boundary: Both domestic and export volumes scale by z. Prices, fixed costs and debt service do not. Recompute NWC; no optimal allocation or substitution is solved.

M18 | Receivable-delay threshold

CONDITIONAL REVERSE STRESS

$$C(d) = C(0) - R \times d/365 \tag{M18a}$$

$$d_{zero} = 365 \times C(0)/R \tag{M18b}$$

C is the transition cash proxy at +20% FX. d is additional collection days on the model's revenue base; R is annual scenario revenue.

Assumptions / boundary: Only receivable days change. A negative d_zero means the proxy is already below zero. Opening cash and additional financing remain outside this proxy.

Source: IDER calculations. [\[S11\]](#)

Note: Every model entry records its status and limits; an executed accounting model is not an identified causal effect.

Parameter envelopes and retrospective prediction controls

Finite deterministic sensitivity ranges and observed forecast errors have different meanings.

M19 | Finite joint parameter grid

EXECUTED CONDITIONAL SENSITIVITY

Envelope = $[\min_{\theta \in G} C(\theta), \max_{\theta \in G} C(\theta)]$ (M19a)

$|G| = 3 \times 3 \times 3 \times 3 = 81$ (M19b)

Grid: own and competitor elasticities at base ± 0.15 (floor 0); demand at 0/base/2 $\times$ base; local cost at 0/base/0.30. Q_cap=1.

Assumptions / boundary: All other parameters fixed at +20% FX. These are tested-grid extrema, not continuous global bounds, confidence bands or equally likely future states.

V01 | Common-origin loss validation

EXECUTED PSEUDO-OUT-OF-SAMPLE

RMSE = $\sqrt{\text{mean}[(100y_t - 100\hat{y}_t)^2]}$ (V01a)

MAE = $\text{mean}|100y_t - 100\hat{y}_t|$ (V01b)

Start with 24 extended observations; expand through 25 test months. Compare fixed lag-only OLS, training-sample mean and the constant zero forecast.

Assumptions / boundary: No tuning on held-out outcomes. Fixed-vintage inputs do not reconstruct real-time data release delays. No formal forecast-dominance test is claimed.

Sources: IDER calculations; Hesse et al. (2026), Table 1. [\[S11\]](#) [\[S12\]](#)

Note: Every model entry records its status and limits; an executed accounting model is not an identified causal effect.

The 16 added observations are visible and source-labelled

Hesse et al. (2026), Table 1, PDF p.14; GHS/litre. Overlapping 2020–2022 values are unchanged.

Table 38. The 16 added observations are visible and source-labelled

Month	2019: added levels	2023: added levels
Jan	4.89	14.12
Feb	4.90	14.06
Mar	5.15	13.20
Apr	5.19	12.95
May	5.20	Not supplied
Jun	5.16	Not supplied
Jul	5.15	Not supplied
Aug	5.15	Not supplied
Sep	5.24	Not supplied
Oct	5.30	Not supplied
Nov	5.32	Not supplied
Dec	5.34	Not supplied

Sources: Hesse et al. (2026), Table 1; IDER calculations. [\[S12\]](#) [\[S11\]](#)

Note: May–December 2023 are absent, not zero. The common estimation window starts in April 2019 to align all two-lag specifications.

The original 36 petrol-price observations are retained

BoG indicative petrol series; GHS/litre. These source inputs are not generated or imputed values.

Table 39. The original 36 petrol-price observations are retained

Month	2020	2021	2022
Jan	5.39	4.91	6.68
Feb	5.40	5.03	7.55
Mar	5.14	5.25	9.05
Apr	4.09	5.32	9.30
May	4.03	5.91	9.47
Jun	4.40	6.00	10.62
Jul	4.68	6.11	11.27
Aug	4.71	6.12	10.88
Sep	4.66	6.18	11.13
Oct	4.59	6.49	12.29
Nov	4.58	6.79	17.43
Dec	4.64	6.66	16.58

Source: BoG: petrol. [\[S03\]](#)

Note: Official-domain cached-table transcription; direct HTML retrieval failed. The full CSV and source status are included for verification.

Trace the published evidence to executed files

The report’s quantitative layers have different input sources and interpretation limits.

Table 40. Trace the published evidence to executed files

Layer	Input / code	Output / check
Observed FX and survey evidence	data/inputs/monthly_ghs_usd_eop.csv; enterprise_survey_appendix.csv	outputs/fx_history.csv; charts/figure_*_data.csv
Historical price regressions	Original and extended petrol inputs; FX and Brent; analyse.py and enhance.py	coefficients.csv; enhanced_* coefficient, influence, OVB and prediction files
Enterprise scenarios	archetype_assumptions.csv; analyse.py; extend.py; enhance.py	Original scenarios plus enhanced_constraints, receivable_delay and parameter_grid outputs
Publication and source exceptions	sources/source_register.json; source_exceptions.csv; code/build_report.py	Editable vectors, linked references, registers and final PDF checks

Source: IDER calculations. [\[S11\]](#)

Note: The original input vintage and selected source inconsistencies are preserved. Reproducibility is not an external audit or a causal validation.

Release limitations that affect how the results may be used

The companion source-exception register retains all identified issues.

Table 41. Release limitations that affect how the results may be used

Issue	Status in this report	Use restriction
Cached petrol source; original HTML unavailable	Original 36 levels retained; 52-level research-table extension separately labelled; direct BoG retrieval gap disclosed	Do not present regression standard errors as authentication of source inputs.
Within-source survey and issuer differences	Primary PDF images checked; unresolved differences retained	Do not combine incompatible rows or manufacture missing adjustments.
Small historical regression sample	HAC, HC3, lag, sample, leverage and pseudo-OOS checks executed	The coefficient is not a stable universal price or policy parameter.
No representative enterprise panel	Six explicitly assumed profiles; no estimated population weights	Do not aggregate scenario results into national losses or business prevalence.
No causal assignment or validated instrument	Prospective firm design described separately	No policy treatment effect, default probability or investment return is claimed.

Source: IDER calculations. [\[S11\]](#)

Note: All data, inference and model limitations should accompany extracts used in public communication or investment due diligence.

References and source links 1 / 5

Clickable titles; observation dates, source scope and retrieval limitations are recorded in the companion register.

S01 Bank of Ghana | 2026 access

Monthly exchange-rate series

Jan 2019–Aug 2026 end-period; Jan 2024–Dec 2025 average.

S02 International Monetary Fund, via Federal Reserve Bank of St. Louis | 2026 access

Global price of Brent Crude (POILBREUSDM)

Monthly USD/barrel; archive through June 2026. Original fuel fit: 2020–2022; extended common fit: April 2019–April 2023.

S03 Bank of Ghana | 2026 access

Commodity prices: indicative petrol price

36 monthly observations, January 2020–December 2022; GHS/litre.

Source: IDER calculations. [\[S11\]](#)

References and source links 2 / 5

Clickable titles; observation dates, source scope and retrieval limitations are recorded in the companion register.

S04 World Bank Enterprise Surveys | 2024

Ghana 2023 Country Profile

PDF pp.3, 7, 11–12. Interviews February 2023–February 2024, n=713.

S05 Ghana Association of Banks | 2026

Monthly average exchange-rate schedules

December 2025 and August 2026 schedules; USD buy/sell/mid, last-day mid.

S06 Guinness Ghana Breweries Plc | 2025

Annual Report and Financial Statements for the year ended 30 June 2025

FX-risk note, PDF pp.79–80 (printed pp.78–79); operating review.

Source: IDER calculations. [\[S11\]](#)

References and source links 3 / 5

Clickable titles; observation dates, source scope and retrieval limitations are recorded in the companion register.

S07 Amiti, Mary; Oleg Itskhoki; Jozef Konings | 2014

Importers, Exporters, and Exchange Rate Disconnect

American Economic Review 104(7): 1942–1978. DOI: 10.1257/aer.104.7.1942.

S08 Gopinath, Gita, et al. | 2020

Dominant Currency Paradigm

American Economic Review 110(3): 677–719. DOI: 10.1257/aer.20171201.

S09 statsmodels developers | 2026 access

Heteroskedasticity and autocorrelation robust covariance: cov_hac

Bartlett kernel and small-sample covariance correction; execution: statsmodels 0.14.6.

Source: IDER calculations. [\[S11\]](#)

References and source links 4 / 5

Clickable titles; observation dates, source scope and retrieval limitations are recorded in the companion register.

S10 International Monetary Fund, via Federal Reserve Bank of St. Louis | 2026 access

Global price of Cocoa (PCOCOUSD)

Monthly USD/metric tonne, Jan 2019–June 2026 archived vintage.

S11 Institute of Development and Economic Research | 2026

A Changing Cedi: calculation and enterprise-scenario protocol

Analysis: analyse.py; extend.py; enhance.py. Publication: final_publication.py; finalize_publication.py. Frozen inputs, outputs and registries are in the companion package.

S12 Hesse, Christian Akrong; et al. | 2026

Intervention Analysis of COVID-19: Implications for Fuel Prices in Ghana

Journal of Business and Professional Studies 16(1), published 7 August 2026. Table 1, PDF p.14; methods p.10.

Source: IDER calculations. [\[S11\]](#)

References and source links 5 / 5

Clickable titles; observation dates, source scope and retrieval limitations are recorded in the companion register.

S13 Cinelli, Carlos; Hazlett, Chad | 2020

Making Sense of Sensitivity: Extending Omitted Variable Bias

Journal of the Royal Statistical Society B 82(1):39–67; DOI 10.1111/rssb.12348. Author manuscript Sections 4–5.

SG1 World Bank Group | 2020

World Bank Group Publications Editorial Style Guide

Selected indexed guidance on figure/table source attribution; used for editorial presentation only.

SG2 International Monetary Fund | 2024

IMF Editorial Style Guide, second edition

Selected indexed guidance on source-before-note ordering. Full-guide compliance or institutional approval is not claimed.

Source: IDER calculations. [\[S11\]](#)

Executed checks cover calculation integrity—not unobserved national risks

The numerical test suite runs with the supplied frozen inputs and current model assumptions.

Table 42. Executed checks cover calculation integrity—not unobserved national risks

Verification layer	Completed procedure	Limit
Regression computation	NumPy, QR and FWL checks reproduce the relevant OLS estimates; original and extended results are separate	Same data and mean specification; not a second independent empirical study.
Covariance implementation	Calendar-distance HAC matches the library on the contiguous main sample	Small-sample interval coverage and causal assumptions are not certified.
Accounting and scenario tests	Original 72 checks and 73 extension checks pass; exact Shapley bridges and constrained-case recalculations are recorded	Parameter choices and source omissions can still change business implications.
Replication and publication	Re-executable scripts, figure datasets, source/page/model registers and QR checks	No external review, formal accessibility certificate or live market feed is implied.

Source: IDER calculations. [\[S11\]](#)

Note: The evidence package records the software versions and verification results. No test count is presented as independent statistical evidence.

The business effect is the net result of contracts, behaviour and funding

A changing cedi redistributes pressures across the firm’s accounts; it does not supply a universal business verdict.

WHAT TO MEASURE	WHAT TO TEST	WHAT TO COMMUNICATE
The currency, amount and date of costs, sales, liabilities and hedges. Separate price changes from quantity changes and source-reported facts from model assumptions.	Both appreciation and depreciation; joint supplier and export prices; local-cost feedback; demand; working capital; and due debt service. A closing profit or cash balance is not enough.	Historical associations may be unstable. Scenario results are conditional. Firm-level evidence and credible identification are needed before moving from business arithmetic to causal or national conclusions.

Source: IDER calculations. [\[S11\]](#)

Note: The report’s practical contribution is a reproducible framework for exposure, margin and cash analysis—not a forecast of the cedi.



Institute of Development and Economic Research

EVIDENCE FOR YOUR NEXT DECISION

Research. Business intelligence. Reproducible evidence.

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