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THE EXCHANGE RATE VOLATILITY AND MOROCCAN EXPORTS: AN EMPIRICAL INVESTIGATION

Achraf Louati[1+]
Abdellah Echaoui[2]
Abdelatif Mouatassim[3]

[1]*Mohammed V University in Rabat, Faculty of Legal, Economic and Social Sciences Agdal, Avenue des Nations-Unies, Rabat, Morocco.*
[1]*Email: achraf.louati@fsjes-agdal.um5.ac.ma Tel: +212664305712*
[2,3]*Mohammed V University in Rabat, Faculty of Legal, Economic and Social Sciences Souissi, Avenue Mohammed Ben Abdallah Ragragui, Rabat, Morocco.*
[2]*Email: abdellah.echaoui@fsjes-souissi.um5.ac.ma Tel: +212668417875*
[3]*Email: abdellatif.mouatassim@gmail.com Tel: +212661768821*


(+ Corresponding author)

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ABSTRACT

This article aims to study exchange rate volatility and its impact on exports. We examine using a VECM model the relationship between Moroccan exports and the volatility of the real effective exchange rate, over a period from the first quarter of 2000 to the first quarter of 2017. The methodology adopted takes into account the long-term relationship term between the variables, using the moving standard deviation as a measure of volatility and real-world GDP as a proxy for global demand. Although a large number of empirical studies find that exchange rate volatility tends to reduce the level of foreign trade. Our results indicate that the increase in exchange rate volatility has a positive effect on the demand for Moroccan exports. Also, the short-term dynamics show that the Granger causal effects of volatility on real exports are significant. Moreover, this article joins the empirical studies that confirm the risk-loving behaviour of exporters in the face of risk of fluctuating exchange rates.

Contribution/Originality: This article shows that exporters have a risk-loving behaviour vis-à-vis the volatility of the exchange rate. Thus, the adoption of the floating exchange rate regime is more favorable for the development of the Moroccan economy.

1. INTRODUCTION

In a globalized and interdependent world, the exchange rate plays a fundamental role in a country's economic policy. It acts directly on import and export prices and is an instrument for correcting external imbalances, thus contributing to the effectiveness of stabilization programs.

Currently, Morocco is preparing for its gradual migration to a flexible exchange rate regime, this transition will necessarily affect the economic, political and social sectors of the country. Therefore, this change requires a primer not only from the public monetary and financial authorities, but also it is necessary that all private operators prepare for this change to guard against the risk of depreciation of the national currency.

The objective of this paper is to contribute to the debate on the exchange rate policy in Morocco, and more specifically to the problem of the flexibility of the exchange rate of dirhams. Does the question of floating exchange rate present an advantage for the Moroccan economy or on the contrary a threat?

In the light of these considerations, we will analyse to what extent the exchange rate is a determinant of the external competitiveness of Morocco? From this issue arise the following questions: how does the exchange rate affect the economy? And more particularly on foreign trade. Do exchange rate fluctuations affect Morocco's foreign trade? Does high volatility decrease Morocco's export?

To answer these questions, it will be necessary to analyse the effects of exchange rate volatility on Moroccan exports over the period from the first quarter of 2000 to the first quarter of 2017.

Several studies have been established to show the existence of a possible relationship between the exchange rate and foreign trade. The literature review highlights the model of Hooper and Kohlhagen (1978) as a basic model after Clark (1973); Ethier (1973) and Baron (1976). Specificities have been introduced into the model by Cushman (1983); De Grauwe (1988) and Franke (1991). Regarding empirical studies, are very abundant and differ from the methodology pursued, the types of data between annual, quarterly or monthly and type of global or sectoral analysis as well as the measurement of volatility, i.e. ARCH, mobile standard deviation or by another simple measure such as standard deviation and variance. Despite the large number of studies conducted, no real consensus has emerged on the impact of exchange rate volatility on trade flows.

The remainder of the paper is organised as follows: section 2 provides a brief overview of the theoretical underpinnings of the relationship between the exchange rate and foreign trade and some empirical studies of the relationship with, of course, special analysis of the studies conducted on MENA countries or countries with similar characteristics as Morocco; section 3 reviews the model specification; section 4 presents the data and the empirical results and section 5 concludes with an appendix on the data series employed.

2. LITERATURE REVIEW

In this section we present some work that tries to explain if the uncertainty of the exchange rate reduces the incentive to engage in foreign trade and others that focuses on the negative relationship between exchange rate volatility and trade.

The first attempts to explain the effect of exchange rate variability on foreign trade are contained in an innovative paper by Clark (1973) which describes the hypothetical case of a company producing competitively a unique product that contains no imported inputs and destined entirely for export. The company is assumed to be small and risk-averse and has limited access to hedging currency risk. In addition, the model assumes that contracts are only in the foreign currency, so uncertainty about exchange rate changes translates directly into uncertainty about future revenues in the national currency, and therefore the firm in question, which the variability of its profit depends solely on the variation of exchange rates, must consequently determine an export level which incorporates this uncertainty. And afterwards, a great volatility of the exchange rate causes the company to reduce its production.

In the same context of exchange rate uncertainty, Ethier (1973) modeled the decisions made by a risk-averse firm regarding the volume of goods to be imported and the amount of forward exchange hedging. He assumes that the price of imports is denominated in foreign currency and that the enterprise knows in advance the level of its profits for any given value of the exchange rate. Thus, he has shown that the exchange rate uncertainty does not affect the level of trade, but it determines the degree of forward coverage that must be taken.

In turn, Baron (1976) discusses the role of currency invoicing and interprets the impact of this billing as appropriate. When the exporter bills in foreign currency, they face a price risk; however, when invoicing is made in national currency, the exporter faces a quantity risk.

These essays remain mere attempts to explain the effect of exchange rate volatility due to the adoption of the flexible system on the incentive to trade internationally, but we waited until 1978 to see a real model referred to as a reference of the analysis of the impact of exchange rate volatility on foreign trade developed by Hooper and Kohlhagen (1978). The authors developed a differential risk model composed of two functions: the import demand function and the export function in the tradable goods market. This is to analyse both theoretically and empirically the impact of exchange risk on prices and equilibrium quantities.

This model assumes that the source of uncertainty for economic agents is the future value of the exchange rate. Thus, contracts are exclusively denominated in the currency of the exporter or importer. In addition, no hedging on the futures market is available regardless of the degree of exposure to currency risk. Thus, the authors finally assume that the behaviour of agents is characterised by a certain degree of risk aversion that will be the essential foundation of the negative relationship between exchange rate volatility and international trade.

Furthermore, over the period 1965-1975, the authors test empirically the effects on trade flows between the US and Germany. The results showed that the nominal exchange rate uncertainty had a significant impact on prices, but no significant effect on the volume of trade.

Hooper and Kohlhagen (1978) model has the merit of having established a basic research base for subsequent work, but its use in empirical studies remains unsatisfactory because of divergent results. On that account, several criticisms have been made of this model concerning the source of uncertainty, risk aversion, the type of exchange rate and the degree of risk coverage.

In this sense, Cushman (1983) reformulates the model of Hooper and Kohlhagen (1978) by indicating that companies are interested in real profits rather than nominal ones not only during current situations, but also for future ones. However, the possibility of hedging may not be available in the absence of a futures market. In addition, domestic and foreign prices are uncertain, as well as the exchange rate. The Cushman (1983) model based on real volatility is tested over a 12-year period (1965-1977) taking into account trade between the United States of America and five developed countries, namely the United Kingdom, France, Germany, Canada and Japan, as well as trade between Germany and three other countries, including the United Kingdom, France and Japan. The results showed that the increase in exchange rate uncertainty reduces the quantity exported, whereas the real exchange rate variability exerts no effect on prices.

Cushman (1986) suggested that the effect of exchange risk on bilateral and aggregate trade flows should be analysed by including the impact of third-country exchange risk factors. The author studied, over two estimation period 1965-77 and 1973-83, the bilateral export flows of the USA to its six largest trading partners: the United Kingdom, the Netherlands, France, Germany, Canada and Japan. The results showed that exchange risk has indeed played a significant role in depressing international trade during floating, but that third-country (out of USA six partners) as well as direct risk effects ought to be included in addition to direct bilateral or multilateral risk. He found also a steadily growing negative impact on trade flows from exchange risk during floating.

Akhtar and Hilton (1984) found a negative effect of exchange rate variability on international trade in manufactured goods between Germany and the United States of America between 1974 and 1981. However, using the same methodology as Akhtar and Hilton and extending the analysis to three other countries, namely France, Japan and the USA, Gotur (1985) showed that the relationship between foreign trade and the exchange rate is more systematic as suggested by both authors.

The IMF (1984) that estimated bilateral export functions among the G-7 countries. The period is between the first quarter of 1969 and the fourth quarter of 1982. The results show that the coefficient of volatility can be negative or positive depending on the country. This finding was endorsed by another IMF (2004) which found that there is no clear negative relationship between overall exchange rate volatility and international trade.

Willett (1986) underlines the tendency of empirical studies to highlight the negative effects of volatility on international trade. The volatility according to him should be ascribed to the instability of the underlying environment rather than floating rates. He advances that even if there has been a differential increase in international risk since floating began, this has not been sufficient to offset the benefits from international diversification. According to him, to further assess the effects of exchange rate volatility, we need to undertake industrial-organization-type studies which look specifically at a number of different types of firms and industries and construct appropriate types of risk measures.

De Grauwe (1988) criticizing the utility function used by Hooper and Kohlhagen (1978) argues that exchange rate volatility can push firms to increase exports. Indeed, when risk increases, the very risk-averse individuals will export more to avoid the possibility of a drastic decline in their revenues. Less risk-averse individuals are less concerned with extreme outcomes. They view the return on export activity now as less attractive given the increase in risk and decide to export less.

Franke (1991) analysed the export strategy of a risk-neutral company. In this case, the firm adjusts the volume of its trade according to the level of the exchange rate and its variability on the foreign exchange markets.

As for the work of Viaene and De Vries (1992) it points out that the volatility of the spot exchange rate can indirectly affect the volume of trade, even in the presence of a futures market. In this sense, the impact of volatility will be felt through its effect on the forward rate.

Dell'Ariccia (1999) studied the bilateral trade of the 15 countries of the European Union including Switzerland during 20 years, from 1974 to 1995. He founds that exchange rate volatility has a small but significantly negative impact on trade.

However, similar studies for Africa are very rare. Savvides (1992) using a panel of 62 industrialised and developing countries over the period 1973-1986, showed that the volatility of unanticipated exchange rate movements has inhibited export growth in developing countries.

Among the studies on the least developed countries are those carried out by Ghura and Grennes (1993). Using panel data from 33 African countries with a fixed exchange rate regime covering the period 1972-1987, they came to the conclusion that exchange rate volatility has, statistically, a significantly negative impact on trade flows.

Sekkat and Varoudakis (2000) analysed the impact of exchange rate volatility on the performance of manufacturing exports of a panel of 11 countries in sub-Saharan Africa over the period 1970 to 1992. They distinguished between CFA countries (African Financial Community) with fixed rates and the more flexible regimes of non-CFA countries. The results obtained show that there is no significant impact between the volatility of the exchange rate and exports.

Achy and Sekkat (2003) have attempted to study the effects of MENA exchange rate policies vis-à-vis the euro on their exports of manufactured products to Europe over the period 1970-1997 for 4 MENA countries (Algeria, Morocco, Tunisia, Egypt) plus Turkey. The results allow us to identify a robust negative effect of the real effective exchange rate variability on manufactured exports and therefore suggest a crucial role for exchange rate policy in providing export incentives.

Bouoiyour and Rey (2005) have studied the behaviour of real effective exchange rates of Dirham vis-à-vis the currencies of 15 European partners for the period 1960-2000 (annual data). The results show that an increase in Dirham volatility has a negative effect on trade flows, and an overvaluation of the Dirham reduces Moroccan exports to Europe and favors increased imports.

Karimi and Karamelikli (2015) examined the relationship between exchange rate volatility and volume of international trade of six MENA countries (Saudi Arabia, Egypt, United Arabic Emirates, Iran, Jordan and Algeria) over the period 1980Q1-2012Q1. They found that real exchange rate volatility exerts significant negative effects on exports both short run and the long run in each of the MENA countries.

3. MODEL SPECIFICATION

Most of the empirical work has focused on studying the impact of exchange rate volatility on aggregate trade flows of predominantly industrialised countries using a bilateral or multilateral approach. Indeed, the choice of the level of aggregation depends essentially on the objectives of the researcher, what he tries to measure or verify and very often on the availability and reliability of the data.

At the level of the specification of the equations to be estimated, all the empirical studies are more or less inspired by the model developed by Hooper and Kohlhagen (1978) and Cushman (1983); Cushman (1986). Their model therefore proposes to estimate an equation of demand for imports, export supply or a reduced form for the price and volume of imports or exports. Thus, the Esquivel and Larrain (2002) holds that exports are a function of some kind of proxy of world income, exchange rate, and volatility currencies.

In this sense, the reduced form of the export demand function in the model of Hooper and Kohlhagen (1978) is written as follows:

$$Q^* = d_0 + d_1UC^* + d_2UC + d_3PD + d_4Y + d_5CU + d_6EH^* + d_7EH + d_8\delta^* \sigma 1/_{R1} + d_9\delta\sigma_{R1}$$

(1)

Where Q*is the export quantity, UC * and UC are the domestic unit costs of production for the exporter and the importer, Y is the income of the domestic economy, CU is a quantity rationing measure, EH * and EH are the expected costs of foreign exchange, PD is the price level of the national economy, δ and δ * measure the proportion of the quantities exchanged in foreign currency not hedged at term, and therefore being subject to currency risk, σ_{R1} is a measure of currency risk (variance in past spot rates and spread between spot and forward rates). According to the authors' theoretical analysis and their predictions, the coefficients d_3, d_4 and $d_6$must be positive, $d_0$is positive or negative, and all other coefficients are negatives.

In turn, and with the aim of improving the analysis, Cushman (1983) modified the reduced-form equations of the Hooper and Kohlhagen (1978) in order to obtain a reduced form equation for export volume. in real terms. He therefore estimated the following equation:

$$Q = a_0 + a_1Y + a_2CU + a_3UC + a_4UC^* + a_5R + a_6M + a_7S + a_8D \qquad (2)$$

Where Y is the real income of the importing country, CU is the capacity utilization rate of the importing country, UC and UC * are the actual unit costs of production of the importer and exporter respectively, R is defined as the real exchange rate (relative prices of traded goods), M is a "proxy" or index of the future evolution of the real exchange rate, and finally S represents a "proxy" for measuring the standard deviation associated with changes in the real exchange rate. real exchange rate and D a dummy variable. With the exception of a_1, a_5 and a_8 which are presumed positive, all other coefficients are theoretically negative. Thus, Cushman (1986) extends the work of Cushman (1983) by introducing the possibility of third country effects in the model based on the technique of the mobile standard deviation as a measure of exchange rate volatility.

Several other researchers are inspired by the work of Cushman (1983); Cushman (1986). They specified a traditional model of long-term equilibrium export demand function, in a flexible exchange rate environment. For example, Esquivel and Larrain (2002) estimated the following model:

$$LogX_t = a + b\, Log(GDP_W) + c\, RER_{US} + d\, VOL_{Yen/\$} + e\, VOL_{DM/\$} + \varepsilon_t \qquad (3)$$

Where X_t is the real exports, $GDP_W$is the real World GDP, RER_{US} is the bilateral real exchange rate with the dollar and the variables VOL(Yen/$) and VOL(DM/$) are exchange rate volatility measures.

In our case, we will attempt to examine the evidence of a negative impact of exchange rate volatility on Morocco's exports. To achieve this goal, the model we propose is essentially inspired by the work of Esquivel and Larrain (2002).

Our empirical study focuses on the explanation of real Moroccan exports by international demand, measured by the proxy variable "Real world GDP", the real effective exchange rate and its volatility. The model can be written as follows:

$$\mathrm{LRX_t} = \beta_0 + \beta_1\mathrm{LWGDP_{M,t}} + \beta_2\mathrm{LREER_t} + \beta_3\mathrm{LVOL_t} + \varepsilon_t \qquad (4)$$

Where $\mathrm{LRX_t}$ represents the Log of Morocco's real exports, $\mathrm{LWGDP_{M,t}}$ is the Log of real world gross domestic product, $\mathrm{LREER_t}$ is the Morocco's real effective exchange rate, $\mathrm{LVOL_t}$ is the Log of the volatility of Morocco's real effective exchange rate and ε_t is a white-noise disturbance term.

In order to establish whether there is a long-run equilibrium relationship among the variables, we employ the concept of co-integration. Also, we verify the causal effect of volatility on exports in the long and the short run.

4. DATA AND EMPIRICAL RESULTS

In this study, the data used are quarterly and cover a period of 69 quarters, ranging from the first quarter of 2000 to the first quarter of 2017.

Different sources of data were used to carry out our empirical study. The export series have been extracted from the statistics published by the Office des Changes. The series of Morocco's real effective exchange rate (value of exports adjusted by the consumer price index) and world GDP at constant price come from the IMF's International Financial Statistics (IFS).

The method of the moving average standard deviation is used as a measure of the volatility of Morocco's real effective exchange rate. It takes into account the periods that characterise a low and high degree of currency risk. It's expressed as follows:

$$\mathrm{VOL}_{t+m} = \left[\frac{1}{m}\sum_{i=1}^{m}(\ln \mathrm{REER}_{t+i-1} - \ln \mathrm{REER}_{t+i-2})^2\right]^{1/2} \tag{5}$$

Where the order of the moving average m is equal to 3 and $\ln \mathrm{REER}_t$ is the natural logarithm of the real effective exchange rate.

This measure of volatility is similar to that used in several empirical research on currency risk and its impact on international trade in real terms (see Esquivel and Larrain (2002); Arize, Osang, and Slottje (2000); Arize, Malindretos, and Kasibhatla (2003) and Rey (2006)).

It should be noted that the series of Morocco's real exports and world GDP are seasonally adjusted. On the other hand, the series of the Morocco's real effective exchange rate and volatility are not tainted by seasonality. Figure 1 illustrates the evolution of these variables over the study period.

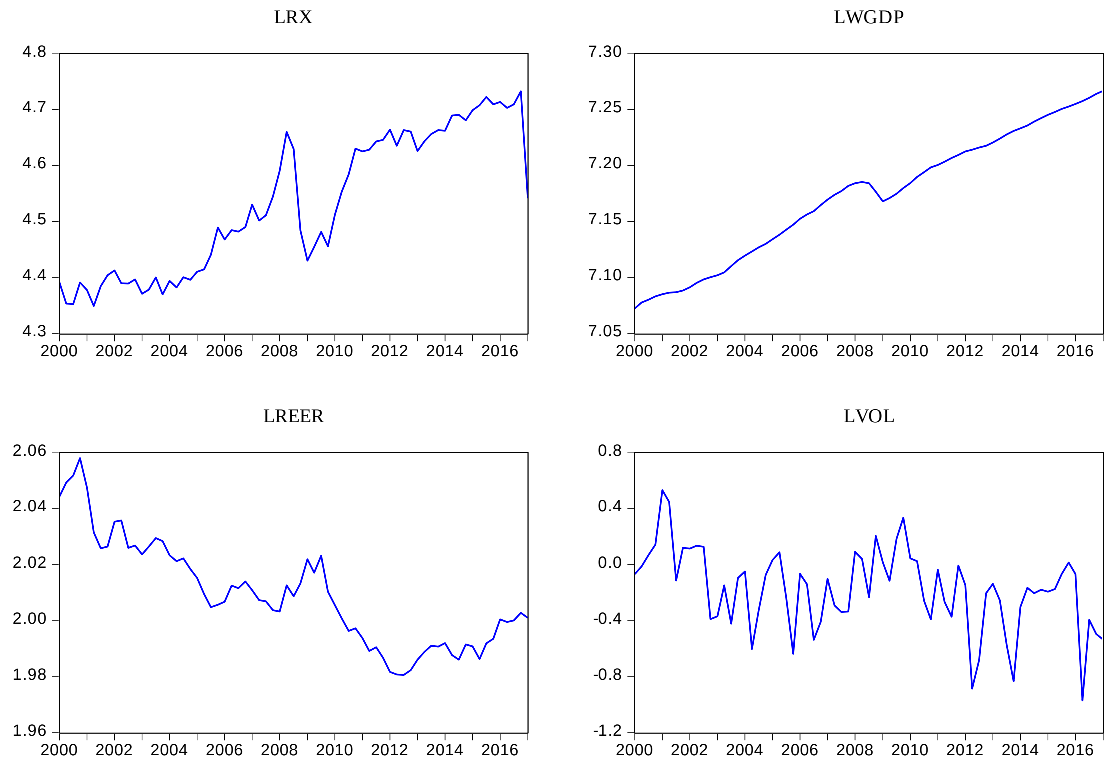

Figure 1. Graphical representation of different variables selected.

From a first reading of Figure 1, it is clear that all the variables are not stationary, but it is necessary to do the tests to verify this hypothesis.

Before estimating the model equation, all variables must be tested to determine the presence of unit roots. We use the Augmented Dickey-Fuller Test (ADF) suggested by Fuller (1976) and Dickey and Fuller (1981) to test the roots of the unit. The ADF test was performed on the time series of LRX, LWGDP, LREER and LVOL, and the test results and optimal latency are presented in Table 1.

Table 1. ADF stationarity tests.

Variable	Level			First Difference		
	None	Intercept	Intercept and Trend	None	Intercept	Intercept and Trend
LRX	0.427	-1.517	-2.621	-5.842**	-5.808**	-5.746**
LWGDP	3.683	-0.606	-3.143	-2.368*	-4.564**	-4.544**
LREER	-1.097	-1.872	-1.169	-7.054**	-7.140**	-7.296**
LVOL	-1.813	-4.813**	-5.472**	-10.497**	-10.438**	-10.358**

Notes: (**) Stationarity at 1%.
(*) Stationarity at 5%.

Dickey-Fuller stationarity tests indicate that, after the first difference, the LRX, LWGDP and LREER variables are stationary at the significance level of 5% or 1%. Whereas, the variable LVOL is stationary at level. Thus, the variables LRX, LWGDP and LRRER are integrated of order 1, that is to say of type I (1) and the variable LVOL is of type I (0). To analyse a relationship between variables, a VAR structure should be used in our model.

Before proceeding with estimating the model, it is important to determine the optimal delay count, in order to have a good estimate of the model. This optimal number of delays is determined using a set of selection criteria. Its last must be minimal so that the number of delays is optimal.

Table 2. VAR lag order selection criteria.

Lag	LogL	LR	FPE	AIC	SC	HQ
0	422.477	NA	2.00e-11	-13.285	-13.149	-13.232
1	688.656	490.108	7.11e-15	-21.227	-20.547	-20.960
2	722.201	57.505	4.10e-15	-21.784	-20.560*	-21.303
3	747.297	39.834	3.12e-15	-22.073	-20.304	-21.377*
4	766.329	27.794*	2.92e-15	-22.169	-19.856	-21.259
5	784.101	23.696	2.91e-15*	-22.225*	-19.368	-21.102
6	796.172	14.562	3.56e-15	-22.101	-18.699	-20.763

Notes: * indicates lag order selected by the criterion.

The Table 2 shows that the optimal number of lags indicated by the Ackaike information criterion (AIC) criteria, Final prediction error (FPE) is equal to 5, while Sequential modified LR test statistic indicates 4. Therefore, we retain the number of lags 5 displayed by AIC and FPE.

As a very important step for this modeling, we will perform the Johansen test to verify the existence of one or more co-integrating relationships. However, before this test, we must determine the specification of the types of processes. Indeed, all the variables of interest are DS processes, which means that we will use the 3rd specification.

The Johansen test based on the calculation of traces as well as that based on the calculation of the eigenvalues both show that it is a model with a single co-integrating relation (see Appendix 1).

After determining the optimal number of lags and establishing the co-integration test, we estimated the VECM model with 4 lags (see Appendix 2). The error correction model is presented as follows:

$$ECT_{t-1} = [1{,}00LX_{t-1} + 3{,}50LWGDP_{t-1} + 44{,}04LREER_{t-1} - 4{,}27LVOL_{t-1} - 118{,}83] \quad (6)$$

The error correction coefficients of the Equation 1 and the Equation 2 are negatives and significant, that indicates the presence of long-run causal relationship. Indeed, it exist a bi-directional causality between exports and world GDP and a unidirectional causality between the exports and the real effective exchange rate and its volatility.

In addition, the estimation of the long-run coefficients makes it possible to conclude that a 1% change in volatility increases exports by 4.27%. Also, a 1% change in the real effective exchange rate translates into a 44% drop in exports. WGDP is not significant until after a delay of four quarters.

Regarding to the short run causality, we apply the Wald causality test on lagged explanatory variable. Jointly, all the variables have a short run relationship with exports (see Table 3).

Table 3. Granger/Wald causality test on lagged explanatory variables.

Dependent variable: D(LRX)			
Excluded	**Chi-sq**	**df**	**Prob.**
D(LWGDP)	18.872	4	0.001
D(LREER)	3.091	4	0.543
D(LVOL)	13.236	4	0.010
All	40.124	12	0.000

Finally, residual diagnosis analysis of normality test (Jarque-Bera), heteroscedasticity test and serial correlation (LM) test results, reported in Table 4, 5 and 6, shows no serial correlation, no heteroscedasticity and the residuals are not normally distributed.

Table 4. VECM residual serial correlation LM tests.

Lags	LM-Stat	Prob
1	20.418	0.202
2	16.889	0.393
3	13.748	0.618
4	16.881	0.393
5	9.079	0.910

Notes: Probs from chi-square with 16 df.

Table 5. VECM residual heteroskedasticity tests.

Joint test:		
Chi-sq	**df**	**Prob.**
366.061	340	0.159

Table 6. Residual normality tests.

Component	Jarque-Bera	Df	Prob.
1	16.016	2	0.000
2	0.813	2	0.666
3	0.031	2	0.985
4	0.995	2	0.608
Joint	17.855	8	0.022

5. CONCLUSION

The present work was conducted with the aim of modeling the impact of the volatility of the dirham's real effective exchange rate on Moroccan exports. Examining the dynamic relationship between exports and exchange rate volatility in Morocco, via a multivariate error correction model, led to significant results. Indeed, estimates show statistically significant dependency at the 5% threshold between exports and exchange rate volatility. However, this relationship is positive, which is inconsistent with the theory developed by Hooper and Kohlhagen (1978) which predicts that firms are risk-averse and subsequently, exchange rate volatility negatively impacts foreign trade.

These findings highlight the specificity introduced by De Grauwe (1988); De Grauwe (1992) that of the risk aversion question, that is, the increase in volatility could increase the marginal utility of export earnings, and as a result, it encourages them to increase exports.

Then, the model estimate reveals that Morocco's exports are growing in the same direction as exchange rate volatility. However, this is the opposite case for the fluctuation of the real effective exchange rate and the world GDP, knowing that for the latter it is necessary to cause a delay of a few quarters.

Morocco is preparing to migrate to a floating exchange rate regime. This could lead to an increase in the volatility of the exchange rate. Based on this work, the results showed that exports are sensitive to changes in the exchange rate. Since the effects of exchange rate volatility are favorable to the economy, the adoption of flexible regime is more conducive to developing Moroccan exports.

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Appendix 1. Johansen cointegration test.

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized No. of CE(s)	**Eigenvalue**	**Trace Statistic**	**0.05 Critical Value**	**Prob.****
None *	0.363	52.365	47.856	0.018
At most 1	0.217	23.488	29.797	0.223
At most 2	0.090	7.846	15.495	0.482
At most 3	0.028	1.846	3.842	0.174

Note: Trace test indicates 1 cointegratingeqn(s) at the 0.05 level.
*Denotes rejection of the hypothesis at the 0.05 level.
**MacKinnon, Haug, and Michelis (1999) p-values.
Unrestricted Cointegration Rank Test (Maximum Eigenvalue).

Appendix 1. Continue…

Hypothesized No. of CE(s)	**Eigenvalue**	**Max-Eigen Statistic**	**0.05 Critical Value**	**Prob.****
None *	0.363	28.877	27.584	0.034
At most 1	0.217	15.642	21.132	0.247
At most 2	0.090	6.000	14.265	0.613
At most 3	0.028	1.846	3.842	0.174

Note: Max-eigenvalue test indicates 1 cointegratingeqn(s) at the 0.05 level.
* Denotes rejection of the hypothesis at the 0.05 level.
** MacKinnon et al. (1999) p-values.

Appendix 2. VECM model estimation.

Cointegrating Equation:	CointEq1			
LRX (-1)	1.000			
LWGDP (-1)	3.502 (4.529) [0.773]			
LREER(-1)	44.040 (16.010) [2.751]			
LVOL(-1)	-4.273 (0.835) [-5.120]			
C	-118.835			
Error Correction:	D(LRX)	D(LWGDP)	D(LREER)	D(LVOL)
CointEq1	-0.027 (0.011) [-2.437]	-0.001 (0.000) [-1.735]	0.002 (0.002) [1.008]	0.271 (0.075) [3.634]
D(LRX(-1))	-0.257 (0.198) [-1.303]	-0.012 (0.008) [-1.533]	-0.014 (0.028) [-0.505]	1.281 (1.336) [0.959]
D(LRX(-2))	-0.828 (0.201) [-4.116]	-0.050 (0.008) [-6.505]	0.034 (0.028) [1.216]	2.888 (1.361) [2.122]
D(LRX(-3))	-0.602 (0.242) [-2.485]	-0.038 (0.009) [-4.132]	-0.029 (0.034) [-0.869]	2.426 (1.639) [1.480]
D(LRX(-4))	-0.463 (0.220) [-2.101]	-0.020 (0.008) [-2.306]	0.002 (0.031) [0.068]	1.472 (1.490) [0.988]
D(LWGDP(-1))	3.598 (4.010) [0.897]	0.698 (0.154) [4.543]	-0.362 (0.560) [-0.646]	-12.997 (27.131) [-0.479]
D(LWGDP(-2))	3.434 (4.671) [0.735]	0.355 (0.179) [1.985]	-0.972 (0.653) [-1.489]	-12.740 (31.604) [-0.403]
D(LWGDP(-3))	11.122 (4.394) [2.531]	0.177 (0.168) [1.053]	1.048 (0.614) [1.707]	-78.244 (29.726) [-2.632]
D(LWGDP(-4))	-0.266 (3.206) [-0.083]	0.075 (0.123) [0.609]	-0.416 (0.448) [-0.928]	6.921 (21.688) [0.319]
D(LREER(-1))	0.569 (1.176) [0.484]	0.088 (0.045) [1.955]	0.060 (0.164) [0.363]	-14.865 (7.953) [-1.869]
D(LREER(-2))	0.019 (1.107) [0.018]	0.011 (0.042) [0.254]	-0.192 (0.155) [-1.240]	-5.954 (7.492) [-0.795]
D(LREER(-3))	-0.409 (1.059) [-0.386]	-0.098 (0.041) [-2.426]	0.047 (0.148) [0.315]	-15.951 (7.162) [-2.227]
D(LREER(-4))	-1.632 (1.143) [-1.427]	-0.023 (0.044) [-0.522]	-0.428 (0.160) [-2.676]	3.546 (7.735) [0.459]
D(LVOL(-1))	-0.058 (0.039) [-1.490]	-0.002 (0.002) [-1.551]	0.004 (0.005) [0.637]	0.453 (0.263) [1.725]
D(LVOL(-2))	-0.074 (0.033) [-2.222]	-0.002 (0.001) [-1.265]	0.001 (0.005) [0.258]	0.019 (0.224) [0.083]

D(LVOL(-3))	0.003 (0.026) [0.099]	-0.002 (0.001) [-2.036]	0.003 (0.004) [0.711]	0.214 (0.174) [1.233]
D(LVOL(-4))	-0.023 (0.022) [-1.027]	-0.002 (0.001) [-2.478]	0.001 (0.003) [0.309]	-0.115 (0.148) [-0.777]
C	-0.038 (0.013) [-3.004]	-0.000 (0.001) [-0.543]	0.001 (0.002) [0.580]	0.193 (0.086) [2.242]
R-squared	0.511	0.797	0.332	0.626
Adj. R-squared	0.330	0.722	0.085	0.487
Sum sq. resids	0.048	0.000	0.001	2.199
S.E. equation	0.032	0.001	0.005	0.219
F-statistic	2.824	10.607	1.344	4.520
Log likelihood	139.417	348.235	265.360	17.058
Akaike AIC	-3.794	-10.320	-7.730	0.029
Schwarz SC	-3.187	-9.713	-7.123	0.637
Mean dependent	0.003	0.003	-0.001	-0.017
S.D. dependent	0.040	0.002	0.005	0.305
Determinant resid covariance (dof adj.)		1.17e-15		
Determinant resid covariance		3.12e-16		
Log likelihood		779.304		
Akaike information criterion		-21.978		
Schwarz criterion		-19.415		