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Modeling the Structural and Cyclical Determinants of Morocco's Trade Balance: An Econometric Approach

Khalil Bourouis [1], Mohamed EL Yahyaoui [2*], Hassan Oukhouya [3,4*], Abdellali Fadlallah [1], Saida Amine[2]

[1]*GEAS3D Lab, National Institute of Statistics and Applied Economics, Rabat, Morocco*
[2]*Laboratory of mathematics, computer science and applications, Faculty of Science and Technologies of Mohammedia, Hassan II University of Casablanca, Morocco*
[3]*LaMSD, MSASE, Department of Economics, FSJES, University Mohammed First of Oujda, Morocco*
[4]*MAEGE, Department of Statistics and Applied Mathematics, FSJES Ain Sebaâ, Hassan II University of Casablanca, Morocco*

Abstract This study examines the dynamics of Morocco's trade balance, with a focus on the distinction between its structural and cyclical components. Firstly, a cyclical adjustment approach is used to neutralize the effects of internal and external economic fluctuations. The rationale behind this method is based on estimating the relationship between trade volumes (exports and imports) and their fundamental factors, including domestic and foreign income and prices. Secondly, a modified version of the Hodrick-Prescott filter, known as the modified Hodrick-Prescott filter (MPHF), is employed to accurately extract the trend components from price indicators and gross domestic product (GDP). The second method of estimating income elasticities of foreign trade is through autoregressive distributed lag (ARDL) models, which allow for both short and long-run effects. In order to ensure the accuracy of these findings, sensitivity analysis is conducted on different alternative methods. Overall, there is also a more profound comprehension regarding persistent disparities in external balances, since the approach can allow for different paths for the sustainability of Morocco's current balance. The study highlights the role of structural elements in foreign trade phenomena in Morocco, where structural differences are considered the primary cause of the country's trade deficit. Nevertheless, import and export cycles have had minor effects.

Keywords Trade Balance, Structural and Cyclical Components, Trade Elasticities, ARDL Model, Fully modified Hodrick-Prescott Filter, Sensitivity Analysis.

AMS 2010 subject classifications 91B55, 91B60, 91B84, 93A30, 91G70, 62P20

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1. Introduction

External balances offer insight into a country's overall economic integration and stability within the global economy, as such stability is a key point of concern moving forward. Several analytical perspectives contribute to the determination in the literature, including the negative standardization of the external account, the negative sustainable level of the external account, and cyclical adjustments. These frameworks are analyzed cohesively in the literature [1, 2]. The external account, in its simplest form, is the sum of the economic transactions that occur between a country's residents and non-residents in a period of time, and in evidence includes trade of all types, service income, and current transfers [3]. The current account is considered closed sustainable over time if one does not accrue external debt that is easily unsustainable, or lose one's financial reserves over time [4]. Analysts

*Correspondence to: Mohamed EL Yahyaoui (Email: med.elyahyaoui19@gmail.com). Department of Mathematics, FST Mohammedia, Hassan II University of Casablanca. BP 146 Mohammedia 28806, Morocco.
Hassan Oukhouya (Email: oukhouya.hassan@ump.ac.ma). Department of Economics, FSJES, University Mohammed First of Oujda. BV Mohammed VI B.P. 724 Oujda 60000, Morocco.

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typically attempt to measure the depth of the sustainability triangle [5], as this is the region most likely to contain the most significant degree of external and structural imbalance, and therefore the most important adverse impacts likely to be realized 'externally'.

1.1. Literature review

A new understanding of the underlying current account has been put forth in recent literature. This idea assumes a scenario in which domestic and foreign economies have equal output levels and any delayed effects of exchange rate fluctuations have already dissipated. According to this perspective, the difference between the underlying current account and its normative or sustainable value is known as the current account gap. To restore equilibrium in the current external position, real exchange rate adjustments would be necessary if the gap were noticeably positive or negative. Haltmaier [6] conducted an empirical analysis to measure the cyclical component of current account balances using data from 35 countries. The approach uses three different estimates of the responsiveness of current account balances to changes in the output gap, as well as measures of the degree to which business cycles in each country have tended to lag or lead those in its trading partners. His findings suggest that the current cycle reduces the world's current account balance by about 0.5 percentage points. But this effect varies from country to country, Haltmaier says, with some countries seeing more of an impact than others.

To extract the cyclical component of Turkey's current account balance, the study by [7] employs a straightforward methodology. The three primary drivers of the analysis are external trade prices, domestic demand, and foreign demand. After considering cyclical factors, the analysis revealed that the underlying current account deficit worsened between 1998 and 2007, before stabilizing at approximately 6% of gross domestic product (GDP) in recent years. The impact of cyclical factors on Italy's external balance adjustment since 2010 was studied by [8]. To calculate the possible levels of imports, exports, and domestic demand, they created a model. This model systematically accounts for composition effects and is based on an external estimate of potential output. Tüzün & Eren [9] investigated how economic cycles in both Turkey and its partner countries impact Turkey's current account position. They proposed a method of calculating current account balances that considers these cyclical fluctuations, extending from the first quarter of 2003 to the first quarter of 2019. Their results showed that non-cyclical factors were the dominant determinants of Turkey's external position in terms of size and dynamics. At the same time, the significant influence of regional business cycles explained the cyclical component of Turkey's external position. However, Bettah and Zniber [10] analyzed to determine the roles that structural and cyclical factors play in Morocco's external trade balance. The results showed that structural factors were the main causes of the deficit in the country, accounting for nearly 9% of the country's nominal GDP in 2017. The report [11] describes the economic development experienced by eight successful countries in Asia, including Japan and those in East and Southeast Asia, between 1965 and 1990. The improvements in growth and living standards attained between these dates were notable. The smart rules and plans that guided them led to the success of their economies and the improved lives of their citizens. They aimed to ensure that all citizens enjoyed better lives and achieved income equality.

The diversification of exportable supplies from East Asia confirms the role of exports in economic growth [11, 12]. The adverse impact of diversification of external demand on export concentration is well-documented [13, 14]. Hausmann et al. [15] highlight the role of export composition in countries' economic growth. The more diverse the basket of goods in a country, the more it will influence the long-term economic growth of the country. The authors draw attention to the fact that the absence of structural features in the production of goods is explained by the dominant knowledge flow within the countries that focus on producing goods. They developed an index measuring the "income level of a country's exports," examined its features, and proved that it accurately predicts future economic results in order to support their claim. Additionally, Hooper and Tryon [16] examined the cyclical fluctuations in the current account positions of Germany, Japan and the United States. Their study focuses on quantifying the impact of cyclical factors on the current account balances of these three major economies, both recent and anticipated. It also provides a concise analysis of the effects of the decline in exports to developing countries. Jain [17] provides a comprehensive introduction to data clustering, highlighting its essential function in arranging data without previous category labels.

This paper examines the trade balance system in Morocco, focusing on the impact of various driving components: foreign demand, domestic demand, and the trade price ratio. Applying the Fully Modified Hodrick-Prescott (HP) filter, the driving components are separated into trend components and cyclical components. The objective of this paper is to determine whether the trade problem in Morocco is a structural issue or a cyclical one. The novelty of this paper lies in the application of econometric methods, which take into consideration the distinctive nature of the Moroccan economy in relation to the trade structure with the European Union, as well as the country's reliance on imports not only in the final consumption of goods in the domestic market but in the processing of goods in export industries. The rest of the paper is organized as follows: Section 2 describes the methodological framework, which includes the cyclical adjustment formula for the current account, the autoregressive distributed lag (ARDL) cointegration model design, and the use of the Fully Modified HP Filter. In Section 3, the empirical results are presented, focusing on foreign trade estimation using the ARDL approach. The precision and sensitivity analysis in Section 4 provides a study that shows the main results do not depend on particular modeling or filter choices. Lastly, Section 5 concludes, among them, further research lines.

2. Methodology

2.1. Cyclical adjustment of current account

The business cycles of key trading partners also affect the current account and trade balances, in addition to changes in the domestic economy. When demand for imported goods and services declines during economic downturns, these balances usually show an inverse relationship with national business cycles. It is crucial to implement an adjustment process that separates the structural component of the current account to account for these cyclical effects. Finding variables that react to domestic and international economic cycles is a prerequisite for removing the cyclical component of the current account. Although domestic income fluctuations mainly influence import behavior, exports are generally more sensitive to changes in global income and, consequently, to international economic conditions. When it comes to pricing, it is assumed that there is no impact due to the national and international economic cycle; it is just the pricing behavior alone, or it follows some cyclical behavior. That is to say, the current account balance, cyclically adjusted, is the level hypothesized to exist, provided the output gaps, both national and global, were zero. This study, like others, assumes this conventional method, albeit for the study of the trade balances of goods and services only to start with. The main method for the cyclical adjustment of the balance of payment used in this study is based on the long-run cointegrating relationship that exists between the real variable A_t and the real income Y_t [†]. The presence of the real exchange rate or relative prices is well known to impact the quantity in question. Hence, these variables will need to be included in the estimation of long-run relationships, assuming they can be regarded as statistically significant. A typical long-run relationship can be illustrated as follows:

$$\ln(A_t) = c + \alpha \ln(Y_t) + \beta \ln(Z_t) \tag{1}$$

where A_t is the trade activity that can refer to either the export or import of volumes, the variable Y_t represents the amount of real GDP at a national or international level, and Z_t is a co-vector consisting of other explanatory variables. [‡] The cyclical component of a variable is given by its deviation from trend:

$$a = A_t - \Delta A_t \tag{2}$$

In this context, a represents the trend component, while ΔA_t captures the cyclical deviation. Following standard convention, lowercase letters are used throughout the report to denote trend components. Accordingly, Equation (2) can be reformulated as follows:

[†]This method is used by the European Commission (EC) in relation to the impact of the cycle on the balance of the current account. So do [8] in estimating their works.
[‡]We do not distinguish at this point for convenience's sake between exports and imports or domestic GDP and world GDP.

$$a = A_t \left(1 - \frac{da}{1+da}\right) \tag{3}$$

Where $da = \Delta A_t$ denotes the percentage deviation from the long-term trend. By omitting all variables except income in Equation (1), and under the assumption of constant elasticity—where imports respond iso-elastically to domestic GDP and exports respond iso-elastically to the GDP of trading partners—it follows that a 1% increase in domestic (foreign) GDP in year t, required to close the output gap, would have resulted in a θ increase in imports (exports). Focusing initially on the export side, the potential level of real exports is computed as follows:

$$a = A_t \left(1 - \frac{\theta\, dy}{1+dy}\right) \tag{4}$$

Here, dy denotes the output gap expressed as a percentage of potential GDP. Once export and import volumes are adjusted to account for cyclical fluctuations in domestic and foreign GDP, the corresponding adjusted values for exports and imports are derived by multiplying these volume measures by their respective price indices.

2.2. Specification of the ARDL cointegration model

2.2.1. ARDL modeling

To analyze export and import demand functions and estimate long-term income elasticities in Morocco, we will apply the Auto Regressive Distributed Lag (ARDL) model. This model falls within the category of dynamic models and is designed to capture temporal dependencies [18]. It is represented as follows:

Let Y_t be an endogenous variable whose current value is explained by its past realizations (Y_{t-i}), consistent with the structure of an autoregressive (AR) model, which can be formally written as:

$$Y_t = a_0 + a_1 Y_{t-1} + \cdots + a_p Y_{t-p} + \varepsilon_t \tag{5}$$

where ε_t are assumed to be independent and identically distributed (i.i.d.) (i.e. $\varepsilon_t \sim$ i.i.d.$(0, \sigma^2)$) denotes a white noise error term. Exogenous variables (X_t) and their lagged values (X_{t-i}), which lead to a distributed lag (DL) model of the form:

$$Y_t = \beta + b_0 X_t + \cdots + b_q X_{t-q} + z_t \tag{6}$$

where $z_t \sim$ i.i.d.$(0, \sigma^2)$ is an error term. Combining both autoregressive and distributed lag components results in the Autoregressive Distributed Lag (ARDL) model, expressed as:

$$Y_t = \varphi + \sum_{i=1}^{p} a_i Y_{t-i} + \sum_{j=0}^{q} b_j X_{t-j} + e_t \tag{7}$$

where $e_t \sim$ i.i.d.$(0, \sigma^2)$. In this formulation, the coefficient b_0 captures the short-run impact of X_t on Y_t. To evaluate the long-run effect of X_t on Y_t, one can compute the long-run multiplier μ using the following equilibrium relationship:

$$Y_t = k + \mu X_t + u_t \tag{8}$$

where k represents the long-run constant (or equilibrium intercept), which is directly derived from the constant term of the ARDL model, and u_t denotes the long-run error term, also referred to as the equilibrium residual or cointegration residual. The long-run coefficient is given by:

$$\mu = \frac{\sum b_j}{1 - \sum a_i} \tag{9}$$

The ARDL modeling approach enables the examination of both short-run and long-run relationships, as well as cointegration, even when the variables exhibit different orders of integration, so long as none are integrated of order two or higher.

2.2.2. Cointegration test

Several methods available in the econometric literature for testing the existence of cointegration among time series include, among others, the Engle-Granger and Johansen-Juselius tests. While the Engle-Granger test is suitable for bivariate analysis, enabling the detection of cointegration between two variables that are integrated of order one, it may not be effective in multivariate contexts. On the other hand, the Johansen test is designed for multivariate frameworks, and it becomes applicable when all series are integrated of the same order. However, in practical applications, the general case often is that variables exhibit different integration orders. The cointegration test of [19], i.e., the "bounds" test, is helpful in such a case. First proposed by [20] and referred to as the ARDL bounds testing approach, it checks for cointegration in an ARDL framework. The cointegrated ARDL specification defining the model under lag cointegration testing is:

$$\Delta Y_t = \varphi + \sum_{i=1}^{p} a_i \Delta Y_{t-i} + \sum_{i=0}^{q} b_i \Delta X_{t-i} + \theta Z_{t-1} + \varepsilon_t \tag{10}$$

Here, Z_{t-1} denotes the error correction term obtained from the established long-run equilibrium relationship, while θ represents the adjustment coefficient that captures the speed at which the system converges back to equilibrium following a disturbance. In our approach, national and global GDP gaps are treated as exogenous variables. Consequently, it is essential to first select an appropriate method for decomposing real income series into their trend and cyclical components. We choose to work with the FMHP method for this purpose.

2.3. Fully Modified HP Filter

The Hodrick-Prescott (HP) filter is a widely used technique for extracting the cyclical component c_t from a time series. It does so by minimizing the sum of squared deviations between the observed values y_t and the estimated trend component g_t, while imposing a smoothness penalty on the trend. Mathematically, this involves solving the following optimization problem:

$$\min_{\{g_t\}} \left[\sum_{t=1}^{T} (y_t - g_t)^2 + \lambda \sum_{t=2}^{T-1} \left((g_{t+1} - g_t) - (g_t - g_{t-1}) \right)^2 \right] \tag{11}$$

where λ is the smoothing parameter barring variant trend changes. The HP filter is preferred due to its prevalence among digital calculus systems and its smoothing properties. However, the sample final value bias (EPB) [21, 22] poses the first and second efficiency challenges. One popular class of attempts to charm the murky twins of ex-ante and ex-post smoothing criteria is [23], who has configured a novel blended methodology of endogenous scale weighting. It is hybridized with the Bloechl construct [24], which offsets endpoint bias to deliver a final optimal smoothing calculus routine using McDermott's [25] HP filter, thereby alleviating the problem of no-flex smoothing. Of special note is Bloechl's construct of a flexible midpoint of the interval to moderate excessive oscillation often associated with crippling anchor or boundary volatility. The FMHP Filter [23] ameliorates this by compensating for the endpoint bias and using a dynamically chosen smoothing parameter, determined as a function of the time series characteristics. Thus, whenever we use it, the benchmark index provides a trend component which we interpret as indicating something of the structural dimension in the macroeconomic series under analysis. This component is designed to capture underlying long-term changes, while attenuating short-term noise and unsystematic innovations. Nevertheless, we recognize that some persistent cyclical dynamics may remain embedded in this trend, making the separation from structural factors imperfect. In the Moroccan case, the notion of "structural" refers to relatively stable and enduring determinants of growth, such as the development of infrastructure, the orientation of trade policy, and the progressive transformation of the sectoral composition of output. The FMHP-based trend should therefore be understood as an approximation of these fundamental drivers, while acknowledging its possible contamination by protracted cyclical influences.

Consequently, we adopt the FMHP filter as the basic methodology for isolating the trend components of export-weighted national and global GDPs. Trend prices from the export and import price index series are extracted by applying the modified HP filter to the annual export and import price index series. The use of this approach is dictated by the concern to filter price indices from their cyclical fluctuations and to allow a nominal level of foreign

trade filtered from both cyclical components relating to domestic economic activity and that of partner countries, as well as from cyclical price fluctuations. Figure 1 illustrates the methodological framework adopted in this study. The process begins with the estimation of export and import functions, followed by the derivation of long-term elasticities. Key variables are then filtered to extract structural information, allowing the decomposition of trade flows into structural and cyclical components. Finally, the structural trade deficit is computed, forming the basis for the subsequent empirical results.

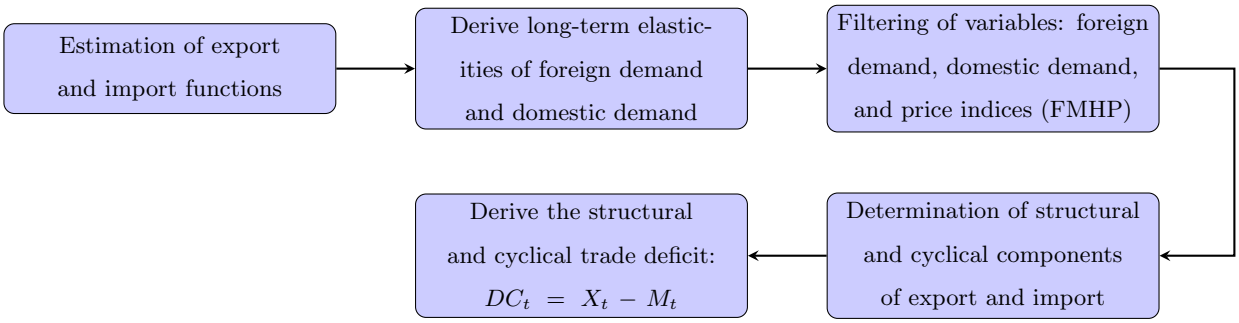

Figure 1. Methodological framework of the study

3. Results and discussion

3.1. Estimation of foreign trade using the ARDL model

This subsection focuses on the analysis of the structural and cyclical components of the international trade balance. We will examine the estimation of export and import functions, as well as the determination of long-term income elasticities. In addition, we analyse the contribution of cyclical and structural factors to the variation in the trade deficit.

3.1.1. Choice of variables

Drawing on insights from the preceding literature review, Table 1 presents the key variables selected for the model. Accordingly, the following functional forms are adopted for estimating exports and imports:

The export function is defined as $X_t = F(GDP_F, Ex, Prod_c, PX/PM)$, where exports X_t are primarily influenced by the foreign gross domestic product (GDP_F) of the European Union (EU), which captures external demand conditions. This variable is considered given that more than 60% of Moroccan exports are destined for the EU. We deliberately retained the EU as the reference partner for both methodological and empirical reasons. First, the EU remains Morocco's predominant trading partner, as illustrated in Figure X below. Over the period 2001–2019, the European Union (EU-28) consistently accounted for approximately 65–75% of Morocco's total exports and 50–60% of its imports, underscoring its structural importance in Morocco's external sector. Despite a gradual increase in trade with other regions, this persistent concentration confirms that EU economic activity remains the principal driver of Morocco's external demand. Second, the EU provides the most consistent, harmonized, and long-term macroeconomic data, which ensures statistical comparability over the full estimation horizon. This data reliability is essential for the econometric framework employed in our study and supports the robustness of the estimated elasticity of 1.29 with respect to EU GDP. The exchange rate (Ex) affects the relative price of domestic goods on international markets, while the ($Prod_c$) reflects cereal grain production, used in this context as a proxy for agricultural performance, which significantly impacts the level of imports and exports of agricultural and agrifood products.[§] The ratio of export to import prices (PX/PM) represents

[§]Our choice is mainly driven by data availability and by the historical role of cereals as the principal source of output volatility in Morocco. This relevance is supported by the strong correlation between cereal production, overall agricultural production, and agricultural value

the terms of trade, which also influences export performance. Similarly, the import function is specified as $M_t = F(DI, X, Ex, Prod_c, PM/PX)$, where imports M_t depend on the domestic demand (DI), including consumption and investment. Exports (X_t) are included to account for backward linkages, such as imported inputs in export production. The price ratio PM/PX reflects the inverse terms of trade, influencing the relative cost of imports. These formulations reveal the close relationship between trade flows, macroeconomic variables, and changes in relative prices.

Table 1. Selected Variables for Export and Import Demand Estimation

Variable (in log L_variable)	**Description**	**Source**	**Effect**
LX	Export volume	HCP[1]	-
LM	Import volume	HCP	-
LGDP_E	Gross Domestic Product of the European Union	IMF[2]	Captures the fluctuations in international economic activity levels affecting trade volumes with the EU, Morocco's major partner
LDI	Real domestic demand	HCP	Measures domestic demand for goods and services
LEX	Real effective exchange rate index of Morocco	IMF	A key determinant of the trade deficit, as its appreciation tends to boost import demand and reduce foreign demand for exports
LProd_c	Cereal production in Morocco	MFE[3]	A proxy for agricultural performance, especially since cereals are among Morocco's main imports
LPX-PIM	Difference between the export and import price indices	Computed by the author using data from HCP	Accounts for the impact of fluctuations in relative prices of traded goods compared to foreign goods on imports and exports

[1] HCP stands for High Commission for Planning, the Moroccan statistical agency.
[2] IMF stands for International Monetary Fund.
[3] MFE stands for Ministry of Economy and Finance of morocco.

Table 2. Unit Root Test

Series	**Stationarity**	**Order of Integration**
LX	Non-stationary	I(1)
LEx	Non-stationary	I(1)
LPx/Pm	Stationary	I(0)
LGDP_E	Non-stationary	I(1)
LProd_c	Stationary	I(0)

3.1.2. Estimation of the export function

added. In fact, the Pearson correlation coefficient reaches nearly 90% between cereal production and agricultural value added, and around 64% between cereal production and total agricultural production.

Series stationarity

The stationarity of the model variables is assessed using the Augmented Dickey-Fuller (ADF) test. The results of the unit root tests are reported in Table 2.

We can observe that the series for exports, the real effective exchange rate, and the European GDP are integrated of order one, meaning they become stationary after first differencing. In contrast, the series for cereal production, the Px/Pm ratio (export price index/import price index), and foreign demand remain stationary at a level, meaning they do not require differencing to achieve stationarity. Therefore, the variables are integrated at different orders, making the bounds cointegration test appropriate. According to the previous table, all variables are integrated at different orders strictly less than 2. Therefore, the Autoregressive Distributed Lag (ARDL) model can be applied [19], following its standard specification.

Optimal Lag Selection and ARDL Model Estimation

The optimal ARDL model is selected based on the Schwarz Information Criterion (SIC) [26], which favors the model that achieves statistical significance with the fewest parameters. The results from the forecasting using the ARDL model specification are presented in Table 3:

Table 3. ARDL(4, 2, 4, 2) model selection with optimal parameters

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LX(-1)	0.206249	0.135516	1.521955	0.1520
LX(-2)	0.398632	0.145878	2.732642	0.0171
LX(-3)	0.142241	0.133564	1.064966	0.3063
LX(-4)	0.369152	0.114374	3 227587	0.0066
LPX_PM	-0.693479	0.167306	-4.144965	0.0012
LPX_PM(-1)	0.108422	0.201003	0.539404	0.5987
LPX_PM(-2)	0.719189	0.184021	3.908194	0.0018
LPX_PM(-3)	0.029294	0.189170	0.154856	0.6293
LPX_PM(-4)	0.468696	0.143594	3.264042	0.0062
LPROD_C	-0.012252	0.15678	-0.781469	0.4485
LPROD_C(-1)	-0.011052	0.016787	-0.658356	0.5218
LPROD_C(-2)	0.16278	0.01273	1.065779	0.3059
LPROD_E	2.474148	0.399226	6.197363	0.0000
LGDP_E(-1)	-1.536208	0.710910	-2.160904	0.0500
LGDP_E(-2)	-0.050716	0.719040	-0.070533	0.9448
LGDP_E(-3)	-0.397334	0.648159	-0.613019	0.5504
LGDP_E(-4)	-0.640279	0.463289	-1.382029	0.1902
LEX	-0.084654	0.307175	-1.275590	0.7872
LEX(-1)	-0.636912	0.505171	-1.260784	0.2295
LEX(-2)	0.794831	0.268445	2.960875	0.0110
A1988	0.199567	0.038183	5.226656	0.0002
A2000	-0.080735	0.036906	-2.187591	0.0476
R-squared	0.9997970	Mean dependent var	11.92652	
Adjusted R-squared	0.997829	S.D. dependent var	4.548045	
S.E. of regression	0.025533	Akaike info criterion	-4.230959	
Sum squared resid	0.008475	Schwarz criterion	-3.253311	
Log likelihood	96.04178	Hannan-Quinn criter.	-3.893475	
Durbin-Watson stat	1.749116			

*Note: p-values do not account for model selection uncertainty.

Model Diagnostic Tests

During the model validation phase, a multitude of diagnostic checks are used to verify the robustness and accuracy of the estimated model. These tests cover residuals, white noise, autocorrelation, and heteroscedasticity, as well as the normality of residuals and, more generally, the stability of the model. In this way, we can test all aspects of the model and ensure that it is consistent with the observed data.

Normality Test of Residuals:

This test was run in EViews to produce the results displayed in Figure 2. The residuals' normal distribution and Gaussian white noise characteristics are confirmed by the Jarque-Bera test p-value exceeding the 5% significance threshold.

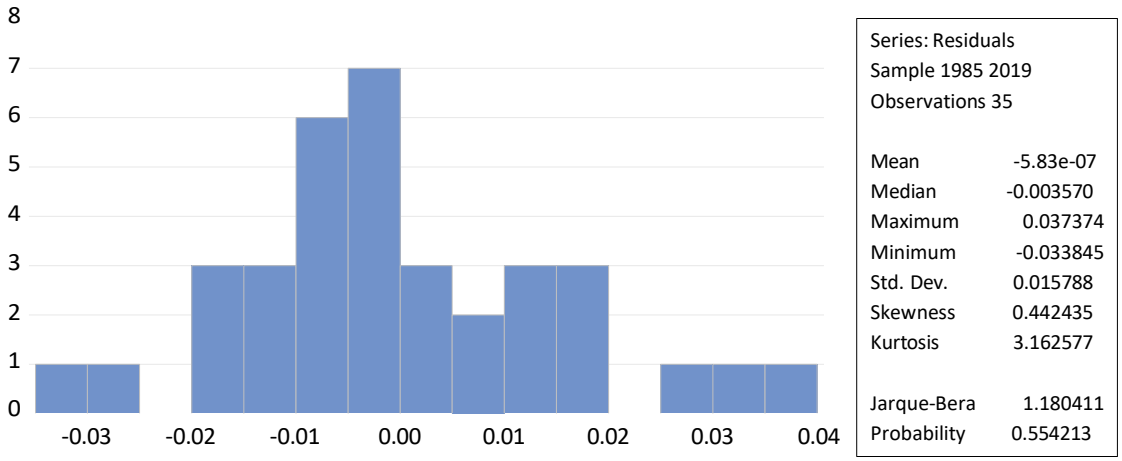

Figure 2. Histogram of residual distribution

Error Autocorrelation Test:

Error terms in the model should be free of each other, and this is particularly important because lagged forms of the dependent variable are included in the explanatory regressors in the model. Otherwise, the parameters could fail to be consistent. As shown in Table 4, the test for the absence of autocorrelation in the residuals yields a p-value

Table 4. Breusch-Godfrey LM Test for Serial Correlation. Null hypothesis (H_0): Absence of serial correlation up to 2 lags

F-statistic	0.164148	Prob. F(2, 11)	0.8507
Obs*R-squared	1.014307	Prob. Chi-Square(2)	0.6022

exceeding the 5% significance level, indicating that autocorrelation is not present in the residuals.

Heteroscedasticity Test:

This assumption is one of the key requirements of linear models. Residuals are said to be heteroscedastic if they do not have constant variance (i.e., if the errors are not homoscedastic). To verify whether the residuals exhibit heteroscedasticity or homoscedasticity, we can use the Breusch-Pagan test: Based on the results presented in Table

Table 5. Breusch-Pagan heteroskedasticity test

F-statistic	0.286615	Prob. F(22, 12)	0.9946
Obs*R-squared	12.05610	Prob. Chi-Square(22)	0.9562
Scaled explained SS	1.798398	Prob. Chi-Square(22)	1.0000

5, the null hypothesis of homoscedasticity cannot be rejected, as the p-value associated with the F-statistic exceeds the 5% significance threshold. This indicates that the residuals exhibit constant variance throughout the model.

Model Stability Test:

The CUSUM of Squares test is particularly useful for evaluating the stability of a model. It is based on the cumulative sum of squared recursive residuals, with the null hypothesis positing that the underlying relationship remains stable. The test's outcome is assessed by verifying that the plotted curve stays within the two boundary lines that define the confidence interval.

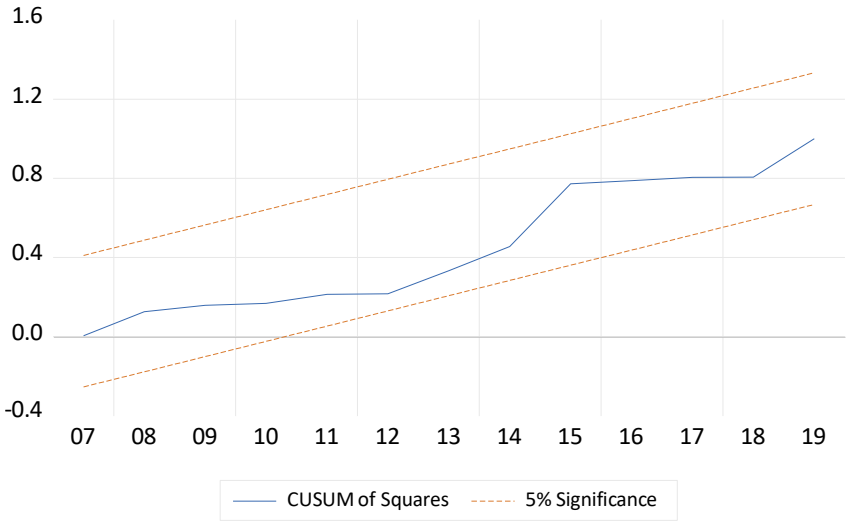

Figure 3. CUSUM of Squares test for model stability

Based on Figure 3, the CUSUM of Squares test results are shown in the graph above, we can conclude that the estimated model is stable, as the test curve remains within the dotted confidence bands. This implies that the model's coefficients are stable over time. Overall, the findings from the diagnostic tests support the adequacy and reliability of the ARDL(4, 4, 2, 4, 2) model specification.

Bounds Cointegration Test

We employ the bounds cointegration test proposed by Pesaran. This test has been discussed in detail earlier. The calculated value of the test statistic is compared to critical values (which form lower and upper bounds). In Table 6 shows the results obtained from applying the bounds cointegration test. The results of the bounds cointegration test confirm the existence of a cointegrating relationship between the series under study. The F-statistic exceeds the upper bound, which allows for the estimation of the long-run effects of *LEX*, *LPX/PM*, and *LGDP_E* on *LX*.

Long-Run Coefficients and Short-Run Dynamics

Based on the information derived from Table 3, we estimate an ARDL(4, 4, 2, 4, 2) model. This model was selected to study the relationship between the dependent variable (X) and a set of exogenous variables considered as key determinants of Morocco's export volume.

Short-Run Coefficients :

According to the presented Table 7, we can observe that the European GDP has a positive short-term effect on Moroccan exports. A 1% increase in GDP leads to a 2.47% growth in Moroccan exports in the short run. The ratio between the export and import price indices has a negative impact on Moroccan exports due to price competitiveness and production costs. Moroccan products may become less competitive in international markets if export prices are less favorable than import prices, potentially leading to a decline in exports. Furthermore, if export prices increase at a slower rate than import prices, it can result in higher production costs for Moroccan exporters, further diminishing their competitiveness.

Table 6. Bounds test

F-Bounds Test		H_0: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	13.86066	10%	1.9	3.01
k	4	5%	2.26	3.48
		2.5%	2.62	3.9
		1%	3.07	4.44
Actual Sample Size	35		Finite Sample: n=35	
		10%	-1	-1
		5%	-1	-1
		1%	-1	-1

Table 7. Conditional Error Correction Regression (Short-Run Dynamics)

Variable	Coefficient	Std. Error	t-Statistic	Prob.[b]
LX(-1)	0.116272	0.033418	3.479336	0.0041
LPX_PM(-1)	0.632122	0.362009	1.746147	0.1044
LPROD_C(-1)	-0.007026	0.073559	-0.187060	0.8545
LGDP_E(-1)	-0.150389	0.053509	-2.810518	0.0147
LEX(-1)	0.073265	0.147990	0.495068	0.6288
D(LEX(-1))	-0.910024	0.148876	-6.112629	0.0000
D(LX(-2))	-0.511392	0.126183	-4.052778	0.0014
D(LX(-3))	-0.369152	0.114374	-3.227587	0.0066
D(LPX_PM)	0.693479	0.167306	4.144965	0.0012
D(LPX_PM(-1))	-1.217179	0.257928	-4.719066	0.0004
D(LPX_PM(-2))	-0.497990	0.203837	-2.443082	0.0296
D(LPX_PM(-3))	-0.468696	0.143594	-3.264042	0.0062
D(LPROD_C)	-0.016225	0.015678	-0.781469	0.4485
D(LPROD_C(-1))	-0.162780	0.153273	-1.062578	0.3059
D(LGDP_E)	2.474148	0.399226	6.197363	0.0000
D(LGDP_E(-1))	1.088329	0.536924	2.026972	0.0637
D(LGDP_E(-2))	1.037613	0.456778	2.271591	0.0407
D(LGDP_E(-3))	0.640279	0.463289	1.382029	0.1902
D(LEX)	-0.084654	0.307175	-0.275590	0.7872
D(LEX(-1))	-0.794831	0.268445	-2.960875	0.0110
A1988	0.199567	0.038183	5.126656	0.0002
A2000	-0.080735	0.038906	-2.187591	0.0476

Note: [b]Prob. are p-values based on the ARDL bounds-testing distribution (Pesaran et al. [27]), not the standard t-distribution.

Long-term coefficients:

In Table 8, the long-run coefficients (elasticities) calculated from the model are displayed. Based on the results, it was revealed that the GDP of Europe (LGDP_E) and the export/import price ratio (LPX_PM) are significant variables in the long run. Similar to the short-run findings, foreign GDP exerts a positive and more than proportional impact on exports: a 1% increase in European GDP is associated with a 1.29% rise in exports over the long run. Conversely, the price ratio has a negative influence. Specifically, an increase in the GDP of trading partners,

Table 8. Regression Results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LPX_PM	-5.436556	2.117961	-2.566882	0.0234
LPROD_C	0.060425	0.310802	0.194417	0.8489
LGDP_E	1.293417	0.398989	3.241735	0.0064
LEX	-0.630117	1.415473	-0.445164	0.6635

EC = LX - (-5.4366*LPX_PM + 0.0604*LPROD_C + 1.2934*LGDP_E - 0.6301*LEX)

reflecting stronger foreign demand for Moroccan goods, is expected to enhance exports. In contrast, a relatively faster growth in export prices compared to import prices signals a loss in Morocco's price competitiveness, which tends to reduce export volumes, increase import volumes, and consequently deteriorate the real coverage ratio, thereby exerting an adverse effect. In order to validate the rigour of our conclusions, we carried out a sensitivity check by re-estimating long-run elasticities according to different lag length parameters. More specifically, we compared the results of the best models recommended by the Hannan-Quinn, SIC and AIC criteria. Our main conclusion is not unduly influenced by the chosen lag selection rule, as evidenced by the estimated elasticity of exports relative to EU GDP, which remains largely constant across various specifications. In particular, the elasticity is estimated at a level close to our benchmark estimate, i.e. 1.29 according to the AIC-based model, 1.37 according to the SIC-based model, and 1.43 according to the Hannan-Quinn criterion.

We used Johansen's cointegration technique on the subset of I(1) variables (exports, EU GDP, relative prices, and exchange rates) to check its robustness. The maximum eigenvalue test verifies at least one long-run equilibrium vector at the 5% significance level, while the trace test indicates up to three cointegration associations. The solidity of our major findings is reinforced by the calculated coefficients, which show a stable long-run connection between exports, EU GDP, prices, and the exchange rate, consistent with the results of the ARDL limits test. Specifically, the null hypothesis of no cointegration is strongly rejected by the trace statistic of 114.4 (critical value 69.8, p = 0.000) and the maximum eigenvalue statistic of 48.0 (critical value 33.9, p = 0.0006). Long-term linkages are further corroborated by the trace statistic, which is significant (66.3 vs. 47.8) even when testing for additional cointegration vectors.

3.1.3. Estimation of the Import Function

Stationarity of the Series:

The stationarity of all variables involved in the modeling process is evaluated using the Augmented Dickey-Fuller (ADF) unit root test.

Table 9. Unit Root Test Results and Integration Order of Variables

Variables (in Log)	Stationarity	Order of Integration
IM	Non-stationary	I(1)
LX	Non-stationary	I(1)
Lex	Non-stationary	I(1)
LPm/Px	Stationary	I(0)
LDI	Non-stationary	I(1)
LProd_c	Stationary	I(0)

The series for imports, exports, real effective exchange rate, and domestic demand are integrated of order 1, which means they become stationary after first differencing, according to the results summarised in Table 9.

The Pm/Px ratio (export price index/import price index) and the cereal production series, on the other hand, are stationary at a level, suggesting that no differencing is required to reach stationarity. The bounds testing approach to cointegration is therefore appropriate for our analysis, as the series exhibit various orders of integration. Additionally, the ARDL model can be used because the order of integration is less than 2.

Optimal Lag Selection and ARDL Model Estimation

Table 10 showcases the estimation findings from the most suitable ARDL model determined by the Akaike Information Criterion (AIC). The lagged dependent variables exhibit high levels of positive persistence. Meanwhile, real domestic demand (LDI) and exports (LX) have a positive and significant impact on imports, indicating their stimulating effect. In contrast, the real effective exchange rate (LEX) and domestic cereal production (LPROD_C) show substantial negative impacts that can be explained by the lower demand for imports due to the high prices of the imports and the locally produced cereals, and the increased local agricultural supply, respectively. The positive 1982 and 2008 dummy variables are significant, which can be explained by the structural breaks resulting from the 1982 economic crisis and subsequent structural adjustment programs, as well as the 2008 global financial crisis that affected Morocco's major trading partners. The outcomes reflect the trade and import demand theories, as well as the economic features of Morocco, which are influenced by its dependence on agricultural imports and the financial vulnerability of the exchange rate resulting from the demand for imports.

Table 10. Chosen Model: ARDL(1, 0, 0, 0, 1) — Estimation Conducted on a Larger Sample Than the Selection Period

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LM(-1)	0.38139	0.089767	4.290441	0.0002
LEX	-0.221185	0.080360	-2.752418	0.0101
LDI	0.298182	0.081278	3.668677	0.0010
LPM	-0.102761	0.079868	-1.2806635	0.2084
LPROD_C	-0.036226	0.011964	-3.027839	0.0051
LX	0.311364	0.086662	3.592843	0.0012
LX(-1)	0.145615	0.106666	1.365152	0.1827
A2008	0.095637	0.034110	2.803827	0.0089
A1982	0.132377	0.041054	3.224436	0.0031
R-squared	0.997816	Mean dependent var	12.10523	
Adjusted R-squared	0.997213	S.D. dependent var	0.609490	
S.E. of regression	0.032175	Akaike info criterion	-3.831868	
Sum squared resid	0.030021	Schwarz criterion	-3.444018	
Log likelihood	81.80549	Hannan-Quinn criter.	-3.693874	
Durbin-Watson stat	1.602602			

*Note: p-values do not adjust for model selection

Model Diagnostic Tests

Autocorrelation Test of the Errors:

As seen in Table 11 below, the test gives a p-value greater than the 5% significance level, confirming the non-existence of autocorrelation in the residuals. Based on the Breusch-Godfrey Serial Correlation LM Test, there are no serial autocorrelations in the residuals of the model up to the second order. Both the chi-square statistic of 1.6236 with a p-value of 0.2159 and the Obs*R-squared statistic of 4.0795 with a p-value of 0.1301 are greater than the traditional 5% significance level; thus, the null hypothesis of the non-existence of autocorrelations in the residuals of the model is not rejected. This further indicates the existence of independently distributed residuals in the model. The absence of serial autocorrelations in the residuals enhances the accuracy of estimating the model coefficients. Additionally, it makes the model interpretation more robust, as required in traditional linear regression models.

Table 11. Breusch-Godfrey LM Test for Serial Correlation. Null Hypothesis (H_0): Absence of Serial Correlation up to Lag 2

F-statistic	1.623596	Prob. F(2, 27)	0.2159
Obs*R-squared	4.079497	Prob. Chi-Square(2)	0.1301

Normality Test of the Residuals:

The results in Figure 4 confirm that the residuals are Gaussian white noise (i.e., they follow a normal distribution), since the Jarque-Bera test p-value is greater than 5%.

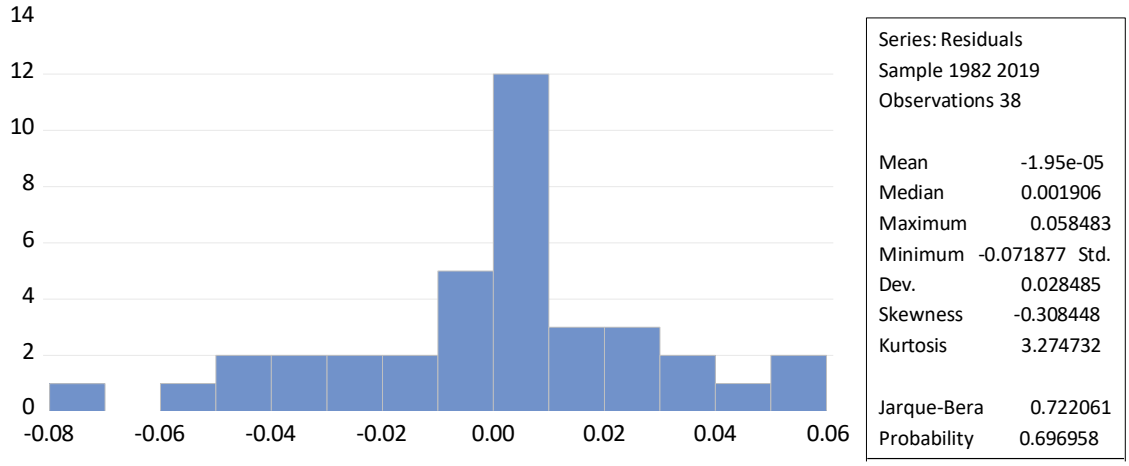

Figure 4. Histogram of residual distribution

Heteroscedasticity Test:

As indicated in Table 12, we conclude that the residuals are not heteroscedastic, since the probability of the F-statistic exceeds the 5% threshold. Therefore, the variance of the residuals in our model is constant.

Table 12. Heteroscedasticity test: Breusch-Pagan-Godfrey (H_0: Homoscedasticity)

F-statistic	0.573554	Prob. F(9, 28)	0.8070
Obs*R-squared	5.915073	Prob. Chi-Square(9)	0.7484
Scaled explained SS	3.919696	Prob. Chi-Square(9)	0.9196

Stability Test of the Model

The stability of the model is evaluated using the CUSUM of Squares test, as illustrated in Figure 5. Since the curve remains within the dotted boundaries, the estimated model is considered stable. In conclusion, the outcomes of the diagnostic assessments support the validity of the ARDL(1, 0, 0, 0, 0, 1) model specification.

Bounds Cointegration Test:

The findings reported in Table 13 from the bounds cointegration test provide evidence of a cointegrating relationship among the variables analyzed, as indicated by the F-statistic exceeding the upper critical bound. This confirms the suitability of estimating the long-run impacts of *LEX*, *LPM/PX*, *LDI*, and *LX* on *LM*.

Long-run Coefficients:

According to the data presented in Table 14, we observe that the following variables, namely the exchange rate, domestic demand, cereal production, and exports, have a significant impact on the long-term variations in Moroccan imports. An Average of 1% change in domestic demand causes a change of 0.48% in imports. This

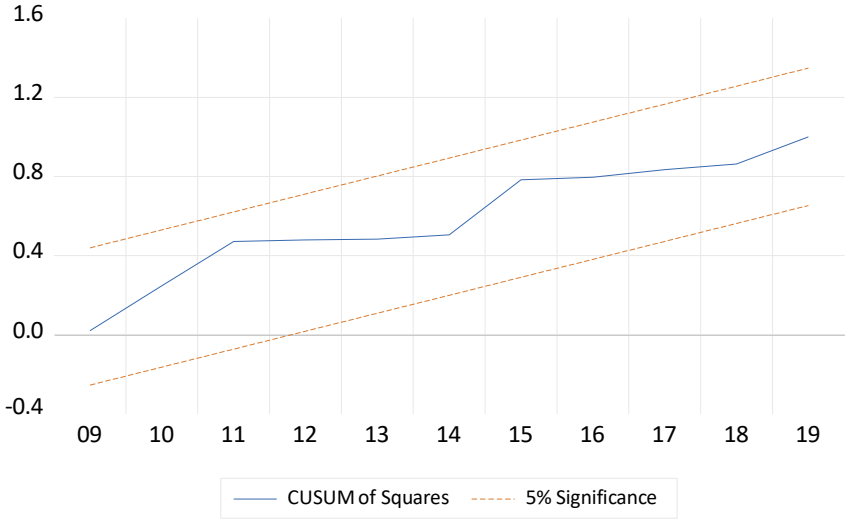

Figure 5. CUSUM of Squares test for model stability

Table 13. F-Bounds Test (H_0: No levels relationship)

F-Bounds Test			H_0: No levels relationship	
Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	15.21058	10%	1.81	2.93
k	5	5%	2.14	3.34
		2.5%	2.44	3.71
		1%	2.82	4.21
Actual Sample Size	38		Asymptotic: n=1000	
		10%	-1	-1
		5%	-1	-1
		1%	-1	-1
			Finite Sample: n=35	
		10%	-1	-1
		5%	-1	-1
		1%	-1	-1

indicates that when there is a change in domestic demand, people tend to rely on importing more products as they expand their requirements, especially in Morocco, as Morocco relies heavily on imports. An average increase of 1% in exports results in an average increase of 0.74% in Moroccan imports. This relationship can be explained by the country's dependence on the importation of raw materials and intermediate goods to support its industries and production. When exports rise, it generally reflects an increase in national production and economic activity.

Short-run Coefficients:

According to Table 15, imports are related to all explanatory variables in the short run. A key observation is the negative relationship between imports in year t and those in the previous year, which may be attributed to seasonal or cyclical fluctuations in imports. For instance, if imports of a certain product are high in one year, they are likely to decrease the following year due to reduced demand or inventory adjustments. Moreover, the other variables exhibit similar effects to those observed in the long run.

Table 14. Levels Equation (No Constant and No Trend)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LEX	-0.359732	0.125736	-2.861011	0.0078
LDI	0.484959	0.111067	4.366385	0.0001
LPM	-0.167129	0.124162	-1.346061	0.1887
LPROD_C	-0.058918	0.021952	-2.683982	0.0119
LX	0.743224	0.085996	8.642592	0.0000

EC = LM - (-0.3597*LEX + 0.4850*LDI - 0.1671*LPM - 0.0589*LPROD_C + 0.7432*LX)

Table 15. Conditional Error Correction Regression

Variable	Coefficient	Std. Error	t-Statistic	p-value
LM(-1)	-0.614861	0.089767	-6.849526	$< 0.0001^{***}$
LEX	-0.221185	0.080360	-2.752418	0.0101^{**}
LDI	0.298182	0.081278	3.668677	0.0010^{***}
LPM	-0.102761	0.079868	-1.286635	0.2084
LPROD_C	-0.036226	0.011964	-3.027839	0.0051^{***}
LX(-1)	0.456979	0.080223	5.696375	$< 0.0001^{***}$
D(LX)	0.311364	0.086662	3.592843	0.0012^{***}
A2008	0.095637	0.034110	2.803827	0.0089^{***}
A1982	0.132377	0.041054	3.224436	0.0031^{***}

Note: $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.10$.

3.1.4. Fully modified HP filter results

The table 16 reports the results of applying the FMHP filter to EU GDP, export prices, and import prices, namely the endogenously estimated values of the smoothing parameter λ together with their corresponding 95% confidence intervals. These results provide a transparent benchmark against which conventional exogenous choices of the smoothing parameter can be evaluated.

Table 16. Optimal value of λ

Series	**Optimal λ value**	**95% Confidence Interval**
EU GDP (GDP_E)	3.3	[2.1 ; 5.2]
Export Prices (PX)	5.2	[3.6 ; 8.0]
Import Prices (PM)	3.3	[2.0 ; 5.5]

The estimated values of λ reported in Table 16 are considerably smaller than the conventional exogenous choices typically imposed in the literature, such as $\lambda = 100$ for annual data in the OECD methodology [28] or the widely used $\lambda = 1600$ for quarterly data originally proposed by Hodrick and Prescott [29]. In fact, the results obtained here, with λ ranging between 3 and 5, are much closer to the theoretical adjustment suggested by Ravn and Uhlig [30], who argued that the smoothing parameter should be rescaled according to the frequency of the data, yielding $\lambda \approx 6.25$ for annual series. Similar practices can also be found in applied work by international institutions: both the IMF and the World Bank often rely on HP filtering with $\lambda = 6.25$ in the estimation of potential output and output gaps [31, 32], whereas the OECD generally employs $\lambda = 100$ for annual series in its potential GDP framework [28]. Against this background, the endogenous FMHP estimates appear economically and methodologically justifiable, as they align with the frequency-adjusted rule of Ravn and Uhlig while diverging from rigid exogenous norms,

thereby confirming the advantage of data-driven approaches such as the FMHP filter [33], which adapt the degree of smoothness to the intrinsic volatility and structural properties of each macroeconomic series.

3.2. The main results

3.2.1. Long-Run Elasticities

The baseline results are obtained from the model outlined in the preceding section. Specifically, the long-run elasticity of exports with respect to foreign GDP, denoted as θ_X, is derived from the export and import equations within the ARDL framework, representing the sensitivity of domestic exports to changes in foreign GDP. The long-term elasticities of imports relative to exports (θ_M^x) and domestic demand (θ_M^I) are estimated using a similar approach. The table 17 summarizes the estimated elasticity values.

Table 17. Long-term Elasticities

	Determinants	**Long-term Elasticities**
Imports	Domestic demand (θ_M^I)	$= 0.48$
	Exports (θ_M^X)	$= 0.74$
Exports	European GDP (θ_X)	$= 1.29$

As a comparison, the author [6] used quarterly data to estimate these elasticities for Turkey at θ_X = 2.4 and θ_M^I = 1.2 for the years 2003-2012. However, another study by [9] reported θ_X=2.17 and θ_M^I = 1.25 for goods, and θ_X = 1.35 and θ_M^I= 1.28 for services. In this context, the structural dependence of the Moroccan economy on the European economic cycle explains its relatively low value, as this cycle has a considerable impact on the development of Moroccan exports [34]. In addition, Morocco's sectoral recovery has been accompanied by greater import penetration, which contributes to maintaining a relatively high elasticity of imports relative to exports, particularly thanks to growth in exports of automobiles and aeronautics. The comparison of elasticities in Morocco and Turkey is only relevant if the institutional and structural differences between the two countries are clarified beforehand. Turkey's manufacturing base is stronger and more diversified upstream and downstream, resulting in a larger share of national value added in gross exports and stronger integration into complex manufacturing chains [35]. In Morocco, on the other hand, despite a significant increase in local content, long-term growth in the automotive, aerospace, and electrical components sectors depends on ecosystems that still contain a significant share of imported intermediate goods [36, 37]. Thus, moderate import and export elasticity (estimated at 0.74) is justified by these structural characteristics: exports react strongly to the availability and prices of imported inputs, but the impact is tempered by growing local integration, unlike what happens in more refined supply chains.

Industrial policy explains this trend. Morocco has expanded dedicated platforms (Tanger Med/Tangier Automotive City, Atlantic Free Zone Kénitra), drawn anchor companies (Renault, Stellantis), and is now positioned for EV supply chains (battery materials and cathodes) with explicit integration targets ranging from roughly 60–69% to 75–80% since the *Industrial Acceleration Plan 2014–2020* [38, 39, 40].This policy mix is in line with the estimated elasticity of 0.74: it reflects the growth of upstream linkages within Morocco's export platforms, while taking into account the persistent intensity of foreign inputs during the transition.

Morocco's position relative to its southern Mediterranean peers supports this interpretation. Tunisia's industrial exports show remarkable resilience but remain limited by imported inputs in traditional sectors such as textiles and leather, with gradual modernization in the field of electrical components [41, 42]. Egypt's export basket is more resource- and energy-intensive, with lower complex-manufacturing depth and correspondingly different TiVA profiles [43, 44]. Hence, Morocco's import and export elasticity is average because, compared to these reference countries, its targeted ecosystems (automotive, aviation, and electricity) and logistical advantages enable it to progress more quickly up the value chain than its resource-based counterparts, but they still fall short of Turkey's well-established capabilities in the intermediate sector.

From a policy perspective, this has two implications. First, the share of foreign inputs indicated by TiVA should be reduced and the sensitivity of exports to imported intermediates should be further diminished if local content targets (supplier development, tooling, materials, and engineering services) are maintained and accelerated.

Second, increasing the value added of services (design, testing, R&D, logistics, finance), which are currently included in Morocco's TiVA profile, can increase the share of the country's export value while broadening its exposure beyond basic inputs [37, 45]. Maintaining market openness and access centered on the EU, it is expected that as these reforms accumulate, the measured elasticity of imports and exports will decrease to levels seen in economies with denser domestic supplier networks, such as several Turkish industries.

3.2.2. Adjusted Trade Balance

The adjustment of the trade balance for goods and services is performed by independently applying equation (4) to both exports and imports. The adjusted trade balance is then calculated as the difference between the adjusted export and import values.

Adjustment of Exports of Goods and Services:

Considering the impact of external demand, we decompose the export series according to the equation (3). The following Figure 6 shows both the structural and cyclical components of exports. During the period 1981–2019, the gap between nominal exports and structural exports was small, not exceeding 6%. This difference is largely attributable to the impact of certain external shocks that occurred during this period, such as the 2008 economic crisis and recurrent droughts. Moreover, the growth of exports seems to be only slightly influenced by the changes in the GDP output gap of the trade partners. Next, we analyze the impact of the price index. As covered before, we take the structural part of the export volume, and multiply it by the structural part of the price index in order to find the value components of the exports.

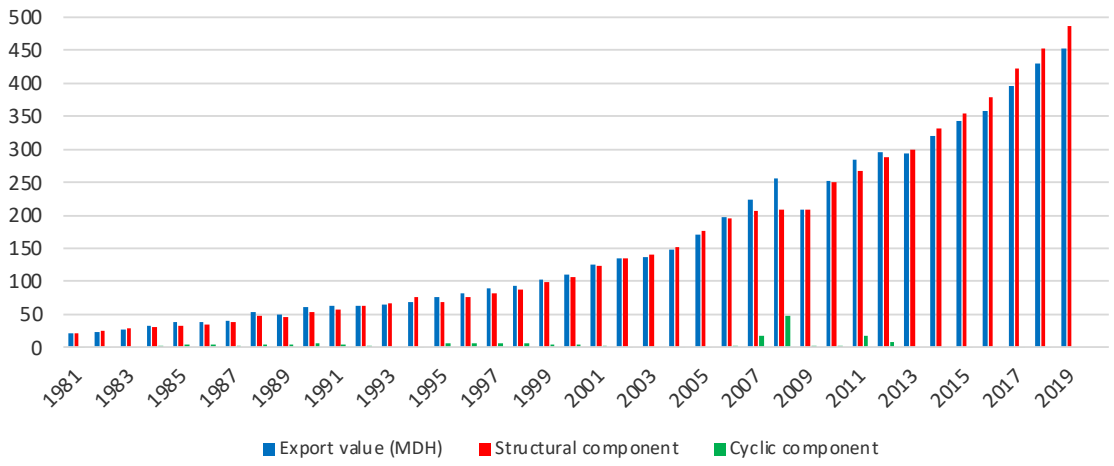

Figure 6. Cyclical and structural trends in Moroccan nominal exports

As can be seen from Figure 6 below, this is particularly true in the case of Morocco. Between 1981 and 2006, the difference between current and structural exports in the Moroccan case was almost non-existent. However, in 2009, the difference between current and structural exports reached its maximum value of 19%. Such a substantial increase can be attributed to the temporary effects that may have influenced the Moroccan exports during that year. After 2010, Moroccan exports continued to be influenced by structural factors such as key economic sectors, comparative advantages, and international trade dynamics.

Adjustment of Imports of Goods and Services:

As shown in the Figure 7 below, the gap between imports and their structural components remained below 8% throughout the entire period under study. Therefore, it can be concluded that the evolution of domestic demand and exports had no significant effect on imports.

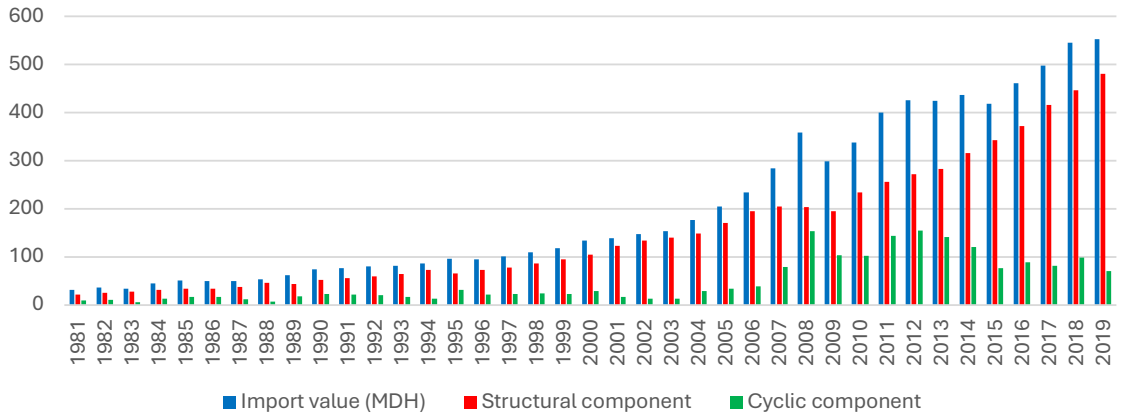

Figure 7. Cyclical and structural trends in Moroccan imports

Over the study period, fluctuations in import values were mainly driven by structural factors. However, the cyclical component experienced an increase in recent periods. The economic and financial crisis between 2007 and 2011 caused a reduction in prices, leading to a deceleration in foreign economic growth and, subsequently, a decline in exports, which maintain a positive correlation with imports. During the period from 2012 to 2015, rising oil prices prompted the government to reduce subsidies on energy products.

Adjustment of the Goods and Services Trade Deficit:

The adjustment of the trade deficit is calculated by subtracting the export components from the import components. As shown in the following Figure 8, the trade deficit is mainly structural in nature, meaning that its variations are significantly linked to long-term factors. These factors include Morocco's strong dependence on imports of foreign goods and services, as well as the low competitiveness of Moroccan products in certain sectors, which has led to weaker exports. This structural situation has contributed to the persistence of the trade deficit. As

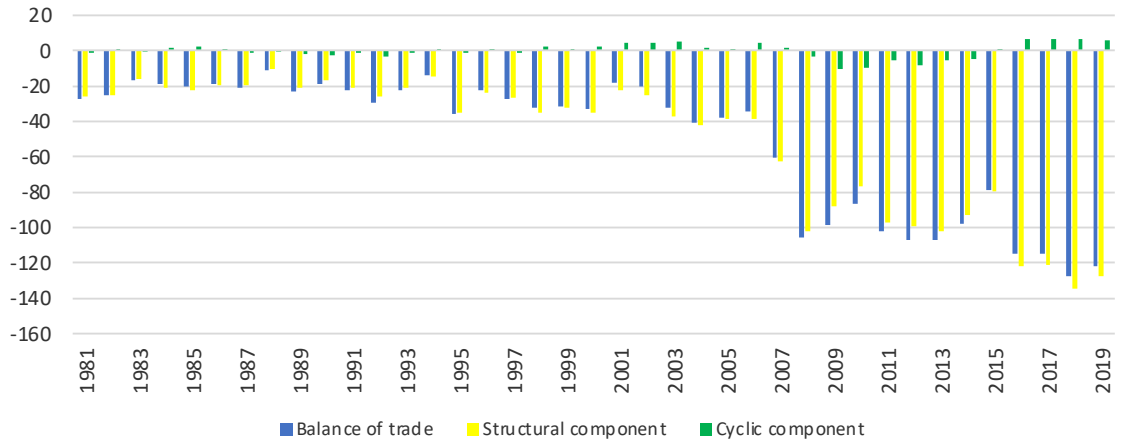

Figure 8. Cyclical and structural trends in Morocco's real deficit

shown in Figure 9, the variation in the nominal trade balance is mainly structural in nature. Although the cyclical component of the trade deficit has increased recently, this trend is largely attributable to rising prices rather than cyclical economic fluctuations. Therefore, it is essential to consider both the cyclical variation and structural factors to understand the long-term evolution of Morocco's trade deficit. Table 18 shows that the cyclical component of the trade deficit has undergone significant changes:

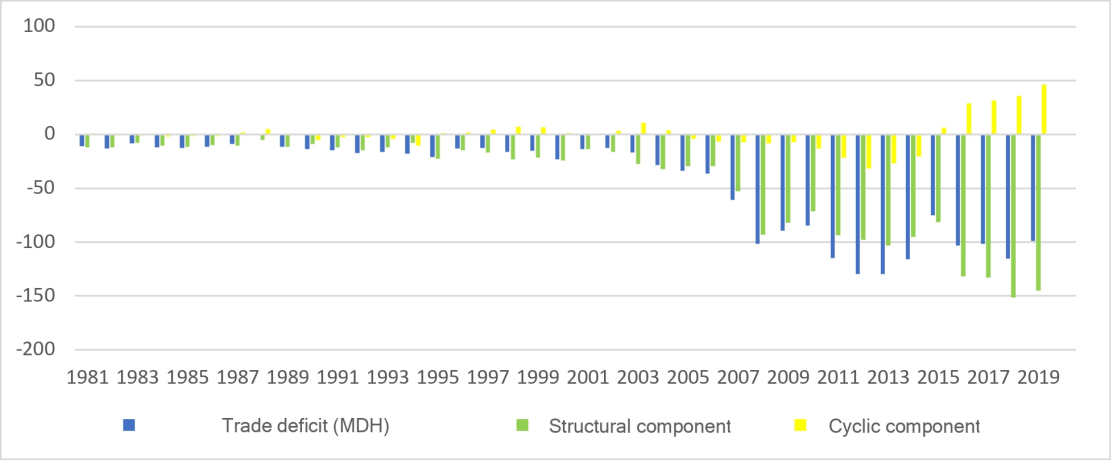

Figure 9. Cyclical and structural trends in Morocco's nominal deficit here

Table 18. Structural and cyclical components by period

Period	Structural component	Cyclical component
1981–1999	99.09%	0.91%
2000–2006	111.98%	-11.98%
2007–2011	85.50%	14.50%
2012–2015	86.38%	13.62%
2016–2019	134.16%	-34.16%

Between 2007 and 2011, the share of Morocco's trade balance attributable to cyclical variation increased significantly compared to the period 2000–2006. This was primarily due to the global economic downturn triggered by the 2008 financial crisis, which caused a sharp decline in international commodity prices. The resulting slowdown in global economic growth reduced foreign demand for Moroccan exports, contributing to a noticeable drop in export volumes. Furthermore, the general impact on the trade balance at that time was amplified by the significant positive correlation between imports and exports. However, it is equally crucial to take into account the competitiveness of comparative prices and exchange rate fluctuations. The Moroccan dirham (MAD) is subject to currency volatility, particularly against the euro, as it is nominally linked to a basket of currencies dominated by the euro (60%) and the US dollar (40%). Periods of euro appreciation between 2007 and 2011 led to a brief overvaluation of the real effective exchange rate (REER), which reduced export competitiveness and increased import costs, especially for dollar-denominated energy exports[46, 47]. The calculated coefficient on the real effective exchange rate variable (*LEX*) is statistically insignificant in the long-run specification ($p = 0.66$), according to the empirical results presented in Table 8.

The controlled structure of Morocco's exchange rate regime and the very low short-term pass-through of nominal exchange rate movements to domestic prices are probably the reasons for this lack of significance. In this regard, the studies on exchange rate dynamics in Morocco [48, 49] confirmed that the effect of exchange rates on inflation and trade volumes remains limited under the current currency basket system. This statistically insignificant relationship does not imply a lack of economic relevance: prolonged deviations of the REER from equilibrium can still harm competitiveness and increase the structural trade deficit. To extend the analysis, future extensions could include explicit channels for exchange rate transmission or a commodity terms-of-trade index that takes into account Morocco's vulnerability to shocks related to phosphate and energy prices. Examining the overall effect of price and exchange rate fluctuations in the rest of the world on the trade balance would be part of this strategy. In a situation where the simultaneous impact of energy imports and raw material exports is more significant for the

Moroccan economy, the existence of the terms of trade variable, which is represented by the value of export prices relative to import prices, becomes more relevant [50, 51]. These new mechanisms would strengthen the robustness of the equilibrium model and enhance the analysis of cyclical deficits.

In the second phase, from 2012 to 2015, the influence of cyclical fluctuations also remained significant. However, this is marked by an increase in international oil prices, causing the Moroccan government to cut energy subsidies. The reduction of these subsidies led to price increases, which in turn affected trade dynamics. However, from 2016 to 2019, the influence of cyclical fluctuations on Morocco's trade balance position started to decrease gradually. This reduction can be attributed to the relative stabilization of most key cyclical economic factors, specifically the exchange rate. When the exchange rate stabilized, it became possible to reduce the fluctuations affecting both exports and imports over a shorter term, thereby reducing the influence of these fluctuations on the demand for Moroccan products over a shorter term. However, the influence of cyclical fluctuations is limited in comparison to structural fluctuations, which contribute nearly entirely to Morocco's trade deficit. This suggests that the influence of internal factors, such as domestic demand, and external factors, such as foreign GDP, is negligible within the broader context of fluctuations in the country's trade balance. This balance is significantly influenced by the structure of the Moroccan economy itself, as well as its dependence on imported products and the lack of competitiveness within each respective sector.

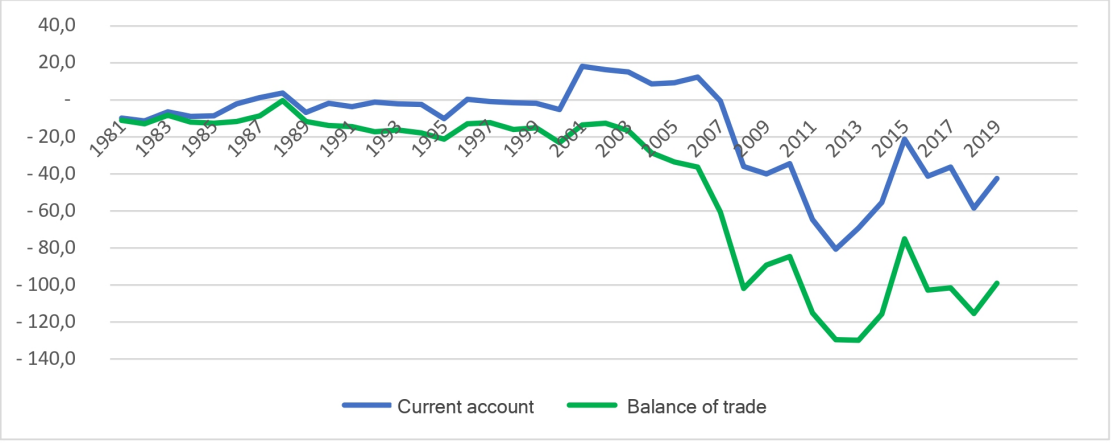

Figure 10. Evolution of the current account balance and trade balance in MDH between 1981 and 2019

Throughout the examined period, the current account balance and trade balance trajectories show comparable patterns, as shown in Figure 10. The trade balance is the main factor influencing the current account balance, as evidenced by the strong correlation between these elements. These long-term economic traits, such as competitiveness, sectoral specialisation, and productivity, have a similar impact on changes in the current account since underlying structural factors affect the trade balance. The current account may also be impacted by cyclical factors like fluctuations in commodity prices and exchange rates, but these effects are typically temporary and less substantial than those resulting from structural factors.

3.3. Policy implication discussion

The results of the analysis also indicate that Morocco's current trade deficit is more structural than cyclical, due to sharp and chronic imbalances between the country's production capacities and its dependence on imports. This proves, at the same time, that the capacity of the external balances is limited to short-term shocks. From this situation, it also follows that, in order to reinforce the basic structure of production and trade, policy strategies cannot be confined to the strict umbrella of economic stabilization. Although they are of great relevance in terms of social and job creation, exports remain modest and concentrated in low-value-added branches, such as agriculture, textiles, and fisheries. These sectors make a modest contribution to productivity spillovers, and their

impact on current account sustainability is minimal, with the estimated threshold remaining below 4% of GDP, even under favorable reserve conditions. The significant flexibility of exports compared to imports, as revealed by the econometric results, also means that Morocco's export performance depends fundamentally on imported intermediate goods. This structural interdependence necessitates targeted import substitution strategies to enhance national value chains. Two recent programs, the Constructed in Morocco and the Banque de Projets, represent a crucial step toward relocating production and strengthening industrial sovereignty. The development of activities supporting export-oriented sectors, such as the automotive and aeronautical industries, where Morocco has now achieved some level of competitiveness, should be a priority for policymakers, especially in the mechanical engineering, metallurgy, electrical, and chemical industries. Fiscal incentives, industrial clustering, and specialized vocational training would increase external viability by raising local integration rates and, ultimately, reducing the structural component of imports.

The recommendations formulated should, thus, take into consideration the current industrial and energy plans of Morocco, namely the *Plan d'Accélération Industrielle* (PAI, 2014-2020), and its subsequent plans in such a way that the broad vision of improving competitiveness would be achieved. This has been followed by the emergence of industrial ecosystems in the textile industry, automotive industries, aviation industries, and agriculture industries, which form the present framework for a new round of diversification of exports. In order to reduce Morocco's structural dependence on European demand and promote South-South trade with African partners, targeted tax incentives and infrastructure support should promote the growth of manufacturing hubs in the field of electronics and information technology, capable of producing higher value-added components and services. Fossil fuels accounted for nearly 27% of all imports in 2019 [51], clearly demonstrating the urgent need to promote renewable energies as an industrial and macroeconomic lever. However, reducing the structural weight of imports requires an ambitious energy diversification strategy. Public-private partnerships, local content requirements, and integration with the Noor Ouarzazate project and other renewable projects would strengthen local supply chains for solar panels, wind turbine components, and green hydrogen technologies, reducing external vulnerability. local supply chains for solar panels, wind turbine components, and green hydrogen technologies would be strengthened, thereby reducing external vulnerability and generating new exportable capacities in the green economy. Consistency between industrial deepening, energy independence, and the long-term sustainability of Morocco's external accounts is ensured by anchoring these policies in the PAI.

Morocco's real GDP growth and export diversification are positively correlated and have significant relationships with one another, especially in relation to the inverse Herfindahl-Hirschman index, where a 1% increase corresponds to a 0.13% growth in real output. Therefore, the increasing and improving of Morocco's export structure is of utmost importance. However, it is important to note that this diversification is not simply about increasing the number of goods exported or the number of countries a nation exports to. As outlined in [15], the goal of this diversification should be to export goods with higher income and/or export goods that are of higher technological sophistication. Therefore, the policies that are put into place should promote not only the research, and innovation, and technological learning, but also the strengthening of the industrial ecosystem in the high value added sectors, such as automotive, aerospace, renewables components, as well as digital services. To achieve resilient, inclusive, and sustainable growth, Morocco's export base must undergo this qualitative transition. Furthermore, the re-evaluation of agricultural policy is equally important. Although progress has been made under the *Green Morocco Plan* and other rural development initiatives, the national economy remains vulnerable to global price fluctuations due to its structural dependence on imports of energy-intensive raw materials and cereals.

The adoption of agroecological models based on crop diversification, soil restoration, and limiting chemical inputs would help strengthen the resilience of agricultural systems and food security. By integrating these approaches into South-South cooperation frameworks, particularly through the African Agricultural Adaptation Initiative (AAA), Morocco could consolidate its regional role and promote the dissemination of sustainable agricultural practices. Furthermore, close coordination between agricultural reform and environmental and social objectives would reduce dependence on imports and improve the structural balance of the current account.

The fluctuations of the European economic cycle and risk management are determined by the high sensitivity of Moroccan exports to the GDP of the European Union. The eurozone has already shown a negative correlation with employment trends in Morocco. The European Union is also Morocco's main trading partner, accounting for around

65% of its exports and 55% of its imports. Employment, export revenues, and the budget balance are all affected in the event of a slowdown in the eurozone. A slowdown in the eurozone could therefore have a significant impact on export revenues, budget balance, and employment in Morocco. While accelerating diversification towards African, Middle Eastern, and American markets, policymakers should therefore consider macroeconomic hedging instruments, including export credit guarantees, trade insurance, and countercyclical fiscal reserves. Strengthening regional production networks and transport routes would make Morocco's external sector more resilient and less dependent on the European demand cycle.

Finally, Morocco's progressive evolution towards a more flexible exchange rate regime, launched in 2018, presents an opportunity to enhance competitiveness and shield the economy against external shocks. On the one hand, being more flexible on the exchange rate in conjunction with a tight monetary stance in an inflation-targeting framework can enhance the management of the exchange rate and ensure the real exchange rate is properly aligned in case the terms of trade are negatively affected by external shocks, thereby ensuring financial sector stability. A more flexible nominal regime will enhance foreign direct investment flows and the performance of the tradable sector. On the other hand, this approach will allow Morocco to deepen its transition to a sustainable growth strategy centered on innovation, in conjunction with the development of industry and exports.

4. Robustness and Sensitivity Analysis

The accuracy of any method for cyclical decomposition is closely linked to the choice of filter and smoothing parameters. It is therefore essential to ensure that our results are not simply the result of a particular specification. We extend the analysis by comparing our benchmark results, obtained through an endogenous and theoretically grounded estimation of the smoothing parameter, with various detuning methods. The objective is not to replace the FMHP results but to verify their robustness. The conclusions regarding trade balance dynamics can be considered methodologically sound and relatively insensitive to technical modeling choices if several filters based on different assumptions produce coherent structural-cyclical decompositions in general. We reevaluate our decomposition against three popular detrenders: Christiano–Fitzgerald (finite-sample optimum band-pass, 2–8 years), the Hamilton (2018) filter (two-step regression with a two-year horizon and four lags for yearly data), and HP (annual, $\lambda = 6.25$). Hamilton reattributes a larger share to the cyclical component precisely in the windows where short- and medium-term movements dominate the dynamics of the trade balance, while HP and CF produce divisions between trend and cycle close to our benchmark index for most sub-periods, as shown in the table 19. In a sensitivity investigation, this triangulation is beneficial since it verifies that the qualitative interpretation of each sub-period (trend-dominated versus cycle-intensive) is largely invariant to the detrending architecture and that our results are not influenced by a single filter selection. The Comparison of the results reveals that, although they have different frequency bands and processing of endpoints, the structural and cyclical decompositions produced from the other filters are largely consistent with our FMHP benchmark index, with only minor differences between sub-periods.

Table 19. Structural and cyclical components by period: FMHP vs HP, Hamilton [21], and Christiano–Fitzgerald (CF)

Period	our approach $_{str}$	our approach$_{cyc}$	HP$_{str}$	HP$_{cyc}$	Hamilton$_{str}$	Hamilton$_{cyc}$	CF$_{str}$	CF$_{cyc}$
1981–1999	99.09%	0.91%	99.30%	0.70%	191.87%	-63.88%	101.68%	-1.68%
2000–2006	111.98%	-11.98%	106.93%	-6.93%	92.61%	7.39%	100.04%	-0.04%
2007–2011	85.50%	14.50%	99.97%	0.03%	76.12%	23.88%	102.59%	-2.59%
2012–2015	86.38%	13.62%	98.90%	1.10%	101.75%	-1.75%	100.39%	-0.39%
2016–2019	134.16%	-34.16%	98.47%	1.53%	102.03%	-2.03%	86.57%	13.43%

Quantitatively, the differences between the filters are concentrated where end treatment and frequency targeting are most important: HP remains sensitive to λ near the edges of the sample; Hamilton minimizes end bias by definition but can amplify mid-frequency residuals; and CF explicitly targets the 2–8-year band at the expense of higher-order weights.Nevertheless, we observe that in view of these differences in methodology, there is sufficient

proximity in the magnitude of structural components compared with cyclical components per period to warrant our findings. Expansionary episodes characterized by lengthy expansions or policy changes reflect a larger structural element in accordance with our FMHP estimates, while periods of primarily medium-frequency price movements in trade patterns are reflected in relatively large cyclical components in accordance with Hamilton/CF methodology. On a whole, filter convergence adds significantly to the robustness and resilience of our original findings.

5. Conclusion

The ARDL model estimation revealed the short- and long-term determinants of foreign trade. The results show, in particular, the importance of export and import price indices, domestic demand, and European GDP, among other economic variables, in explaining the dynamics of foreign trade. The 1% increase in European GDP translates into a 1.29% increase in Moroccan exports, reflecting the strong economic interdependence between Morocco and Europe. European economic growth therefore has a direct impact on Morocco's export performance, which reflects the high concentration of Moroccan products on the European market. In addition, imports are positively influenced by domestic demand and exports, with elasticities estimated at 0.48 and 0.74, respectively. Thus, a 1% increase in domestic demand leads to an average increase of 0.48% in imports, while a 1% increase in exports leads to an average increase of 0.74% in imports.

The analyses conducted show the decisive role played by the structure of Morocco's foreign trade. Due to a specific trade pattern, trade imbalances are mainly explained by structural factors, with the the structural trade deficit exceeding 85%, while the effect of cyclical fluctuations remains marginal. Therefore, controlling the trade deficit requires the implementation of results-oriented policies, aimed in particular at diversifying exports, strengthening self-sufficiency in imports, and improving the competitiveness of Moroccan products. In addition, the trade balance could also benefit from policies that promote economic growth and stimulate domestic demand. Further research should examine the extent to which the structural and cyclical components of foreign trade influence economic growth, unemployment, inflation, and investment (see e.g., [52, 53, 54, 55, 56]). To capture complex relationships and non-linear patterns, advanced methods such as *machine learning* and *deep learning* will be employed. Furthermore, stochastic approaches may help address uncertainty and external shocks affecting Morocco's trade and macroeconomic performance (see [57, 58, 59, 60]).

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Data and Material Accessibility

The data used and analyzed in this study are publicly available from the following sources:

- https://www.hcp.ma/
- https://www.oc.gov.ma/fr
- https://manar.finances.gov.ma/manar/initAccueilInscription
- https://www.imf.org/en/Data
- https://unctadstat.unctad.org/FR

Competing interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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