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The uncertainty of economic policies in the United States and its impact on the stock markets of some African countries: An empirical study with VAR modeling

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Abstract. The economic and financial integration that has taken place over the last 20 years has led to a situation where the reaction of financial markets is no longer solely due to local factors, but also to macroeconomic and financial news of regional and international origin. In this regard, we focus on the effect of the international transmission of uncertainty shocks on global stock market performance. Given that the United States is the world's leading economic power, some studies have highlighted the adverse effects of the international propagation of US uncertainty shocks on international stock markets (Ehrmann and Fratzscher, 2009; Klobner and Sekkel, 2014; Hammoudeh et al., 2016). Using VAR modeling, our study examines the specific impact of economic policy uncertainty in the USA on the stock markets of four African countries: Tunisia, Egypt, Morocco, and South Africa. Although geographically distant from the USA, these economies are closely integrated into the global economy and are likely to be affected by international economic and political developments, particularly those originating in the USA, a major economy and a key player on the global stage.

Keywords. Economic policy uncertainty, Stock market volatility, VAR modelling

Introduction

The world's economies have become more interconnected than ever. This phenomenon is undoubtedly a direct consequence of uncertainty. Indeed, over the past decade, in the wake of the financial crisis, uncertainty in economic policy has attracted much attention because of its potential negative effects on economic activity (Bloom et al., 2018; Bloom, 2009; Pastor and Veronesi, 2012, 2013; Baker et al., 2016; Brogaard and Detzel, 2015; Gulen and Ion, 2015). For example, the Federal Open Market Committee (2009) and the International Monetary Fund (2012, 2013) have suggested that uncertainty over US and European fiscal, regulatory, and monetary policies contributed to a sharp downturn in 2008-2009. In addition, many authors, such as Baker et al. (2016) have also suggested that high levels of policy uncertainty are behind the weak recoveries from the 2007 financial crisis.

However, uncertainty is difficult to quantify because it is variable, complex, unobservable, and multifaceted (St-Pierre and Labelle, 2017). To empirically quantify the impact of uncertainty, several researchers have attempted to develop measures of economic uncertainty using various methods. Among the various measures of policy uncertainty, the economic policy uncertainty index based on newspaper coverage frequency proposed by Baker et al. (2016) has become a benchmark for measuring economic policy uncertainty (Sum, 2012a, 2012b; Antonakakis et al., 2013; Gulen and Ion, 2015). Baker, Bloom, and Davis (2016) have developed a new measure of uncertainty linked to the conduct of economic policies for certain developed countries (Economy Policy Uncertainty Index - EPU index). This measure combines quantitative and qualitative data to assess the uncertainty. The EPU index is based on three components: the first quantifies the newspaper coverage of economic policy uncertainty; the second measures fiscal policy uncertainty; and the third is used as an indicator of fiscal and monetary policy uncertainty.

Economic policy uncertainty can also be linked to stock market performance. Many researchers have paid particular attention to the impact of economic policy uncertainty on stock market performance. Moreover, their results converge towards a proven increase in stock market volatility in the presence of economic policy uncertainty (Fernandez, Villaverde and Rubio-Ramirez, 2010; Pastor and Veronesi, 2012). Moreover, economic policy uncertainty may have predictive capacity for future stock market returns. Antonakakis et al. (2013) examine the dynamic correlations between S&P 500 market returns, implied volatility, and Baker et al.'s (2013) policy uncertainty index. They find that increased conditional stock market volatility increases policy uncertainty and dampens stock market returns, while increases in Policy uncertainty volatility lead to negative stock market returns and increase policy uncertainty.

Several previous studies have addressed the impact of economic policy uncertainty on stock markets worldwide. For example, Christou et al. (2017) examine the role of economic policy uncertainty (EPU) in the US on stock market returns in six countries (Australia, Canada, China, Japan, Korea, and the US). Their results suggest that UPR shocks in the U.S. also have a significant negative effect on stock market returns in Canada, China, Japan, and Korea, suggesting the existence of international uncertainty spillovers. By contrast, they find no evidence of negative spillovers from US uncertainty to the Australian stock market. This result could be explained by the favorable opportunities that investors could gain by investing in this country following an increase in US economic policy uncertainty levels. Similarly, Sum (2013) examines whether changes in US economic policy uncertainty can explain returns in the Indonesian, Malaysian, Philippine, Singaporean, and Thai stock markets. Their results show that the returns of the five Asian stock markets react negatively to changes in economic policy uncertainty. Changes in U.S. economic policy uncertainty drive stock market returns in Singapore and Malaysia, but not in Indonesia, the Philippines, and Thailand. Their results suggest that Asian stock market performance is linked to US economic policy conditions and stock markets.

However, despite these earlier contributions, there are still gray areas, particularly about the specific impact of US economic policy uncertainty on the stock markets of the targeted African countries. Specifically, this study finds its relevance. Using a vector autoregressive (VAR) modeling approach, we aim to examine in detail how variations in U.S. economic policy uncertainty translate into responses in the stock market returns of Tunisia, Egypt, Morocco, and South Africa.

In line with previous studies, this research makes an essential contribution to understanding the complex mechanisms underlying the interactions between global economic and political development and the reactions of regional financial markets. Investors can use this study as a guide to forecast the profitability of the indices. It is difficult for stock market participants to predict how these indices will react to economic uncertainty shocks. This difficulty prevents them from mobilizing appropriate hedging operations; therefore, our study could represent a source of information for these players, enabling them to identify suitable hedging operations. The findings of this study could also offer useful insights for financial analysts and policymakers, shedding further light on how US economic policy uncertainty can influence stock market returns in the African countries studied here.

Consequently, this study aims to address the following problem:

What impact does the uncertainty surrounding US economic policy have on the performance of stock market indices in South Africa, Egypt, Morocco, and Tunisia?

Under these two assumptions

H1: Uncertain U.S. economic policies have a negative impact on the performance of South African, Egyptian, Moroccan, and Tunisian stock indices.

H2: Uncertain U.S. economic policies have a positive impact on the performance of South African, Egyptian, Moroccan, and Tunisian stock indices.

The remainder of this paper is organized as follows. First, we describe the model variables, then present the methodology adopted, the econometric model used, and then explain the data analysis process. We then focus on the description of the database and descriptive statistics of the model variables. Finally, we discuss the results and their interpretation.

Section 1. Description of variables

A stock market index can be defined as a basket of shares representative of a given market. It is a summary measure of the price movement of a particular market or market sector. Considered a market thermometer, the stock index describes the intensity of upward or downward fluctuations in the market (Niang, 2011).

1.1. TUNINDEX

The stock exchange generally designates an exchange market (possibility of sales and purchases) of financial securities, such as shares or bonds. The stock market Securities of Tunis (often called by its acronym BVMT) has the mission to ensure the management, security, and promotion of the Tunisian securities market.

The TUNINDEX index is the benchmark index of the Tunis Stock Exchange. It is weighted by floating capitalizations with a base of 1000, December 31, 1997. The TUNINDEX is made up of the fifty main market capitalizations of the country. It measures the general trend of the capital securities markets listed on the Tunis Stock Exchange. The TUNINDEX is also calculated in US Dollars and Euro. The annual performances of the TUNINDEX index have come closer to those of the Dow Jones, the DAX, the CAC 40, and the Footsie, the major stock markets being increasingly dependent on each other for the past fifteen years.

The TUNINDEX beat its historical high dating from September 2010, thus registering a new record at 5,699.34 points. The same source showed that the TUNINDEX recorded an increase of 14.45% in 2017 against an increase of 8.86% in 2016, to close the year at 6,281.83 points.

After an upward trend that began in January and culminated at its highest historical level on September 4, at 6,382.25 points, the TUNINDEX ended the month down 2.6% to recover during November and December. 2017. As a result, the balance of price variations experienced a strengthening of 42 values against a decline of 39 values. Estimated in euros, the index recorded a decline of 5.41%. On the other hand, it reached an increase of 7.73% when estimated in US dollars. Knowing that in 2017, the dinar exchange rate recorded a depreciation of 21% against the euro and 6% against the dollar (According to the *l'Economiste Maghrébin* magazine).

1.2. FTSE/JSE Top 40

The Johannesburg Stock Exchange ("JSE") is currently ranked the 19th largest stock exchange in the world by market capitalization and the largest stock exchange on the African continent. The Financial Times Stock Exchange (FTSE)/Johannesburg Stock Exchange (JSE), affectionately referred to as the FTSE/JSE Top40 Index, is a capitalization-weighted index. The companies included in this index are the 40 largest companies by market capitalization included in the FTSE/JSE All Shares Index. It is therefore the most active index on the continent, with solid performances that are close to those of the major American and European markets.

The annual performance of the index has come close to that of the Dow Jones, the DAX, the CAC 40, and the Footsie. The index was developed with a base value of 10399.53 as of June 21, 2002. It represents over 80% of the total market capitalization of all JSE-listed companies.

As of June 30, 1995, the index level was 4779.621. On May 30, 2017, it closed at 47,699.35. If an investor had invested in the index on June 30, 1995, they would have achieved a mere return of nearly 900% over 22 years. This gives an annual return of 40.1% over this period.

The fall during the 2008 financial crisis is noticeable. On May 22, 2008, the index hit an all-time high of 31,315.34. However, within 10 months, it halved to 16,334.1 (March 9, 2009). After that date, the index rebounded with a vengeance and is currently trading well above the highs reached in the first quarter of 2008 (Kotze, 2017).

1.3. EGX 30

Cairo's square has once again become the second in Africa after Johannesburg. The EGX 30 is the essential index of the Egyptian stock market. It was created in 1998, weighted according to the free float capitalization of the 30 most capitalized and most liquid stocks traded on the Egyptian Stock Exchange. The components of the EGX 30 are reviewed and changed twice a year (end of January and end of July). The index was developed with a base level of 1,000 on January 1, 1998, and was previously called the CASE 30 Index.

The Egyptian Stock Exchange has responded positively to the decision taken on Friday, November 11, 2016, by the IMF to grant Egypt a $12 billion loan. The EGX30, the main index of this financial market, started the week with an increase of 2.14% (according to the magazine Le Monde Economique).

The EGX 30 has risen by 418 points or 3.16% since the beginning of 2019. Historically, the Egyptian stock market (EGX30) reached an all-time high of 18414.11 in April 2018 (according to Trading Economics).

In April 2019, the listed enterprise capital market lost LE 3.8 billion, recording LE 819.04 billion, after total transactions reached LE 843 million. The main EGX 30 index fell 0.09% to 15.055 points.

It has fallen by 7.7% since April 30, 2019. It suffered particularly on May 29, when it experienced its largest volume of shares traded over the period (140.6 million shares) when it was overall down 0.38%. Remember, however, that this is not the biggest drop for the EGX 30 during the period. In 2018, when Ramadan was only considered towards the end of the month, the index fell by 10.7% over the period. Also, we note that on May 30, 2019, only two companies in the index ended in the green, the other companies saw their stock market values decline.

1.4. Moroccan All Shares Index

The Casablanca Stock Exchange is the first stock exchange in Maghreb and West Africa and the fourth stock exchange in Africa in terms of capitalization (5,002.77 billion euros). The Casablanca Stock Exchange has 75 listed companies and 17 brokerage firms. The MASI (Moroccan All Shares Index) is the main stock market index of the Casablanca Stock Exchange. It is made up of all the securities listed on the Casablanca market. The MASI aims to present the evolution of the market as a whole and to provide a long-term reference measure for the management of equity portfolios (according to the Moroccan newspaper Le Matin).

The MASI is a global capitalization index. It is thus composed of all equity-type values listed on the Casablanca Stock Exchange. The number of securities making up its sample will thus evolve, depending on admissions to listing, delistings, mergers, absorption, etc. operations. The Moroccan all-shares index, includes at its launch, on January 1, 2002, 55 stocks and their secondary lines, and has a base of 1000, on December 31, 1991.

In 2004, the Casablanca Stock Exchange changed the method of calculating its indices, based on the idea of floating, to better match a company's market position and its position in the index. MASI is now often called MASI Float or MASI Free Float Index.

The floating MASI (Moroccan All Shares Index) is a comprehensive index that includes all stocks listed on the Casablanca Stock Exchange. It makes it possible to measure the overall performance of the long-term market, i.e., the daily evolution of the free-floating market capitalization due to price variations. From 1999 to 2011 the MASI (Moroccan All Shares Index) rose from 4,865.07 to 11,027.65, an increase of almost 126.7%. Approximately 9,275.98 points as of April 23, 2013. In the fall of 2016, MASI was hovering around the 10,000 mark, and by mid-2017 it was above 12,000.

1.5 UPR US index

Remember that the choice of the American economy seems obvious, given its global influence on other stock markets (Ehrmann and Fratzscher, 2009; KlôBner and Sekkel, 2014; Hammoudeh et al., 2016). The US EPU index is calculated daily and built based on three components, namely:

1. The frequency with which terms such as "economic policy" and "uncertainty" appear together in the media. Indeed, uncertainty about economic policy decisions is considered by the number of articles containing specific policy-related terms (uncertainty or uncertain, economic, Congress, deficit, federal reserve, legislation, regulation). The articles come from the 10 major American newspapers, namely: Boston Globe, Chicago Tribune, Dallas Morning News, Los Angeles Times, Miami Herald, New York Times, San Francisco Chronicle, USA Today, Wall Street Journal, and Washington Post.
2. The number of tax provisions that are due to expire in the next few years. This component will provide a measure of the degree of uncertainty regarding the path that the federal tax code will take in the future.
3. The gap between government spending and inflation forecasts. This component is based on the survey of professional forecasters from the Federal Bank of Philadelphia Reserve. Indeed, researchers use forecast disagreement on federal and state government purchases as a measure of fiscal policy uncertainty, while forecast disagreement on future inflation is used as a proxy for uncertainty in fiscal policy. monetary policy. The US EPU index is calculated using proportions equal to 1/2 for the first component, 1/6 for the second, and 1/6 for inflation and government purchases in the third part of the index (Antonakakis et al., 2013).

Section 2. Methodology

Our methodology consists of estimating four models to examine the reaction of the South African, Egyptian, Moroccan, and Tunisian stock markets to shocks of uncertainty related to economic policies in the United States. ΔEPU US_t represents a change in US economic policy uncertainty index taking the first difference; it is the value of the economic policy uncertainty index at month t minus month t-1.

Each model looks like this:

Model 1: Impact of change in US economic policy uncertainty on Tunisian stock market performance:

$$R_t = \alpha + \beta \Delta EPU\ US_{\ t} + \xi_t$$

Were R_t = return of the TUNINDEX index (Tunisia) in month t; $R_t = (P_t - P_{t-1})/(P_{t-1})$

Model 2: Impact of changing US economic policy uncertainty on South African stock market performance:

$$R_t = \alpha + \beta \Delta EPU\ US_{\ t} + \xi_t$$

Were R_t = return of the FTSE/JSE Top 40 index (South Africa) in month t.

Model 3: Impact of change in US economic policy uncertainty on Egyptian stock market performance:

$$R_t = \alpha + \beta \Delta EPU\ US_{\ t} + \xi_t$$

Were R_t = return of the EGX 30 index (Egypt) in month t

Model 4: Impact of change in US economic policy uncertainty on Moroccan stock market performance:

$$R_t = \alpha + \beta \Delta EPU\ US_{\ t} + \xi_t$$

Were R_t = return of the MASI index (Morocco) in month t

In this work, the VAR model is used to examine the impact of a shock of economic policy uncertainty in the United States on the South African, Egyptian, Moroccan, and Tunisian stock markets.

The seminal work that popularized the VAR (Vector Auto regression) vector model is the article titled “Macroeconomics and Reality” by Sims (1980). Therefore, VAR models are a widely adopted tool in empirical studies to analyze the transmission channels of economic policies (Gossé and Guillaumin, 2013). The VAR model is suitable for analyzing the dynamic links between variables (financial, economic) and the propagation of shocks in an economic system. This model had the advantage of being dynamic, in the sense that it considers the origin of the shocks, their impact, their amplitude, and their amortization period (Enders, 2015).

Gujarati (1995) emphasized the importance of the vector autoregressive (VAR) model which requires less prior information and indeed has the advantage of treating each variable as endogenous when an economic theory cannot offer information a priori on the variables used in the VAR. This makes VAR estimation simpler. From a statistical point of view, the VAR is a multivariate modeling with simultaneous equations with endogenous variables. This is to allow the stochastic process to manage the dynamic interactions between a set of variables over time (Bourbonnais, 2011).

General representation of the VAR model

The VAR model with N variables and a number p of lags is represented as follows:

$Y_t = \Phi_0 + \Phi_1 Y_{t-1} + \Phi_2 Y_{t-2} + \ldots + \Phi_P Y_{t-P} + \mu_t$

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$$Y_t = \begin{pmatrix} Y1t \\ Y2t \\ \vdots \\ YNt \end{pmatrix}, \Phi_0 = \begin{pmatrix} a1,0 \\ \vdots \\ aN \end{pmatrix}, \Phi_P = \begin{bmatrix} a11,p & \cdots & a1N,p \\ \vdots & \ddots & \vdots \\ aN1,p & \cdots & aNN,p \end{bmatrix}, \mu_t = \begin{pmatrix} \mu1t \\ \mu2t \\ \vdots \\ \mu Nt \end{pmatrix}$$

Where Y_t is a stochastic process that traces the joint evolution of random variables. Φ_P is a matrix that represents the coefficients that summarize the dynamic relations between the N variables of the model. μ_t is a white noise process.

Section 3. Database and Descriptive Statistics

3.1 Description of databases

Measures of uncertainty related to the conduct of economic policies (US EPU) are provided by the website https://www.policyuncertainty.com. The values of the TUNINDEX, FTSE/JSE Top 40, EGX 30, and Moroccan All Shares Index indices are available on the website https://www.investing.com. For the eight models, we have limited ourselves in the use of monthly data, because the EPU USA indices are only available every month. The sample used for these models covers the period from February 2002 to October 2019, with a total of 213 observations for each model.

3.2 Descriptive statistics

Thus, the table below indicates the key indicators of the nature of the distributions of the variables studied in the estimation.

Table 1. Descriptive statistics

	Moyenne	Ecart-type	Minimum	Maximum	Skewness	Kurtosis	Jarque-Bera	Observations
EPU US	125,2520	48,10226	44,78275	284,1359	0,904995	3,663323	32,98003	213
EGX 30	0,020828	0,093475	-0,3319	0,366	0,257932	4,886661	33,79285	212
FTSE JSE TOP40	0,008709	0,047447	-0,1491	0,1467	-0,092691	3,695393	4,596693	213
MASI	0,006258	0,042719	-0,1561	0,2013	0,460587	5,808172	77,51773	213
TUNINDEX	0,008655	0,036256	-0,1329	0,1346	0,049459	4,607046	23,00738	213

The table above reports the main results of the descriptive statistics of the variables. One could deduce from the standard deviation values that the Egyptian stock market has the highest level of risk over the period 2002M02 to 2019M10 followed by South Africa and Morocco (0.093475; 0.047447 and 0.042719 respectively). Indeed, Egypt has the best stock market return (0.020828) followed by South Africa (0.008709).

The maximum and minimum values of each series give us an idea of the enormous economic and financial instability and pronounced fluctuations in the economy of each country.

To study the characteristics of the distributions, we use the values of Skewness and Kurtosis, the latter give an idea of the nature of the distributions of the variables. Indeed, the positive Skewness values show that the distribution of the variables is left-skewed concerning the normal distribution, which is the case for all the variables in our sample except for the South African stock market, which is negative (the distribution is right-skewed).

Moreover, Kurtosis values greater than 3 show that the value distribution functions have thicker tails than normal, which is the case for all the variables in our sample.

For normality, the Jarque-Bera test is used. Thus, the given statistics show that all the variables do not follow the normal law since they have a critical value greater than 5.9915 at the 5% threshold except for the South African stock market. This means that the Jarque-Bera test statistic strongly rejects the normality hypothesis except for South Africa.

Section 4. Results and Interpretations

In this section, we will study the impact of economic policy uncertainty shock in the United States on the South African, Egyptian, Moroccan, and Tunisian stock markets using a VAR model.

4.1 Unit Root Test

Unit root tests make it possible to highlight the stationary or non-stationary character of a chronicle by determining a deterministic or stochastic trend. There are two types of non-stationary processes: TS (Trend Stationary Process) processes which present a non-stationarity of the deterministic type, and DS (Difference Stationary Process) processes for which the stationarity is of the random type. There are several tests to detect stationarity. We exploit the most used empirical work, namely the Augmented Dickey-Fuller test.

If the result concludes that the series is not stationary, then the series must be differentiated and the test repeated until a stationary result is obtained.

Thus, we retain that the US EPU variables are not stationary in level. They do not admit a unit. The series is not stationary of type DS, so we pass to the first difference.

On the other hand, the stock market return of EGX 30, FTSE JSE TOP 40, MASI and TUNINDEX does not admit either a unit root or a trend. All the values of the t-statistic are below the critical value at the 5% threshold (-12.29; -15.64; -13.25; -12.83 respectively < -3.431), as well as the probability of the test ADF for all stock returns, is less than 0.05 (0.000<0.05). Similarly, the probability of the trend is greater than 0.05 (0.1135; 0.4599; 0.1159; 0.454 respectively > 0.05). Stationarity is accepted for these variables.

After making the first difference for the variables EPU US, we notice that all the values of probabilities of (ADF) in the first difference are less than 0.05 (0.000<0.05) as well as the values of probabilities of the trend in the first difference are greater than 0.05 (0.7186 respectively). So, we can conclude that the variables are stationary now.

The VAR models to be estimated will therefore be constructed from the change in US economic policy uncertainty (ΔEPU US), the stock index return Egyptian (EGX 30), Moroccan (MOROCCAN ALL SHARES), South African (FTSE JSE TOP 40) and Tunisian (TUNINDEX).

4.2 Number of the optimal delay

The estimation of a VAR model requires the choice of a suitable order. To determine the number of lags of a stepped-delay model, we use the Aikaike and Schwartz criteria in the case of the VAR representation, these criteria can be used to determine the order *h* of the model. The procedure for selecting the order of the representation consists in estimating all the VAR models for an order ranging from *0* to *P*. The lag *h* which minimizes the AIC or SC criteria is retained.

• Number of model 1 delays between EPU US and TUNINDEX:

Furthermore, h=14 has been chosen as the maximum allowable number of delays by the available data. Subsequently, the values of the criterion function (AIC) were calculated in an order ranging from 1 to 14.

According to Table 1 (see Appendix 2), the minimum value of the AIC function is equal to 6.284819. Thus, the number of lags retained is equal to 4. We then deduce that model 1 is a 4th-order VAR with two variables, namely EPU US and TUNINDEX.

• Number of model 2 lags between EPU US and FTSE/JSE Top 40:

Table 2 (see Appendix 2) represents the results of the estimation of the AIC function for an order ranging from 1 to 14. We thus notice that Min AIC = 6.726695 corresponds to $P = 4$. We then deduce that model 2 is a 4th-order VAR with two variables.

• Model 3 delay number between EPU US and EGX 30:

According to Table 3 (see Appendix 2), the minimum value of the AIC function is equal to 8.124517. Thus, the number of lags retained is equal to 4. We then deduce that model 3 is a 4th-order VAR with two variables, namely EPU US and EGX 30.

• Number of delays of model 4 between EPU US and Moroccan All Shares:

In reading Table 4 (see Appendix 2), we see that the minimum value of the AIC function is equal to 6.701287. Thus, the number of lags retained is equal to 4. We then deduce that model 4 is a fourth-order VAR with two variables.

The use of the AIC criteria makes it possible to conclude that a delay of order 4 is the most suitable for models 1, 2.3, and 4.

In addition, vector autoregressive (VAR) analysis is used to determine how each country's stock market responds to economic policy uncertainty shocks in the United States and to determine the causal link between changes in economic policy uncertainty in the United States and stock market returns in each country.

Indeed, it is the GRANGER causality tests and the impulse response function graphs that will reveal to us the existence of the impact of one on the other.

4.3 Granger Causality Test

The analysis of causality in Granger's sense makes the possibility to see how the variable Y can be explained from another variable. Granger causality states that one variable causes another if and only if the current and past values of the latter better predict the values of the former. According to Hairault (1995), the analysis of causality in the sense of Granger highlights the interactions between variables. The variable Y is said to be caused in the Granger sense by the variable X if the lagged values of X help in the prediction of Y. For this, we must test the hypothesis that the variable X causes the variable Y and vice versa.

Table 2. Granger causality test results between ΔEPU US and stock index returns

Equation	Excluded	chi2	df	Prob > chi2
ΔEPU US	TUNINDEX	0,6939	4	0,9521
TUNINDEX	ΔEPU US	4,8595	4	0,3020
ΔEPU US	FTSE	8,5147	4	0,0744
FTSE	ΔEPU US	4,3743	4	0,3577
ΔEPU US	EGX30	10,605	4	0,0314
EGX30	ΔEPU US	2,0534	4	0,7259

ΔEPU US	MASI	1,2652	4	0,8672
MASI	ΔEPU US	2,5434	4	0,6369

For the TUNINDEX variable, its probability is (0.9521), not significant at the 10% threshold, so it does not cause ΔUPS US, as well as for the variable ΔUPS US, its probability is (0.302) also not significant then it does not cause the TUNINDEX. Indeed, a shock of change in the uncertainty of economic policy in the United States does not affect the Tunisian stock market return. The converse is also verified as well.

For the FTSE variable, its probability is (0.0744), significant at the 10% level, so it causes the ΔUPS US. For the variable ΔEPU US, its probability is (0.3577) insignificant at the 10% level, so it does not cause FTSE. The model indicates there is a one-way causal impact between the two variables. Indeed, a shock of change in economic policy uncertainty in the United States does not affect the South African stock market return. The converse is also not verified.

For the variable EGX30, its probability is (0.0314), significant at the 10% level, so it causes the ΔUPS US. For the variable ΔEPU US, its probability is (0.7259) insignificant at the 10% threshold, so it does not cause EGX30. The model indicates there is a one-way causal impact between the two variables. Indeed, a shock of change in economic policy uncertainty in the United States does not affect the Egyptian stock market return. The converse is also not verified.

For the variable MASI, its probability is (0.8672), not significant at the 10% threshold, so it does not cause ΔUPS US, as well as for the variable ΔUPS US, its probability is (0.6369) no significant also so it does not cause MASI. Indeed, a shock of change in the uncertainty of economic policy in the United States does not affect the Moroccan stock market return. The converse is also verified as well.

4.4 Impulse Response Functions

We now come to the heart of the analysis of VAR models. A VAR model essentially models the dynamic relationships between a group of variables chosen to characterize a particular economic phenomenon. The impulse analysis will make it possible to determine the influence of a shock linked to the evolution of one of the variables on the other variables of the system.

In this section, we analyze the dynamic response of the TUNINDEX, FTSE/JSE Top 40, EGX 30, and MASI variables to an uncertainty shock in the four models. The results are presented, respectively in figures 1, 2, 3, et 4. The blue line traces the trajectory of the dynamic reaction of the variables of the model, the two broken red lines represent the limits of the interval confidence or 5%.

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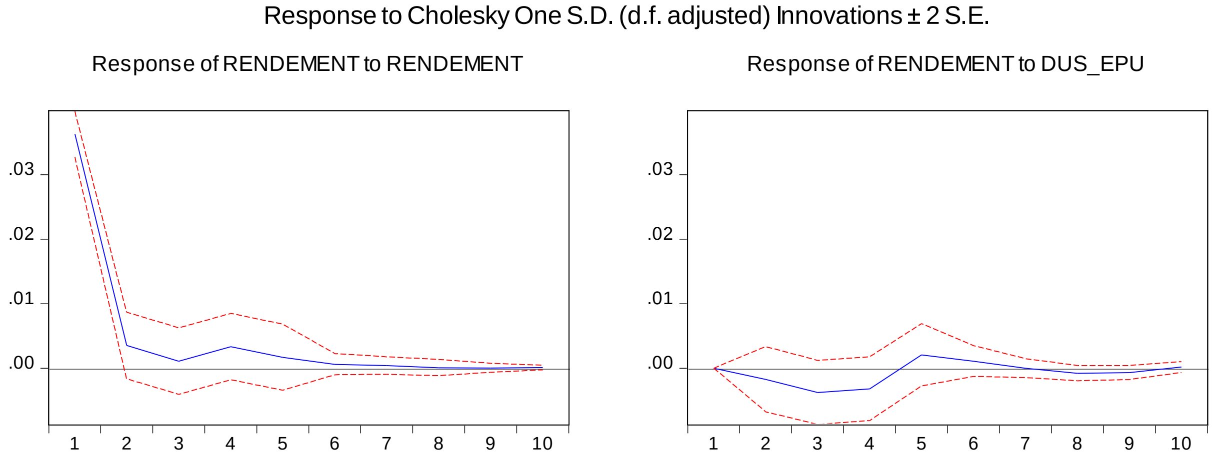

Figure 1. (a) **Figure 1. (b)**

Figure 1. (a): dynamic response of the TUNINDEX variable to its shocks.

Figure 1. (b): dynamic response of the TUNINDEX variable to an American uncertainty shock.

According to Figure 1(b), we find that a positive shock of change in US economic policy uncertainty significantly and weakly influences the performance of TUNINDEX. We also note that in a horizon of 10 months of estimation, the dynamic response goes through several sequences, thus the US EPU variable influences negatively and positively the TUNINDEX variable.

In reading Figure 1(b), there is first a zero effect of the UPE US variable to a shock affecting the TUNINDEX variable for the first month (0.0000). Then, a negative effect appears in the second, third, and fourth months (-0.001693; -0.003729; -0.003164 respectively). We thus notice that the negative effect of the third month is greater than that of the second and fourth months. Thus, a small expansion will take place for the first time for the fifth, sixth, and seventh months (0.002099; 0.001125; 0.0000195 respectively). We also notice that the positive effect of the fifth month is greater than that of the sixth and seventh months. Another recession will take place in the eighth and ninth months (-0.000760; -0.000655). At the end of the period, the effect approaches zero. The most significant negative effect during the ten months appears in the third month. The most important positive effect during the ten months appears in the fifth month.

According to Figure 1(a); the response of the TUNINDEX variable to its shock; we find that the most important determinant of the return of the TUNINDEX index is this delayed return. It is the history in terms of yield recorded during the previous month that influences the current yield, which is why the effect of the US EPU variable on the TUNINDEX variable is more or less weak.

Economic policy uncertainty in the United States has a small or almost negligible effect on the Tunisian stock market. The Tunisian stock market seems to be not sufficiently developed and attached to international markets. The performance of this market is more influenced by factors relating to internal situations and events than external ones.

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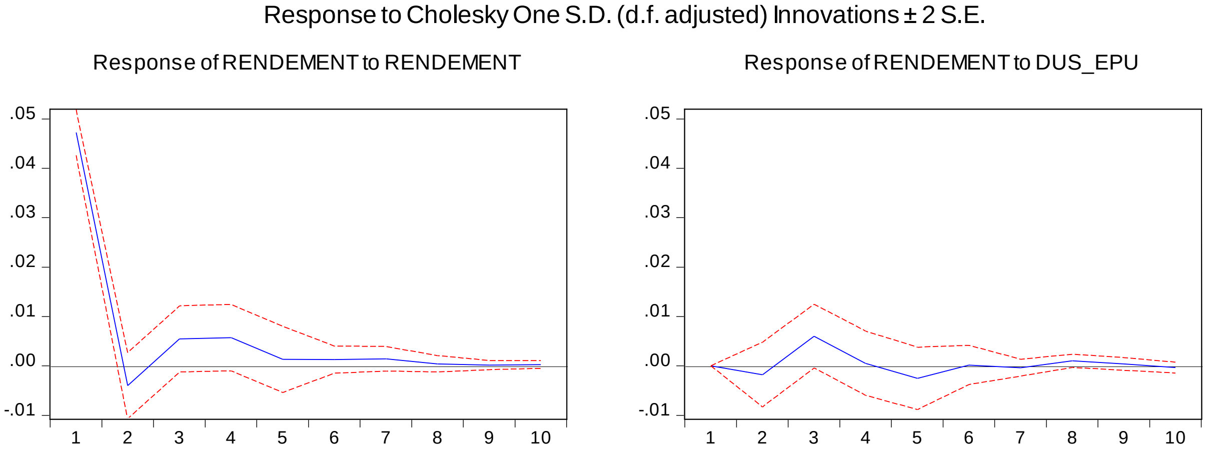

Figure 2. (a) **Figure 2. (b)**

Figure 2. (a): dynamic response of the FTSE JSE TOP 40 variable to its shocks.

Figure 2. (b): dynamic response of the FTSE JSE TOP 40 variable to an American uncertainty shock.

According to Figure 2. (b), we find that a positive shock of the change in the uncertainty of the American economic policy influences significantly and weakly the return of FTSE JSE TOP 40. We also notice that in a horizon of 10 months estimation, the dynamic response goes through several sequences, thus the EPU US variable influences negatively and positively the FTSE JSE TOP 40 variable.

In reading Figure 2. (b), there is first a zero effect of the EPU US variable to a shock affecting the FTSE JSE TOP 40 variable for the first month (0.0000). Then, a negative effect was recorded for the first time in the second month (-0.001767). Thus, an expansion will take place for the first time in the third and fourth months (0.006021; 0.000524 respectively). We also notice that the positive effect of the third month is much greater than that of the fourth month. Another recession higher than the first will take place in the fifth month (-0.002537). Another small expansion appears in month six (0.000182) but is much smaller than the peak in month three. After these months, the effect remains close to zero.

The greatest positive effect during the ten months appears in the third month

The most significant negative effect during the ten months appears in the fifth month.

The same applies to the return of the FTSE JSE TOP 40 index, as shown in Figure 2. (a); the response of the FTSE JSE TOP 40 variable to its shock; we find that the most important determinant of the return of the FTSE JSE TOP 40 index is this lagged return.

South Africa is influenced by the uncertainty of American and European economic policy, unlike Tunisia, this can be explained by the fact that South Africa has represented itself among the BRICS countries; emerging countries that are more exposed and more influenced by international stock market indices and by internal and external events as well as its economy is more developed than that of Tunisia.

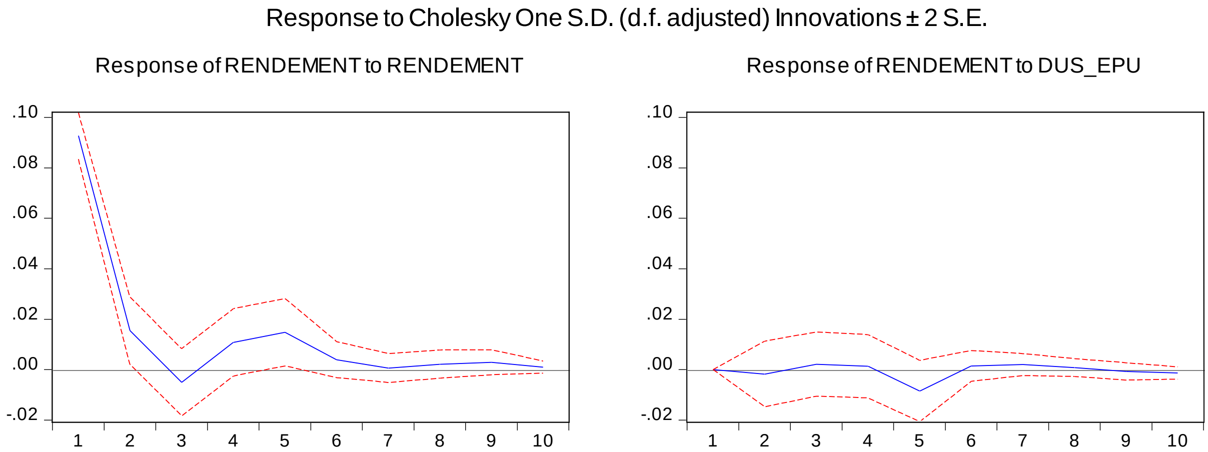

Figure 3. (a) **Figure 3. (b)**

Figure 3. (a): dynamic response of the EGX 30 variable to its shocks.

Figure 3. (b): dynamic response of the EGX 30 variable to an American uncertainty shock.

On the other hand, according to Figure 3. (b), we find that a positive shock of change in US economic policy uncertainty significantly and weakly influences the return of EGX30. We also note that in a horizon of 10 months of estimation, the dynamic response goes through several sequences, thus the US EPU variable negatively and positively influences the EGX30 variable.

Indeed, there is also a zero effect of the UPE US variable to a shock affecting the EGX30 variable for the first month (0.0000). Then, a too-weak negative effect which is displayed in the second month (-0.001765). Thus, just after the second month, a positive effect will take place for the first time in the third and fourth periods (0.002170; 0.001321 respectively). A negative effect will take place for the second time in the fifth month (-0.008498) higher than that of the second month. Subsequently, a positive effect is displayed for three consecutive months; the sixth, seventh, and eighth months (0.001466; 0.001998; 0.000763 respectively); but these positive effects are less than that of the third month. After the effect converges to zero and the curve merges with the abscissa axis.

The most important positive effect during the ten months appears in the third month.

The most significant negative effect during the ten months appears in the fifth month.

Similarly for the return of the EGX30 index, according to Figure 3. (a) of the response of the EGX30 variable to its shock; we find that the most important determinant of the return of the EGX30 index is this lagged return. It is the history in terms of performance recorded during the previous month that influences the current performance. Like the Tunisian stock market, the Egyptian stock market is weakly influenced by the uncertainty of American economic policy because it is also not sufficiently developed and open to international markets.

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Figure 4. (a) **Figure 4. (b)**

Figure 4. (a): dynamic response of the MASI variable to its shocks.

Figure 4. (b): dynamic response of the MASI variable to an American uncertainty shock

Moreover, according to Figure 4. (b), we find that a positive shock of change in US economic policy uncertainty significantly and weakly influences the stock market return of MASI. We also note that in a horizon of 10 months of estimation, the dynamic response goes through five sequences, thus the US EPU variable influences negatively and positively the MASI variable.

Indeed, there is also a zero effect of the UPE US variable to a shock affecting the MASI variable for the first month (0.0000). Then, a small positive effect that shows in the second month (0.002140). For the first time, a negative effect will take place in the third, fourth, and fifth months (-0.001820; -0.002657; -0.002073 respectively) but the negative effect of the fourth month is the most important. An expansion is displayed during the sixth and seventh month (0.001676; 0.000936 respectively) but it is less important than that of the second month. Similarly, at the end of the period, the effect approaches zero.

The most important positive effect during the ten months appears in the second month.

The most significant negative effect during the ten months appears in the fourth month.

The same applies to the return of the MASI index, according to Figure 7(a); we find that the most important determinant of the return of the MASI index is this lagged return.

The most significant negative effect during the ten months appears during the fourth month.

The greatest positive effect during the ten months appears during the fifth month.

Morocco and Tunisia as well as Egypt (countries in the MENA region) have the same financial structure and therefore stock markets are more influenced by internal than external events and therefore the impact of economic policy uncertainty. In the United States is quite low, contrary to the results observed for South Africa. But compared to the Tunisian stock market, the Moroccan stock market reacts to shocks of American economic uncertainty.

Section 5. Forecast Error Variance Decomposition

The decomposition of the variance of the forecast error aims to calculate each of the innovation’s contributions to the variance of the error.

5.1 Model 1

The decomposition of the variance of the variables allows us to determine the proportion of movements in the forecast errors of the variable TUNINDEX due to unanticipated uncertainty shocks affecting the UPR US variable. Appendix 5 shows the results of this decomposition. Thus, we see that the most important part of the performance of TUNINDEX is explained by its shocks during this period. The performance of TUNINDEX is predominated by itself, it explains almost all of the variables. Thus, the contribution of these shocks oscillates between 97% and 100%.

Then, an unexpected shock on the US EPU variable explains at most 2.42% of the total variance of the TUNINDEX variable but the contribution of US economic policy uncertainty shock on the TUNINDEX variable is expanding, it oscillates between 0 % and 2.42%. This result shows that innovations at the level of US economic uncertainty represent only a modest proportion of the total variance of the Tunisian stock market return.

5.2 Model 2.

Thus, an unexpected shock on the US EPU variable explains at most 2.6% of the total variance of the FTSE JSE TOP 40.

This result also shows that the contribution of the shock of US economic policy uncertainty on the South African stock market African is close to 2%. So the South African stock market is influenced by the US EPU.

5.3 Model 3

The appendix represents the decomposition of the total variance of the EGX30 variable following its shock as well as the decomposition of the total variance of the EGX30 variable following an unanticipated US uncertainty shock. The appendix shows the results of this decomposition. Thus, we see that the largest part of the return of EGX30 is explained by its shocks during this period. The performance of EGX30 is predominately on its own, explaining almost all of the variability. Thus, the contribution of these shocks oscillates between 99% and 100%.

Concerning the decomposition of the total variance of the EGX30 variable following an unexpected uncertainty shock on the US EPU variable, the appendix demonstrates that innovations relating to the level of uncertainty of US economic policies represent only one small proportion of the total variance of the EGX30 variable, i.e. a maximum of 0.97%, but the contribution of the uncertainty shock of American economic policy on the EGX30 variable is also expanding, it oscillates between 0% and 0.97%.

Like the results observed in models 1 and 2 (the case of Tunisia and South Africa), this result shows that innovations at the level of American economic uncertainty represent only a modest proportion of the total variance of the Egyptian stock market return.

5.4 Model 4

of the variance of the variables of model 4 allows us to determine the proportion of movements in the forecast errors of the MASI variable due to unanticipated uncertainty shocks affecting the UPR US variable. The appendix shows the results of this decomposition. Thus, we see that the largest part of MASI’s return is explained by its shocks during this period. MASI’s yield is predominated by itself, explaining almost all of the variability. Thus, the contribution of these shocks oscillates between 98% and 100%.

Then, an unexpected shock on the US EPU variable explains at most 1.23% of the total variance of the MASI variable but the contribution of US economic policy uncertainty shock on the MASI variable is expanding, it oscillates between 0 % and 1.23%. This result shows that innovations at the level of US economic uncertainty represent only a modest proportion of the total variance of the Tunisian stock market return.

Conclusion

Using a VAR modeling approach, this study sought to analyze the impact of US economic policy uncertainty on the stock markets of Tunisia, Egypt, Morocco, and South Africa. The results highlight several significant observations that provide valuable insights into how fluctuations in US economic policy uncertainty influence the financial markets of these countries.

First, our study reveals that the impact of US economic policy uncertainty on African stock markets is momentary. US economic policy uncertainty has a positive, negative, and sometimes zero impact on the returns of the African stock markets studied. This duality of reactions reflects the inherent complexity of financial markets, where investors and participants react differently to various economic, political, and psychological factors. This also means that the effects of uncertainty dissipate relatively quickly, which may be due to the adaptability of markets and investors' ability to quickly integrate new information. This temporal characteristic underlines the importance of stock market agility in response to global events. Thus, the results suggest that uncertainty cannot be reduced to a simple linear correlation with stock market returns but generates complex, multifaceted dynamics.

This observation has been reported by some researchers. For example, Christou et al. (2017) examine the impact of locally generated uncertainty shocks on stock market returns in six countries (Australia, Canada, China, Japan, Korea, and the USA), and their results show that the impact of country-specific economic uncertainty shocks on stock market returns is momentary. Specifically, the impact is negative and significant for the first month but becomes positive and insignificant in the following month.

Second, it is important to note that the impact of US economic policy uncertainty on African stock markets is low. This underscores the resilience of these markets to uncertainty. This low impact can be explained by the fact that these four countries have modest integration into global financial markets, and their stock markets are less developed, so they are attached to these international markets. African economies and financial markets may be influenced more by specific regional and national factors, such as internal politics, local economic cycles, and regional dynamics. These factors cushion the impact of foreign uncertainty. This also highlights the complexity of the relationship between uncertainty and returns, and the need to consider other variables and explanatory factors in the analysis.

In addition, stock markets may not react immediately or effectively to information from abroad because of the limited speed of information transmission, time-zone differences, and delays in receiving accurate information. Investor psychology may also differ, with investors adopting more conservative behavior in response to uncertainty, which could limit extreme market movements. This could translate into less-pronounced variations in stock market returns in response to uncertainty. Similarly, governmental and political reactions in African countries to global economic uncertainty can mitigate their effects on markets. The monetary and fiscal policies adopted by governments can play an important role in stabilizing markets.

In economic and financial terms, these results underline the interconnectedness of global markets and highlight the importance of considering major economic and political developments when managing investments. Investors and portfolio managers need to be aware of the potential repercussions of US events in African markets while recognizing that reactions may be transitory and variable. In addition, policymakers in African countries may wish to consider these findings in their economic policies and risk management strategies.

In reality, we find ourselves in either high or low uncertainty, but not in both cases at the same time. This research could pave the way for new avenues of investigation into the impact of economic policy uncertainty on stock market returns, considering the economic cycle. Indeed, these impacts may differ depending on whether we deal with an economic expansion or contraction phase.

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Appendix
Appendix 1: Unit Root test

- EGX 30

Null Hypothesis: RENDEMENT has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=14)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-12.29391	0.0000
Test critical values:	1% level	-4.002354	
	5% level	-3.431368	
	10% level	-3.139353	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(RENDEMENT)
Method: Least Squares
Date: 12/24/19 Time: 22:42
Sample (adjusted): 2002M03 2019M10
Included observations: 210 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RENDEMENT(-1)	-0.857455	0.069746	-12.29391	0.0000
C	0.035323	0.013118	2.692773	0.0077
@TREND("2002M02")	-0.000166	0.000105	-1.589260	0.1135

R-squared	0.422028	Mean dependent var	-0.001199
Adjusted R-squared	0.416444	S.D. dependent var	0.121017
S.E. of regression	0.092446	Akaike info criterion	-1.910209
Sum squared resid	1.769063	Schwarz criterion	-1.862393
Log-likelihood	203.5719	Hannan-Quinn criter.	-1.890879
F-statistic	75.57454	Durbin-Watson stat	1.950666
Prob(F-statistic)	0.000000		

- FTSE/JSE Top 40

Null Hypothesis: RENDEMENT has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=14)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-15.64947	0.0000
Test critical values:	1% level	-4.001931	
	5% level	-3.431163	
	10% level	-3.139232	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(RENDEMENT)
Method: Least Squares
Date: 12/24/19 Time: 20:20
Sample (adjusted): 2002M03 2019M10
Included observations: 212 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RENDEMENT(-1)	-1.077288	0.068839	-15.64947	0.0000
C	0.013337	0.006607	2.018545	0.0448
@TREND("2002M02")	-3.95E-05	5.33E-05	-0.740322	0.4599

R-squared	0.539585	Mean dependent var	-0.000155
Adjusted R-squared	0.535179	S.D. dependent var	0.069606
S.E. of regression	0.047456	Akaike info criterion	-3.243982
Sum squared resid	0.470681	Schwarz criterion	-3.196483
Log likelihood	346.8621	Hannan-Quinn criter.	-3.224784
F-statistic	122.4689	Durbin-Watson stat	1.985353
Prob(F-statistic)	0.000000		

- MASI

Null Hypothesis: RENDEMENT has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=14)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-13.25368	0.0000
Test critical values:	1% level	-4.001931	
	5% level	-3.431163	
	10% level	-3.139232	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(RENDEMENT)
Method: Least Squares
Date: 12/24/19 Time: 21:09
Sample (adjusted): 2002M03 2019M10
Included observations: 212 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RENDEMENT(-1)	-0.912487	0.068848	-13.25368	0.0000
C	0.013864	0.005951	2.329760	0.0208
@TREND("2002M02")	-7.59E-05	4.80E-05	-1.578713	0.1159

R-squared	0.456673	Mean dependent var	1.93E-05
Adjusted R-squared	0.451474	S.D. dependent var	0.057439

S.E. of regression	0.042541	Akaike info criterion	-3.462650
Sum squared resid	0.378234	Schwarz criterion	-3.415151
Log likelihood	370.0409	Hannan-Quinn criter.	-3.443452
F-statistic	87.83353	Durbin-Watson stat	2.013959
Prob(F-statistic)	0.000000		

- TUNINDEX

Null Hypothesis: RENDEMENT has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=14)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-12.83983	0.0000
Test critical values:	1% level	-4.001931	
	5% level	-3.431163	
	10% level	-3.139232	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(RENDEMENT)
Method: Least Squares
Date: 12/24/19 Time: 21:21
Sample (adjusted): 2002M03 2019M10
Included observations: 212 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RENDEMENT(-1)	-0.881697	0.068669	-12.83983	0.0000
C	0.010937	0.005055	2.163766	0.0316
@TREND("2002M02")	-3.05E-05	4.07E-05	-0.749477	0.4544

R-squared	0.440986	Mean dependent var	-1.23E-05
Adjusted R-squared	0.435636	S.D. dependent var	0.048167
S.E. of regression	0.036185	Akaike info criterion	-3.786281
Sum squared resid	0.273659	Schwarz criterion	-3.738782
Log likelihood	404.3458	Hannan-Quinn criter.	-3.767083
F-statistic	82.43620	Durbin-Watson stat	2.007429
Prob(F-statistic)	0.000000		

- EPU US

Null Hypothesis: US_EPU has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=14)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.251733	0.0000
Test critical values:	1% level	-4.001931	

	5% level	-3.431163	
	10% level	-3.139232	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(US_EPU)
Method: Least Squares
Date: 12/15/19 Time: 11:59
Sample (adjusted): 2002M03 2019M10
Included observations: 212 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
US_EPU(-1)	-0.401905	0.055422	-7.251733	0.0000
C	37.40506	7.127845	5.247738	0.0000
@TREND("2002M02")	0.123212	0.043516	2.831404	0.0051

R-squared	0.201037	Mean dependent var	0.248447
Adjusted R-squared	0.193391	S.D. dependent var	39.83548
S.E. of regression	35.77680	Akaike info criterion	10.00653
Sum squared resid	267515.7	Schwarz criterion	10.05402
Log likelihood	-1057.692	Hannan-Quinn criter.	10.02572
F-statistic	26.29454	Durbin-Watson stat	2.081658
Prob(F-statistic)	0.000000		

- EPU US

Null Hypothesis: D(US_EPU) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 3 (Automatic - based on SIC, maxlag=14)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-11.60697	0.0000
Test critical values:	1% level	-4.002786	
	5% level	-3.431576	
	10% level	-3.139475	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(US_EPU,2)
Method: Least Squares
Date: 12/15/19 Time: 11:59
Sample (adjusted): 2002M07 2019M10
Included observations: 208 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(US_EPU(-1))	-2.280938	0.196515	-11.60697	0.0000
D(US_EPU(-1),2)	0.871757	0.158570	5.497610	0.0000

D(US_EPU(-2),2)	0.543722	0.116899	4.651195	0.0000
D(US_EPU(-3),2)	0.202358	0.070479	2.871188	0.0045
C	-0.697658	5.228463	-0.133435	0.8940
@TREND("2002M02")	0.015229	0.042207	0.360830	0.7186

R-squared	0.679367	Mean dependent var	-0.201483
Adjusted R-squared	0.671431	S.D. dependent var	63.68015
S.E. of regression	36.50207	Akaike info criterion	10.06104
Sum squared resid	269145.1	Schwarz criterion	10.15731
Log likelihood	-1040.348	Hannan-Quinn criter.	10.09997
F-statistic	85.60083	Durbin-Watson stat	1.980371
Prob(F-statistic)	0.000000		

Appendix 2: Lag Order Selection
Model 1

VAR Lag Order Selection Criteria
Endogenous variables: DUS_EPU RENDEMENT
Exogenous variables: C
Date: 12/24/19 Time: 21:27
Sample: 2002M02 2019M10
Included observations: 198

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-631.1088	NA	2.052964	6.395038	6.428253*	6.408483
1	-623.3027	15.37558	1.975544	6.356593	6.456238	6.396926
2	-618.7951	8.787550	1.965474	6.351466	6.517540	6.418687
3	-608.7420	19.39549*	1.848968	6.290323	6.522827	6.384433*
4	-604.1971	8.676578	1.838942*	6.284819*	6.583753	6.405817
5	-601.8031	4.522049	1.869210	6.301041	6.666404	6.448928
6	-598.9524	5.327106	1.891319	6.312650	6.744443	6.487425
7	-594.0269	9.104587	1.874102	6.303302	6.801524	6.504966
8	-591.6930	4.267022	1.906416	6.320132	6.884783	6.548684
9	-590.4779	2.196961	1.961467	6.348262	6.979344	6.603703
10	-587.5082	5.309621	1.982811	6.358668	7.056179	6.640998
11	-583.9461	6.296550	1.992609	6.363092	7.127033	6.672310
12	-581.5851	4.125856	2.027093	6.379647	7.210018	6.715754
13	-580.6737	1.574246	2.092815	6.410845	7.307645	6.773840
14	-577.8545	4.812462	2.119675	6.422773	7.386003	6.812656

* indicates lag order selected by the criterion

Model 2

VAR Lag Order Selection Criteria
Endogenous variables: RENDEMENT DUS_EPU
Exogenous variables: C
Date: 12/24/19 Time: 20:22
Sample: 2002M02 2019M10
Included observations: 198

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-680.4274	NA	3.378569	6.893206	6.926421	6.906650
1	-669.3845	21.75129	3.146578	6.822065	6.921710*	6.862398
2	-663.9259	10.64133	3.100614	6.807333	6.973407	6.874554
3	-654.3247	18.52356	2.930168	6.750755	6.983259	6.844865*
4	-647.9428	12.18362	2.860700*	6.726695*	7.025629	6.847694
5	-644.2939	6.892415	2.871161	6.730241	7.095604	6.878128
6	-643.9453	0.651432	2.979479	6.767124	7.198917	6.941900
7	-638.1888	10.64073*	2.927679	6.749382	7.247604	6.951046
8	-633.6203	8.352617	2.911687	6.743639	7.308291	6.972192
9	-631.9187	3.076584	2.981082	6.766856	7.397937	7.022296
10	-629.9108	3.589934	3.042943	6.786978	7.484489	7.069307
11	-626.4018	6.202752	3.059618	6.791937	7.555878	7.101155

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12	-621.5572	8.465814	3.035456	6.783406	7.613776	7.119512
13	-621.3167	0.415474	3.155179	6.821380	7.718180	7.184375
14	-620.0926	2.089621	3.247579	6.849420	7.812650	7.239303

* indicates lag order selected by the criterion

Model 3

VAR Lag Order Selection Criteria
Endogenous variables: RENDEMENT DUS_EPU
Exogenous variables: C
Date: 12/24/19 Time: 20:46
Sample: 2002M02 2019M10
Included observations: 183

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-760.6148	NA	14.27963	8.334588	8.369664	8.348806
1	-746.6732	27.42614	12.80951	8.225936	8.331165*	8.268591
2	-742.3092	8.489507	12.75893	8.221958	8.397340	8.293049
3	-734.0834	15.82225	12.18366	8.175775	8.421309	8.275302
4	-725.3933	16.52541*	11.57586*	8.124517*	8.440204	8.252481*
5	-724.7716	1.168627	12.01282	8.161439	8.547278	8.317838
6	-722.4769	4.263413	12.24112	8.180076	8.636068	8.364912
7	-718.0384	8.149360	12.18574	8.175283	8.701429	8.388556
8	-716.3101	3.135483	12.49628	8.200111	8.796409	8.441820
9	-713.1815	5.607607	12.62125	8.209634	8.876085	8.479779
10	-712.3745	1.428709	13.07638	8.244531	8.981134	8.543112
11	-710.4111	3.433355	13.37927	8.266788	9.073544	8.593806
12	-708.9715	2.485909	13.76947	8.294770	9.171679	8.650224
13	-708.6545	0.540362	14.34795	8.335022	9.282084	8.718913
14	-705.3570	5.549994	14.47369	8.342699	9.359913	8.755026

Model 4

VAR Lag Order Selection Criteria
Endogenous variables: DUS_EPU RENDEMENT
Exogenous variables: C
Date: 12/24/19 Time: 21:12
Sample: 2002M02 2019M10
Included observations: 198

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-671.8255	NA	3.097404	6.806318	6.839533*	6.819763
1	-663.8396	15.72987	2.975187	6.766056	6.865701	6.806389*
2	-659.4394	8.578138	2.963235	6.762014	6.928088	6.829235
3	-651.6622	15.00460	2.852412	6.723860	6.956364	6.817970
4	-645.4275	11.90260	2.788932*	6.701287*	7.000221	6.822286
5	-644.5697	1.620167	2.879171	6.733027	7.098390	6.880914
6	-643.8278	1.386420	2.975945	6.765937	7.197730	6.940713
7	-635.9055	14.64433*	2.860926	6.726318	7.224540	6.927982

8	-634.7691	2.077572	2.945672	6.755243	7.319895	6.983796
9	-632.5947	3.931482	3.001507	6.773684	7.404765	7.029125
10	-630.9961	2.858089	3.076486	6.797941	7.495452	7.080270
11	-627.6001	6.003068	3.096877	6.804041	7.567982	7.113259
12	-625.9660	2.855467	3.173692	6.827940	7.658310	7.164046
13	-625.2266	1.277166	3.282286	6.860875	7.757675	7.223870
14	-622.1779	5.204475	3.316710	6.870483	7.833713	7.260367

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Appendix 3 : Granger Causality Test

Model 1

VAR Granger Causality/Block Exogeneity Wald Tests
Date: 12/28/19 Time: 11:45
Sample: 2002M02 2019M10
Included observations: 208

Dependent variable: RENDEMENT

Excluded	Chi-sq	df	Prob.
DUS_EPU	4.859501	4	0.3020
All	4.859501	4	0.3020

Dependent variable: DUS_EPU

Excluded	Chi-sq	df	Prob.
RENDEMENT	0.693946	4	0.9521
All	0.693946	4	0.9521

Model 2

VAR Granger Causality/Block Exogeneity Wald Tests
Date: 12/28/19 Time: 11:36
Sample: 2002M02 2019M10
Included observations: 208

Dependent variable: VARIATION

Excluded	Chi-sq	df	Prob.
DUS_EPU	4.374353	4	0.3577
All	4.374353	4	0.3577

Dependent variable: DUS_EPU

Excluded	Chi-sq	df	Prob.
VARIATION	8.514714	4	0.0744
All	8.514714	4	0.0744

Model 3

VAR Granger Causality/Block Exogeneity Wald Tests
Date: 12/28/19 Time: 11:18
Sample: 2002M02 2019M10
Included observations: 203

Dependent variable: RENDEMENT

Excluded	Chi-sq	df	Prob.
DUS_EPU	2.053455	4	0.7259
All	2.053455	4	0.7259

Dependent variable: DUS_EPU

Excluded	Chi-sq	df	Prob.
RENDEMENT	10.60579	4	0.0314
All	10.60579	4	0.0314

Model 4

VAR Granger Causality/Block Exogeneity Wald Tests
Date: 12/28/19 Time: 11:51
Sample: 2002M02 2019M10
Included observations: 208

Dependent variable: RENDEMENT

Excluded	Chi-sq	df	Prob.
DUS_EPU	2.543405	4	0.6369
All	2.543405	4	0.6369

Dependent variable: DUS_EPU

Excluded	Chi-sq	df	Prob.
RENDEMENT	1.265253	4	0.8672
All	1.265253	4	0.8672

Appendix 4 : Impulse Response Functions

Model 1

Response of RENDEMENT: Period	RENDEMENT	DUS_EPU
1	0.036309	0.000000
	(0.00178)	(0.00000)
2	0.003531	-0.001693
	(0.00258)	(0.00253)
3	0.001096	-0.003729
	(0.00258)	(0.00248)
4	0.003372	-0.003164
	(0.00257)	(0.00247)
5	0.001714	0.002099
	(0.00256)	(0.00241)
6	0.000631	0.001125
	(0.00082)	(0.00120)
7	0.000429	1.95E-05
	(0.00068)	(0.00073)
8	0.000107	-0.000760
	(0.00062)	(0.00059)
9	6.73E-05	-0.000655
	(0.00034)	(0.00054)
10	0.000113	0.000197
	(0.00018)	(0.00043)

Model 2

Response of RENDEMENT: Period	RENDEMENT	DUS_EPU
1	0.047274	0.000000
	(0.00232)	(0.00000)
2	-0.003990	-0.001767
	(0.00334)	(0.00327)
3	0.005459	0.006021
	(0.00334)	(0.00322)
4	0.005717	0.000524
	(0.00335)	(0.00325)
5	0.001307	-0.002537
	(0.00336)	(0.00315)
6	0.001257	0.000182
	(0.00137)	(0.00198)
7	0.001403	-0.000371
	(0.00124)	(0.00086)
8	0.000402	0.001022
	(0.00084)	(0.00067)

9	0.000169	0.000385
	(0.00046)	(0.00064)
10	0.000277	-0.000350
	(0.00040)	(0.00055)

Model 3

Response of RENDEMENT: Period	RENDEMENT	DUS_EPU
1	0.092771	0.000000
	(0.00460)	(0.00000)
2	0.015497	-0.001765
	(0.00674)	(0.00652)
3	-0.005022	0.002170
	(0.00667)	(0.00635)
4	0.010775	0.001321
	(0.00669)	(0.00629)
5	0.014813	-0.008498
	(0.00669)	(0.00607)
6	0.003958	0.001466
	(0.00357)	(0.00305)
7	0.000593	0.001998
	(0.00287)	(0.00216)
8	0.002164	0.000763
	(0.00279)	(0.00176)
9	0.002879	-0.000724
	(0.00250)	(0.00171)
10	0.000956	-0.001353
	(0.00119)	(0.00121)

Model 4

Response of RENDEMENT: Period	RENDEMENT	DUS_EPU
1	0.043039	0.000000
	(0.00211)	(0.00000)
2	0.003407	0.002140
	(0.00304)	(0.00300)
3	0.003444	-0.001820
	(0.00304)	(0.00292)
4	0.001409	-0.002657
	(0.00303)	(0.00290)
5	0.004615	-0.002073
	(0.00302)	(0.00282)
6	0.000861	0.001676
	(0.00097)	(0.00140)
7	0.000746	0.000936
	(0.00087)	(0.00082)
8	0.000367	-2.11E-05

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	(0.00076)	(0.00075)
9	0.000553	-0.000807
	(0.00073)	(0.00069)
10	0.000173	-0.000433
	(0.00030)	(0.00050)

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Appendix 5: Forecast Error Variance Decomposition

Model 1

Variance Decomposition of RENDEMENT: Period	S.E.	RENDEMENT TUN	DUS_EPU
1	0.036309	100.0000	0.000000
2	0.036520	99.78507	0.214932
3	0.036726	98.75630	1.243698
4	0.037016	98.04519	1.954811
5	0.037115	97.73571	2.264286
6	0.037137	97.64666	2.353335
7	0.037140	97.64695	2.353049
8	0.037148	97.60605	2.393945
9	0.037154	97.57573	2.424268
10	0.037154	97.57301	2.426990

Cholesky Ordering: RENDEMENT DUS_EPU

Model 2

Variance Decomposition of RENDEMENT: Period	S.E.	RENDEMENT FTSE	DUS_EPU
1	0.047274	100.0000	0.000000
2	0.047475	99.86144	0.138562
3	0.048165	98.30258	1.697420
4	0.048506	98.31470	1.685299
5	0.048590	98.04797	1.952032
6	0.048607	98.04789	1.952107
7	0.048629	98.04381	1.956186
8	0.048641	98.00069	1.999314
9	0.048643	97.99458	2.005418
10	0.048645	97.98956	2.010438

Cholesky Ordering: RENDEMENT DUS_EPU

Model 3

Variance Decomposition of RENDEMENT:			
Period	S.E.	RENDEMENT EGX	DUS_EPU
1	0.092771	100.0000	0.000000
2	0.094073	99.96479	0.035213
3	0.094231	99.91187	0.088126
4	0.094855	99.89362	0.106377
5	0.096380	99.11961	0.880385
6	0.096472	99.09821	0.901786
7	0.096495	99.05575	0.944245
8	0.096522	99.05004	0.949962
9	0.096567	99.04531	0.954693
10	0.096582	99.02597	0.974027

Cholesky Ordering: RENDEMENT DUS_EPU

Model 4

Variance Decomposition of RENDEMENT:			
Period	S.E.	RENDEMENT MASI	DUS_EPU
1	0.043039	100.0000	0.000000
2	0.043227	99.75486	0.245139
3	0.043402	99.58093	0.419067
4	0.043506	99.20997	0.790027
5	0.043799	98.99651	1.003491
6	0.043840	98.85227	1.147735
7	0.043856	98.80759	1.192409
8	0.043858	98.80765	1.192348
9	0.043868	98.77441	1.225592
10	0.043871	98.76479	1.235206

Cholesky Ordering: RENDEMENT DUS_EPU