The Impact of Real Exchange Rate Volatility on Foreign Direct Investment Inflows in Tunisia

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ABSTRACT

This article aims to determine the impact of the Real Effective Exchange Rate (REER) and its volatility on Tunisian Foreign Direct Investment (FDI) Inflows for the period from 1980 to 2018. By applying the Auto Regressive Distributed Lag (ARDL) model, we noticed that an increase in exchange rate volatility tends to lower FDI inflows over a long-term horizon. We have also shown that an increase in REER, equivalent to a real appreciation (quotation at certain), will decrease FDI. While in the short term, the relationship between REER and FDI is positive, while volatility retains its negative long term effect.

Keywords: Foreign Direct Investment, Real Effective Exchange Rate Volatility, ARDL Model, Tunisia
JEL Classifications: C130, G150, F310

1. INTRODUCTION

The attraction of FDI is an objective sought by several economies since they can achieve the optimum of expected objectives in inclusive growth, job creation, regional development and technology transfer. Thus, it must play the role of the substitute for external debt in financing.

In this context, global FDI flows increased during the 1980s, an average rate of almost 30%, and registered a new growth in the 1990s (Kosteletou and Liargovas, 2000). While Tunisia still lags behind other countries in attracting foreign investments, the FDI rate –as a percent of Gross Domestic Product (GDP) was limited to an average of 1.98% during the period 1987-2005. After a drop observed in 2011 due to the Tunisian Revolution, FDI inflows recorded a slight increase during 2012-2018.

Given the important roles of FDI in improving economic growth, the search for the factors that influence FDI inflows has been the subject of several theoretical and empirical levels. One of these factors that have recently been debated and topical for economists is the REER and its volatility.

The article is organized as follows. In the second section, we will present a review of the theoretical and empirical literature. The third section will be devoted to the empirical application. Finally, the conclusion will be presented in the fourth section.

2. THE THEORETICAL AND EMPIRICAL IMPACT OF THE REER AND ITS VOLATILITY ON FDI IN THE ECONOMIC LITERATURE

2.1. Definitions of FDI
According to the World Bank, FDI is defined as "the net inflows of investment to acquire a lasting management interest (10% or

more of voting stock) in an enterprise operating in an economy other than that of the investor. It is the sum of equity capital, reinvestment of earnings, other long-term capital, and short-term capital as shown in the balance of payments."

For the Bank of France, FDI is considered as an international investment by which entities residents in an economy acquire or have acquired a lasting interest in an entity resident in an economy other than that of the investor. The lasting interest comes from the existence of a long-term relationship between the direct investor and the company invested and the significant influence of the first on the second's management.

According to the International Monetary Fund (IMF) and the Organization for Economic Co-operation and Development (OECD) "a direct investor may be an individual, an incorporated or unincorporated private or public enterprise, a government, a group of related individuals, or a group of related incorporated and/or unincorporated enterprises which have a direct investment enterprise, operating in a country other than the country of residence of the direct investor. A direct investment enterprise is an incorporated or unincorporated enterprise in which a foreign investor owns 10% or more of the ordinary shares or voting power of an incorporated enterprise or the equivalent of an unincorporated enterprise. Direct investment enterprises may be subsidiaries, associates or branches. A subsidiary itself is an incorporated enterprise in which the foreign investor controls directly or indirectly more than 50% of the shareholder's voting power. An associate is an enterprise where the direct investor and its subsidiaries control between 10% and 50% of the voting shares. A branch is a wholly or jointly owned unincorporated enterprise. Once a direct investment enterprise has been identified, it is necessary to define which capital flows between the enterprise and entities in other economies should be classified as FDI."

Between these definitions, there is a common point that is related to FDI. The latter is presented as to foreign participation that influences the company's management where the investment was made.

2.2. Exchange Rate Volatility
The notion of volatility generally refers to the distribution of all the probable outcomes of an uncertain variable. In financial markets, we are interested in propagating an asset's returns or fluctuations in currency prices in foreign exchange markets.

To measure exchange rate volatility, various statistical measures have been proposed. In previous studies, variance and/or standard deviations represent the most widely used measures. However, these two measures have been criticized for ignoring information on the stochastic exchange rate process (Jansen, 1989). They are a full measure, that is, they do not isolate the part of the expected past volatility based on the available information (Rey, 2006).

According to Engle (1982), exchange rate volatility can be estimated using ARCH models (Autoregressive Conditional Heteroskedasticity), and subsequent generalizations (GARCH models: Generalized Autoregressive Conditional Heteroscedasticity,

IGARCH.). However, other authors such as Baillie and McMahon (1989) have shown that ARCH-type effects remain very strong in high-frequency data and decrease in monthly or quarterly. Thus, Siregar and Rajan (2004) wrote: "the ambiguous results obtained in the empirical literature may also be partly due to the adverse effect of a uniform definition or means of computing volatility."

Rey (2006) used two different measures of exchange rate volatility to overcome this problem: the moving standard deviation and the GARCH model. First, the author calculates the average of the moving standard deviation.

$$\sigma_t = \left[\frac{1}{m} \sum_{i=1}^{m} \left((lne_{t+i-1} - lne_{t+i-2}) / (lne_{t+i-2}) \right)^2 \right]^{1/2} \tag{1}$$

Where: m= the order of the mean of the moving standard deviation

e=the REER

ln=the natural logarithm

By studying the Middle East and North Africa (MENA) countries, Rey took m equal to 8 quarters, which forms a standard measure in the literature. In a second step, He calculates the average of the standard deviations for each year.

In this work, we use the GARCH (Generalised ARCH) model developed by Bollerslev (1986) and which was built to model the conditional variance (noted ϵ_t). By deriving the residues ϵ_t from an underlying process[1] for the set of information Ω, the GARCH process (p, q) is given by $\epsilon_t/\Omega_{t-1} \sim N(0,h_t)$. The equation of autoregressive variance is written as follows:

$$h_t = \delta + \sum_{i=1}^{p} \alpha_i \epsilon_{t-1}^2 + \sum_{j=1}^{q} \beta_j h_{t-1} \tag{2}$$

s = √h: is the standard deviation. It is none other than volatility.

Conditional volatility is used to model the conditional variance of errors. It measures the effect of persistence specific to financial series. If the value of the sum $(\alpha_1 + \beta_1)$ is close to 1, the persistence, in this case, is stronger. For a $(\alpha_1 + \beta_1)$ less than 1, the variance (h_t) is unconditional.

2.3. Theoretical Review
Although it has been neglected by traditional international economic theories and traditional neoclassical, the Reel Exchange Rate (RER) plays a vital role in the attractiveness of territories. To explain this, the economic literature has adopted several approaches. We will retain the attempted portfolio theory approach, the relative wealth approach and the production factor cost approach (De Prost, 2012).

1　If r_t is equal to ln (et/et−1), then we have $r_t = \mu + \epsilon_t$ where μ is the conditional mean. r_t is conditioned on the past information $\Omega_{(t-1)}$.

2.3.1. The portfolio theory approach

The portfolio theory approach is one of the first approaches to introduce the exchange rate as an explanatory variable of FDI. Unlike FDI, portfolio investments are engaged in a purely financial logic and seek only the best profitability at a lower risk. The Portfolio diversification strategy[2], therefore, promises to be an effective and essential strategy for investors.

In this context, Logue and Thomas (1974) have shown that the medium-term trends of RER can affect international movements of different capital types. Thus, they invoked the principle of "portfolio rebalancing." "For each of the assets he owns, the individual will allocate a given percentage of his wealth. The weighting thus constituted is supposed to be invariable from year to year. However, the depreciation (or devaluation) of domestic currency will lead, within an internationally diversified portfolio, to reduce the share of the agent's wealth devoted to securities denominated in the currency considered compared to that reserved for securities denominated in foreign currencies. In this case, to restore the initial stability of the weights granted to the different titles, necessary for optimal diversification, a portfolio rebalancing must be carried out by the investor. The economic agent's action will simply consist of selling part of its securities denominated in foreign currencies to invest more in the country experiencing depreciation (devaluation). An appreciation (reassessment) would imply the opposite reasoning." (De Prost, 2012. p 111-112).

2.3.2. The relative wealth approach or the wealth effect

Froot and Stein (1991) and Blonigen (1997) used the concept of the "wealth effect" (or relative wealth) as a common thread to study the relationship between exchange rate and FDI. Following a permanent depreciation of the national currency vis-à-vis the foreign currency, foreign investors would find themselves relatively "richer." This is true for those who have the majority of their assets in foreign currency.

2.3.2.1. The wealth effect of Froot and Stein (1991)

In the presence of an imperfect capital market, Froot and Stein (1991) have shown that the RER can influence FDI behaviour. Thus, information asymmetry leads to a divergence between internal and external financing, making the latter more expensive than the former since lenders bear monitoring costs. However, if the information is transparent, the RER does not influence on FDI. Within this framework, the authors suggested that while weakness in the US dollar would allow a foreign investor to acquire cheap US securities, US agents can access a similar advantage by taking loans denominated in foreign currency without additional cost. In such a case, if the foreign investors keep their wealth in foreign currency, the depreciation of the national currency will increase the wealth of the foreign agents compared to the national agents, which pushes foreign investors to make a more aggressive offer in local currency.

2.3.2.2. Blonigen's contribution (1997)

Blonigen (1997) has shown that a depreciation of the host country's exchange rate can increase FDI in that country. To model his theoretical model, he took the example of the case of a firm holding a "specific good" (or "firm-specific assets"). Thus, he stated three hypotheses. First, the purchasing power parity rule is not verified. Second, the production and sales activities of firms are carried out only in the countries of origin. Third, the "target firm" owns a "specific asset." The latter allows it to attract potential buyers' attention, increase productivity, and achieve innovation in products or production techniques.

By combining the second and the third hypothesis, a foreign company (say Japanese) can buy a "target firm" (say American) to derive a productivity advantage that can be realized in a foreign country (Japan). Costs are incurred in dollars while revenues are collected in yen. Thus, a depreciation of the dollar against the yen may increase the expected net returns on the potential Japanese buyer's dollar-denominated investment relative to those that a possible US buyer may earn. For this, Blonigen pointed out that a depreciation of the dollar can positively affect FDI inflows, and more particularly, on acquisitions in the United States through the "wealth effect" (De Prost, 2012).

2.3.3. The approach by the relative costs of factors of production

Stevens (1974) and Kohlhagen (1974) sought to study the impact of RER on FDI via the mechanism of cost of factors of production. They based their analysis on a profit maximization model of globalized companies.

To present his model, Stevens (1974) took the example of American Multi National Firms (MNFs) classified according to their activities' structure. In other words, in which currency they receive their income and incur their production costs.

The first configuration concerns the American MNF whose subsidiaries seek to serve the establishment market by opting for domestic production factors. Thus, the costs and revenues of the subsidiary are denominated in foreign currency. Then, these subsidiaries express their profits in US dollars when they are repatriated to the parent company. According to Stevens, a change in the US exchange rate (nominal or real) has no influence on outward FDI from the United States.

The second category of MNF mentioned by Stevens concerns a foreign subsidiary that uses production factors from the United States. In this case, a portion of its production costs would be denominated in dollars. From a foreign subsidiary of American origin, a depreciation of the dollar will make the costs incurred in this currency less expensive. In addition, its marginal costs would be lower than its marginal revenues expressed in a local currency, which pushes the parent company to increase FDI to the foreign country in question. In this context, Stevens pointed out that a sustained depreciation of the dollar positively affects outward FDI from the United States.

In the last category, we find an American subsidiary established in a foreign country (and opting for factors of production which

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2   The portfolio diversification strategy developed by Harry Markowitz. It was expressive under the adage "Never put all eyes in one basket". It is modeled and further that the individual constitutes a basket of different assets with complementary characteristics to obtain the best return between profitability and risk according to his preferences and increase his financial assets.

are attached to it). But, the sales would be intended for a third country or the United States. Following a depreciation of the dollar, the subsidiary's relative production costs would be more expensive and the revenues denominated in dollars would remain unchanged. Thus, the American MNF would have more interest in investing in the domestic territory than to engage new capital abroad. According to Stevens, the conclusion of Logue and Thomas (1974) is only verified if the companies concerned belong to the third stated category (De Prost, 2012).

For Kohlhagen (1974; 1977), the model proposed by Stevens did not take into account the opportunity cost of MNF. He took the example of an MNF of American origin, which opts for domestic production for export and incurs its foreign currency costs. He showed that exchange rates could influence FDI if their levels and variations are likely to modify the relative profitability of different production places.

Assuming that changes in nominal exchange rates do not affect different countries' general price level, Kohlhagen concluded that a depreciation of the dollar encourages companies to produce in the United States instead of investing abroad. He considered that the sales receipts of exported goods are collected in foreign currencies. The choice between investing in the national territory or elsewhere depends on the costs of production. Following a depreciation of the dollar against the foreign currency, the production costs expressed in US currency become cheaper. However, reasoning in nominal exchange rate significantly undermines this study (De Prost, 2012).

Kohlhagen then assumed that the prices of different countries would change following a depreciation of the dollar. Thus, the conclusion obtained beforehand is corrected: the relative profitability of the various production sites also depends on the degree of price sensitivity to variations in the exchange rate and the foreign economy's openness. If domestic and international prices change only slightly following a nominal devaluation of the dollar, and the American subsidiary established abroad employs few imported American factors of production, it would, therefore, be advantageous for the firm to produce locally and export rather than set up directly in the foreign market.

In summary, Kohlhagen's work suggests that the negative relationship between the exchange rate and the country's attractiveness can only be verified by considering the reactions of prices to changes in exchange rates. So you should use the real exchange rate and not the nominal exchange rate.

2.4. Empirical Literature

Caves (1989) studied the impact of nominal and real bilateral exchange rates on FDI inflows to the United States from fifteen developed countries during the period 1978-1986. He found that nominal and real exchange rate volatility negatively affects sustainable transnational investments.

A study by Healy and Krishna (1993) showed no link between RER and cross-border acquisitions of securities among 11 developed countries during the period 1989-2002. Similarly, Wakelin and Gorg (2002) did not find statistically significant relationship between RER volatility and FDI.

Goldberg and Kolstad (1995) have shown that the impact of exchange rate volatility (measured by the standard deviation) positively affects FDI flows from Canada, Japan and the United Kingdom. A study by Stokman and Vlaar (1996) also suggested a positive and statistically significant relationship between exchange rate volatility and long-term inward and outward FDI flows from the Netherlands. Hubert and Pain (1999) have shown that currency risk reduces FDI flows from Germany to developing countries. According to Benassy-Quere et al. (2001), exchange rate volatility negatively affects FDI flows to developing countries.

In the work of Barrell et al. (2003), the authors empirically investigated, using data covering the period 1982-1998, the impact of exchange rate volatility on FDI from the United States to the European Union. They used the method of generalized moments (GMM). Their results suggest a negative relationship between the two variables.

Khraiche and Gaudette (2013) have shown that the impact of exchange rate volatility on FDI behavior in economies with a low financial development level is positive and statistically significant. While for countries with a high level of economic development, the effect is statistically insignificant.

Osei-Fosu and Kenneth (2015) studied the link between exchange rate volatility and Ghana's FDI inflows. Using a simultaneous equation structural model, the authors found a negative but statistically insignificant relationship between the two variables.

De Sousa (2015) examined the impact of RER volatility on Brazilian FDI flows from 1976 to 2013. Using an ARDL model, the author finds a negative and statistically significant relationship between the two variables.

Muhammad et al. (2018) studied, using the ARDL model, the effect of the RER and its volatility (measured by the GARCH model (1,1)) on FDI inflows from Nigeria for the period 1970 to 2014. Their results showed that in the short run, a depreciation of the REER increases FDI while volatility affects it negatively. Thus, real depreciation reduces production costs and promotes the production of products for export. The sign associated with volatility is explained by the fact that an increase in currency risk discourages risk-averse investors. In the long term, the coefficients of the RER and its volatility are not statistically significant.

Using annual data covering the period 1990-2015 and a sample of 80 developed and developing countries, Marek et al. (2018) studied the relationship between exchange rate volatility and FDI inflows. They showed the existence of a negative relationship between the two variables. Thus, over a long-term horizon, a decrease in exchange rate volatility of 10% tends to increase FDI inflows by 0.27% and economic growth by 0.48%. Apply to the countries of South Africa, which have experienced high volatility in their currencies.

Latief and Lefen (2018) studied the effect of exchange rate volatility on FDI and international trade for seven developing countries, including Bangladesh, Bhutan, Maldives, India, Nepal,

Table 1: Works with independent variables statistically significant with FDI

Independent variables	Statistically significant positive relationship with FDI	Statistically significant negative relationship with FDI
GDP growth	Meyer and Nguyen (2005); Furceri and Borelli (2008); Akin (2009); Ezeoha and Cattaneo (2011); Takagi and Shi (2011); Deseatnicov and Akiba (2012); Abbott et al., (2012); Khraiche and Gaudette (2013); Mugableh (2015)	
Population growth	Meyer and Nguyen (2005); Akin (2009)	Alfaro et al. (2004); Al-sadig (2009)
Trade openness	Furceri and Borelli (2008); Adeoye (2009); Ezeoha and Cattaneo (2011); Takagi and Shi (2011); Deseatnicov and Akiba (2012); Abbott et al., (2012); Khraiche and Gaudette (2013); Hasnain (2014)	Ramzi and Behname (2012)
Inflation	Ezeoha and Cattaneo (2011), Saleem (2013)	Borensztein et al., (1998); Hasnain (2014); Mugableh (2015)
Information infrastructure[3]	Rehman et al., (2011); Ezeoha and Cattaneo (2011)	Fung et al., (2004); Razmi and Behname (2012)
Financial development	Alfaro et al., (2004); Ezeoha and Cattaneo (2011); Khraiche and Gaudette (2013)	

Source: developed by De Sousa (2015. P. 22)

Pakistan and Sri Lanka. The exchange rate volatility was measured by applying heteroscedastic modeling: GARCH (1,1) models and TGARCH (1,1) (Threshold GARCH) model. The study period is from 1995 to 2016. The authors have shown that exchange rate volatility harms FDI and international trade.

Some studies have shown that the magnitude of the effect of exchange rate volatility on FDI depends on the industries (Froot and Stein, 1991), the countries included in the estimate (Ogunleye, 2005), the period study (Wakelin and Gorg, 2002; Schmidt and Broll, 2009), as well as the motivation of the investing company (Chen et al., 2006; Phillips and Ahmadi-Esfahani, 2008).

3. EMPIRICAL MODELING

Many studies (Table 1) have shown that FDI is influenced by other determinants other than the REER and its volatility (key variables in our study). Thus, the choice of control variables was based on the existing literature and the availability of data. These variables (Table2) are GDP growth, population growth, financial development, trade openness, inflation and Information Infrastructure.

3.1. GDP Growth
This variable is listed in most works on FDI as an essential determinant (Furceri and Borelli, 2008; Akin, 2009; Mugableh, 2015). The relationship between the two variables is assumed to be positive since investors prefer to locate in economies characterized by a high rate of GDP growth.

3.2. Population Growth
As an indicator of the development of market size, population growth is an important determinant of FDI (Nunnenkamp, 2002; Cobrin, 2005; Akin, 2009; Wadhwa and Reddy, 2011). Thus, FDI inflows are positively associated with the demographic growth of the host economy. This is explained by the fact that a high level of population growth in an economy offers many opportunities to increase the sales of products and services and attract potential consumers.

3.3. Trade Openness
Trade openness, expressed as the sum of exports and imports to GDP, reflects the degree of "economic freedom" that a country can receive from foreign investment. Thus, the expected sign of this variable is positive.

3.4. Inflation
The inflation rate is used to measure the country's overall macroeconomic stability (Borensztein et al., 1998; Furceri and Borelli, 2008; Ezeoha and Cattaneo, 2011). Thus, a high rate of inflation should have a negative effect on FDI. This is explained by the fact that investors prefer to invest in more stable economies (Bajo-Rubia and Sosvilla-Rivero, 1994; Yang et al., 2000).

3.5. Financial Development
According to Shaw (1973), financial development can be defined as "the accumulation of financial assets faster than the accumulation of non-financial assets." At the same time, Levine (1996) has pointed out that a developed financial system is characterized by reducing the costs of obtaining information, the costs of transactions and the costs of executing contracts. It is measured by the ratio of the money supply to GDP (Alfaro et al., 2004 and Ezeoha and Cattaneo, 2011). It plays an important role in reducing the degree of exchange rate volatility and thus stimulates FDI.

In the following Graph 1, we can observe the evolution, over the study period, of all the variables previously defined.

3.6. Analysis of Statistical Properties of Variables
3.6.1. Stationarity of series
The results of the ADF test are given in Table 3. They show that the REER series, financial development and trade openness rate are not stationary in level (we reject the hypothesis of stationarity). By applying the first difference, the ADF test values are lower than the critical values (CV), which confirms that they are integrated of order 1 (stationary after the first difference). For FDI inflows, REER volatility, population growth rate, inflation and real GDP growth rate, they are stationary in level (without differentiation).

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3   We did not include in our model the variable representing the Information Infrastructure because of lack of data during the estimation period.

Graph 1: The evolution of variables
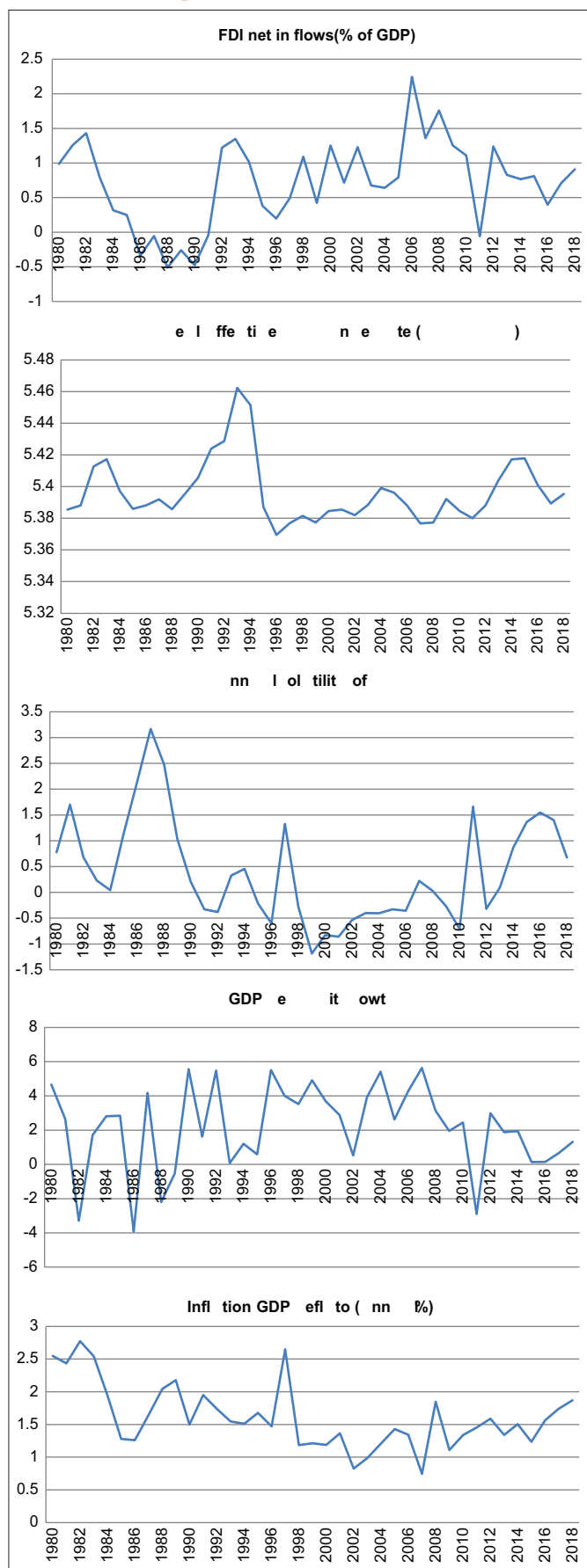
Graph 1: (Continued)
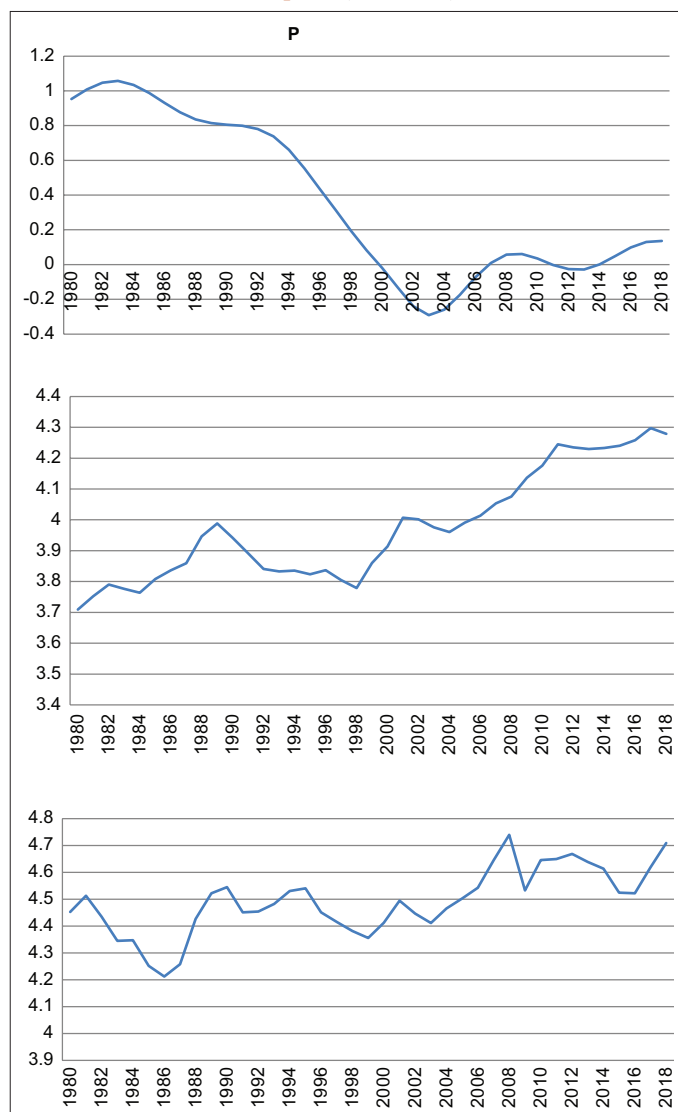
Table 2: Presentation of variables[4]

Variables	Descriptions	Sources
FDI	The real Inward FDI.It was calculated by dividing the Inward FDI at current prices by the GDP	World Bank (WB)
REER	The real effective exchange rate (quotation at certain)	International Financial Statistics
VOL	The volatility of the REER	Authors' estimates on Eviews 9[5]
GDPGRO	The GDP per capita growth	WB
INF	The inflation (is measured by the GDP deflator)	WB
POPGRO	The population growth	WB
FD	The financial development (is measured by the ratio of the money supply to GDP)	WB
OPEN	The trade openness (is expressed as the sum of exports and imports to GDP)	WB

4 All the variables are expressed in natural logarithm except for the variables inward FDI flows and GDP growth rate (they contain some negative values).

5 For more details see appendix 1

(Contd...)

Table 3: Stationarity tests of variables[6]

Variables	Level		First difference		Observation
	ADF	VC	ADF	VC	
FDI	−3.234886	−2.941145	-	-	I(0)
REER	−0.138253	−1.950394	−6.004629	−1.950394	I(1)
VOL	−2.726235	−1.949856	-	-	I(0)
POPGRO	−2.116362	−1.950687	-	-	I(0)
FD	−2.364314	−3.536601	−3.753828	−1.950117	I(1)
INF	−3.776348	−2.941145	-	-	I(0)
GDPGRO	−6.032435	−2.941145	-	-	I(0)
OPEN	−2.849355	−3.533083	−5.414833	−1.950117	I(1)

Source: Authors' estimates on Eviews 9

Table 4: Result of Cointegration Bound Test

F-statistic	Significant level	Lower bound	Upper bound
4.044989	10%	1.7	2.83
	5%	1.97	3.18
	2.5%	2.22	3.49
	1%	2.54	3.91

Source: Authors' estimates on Eviews 9

Table 5: Estimated long-run coefficient

Variables	Coefficients	Standard error	T-Statistic	Prob.
REER	−0.427315	0.064269	−6.648845	0.0950
VOL	−0.355807	0.029453	−12.080543	0.0526
GDPGRO	−0.089007	0.007669	−11.606519	0.0547
OPEN	−1.587409	0.174017	−9.122152	0.0695
INF	0.717799	0.078988	9.087453	0.0698
FD	2.360705	0.150428	15.693260	0.0405
POPGRO	0.042107	0.040604	1.036995	0.4884

Source: Authors' estimates on Eviews 9

Table 6: Estimation results of ST coefficients

Variables	Coefficients	Standard error	T-Statistic	Prob.
D(FDI(−1))	4.509682	0.320692	14.062349	0.0452
D(FDI(−2))	5.257128	0.346899	15.154654	0.0419
D(FDI(−3))	4.739042	0.306678	15.452811	0.0411
D(FDI(−4))	4.324607	0.289965	14.914234	0.0426
D(FDI(−5))	3.986595	0.265363	15.023167	0.0423
D(FDI(−6))	3.890404	0.262117	14.842253	0.0428
D(FDI(−7))	3.446228	0.242149	14.231847	0.0447
D(FDI(−8))	2.426120	0.157581	15.396029	0.0413
D(FDI(−9))	2.303979	0.169230	13.614499	0.0467
D(FDI(−10))	1.750215	0.125773	13.915696	0.0457
D(FDI(−11))	1.109176	0.097734	11.348969	0.0560
D(REER)	19.367544	2.278358	8.500657	0.0745
D(VOL)	−1.150740	0.086129	−13.360595	0.0476
D(GDPGRO)	−0.225055	0.021912	−10.270993	0.0618
D(OPEN)	−1.273847	0.611864	−2.081913	0.2851
D(INF)	2.019865	0.190654	10.594372	0.0599
D(FD)	−3.004462	1.120416	−2.681559	0.2272
D(POPGRO)	18.424839	1.235961	14.907298	0.0426
Ecm (−1)	−4.786860	0.297510	−16.089726	0.0395

Source: Authors' estimates on Eviews 9

3.6.2. Cointegration test at the terminals
The results of the cointegration test, as presented in Table 4, show that the value of F-stat is > that of the upper bound, which confirms the existence of a cointegration relationship between the series under study.

3.6.3. Long-term coefficients and short-term dynamics
3.6.3.1. Long term coefficients (LT)
The existence of a cointegration relationship gives us the possibility of estimating the long-term effects of REER, VOL, OPEN, FD, INF, GDPGRO and POPGRO on FDI.

The results (Table 5) found show that financial development and inflation positively affect FDI inflows. Simultaneously, signs associated with GDP growth rate[7] and trade opening are not in line with those expected. The population effect is statistically insignificant.

Concerning the key variables of our work, we find that FDI is negatively associated with the REER and its volatility. The results obtained confirm what the theoretical analysis predict. Thus, over a long term horizon, an increase in exchange rate volatility tends to lower FDI inflows. We also note that an increase in the REER, equivalent to a real appreciation (quotation at certain), will lead to a decrease in FDI.

3.6.3.2. Short-term coefficients (ST)
The short-term dynamics (Table 6) show that the REER's volatility and the GDP growth rate keep the negative long-term sign. We also find that the REER, population and inflation exert a positive influence on FDI. As regards financial development and trade openness, their impacts on FDI are statistically insignificant.

4. CONCLUSION

FDI is an important engine of economic growth and a crucial source of finance for developing countries. Thus, the study of the factors that influence FDI entry is a major concern for economists. In this context, the RER volatility is frequently considered one of the most important determinants that affect the attractiveness of territories. But, the existing literature has not given consistent results.

This work's objective was to determine the impact of the RER and its volatility on FDI inflows into Tunisia during the period 1980-2018. The measurement of volatility is performed using the GARCH model (1, 1).

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6   For more details see appendix 2

7   Akin (2009) and De Sousa (2015) also found a negative relationship between GDP and FDI inflows.

Using the ARDL model, we found that over a long-term horizon, an increase in exchange rate volatil·ity tends to decrease FDI inflows. We also note that an increase in the REER, equivalent to a real appreciation (quotation at certain), will lead to a decrease in FDI. In the short term, the relationship between REER and FDI is positive, while volatility retains its negative long term effect.

Since investors prefer to invest in more stable economies, the Tunisian authorities should smooth out movements in the exchange rate.

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APPENDIX

1: ESTIMATION OF GARCH (1,1) MODEL

Dependent Variable: RETURN				
Method: ML ARCH - Normal distribution (BFGS / Marquardt steps)				
Sample (adjusted): 1980M02 2018M12				
Included observations: 467 after adjustments				
Convergence achieved after 27 iterations				
Coefficient covariance computed using outer product of gradients				
Presample variance: backcast (parameter = 0.7)				
GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*GARCH(-1)				
Variable	**Coefficient**	**Std. Error**	**z-Statistic**	**Prob.**
C	−0.119066	0.046177	−2.578486	0.0099
AR(1)	0.076267	0.049016	1.555958	0.1197
Variance equation				
C	0.020410	0.008189	2.492550	0.0127
RESID(−1)^2	0.211851	0.031098	6.812381	0.0000
GARCH(−1)	0.827327	0.016968	48.75674	0.0000
R-squared	0.006226	Mean dependent var		−0.229976
Adjusted R-squared	0.004089	S.D. dependent var		1.418413
S.E. of regression	1.415510	Akaike info criterion		3.110784
Sum squared resid	931.7060	Schwarz criterion		3.155177
Log likelihood	−721.3680	Hannan-Quinn criter.		3.128254
Durbin-Watson stat	1.910950			
Inverted AR Roots		0.08		

APPENDIX 2: ADF TEST

• FDI

Null Hypothesis: FDI has a unit root				
Exogenous: Constant				
Lag Length: 0 (Automatic - based on SIC, maxlag=9)				
			t-Statistic	**Prob.***
Augmented Dickey-Fuller test statistic			−3.234886	0.0256
Test critical values:	1% level		−3.615588	
	5% level		−2.941145	
	10% level		−2.609066	

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

Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(FDI)				
Method: Least squares				
Sample (adjusted): 1981 2018				
Included observations: 38 after adjustments				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
FDI(−1)	−0.449188	0.138857	−3.234886	0.0026
C	0.319905	0.131695	2.429132	0.0203
R-squared	0.225215	Mean dependent var		−0.002059
Adjusted R-squared	0.203693	S.D. dependent var		0.595758
S.E. of regression	0.531631	Akaike info criterion		1.625462
Sum squared resid	10.17474	Schwarz criterion		1.711651
Log likelihood	−28.88378	Hannan-Quinn criter.		1.656127
F-statistic	10.46448	Durbin-Watson stat		2.166739
Prob(F-statistic)	0.002610			

• REER

Null hypothesis: REER has a unit root				
Exogenous: None				
Lag Length: 2 (Automatic - based on SIC, maxlag=9)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			−0.138253	0.6291
Test critical values:	1% level		−2.630762	
	5% level		−1.950394	
	10% level		−1.611202	

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

Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(REER)				
Method: Least Squares				
Sample (adjusted): 1983 2018				
Included observations: 36 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
REER (−1)	−5.86E-05	0.000424	−0.138253	0.8909
D(REER (−1))	0.400048	0.149194	2.681397	0.0114
D(REER (−2))	−0.457921	0.150319	−3.046322	0.0045
R-squared	0.280234	Mean dependent var		−0.000485
Adjusted R-squared	0.236612	S.D. dependent var		0.015690
S.E. of regression	0.013709	Akaike info criterion		−5.661919
Sum squared resid	0.006202	Schwarz criterion		−5.529959
Log likelihood	104.9145	Hannan-Quinn criter.		−5.615862
Durbin-Watson stat	1.909732			

Null Hypothesis: D(REER) has a unit root				
Exogenous: None				
Lag Length: 1 (Automatic - based on SIC, maxlag=9)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			−6.004629	0.0000
Test critical values:	1% level		−2.630762	
	5% level		−1.950394	
	10% level		−1.611202	

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

Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(REER)				
Method: Least Squares				
Sample (adjusted): 1983 2018				
Included observations: 36 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(REER(-1))	−1.058387	0.176262	−6.004629	0.0000
D(REER(-1),2)	0.458539	0.148069	3.096790	0.0039
R-squared	0.517140	Mean dependent var		−0.000519
Adjusted R-squared	0.502938	S.D. dependent var		0.019162
S.E. of regression	0.013509	Akaike info criterion		−5.716896
Sum squared resid	0.006205	Schwarz criterion		−5.628923
Log likelihood	104.9041	Hannan-Quinn criter.		−5.686191
Durbin-Watson stat	1.908873			

• OPEN

Null Hypothesis: OPEN has a unit root				
Exogenous: Constant, Linear Trend				
Lag Length: 0 (Automatic - based on SIC, maxlag=9)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			−2.849355	0.1897
Test critical values:	1% level		−4.219126	
	5% level		−3.533083	
	10% level		−3.198312	

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

Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(OPEN)				
Method: Least Squares				
Sample (adjusted): 1981 2018				
Included observations: 38 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
OPEN (−1)	−0.366679	0.128688	−2.849355	0.0073
C	1.585174	0.559672	2.832328	0.0076
@TREND ("1980")	0.003398	0.001384	2.454739	0.0192
R-squared	0.198541	Mean dependent var		0.006755
Adjusted R-squared	0.152743	S.D. dependent var		0.075711
S.E. of regression	0.069689	Akaike info criterion		−2.413886
Sum squared resid	0.169980	Schwarz criterion		−2.284603
Log likelihood	48.86384	Hannan-Quinn criter.		−2.367888
F-statistic	4.335168	Durbin-Watson stat		1.580358
Prob (F-statistic)	0.020793			

Null Hypothesis: D(OPEN) has a unit root				
Exogenous: None				
Lag Length: 0 (Automatic - based on SIC, maxlag=9)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			−5.414833	0.0000
Test critical values:	1% level		−2.628961	
	5% level		−1.950117	
	10% level		−1.611339	

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

Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(OPEN,2)				
Method: Least Squares				
Sample (adjusted): 1982 2018				
Included observations: 37 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(OPEN (−1))	−0.908716	0.167820	−5.414833	0.0000
R-squared	0.448835	Mean dependent var		0.000814
Adjusted R-squared	0.448835	S.D. dependent var		0.102490
S.E. of regression	0.076089	Akaike info criterion		−2.287170
Sum squared resid	0.208424	Schwarz criterion		−2.243631
Log likelihood	43.31264	Hannan-Quinn criter.		−2.271820
Durbin-Watson stat	1.856839			

• POPGRO

Null Hypothesis: POPGRO has a unit root			
Exogenous: None			
Lag Length: 3 (Automatic - based on SIC, maxlag=9)			
		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		−2.116362	0.0347
Test critical values:	1% level	−2.632688	
	5% level	−1.950687	
	10% level	−1.611059	

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

Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(POPGRO)				
Method: Least Squares				
Sample (adjusted): 1984 2018				
Included observations: 35 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
POPGRO(-1)	−0.008641	0.004083	−2.116362	0.0424
D(POPGRO(-1))	2.108501	0.140531	15.00384	0.0000
D(POPGRO(-2))	−1.770454	0.240239	−7.369538	0.0000
D(POPGRO(-3))	0.576975	0.133125	4.334079	0.0001
R-squared	0.970835	Mean dependent var		-0.026312
Adjusted R-squared	0.968013	S.D. dependent var		0.063358
S.E. of regression	0.011332	Akaike info criterion		−6.015249
Sum squared resid	0.003980	Schwarz criterion		−5.837495
Log likelihood	109.2669	Hannan-Quinn criter.		−5.953888
Durbin-Watson stat	1.853047			

• FD

Null Hypothesis: FD has a unit root				
Exogenous: Constant, Linear Trend				
Lag Length: 1 (Automatic - based on SIC, maxlag=9)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			−2.364314	0.3911
Test critical values:	1% level		−4.226815	
	5% level		−3.536601	
	10% level		−3.200320	

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

Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(FD)				
Method: Least Squares				
Sample (adjusted): 1982 2018				
Included observations: 37 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
FD(−1)	−0.180289	0.076254	−2.364314	0.0241
D(FD(−1))	0.463949	0.156645	2.961780	0.0056
C	0.669771	0.281548	2.378885	0.0233
@TREND("1980")	0.002670	0.001173	2.276314	0.0294
R-squared	0.262519	Mean dependent var		0.014225
Adjusted R-squared	0.195475	S.D. dependent var		0.037697
S.E. of regression	0.033813	Akaike info criterion		−3.834151
Sum squared resid	0.037729	Schwarz criterion		−3.659998
Log likelihood	74.93179	Hannan-Quinn criter.		−3.772754
F-statistic	3.915636	Durbin-Watson stat		1.965683
Prob(F-statistic)	0.016975			

Null Hypothesis: D(FD) has a unit root				
Exogenous: None				
Lag Length: 0 (Automatic - based on SIC, maxlag=9)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			−3.753828	0.0004
Test critical values:	1% level		−2.628961	
	5% level		−1.950117	
	10% level		−1.611339	

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

Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(FD,2)				
Method: Least Squares				
Sample (adjusted): 1982 2018				
Included observations: 37 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(FD(−1))	−0.549819	0.146469	−3.753828	0.0006
R-squared	0.280155	Mean dependent var		−0.001675
Adjusted R-squared	0.280155	S.D. dependent var		0.042340
S.E. of regression	0.035923	Akaike info criterion		−3.788247
Sum squared resid	0.046455	Schwarz criterion		−3.744709
Log likelihood	71.08258	Hannan-Quinn criter.		−3.772898
Durbin-Watson stat	1.895865			

• INF

Null Hypothesis: INF has a unit root				
Exogenous: Constant				
Lag Length: 0 (Automatic - based on SIC, maxlag=9)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			−3.776348	0.0066
Test critical values:	1% level		−3.615588	
	5% level		−2.941145	
	10% level		−2.609066	

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

Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(INF)				
Method: Least Squares				
Sample (adjusted): 1981 2018				
Included observations: 38 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
INF(−1)	−0.517173	0.136951	−3.776348	0.0006
C	0.811005	0.229535	3.533254	0.0011
R-squared	0.283736	Mean dependent var		−0.017896
Adjusted R-squared	0.263840	S.D. dependent var		0.482328
S.E. of regression	0.413837	Akaike info criterion		1.124505
Sum squared resid	6.165388	Schwarz criterion		1.210694
Log likelihood	−19.36560	Hannan-Quinn criter.		1.155170
F-statistic	14.26080	Durbin-Watson stat		2.293907
Prob(F-statistic)	0.000576			

• GDPGRO

Null Hypothesis: GDPGRO has a unit root				
Exogenous: Constant				
Lag Length: 0 (Automatic - based on SIC, maxlag=9)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			−6.032435	0.0000
Test critical values:	1% level		−3.615588	
	5% level		−2.941145	
	10% level		−2.609066	

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

Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(GDPGRO)				
Method: Least Squares				
Sample (adjusted): 1981 2018				
Included observations: 38 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
GDPGRO (−1)	−0.992914	0.164596	−6.032435	0.0000
C	2.075206	0.542849	3.822805	0.0005
R-squared	0.502696	Mean dependent var		−0.088204
Adjusted R-squared	0.488882	S.D. dependent var		3.513795
S.E. of regression	2.512101	Akaike info criterion		4.731312
Sum squared resid	227.1835	Schwarz criterion		4.817501
Log likelihood	−87.89493	Hannan-Quinn criter.		4.761977
F-statistic	36.39027	Durbin-Watson stat		2.009867
Prob(F-statistic)	0.000001			

- **VOL**

Null Hypothesis: VOL has a unit root			
Exogenous: None			
Lag Length: 0 (Automatic - based on SIC, maxlag=9)			
		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		−2.726235	0.0077
Test critical values:	1% level	−2.627238	
	5% level	−1.949856	
	10% level	−1.611469	

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

Augmented Dickey-Fuller Test Equation			
Dependent Variable: D(VOL)			
Method: Least Squares			
Sample (adjusted): 1981 2018			
Included observations: 38 after adjustments			
Variable	Coefficient	Std. Error	t-Statistic	Prob.
VOL(−1)	−0.332848	0.122091	−2.726235	0.0097
R-squared	0.167266	Mean dependent var		−0.002709
Adjusted R-squared	0.167266	S.D. dependent var		0.888716
S.E. of regression	0.810992	Akaike info criterion		2.444845
Sum squared resid	24.33517	Schwarz criterion		2.487940
Log likelihood	−45.45206	Hannan-Quinn criter.		2.460178
Durbin-Watson stat	1.943454			