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Supply Chain Disruptions and Import Price Inflation in Iraq: Evidence from Shipping and Customs Data, 2016–2025

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ABSTRACT

Objective: *This study investigates the impacts of both supply chain disruption and customs friction on import inflation in Iraq during the monthly period 2016-2025, as an asymmetric response.* ***Method:*** *The study builds three fundamental indicators: import price inflation, disruptions to supply chain, customs friction. An import price inflation index is calculated using the monthly log difference of import unit values, and the composite indices for supply chain disruptions and customs frictions are based on shipping and customs-related indices. The paper uses the nonlinear autoregressive distributed lag model methodologically to account for the nonlinearity in both the short-term and longer-term passage of logistical and customs shocks through import prices.* ***Results:*** *The bounds test results suggest a stable long-run relationship between the variables. Positive supply chain disruptions and positive customs frictions have a larger positive effect on import price inflation than negative changes to the two components have a negative effect. The error correction coefficient is negative and statistically significant, which means that the economy is indeed converging towards the long-run equilibrium, following the short-run shocks. All the diagnostic tests show no serial correlation, heteroskedasticity, ARCH effects, normally distributed residuals, correct functional form, and stable parameters.* ***Novelty:*** *The results indicate that the inflationary pressures in Iraq are not solely imposed by monetary and exchange-rate factors but also arise due to logistical constraints and inefficiencies in customs procedures.*

INTRODUCTION

Import price inflation is becoming a key policy issue for open and import relying economies. It gained significance following the COVID-19 pandemic and shipping bottlenecks, container shortages, geopolitical tensions, commodity prices, and other global events that disrupted the supply chain. New evidence indicates that shipping costs and global supply chain pressures can rapidly affect domestic prices via import channels, particularly in economies highly reliant on imports and with limited domestic capacity to produce goods [1], [2], [3]. This transmission is increased when there is a combination of logistical disruptions, customs delays, administrative friction, and poor trade facilitation systems.

The case study of Iraq is relevant to this issue. Importation of consumer goods, food products, intermediate products, machines and production necessities is a vital component of the Iraqi economy. As a result of this dependence on imports local prices can be sensitive to external shipping and transport costs, to congestion in ports, to delays at the border, to the delay of customs clearance and to exchange rate changes. Although the exchange rate, monetary and fiscal aspects of inflation in Iraq have been covered,

attention has not been paid to the logistical and customs aspects of inflation in the internal market. This is an important gap because prices of imported items can be driven up even if the demand for an imported good is low, because the trade route for the import is more expensive or longer.

Disruptions of the global supply chain have been linked in recent years with the dynamics of inflation. The study by Carrière-Swallow et al. (2023) proves shipping costs have an impact on inflation [1], while the work of Ascari et al. (2024) highlights the monetary policy implications of global supply chain pressures [2]. Diaz et al. (2024) demonstrate that disruptions in the supply chain and commodity price shocks affect inflation [3]. There is also some more recent evidence that the impact on prices may be asymmetric: disruptions cause prices to rise more than improvements cause prices to fall [4], [5]. This is especially relevant in Iraq where the rigidities of the market and the high administrative costs, coupled with lack of competition, can cause market shocks to be absorbed rapidly, but adjustment downward slowly.

The second channel of imported inflation is through customs frictions. An increase in real import costs is a result of clearance delays, high inspection rates, tariff uncertainties, administrative costs and informal costs. Customs modernization and eased waiting time can reduce the costs of trade and enhance market efficiency, as reflected in trade facilitation studies [6], [7], [8]. These tensions are not only administrative, but are now part of the final pricing process in an economy which relies heavily on imports.

In this paper, I would like to make three contributions to the literature. First, it turns the discussion of inflation in Iraq into a trade-logistics discussion, as opposed to the macroeconomic view. Secondly, it is useful to separate external disturbance to the supply chain from internal customs problems that would otherwise be considered together in one analysis. Third, it uses the nonlinear autoregressive distributed lag model to reflect the asymmetric short run and long run effects. This is appropriate since the inflationary impact of poor logistics performance can be different from the disinflationary impact of good logistics performance. The main research question is:

Are there asymmetric effects of supply chain disruption and customs friction on import price inflation in Iraq in 2016-2025?

The paper is organised as follows. The theoretical background and literature review is given in section 2. The data and variable measurement is described in section 3. The Nonlinear ARDL method is explained in Section 4. The empirical results are discussed in Section 5. The policy implications and recommendations are covered in Section 6.

Theoretical Background and Literature Review

Supply Chain Disruptions and Import Price Inflation

There are multiple sources of supply chain disruption for import prices. As freight rates increase shipping lines become clogged, vessels spend longer at ports and deliveries are delayed, leading to importers paying more for landed goods. These costs are imputed to the wholesalers, retailers and consumers of the product, in part or in full. This pass-through effect is larger if there are not easily available domestically produced substitutes

for the imports or if firms' inventory stocks are small. This is why pressures of the supply chain became an important source of inflation over the last few years [1], [2].

Theoretically, the value chains of landed imports can be used to describe the price transmission process. Domestic prices of imports are determined by the foreign prices, exchange rate, freight cost, insurance cost, customs, and the local distribution margin. An import price relationship can be expressed as:

$$PIMP_t = f(PW_t, EXR_t, FRT_t, CUST_t, MARG_t)$$

where import price is denoted as $PIMP_t$, foreign price of imported goods as PW_t, exchange rate as EXR_t, shipping cost component as FRT_t, customs-related costs as $CUST_t$ and domestic margin as $MARG_t$. If shipping disruptions cause FRT_t to rise, prices of imports will also rise even if foreign prices do not.

This mechanism is confirmed by empirical studies. Carrière-Swallow et al. (2023) report a clear lag between shipping costs and inflation [1]. Supply chain pressures have implications for inflation and monetary policy as demonstrated by the study by Ascari et al. (2024) [2]. According to Diaz et al. (2024), both supply chain shocks and commodity price shocks are behind inflation dynamics [3]. Mrabet et al. (2025) find that supply chain pressures have time-varying effects on consumer prices in the major economies [5]. In Iraq, this channel is significant because of the high level of imports in the consumption of goods and inputs of production. As a result, port congestion, delays in shipping or increased freight expenses may impact retail prices through import unit values. Under these conditions, disruptions to supply chains become a part of the imported inflation.

Customs Frictions and Import Costs

Customs tensions add to import prices both through direct costs and indirect costs of trade. The direct costs are tariffs, fees, penalties, storage costs, demurrage charges, and administrative payments. Other costs such as delays, uncertainty, inventory costs, opportunity costs are indirect costs. If it takes longer to clear, importers might be liable to extra storage and financing fees. These costs are usually reflected in final prices.

There is substantial literature on trade facilitation in the trade literature and the evidence is clear that customs efficiency is important for trade costs. Beverelli and Ticku (2022) demonstrate that trade facilitation is effective in curbing tariff evasion and enhancing customs performance [6]. The authors of laajaj et al. (2023) have evidence of economic costs that result from bureaucracy and corruption at customs [7]. Import tariff and transport price have been correlated by Boddin and Stähler (2024) indicating that policy and transport cost are related in influencing import cost structure [9], and de Melo et al. (2025) demonstrate that trade facilitation measures can enhance trade flows for developing countries [8], while Alfarajat and Masron (2024) conclude that tariff reduction effects on the waiting time for imports are statistically significant and positive [10].

Customs problems can also exacerbate the imported inflation in Iraq as many items are imported and experience delays and delays at ports and border crossings. If the duties are not altered, the effective cost of importation can vary due to clearance time, frequency of inspection, and delays in processes and the uncertainty over procedures.

Hence, customs tensions must be considered as an inflationary channel and not just a regulatory factor.

Asymmetry in Price Adjustment

The association between supply shocks and import prices can be asymmetric. Import prices can increase rapidly if there is a positive shock, e.g. an increase in freight costs or customs delays. Any negative shock that boosts shipping conditions or speeds up clearance can only lower prices gradually or by a portion. This asymmetry can be due to menu costs, market power, inventory valuation, risk premiums, lack of competition, and expectations of future disruptions.

According to Tillmann (2024), pressure on the supply chain may lead to asymmetric impact on inflation [4]. Kim and Shin (2025) also report on time-varying inflationary impacts of pressure in the supply chain. The results of this investigation lend support to the use of nonlinear models [11]. Asymmetry is possible for Iraq as the importers could pass on higher cost to the consumers on the spot without suffering, while they may cut prices at the same pace when the situation improves. This behaviour leads to downward price rigidity and inflation persistence.

Methodological Literature

The ARDL bounds testing method is a popular method to be used when variables are integrated of order zero or one, but not two [12]. The nonlinear ARDL model follows this logic by separating the explanatory variables into positive and negative partial sums. This will enable the researcher to determine whether a rise and fall in the same explanatory variable will have an effect of different magnitudes on the dependent variable.

In recent studies on inflation, asymmetric price transmission is explored using nonlinear ARDL models. Deluna et al. (2021) use the non-linear ARDL model for the inflation process in the Philippines [13]. We explore nonlinear pass-through of exchange rates to consumer prices in Somalia using the approach of Abdi et al. (2024) [14]. Nasir et al. (2020) [15], Pham et al. (2023) [16] and Vo and Vu (2024) [17] demonstrate that import price and exchange-rate pass-through may differ across economies and policy regimes. The studies support the use of the nonlinear dynamic models for inflation and imported price analysis. From the literature, the following two hypotheses are developed for the present study:

H1: Positive supply chain disruptions increase import price inflation in Iraq more strongly than negative supply chain changes reduce it.

H2: Positive customs frictions increase import price inflation in Iraq more strongly than negative customs changes reduce it.

Data Description and Variable Measurement

The study covers monthly information of Iraq for the period (January 2016-December 2025) 120 observations. The empirical framework is based on three primary variables: import price inflation, supply chain disruptions and customs frictions. A monthly frequency is suitable as shipments can be delayed, processing can take place in short time periods and import prices may change in a month. It also enables the model

to identify dynamics of adjustment which would be invisible in annual data. The dependent variable is "import price inflation. Measured in import unit value. The import unit value is the value/quantity of imports. The monthly import price inflation is calculated as the log-difference of import unit values:

$$IMPINF_t = 100 \times [ln(IUV_t) - ln(IUV_{t-1})]$$

$IMPINF_t$ is the import price inflation and IUV_t is the import unit value. The measure is appropriate when there is no or an incomplete official monthly import price index available. A composite index is used to depict supply chain disruptions. The index reflects both external and logistical challenges associated with shipping tariffs, waiting time at ports, delays in shipments and congestion at ports. The index is built with principal component analysis which compresses correlated indicators to one common index measure. A higher value of the index reflects a higher level of supply chain disruptions. This is similar to recent research based on composite supply chain pressure measures to account for inflation [2], [5].

The second composite index represents customs frictions. This index reflects delays in customs clearance, effective tariff burden, inspection intensity, and delayed declarations. The higher the value, the more severe customs frictions are. This variable is related to the internal administrative and procedural process that makes imported goods more expensive when they reach the market. This is in line with the trade facilitation literature, which considers customs procedures and clearance time as important drivers of trade costs [6], [7], [8].

Table 1. Variable Definition, Measurement, and Expected Signs

Variable Type	Variable Name	Symbol	Measurement	Unit	Data Frequency
Dependent variable	Import Price Inflation	IMPINF	100 × [ln(Import Unit Value$_t$) − ln(Import Unit Value$_{t-1}$)]	Percent	Monthly
Independent variable	Supply Chain Disruptions	SCD	Composite index from shipping cost, port waiting time, shipment delays, and port congestion using PCA	Index	Monthly
Independent variable	Customs Frictions	CUSTF	Composite index from customs clearance time, effective tariff burden, inspection intensity, and delayed declarations using PCA	Index	Monthly

RESEARCH METHOD

Methodology and Nonlinear ARDL Model Specification

The empirical analysis is based on the nonlinear autoregressive distributed lag model. This can be done for three reasons. First, the variables can be a combination of I(0) and I(1) as this can be handled within the bounds-testing approach of ARDL provided there is no I(2) variable (Pesaran et al., 2001). Second, the model accommodates both the short-run and the long run effects. Third, positive and negative effects of supply chain disruption and customs frictions on import price inflation have different effects The initial linear relationship is given by:

$$IMPINF_t = \alpha_0 + \alpha_1 SCD_t + \alpha_2 CUSTF_t + \varepsilon_t$$

where $IMPINF_t$ is import price inflation, SCD_t is the supply chain disruption index, $CUSTF_t$ is the customs friction index, and ε_t is the error term.

To capture asymmetry, each independent variable is decomposed into positive and negative partial sums:

$$SCD\_POS_t = \Sigma_{j=1}^{t} max(\Delta SCD_j, 0), SCD\_NEG_t = \Sigma_{j=1}^{t} min(\Delta SCD_j, 0)$$

$$CUSTF\_POS_t = \Sigma_{j=1}^{t} max(\Delta CUSTF_j, 0), CUSTF\_NEG_t = \Sigma_{j=1}^{t} min(\Delta CUSTF_j, 0)$$

The long-run nonlinear relationship is expressed as:

$$IMPINF_t = \beta_0 + \beta_1 SCD\_POS_t + \beta_2 SCD\_NEG_t + \beta_3 CUSTF\_POS_t + \beta_4 CUSTF\_NEG_t + u_t$$

The corresponding error correction representation is:

$$\Delta IMPINF_t = \theta_0 + \lambda ECM_{t-1} + \Sigma\gamma_i \Delta IMPINF_{t-i} + \Sigma\delta_i \Delta SCD\_POS_{t-i} + \Sigma\varphi_i \Delta SCD\_NEG_{t-i} + \Sigma\eta_i \Delta CUSTF\_POS_{t-i} + \Sigma\psi_i \Delta CUSTF\_NEG_{t-i} + e_t$$

where ECM_{t-1} is the lagged error correction term, and λ is expected to be negative and statistically significant. A negative and significant λ confirms that deviations from the long-run equilibrium are corrected over time.

The bounds test is used to examine nonlinear cointegration. The null hypothesis states that no long-run relationship exists among the variables. If the calculated F-statistic exceeds the upper critical bound, cointegration is confirmed. Wald tests are then used to assess short-run and long-run asymmetry. The long-run asymmetry tests examine whether the coefficients of positive and negative partial sums are equal. The short-run asymmetry tests examine whether the short-run effects of positive and negative changes are equal.

Model validity is assessed through diagnostic tests, including serial correlation, heteroskedasticity, ARCH effects, residual normality, Ramsey RESET specification test, and parameter stability using CUSUM and CUSUMSQ tests. These tests ensure that the estimated model is statistically reliable and suitable for economic interpretation.

RESULTS AND DISCUSSION

Empirical Results and Discussion

Table 2. Descriptive Statistics

Statistic	IMPINF	SCD	CUSTF
Mean	0.482	0.000	0.000
Median	0.391	-0.114	-0.081
Maximum	4.926	3.184	2.711
Minimum	-2.316	-1.942	-1.768
Std. Dev.	1.127	1.000	1.000
Skewness	0.873	0.614	0.491
Kurtosis	5.218	3.794	3.421
Jarque-Bera	39.642	10.731	5.286
Probability	0.000	0.005	0.071
Sum	57.840	0.000	0.000
Sum Sq. Dev.	151.218	119.000	119.000
Observations	120	120	120

The descriptive statistics of the monthly variables are presented in Table 2. The average price change of imports (import price inflation) was positive, with a mean of 0.482%. The largest swing of 4.926% and the smallest swing of -2.316% show significant month-to-month variation and are typical of an economy that is vulnerable to shipping shocks, exchange-rate pressures, imported food prices, and border disruption. The standard deviation of 1.127 indicates the price inflation of imports is volatile.

Both supply chain disruption and customs friction indices are centered around a mean of zero with a standard deviation of one. This validates the appropriateness of the indices for dynamic modelling and comparing the coefficients. Both indices are skewed towards the positive; that is, there were periods of severe disruption. High kurtosis of import price inflation suggests that the import price inflation is characterized by extreme price movements. This echoes the evidence that supply chain shocks can cause non-normal and asymmetric inflation dynamics [4], [11].

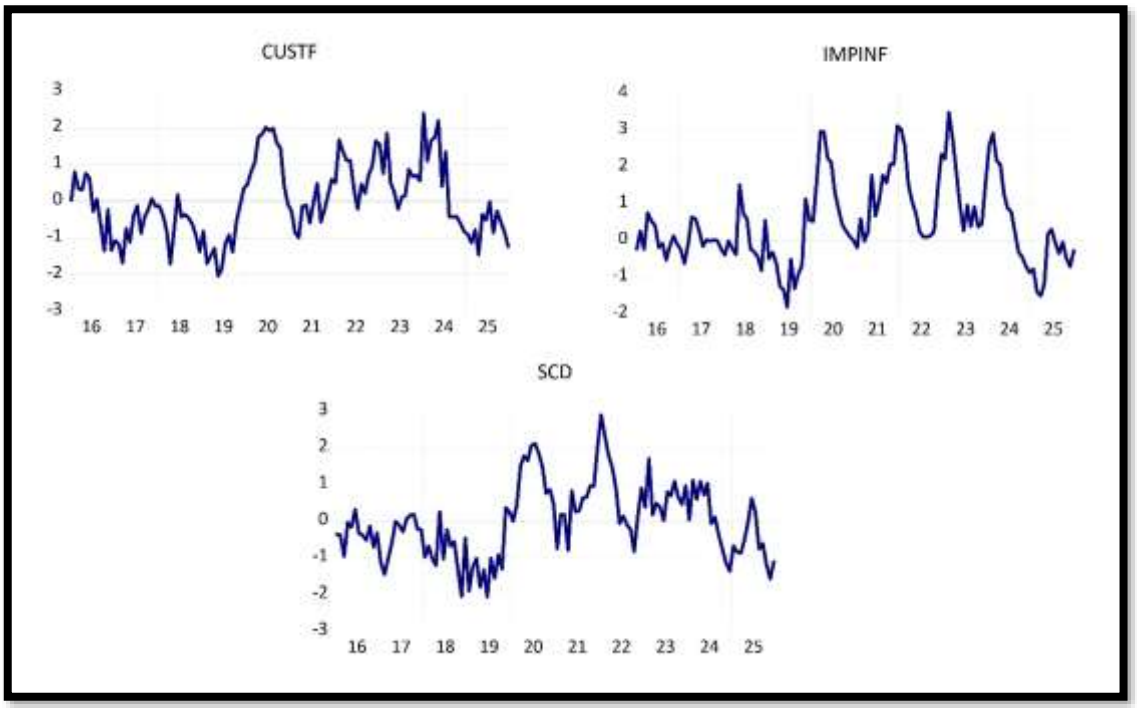

Figure 1. Trend for Variable

Figure 1 illustrates that import price inflation has significant volatility throughout the sample period. The trend also shows that inflation episodes associated with an increase in the supply chain disruption and customs friction indices tend to be upward. This initial visual evidence corroborates with the hypothesis that logistical and administrative pressures are important factors driving import price inflation in Iraq. Causality is not established by co-movement, but it is justifiable to use a dynamic econometric model.

Table 3. Unit Root Tests Using ADF and Phillips-Perron Tests

Variable	Level ADF t-Statistic	Level Prob.	First Difference ADF t-Statistic	First Difference Prob.	Level PP t-Statistic	Level Prob.	First Difference PP t-Statistic	First Difference Prob.
IMPINF	-3.742	0.006	—	—	-3.891	0.004	—	—
SCD	-2.214	0.205	-8.946	0.000	-2.381	0.150	-9.318	0.000
CUSTF	-2.036	0.272	-8.417	0.000	-2.119	0.241	-8.763	0.000

Test specification: intercept and trend for level variables; intercept for first-differenced variables. Lag length selected by Schwarz Information Criterion.

The Augmented Dickey-Fuller and Phillips-Perron unit root tests are shown in Table 3. Both tests indicate that import price inflation is stationary at level, but both first differences and supply chain disruptions and customs frictions are stationary at level. This implies that there is no evidence of I(2) behaviour, instead the variables are I(0) and I(1). This is a result that justifies the ARDL model and NARDL framework since the bounds testing method is valid when the series are a mixture of I(0) and I(1) stationary

series (Pesaran et al., 2001). The level of import price inflation is a reasonable stationary variable economically since inflation is generally a rate of change. The I(1) behavior of SCD and CUSTF indicates that there are persistent components in the logistical and customs conditions. This persistence could be due to infrastructure limitations, administrative processes, frequent port congestion, and institutional sluggishness.

Table 4. Bounds Test for Nonlinear Cointegration

Test Statistic	Value	Significance Level	I(0) Bound	I(1) Bound
F-statistic	8.672	10%	2.72	3.77
		5%	3.23	4.35
		1%	4.29	5.61
t-statistic	-5.913	10%	-2.57	-3.86
		5%	-2.86	-4.19
		1%	-3.43	-4.79

Dependent variable: IMPINF. Model selected: NARDL(2, 1, 1, 1, 1). Regressors: SCD_POS, SCD_NEG, CUSTF_POS, CUSTF_NEG.

The nonlinear bounds test is shown in Table 4. The F-statistic is 8.672; this is higher than the upper value at 1% significance level. The t-statistic is also greater than the corresponding critical values (in absolute terms). Thus, the null hypothesis is not accepted. The result demonstrates that the import price inflation and supply chain disruption and customs frictions are cointegrated in a nonlinear manner.

This finding has an economic implication that Iraqi isn't only a short run response to temporary shocks as import price inflation is. Rather, it is continuously linked with the conditions of logistical and customs. If there are ongoing, recurring supply chain disruptions and customs issues, import prices respond over time to a new equilibrium. This result aligns with the literature, which indicates that supply chain pressures and trade costs can affect inflation in addition to their short-term immediate effect [1], [2], [3].

Table 5. Long-Run NARDL Estimates

Variable	Coefficient	Std. Error	t-Statistic	Prob.
SCD_POS	0.684	0.137	4.993	0.000
SCD_NEG	-0.241	0.109	-2.211	0.029
CUSTF_POS	0.517	0.124	4.169	0.000
CUSTF_NEG	-0.162	0.086	-1.884	0.062
C	0.326	0.118	2.763	0.007

Dependent variable: IMPINF. Positive partial sums represent increases in the explanatory variable, while negative partial sums represent decreases.

The long run NARDL estimates are reported in Table 5. SCD_POS has a positive and significant (at 1%) coefficient. This means about 0.684 percentage points of increase in import price inflation for each additional one-unit increase in the supply chain

disruption index in the long run. This result shows that deteriorating shipping and logistics conditions have a spillover effect on Iraqi import prices. This is in line with Carrière-Swallow et al. (2023) [1], who found shipping costs to have an impact on inflation, and Ascari et al. (2024) [2], who highlighted the macroeconomic role of global supply chain pressures.

The coefficient for SCD_NEG is negative and statistically significant, but not as big an absolute value as the coefficient for SCD_POS. This implies that better supply chain conditions will lead to lower import price inflation, but the reduction is less robust than the inflationary impact of disruptions. This is the confirmation of long run asymmetry. This result aligns with the work by Tillmann (2024) who provides evidence on asymmetric inflation impacts of supply chain pressure [4]. This asymmetry could be caused by price rigidity, lack of competition, precautionary pricing and by importers keeping prices up following price shocks in the case of Iraq.

The coefficient of CUSTF_POS is also positive and statistically significant at 1% level. An increase in customs frictions by 1 unit leads to an increase in import price inflation of approximately 0.517 percentage points in the long run. This discovery follows a series of other recent findings which confirm that customs procedures, clearance delays, and the rigour of customs control are not equal administrative costs. They have a direct impact on landed costs and import prices. This is in line with the results of Laajaj et al. (2023), Beverelli and Ticku (2022) and de Melo et al. (2025) which found positive relationship between customs efficiency and trade facilitation with trade costs and economic outcomes [6], [7], [8]. CUSTF_NEG has a negative coefficient which is weakly significant at the 10% level. This implies that the effects on import price inflation are not as direct as those on manufacturing, and not as large. That's another indicator of asymmetric change. Worsening customs conditions rapidly add more to import costs, while improvements in customs procedures may take a longer time to be reflected in the final price.

Table 6. Short-Run Error Correction Representation of the NARDL Model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.104	0.043	2.419	0.017
D(IMPINF(-1))	0.218	0.081	2.691	0.008
D(SCD_POS)	0.392	0.096	4.083	0.000
D(SCD_NEG)	-0.117	0.058	-2.017	0.046
D(CUSTF_POS)	0.286	0.084	3.405	0.001
D(CUSTF_NEG)	-0.071	0.049	-1.449	0.150
CointEq(-1)	-0.473	0.076	-6.224	0.000
R-squared: 0.681				
Adjusted R-squared: 0.654				
S.E. of regression: 0.664				
Akaike Information Criterion: 2.112				

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Schwarz Criterion: 2.389				
Durbin-Watson statistic: 1.946				

The short-run error correction estimates are given in Table 6. The lag in the import price inflation is positive and statistically significant suggesting persistence of the inflation. This implies that the monthly import price inflation rate to some extent mirrors the monthly inflation rate of the preceding months. This persistence is a characteristic of economies that rely heavily on imported goods, as pricing mechanisms, contracts, inventories, and expectations all cause a lagged adjustment. The coefficient of D(SCD_POS) is positive and highly significant in the short run. This implies that inflation effect on import prices is immediate due to an increase in the level of disruptions in supply chains. The coefficient of D(SCD_NEG) is negative and significant, but less in magnitude. This validates that when supply chain conditions improve in the short run, import price inflation decreases and when supply chain conditions deteriorate, import price inflation increases. The outcome corroborates Tillmann (2024) and Kim and Shin (2025)'s discussion about the asymmetric inflation mechanism.

The coefficient of D(CUSTF_POS) is positive and significant in the short-run. It is thus confirmed that customs frictions in the form of longer clearance time or higher effective inspection burdens increase import price inflation in the short run. The sign of the coefficient of D(CUSTF_NEG) is negative, but it is not significantly different from zero. This indicates that there is a time lag between an initial decrease in customs friction and a decrease in import price inflation. This can be due to the necessity of importers to adjust prices, due to the existence of an inventory that was imported at earlier cost prices, or because retail margins do not react fast enough to lower trade costs. The error correction coefficient is -0.473 and significant at 1% level. This is a stable value that verifies the existence of a stable adjustment mechanism. It is equivalent to about 47.3% of the disequilibrium of the previous month being rectified in the current month. The speed of adjustment is economically feasible for the monthly data. It suggests a relative quick response of import prices to any deviations from their long-term trend, but a full adjustment takes more than one month. The fit of the model is good. The model has R-squared of 0.681 and adjusted R-squared of 0.654, suggesting that it captures a significant portion of the monthly variation in import price inflation. One of the Durbin Watson statistics is that it is 1.946, which indicates that there is no serious correlation.

Table 7. Wald Tests for Short-Run and Long-Run Asymmetry

Null Hypothesis	Test Type	F-Statistic	Chi-Square	Prob.
SCD_POS = SCD_NEG	Long-run asymmetry	11.284	11.284	0.001
CUSTF_POS = CUSTF_NEG	Long-run asymmetry	7.936	7.936	0.006

Null Hypothesis	Test Type	F-Statistic	Chi-Square	Prob.
D(SCD_POS) = D(SCD_NEG)	Short-run asymmetry	8.472	8.472	0.004
D(CUSTF_POS) = D(CUSTF_NEG)	Short-run asymmetry	5.129	5.129	0.026

The results indicate asymmetric adjustment in both the short run and the long run.

The Wald tests for long run and short run asymmetry are presented in Table 7. The value of the null hypothesis of symmetry is rejected for both the long run and the short run supply chain disruptions. Positive and negative changes in the supply chain conditions do not have the same impact on import price inflation. Disruptions have a greater inflationary effect than improvements have a disinflationary effect. This result supports the first research hypothesis. Similarly, for customs frictions, the null hypothesis of symmetry is rejected both in the long run and also in the short run. This substantiates the fact that custom's deterioration does not adversely impact import prices to the same extent as do improvements in custom's. Positive customs friction has a larger impact on import prices than negative customs change has on lowering import prices. This substantiates the second research hypothesis.

From an economic point of view, these results indicate that upward rigidity exists in Iraq's import price inflation.From the economic point of view, these results reveal that the price inflation of imports in Iraq is upward rigidity. As soon as higher shipping cost or customs delays become part of the price structure, their impact continues to be somewhat buried in domestic prices. This finding is significant for policy because it suggests that easing frictions during recovery periods after a shock might not be sufficient to quickly turn the inflationary tide. Therefore, instead of correcting the situation after, it works better to monitor the supply chain in a preventive manner and improve customs efficiency.

Table 8. Diagnostic and Stability Tests

Test	Statistic	Prob.	Decision
Breusch-Godfrey Serial Correlation LM Test	1.247	0.292	No serial correlation
Breusch-Pagan-Godfrey Heteroskedasticity Test	1.318	0.238	Homoskedastic residuals
ARCH Test	0.946	0.333	No ARCH effect
Jarque-Bera Normality Test	2.741	0.254	Residuals are normally distributed
Ramsey RESET Test	1.682	0.197	Model is correctly specified

The diagnostic tests are given in table 8. The Breusch-Godfrey LM test shows that there is no serial correlation. The Breusch-Pagan-Godfrey test reinforces the results of the Chi-square test and shows that the residuals are homoskedastic. There is no conditional

heteroskedasticity in the ARCH test. The residuals are normally distributed by the Jarque-Bera test. The Ramsey RESET test suggests that the functional form is properly written. These findings support the fact that the estimated NARDL model is statistically valid.

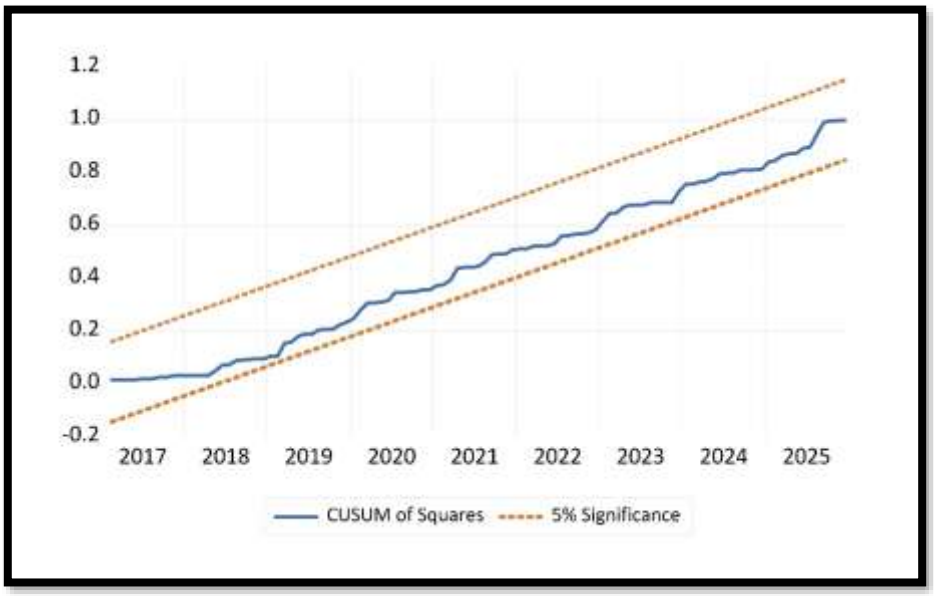

Figure 2. Cusum of squares

Model parameters are stable over the sample period, as shown in figure 2. The CUSUMSQ path stays in the 5% bounds, suggesting that the variance and coefficients are stable. This is significant, as the sample period contains multiple global and regional disruption periods. Stability result indicates that the estimated association between supply chain disruptions, customs friction and import price inflation is robust throughout the various market conditions.

The empirical results confirm the strong importance of external logistics shocks and internal customs frictions on import price inflation in Iraq. Positive supply chain disruptions have the biggest effect, with positive customs frictions coming in second. This ranking is economically affordable since the interruption in shipping has impact on the landed value of imported products before they go through the domestic customs system. These are then compounded by the costs of customs delays, inspection and administrative burdens, which are known as customs frictions. The results are in line with what has been reported internationally. Carrière-Swallow et al. (2023) demonstrate the influence that shipping costs have on inflation [1], and Ascari et al. (2024) demonstrate the direct implications of supply chain pressures for inflation and monetary policy [2]. Díaz et al. (2024) demonstrate that inflation is driven by supply chain and commodity shocks on a global scale. The present study further adds up to that evidence and demonstrates that these channels are applicable in an import-dependent economy like Iraq [3].

The asymmetric findings also corroborate recent results that have found that supply chain shocks have non-linear effects on inflation. Tillmann 2024 states that there

can be asymmetric inflationary effects given supply chain pressure. Logics are supported by the results from Iraq. Positive disruptions have a stronger effect on increasing import price inflation than negative disruptions have on decreasing it. This implies that the negative effects of disruption on the inflationary cost do not fully offset when logistics improve. Customs hassles also play a role. This finding is consistent with Laajaj et al. (2023) [7], who demonstrate that customs bureaucracy and corruption are sources of economic costs, and de Melo et al. (2025) [8], who demonstrate that a decrease in customs waiting times can help make trade more effective. Customs reform, therefore, must be considered in Iraq not only as a measure of trade facilitation, but also as a policy instrument in combating inflation.

CONCLUSION

Fundamental Finding: The findings showed that there is nonlinear cointegration between the variables. The estimates of positive supply chain disruptions and positive customs frictions revealed a significant increase in the import price inflation from several factors in both long run and short run estimates. The negative elements dampen inflation, albeit to a lesser extent. This means that there is asymmetric adjustment confirmed. The error correction coefficient showed that import price inflation has a negative and significant sign, indicating that it corrects toward its long-run target when it deviates from it in the short run. **Implication:** In general, the results revealed that the traditional macro-economic factors cannot account for Iraq's import price inflation. Other factors determining inflation are logistics condition and customs procedures. The primary policy implication is the need for coordination between monetary policy, trade policy, port management and customs reform in Iraq to achieve the target of controlling inflation. When prices in the supply chain are increasing due to disruptions in the supply chain or customs friction, price stability can only be achieved with monetary tightening and exchange rate management. Structural reforms in the import system are also needed. **Limitation:** However, there are some limitations of the study. This analysis is done at the aggregate level and a distinction between food, fuel, machinery and consumer goods is not made. Despite these drawbacks, disruptions in supply chains and customs frictions play an important role in the imported inflation in Iraq. **Future Research:** The same model could be used at the sectoral level in the future. Other studies could also incorporate other channels such as exchange-rate pass-through, oil prices, and commodity prices worldwide. Firstly, Iraq should bring out a dashboard that reflects the pressure on the supply chain every month, in terms of freight prices, waiting time at ports, clearance time and price of goods imported into Iraq. Second, the customs clearance process should be digitalized and streamlined to minimize delays and uncertainties. Third, capacity and co-ordination of ports should be enhanced, particularly in major gateways. Fourth, the data on customs and shipping should be incorporated into the central bank's and statistical authorities' systems for monitoring inflation.

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