Two Roads from Brent to the Basket: Oil-Price Pass-Through in Morocco and North Macedonia

Youssef Lamrani Laghrib[1]

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Abstract

This paper compares the pass-through of international oil-price shocks to domestic inflation in Morocco and North Macedonia, two energy-importing economies that share a common exposure to global oil markets but differ sharply in fuel-pricing institutions and exchange-rate regimes. Using monthly data from January 2010 to December 2025, we decompose the transmission mechanism into two stages estimated with the Autoregressive Distributed Lag (ARDL) bounds-testing procedure of Pesaran et al. (2001): an upstream stage linking international oil prices and the exchange rate to a domestic fuel-price proxy, and a downstream stage linking that proxy to headline inflation, conditional on the monetary policy stance. We find that the two countries' pass-through mechanisms diverge in a pattern the standard liberalized-versus-regulated narrative does not fully anticipate. The exchange-rate channel behaves as predicted: Morocco's cumulative FX pass-through to fuel prices (0.178) is roughly 2.4 times North Macedonia's (0.075). The oil-price channel runs in the opposite direction: North Macedonia's cumulative oil pass-through (0.166) is roughly twice Morocco's (0.081), a result that survives an explicit decomposition of exchange-rate movements into direction and size, ruling out currency confounding as the explanation. At the downstream stage, Morocco's inflation process corrects toward its long-run equilibrium with fuel prices at a well-identified pace (half-life ≈13 months), while North Macedonia's corresponding adjustment is econometrically fragile: the bounds F-test indicates cointegration, but the complementary bounds t-test on the error-correction term does not, a disagreement we trace to North Macedonia's headline CPI process being close to a unit root even conditional on its regressors. A core-CPI extension designed to separate the direct, mechanical fuel-in-the-basket effect from an indirect cost-push channel yields informative but underpowered results given the shorter common sample this test requires. We interpret the findings through the two countries' institutional architecture , North Macedonia's seven-day, dollar-indexed, margin-regulated administered pricing formula transmits oil shocks with little discretionary smoothing, while Morocco's liberalized downstream market appears to absorb the direct oil signal, plausibly through distributor margins, while remaining comparatively exposed to currency movements , and we draw out the resulting, and diverging, policy implications for each country.

Keywords: oil price pass-through, inflation, ARDL bounds testing, exchange-rate regimes, fuel-price regulation, Morocco, North Macedonia, comparative macroeconomics

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[1] Master's student in Economics at *Institut Polytechnique de Paris (IP Paris)*, and holder of a Bachelor's degree in Applied Economics from *Mohammed VI Polytechnic University (UM6P).* Research conducted during a research internship at the Center for Economic Analyses (CEA), Skopje, North Macedonia,(www.cea.org.mk) under the supervision of Vesna Garvanlieva Andonova, Senior Economist. This study was conducted by the author with the institutional support and mentorship of CEA, within the framework of a signed Internship Memorandum of Understanding between the author, UM6P, and CEA; the research plan underlying this paper was reviewed and approved under that framework. Corresponding author: youssef.lamrani05@gmail.com. All errors are the author's own.

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1 Introduction

Oil-importing economies remain structurally exposed to a price they do not set. When Brent crude moves, the speed and completeness with which that movement reaches a household's fuel bill and, from there, the broader consumer price index (CPI), depends not on the size of the shock alone but on the institutional architecture that sits between the world price and the domestic one: how the exchange rate is managed, how fuel prices are set, and how credible the monetary authority's response is expected to be (Taylor, 2000; Mishkin, 2008; Campa and Goldberg, 2010). This paper studies that architecture directly, by comparing two countries that share an oil-importing profile but sit at opposite ends of the institutional spectrum on both dimensions that matter most: Morocco, which liberalized fuel pricing at end-2015 and operates a managed, comparatively flexible exchange-rate regime; and North Macedonia, which regulates retail fuel prices through a formula-based administered mechanism and maintains a hard peg of the denar to the euro.

The research premise motivating this comparison, set out in the study's approved research plan, is intuitive and consistent with the exchange-rate pass-through literature: Morocco's liberalized, more flexible framework should transmit oil shocks *more* strongly and more quickly than North Macedonia's regulated, pegged one (Cuñado and Pérez de Gracia, 2005; IMF, 2017). We test this premise using a two-stage ARDL bounds-testing framework on monthly data spanning January 2010 to December 2025 ($T = 192$), separating the transmission mechanism into (i) the pass-through of international oil prices and the exchange rate to a domestic fuel-price proxy, and (ii) the pass-through of that fuel-price proxy to headline CPI, conditional on the policy rate. This decomposition, motivated by the observation that a single reduced-form regression of CPI on oil prices conflates two economically distinct transmission links, allows us to locate *where* in the chain the two countries' experiences diverge, rather than only observing a single combined elasticity.

The headline finding complicates the premise rather than confirming or rejecting it outright. The exchange-rate channel behaves exactly as the institutional story predicts: Morocco's currency pass-through to fuel prices is markedly stronger than North Macedonia's. The oil-price channel, however, runs in the *opposite* direction: North Macedonia's regulated, formula-based pricing mechanism transmits international oil shocks to domestic fuel prices roughly twice as strongly as Morocco's liberalized market. We show that this reversal is not an artifact of the exchange-rate specification , an explicit decomposition of currency movements into direction (depreciation versus appreciation) and size leaves North Macedonia's oil coefficient essentially unchanged and Morocco's only marginally affected , which points instead to an institutional explanation: North Macedonia's Energy Regulatory Commission (ERC) resets maximum retail fuel prices on a fixed seven-day schedule using a formula directly indexed to international quotations, regulated margins, and the US-dollar exchange rate, leaving little room for discretionary smoothing, while Morocco's post-liberalization downstream market appears to absorb part of the direct oil signal, plausibly through distributor and retail margin adjustment.

At the second stage, we document a further asymmetry in the *speed* rather than the *size* of adjustment: Morocco's inflation process corrects deviations from its long-run relationship with fuel prices at a well-identified monthly rate, implying a half-life of roughly thirteen months, while North Macedonia's corresponding error-correction term is econometrically fragile , detected by the bounds F-test but not by the complementary bounds t-test , a disagreement we trace to near-unit-root behaviour in North Macedonia's own CPI dynamics rather than to a specification failure. We further test, using a core-CPI (excluding food and energy) extension, whether fuel-price shocks pass into non-fuel prices through an indirect, cost-push channel beyond the direct, mechanical effect of fuel's own weight in the CPI basket; the results are informative for Morocco but constrained by statistical power for North Macedonia, given the shorter common sample this test requires.

The contribution of the paper is threefold. First, on evidence: to our knowledge, no existing study places Morocco's and North Macedonia's oil-inflation pass-through mechanisms within a single, comparable, two-stage ARDL framework over a common recent sample; the panel-averaging designs that dominate the cross-country pass-through literature are, by construction, unable to answer where in the transmission chain two specific, contrasting institutional configurations diverge. Second, on interpretation: the paper shows that "liberalized" and "regulated" fuel-pricing regimes do not uniformly amplify or suppress pass-through; they can instead route the same external shock through different

channels, at different speeds, and it is this channel-specific pattern , not a single aggregate elasticity , that carries the policy content. Third, on method: the paper demonstrates, through the FX decomposition and core-CPI extensions, how a disagreement between the bounds F- and t-tests, and the sensitivity (or lack thereof) of a coefficient to an alternative specification, can be used diagnostically to distinguish a genuine institutional finding from an econometric artifact, rather than defaulting to the more convenient of two conflicting test results.

The remainder of the paper proceeds as follows. Section 2 reviews the relevant literature on oil-price pass-through and its institutional determinants. Section 3 describes the institutional background of the two fuel-pricing and exchange-rate regimes. Section 4 details the data and variable construction. Section 5 sets out the econometric methodology. Section 6 presents the baseline results. Section 7 reports robustness checks and extensions organized around four questions raised in the course of this research. Section 8 discusses the economic interpretation and policy implications. Section 9 concludes.

2 Literature Review

A large body of research confirms that international oil-price shocks pass through to domestic inflation, but that this pass-through is incomplete, has weakened over recent decades, and is asymmetric, with price increases transmitting more forcefully than decreases (Hooker, 2002; Salisu et al., 2017). Hooker (2002) documents a structural break in the United States after which oil shocks largely ceased to feed core inflation, establishing that pass-through is time-varying and can decline discretely, an insight that motivates close attention to the possibility of a regime change around Morocco's December 2015 fuel-price liberalization. Blanchard and Galí (2010) attribute the milder inflationary response to oil shocks observed in the 2000s, relative to the 1970s, to more credible monetary policy, lower energy intensity, and greater wage flexibility, while De Gregorio et al. (2007) show, across roughly thirty economies, that pass-through is lower where oil intensity, exchange-rate pass-through, and trend inflation are themselves low. Choi et al. (2018), the modern cross-country benchmark, estimate that a 10% rise in global oil-price inflation raises domestic inflation by roughly 0.4 percentage points on impact, fading within about two years, with the effect larger for positive shocks and strongest where the transport share of the CPI basket is high and energy is subsidized. Taken together, this literature supports the premise on which the present study rests: differences in pass-through across countries are driven less by an advanced-versus-developing-economy divide than by institutions, the exchange-rate regime, monetary credibility, the weight of energy in the CPI, and the mechanism by which fuel prices are set.

2.1 The exchange-rate and credibility channel

Because oil is invoiced in US dollars, Cuñado and Pérez de Gracia (2005) show that its inflationary effect is significantly stronger when measured in local-currency terms, so that currency movements amplify transmission independently of the dollar oil price itself. Taylor (2000) supplies the underlying mechanism: firms pass a cost shock through to prices fully only when they expect it to persist, and a credible, low-inflation monetary regime lowers that expected persistence, thereby weakening pass-through. Consistent with this, Gagnon and Ihrig (2004) and Mishkin (2008) find that more credible, anti-inflationary monetary policy is associated with lower exchange-rate pass-through and better-anchored inflation expectations, allowing central banks to look through first-round price effects while remaining vigilant against second-round wage-price spillovers. Campa and Goldberg (2010) add that a country's CPI sensitivity to the exchange rate rises with import content and falls with distribution margins, a mechanism directly relevant to the comparison below, since Morocco's liberalized downstream fuel market and North Macedonia's regulated one imply different margin structures through which currency movements must pass. This channel structures the comparative hypothesis directly: Morocco's comparatively flexible exchange rate should, in principle, transmit oil shocks more strongly than North Macedonia's hard euro peg, which by construction suppresses the exchange-rate channel against the euro, though, as Section 3 discusses, not necessarily against the US dollar, in which oil is invoiced.

2.2 The fuel-pricing regime channel

The second institutional channel is the fuel-pricing regime itself, on which the two countries diverge sharply. Morocco is cited by the IMF (2017) as a reform success that eliminated the great majority of fuel subsidies through a phased liberalization completed by end-2015. Bentour (2015), using an input-output cost-push framework, models this liberalization as a shock that added inflationary pressure precisely because subsidies had previously suppressed measured inflation, and explicitly recommends a more flexible exchange-rate framework to help absorb external oil shocks going forward, a recommendation Morocco's managed-float regime partially satisfies relative to North Macedonia's hard peg. North Macedonia, by contrast, operates an administered regime in which the Energy Regulatory Commission (ERC) sets maximum retail prices for oil derivatives on a fixed schedule, via a formula indexed to international quotations, regulated distribution margins, and taxes (ERC, 2024), producing a smoothed, rule-based rather than freely market-determined transmission process. The literature's working expectation is that liberalized, market-based pricing should make pass-through faster and more direct, while administered pricing should make it slower, though regulation can also *prolong* rather than uniformly suppress pass-through, a nuance the present paper's results bear out in a specific and unanticipated way.

2.3 Methodological precedents

Methodologically, this comparison follows the strand of the pass-through literature that models inflation dynamics in Autoregressive Distributed Lag (ARDL) form. Sek et al. (2015) provide the closest direct template, estimating a pass-through equation in ARDL form and finding that oil affects inflation directly in low-oil-dependency economies but indirectly, through production costs, in high-dependency ones. Živkov et al. (2019) offer the nearest regional analogue for North Macedonia, finding pass-through in Central and Eastern Europe to be low on average and concentrated at longer horizons, implying that indirect, second-round effects dominate in this region, a finding the present paper's core-CPI extension speaks to directly. The ARDL bounds-testing procedure of Pesaran et al. (2001) tests for the existence of a long-run relationship among variables without requiring them to be pre-classified as $I(0)$ or $I(1)$, provided none is $I(2)$, and its nonlinear (asymmetric) extension (Shin et al., 2014) permits a formal test of the up-versus-down asymmetry documented throughout this literature; the exchange-rate direction-and-size decomposition in Section 7 draws on this logic without imposing the full nonlinear ARDL apparatus.

2.4 Country-specific evidence

For Morocco, the direct evidence is informative but mixed. Balamou and El Baz (2025) find no clear structural break in oil-to-inflation pass-through at the 2015 liberalization date, an apparent complication for the present hypothesis that must be read with caution: liberalization coincided almost exactly with the collapse of Brent from roughly USD 110 to USD 30 a barrel, so that domestic prices fell precisely when strong upward pass-through could not be observed, mechanically obscuring any regime change over a short post-liberalization window. Complementary studies trace specific links in the transmission chain: Drar and Aoufir (2024) find that a 1% rise in the imported gasoil price raises the Moroccan pump price by approximately 0.30%, with no significant asymmetry, while El Amri et al. (2021), using a structural VAR, find exchange-rate pass-through to consumer prices to be positive but incomplete and delayed. Sekkach and Boubrahimi (2022) examine oil-price volatility and Moroccan GDP more broadly. Together, these results suggest that Moroccan CPI pass-through may remain muted and lagged even in a liberalized pricing environment, consistent with, though not identical to, the muted Stage 1 oil coefficient this paper documents.

For North Macedonia, the evidence must be drawn largely from regional studies in which the country is embedded rather than isolated. Minasyan et al. (2023) decompose Western Balkan inflation into external and domestic drivers and find both matter, without isolating an oil-specific estimate for North Macedonia individually. Baba and Lee (2022) show that pass-through to wages and prices in Europe is state-dependent, higher under high inflation, lower under credible monetary policy, and higher in emerging than advanced economies, mapping directly onto this paper's comparative hypothesis. Ramadani Mehmedi (2024) provides the closest Western Balkan energy-inflation estimate specific to the

region and finds North Macedonia's inflation structurally below the regional baseline, though energy is proxied there by electricity prices on an annual frequency. The IMF (2024) documents that North Macedonia's euro peg has delivered nominal stability but only modest interest-rate pass-through, limiting the traction of monetary policy through the conventional interest-rate channel, a finding directly consistent with the statistically insignificant policy-rate coefficients this paper estimates in both countries' Stage 2 specifications. A related IMF Selected Issues analysis (IMF, 2025) notes that although the euro peg mutes the exchange-rate channel against the euro, North Macedonia's energy weight in the CPI basket is high and import dependence substantial, which can raise and prolong, rather than uniformly suppress, pass-through, a nuance consistent with the stronger short-run oil coefficient this paper finds for North Macedonia's Stage 1.

In sum, the literature establishes that oil-price pass-through is real, incomplete, asymmetric, and institutionally determined, but it has not, to our knowledge, placed Morocco's liberalized configuration and North Macedonia's regulated, pegged configuration within a single comparative ARDL framework over a common, recent monthly sample. By doing so for 2010,2025, this paper isolates how these specific institutional differences shape the size and the speed of oil-price pass-through, a question the panel-averaging designs dominating the cross-country literature cannot, by construction, answer at the level of an individual country pair.

3 Institutional Background

3.1 Morocco: liberalization and a managed exchange rate

Morocco eliminated most fuel subsidies through a phased liberalization completed by end-2015, following a reform sequence that began in June 2012; subsidy spending fell from roughly 5,6% of GDP toward 1,2% over this period (World Bank/ESMAP). Bentour (2015) models this liberalization as a cost-push shock that removed a subsidy which had previously suppressed measured inflation and recommends a more flexible exchange-rate framework to help absorb external oil shocks going forward. Morocco's exchange-rate regime has itself evolved toward greater flexibility, with the dirham's fluctuation band widened in stages since 2018, though the regime remains a managed float rather than a freely floating currency. Since liberalization, retail fuel prices in Morocco are set by individual distributors within a competitive downstream market, without a binding regulatory price schedule, creating room, at least in principle, for distributor margins to absorb part of an international price movement rather than passing it through mechanically.

3.2 North Macedonia: administered pricing and a euro peg

North Macedonia's Energy Regulatory Commission (ERC) sets maximum retail prices for oil derivatives on a fixed schedule, adjusting prices every seven days according to a formula that incorporates the international quotation for the relevant petroleum product, a regulated distribution margin, applicable taxes, and the US-dollar exchange rate (ERC, 2024). This is an administered rather than a market-determined pricing mechanism: because the formula is mechanically indexed to international quotations on a short, fixed cycle, and because the permitted margin is itself regulated rather than freely set by distributors, there is comparatively little scope for discretionary smoothing of an international price movement before it reaches the pump.

Formally, Article 3 of the ERC's *Rulebook on the Formation of the Highest Retail Prices of Different Oil Derivatives and Transport Fuels* (ERC, 2020) sets the highest basic price of each oil derivative as

$$C_{max} = \left[\left(\frac{\sum_{i=1}^{n} FOB\,Med_i \cdot K_i}{n} + P \cdot K_i\right) \cdot \frac{\rho_e}{\rho_d} + T \cdot K_i\right] \cdot \frac{\rho_d}{1000} + D,$$

where C_{max} (MKD/l) is the highest basic price of the derivative; $FOB\,Med_i$ (USD/t) is the average daily "Mediterranean cargoes FOB (Italy)" quotation published in Platts European Marketscan for day i of the seven-day calculation period; K_i (MKD/USD) is the National Bank of the Republic of North Macedonia's middle exchange rate on day i; n is the number of days in the calculation period for which

$FOB\ Med_i$ is published; ρ_d and ρ_e (kg/l) are, respectively, the de-escalated and escalated densities of the derivative; P and T (USD/t) are the premium and transport-to-storage compensations; and D (MKD/l) is the compensation for storage and operating costs and the trade margin, inclusive of transport from storage to the pump. The highest retail price is then C_{max} plus the prescribed excise duty and VAT (Art. 6). Critically for the empirical analysis below, the ERC recalculates C_{max} every Monday, while ρ_d, ρ_e, P, T, and D are reset only twice yearly (Art. 5); nearly all of the formula's week-to-week movement is therefore driven mechanically by the two terms this paper's Stage 1 targets directly, $FOB\ Med_i$ and K_i, leaving essentially no room for discretionary smoothing between resets.

The denar (MKD) has, since 1997, maintained a de facto hard peg to the euro, managed by the National Bank of the Republic of North Macedonia, which has delivered a high degree of nominal exchange-rate stability against the euro and is widely credited with anchoring inflation expectations in a small, trade-open economy (IMF, 2024).

3.3 The peg does not neutralize oil-price currency exposure

A point easily overlooked in a hard-peg narrative is that the denar's peg is to the *euro*, while Brent crude is invoiced in *US dollars*. The peg therefore stabilizes the MKD/EUR rate by construction, but leaves the MKD/USD rate, the rate that actually matters mechanically for an oil-price shock, both directly and through the ERC formula's own USD-indexation via K_i in Equation (1) , free to move with the EUR/USD cross rate. Table 1 reports the coefficient of variation and month-on-month volatility of each country's dollar exchange rate over the sample. North Macedonia's MKD/USD rate exhibits a *higher* coefficient of variation (9.03%) and higher month-on-month volatility (1.92%) than Morocco's MAD/USD rate (7.62% and 1.57%, respectively), the opposite of what a simple "hard peg equals low currency exposure" reading would suggest. This is a first indication that the hard peg, while successfully suppressing pass-through through the specific mechanism the original hypothesis emphasized (denar volatility against the euro), does not shield North Macedonia from oil-price-driven currency exposure through the dollar-invoicing channel , a distinction the results in Sections 6,8 return to repeatedly.

Table 1: Exchange-rate variability against the US dollar, 2010,2025

Country (pair)	Mean	Std. dev.	CV (%)	MoM volatility (%)
Morocco (MAD/USD)	9.27	0.71	7.62	1.57
North Macedonia (MKD/USD)	52.36	4.73	9.03	1.92

Note: Month-on-month volatility is the standard deviation of the monthly log-difference of the exchange rate. Despite North Macedonia's hard peg of the denar to the euro, its MKD/USD rate is more variable, not less, than Morocco's managed MAD/USD rate, because oil is invoiced in US dollars while the peg targets the euro.

4 Data and Variable Construction

4.1 Sample and sources

The analysis uses monthly data for Morocco and North Macedonia from January 2010 to December 2025 ($T = 192$). Six series were collected for each country: the international Brent crude oil price (World Bank Commodity Price Data / FRED, USD), the headline Consumer Price Index (national statistical offices, via IMF International Financial Statistics), the Transport CPI sub-index, the nominal exchange rate against the US dollar, and the central bank policy rate (Bank Al-Maghrib for Morocco; the National Bank of the Republic of North Macedonia for North Macedonia). Source and access date were recorded for each series. Morocco's policy rate, revised only at Bank Al-Maghrib's quarterly monetary policy meetings, was converted to a monthly series by carrying the prevailing rate forward until the next revision, so that the resulting series reflects the rate in effect each month. Two isolated missing observations in North Macedonia's Transport CPI series (June 2019 and March 2020) were filled by linear interpolation between adjacent months; no other missing observations were identified.

4.2 The fuel-price proxy

The paper uses the Transport CPI sub-index, rather than raw retail pump-price data, as the proxy for domestic fuel prices. This choice is driven by data availability and by an identification concern, not by convenience alone. Consistent, monthly pump-price series proved unavailable across the full 2010,2025 sample for both countries: Morocco's fuel prices were regulated until the December 2015 liberalization and market-determined thereafter, making a single continuous pump-price series methodologically ambiguous across the two pricing regimes, while North Macedonia's pump-price data is fragmented across sources and formats. Transport CPI, compiled with a harmonized national-accounts methodology by each country's statistical office, is the component of headline CPI that mechanically incorporates fuel costs, and its use as a fuel-price proxy in comparative pass-through studies has direct precedent in the literature (Choi et al., 2018; Minasyan et al., 2023). Using Transport CPI as a regressor, rather than a raw fuel-price series, also avoids a mechanical correlation problem: because fuel prices are themselves a component of headline CPI, including a raw fuel-price series as both a component of the dependent variable and an independent regressor would confound the estimated pass-through elasticity.

4.3 Variable transformations

All price-level variables (CPI, Transport CPI, oil, and the exchange rate) enter the model in natural logarithms, so that estimated coefficients are directly interpretable as elasticities. The exchange rate is defined as units of local currency per US dollar, so that an increase corresponds to a nominal depreciation. The policy rate enters in levels, since it is already expressed as a percentage and a logarithmic transformation of a rate that can approach zero is not economically meaningful. Headline inflation is constructed as

$$\pi_t = 100 \times [\ln(\mathrm{CPI}_t) - \ln(\mathrm{CPI}_{t-1})],$$

the standard month-on-month definition of the inflation rate, and, unlike the CPI level itself, expected to be stationary or near-stationary, a property required for the subsequent econometric analysis.

4.4 Descriptive overview

Table 2 reports descriptive statistics for the core variables in log form (levels), and Figure 1 plots all six raw and transformed series for both countries over the sample. Figure 2 isolates the Transport CPI proxy, with Morocco's December 2015 liberalization date marked. Two features are visible immediately. First, North Macedonia's Transport CPI is both higher on average and substantially more volatile than Morocco's over 2020,2025, consistent with a pricing mechanism that adjusts quickly and directly to international conditions. Second, Morocco's Transport CPI shows a distinct level shift around the 2015 liberalization date, moving from a low, relatively flat pre-2015 path to a more oil-correlated post-2015 path, motivating the structural-break robustness check reported in Section 7.

Table 2: Descriptive statistics, log levels (unless noted), 2010,2025

Country	Variable	n	Mean	SD	Min	Max	Skew.
Morocco	ln(CPI)	192	4.627	0.086	4.500	4.790	0.68
Morocco	ln(Oil)	192	4.298	0.341	2.911	4.832	−0.70
Morocco	ln(Transport)	192	4.648	0.083	4.542	4.838	0.73
Morocco	ln(Exch. rate)	192	2.224	0.077	2.059	2.395	−0.34
Morocco	Policy rate (%)	192	2.499	0.554	1.500	3.250	−0.36
Morocco	Inflation (%, MoM)	191	0.145	0.517	−1.101	1.775	0.47
N. Macedonia	ln(CPI)	192	4.309	0.140	4.130	4.625	1.06
N. Macedonia	ln(Oil)	192	4.298	0.341	2.911	4.832	−0.70
N. Macedonia	ln(Transport)	192	4.720	0.119	4.535	5.003	0.71
N. Macedonia	ln(Exch. rate)	192	3.954	0.092	3.753	4.139	−0.48
N. Macedonia	Policy rate (%)	192	3.636	1.495	1.250	8.000	0.45
N. Macedonia	Inflation (%, MoM)	191	0.259	0.611	−1.539	2.738	0.63

Note: The Brent oil series is common to both countries by construction.

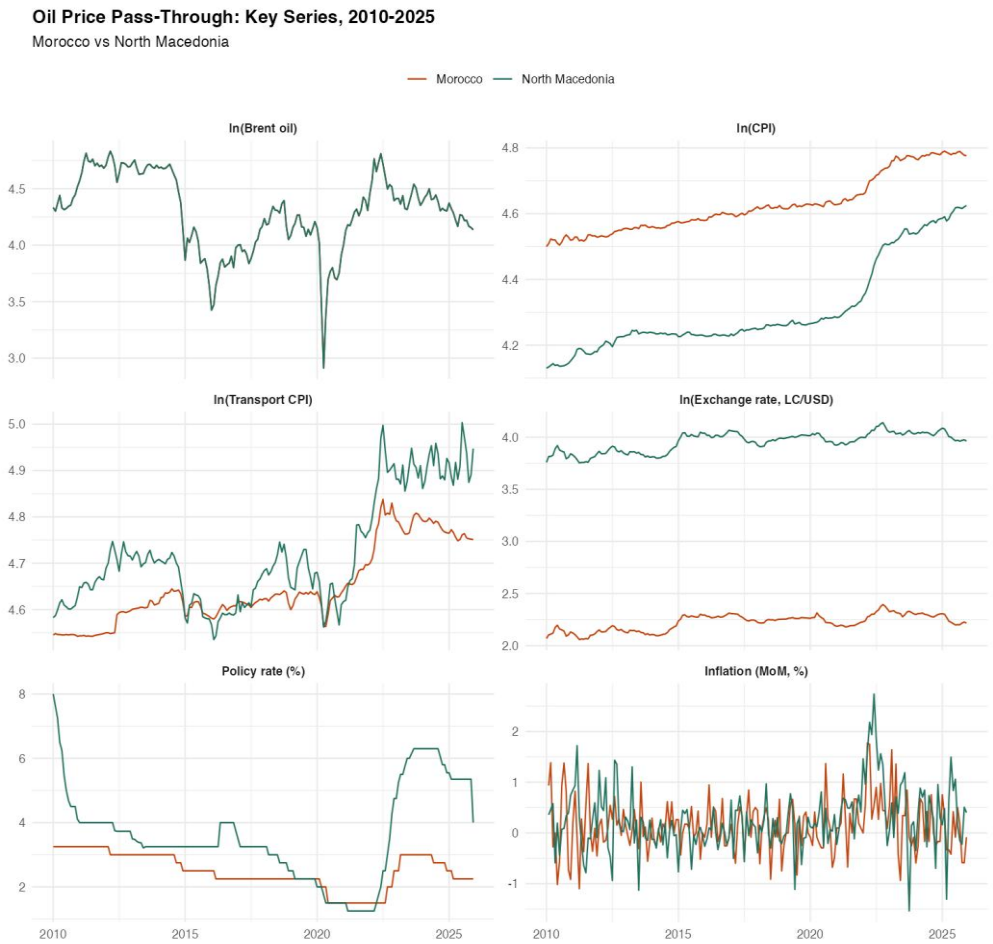

Figure 1: Key series, Morocco vs. North Macedonia, 2010,2025. Panels show log Brent oil, log CPI, log Transport CPI, log exchange rate (local currency per USD), the policy rate, and month-on-month inflation.

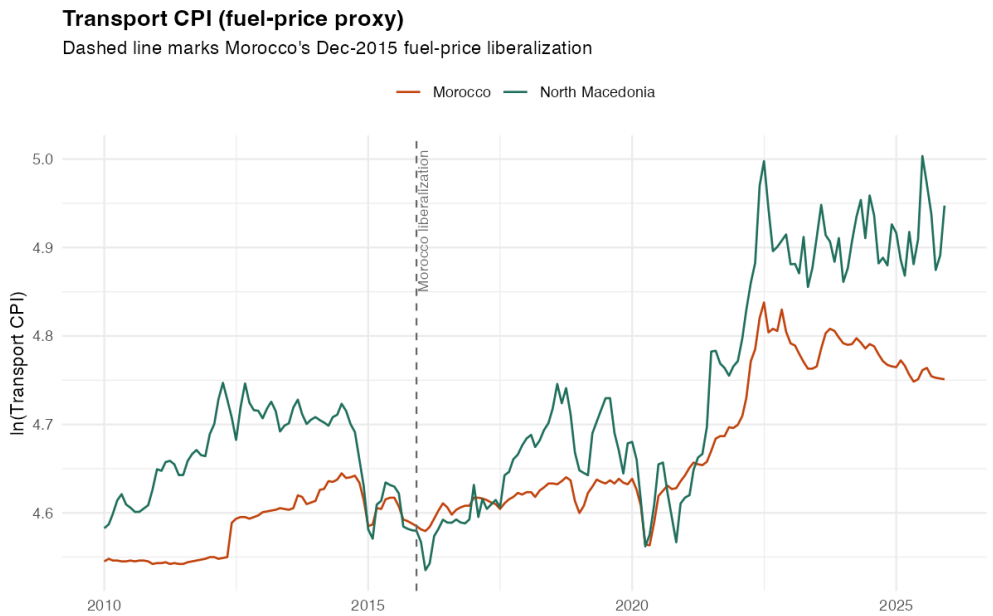

Figure 2: Transport CPI (fuel-price proxy), Morocco vs. North Macedonia. The dashed line marks Morocco's December 2015 fuel-price liberalization.

5 Econometric Methodology

5.1 Unit root testing

Before estimating any dynamic model, each series was tested for stationarity using the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests (null hypothesis: the series has a unit root) and the KPSS test (null hypothesis: the series is stationary), applied to both the level and first-differenced form of every variable. Table 3 summarizes the results. All price-level variables in both countries were non-stationary in levels and stationary after first-differencing, consistent with an $I(1)$ process; no series was found to be integrated of order two. Two minor disagreements among the three tests are worth flagging: North Macedonia's first-differenced CPI and policy rate each show one test (KPSS and ADF, respectively) failing to reject at the 5% level even after differencing, which we attribute to the tests' known low power in finite samples of this size rather than evidence of $I(2)$ behavior, especially given that the other two tests concur in both cases. This confirms that the ARDL bounds-testing framework, which requires only that no regressor be $I(2)$, is appropriate for this application.

Table 3: Unit root test summary (level vs. first difference)

Country	Series	ADF p	PP p	KPSS p	Conclusion
Morocco	ln(CPI), level	0.755	0.897	0.010	Non-stationary
Morocco	ln(CPI), 1st diff.	0.010	0.010	0.100	Stationary
Morocco	ln(Oil), level	0.534	0.516	0.014	Non-stationary
Morocco	ln(Oil), 1st diff.	0.010	0.010	0.100	Stationary
Morocco	ln(Transport), level	0.503	0.609	0.010	Non-stationary
Morocco	ln(Transport), 1st diff.	0.010	0.010	0.064	Stationary
Morocco	ln(Exch.), level	0.513	0.451	0.010	Non-stationary
Morocco	ln(Exch.), 1st diff.	0.010	0.010	0.130	Stationary
Morocco	Policy rate, level	0.430	0.830	0.010	Non-stationary
Morocco	Policy rate, 1st diff.	0.010	0.010	0.131	Stationary
N. Macedonia	ln(CPI), level	0.955	0.990	0.010	Non-stationary
N. Macedonia	ln(CPI), 1st diff.	0.010	0.010	0.024**	Stationary*
N. Macedonia	ln(Transport), level	0.764	0.662	0.010	Non-stationary
N. Macedonia	ln(Transport), 1st diff.	0.010	0.010	0.100	Stationary
N. Macedonia	ln(Exch.), level	0.400	0.292	0.010	Non-stationary
N. Macedonia	ln(Exch.), 1st diff.	0.010	0.010	0.119	Stationary
N. Macedonia	Policy rate, level	0.571	0.645	0.026	Non-stationary
N. Macedonia	Policy rate, 1st diff.	0.128**	0.010	0.045	Stationary*

Note: ln(Oil) is identical across countries by construction and reported once in Table 2. *Two of three tests concur; **marks the dissenting test.

5.2 Two-stage model specification

Rather than estimating a single reduced-form equation regressing headline CPI directly on oil prices, the exchange rate, and the policy rate, the transmission mechanism is decomposed into two stages. Stage 1 models the transmission of the international oil price and the exchange rate to the domestic fuel-price proxy:

$$\ln(\text{Transport CPI})_t = f(\ln(\text{Oil})_t,\ \ln(\text{Exch. rate})_t).$$

Stage 2 models the transmission of domestic fuel prices to headline inflation, controlling for the monetary policy stance:

$$\ln(\text{CPI})_t = g\big(\ln(\text{Transport CPI})_t,\ \text{Policy rate}_t\big).$$

This decomposition distinguishes *where*, in the transmission chain, the two countries' pass-through mechanisms diverge, rather than collapsing the chain into a single combined elasticity.

5.3 ARDL bounds testing for cointegration

For each stage and each country, the presence of a long-run equilibrium relationship is tested using the ARDL bounds-testing procedure of Pesaran et al. (2001). This approach is preferred over conventional cointegration tests (*e.g.* Johansen) for three reasons specific to this application: it remains valid regardless of whether the underlying regressors are $I(0)$, $I(1)$, or a mixture of the two, provided none is $I(2)$; it performs comparatively well in the finite sample available here ($T = 192$); and it recovers both short-run dynamics and a long-run equilibrium relationship from a single estimated specification.

The procedure involves estimating the unrestricted error-correction model (UECM),

$$\Delta y_t = \alpha + \sum_{i=1}^{p-1} \phi_i \, \Delta y_{t-i} + \sum_{j=0}^{q-1} \beta_j \, \Delta x_{t-j} + \theta_y y_{t-1} + \theta_x x_{t-1} + \varepsilon_t,$$

where y_t is the dependent variable of the relevant stage and x_t the vector of regressors and testing the joint null hypothesis that the lagged-level coefficients are zero, $H_0: \theta_y = \theta_x = 0$, which corresponds to the absence of a long-run relationship. The resulting F-statistic is compared against the critical value bounds tabulated by Pesaran et al. (2001) under Case III (unrestricted intercept, no trend). Because asymptotic critical values are calibrated for large samples, exact critical values obtained by simulation (10,000 replications) and matched to the actual sample size of each specification are reported instead. As Pesaran et al. (2001) also propose a complementary t-test on the error-correction term itself, both the F- and t-forms of the bounds test are reported in each case, rather than relying on the F-test alone; any disagreement between the two is treated as requiring investigation rather than selective reporting.

Lag orders (p, q) for each specification were selected by minimizing the Akaike Information Criterion (AIC) over a maximum lag order of four months. All ARDL estimation was implemented in R using the ARDL package (Natsiopoulos and Tzeremes, 2022), whose validity was independently confirmed by replicating the original results of Pesaran et al. (2001).

When a stage is found to be cointegrated, the long-run elasticity is recovered from the UECM coefficients as

$$\widehat{\mathrm{LR}}_x = -\frac{\hat{\theta}_x}{\hat{\theta}_y},$$

and the corresponding error-correction representation is estimated as

$$\Delta y_t = \alpha + \sum_{i} \phi_i \, \Delta y_{t-i} + \sum_{j} \beta_j \, \Delta x_{t-j} + \rho \, \widehat{\mathrm{ECT}}_{t-1} + \varepsilon_t, \qquad \widehat{\mathrm{ECT}}_{t-1} = y_{t-1} - \widehat{\mathrm{LR}}_x \, x_{t-1},$$

where $\rho = \hat{\theta}_y$ is the error-correction (speed-of-adjustment) term, expected to be negative and less than one in absolute value for a stable equilibrium. The implied half-life of a deviation from equilibrium is

$$h = \frac{\ln(0.5)}{\ln(1 + \rho)}.$$

Where the bounds test does *not* confirm cointegration, no long-run or error-correction interpretation is econometrically valid; in these cases, a short-run dynamic model in first-differenced variables only is estimated instead, with lag order again selected by AIC, and cumulative short-run pass-through, the sum of the contemporaneous and lagged coefficients, is reported in place of a long-run elasticity:

$$\text{Cumulative PT}_x = \sum_{j=0}^{q-1} \hat{\beta}_{x,j}.$$

5.4 Diagnostic testing

Each estimated specification was subjected to a standard battery of diagnostic tests: the Breusch-Godfrey test for residual serial correlation, the Breusch-Pagan test for heteroskedasticity, the Jarque-Bera test for normality of residuals, and the CUSUM test for parameter stability over the sample period.

Where heteroskedasticity was detected, heteroskedasticity-robust (HC1) standard errors are reported in place of conventional ones.

6 Baseline Results

6.1 Bounds testing results

Table 4 reports the bounds test results for both stages and both countries. A clear pattern emerges: **Stage 2 exhibits a robust long-run cointegrating relationship in both countries**, while **Stage 1 does not, in either country**. This asymmetry is itself informative. Fuel prices and headline CPI, both domestic price indices compiled by the same statistical offices, with Transport CPI mechanically embedded in the CPI basket, move together in a stable long-run equilibrium, as economic theory would predict. The relationship between international Brent prices, the exchange rate, and *domestic* fuel prices is evidently more complex, plausibly reflecting institutional pricing mechanisms (subsidy regimes, tax and margin structures, price-smoothing rules) that decouple the international price signal from a stable linear long-run relationship over the full sample period. Consequently, Stage 1 is estimated and reported as a short-run dynamic model only, while Stage 2 is estimated as a full ARDL error-correction model in both countries.

Table 4: ARDL bounds test results

Specification	ARDL order	F-stat.	p	$I(1)$ bound (5%)	Conclusion
Morocco, Stage 1 (fuel ← oil, FX)	(2,2,2)	0.355	0.978	4.88	No cointegration
Morocco, Stage 2 (CPI ← fuel, rate)	(1,1,0)	7.120	0.005	4.85	**Cointegration**
N. Macedonia, Stage 1 (fuel ← oil, FX)	(1,2,0)	1.500	0.703	4.84	No cointegration
N. Macedonia, Stage 2 (CPI ← fuel, rate)	(2,1,0)	5.446	0.027	4.87	**Cointegration***

Note: $I(0)$ bounds omitted for space; see Appendix Table 13. *North Macedonia's Stage 2 F-test result is qualified by a disagreeing t-test on the error-correction term.

6.2 Stage 2: fuel prices to headline CPI

6.2.1 Morocco

The selected ARDL(1,1,0) specification yields a long-run elasticity of headline CPI with respect to Transport CPI of **1.082** (SE $= 0.090$, $p < 0.001$; Table 5), statistically indistinguishable from unity, consistent with the mechanical embedding of the fuel-price sub-index within the CPI basket. The long-run coefficient on the policy rate is small and not statistically significant (-0.019, $p = 0.146$), suggesting that monetary policy's long-run offsetting effect on inflation is limited over this sample, at least through this channel. The error-correction term is $\hat{\rho} = -0.052$ (SE $= 0.011$, $p < 0.001$), confirmed by the bounds t-test ($t = -4.24$, exceeding the 5% critical bounds), implying via Equation (8) that approximately 5.2% of any deviation from the long-run equilibrium is corrected each month, a half-life of $\ln(0.5)/\ln(0.948) \approx 13$ months.

Table 5: Morocco, Stage 2 long-run coefficients (CPI ~ Transport CPI + policy rate)

Term	Estimate	Std. error	t	p
Intercept	-0.329	0.426	-0.77	0.441
ln(Transport CPI)	1.082	0.090	11.98	< 0.001
Policy rate	-0.019	0.013	-1.46	0.146

Diagnostics indicate no evidence of heteroskedasticity (Breusch-Pagan $p = 0.68$) and parameter stability over the full sample (CUSUM $p = 0.99$). The Breusch-Godfrey test indicates residual serial correlation ($p < 0.001$), robust to widening the lag search, most plausibly attributable to unmodelled seasonality in the month-on-month CPI series; we flag seasonal dummies as a robustness extension. Residuals also depart from normality (Jarque-Bera $p = 0.003$); given the sample size ($T = 192$), we do not consider this to materially threaten inference but note it as a limitation.

6.2.2 North Macedonia

The selected ARDL(2,1,0) specification presents a more delicate case (Table 6). The long-run elasticity of headline CPI with respect to Transport CPI is estimated at **2.851** (SE $= 1.398$, $p = 0.043$) , nominally significant, but with a confidence interval wide enough to be uninformative, and a point estimate difficult to justify mechanically given that Transport CPI is a sub-component of headline CPI (an elasticity near or below unity would be the theoretically expected magnitude). The long-run policy-rate coefficient is not significant (-0.086, $p = 0.260$).

Table 6: North Macedonia, Stage 2 long-run coefficients (CPI ~ Transport CPI + policy rate)

Term	Estimate	Std. error	t	p
Intercept	-8.618	6.199	-1.39	0.166
ln(Transport CPI)	2.851	1.398	2.04	0.043
Policy rate	-0.086	0.076	-1.13	0.260

Critically, while the F-bounds test rejects the null of no cointegration ($F = 5.45$, above the upper bound of 4.87), the complementary bounds t-test on the error-correction term does not ($t = -1.36$, against critical bounds of $-2.88/-3.53$, not close). Since Pesaran et al. (2001) recommend that both the F- and t-forms of the bounds test be consulted, this disagreement is reported directly rather than resolved by selective reporting of the more favorable test. Diagnostics are otherwise clean: no residual serial correlation (Breusch-Godfrey $p = 0.78$), no heteroskedasticity (Breusch-Pagan $p = 0.20$), and stable parameters over the sample (CUSUM $p = 0.68$); residuals depart from normality (Jarque-Bera $p < 0.001$), as in the Morocco specification.

6.3 Stage 1: oil and the exchange rate to domestic fuel prices

As Stage 1 shows no cointegrating relationship in either country, results are reported as short-run dynamics only, the sum of contemporaneous and one-month-lag coefficients, following Equation (9).

6.3.1 Morocco

Table 7 reports the selected short-run specification (own-lag order 1, common regressor lag order 1), estimated with HC1-robust standard errors following a significant Breusch-Pagan test ($p = 0.012$). Oil pass-through is statistically significant at both the contemporaneous horizon (0.030, $p < 0.001$) and the one-month lag (0.051, $p < 0.001$), for a cumulative short-run oil pass-through of **0.081**. Exchange-rate pass-through loads primarily on the one-month lag (0.123, $p = 0.013$) rather than contemporaneously (0.055, $p = 0.115$), for a cumulative FX pass-through of **0.178**, consistent with an operational lag typically observed between exchange-rate movements and downstream fuel-price adjustment. No evidence of residual serial correlation (Breusch-Godfrey $p = 0.33$) or parameter instability (CUSUM $p = 0.68$) is found, though residuals are markedly non-normal (Jarque-Bera $p < 0.001$), likely reflecting the small number of large-magnitude observations associated with the 2020 and 2022 oil-price shocks.

Table 7: Morocco, Stage 1 short-run coefficients (first-differenced, HC1-robust SEs)

Term	Estimate	Std. error	t	p
Intercept	0.0009	0.0005	1.82	0.071
$\Delta\ln(\text{Transport})_{t-1}$	0.109	0.077	1.41	0.160
$\Delta\ln(\text{Oil})_t$	0.030	0.007	4.45	< 0.001
$\Delta\ln(\text{Oil})_{t-1}$	0.051	0.007	6.99	< 0.001

Term	Estimate	Std. error	t	p
$\Delta\ln(\text{Exch.})_t$	0.055	0.035	1.58	0.115
$\Delta\ln(\text{Exch.})_{t-1}$	0.123	0.049	2.52	0.013

6.3.2 North Macedonia

Table 8 reports the selected specification (own-lag order 0, common regressor lag order 1). Oil pass-through is significant both contemporaneously (0.070, $p < 0.001$) and at the one-month lag (0.096, $p < 0.001$), for a cumulative short-run oil pass-through of **0.166**, roughly *twice* Morocco's. The exchange-rate response is noisier: the contemporaneous coefficient is negative and not significant (-0.093, $p = 0.221$), while the one-month lag is positive and only marginally significant (0.168, $p = 0.038$), for a cumulative FX pass-through of **0.075**, with a wide standard error (0.108). The contemporaneous sign carries limited interpretive weight given the lack of significance at that horizon; it is more likely sampling noise than a genuine overshoot-and-correct dynamic. Diagnostics show mild residual serial correlation (Breusch-Godfrey $p = 0.033$, weaker than the corresponding issue in Morocco's Stage 2), homoskedasticity, stable parameters (CUSUM $p = 0.81$), and non-normal residuals, as in all other specifications.

Table 8: North Macedonia, Stage 1 short-run coefficients (first-differenced, HC1-robust SEs)

Term	Estimate	Std. error	t	p
Intercept	0.0019	0.0016	1.19	0.235
$\Delta\ln(\text{Oil})_t$	0.070	0.017	4.13	< 0.001
$\Delta\ln(\text{Oil})_{t-1}$	0.096	0.020	4.88	< 0.001
$\Delta\ln(\text{Exch.})_t$	-0.093	0.076	-1.23	0.221
$\Delta\ln(\text{Exch.})_{t-1}$	0.168	0.081	2.09	0.038

6.4 Consolidated pass-through magnitudes

Table 9 consolidates the short-run, cumulative, and long-run coefficients across both stages and both countries, the quantity a comparative pass-through study is ultimately built around.

Table 9: Consolidated pass-through magnitudes

Country	Stage / horizon	Estimate	SE	Reliable?
Morocco	Stage 2: short-run (per 1% fuel-CPI change)	0.114	0.035	Yes
Morocco	Stage 2: long-run elasticity	1.082	0.090	Yes
Morocco	Stage 2: error-correction speed (per month)	-0.052	0.011	Yes
N. Macedonia	Stage 2: short-run (per 1% fuel-CPI change)	0.100	0.014	Yes
N. Macedonia	Stage 2: long-run elasticity	2.851	1.398	**No***
N. Macedonia	Stage 2: error-correction speed (per month)	-0.008	0.002	**No***
Morocco	Stage 1: cumulative oil pass-through	0.081	0.0075	Yes**
Morocco	Stage 1: cumulative FX pass-through	0.178	0.052	Yes**
N. Macedonia	Stage 1: cumulative oil pass-through	0.166	0.026	Yes**
N. Macedonia	Stage 1: cumulative FX pass-through	0.075	0.108	Yes**

Note: *F/t bounds tests disagree. **Short-run only; no long-run/ECM interpretation is valid in the absence of Stage 1 cointegration.

Two comparative facts anchor the paper's central results. **Oil pass-through to domestic fuel prices is roughly twice as strong in North Macedonia (0.166) as in Morocco (0.081). Exchange-rate pass-through to domestic fuel prices is roughly 2.4 times stronger in Morocco (0.178) than in North Macedonia (0.075)**, though the latter estimate carries a wide standard error and should be treated as suggestive rather than precise. The first fact runs opposite to the research premise; the second confirms it. Section 8 develops the institutional interpretation of both.

7 Robustness Checks and Extensions

This section reports four extensions undertaken in direct response to questions raised during the review of the baseline results, each of which is designed to distinguish a genuine institutional finding from a possible econometric artifact.

7.1 Is Stage 1's instability a liberalization artifact? A structural-break test

Because Morocco liberalized domestic fuel pricing in December 2015, the pooled 2010,2025 sample may mask a stable long-run relationship within one of the two pricing sub-regimes. The Stage 1 bounds test was re-estimated separately on the pre-liberalization window (January 2010, November 2015, $n = 71$) and the post-liberalization window (December 2015, December 2025, $n = 121$); results are in Table 10.

Table 10: Morocco Stage 1, structural-break robustness check

Sample	n	ARDL order	F-stat.	Conclusion
Full sample (2010,2025)	192	(2,2,2)	0.355	No cointegration
Pre-liberalization (2010, Nov. 2015)	71	(1,0,0)	5.073	Cointegration (marginal)*
Post-liberalization (Dec. 2015,2025)	121	(1,2,2)	0.219	No cointegration

The results do *not* support a simple "liberalization created the long-run relationship" narrative. If anything, the marginal evidence of cointegration is concentrated in the *subsidized* pre-2015 period, while the liberalized post-2015 period, which also spans three distinct global oil-price shocks (the 2014,16 collapse, the 2020 COVID-19 collapse, and the 2022 Russia-Ukraine spike), shows no long-run relationship at all. We interpret this as evidence that the Stage 1 relationship is genuinely unstable over the sample period, rather than a two-regime problem solvable by a simple sample split and note that the pre-liberalization result should not be over-interpreted as strong evidence of cointegration given how narrowly it clears the bound on a sample of only 71 months. Section 8.4 discusses what, short of the liberalization date alone, may plausibly be driving this instability.

7.2 Does the oil coefficient survive controlling for FX direction and size?

A natural concern is that Morocco's comparatively muted Stage 1 oil coefficient (0.081, against North Macedonia's 0.166) is a statistical artifact of how the exchange-rate term is specified, that is, that currency movements are partly *absorbing* or confounding the estimated oil effect when FX is entered as a single signed variable. To test this, the exchange-rate term is decomposed, NARDL-style (Shin et al., 2014), into its positive and negative parts,

$$\Delta\ln(\mathrm{FX})_t^+ = \max(\Delta\ln(\mathrm{FX})_t,\, 0), \qquad \Delta\ln(\mathrm{FX})_t^- = \max(-\Delta\ln(\mathrm{FX})_t,\, 0),$$

representing, respectively, the size of a depreciation and the size of an appreciation in a given month, and Stage 1 is re-estimated with $\Delta\ln(\mathrm{FX})_t^+$ and $\Delta\ln(\mathrm{FX})_t^-$ (and their one-month lags) entered separately in place of the single signed term. A second specification adds an interaction between the oil term and a depreciation dummy, $\Delta\ln(\mathrm{Oil})_t \times \mathbb{1}[\Delta\ln(\mathrm{FX})_t > 0]$, to test whether oil pass-through itself differs in months when the currency is simultaneously depreciating. Table 11 reports the oil coefficients across all three specifications for both countries.

Table 11: Oil coefficient stability under FX direction/size decomposition (Stage 1)

Country	Specification	$\Delta\ln(\mathrm{Oil})_t$	p	$\Delta\ln(\mathrm{Oil})_{t-1}$	p
Morocco	Baseline (signed FX)	0.030	< 0.001	0.051	< 0.001
Morocco	FX direction + size	0.029	< 0.001	0.050	< 0.001
Morocco	Oil × depreciation dummy	0.040^a	< 0.001	0.051	< 0.001
N. Macedonia	Baseline (signed FX)	0.070	< 0.001	0.096	< 0.001
N. Macedonia	FX direction + size	0.071	< 0.001	0.095	< 0.001
N. Macedonia	Oil × depreciation dummy	0.077^a	< 0.001	0.098	< 0.001

Note: HC1-robust standard errors; $n = 190$ in all specifications. [a]Coefficient on $\Delta\ln(\text{Oil})_t$ in the presence of the interaction term is not directly comparable to the other rows, as it represents the effect when the depreciation dummy equals zero. The interaction term itself is small and statistically insignificant in both countries (Morocco: -0.015, $p = 0.237$; North Macedonia: -0.014, $p = 0.675$), indicating that oil pass-through does not differ significantly between depreciation and appreciation months in either country.

The oil coefficient is essentially unchanged by the FX decomposition in both countries: Morocco's contemporaneous and one-month-lag oil coefficients move from 0.030/0.051 to 0.029/0.050, and North Macedonia's from 0.070/0.096 to 0.071/0.095. This rules out the FX-confounding hypothesis: Morocco's muted oil pass-through, relative to North Macedonia's, is not a byproduct of how the exchange-rate term is specified and must instead reflect something about the two countries' fuel-pricing mechanisms themselves rather than a statistical artifact of the currency channel. This finding is central to the interpretation developed in Section 8.1.

The decomposition does, however, surface an asymmetry in the FX channel itself worth noting cautiously. For Morocco, the size of a same-month currency *appreciation* carries a marginally significant negative coefficient (-0.105, $p = 0.054$) while the size of a same-month *depreciation* is small and insignificant (0.016, $p = 0.77$); the depreciation effect instead loads, more strongly and significantly, on the one-month lag (0.202, $p = 0.029$). This pattern , appreciation-driven relief arriving quickly, depreciation-driven cost increases arriving with a one-month lag , is the opposite of the "rockets and feathers" asymmetry often reported in retail fuel markets, where prices rise quickly and fall slowly; given the marginal significance of the individual coefficients involved, this is flagged as a pattern worth investigating in future work with a longer, dedicated asymmetric-pass-through design, rather than a finding this paper can support strongly on its own. For North Macedonia, the appreciation-size coefficient is positive and only marginally significant (0.292, $p = 0.057$) with a wide standard error, which is more plausibly noise than an informative signal, consistent with the comparatively small number of sizeable appreciation months against a currency whose broad path is anchored by the euro peg.

7.3 Direct versus indirect pass-through: a core-CPI extension

Stage 2's headline-CPI coefficient necessarily mixes two economically distinct effects: the *direct*, mechanical effect of fuel's own weight in the CPI basket, and any *indirect*, cost-push effect operating through transport and production costs elsewhere in the basket. To separate these, Stage 2 is re-estimated with core CPI (excluding food and energy) as a second dependent variable, using the same regressors and the same fuel-price proxy. If core CPI still responds significantly to the fuel shock, this is evidence of an indirect channel operating beyond the direct, mechanical effect; if core CPI does not respond, most of headline pass-through is the direct effect.

7.3.1 Constructing a comparable core CPI

No official Moroccan core-CPI series matches North Macedonia's food-and-energy exclusion definition: Bank Al-Maghrib's published "inflation sous-jacente" excludes a *different* basket (volatile- and administered-price items, not food and energy specifically) and is therefore not comparable. A Moroccan core CPI matching North Macedonia's definition as closely as possible was reconstructed from HCP's published divisional sub-indices using a residual-weight method: given headline growth g_{total} and the growth rates and basket weights of food ($w_{\text{food}} = 35.535\%$), energy ($w_{\text{energy}} = 5.849\%$), and a fuel-use proxy ($w_{\text{fuel}} = 4.782\%$, an imperfect proxy for North Macedonia's narrower 07.2.2 fuel category, as it also includes vehicle spare parts and maintenance), the implied growth rate of the residual "core" basket is

$$g_{\text{core},t} = \frac{w_{\text{total}}\, g_{\text{total},t} - w_{\text{food}}\, g_{\text{food},t} - w_{\text{energy}}\, g_{\text{energy},t} - w_{\text{fuel}}\, g_{\text{fuel},t}}{w_{\text{total}} - w_{\text{food}} - w_{\text{energy}} - w_{\text{fuel}}},$$

chained into an index from a base of 100. North Macedonia's core CPI was extracted directly from an official pre-built series. Both series are available only for January 2018, December 2025 ($n = 96$), a genuine data-availability constraint on this extension, not a design choice. To ensure the headline-versus-

core comparison is not confounded by a different sample window, headline CPI's Stage 2 was also re-estimated on this same 2018,2025 subperiod, rather than compared against the original 2010,2025 headline results.

7.3.2 Results

Table 12 reports the fuel-proxy coefficient from all four models: headline and core CPI, for both countries, on the common 2018,2025 subperiod.

Table 12: Core-CPI extension: fuel-proxy coefficient, headline vs. core, 2018,2025 subperiod

Country	Dependent variable	Model	Coefficient	p
Morocco	Headline CPI	ECM, long-run	1.056	< 0.001
Morocco	Core CPI	Short-run diff. only (not cointegrated)	-0.070	< 0.001
N. Macedonia	Headline CPI	ECM, long-run	-7.582	0.720
N. Macedonia	Core CPI	ECM, long-run	2.552	0.184

Two results stand out, and both call for a cautious rather than a strong reading. First, Morocco's headline coefficient on this shorter 2018,2025 subperiod (1.056) closely reproduces the full-sample estimate (1.082), which is reassuring for the reliability of the subperiod restriction itself; but Morocco's core-CPI coefficient is *negative* and significant (-0.070, $p < 0.001$) on a model that is not cointegrated. A negative core response is not the pattern a simple cost-push story predicts, and the evidence does not support reading it as a genuine, structural indirect-channel effect; it more plausibly reflects noise introduced by the residual-based construction of the Moroccan core series (Equation (11) nets out three subcomponents from headline growth, so any measurement error or weight misspecification , particularly in the imperfect 07.2.2 fuel proxy , propagates directly and can induce spurious negative correlation) or a genuine but different phenomenon, such as a relative-price substitution effect, that this design cannot distinguish from measurement artifact. It is reported here for completeness and flagged explicitly as requiring a better core-CPI construction (ideally an official Moroccan series with an exact food-and-energy exclusion) before it is treated as evidence either way.

Second, North Macedonia's headline coefficient on this subperiod (-7.582, $p = 0.720$) is both the wrong sign and statistically indistinguishable from zero, a sharp departure from the full-sample estimate (2.851, $p = 0.043$, itself already flagged as unreliable given the F/t bounds-test disagreement). Because this instability appears in the *headline* re-estimation, not only the core one, it indicates that the shorter 96-month subperiod lacks the statistical power to identify North Macedonia's Stage 2 relationship at all, rather than revealing a genuine headline-versus-core contrast. North Macedonia's core-CPI coefficient (2.552, $p = 0.184$) is consequently also uninformative on its own terms. The core-CPI extension is thus directionally useful for Morocco, where it does not support a strong indirect cost-push channel beyond the direct, mechanical fuel-in-the-basket effect, though the negative sign warrants a better core series before this conclusion is drawn firmly, but inconclusive for North Macedonia, for reasons of sample power rather than economic substance. We return to this distinction in Section 8.4 and flag improved core-CPI data as a priority for future work.

8 Discussion: Why, and So What

The findings above raise four questions of economic substance. This section addresses each briefly, in plain terms, focusing on what the results mean rather than on how they were obtained.

8.1 Why does the oil channel reverse the hypothesis, and who absorbs the shock in Morocco?

The reversal is not a currency illusion (Section 7.2); it reflects how each country's fuel-pricing system is built. North Macedonia's regulator resets fuel prices every week using a formula tied directly to the world price, with margins it sets itself rather than leaves to the market , a mechanical conduit that lets an oil shock through largely intact because the system has no room, by design, to soften it. Morocco's liberalized market instead lets distributors set prices competitively, and its much smaller response to oil

moves is consistent with distributors absorbing part of a cost shock into their own margins, particularly when they expect it to be temporary, rather than with any weaker exposure to oil itself.

The deeper contrast is between a mechanical channel with no discretion and a buffer that exists only because market participants choose to sustain it. North Macedonia transmits an oil shock because it has no institutional means of doing otherwise; Morocco absorbs one only for as long as distributors are willing and able to accept thinner margins, a matter of competitive business behaviour, not obligation, and for that reason inherently more fragile than a designed buffer. This distinction motivates the asymmetric recommendations of Section 9: North Macedonia's fast, low-cost pricing leaves consumers with no built-in cushion against a spike, which argues for a modest, rules-based smoothing mechanism; Morocco's cushion is cheaper than a subsidy but informal and could give way under sustained high oil prices, which argues for direct monitoring of fuel retail margins.

This margin-absorption account rests on elimination rather than direct observation, and the distinction is worth making explicit. Section 7.2's FX decomposition rules out currency confounding, taxation is not the object of study and shows no significant change over the relevant window, and Drar and Aoufir (2024) independently corroborate an incomplete pump-price response (approximately 0.30% per 1% oil move) consistent with this paper's own 0.081 estimate. Margins are, in effect, the one channel Morocco's post-2015 institutional structure leaves open for discretion once currency and taxation are set aside; the paper cannot, however, observe distributor margins directly (Section 10), so this remains an inference from institutional structure rather than a measured fact.

A further qualification concerns how competitive Morocco's downstream fuel market is Standard industrial-organization theory predicts that a genuinely competitive market, with price close to marginal cost, has little spare margin to absorb a cost shock, so *full*, not muted, pass-through is the competitive benchmark; a market with room to selectively smooth a shock is, if anything, more consistent with pricing power than with textbook competition. This is not merely a theoretical concern: Morocco's Competition Council found, following an investigation opened in 2020, that three companies hold roughly 60% of the diesel and gasoline distribution market and identified coordinated pricing practices inconsistent with free competition, resulting in a November 2023 settlement of approximately MAD 1.84 billion (Competition Council of Morocco, 2023). If muted pass-through partly reflects market power rather than competitive discipline, the smoother pump prices documented here may come bundled with a persistently higher average markup, a volatility-for-level trade-off that reframes Section 9's monitoring recommendation as a competition-policy concern, not only a macroeconomic one.

A contemporaneous episode outside the sample lends indirect support to the North Macedonian side of this comparison. Facing renewed cost-of-living pressure in 2026, the government paired the standing ERC formula with a sequence of temporary, decree-based measures , a fuel VAT reduction from 18% to 10% under a state-of-crisis declaration, a Brent-linked variable excise-tax reduction (roughly 4 MKD/l on diesel and 2 MKD/l on gasoline), and a short-lived margin concession negotiated with the dominant wholesale distributor, OKTA (approximately 2 MKD/l) , each repeatedly extended through mid-2026.[2] That authorities judged such intervention necessary is consistent with Section 3.2's account of a formula with little built-in discretion. The form it took, however, is instructive: ad hoc fiscal relief, renewed episodically around crisis windows, reintroduces exactly the budgetary exposure that a formula-internal rule such as Equation (12) is designed to avoid, and is arguably harder to insulate from short-term political timing than a standing, pre-committed k/γ rule embedded in the Rulebook itself.

8.2 Is North Macedonia's slow price adjustment genuine persistence, or a limit on what monetary policy can do?

Morocco's inflation reliably settles back toward its normal relationship with fuel prices after a shock; North Macedonia's does not show this pattern with any confidence. Read alongside the IMF's own assessment of the country (IMF, 2024), this fits a broader picture: North Macedonia is a small, trade-open economy anchored by its euro peg, where domestic monetary policy has limited independent power to steer inflation back onto a stable path. In that setting, the path of prices depends more on what happens to world prices themselves than on any dependable internal correction mechanism, so an oil shock is less

[2] Based on Government of North Macedonia, Ministry of Finance, and ERC decisions communicated through mid-2026; compiled from contemporaneous public reporting rather than a single archival source.

an event the economy is bound to grow out of, and more a lasting shift that domestic policy has only limited tools to counteract.

The evidence does not support a firm claim that North Macedonia's fuel shocks pass through quickly and then simply linger indefinitely, nor the opposite claim that the economy always self-corrects. What can be said with confidence is that North Macedonia's prices, once disturbed, lack the kind of dependable self-correcting pull that Morocco's exhibit, reinforcing the case, made above, for smoothing built into fuel pricing itself, since domestic inflation dynamics cannot be relied on to undo the shock further downstream.

8.3 What can each country's authorities forecast about an oil shock?

The two countries' evidence is, in effect, a mirror image, with a direct practical consequence: each country's authorities can currently forecast only one half of an oil-driven price shock, not both. For North Macedonia, the size of the initial hit to inflation is reasonably well known, an oil move reaches fuel prices and then consumer prices quickly and by a predictable amount, but how long any resulting rise in the price level will last cannot currently be forecast with confidence. For Morocco, the situation is reversed: because Moroccan inflation is known to settle back toward normal at a fairly dependable pace, authorities have a good sense of how long a deviation would take to fade, but because the initial link between an oil move and Moroccan fuel prices is itself unstable (Section 8.4), they have much less certainty about how large that initial hit will be in the first place.

Policy communication in each country should be honest about which half of the story is known. North Macedonia can speak with confidence about the immediate size of an oil shock but not its duration; Morocco can speak with confidence about how quickly a shock fades but not reliably about its initial size. Neither country can currently characterize the full path of an oil-driven price shock from start to finish.

8.4 If the 2015 liberalization does not explain the instability in Morocco's fuel-to-oil link, what does?

Splitting the Moroccan sample at the December 2015 liberalization date does not produce a stable oil-to-fuel relationship. This is economically plausible for three reasons. First, the sample spans fundamentally different pricing regimes, from subsidization to market-based pricing. Second, it includes oil shocks with very different characteristics, including the 2014–2016 price collapse, the pandemic-related collapse, and the 2022 supply-driven surge. Third, liberalization was gradual rather than an immediate and complete structural break.

These features make a single linear and time-invariant pass-through coefficient unlikely to describe the full period accurately. The instability is therefore not merely an econometric nuisance; it is itself an economic result. It suggests that oil-price pass-through is not a fixed structural parameter, but a time-varying function of the pricing regime, the origin of the shock, its expected persistence, and firms' capacity to absorb cost changes.

The broader implication extends beyond Morocco. Neither country's estimated elasticity should be treated as a permanent constant around which policymakers can plan over the long term. Section 9 therefore interprets the reported elasticities as sample-specific estimates and recommends that both authorities update their pass-through assessments as market structures, pricing rules, and the nature of global oil shocks evolve.

9 Policy Implications

The two countries' divergent transmission patterns imply different, not symmetric, policy priorities.

For North Macedonia. The ERC's seven-day, dollar-indexed, margin-regulated formula delivers fast, transparent, and fiscally low-cost transmission of international oil prices, avoiding the fiscal liabilities of an implicit fuel subsidy; this is a genuine institutional strength worth preserving. But the same formula provides no shock-absorption buffer, and the downstream inflation process (Section 8.2) cannot be relied upon to correct a resulting price-level deviation quickly. Three specific implications follow.

First, given that the euro peg does not shield North Macedonia from oil-related currency exposure (Section 3.3, Table 1), authorities should treat MKD/USD movements, not only MKD/EUR stability, as a relevant input to assessing imported inflation risk.

Second, introducing an explicit, rules-based smoothing mechanism into the ERC formula itself could reduce imported volatility at a predictable, budgeted cost, without reintroducing the fiscal risk of an open-ended subsidy. Building directly on the mechanism formalized in Equation (1), one concrete version of such a rule would replace the single-week average $FOB\,Med_i$ and the single-week exchange rate K_i with rolling averages taken over k successive seven-day cycles, and would cap the resulting week-on-week price change:

$$C_{max,t}^{ALT} = \left[\left(\frac{1}{kn}\sum_{s=0}^{k-1}\sum_{i=1}^{n} F\,OB\,Med_{i,t-s}\cdot K_{i,t-s} \;+\; P\cdot \bar{K}_t\right)\cdot\frac{\rho_e}{\rho_d} \;+\; T\cdot\bar{K}_t\right]\cdot\frac{\rho_d}{1000} + D,$$

$$\bar{K}_t = \frac{1}{kn}\sum_{s=0}^{k-1}\sum_{i=1}^{n} K_{i,t-s}\,, \qquad \left|\frac{C_{max,t}^{ALT} - C_{max,t-1}^{ALT}}{C_{max,t-1}^{ALT}}\right| \le \gamma,$$

where k is the number of past seven-day cycles included in the rolling window (*e.g.* $k = 4$, a four-week window in place of the current single week) and γ is a pre-announced cap on the week-on-week percentage change in C_{max} , the mirror image of the existing Article-8-adjacent trigger clause, which currently forces an *additional* reset once a move exceeds 2.00 MKD/l for gasoline or diesel, converting the same threshold logic from an accelerant into a shock absorber.

This proposal is not a generic smoothing prescription; each of its two parameters targets a specific finding of this paper. Widening k targets the oil channel directly: it would replicate, as an explicit and transparent rule, the kind of multi-period buffering that Section 8.1 infers is happening informally through Moroccan distributor margins , the mechanism this paper credits with muting Morocco's cumulative oil pass-through (0.081) relative to North Macedonia's (0.166) , without depending on margin compression remaining commercially sustainable indefinitely, a fragility this paper's own discussion of Morocco flags explicitly. Smoothing $\bar{K}_t$ targets the exchange-rate finding of Section 3.3 specifically: because K_i enters the formula in MKD/USD rather than MKD/EUR, it is precisely the term through which the euro peg currently fails to buffer North Macedonia against oil-price-driven currency swings (Table 1), so averaging it directly closes the gap between the peg's intended stabilizing role and its actual mechanical effect on C_{max}. Neither k nor γ touches P, T, D, or the excise/VAT terms, so the formula's cost structure, and the state's fiscal exposure, is unchanged; only the speed of transmission is, which is the specific and narrow failure this paper identifies rather than a case for reintroducing an open-ended subsidy of the kind Bentour (2015) and the IMF (2017) associate with Morocco's pre-2015 regime.

It should be stressed that Equation (12) has not been evaluated against data generated under it: the pass-through estimates reported in Sections 6,7 describe the transmission properties of the *existing*, instantaneous formula (Equation (1)), and the claim that C_{max}^{ALT} would lower North Macedonia's estimated 0.166 short-run oil coefficient is a plausibility argument grounded in the mechanism just described, not a counterfactual estimate. Testing it would require either a natural experiment around a future ERC rule change or a simulation exercise recomputing C_{max}^{ALT} from the historical $FOB\,Med_i$ and K_i series, both left for future work. A related, narrower limitation is that Equation (12) leaves P and T , which bundle freight and marine-insurance costs to Macedonian storage, reset only twice yearly, unchanged; a sharp intra-window move in shipping or war-risk insurance premiums would therefore still go unrecorded until the next biannual reset, a distinct gap the proposed rule does not close.

The proposal also carries a political-economy risk that should be acknowledged directly rather than presented as a costless improvement. The current formula's near-total insulation from discretion is precisely what makes k and γ new levers: unlike $FOB\,Med_i$ and K_i, which are externally observed, k and γ must be administratively set, and a government could press for a wider k or a tighter γ around a politically salient moment, quietly building a deferred price gap rather than genuinely smoothing volatility. Three safeguards would help contain this: fixing k and γ within the Rulebook itself, revisable only through the same biannual, data-grounded procedure that governs P, T, and D; publishing the counterfactual unsmoothed C_{max} alongside the smoothed price each week; and requiring the rule to smooth downward and upward moves symmetrically, closing off one-sided use ahead of elections.

Third, because the policy-rate coefficient is statistically insignificant in both countries' Stage 2 specifications, and interest-rate pass-through in North Macedonia is independently documented as modest (IMF, 2024), conventional interest-rate policy should not be relied upon as the primary tool for managing oil-driven inflation episodes; a fuel-pricing-side instrument, as above, is likely to be more directly effective than a monetary-side one for this specific type of shock.

For Morocco. The liberalized market currently appears to provide informal shock absorption on the oil-price channel, which is a lower-cost mechanism than a subsidy but a less transparent and less certainly durable one, and is unlikely to remain effective if margin compression becomes commercially unsustainable during a sustained period of high oil prices. Two implications follow. First, monitoring downstream fuel-retail margins directly, rather than only Transport CPI, would let authorities distinguish a genuinely absorptive market from one that is simply lagging a shock it will eventually pass through in full, a distinction the present data cannot make. Second, and in contrast to North Macedonia, Morocco's comparatively strong and well-identified FX pass-through (0.178) and fast CPI-stage adjustment (13-month half-life) mean that exchange-rate developments deserve closer monitoring as an inflation-transmission channel in Morocco than in North Macedonia, precisely because Morocco's more flexible regime is, by the evidence here, the more active transmission channel of the two available (FX versus oil) at the fuel-price stage.

Consistent with Section 8.4, neither country's estimated elasticities should be treated as structural constants to plan around over the long term: Morocco's Stage 1 instability across liberalization sub-periods and successive oil shocks, and North Macedonia's fragile long-run Stage 2 estimate, both indicate that pass-through magnitudes shift with the prevailing regime and the character of the shock. More broadly, the comparison is best read not as "Morocco transmits more, North Macedonia transmits less," but as two different pricing philosophies routing the same external shock through different channels at different speeds: Morocco's liberalized market channels oil shocks primarily through the exchange rate, with a fast and well-identified downstream adjustment; North Macedonia's regulated formula channels oil shocks more directly and mechanically at the point of price-setting, but the downstream adjustment of headline inflation to that shock is slow and weakly identified. Plausibly, credibility and expectations-anchoring considerations (Taylor, 2000; Mishkin, 2008) operate differently under an administered-price, currency-board-adjacent framework than under a liberalized, price-flexible one, and this difference, not a simple "more versus less pass-through" ranking, is the paper's central, policy-relevant finding.

10 Limitations

Several limitations qualify the results and should guide their use. First, the absence of a stable long-run cointegrating relationship in Stage 1, in either country, constrains this study to short-run pass-through estimates for the oil-to-fuel-price link, and, as Section 8.4 argues, this instability persists across liberalization sub-periods and is not resolved by the sample split tested here; a more granular investigation of tax, margin, and subsidy-formula changes over the sample , for which this paper did not have data , would be needed to adjudicate directly among the candidate explanations proposed. Second, North Macedonia's Stage 2 long-run elasticity and error-correction speed should be treated with the explicit caveat developed in Section 8.3; we recommend against citing the 2.85 long-run elasticity without that caveat. Third, the core-CPI extension in Section 7.4 is constrained by data availability to a 96-month common subperiod, which is too short to identify North Macedonia's Stage 2 relationship reliably even for headline CPI, and by the imperfect, residual-based construction of Morocco's core series, which lacks an exact official counterpart; both should be revisited with better data before the direct-versus-indirect channel question is considered resolved. Fourth, residual non-normality is present in nearly every specification estimated in this paper; given the sample sizes involved (T=192 for the baseline specifications), we do not consider this to materially threaten inference on coefficient estimates, but it does affect the precision of the reported confidence intervals in finite samples and is noted as a standard caveat of monthly macroeconomic data containing a small number of large shock episodes. Fifth, this paper cannot observe distributor margins directly in either country, and the mechanisms proposed in Section 8.1 to explain Morocco's muted oil coefficient, while consistent with the evidence that rules out an FX-confounding explanation, remain inferred rather than directly measured. Sixth, the alternative smoothing formula proposed in Equation (12) is a proposed mechanism, not an estimated one;

its plausibility rests on the logic connecting it to Sections 3.3 and 8.1, not on any observed pass-through coefficient under k- or γ-adjusted pricing. Finally, the sample, while long by the standards of a single-country ARDL study (T=192 months), remains a single realization of history for each country; the specific mix of shocks experienced (the 2015 oil collapse coinciding with Moroccan liberalization, the 2020 pandemic, the 2022 invasion-driven spike) is not guaranteed to recur in the same sequence, and estimated elasticities should be read as descriptive of this particular seventeen-year window rather than as structural constants.

11 Conclusion

This paper compared the pass-through of international oil-price shocks to domestic inflation in Morocco and North Macedonia using a two-stage ARDL bounds-testing framework over a common 2010,2025 monthly sample. The results support the underlying research premise, that institutional configuration, not oil-importer status alone, determines pass-through, in a more precise and more interesting form than the premise itself anticipated. The exchange-rate channel behaves exactly as a liberalized-versus-pegged story predicts, with Morocco's FX pass-through roughly 2.4 times North Macedonia's. The oil-price channel runs in the opposite direction, with North Macedonia's regulated, dollar-indexed, seven-day pricing formula transmitting oil shocks roughly twice as strongly as Morocco's liberalized market , a result we show, through an explicit FX direction-and-size decomposition, is not an artifact of currency confounding, and which we attribute instead to the mechanical, low-discretion nature of North Macedonia's administered pricing formula (Equation (1)) relative to the (plausibly margin-mediated) absorption occurring somewhere in Morocco's liberalized downstream market. At the CPI stage, Morocco's inflation process corrects toward its long-run equilibrium with fuel prices quickly and precisely, while North Macedonia's corresponding process is close enough to a unit root that its adjustment speed cannot be reliably estimated from the available sample, a distinction with direct consequences for which of each country's estimated coefficients a policy analysis should lean on.

The broader lesson is that "liberalized" and "regulated" fuel-pricing regimes do not uniformly amplify or suppress oil-price pass-through; they route the same external shock through different channels, at different speeds, and a policy analysis that reports only a single combined elasticity , as a reduced-form regression of CPI on oil prices would , cannot distinguish these two qualitatively different transmission stories from each other, even though the two stories imply substantially different policy responses. Morocco and North Macedonia, precisely because they sit at opposite institutional poles on both dimensions this paper examines, offer an unusually clear illustration of that distinction, and this comparative framework , decomposing pass-through by stage, testing coefficient stability against alternative specifications rather than reporting the first result obtained, and following an econometric disagreement (the F/t bounds-test split) to its structural source rather than its more convenient resolution, is intended to prove useful to future comparative work on oil-price pass-through in other institutionally contrasting country pairs.

A Note on the Use of AI-Assisted Tools

AI-assisted language tools were used exclusively for stylistic refinement and linguistic clarity. All conceptual framing, analysis, interpretation, and conclusions are the sole work of the authors.

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A Appendix

Table 13: Full bounds test statistics, including I(0) bounds

Specification	ARDL order	F-stat.	$I(0)$ bound (5%)	$I(1)$ bound (5%)
Morocco, Stage 1	(2,2,2)	0.355	3.876	4.880
Morocco, Stage 2	(1,1,0)	7.120	3.874	4.853
N. Macedonia, Stage 1	(1,2,0)	1.500	3.815	4.844
N. Macedonia, Stage 2	(2,1,0)	5.446	3.834	4.867

Table 14: Missing data log

Date	Series	Treatment
June 2019	N. Macedonia Transport CPI (MAKStat)	Linear interpolation between adjacent months
March 2020	N. Macedonia Transport CPI (MAKStat)	Linear interpolation between adjacent months