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Panel data modeling of exchange rate volatility and disaggregated Moroccan exports

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Résumé

L'objectif principal de cet article est d'étudier l'impact de la volatilité du taux de change réel sur les exportations désagrégées marocaines, durant la période allant de 2000 jusqu'à 2021, à partir des bases de données annuelles de l'office des changes et de la banque mondiale. Nous avons utilisé l'approche économétrique basée sur la modélisation données de panel à effets aléatoires en mesurant la volatilité par un modèle GARCH (1.1). Il s'agit d'une analyse en terme géographique, nous avons estimé les élasticités tout en regroupant les quatre zones (européenne ; américaine ; asiatique et africaine). La plupart des résultats obtenus sont statistiquement significatifs et théoriquement ils ont eu des bons signes montrant que la volatilité du taux de change réel exerce un effet négatif sur les exportations désagrégées.

Mots clés : exportation désagrégée, données de panel, taux de change, volatilité, GARCH.

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Abstract

The main objective of this paper is to study the impact of real exchange rate volatility on disaggregated Moroccan exports, during the period from 2000 to 2021, using the annual databases of the Moroccan foreign exchange office and the World Bank. For this study, we used an econometric approach based on random-effects panel data modeling by measuring volatility with a GARCH model (1.1). In this geographical analysis, we have estimated the elasticities while grouping the four zones (Europe; America; Asia and Africa). Most of the results obtained are statistically significant and had shown good signs. In other words, the volatility of the real exchange rate has a negative effect on disaggregated exports.

Keywords : disaggregated export, panel data, exchange rates, volatility, GARCH.

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Introduction

The subject of this study is panel data modeling of exchange rate volatility and disaggregated exports in the case of the Moroccan economy. This topic remains a hot economic topic among economists specialized in international economics.

The main objective of the research is to use statistical techniques of the random effects panel data estimation method to analyze the impact of real exchange rate volatility on Moroccan disaggregated exports. To do so, we asked the following main question:
Q1: What is the impact of real exchange rate volatility on disaggregated exports in Morocco ?
Thus, based on the empirical literature, we formulated the following research hypothesis :

H1: Real exchange rate volatility has a negative impact on Moroccan sectoral exports.

The structure of the research is based on the elements of answers to bring in order to answer the question raised. First, we will present a literature review. Second, the data and methodology. Thirdly, we will present the results of the random effects panel estimations and finally the discussion.

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1. Literature review

The first theoretical model that remains a fundamental basis in the study of exchange rate volatility and foreign trade, we find Hooper and Kohlhagen (1978), which found a negative relationship between the two economic phenomena studied. This result is linked to the degree of risk aversion of the exporter, but other hypotheses can cause a positive relationship: the weakness of this theoretical link could be explained as follows, an increase in exchange rate risk does not necessarily generate a reduction in risky operations even for exporting companies (De Grauwe (1988); Giovannini (1988)). Hedging tools allow firms to reduce their exchange rate risk considerably (Viaene and Vries (1992)).

However, exchange rate volatility can create favorable conditions for profitable investments and productive foreign trade (Gros (1987) and Frank (1991)), because this volatility can cause profits to rise or fall and become uncertain.

Exchange rate volatility can have an impact on foreign trade flows through several types of channels:

1. First, when there are companies (exporters or importers) that are risk averse, this behavior can lead them to reduce their economic operations in terms of exports and imports because of the uncertainty of the exchange rate to protect themselves against the probable risks ;
2. Second, this volatility represents an uncertainty that can directly influence the level of foreign trade. In this case, prices and profits become uncertain, especially in developing countries where there is no developed futures market and the cost of hedging against risk remains high ;
3. Third, over a long period of time, persistent volatility may cause domestic producers to buy their inputs from internal sources instead of external sources. As a result, this situation may reduce the volume of foreign trade with the rest of the world.

Mckenzie (1998), used the nominal exchange rate and sectoral exports for the case of Australia during the period 1988-1995. In addition, the GARCH technique and the VECM model were applied. The author found that the impact of exchange rate volatility is positive and statistically significant on sectoral exports.

Dimitrios S et al (2011), also worked on the nominal exchange rate and exports by sector of economic activity. The authors studied the case of EU member countries, during the period 1973-2004. The mean standard deviation (MSD) technique and VAR modeling were developed. A mixed relationship was found after the estimation parameters, with negative and positive effects.

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Jianbin S (2015), analyzed the real exchange rate and aggregate exports, in the case of developed countries and less developed countries, during the period 1994-2014. Also, GARCH model was used to estimate the volatility of exchange rate and panel data modeling to study the impact. The author found that there are mixed effects between volatility and aggregate exports.
Flavio V (2016), studied the case of 106 countries, while using the real exchange rate and disaggregated exports, during the period from 2000 until 2011. The ETM method was adopted to estimate the volatility of the real exchange rate, and the generalized moments model (GMM) technique was thus applied. The author found that an increase (decrease) in exchange rate volatility decreases (increases) the volume of disaggregated exports studied.
Haider S (2017), studied the case of Indian economy, while using sectoral data. The study period ranging from 1999 to 2013. The ETM method has been applied. Panel data modeling generated a statistically insignificant and negative effect between real exchange rate volatility and exports.
Yakub et al (2019), analyzed the case of Nigeria during the period 1997-2016. The GARCH technique is applied to measure exchange rate volatility. The results of the ARDL model conclude that the effects are mixed in the short and long run.
Njoroge L (2020), studied 19 COMESA member countries during the period 1997-2019, the GARCH technique and the panel gravity model were used to analyze the effect of nominal exchange rate volatility on aggregate exports. The author found that there is a negative impact.
Tarasenko I (2021), used the ETM method to be able to measure the volatility of the nominal exchange rate, in the case of the economy of Russia during the period 2004 -2018. While using panel data modeling, the author found a negative effect of exchange rate volatility on aggregate exports and imports.
Cuneyt D & Kerem H (2022), worked on the case of Turkey. The study period is from 1998 until 2020. In addition, the GARCH technique was applied and the results of the ARDL model suggested a positive impact between real exchange rate volatility and aggregate exports.

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2. Data and methodology

In this section, we will first present the source and frequency of the variables studied as well as the equation of our model. And secondly, we will see the analysis of the correlation matrix.

2.1. Data

To carry out this work, we used statistical data from the World Bank (WB) and the foreign exchange office (FEO). These data are annual and cover a period from 2000 to 2021. While analyzing the four geographical areas: European Union ; America (USA); Asia and Africa.

It is also interesting to note that the four main export sectors studied are: agribusiness and agriculture (SXAA); electronics and electricity (SXEE); phosphate and derivatives (SXPD); and textiles and leather (SXTL).

In accordance with the nature of the variables studied in our theoretical model, the method applied is that based on panel data of 88 observations, given the heterogeneity in the data. The equation of the model is written as follows:

$$LogSX_{i,t} = \alpha_i + \beta_1 LogGDP_{i,t} + \beta_2 LogREER_{i,t} + \beta_3 LogV_{i,t} + \varepsilon_{i,t} \quad (1)$$

With,

LSX: Logarithm of sectoral exports, i.e. the 4 exporting sectors to the 4 geographical areas studied ;

α_i : Model constant ;

β_i: Elasticities of the model to be estimated ;

LGDP: Logarithm of foreign income measured by the GDP of the geographical area ;

LREER: Logarithm of the real effective exchange rate ;

LV: Logarithm of real exchange rate volatility ;

$\varepsilon_{i,t}$: Error term.

It should be noted at this level that all variables have been transformed into logarithms, in order to linearize the time series studied.

2.2. Research Methodology

In what follows, we will present the motivations for the choice of the statistical approach used. In accordance with the nature of the variables in our model, the method applied is that based on static panel data with random effects. The choice of the model could be justified as follows: We used four statistical databases representing the four geographical areas (Europe; America; Asia and Africa) for each sector of economic activity studied, (in total we estimated four sectors),

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each of which includes a dependent variable and three explanatory variables. The panel data estimation method makes it possible to group all the data in order to obtain a single global database. This technique is very useful in our case.

For the same statistical individual, from an econometric point of view, the data that group together a set of observations during a period represent the panel data, which are observations that are directly linked to a set of individuals observed at several dates. The panel data estimation technique has several types of advantages, in particular: it controls for the presence of unobservable heterogeneity. Also, the high sample size allows to improve the precision of the estimates, by obtaining good expected signs. Finally, this method consists of modeling dynamic relationships by taking into account the effect of unobserved characteristics of the variables during the study period.

Table N°1 : Correlation Matrix

Correlation	LOGSXAA	LOGSXEE	LOGSXPD	LOGSXTL	LOGGDP	LOGREER	LOGV
LOGSXAA	1.000000	-	-	-	-	-	-
LOGGDP	0.466205	0.426677	0.469625	0.394208	1.000000	-	-
LOGREER	-0.369623	-0.155549	-0.667998	-0.062336	-0.283956	1.000000	-
LOGV	-0.358211	-0.100330	-0.612116	-0.042734	-0.247247	0.807547	1.000000

Source : Developed from EViews software by the author

From Table 1 presenting the correlation matrix between the explanatory and statistically dependent variables, we find that there is a negative relationship between the volatility of the real exchange rate and the four sectors exports to the geographical areas studied, which means that the impact of volatility on disaggregated exports is negative.

Moreover, the existing relationship between REER and sectoral exports is negative, while the relationship between foreign GDP and sectoral exports is positive, which is consistent with empirical advances. In other words, these results had the expected good signs and are all consistent with economic theory.

3. Results and discussions

In this section, we first present the estimation of the GARCH model (1.1) for measuring real exchange rate volatility, the results of the Hausman tests, and the results of the random-effects panel estimates of the four sectors.

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3.1. Results

Table N°2 : Estimation of the GARCH model (1.1)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
α_0	3.958747	35488.57	0.000112	0.9999
α_1	0.763181	2341.514	0.000326	0.9997
β_1	0.051640	2812.112	1.84E-05	1.0000

Source : Developed from EViews software by the author

The GARCH (1,1) model equation for measuring volatility is presented as follows:

$$h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 h_{t-1} \qquad (2)$$

With, α_0 : is a constant is equal to 3.95;

α_1 : the coefficient relating the past value of the squared residual to the current level of variance is equal to 0.76;

β_1: the coefficient linking the current variance to that of previous periods is equal to 0.05.

At this level, it is necessary to determine which model is the most appropriate for our empirical study (fixed effects or random effects model). To find out, we need to carry out and apply the Hausman test (1978).

Table N°3 : Hausman tests

Test Summary (Cross-section random)	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
SXAA	0.000000	3	1.0000
SXEE	0.000000	3	1.0000
SXPD	67.14800	3	0.1600
SXTL	78.46100	3	0.5200

Source : Developed from EViews software by the author

From Table 3, we find that for the four estimated regressions, the associated values of the Hausman test probabilities are (100%; 100%; 16%; 52%). Thus, they are all above the 5% significance level, Therefore, we find that we should choose the random effects model.

The estimators of the fixed effects model are then biased. It is preferable to choose the random effects model which is unbiased.

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Table N°4 : Random effects panel elasticity estimates

Variable	SXAA	SXEE	SXPD	SXTL
LOGGDP	0.338859	0.282647	0.365615	0.201539
(P-value)	(0.0000)	0.0000	0.0000	0.0000
LOGREER	-1.732544	-1.090631	-11.37034	0.967788
(P-value)	0.1422	0.1685	0.0000	0.1889
LOGV	-0.564862	0.036516	-0.807486	-0.113997
(P-value)	0.0004	0.7170	0.0015	0.2244
C	25.41259	8.653343	74.58363	4.559684
(P-value)	0.0000	0.0033	0.0000	0.0956
R-squared	0.469458	0.270930	0.623139	0.123174
(Adjusted R-squared)	0.450510	0.244891	0.609680	0.091859
F-statistic	24.77623	10.40507	46.29798	3.933378
(P-value)	0.000000	0.000007	0.000000	0.011165

Source : Developed from EViews software by the author

- **First sector : Agribusiness and agriculture (SXAA)**

Furthermore, the result of the estimation of the elasticity of foreign GDP shows a positive sign. This result is significant. In other words, an increase of 1% in the explanatory variable foreign GDP will lead to a 0.33% increase in exports from the agri-food-agriculture sector. This is a positive impact.

In fact, according to the estimate of the elasticity of the REER, we find that it has a negative sign, i.e. an increase of 1% in the explanatory variable REER will cause a decrease of 1.73% in the dependent variable. This is therefore a negative effect. This result is statistically insignificant.

For our study, it is very important to know the influence of the volatility of the real exchange rate on the exports of the agri-food-agriculture sector. In our case we found a negative and statistically significant elasticity, which confirms that an increase in the explanatory variable "volatility" studied, will generate a reduction of 0.56% of the dependent variable. It is therefore a negative impact.

- **Second sector : Electronics and electricity (SXEE)**

The result of the estimation of the elasticity of foreign GDP shows a positive sign. This result is significant. In other words, an increase of 1% in the explanatory variable GDP, will lead to an increase of 0.28% of exports of the electronics and electricity sector, it is a positive impact.

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Also, according to the estimate of the elasticity of the REER, we find that it has a negative sign, i.e. an increase of 1% in the explanatory variable REER will cause a reduction of 1.09% in the dependent variable, so it is a negative effect. This result is statistically insignificant.

As for the volatility of the real exchange rate on exports from the electronics-electricity sector, we found a positive and statistically insignificant elasticity, which confirms that an increase in the volatility explanatory variable studied will generate an increase of 0.03% in the dependent variable.

- **Third sector : Phosphate and derivatives (SXPD)**

On the other hand, the result of the estimation of the elasticity of foreign GDP shows a positive sign. This result is significant. In other words, an increase of 1% in the explanatory variable foreign GDP will lead to a 0.36% increase in exports from the phosphate-derivatives sector, so this is a positive impact.

In fact, according to the estimate of the elasticity of the REER, we find that it has a negative sign, i.e. an increase of 1% in the explanatory variable REER will cause a decrease of 11.37% in the dependent variable. This is a negative effect.

Regarding the influence of the volatility of the real exchange rate on exports of the phosphate-derivatives sector, we found a negative and statistically significant elasticity, which confirms that an increase of 1% of the explanatory variable volatility studied and cause a decrease of 0.80% of the dependent variable, it is then a negative impact.

- **Fourth sector : Textiles and leather (SXTL)**

Furthermore, the result of the estimation of the elasticity of foreign GDP shows a positive sign. This result is significant. In other words, an increase of 1% in the explanatory variable foreign GDP will lead to an increase of 0.20% in exports of the textile and leather sector, which is a positive impact.

Similarly, from the estimate of the elasticity of the REER, we see that it has a positive sign. That is, a 1% increase in the explanatory variable REER will cause a 0.96% increase in the dependent variable. This is a positive effect.

Thus, regarding the volatility of the real exchange rate, we found a negative and statistically insignificant elasticity, which confirms that an increase in the volatility explanatory variable studied will cause a reduction of 0.11% in exports of the textile and leather sector. This is therefore a negative effect.

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3.2. Discussion

In the following section, we will present a comparison between the results obtained for the estimated variables in terms of expected sign and statistical significance.

Table N°5 : Comparison of the signs and significance of the results obtained

Variables	Expected sign	Sign obtained / significance			
		SXAA	SXEE	SXPD	SXTL
GDP	+	+ / S	+ / S	+ / S	+ / S
REER	-	- / NS	- / NS	- / S	+ / NS
V	-	- / S	+ / NS	- / S	- / NS

+: positive sign; -: negative sign; S: significant; NS: not significant

Source : Developed from EViews software by the author

From the Table 5, we can see that the effects of the foreign GDP variable are positive and significant for all four sectors studied. While for the REER variable, we find that this explanatory variable exerts negative effects in the first three sectors, which is consistent with the literature review, but in the last sector, the effect is positive and insignificant. Finally, concerning the variable real exchange rate volatility, we conclude that the effect of this variable is positive in the second sector studied and not significant. Thus, for the three remaining sectors, the impact of volatility is negative, and statistically significant, except for the last sector in which the result obtained is not significant.

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Conclusion

The main objective of this study was to investigate the impact of real exchange rate volatility on Moroccan disaggregated exports, based on random effects panel data modeling. We conclude that the basic hypothesis is accepted. In other words, the impact of real exchange rate volatility on sectoral exports in Morocco is negative in all three sectors and positive in one sector.

Finally, exchange rate volatility can have an impact on foreign trade flows through several types of channels: Firstly, when there are exporting and/or importing companies that are risk averse, this behavior can lead them to lower their economic operations. Second, this volatility is an uncertainty that can have a direct impact on the volume of foreign trade. In this context, prices and profits become uncertain, especially in developing countries where there is not a well-developed futures market and the cost of hedging against risk remains high.

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