Revue-IRS

Revue Internationale de la Recherche Scientifique
(Revue-IRS)
ISSN: 2958-8413
Vol. 3, No. 6, Novembre 2025

Global Oil Shocks and Inflation in Morocco

Chocs pétroliers mondiaux et inflation au Maroc

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Abstract: This article explores the evolution of the correlation between global oil prices and inflation in Morocco, with special attention to the fuel subsidy reforms that took place between 2012 and 2015. By using rolling regression analysis and structural breaks tests, it has been found that there was not any remarkable breakpoint during the reforms. This result suggests that tools related to price stabilization or monetary policies were efficient in mitigating inflationary pressures in the short term. There has been a subtle transition in the beginning of the 2000s to correspond with the deregulation of the petroleum industry in general and the macroeconomic adjustment reforms. The absence of any remarkable breakpoint since 2015 might be related to inadequate data, delay in the transmission process of economic fluctuation, or the global reduction in oil prices. These results highlight the complex interaction between variations in oil prices and inflationary processes and the prominent effect of institutional and global factors in the inflationary process in the Moroccan economy.

Résumé : Cet article examine l'évolution de la corrélation entre les prix mondiaux du pétrole et l'inflation au Maroc, en portant une attention particulière aux réformes des subventions sur les carburants mises en œuvre entre 2012 et 2015. Grâce à l'utilisation de l'analyse par régression glissante et des tests de ruptures structurelles, il a été constaté qu'aucun point de rupture significatif n'est survenu durant la période des réformes. Ce résultat suggère que les outils liés à la stabilisation des prix ou aux politiques monétaires ont été efficaces pour atténuer les pressions inflationnistes à court terme. Une transition subtile a été observée au début des années 2000, en lien avec la déréglementation du secteur pétrolier et les réformes d'ajustement macroéconomique. L'absence de rupture marquée depuis 2015 pourrait être attribuée à des données insuffisantes, à un retard dans le processus de transmission des fluctuations économiques, ou à la baisse mondiale des prix du pétrole. Ces résultats mettent en lumière l'interaction complexe entre les variations des prix du pétrole et les processus inflationnistes, ainsi que le rôle déterminant des facteurs institutionnels et des dynamiques mondiales dans l'évolution de l'inflation au Maroc.

Keywords: International oil prices; Moroccan inflation; Structural break; Rolling regression; Energy sector liberalization; Price pass-through; Macroeconomic shocks.

Mots-clés : Prix internationaux du pétrole ; Inflation au Maroc ; Rupture structurelle ; Régressions glissantes ; Libéralisation du secteur énergétique ; Transmission des prix ; Chocs macroéconomiques.

Digital Object Identifier (DOI): https://doi.org/10.5281/zenodo.**17680170**

1 Introduction

The link between oil prices in the global market and inflation in individual countries is one of the most essential areas to understand in macroeconomic studies, especially in oil-importing countries. This is because fuel is considered one of the most essential production factors and consumption items in any economy, thereby ensuring that any change in the global market can cause cost-push inflation in any economy. Nevertheless, one should recognize that the pass-through effect between inflation and oil prices does not remain consistent in any economy but fluctuates because of varying policies, institutional settings, and structural shifts in the economy. The case of Morrocco, which is an oil-importing nation, offers an interesting study of this kind.“In Morocco, where the state provides fuel to the population at heavily subsidized prices, it has been explicitly recognized that the aim of fuel subsidization was to shield Moroccans from oil price volatility in the global market.” For many years, the North African state operated an extensive fuel subsidy program that shielded Moroccans from the vagaries of the global petroleum market while incurring large budgetary expenditures in the process. This subsidy policy gradually rolled back between 2012 and 2015 through the adoption of policies to deregulate the prices of fuel, potentially leaving inflation in the country vulnerable to oil price shocks in the global market. The effect of such policies in making inflation in Morrocco vulnerable to any change in the global market can be viewed to be close to being determinate in nature and can thus qualify to be the subject matter of the study proposed in this thesis because it has the effect of being rather close to being natural in nature. “In other words, if prices in general tend to fluctuate in accordance with market forces, they should similarly fluctuate in accordance with market forces in Morrocco in spite of the subsidy policy because the subsidy policy is expected to shield Moroccans from market forces.” This policy makes it essential to examine the impact of the subsidy policy on the pass-through effect within Morrocco with the purpose of establishing whether there has been any structural transformation in the post-reform era in terms of the level of structural connectivity between the inflationary process in Morrocco and any fluctuation that takes place in the global market in terms of petroleum prices. “As Hamilton (1983) wisely noted, “Nearly every post-war U.S. recession followed a major oil price spike,” thus firmly establishing oil shocks as determinants of inflation. However, this pattern has weakened since the 1970s. Hooker (2002) argued that this was because there was a policy regime change—namely, the U.S. Federal Reserve began to follow an “expectation-anchored” monetary policy rule to offset the inflationary effects of oil shocks. Ever since, there has been a paradigm shift toward models which assume that policy institutions in the domestic economy can cushion the effect of oil shocks. For instance, Oyelami et al. (2024) showed that in the African context, the pass-through effect can significantly differ based on individual exchange regimes, oil-import status, and subsidy schemes—highlighting that “the inflationary effect of oil is not universal but rather very context-dependent on local economic and policy fundamentals.” Garrón et al. (2024) further clarified the nature of modern inflationary relationships with oil by advancing the principle of “international vulnerability” to highlight that “global forces such as monetary spillovers in addition to oil market and supply chain shocks are far more determinative of inflation in the global economy.” These works highlight the rapidly growing consensus that the oil-and inflation relationship remains conditional rather than linear and thus remain tempered by the interplay of domestic and global forces.

2 Data description and methodology

2.1 Data description

This study employs data with 34 yearly periods for the nation of Morocco, ranging from 1990 to 2023. The most important macroeconomic variables, such as inflation rates, GDP growth, petroleum import amounts, and total money supply in an economy, are extracted from the World Bank records, as specified in table 1. Crude oil prices, acting as macroeconomic forces in the global market and being especially significant for a crude oil-importer nation such as Morocco, are extracted from the U.S. Energy Information Administration records. The choice of these variables specifically has been made with the aim of incorporating the major channels through which oil prices can affect inflation.

Table 1. Definition of Variables

Variables	Measurement	Sources
Crude Oil	US dollars per barrel	EIA
Inflation	Annual %	World Bank
Broad Money	% of GDP	World Bank
GDP Growth	Annual %	World Bank
Energy Importations	Annual %	World Bank

Source: Author's own construction

2.2 Methodology

This study uses a two-step methodology to examine whether the relationship between oil prices and inflation in Morocco varies over time: (1) visual inspection using rolling regressions, and (2) formal testing for structural breaks. Examining the changing relationship between global crude oil prices and domestic inflation, especially considering the 2012–2015 energy subsidy reforms, is done using the rolling regression methodology. In contrast to static models, rolling regression repeatedly estimates the pass-through coefficient of oil prices, allowing it to fluctuate over time. model across rolling windows, which are moving subsamples of fixed lengths. This method aids in capturing the slow structural changes that could result from significant global shocks or policy changes. Windows of 8, 10, 15, and 15 that roll, and 20 years are used to evaluate the results' resilience over various time periods, offering both short- and medium-term insights into the dynamics of oil and inflation. Inflation is the dependent variable in each specification, and it is regressed on global crude oil prices. Other control variables include GDP growth to account for demand-side pressures, broad money to reflect monetary conditions, and energy imports to account for external energy dependence. The following is the specification for the rolling regression equation:

$$\mathrm{INF}_t = \alpha + \beta_t \cdot \mathrm{OIL}_t + \gamma_1 \cdot \mathrm{BM}_t + \gamma_2 \cdot \mathrm{GDP}_t + \gamma_3 \cdot \mathrm{EI}_t + \varepsilon_t$$

where β_t represents the time-varying coefficient capturing the pass-through effect of oil prices on inflation. This specification allows us to map out how the connection between oil and inflation has changed over time, specifically identifying if Morocco became more, less, or equally sensitive to global oil price shocks after fuel prices were liberalized. Several structural break tests, including the Chow, CUSUM, Supremum-Wald, and Bai-Perron tests are used in the second section of the analysis to look for parameter instability. The Chow test determines if the model coefficients before and after a predetermined breakpoint differ statistically significantly the other three tests check for an unknown breakpoint and don't make any assumptions about the break date. Plotting the cumulative sum of recursive residuals over time allows the CUSUM (Cumulative Sum) test to assess the stability of the regression parameters. The model is regarded as stable if the cumulative sum remains within critical bounds; deviations signify a structural break. By estimating the model across all potential breakpoints within a trimmed range and computing a Wald statistic at each, the Supremum-Wald test finds a single structural break at an unknown point in the sample. Parameter instability is then tested using the largest of these statistics A noteworthy outcome points to a structural fracture. Finally, by dividing the time series into segments and determining whether there are significant differences in the regression parameters between those segments, the Bai-Perron test finds multiple structural breaks. By reducing the total residual variance and comparing the model fit both before and after allowing for breaks, it finds breakpoints. When the improvement in fit (as determined by a test statistic like the F-statistic) surpasses critical values, a structural break is deemed statistically significant. When combined, these techniques offer a thorough evaluation of structural stability by fusing statistical inference under known and unknown breakpoint assumptions with visual inspection from the rolling regressions.

3 Application and Results

3.1 Descriptive statistics

Based on 34 yearly observations, Table 2 displays the descriptive statistics for GDP growth, inflation, broad money supply, and crude oil prices. According to the analysis, average values for crude oil were roughly 52.10, inflation was 2.64, broad money was 86.80, and GDP was 3.59. GDP growth fluctuated the most among these variables, ranging from -7.178 to 12.373. With a standard deviation of 32.33, crude oil prices showed the most volatility, while GDP inflation stayed relatively stable. Despite inflation getting close to the deviation threshold (p = 0.056), the Jarque-Bera normality tests largely confirmed the assumption of a normal distribution. Before moving on to the dynamic analysis of the oil price pass-through to inflation, these preliminary statistics gave a fundamental understanding of the data structure.

Table 2. Descriptive statistics

Statistic	Crude Oil	Inflation	Broad Money	GDP Growth
Mean	52.10265	2.641458	86.79850	3.590188
Median	47.98000	1.719614	94.54207	3.470312
Maximum	111.6300	7.986166	128.8631	12.37288
Minimum	12.76000	0.303386	46.15091	-7.178207
Std. Dev.	32.33022	2.205386	26.64250	3.976320
Skewness	0.472982	0.991741	-0.127836	-0.504394
Kurtosis	1.907361	2.638106	1.523468	4.001091
Jarque-Bera	2.959002	5.758993	3.181145	2.861437
Probability	0.227751	0.056163	0.203809	0.239137
Sum	1771.490	89.80957	2951.149	122.0664
Sum Sq. Dev.	34493.02	160.5029	23424.15	521.7671
Observations	34	34	34	34

Source: Author's own construction

The time series behavior of our key variables for Morocco—crude oil prices, inflation, the total money supply, and GDP growth—is shown graphically in Figure 1, which roughly covers the years 1990 to 2023. We can see several different patterns. Crude oil prices exhibit significant volatility, with notable spikes peaking between 2008 and 2012 and again after 2020, interspersed with precipitous declines like the oil price meltdown of 2014–2016. When measured as a percentage of GDP, the broad money supply shows a distinct and largely consistent upward trend over the course of the period, suggesting either an expanding financial sector or an expansionary monetary policy in relation to economic output. Contrarily, inflation seems to have been mostly contained and stable during this time, typically ranging in the low range (e.g., 0-5%), though some notable increases correspond with the later spikes in the price of crude oil that were seen after 2020. Finally, GDP growth shows normal cyclical oscillations around a positive average, with notable declines noticeable, including one around 2020 that is probably related to the COVID-19 pandemic.

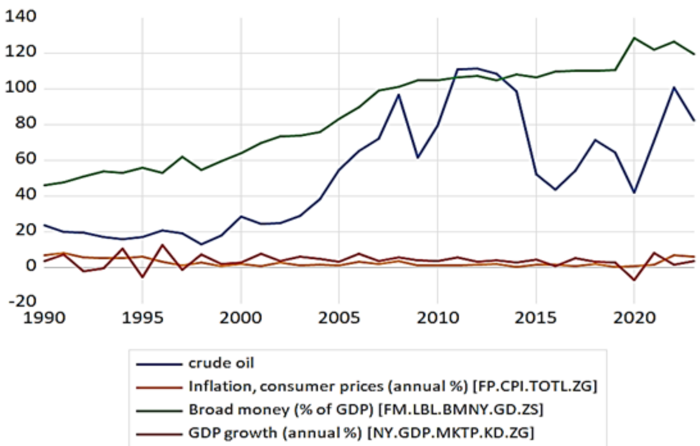

Figure 1. Visual Analysis of Variable Trends

3.2 Stationarity test Results

We first used the Augmented Dickey-Fuller (ADF) unit root test to verify the stationarity of our time series data to make sure our regression analysis was sound and to prevent deceptive "spurious" results. Using a 5% critical value of -1.950, we applied this test to GDP growth, inflation, crude oil prices, energy imports, and the broad money supply. Regarding the order of integration, the results painted a mixed picture. It was discovered that broad money, energy imports, inflation, and crude oil prices were all non-stationary at their starting points. But after being differenced once, they all became stationary, indicating that they are integrated of order one, or I(1). The GDP growth variable, on the other hand, was I(0) since it was already stationary at its initial level. Therefore, we used the first differences for all the I(1) variables and included the already stationary GDP growth variable in its original, undifferenced form to make sure that our subsequent rolling regression analysis was statistically sound and unaffected by non-stationary trends.

Table 3. Unit Root Test

Variable	Undifferenced t-Statistic	Critical Value	1st Difference t-Statistic	Critical Value	Order of Integration
Crude Oil	-0.315	-1.950	-5.252	-1.950	I(1)
Inflation	-1.623	-1.950	-3.406	-1.950	I(1)
Broad Money	2.868	-1.950	-2.517	-1.950	I(1)
GDP Growth	-1.952	-1.950	—	—	I(0)
Energy Imports	0.712	-1.950	-4.126	-1.950	I(1)

Source: Author's own construction

3.3 Rolling regression results

We used window sizes of 8, 10, 15, and 20 years to perform rolling regressions on the stationary variables, employing first differences when required. Regression coefficients along with standard errors were combined with the original dataset for further analysis using Stata's "rolling" command. The form of the regression equation was as follows:

$$\Delta \mathrm{INF_t} = \alpha + \beta_t \cdot \Delta \mathrm{OIL_t} + \gamma_1 \cdot \Delta \mathrm{BM_t} + \gamma_2 \cdot \mathrm{GDP_t} + \gamma_3 \cdot \Delta \mathrm{EI_t} + \varepsilon_t$$

By adjusting for GDP growth, energy imports, and broad money, this specification enabled us to investigate the relationship between changes in oil prices and changes in inflation. Time-varying oil price coefficients from the rolling regressions were then plotted to look for possible structural changes and patterns throughout the sample period.

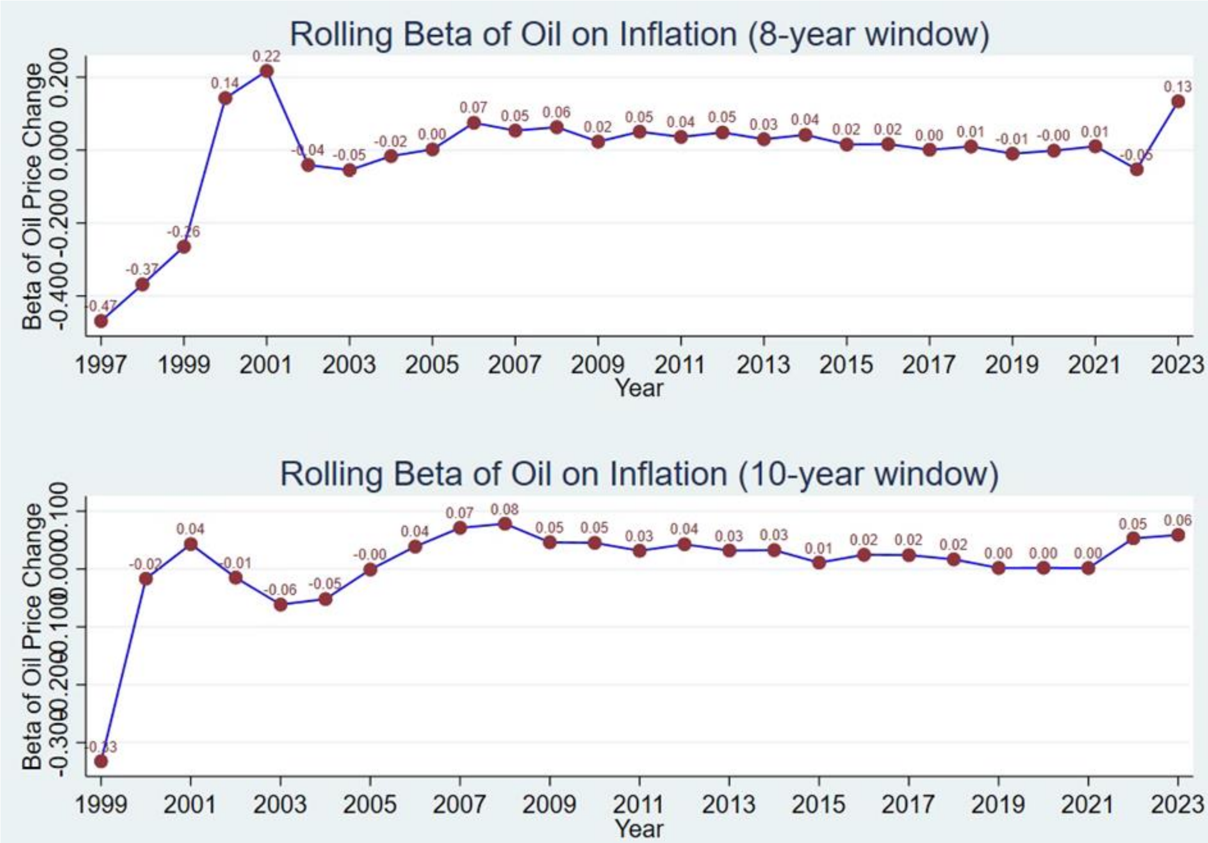

Figure 2. Estimated Rolling Betas of Oil on Inflation (8- and 10-Year Windows)

The estimated coefficient of the change in oil price (β_t) from rolling regressions using 8- and 10-year windows is shown in Figure 2, with each estimate corresponding to the final observation in the rolling sample. The end point of each rolling window is displayed on the x-axis. Despite expectations of a structural break linked to Morocco's energy subsidy reforms from 2012 to 2015, the 8-year and 10-year rolling regressions revealed no discernible discontinuity in the oil price coefficient during that period. For instance, during the 10-year window, the coefficient decreased through 2015 after only marginally increasing between 2011 and 2012 (+0.01). This suggests that the inflationary effects of the reform might have been too gradual to be detected by short-window regressions, delayed, or offset by other economic stabilizers. Other periods, on the other hand, exhibited more pronounced coefficient shifts, suggesting possible structural breaks. From 2010 to 2019, the graphs for both windows displayed relatively stable coefficients; however, greater volatility was observed at the beginning and end of the sample. A sign shift in the oil price coefficient (from negative to positive) or a year-to-year change exceeding 0.04—above the typical sample variation of 0.01–0.03—was considered a potential structural break. According to this criterion, the identified breakpoints were 2000–2001 (sign switch), 2006 (sharp rise in the 8-year window; sign switch in the 10-year), 2009 (moderate drops in both), and 2022–2023. While most other dates did not correspond to clear domestic policy changes, the shift around 2000 coincided with Morocco's gradual privatization and liberalization of the energy sector in the late 1990s (Usman & Amegroud, 2019). However, they also overlapped with major global events such as the 2008–2009 financial crisis and the COVID-19 pandemic, which likely influenced the transmission of oil prices to Moroccan inflation through trade, expectations, and monetary policy. During these periods, oil's inflationary impact increased due to weakened policy buffers, but as external pressures eased, the coefficients tended to decline again. Apparent breaks at the beginning or end of the sample most likely reflected edge effects arising from limited data. Negative coefficients in some years, suggesting an inverse oil–inflation relationship, were attributed to noise in short windows, while larger windows yielded consistently positive coefficients.

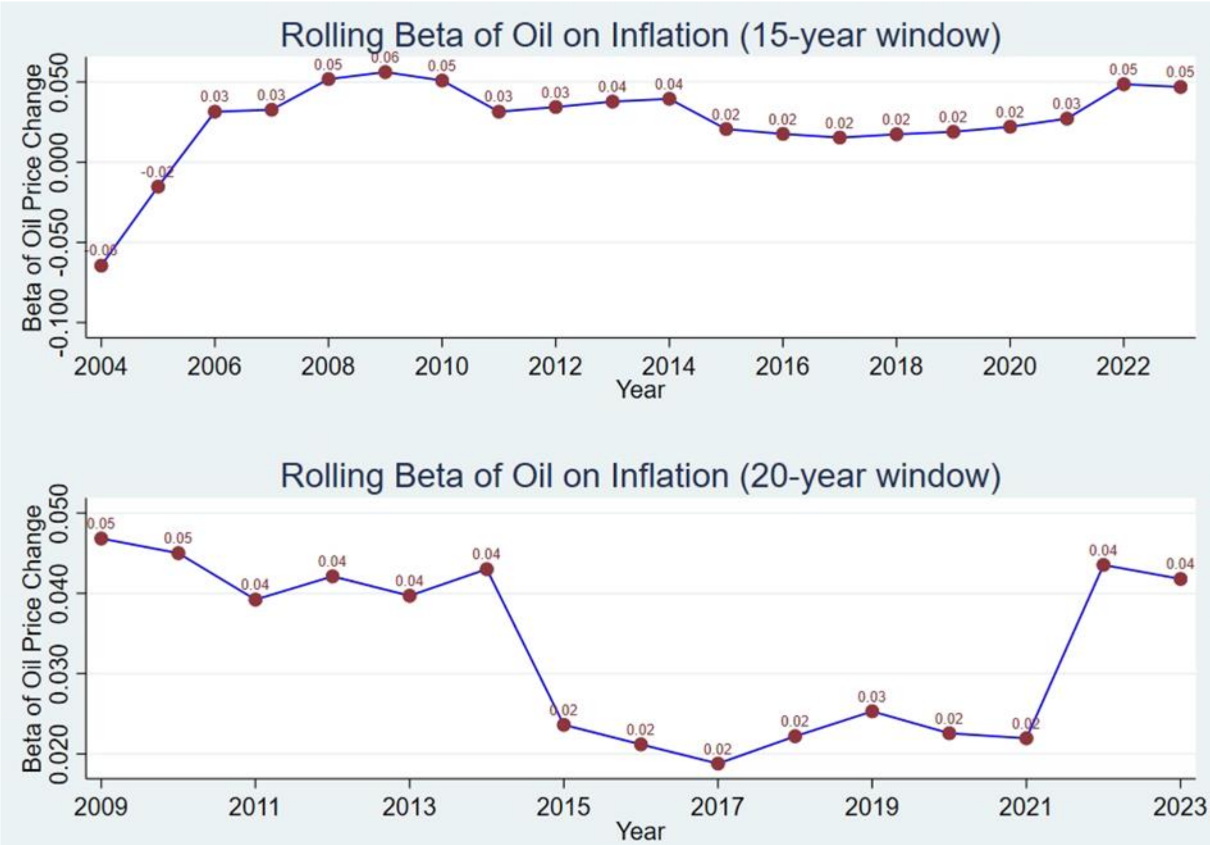

Figure 3. Estimated Rolling Betas of Oil on Inflation (15- and 20-Year Windows)

Figure 3 presented the rolling oil price coefficients using 15- and 20-year windows. The coefficients were more stable and consistently positive compared with shorter windows. Structural breaks were defined as sign switches or coefficient changes ≥ 0.02, since most yearly shifts were smaller. The most prominent pattern was a visible dip in the coefficient from 2015 to 2021 in both graphs—the coefficient fell by 0.02 in 2015 and remained low until rising again in 2022. Although the coefficient was expected to rise after the 2012–2015 subsidy reforms, the decline likely reflected offsetting forces. These included the reforms' overlap with the 2014–2015 global oil price collapse (Bentour, 2015, p.23), Morocco's low-inflation environment dampening cost pass-through (Borio et al., 2023, p.11), and market frictions such as oligopolistic pricing in Morocco's fuel sector (Bertelsmann Stiftung, 2024, p.14), which limited the transmission of global oil price changes to consumer prices. Together, these factors may have delayed the expected rise in oil-inflation sensitivity following the policy change. The rise in 2022 (+0.02 in both windows) represented another potential breakpoint, consistent with the short-window results, and may have reflected the delayed full effect of the subsidy reforms as prior offsetting forces waned. The 15-year window also revealed potential breaks in earlier years: 2005 (+0.04), 2006 (sign switch), and 2008 (+0.02). Collectively, Figures 2 and 3 suggested that structural changes in the oil price–inflation relationship occurred in the early 2000s (possibly tied to Morocco's energy market liberalization), in 2008–2009 (global financial crisis), in the post-reform period after 2015 (reflecting dampened cost pass-through), and in 2022 (likely related to post-pandemic shocks and delayed reform effects). These results stemmed from visual inspection and were treated as diagnostic rather than definitive, highlighting the need for formal break tests to confirm the timing and presence of structural changes. The limited availability of higher-frequency Moroccan macro data meant that each regression included few observations, which reduced precision in estimating the coefficients, widened confidence intervals in hypothesis testing, and could have caused noise to appear as structural shifts.

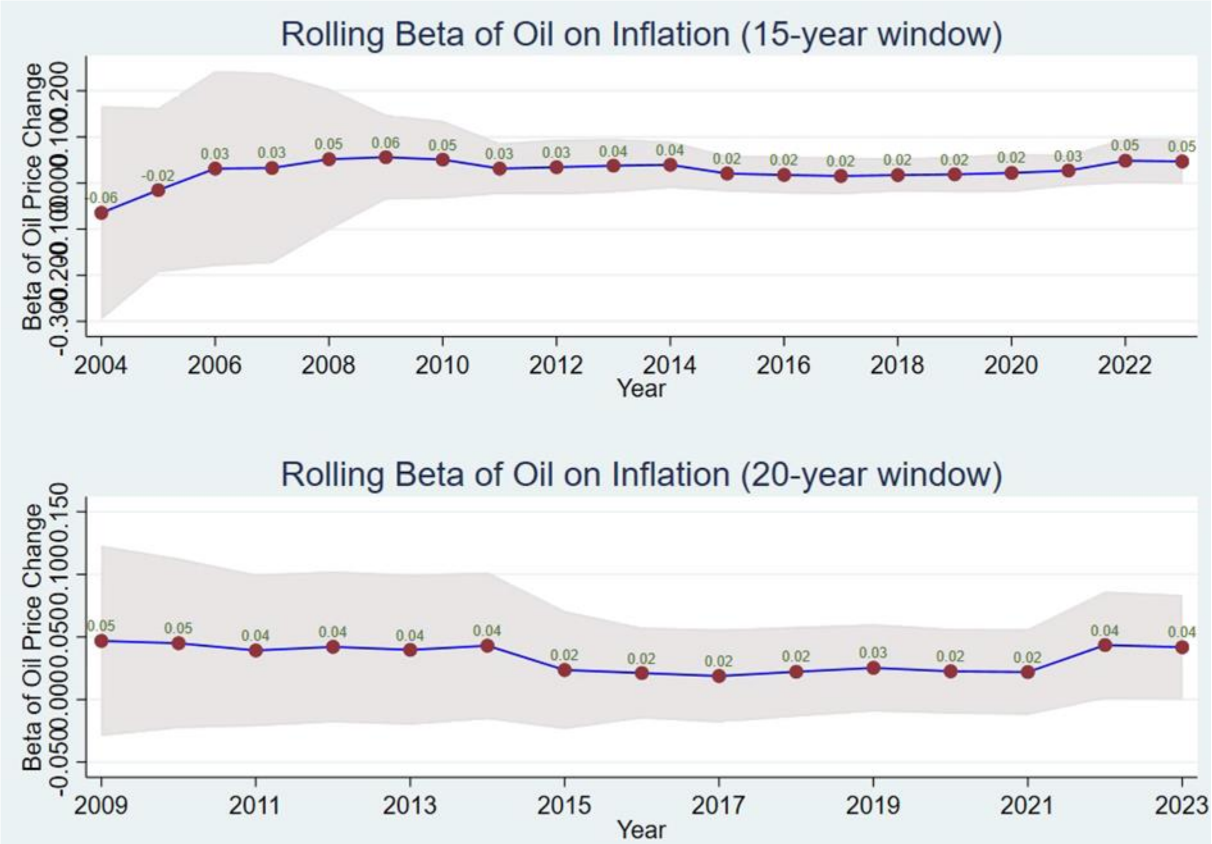

Figure 4. Estimated Rolling Betas of Oil on Inflation with 95% Confidence Bands (15- and 20-Year Windows)

To assess the statistical significance of the rolling oil price coefficient over time, we constructed pointwise 95% confidence intervals using the t-distribution. Each rolling regression's bounds equal the coefficient ± t × standard error, plotted around the coefficient path. These intervals show whether the coefficient at a given point is significantly different from zero at the 5% level. However, with small sample sizes (all <30), these intervals may understate actual uncertainty. Figure 4 shows statistical significance only for the 15-year window ending in 2022 and the 20-year windows ending in 2022 and 2023. The 8- and 10-year windows show no significance (see Appendix, Figure A.1). Where possible structural breaks are suggested visually, we follow up with formal break tests to confirm their statistical validity.

4 Discussion structural break test results

To formally assess structural changes in the oil price coefficient, we conducted several break tests: a Chow test, Supremum Wald test, CUSUM test, and Bai-Perron test (s. Appendix, Table A.1). First, Chow tests were run for selected break years (1999, 2000, 2001, 2008, 2009, 2015, 2022) manually in Stata, using the Chow test formula for comparing the residuals of separate regressions to a pooled regression:

$$F = \frac{\left(RSS_p - (RSS_1 + RSS_2)\right)/m}{(RSS_1 + RSS_2)/(n - 2m)}$$

None of the tested years produced statistically significant results at the 5% level, and the Chow test could not be run for 2022 due to an insufficient number of post-break observations. Next, a Supremum Wald test ("estat sbsingle" in Stata) was performed to detect a single unknown breakpoint. The test trims 25% of the sample from both ends, leaving a trimmed window from 2000 to 2015. The estimated break year is 2000, with a Sup-Wald statistic indicating significance at the 1% level and a structural change in the oil-inflation relationship at the beginning of the 2000s. In contrast, the CUSUM test ("estat sbcusum") found no structural break, as recursive residuals stayed within the 95% confidence bands (s. Appendix Figure A.2). Similarly, the Bai-Perron test, implemented via the "xtbreak" command (after installing "xtbreak" and "moremata"), also failed to detect any structural breaks. This test examines whether there are one or more breaks at unknown dates in the regression coefficients, using the UDmax test and sequential F-tests to evaluate if a structural break exists and whether introducing additional breakpoints improves the model fit. None of the test statistics exceed the corresponding critical values at conventional significance levels. As with the Wald test, the data was trimmed at 25% from both ends.

Taken together, these structural break tests yield mixed results. The Supremum Wald test identifies a break around 2000, consistent with the behavior observed in rolling regressions. However, the Chow, CUSUM, and Bai-Perron tests do not find significant instability. This discrepancy likely stems from data limitations and their effect across tests. Specifically, the Chow test's power reduces with fewer observations and does not detect breaks if observations before/after the split year are limited. Similarly, the CUSUM test has low power in small samples and is weak in detecting breaks near the boundaries of the sample (Bondarenko, 2008; El-Shagi & Giesen, 2010), while the Bai–Perron test is constrained by trimming rules and requires longer time series to identify multiple breakpoints (Antoshin et al., 2008; Carrion-i-Silvestre & Kim, 2017). Here it is also important to note that given a small sample, the Wald test can over reject the null hypothesis of no structural break (Guo et al., 2005; Hansen, 2013). Overall, only the Supremum Wald test shows evidence of a structural break in the year 2000, while findings for other years suggest no breaks in the oil-inflation relationship. However, given the data limitations, all results remain inconclusive at this stage due to the small sample size rather than the true absence of structural change.

5 Conclusion

The visual analysis using rolling regressions (8-20-year windows) reveals that oil-price pass-through to Moroccan inflation varied visibly over time. Shorter windows show more volatility while longer windows yield smoother, consistently positive effects with a dip post-2015 (at the end of the subsidy reforms). The Sup. -Wald test identifies a statistically significant regime shift around the year 2000, with the oil-inflation coefficient increasing after being negative in 1999, suggesting a stronger effect of oil price shocks on inflation. While there weren't any direct reforms specifically aimed at oil price pass-through during that period, it's important to remember that Morocco was in the midst of a broader energy sector liberalization. This involved things like privatizing fuel distribution networks and implementing regulatory changes that enabled independent power producers to generate electricity using imported fossil fuels (Usman & Amegroud, 2019). These changes effectively loosened direct government control over how production costs and pricing were set, and, in doing so, tied domestic energy costs more closely to international oil prices. This likely intensified how global oil shocks translated into local inflation. That being said, it's crucial to approach the Wald test results with a degree of circumspection, especially given that small samples inherently increase the likelihood of a Type I error. Additionally, despite expectations, the 2012–2015 subsidy reform period did not produce a statistically confirmed structural break in oil pass-through. This result suggests that reforms either had delayed effects, were offset by concurrent global shocks (e.g. oil price collapse in 2014–2015), or were muted by market frictions and other stabilizing mechanisms. Additionally, in most structural break tests, the data from 2015 onwards was either trimmed or at the very end of the analyzed sample, reducing statistical power and limiting the ability to detect structural breaks at those edge points. Finally, we acknowledge the main limitations of this paper - a relatively small annual sample (34 observations) due to unavailability of higher frequency data and limited statistical power, particularly for the post-reform periods of interest. These constraints may obscure structural changes at the ends of the observed period and increase risk of Type II (Chow, CUSUM, Bai-Perron) or Type I errors (Wald), distorting results.

6 Appendix

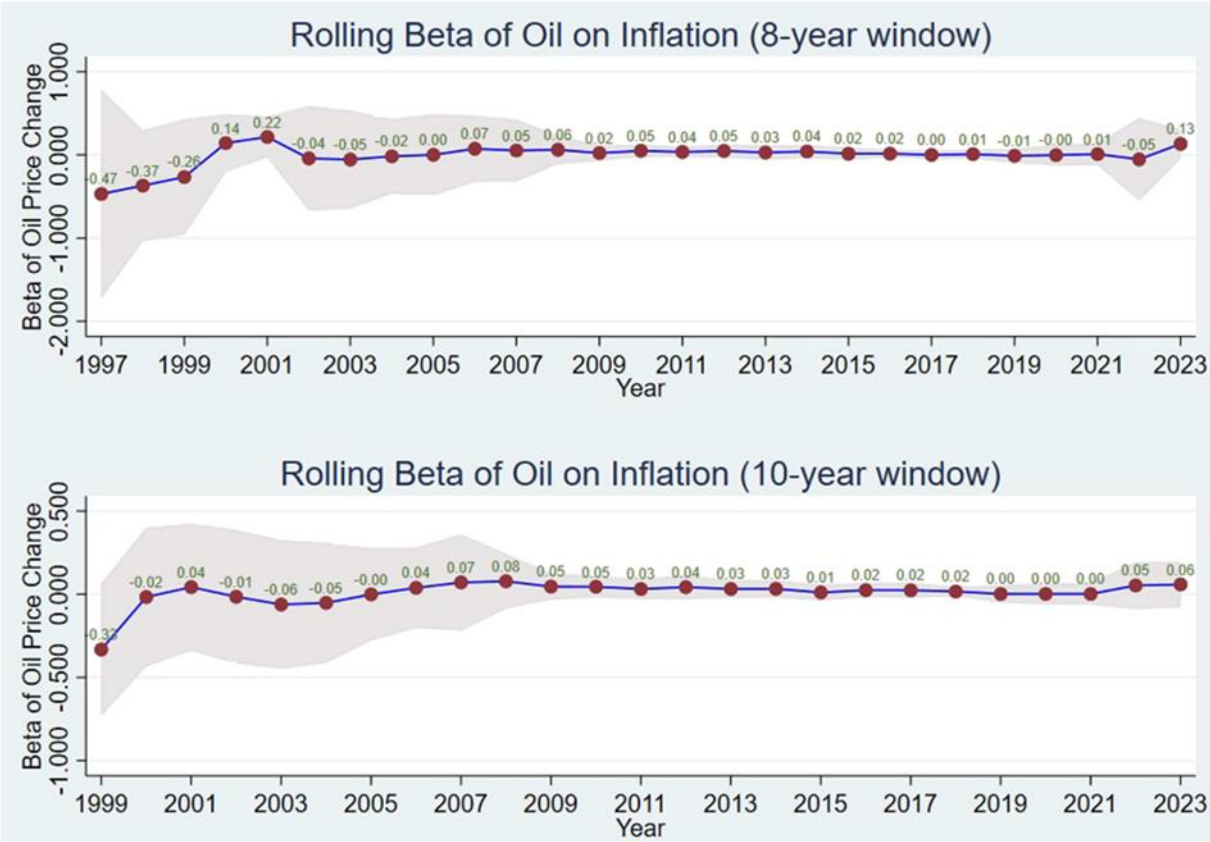

Figure A.1. Estimated Rolling Betas of Oil on Inflation with 95% Confidence Bands (8- and 10-Year Windows)

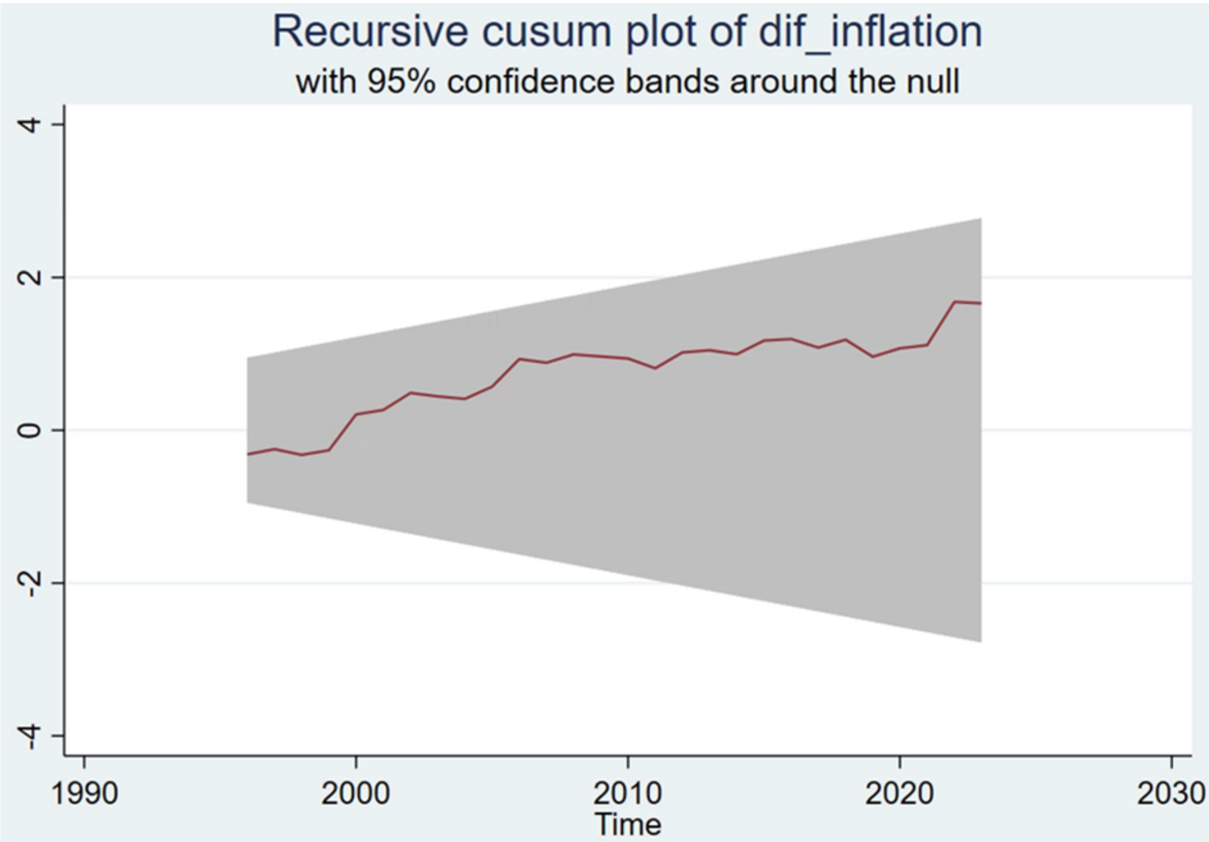

Figure A.2. Recursive CUSUM Plot of the Change in Inflation

Table A.1. Results of Structural Break Tests on the Impact of Oil Price Changes on Inflation Dynamics

Test	Break Year	Test Type	Test Statistic	Break Detected (5%)
Chow Test (1)	1999	F-test	1.217	No.
Chow Test (2)	2000	F-test	2.057	No.
Chow Test (3)	2001	F-test	0.569	No.
Chow Test (4)	2008	F-test	0.396	No.
Chow Test (5)	2009	F-test	0.41	No.
Chow Test (6)	2015	F-test	0.528	No.
Chow Test (7)	2022	F-test	—1	—1
Sup. Wald	Unknown, single	Wald test	12.277**	Yes.
CUSUM	—2	Recursive CUSUM	0.573	No.
Bai-Perron	Unknown, multiple	UDmax3	2.71	No.
		Sequential F(1|0)4	2.49	
		Sequential F(2|1)	2.88	
		Sequential F(3|2)	1.34	

Note. *p<0.05; **p<0.01.
1 The Chow test could not be run for 2022 due to an insufficient number of post-break observations.
2 The CUSUM test does not identify the timing or number of breakpoints; it tests for general instability over the sample.
3 Tests H_0: no break vs. H_1: 1 to 3 breaks.
4 Sequantial tests: H_0: s breaks vs. H_1: s+1 breaks.

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