FINANCIAL LIBERALIZATION AND THE ENVIRONMENTAL QUALITY: EVIDENCE FROM TUNISIA

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ABSTRACT

The purpose of this study is to examine whether the liberalization of the financial sector has deteriorated the quality of the environment in Tunisia. To this end, we used data which covers the period from 1971 to 2011 and we applied an econometric model based on cointegration analysis and error correction techniques. The empirical results reveal strong evidence of the existence of a bidirectional causal relationship between per capita carbon emissions and per capita real income. On the one hand, this interdependency indicates that Tunisia needs more carbon dioxide emissions to realize prosperity and buoyant economic growth. On the other hand, more carbon dioxide emissions also stimulate higher economic growth. Therefore, policy makers should take the right decision on how to preserve environment quality without hampering economic growth.

Keywords: Growth; Energy; Financial development; Trade

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1. INTRODUCTION

Generally speaking, literature on energy economics was principally concentrated on the role of energy on economic growth. Initially, this debate has received a great interest following the second oil shock as the market for energy has triggered a global economic crisis. Hence, several researches have been conducted to study the micro and macroeconomic consequences of energy prices as well as the relationship between energy usage and economic growth. The literature was initiated by the early work of Kraft and Kraft (1978) in which they provided evidence to support unidirectional causality running from income to energy consumption for the United States over the period 1947-1974. Given the importance of these results, Kraft and Kraft's (1978) study has since generated a sizable and fast growing collection of empirical literature examining the relationship between energy usage and economic growth in different countries and regions around the world by the use of a variety of econometric techniques. Some studies focused on carbon dioxide emissions and their consequences on economic growth while some others investigated whether the use of energy resources has deteriorated the environment or not.

Despite the huge amount of literature analyzing the energy-environment nexus, few papers have examined the role of liberalization on the quality of environment. Nowadays, the debate on the consequence of liberalization on energy emissions has been sparse, even though the issue is important. Therefore the aim of this paper is to contribute to improve the available literature on environmental economics and to investigate the impact of financial liberalization on carbon emissions in the case of Tunisia. The latter is an interesting case study since it was among the first countries that liberalized its financial sector in late eighties (Hamdi, 2013).

As liberalization refers to a dynamic of trade activity, hence one could expect that following the liberalization process the quality of Tunisia's environment was affected as emissions of carbon

dioxide exploded. Therefore, this is the main idea of the present study. Precisely, the paper seeks to examine whether liberalization of the financial sector has degraded the quality of Tunisia environment using fresh data[1]. In the empirical section of this paper, we conduct a vector error correction model and cointegration techniques. In contrast to other previous studies, we include a dummy variable which reflects the liberalization date. Our empirical results suggest strong evidence of a bidirectional causal relationship between per capita carbon emissions and per capita real income. This interdependency indicates that Tunisia needs more carbon dioxide emissions to realize buoyant economic growth and also shows that more carbon dioxide emissions stimulate higher economic growth.

The remainder of the paper is organized as follows. Section 2 provides a review of literature on the impacts of liberalization on the environment. Section 3describes the data and methodology. Empirical results are presented in section 4 while conclusion and policy implications are reported in Section 5.

2. LIBERALIZATION AND ENERGY: A REVIEW OF LITERATURE

Nowadays, the debate on the consequence of liberalization on energy emissions has been sparse, despite the importance of the issue. The available literature could be classified into two sets. The first is a devoted study to the consequences of trade liberalization (proxied by trade openness) on the environment quality (Ulph 1994, van Beers and van den Bergh 1996, Grossman and Krueger, 1993; Antweiler *et al*., 2001; Frankel, 2009, Halicioglu 2009). Literature on this topic provided conflicting results regarding the impact of liberalization on the environment quality and economic growth. For example, Brack (1998) showed that trade liberalization can benefit the environment in

[1] In this study we are not intended to test for EKC as it was already checked for the Tunisian context by Belloumi (2009).

several ways. First, free trade can promote the transfer of genetic material and technology that can improve agricultural development and environmental protection in the form of a reduction in chemical use. Second, trade liberalization can also help improve the efficiency of resource allocation by removing inefficient prices and subsidies. Third, trade also encourages environmentally sustainable use. Finally, trade can be argued to be a key factor in increasing environmental standards and increasing the speed with which developing countries reach the environmental stage because it serves in increasing income (Ubben, 1999). Some studies shows that trade liberalization harm the environment, especially for poor countries as they have become a pollution heaven. For example, Lopez (1992) opined that free trade can result in the collapse of traditional practices, increasing environmental degradation and trapping the rural poor in a cycle of poverty. For the Chinese context, Dean (1999) has estimated a two-good trade model with endogenous factor supply using pooled provincial data on Chinese water pollution from 1987-1995. Her results showed that trade liberalization directly aggravates environmental damage via its influence on the terms of trade, but indirectly mitigates it via its effect on income growth. For Turkey, Halicioglu (2009) studied the dynamic causal relationships between carbon emissions, energy consumption, income, and foreign trade during the period 1960-2005. Using ARDL bound testing approach; he found that carbon emissions are determined by energy consumption, income and foreign trade. The author also found that income is determined by carbon emissions, energy consumption and foreign trade. The empirical results suggest that income is the most significant variable in explaining the carbon emissions in Turkey which is followed by energy consumption and foreign trade. The study of Managi et al. (2009) studied the impact of trade openness on environmental quality using the instrumental variables technique. Their results reveal a positive impact of trade on the environment in OECD countries and detrimental effects on sulfur dioxide (SO_2) and carbon dioxide (CO_2) emissions in non-OECD

countries. In the case of Sri Lanka, Naranpanawa (2011) employed an Autoregressive Distributed Lag (ARDL) bounds testing approach to detect cointegration relationships between trade openness and carbon emissions in Sri Lanka during the period 1960 to 2006. He found that neither a long run equilibrium relationship nor long term causality exists between trade openness and carbon emissions for Sri Lanka. However, a short run relationship exists between trade openness and carbon emissions.

The second set of literature analyzed the consequences of financial liberalization on environmental quality. This topic has recently received growing attention by scholars which tried to understand the possible link between financial liberalization and environment quality nexus.

Generally speaking**,** financial liberalization is defined as a set of policies implemented in the financial sector of a country in order to improve its financial condition, which will in turn boost its overall economy. According to this idea financial liberalization is a key factor for economic growth.

In some countries, financial liberalization is followed by huge capital inflows and liberalization that leads to and consists of policies that reduce and/ or remove tariff and non-tariff barriers for the free exchange of goods (Ghani 2012). For China, many studies were devoted to examine the linkage between financial sector development and quality of environment and these studies showed conflicting results. For example, Yuxiang and Chen (2011) examined the impact of financial development on industrial pollutants in china using provincial data. They found a positive impact of financial development on the environment. The author argued that financial development improves environmental quality by increasing income and capitalization, exploiting new technologies and implementing regulations regarding environment. In another study, Zhang (2011) studied the impact of financial development on carbon emissions. He found that the development of the Chinese financial sector increases the use of carbon dioxide emissions. When using a stock market indicator, he found that the financial sector has a greater impact on carbon emissions but the influence of its efficiency is

very limited. In the Turkish case, Ozturk and Acaravci (2013) have used and ARDL bounds testing approach to examine the causal relationship between financial development, trade, economic growth, energy consumption and carbon emissions in Turkey for the period 1960-2007. They found that an increase in foreign trade to GDP ratio is followed by an increase in per capita carbon emissions. This means that the level of CO2 emissions initially increases with income, until it reaches its stabilization point, then it declines in Turkey. They also found no long-run impact of a financial development variable on per capita carbon emissions. Recently, Çoban and Topcu (2013) studied the relationship between financial development and energy consumption in the EU over the period 1990–2011 by using system-GMM model. Their results provided strong evidence of the impact of financial development on energy consumption in the old European Union members. Greater financial development leads to an increase in energy consumption, regardless of whether financial development stems from the banking sector or the stock market. Regarding the new members, they found that the impact of financial development on energy consumption depends on how financial development is measured. In Pakistan, Kakar, et al. (2011), determined the nature of the relationship between energy consumption, financial development and economic growth for the period 1980-2009. By employing co-integration and error correction techniques, their results indicated that financial development can be used as a useful measure to overcome energy problems by achieving efficiency in energy use. For India, Boutabba (2013) employed a multivariate framework to examine the long-run equilibrium between carbon emissions, financial development, economic growth, energy consumption and trade openness. The results revealed strong evidence of the long run relationship between per capita carbon emissions, per capita real income, the square of per capita real income, per capita energy use, financial development and trade openness. The causality tests show evidence a unidirectional Granger causality running from per capita real income, per capita energy consumption, and financial development to per

capita carbon emissions, all without feedback. In a very recent study, Hakimi and Hamdi (2016) have examined the impact of trade liberalization on the environmental quality in Tunisia and Morocco using both a VECM and cointegration techniques and Panel VECEM and Panel cointegartion tests. Their results show that despite the positive impact of trade liberalization on economic growth, massive FDI inflow has harmed the quality of environment in both countries.

3. ECONOMETRIC METHODOLOGY

3.1. Data

We consider the following four variables: carbon dioxide (CO2) emissions, income, trade openness and domestic credit to private sector for the case of Tunisia. The per capita CO2 emissions (measured in metric ton) are used as a proxy for environmental quality. The per capita real GDP is used as a proxy for income. The degree of openness of an economy is constructed by dividing the sum of Tunisia's total exports and imports of goods and services by the GDP. This variable is important in our study because following the liberalization process in 1987, several foreign companies were introduced in the Tunisian trade sector and they started producing goods and services which concentrated on exports. Therefore, trade openness is a critical factor that could affect the environmental quality. We finally use the domestic credit to private sector as a measure of financial development. In the Tunisian context; this ratio is considered as one of the most relevant indicators of the magnitude and the extent of financial intermediation in Tunisia.

The yearly time series covers the period from 1971 to 2011. The main source of our data is the World Development Indicators (WDI) provided by the World Bank and all the variables are transformed into log form.

Table 1 shows the descriptive statistics of the four selected variables.

Table 1 Descriptive statistics

	LCO2	LGDPPC	LFDEV	LTRADE
Mean	0.561724	7.570253	4.09105	4.438559
Median	0.581556	7.497222	4.096724	4.45089
Maximum	0.884434	8.059876	4.265296	4.738789
Minimum	-0.01126	7.184764	3.826706	4.144702
Std. Dev.	0.233689	0.272617	0.121432	0.131466
Skewness	-0.6649	0.455327	-0.78433	-0.187
Kurtosis	3.019792	1.913054	2.91471	2.926564
Jarque-Bera	2.653121	3.016112	3.70191	0.2179
Observations	40	40	40	40

Source: WDI 2013

Following the empirical literature in energy economics, it is conceivable to form the long-run relationship between CO2 emissions, energy consumption, economic growth and foreign trade in linear logarithmic form.

$$LnCO2_t = \alpha_1 + \alpha_2 LnGDPpc_t + LnTO_t . + \alpha_3 LnFDEV_t + \mu_t \quad (1)$$

Where, Co2, GDP, TO, stand respectively for CO2 emissions per capita, gross domestic product per capita, trade openness and μ_t is the error term.

Our investigation is to test whether a dynamic relationship exists between development of the financial sector in Tunisia, trade openness, CO2 emission and economic growth. Our empirical investigation has two dimensions. The first one is to examine the long-run relationship between the variables of the model while the second is to examine the short-run dynamic causal relationship between these series. The basic testing procedure requires three steps. The first step is to test whether the variables contain a unit root to confirm the stationarity of each variable (Engle and Granger, 1987). This is done by using the Augmented Dickey–Fuller tests (F-ADF) (Choi, 2001) and Philips–Perron

(PP) tests (1998). The second step is to test whether there is a long-run cointegrating relationship between the variables. This is conducted by the use of the Johansen-Fisher methods. Finally, the last step, if all variables are integrated of order one I (1) and cointegrated short-run elasticities can be computed using the vector error correction model (VECM) method suggested by Engle and Granger (1987). In this case, an error correction mechanism exists by which changes in the dependent variables are modeled as a function of the level of disequilibrium in the cointegrating relationship, captured by the error-correction term (ECT), as well as changes in the other explanatory variables to capture all short-term relations among variables.

3.2. Unit Root Test

We start our empirical analysis by testing for stationarity in both the level and the first difference for all the variables. The most commonly used test in empirical works is the Augmented Dickey–Fuller (F-ADF). However, it was argued in modern econometric literature that the ADF test has very low power in the presence of structural breaks as under such circumstances, it is biased towards acceptance of a unit root. To overcome this problem we also use the Phillips-Perron (PP) unit root test (1988). The ADF and PP tests are asymptotically equivalent, but may differ substantially in finite samples due to the different ways in which they correct for serial correlation in the test regression. Phillips-Perron (PP) unit root test takes account for possible correlation in the first differences of the time-series using a nonparametric correction and allows for the presence of a non-zero mean and a deterministic time trend. Moreover, the PP test has an advantage over the ADF test as it gives robust estimates when the series has serial correlation and time-dependent heteroscedasticity, and there is a structural break.

3.3. Cointegration and Error Correction Model

To investigate the extent to which financial liberalization and financial development are related to carbon dioxide emissions and vice versa, the theory of cointegration and Error Correction Models (ECM) is conducted. The use of this procedure makes it possible to examine the short-run and long-run relationships between all the variables of the model. The Engle-Granger (1987) two-step cointegration technique is performed in this paper.

Basically, the most widely used test for determining cointegrating relationships is the Johansen (1988) and Johansen and Juselius (1990) maximum-likelihood test procedure. This approach is based on two principal statistic tests: Trace test and Max-Eigen value. The Likelihood Ratio (LR) test is based on the trace statistics (λ trace) which tests the H_0: $r \leq q$ against H_1: $q = r$ is calculated thus: $\lambda_{trace}(r) = -T\sum_{l+1}^{p} \ln(1-\hat{\lambda}i)$ where $\lambda r + i \ldots . \lambda n$, are the least value of eigenvectors $(p-r)$. The second test is the maximal eigenvalue test $(\lambda_{\max})$ which tests the H_0: there are *r* cointegrating vectors against the H_1: there are $r+1$ cointegrating vectors, and is calculated as follows:

$$\lambda_{\max}(r, r+1) = -T\ln(1-\hat{\lambda}r+1)$$

In light of the above discussion, the underlying study will estimate the following equation:

$$LCO2_t = \alpha_1 + LGDPpc_t + LTO_t . + \Delta LFDEV_t + Dummy_{87} + \mu_{1t} \quad (2)$$

Where LCO2 is the natural log of per capita carbon emissions, LGDPpc is the natural log of per capita GDP; LFDEV is the natural log of domestic credit to private sector; LTO is the natural log of trade openness ratio and μ_{1t} is the regression error term. Given the importance of financial liberalization as a key point in which the Tunisian banking sector has experienced the most important

reforms in its history, we follow the same methodology of Hamdi *et al* (2013) by adding a dummy variable which reflects the liberalization date equal to 1 for t=1988 to 2011 and otherwise zero.

$$\text{Dummy}_{87} = \begin{cases} 0 \text{ for } 1971\text{-}1987 \\ \text{and} \\ 1 \text{ for } 1988\text{-}2011 \end{cases}$$

In cases where liberalization makes entry easy, we expect higher growth as a result of a huge inflow of foreign capital and acceleration of trade activities (Hamdi 2013).

In this paper, we use multivariate procedure by the mean of a VECM which is specified as follows:

$$\Delta LCO2_t = \alpha_1 + \sum_{i=1}^{p} \beta_{1i} \Delta LCO2_{t-i} + \sum_{i=1}^{q} \beta_{1i} \Delta LGDPpc_{t-i} + \sum_{i=1}^{r} \beta_{1i} \Delta LTO._{t-i} + \sum_{i=1}^{s} \beta_{1i} \Delta LFDEV._{t-i} + Dummy_{87} + \lambda_1 ect_{t-1} + \mu_{1t} \quad (1)$$

$$\Delta LGDPpc_t = \alpha_2 + \sum_{i=1}^{p} \beta_{1i} \Delta LCO2_{t-i} + \sum_{i=1}^{q} \beta_{2i} \Delta LGDPpc_{t-i} + \sum_{i=1}^{r} \beta_{2i} \Delta LTO._{t-i} + \sum_{i=1}^{s} \beta_{2i} \Delta LFDEV._{t-i} + Dummy_{87} + \lambda_2 ect_{t-1} + \mu_{2t} \quad (2)$$

$$\Delta LFDEV._t = \alpha_3 + \sum_{i=1}^{p} \beta_{3i} \Delta LCO2_{t-i} + \sum_{i=1}^{q} \beta_{3i} \Delta LGDPpc_{t-i} + \sum_{i=1}^{r} \beta_{3i} \Delta LTO._{t-i} + \sum_{i=1}^{s} \beta_{3i} \Delta LFDEV._{t-i} + Dummy_{87} + \lambda_3 ect_{t-1} + \mu_{3t} \quad (3)$$

$$\Delta LTO._t = \alpha_4 + \sum_{i=1}^{p} \beta_{1i} \Delta LCO2_{t-i} + \sum_{i=1}^{q} \beta_{4i} \Delta LGDPpc_{t-i} + \sum_{i=1}^{r} \beta_{4i} \Delta LTO._{t-i} + \sum_{i=1}^{s} \beta_{4i} \Delta LFDEV._{t-i} + Dummy_{87} + \lambda_4 ect_{t-1} + \mu_{4t} \quad (4)$$

Where ECT, the error correction term, is expressed as follows: (5)

$$ECT_t = LCO2_t - \alpha_1 - \beta_{1i} LGDPpc - \beta_2 LTO._{t-i} - \beta_2 LFDEV_{t-i}. - Dummy_{87}$$

Where *t=1...T,* denotes the time period.

4. EMPIRICAL RESULTS

4.1. Unit root tests

First of all, we use the Augmented Dickey–Fuller (F-ADF) unit root test to test the non-stationarity in our data series. Considering the low power of the ADF test we also use the Phillips-Perron (PP) test (1988), which takes account of the serial correlation and heteroscedasticity, as an alternative test.

Table 2 reveals the results of the unit root tests of the Augmented Dickey-Fuller (*ADF*) and Phillips-Perron (*PP*) for LCO2 LGDP, LTO and LFDEV for Tunisia. The tests statistics for the log levels of the series are statistically insignificant. When we apply the unit root test to the first difference of all variables, both tests reject the joint null hypothesis for each variable at the 1 per cent level. Thus, from all of the tests, the unit root test indicate that each variable is integrated of order one.

Table 2. Results of the Unit Root Test

	ADF		PP		Order of Integration
	Level	1st diff,	Level	1st diff	
LCO2	1.5726	-6.6082***	1.5237	-6.5902***	I(1)
LGDPpc	0.4896	-4.8517***	0.9275	-14.1015***	I(1)
LTO	-2.2524	-11.9219***	-2.3388	-11.9281***	I(1)
LFDEV	-2.2855	-11.9253***	-2.3940	-11.9340***	I(1)

Note: The regressions in first difference include intercept.
*** Denotes the rejection of the null hypothesis at 1%level of significance

After checking the integration of our four variables at order one, I(1), we selected the optimal lag length of underlying Vector Auto Regression (VAR henceforth) using the conventional model selection criteria. These criteria established that the optimal lag length is two.

4.2.Cointegration : Long run and short run

Results of the Johanson contegration tests are displayed in Table 3 below. The Trace test and Max-Eigen value test indicate clearly that all null hypotheses are rejected at the 5% level of significance.

Therefore, we reject the null hypothesis of no cointegration. However, we accept the null hypothesis that there is at most one cointegrating relation at 5% significance level. We conclude with the existence of one cointegrating relation between the logarithms of energy emission and the logarithms of GDP per capita in Tunisia (r=1).

Table 3. Johanson contegration tests

Hypothesized	Trace Statistic	Max-Eigen Statistic
None *	47.85613	27.58434
At most 1 *	29.79707	21.13162
At most 2	15.49471	14.26460

Trace and Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

According to Engle and Granger (1987), if two series are co-integrated of order one then a VECM representation must exist in order to govern joint behavior of the series of the dynamic system. The VECM is performed to reestablish the disequilibrium in the cointegration relationship, as well as to test for long and short-run causality among cointegrated variables. The correction of the disequilibrium is done by the mean of the Error Correction Term (ECT).

The results of the long-run equilibrium relationship are presented in Table 4 below. They show that the coefficient of LGDP per capita is 0.6883, which is positive and significant at 1% level of significance. It means that a 1% increase in per capita income will increase energy emission by 0.68% in the long-run. This ratio is somewhat high and shows that income is the main factor affecting environmental quality (CO2 emission). The situation shows that once the GDP per capita increases, Tunisian households increase their demand for energy, especially energy services. It is worth mentioning that the weather conditions in Tunisia are hard: a very hot summer, especially in the south

of the country, in which temperature easily reaches 50 and a very cold winter, in the north-west, that lasts for several months. In these periods, energy demand increases further which in turn increase carbon dioxide emissions. It is also worth recalling that most people living in mountains and small villages in Tunisia are poor with no access to electricity. Therefore, during the cold months people use wood to heat their houses. However; burning wood (coal) is also another important factor that increases the use of carbon dioxide emission. According to the results of table 4; as soon as the minimum wages increase, households invest further in equipment (I.e. cars, motorcycles, heaters, air conditioning, etc.) which in turn increases carbon dioxide emissions from wood..

Table 3 above also reveals that trade openness is negatively linked to carbon dioxide emission and it is statistically significant at the 1 percent level. This shows that trade openness provides access to developing economies of advanced technology emitting less CO2 emissions. A 1% increase in TO decline carbon dioxide emission by 0.33 percent increase. This result is encouraging for the Tunisian context as it reveals that export and import activities did not affect energy usage (carbon emissions) but it even reduces it. This might be achieved by the use of clean energy and/or advanced new technological tools that reduce the use of energy in commercial and trade activities.

Turning now to financial development variable -proxied by domestic credit to private sector- it appears to affect positively and significantly at the 1% level of significance carbon dioxide emissions in Tunisia. As shown in table below; a 1% increase in financial development increase carbon dioxide emission by 0.65%. This could be explained by the fact that the higher credit to private sector, the more people will invest in equipment that emit carbon dioxide. For example, the poor will need personal credit to buy heaters or air-conditioning and the non-poor need credits to improve their well-being by buying cars.

Unfortunately, the financial sector in Tunisia appears as an important factor increasing carbon dioxide emissions in Tunisia and efficient energy substitutes are required to decrease the energy demand.

Table 4. Long-run elasticities
Dependent Variable: LEU

	Coef.	**t-value**
LGDP	0.6883	-10.8498***
LTO	-0.3328	2.4325***
LFDEV	0.6535	-4.0220***
C	-4.6903	

*** Denotes the rejection of the null hypothesis at 1%level of significance

Table 4 shows the results of the short-run estimation. Firstly determined the optimal lag length model using the sequential modified LR test statistic (LR), final prediction error (FPE), Akaike information criterion (AIC), Schwarz information criterion (SC), and Hannan-Quinn information criterion (HQ). The result of selecting the optimal lag length of VAR indicates that the lag order of VAR (k) is 2, for multivariate VAR. Therefore, the variables were estimated with two lags. The results displayed in table 4 show that GDP acts positively and is statistically significant at 1% level of significance. This finding is in line with our long-run analysis and shows that as soon as income increases it will be followed by an increase in energy usage (CO2 emission). The coefficient of trade openness is positively and statistically significant at 10 % level of significance. Hence, the results reveal that export and import activities contribute to the deterioration of the environment' quality in Tunisia in the short-run. Therefore, new policy measures are needed to decrease the use of carbon dioxide emission in trade. Regarding financial development, it has any short-run effects on carbon dioxide emissions.

Turning now to the dummy variable, it is linked to carbon dioxide emission positively and is statistically significant at 10% level of significance. This result shows that the carbon dioxide emissions were firstly influenced by the liberalization process.

The empirical evidence reported in Table 5 shows that the coefficient of *ECT is* -0.52 (0.1624) which is statistically significant at a 1 per cent level of significance. This concludes that a change in carbon dioxide emission is corrected by 16.245 per cent in each year in the long-run. This implies that the adjustment process is fast enough and significant for the Tunisian economy in any shock to the carbon dioxide equation.

Table 5. ECM results based on Johansen cointegration

Regressor	**Coef**	**t-value**
Δ LGDPPC(-1))	1.0709	2.6130***
Δ (LGDPPC(-2))	0.7132	1.5199*
Δ (LTRADE(-1))	0.2066	1.7926*
Δ (LTRADE(-2))	0.2618	2.3215**
Δ (LFDEV(-1))	0.0221	0.1450
Δ (LFDEV(-2))	0.0301	0.1703
$Dummy_{87}$	-0.0476	-1.926*
C	0.0190	0.8280
ECT	-0.5209	-3.206
Diagnostic tests	**t-stats**	**p-value**
White Test	0.4680	0.9810
Normality	3.2094	0.200
Breusch-Pagan-Godfrey	1.6044	0.1726
ARCH	0.01348	0.9071
Breusch-Godfrey LM Test	0.2435	0.7860
Ramsey RESET	0.8924	0.3818
R2	0.741	

*, **, *** Denote the rejection of the null hypothesis at 10%, 5% and 1% level of significance, respectively.

The robustness of the ECM model has been passed by the six most important diagnostic and stability tests i.e. White test, Jacque-Bera normality test, Breusch-Pagan-Godfrey, Breusch-Godfrey serial correlation LM test, ARCH test, and Ramsey RESET specification test. All the tests revealed

that the model provides consistent results. Moreover R2 (0.741) shows that the model is a relatively good fit. Hence, the results reported are valid for consistent interpretation. Finally, the stability of model is also checked by applying the Cumulative Sum of Recursive Residual (CUSUM) and the Cumulative Sum of Squares of Recursive Residual (CUSUMQ) techniques based on equation (4) of the error correction model. They also show that the model is stable.

Fig. 1. Plot of cumulative sum of recursive residual

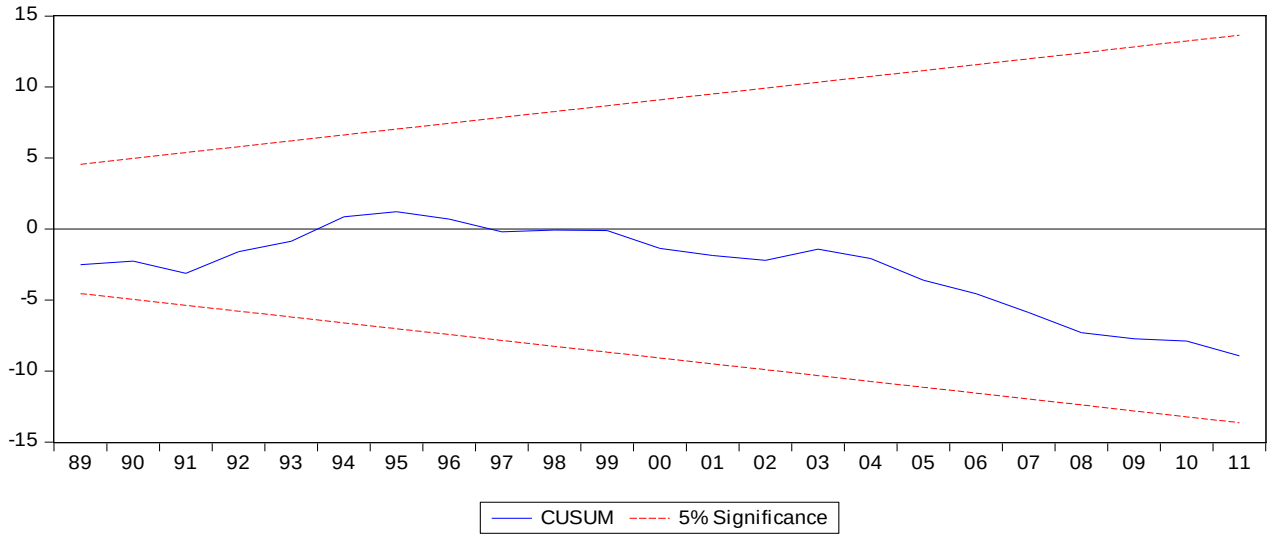
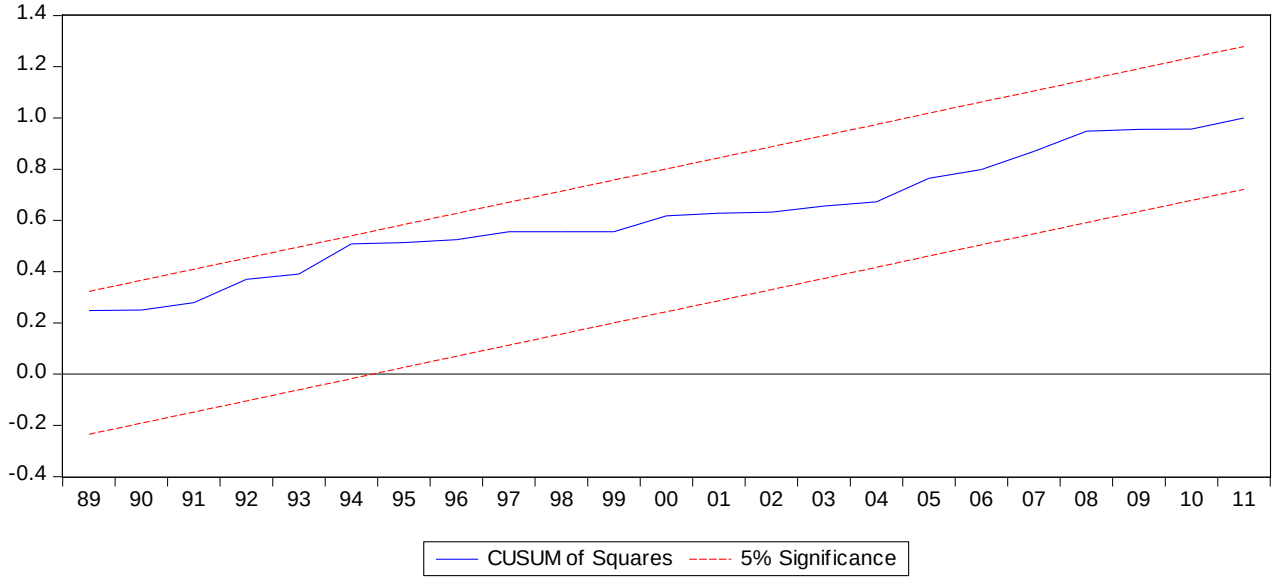


Fig. 2. Plot of cumulative sum of squares of recursive residual



Before discussion of the main results, it is worth to examine the direction of causality between the four variables of the model using the Granger causality procedure. The results are described in Table 5 in which three types of causality tests have been conducted: short-run causality, long-run causality and the joint short and long-run. The first test (in the right side of the table 6) indicates the significance of the sum of lagged terms of each explanatory variable by the mean of the joint Fisher test. The second test shows the significance of the error correction term by the mean of the t-test. Finally the third test shows the short-run adjustment to reestablish the long-run equilibrium.

Table 6: Results of the causality tests

	Short run (F-stats)					*Joint short and long run (F-stats)*			
Variables	ΔLCO2	ΔLGDP	ΔLTO	ΔFDEV	ECT *(t-stat)*	ΔLCO2 & ECT	ΔLGDP & ECT	ΔLTO& ECT	ΔFDEV& ECT
ΔLCO2	-	2.3750**	2.651*	3.193*	-3.206***	-	2.0683**	1.8132	6.571***
ΔLGDPPC	2.3114*	-	0.8489	0.3388	-1.694*	1.7850*		0.5663	0.748
ΔLTO	0.005	0.6661	-	3.6548**	-1.8024*	2.9145**	2.3312**	-	4.3207***
ΔFDEV	0.6846	2.6724*	0.9651	-	1.6403	0.5381	1.3814	0.0594	-

*** Denotes the rejection of the null hypothesis at 1%level of significance

Several interesting conclusions could be drawn from Table 6. We start our analysis by the first part of the table (left side). First, the F statistics of the short-run dynamic reveals a unidirectional relationship between LGDP per capita and LCO2. This means that income Granger cause carbon dioxide emission and hence, the environment quality. An increase in income immediately increases carbon dioxide emissions. This is in line with the so called “scale effect” in which greater economic activity raises demand for all inputs, hence increases emissions (Dean 1999). Second, the results reveal the existence of a unidirectional relationship running from trade openness to LCO2. This finding indicates that export and import activities are a principal factor influencing carbon dioxide emission in Tunisia and this confirms our previous finding in Table 4. However, the results show that

financial development Granger cause carbon dioxide emission. This indicates that granting credits to the private sector increase the use of energy which in turn will increase emissions of Co2. Financing dirty investments and industries could also have a negative impact on the environment quality. Third, the F statistics of the short-run dynamic reveals a unidirectional relationship between LCO2 and LGDP per capita. Therefore, we can confirm the evidence of a bidirectional causal relationship between income and carbon dioxide emission. This interaction between CO2 and GDP means that CO2 contributes to economic growth and vice versa in the short-run. As we argued previously, as soon as income increases Tunisian households tend to improve their well-being by buying essential equipment such as heaters, air conditioning to prepare for the hard weather conditions. Fourth, in the second equation, we find a surprising result as F statistics of the short-run dynamic between FDEV and GDP is not statistically significant. That means that financial development does not lead to growth in Tunisia. A similar conclusion was found for trade openness, which appears to have no potential impact on Tunisian growth. However the results show the existence of a unidirectional causal relationship running from FDEV to trade openness. This means that the more credit to private sector grow, the more dynamic trade activity is. In this sense, one could conclude that credit to private sector is the backbone of the Tunisian trade. Fifth, Table 5 reveals that *F* statistics of the short-run dynamic reveals a unidirectional relationship between LGDP per capita to FDEV. This means that an increase in the per capita income would have an impact on future ratio of banking activities. This result is in line with the one found by Boulila and Trabelsi (2003) in the Tunisian context. This may reflect the problem with credit conditions imposed by Tunisian banks which requires a high level of per capita income. As soon as income increases, access to credit becomes much easier.

Regarding the middle part of Table 5, the significance (t-test) of the error correction term is found to be negative and significant for all the variables except financial development. This means

that shift from the long-run equilibrium is corrected by carbon dioxide emissions, per capita income, and trade openness while Financial development appears to be weakly exogenous. This shows the fact that any changes in financial development that disturb long- run equilibrium are corrected by counter-balancing changes in carbon emissions, per capita income, and trade openness.

Finally, the last part of Table 5 shows the results of F-statistics on the significance of joint short- and long-run estimations. In the carbon emission equation, error correction term and per capitaGDP are jointly significant, while trade openness and FDEV are not. In the trade equation, error correction term and per capita GDP are jointly significant. Similar results were found with FDEV and trade openness. Finally, none of the joint term in the FDEV equation is significant which further confirms the exogeneity of FDEV.

5. CONCLUSION AND POLICY IMPLICATIONS

The broad aim of this paper is to investigate whether financial liberalization degrades the environment quality in Tunisia or not. Following previous studies, the quality of the environment was proxied by carbon dioxide emissions. We use annual data which covers the period 1971–2011. In the empirical section, we conducted a vector error correction model and cointegration technique to estimate carbon dioxide emissions and to examine the financial development, trade openness and real output sensitivity issues of both long and short-run emissions.

The empirical results suggest that there is strong evidence of a bidirectional causal relationship between per capita carbon emissions and per capita real income. This interdependency indicates on the one hand that Tunisia needs more carbon dioxide emissions to realize prosperity and buoyant economic growth, and on the other hand that more carbon dioxide emissions also stimulate higher economic growth. Therefore, policy makers should take the right decision on preserving environment

quality without hampering economic growth. Therefore, as CO2 is a driver of economic growth, we do not support the conservation policy to reduce CO_2 emissions. In this dilemma, the government of Tunisia should gradually substitute carbon dioxide emissions by clean energy resources like renewable energy and solar energy in the economic activities process. Given the strong link between CO2 and income, decisions should be taken with great vigilance to avoid any shocks to economic growth. The Tunisian government should, for example, invest further in R&D and encourage enterprises and manufactories to use clean and green energy and to permanently control and effectively use energy so not to worsen the quality of the environment and preserve the well-being of Tunisian citizens.

Another important conclusion to be drawn from this paper is the absence of feedback between financial development (proxied by domestic credit to private sector) and economic growth. In this sense we can say that despite the massive reforms implemented by the Tunisian government during the nineties and early 2000s, the banking and financial sector does not bring any effective support to Tunisian growth. Here again, we encourage the Tunisian government to undertake further reforms in order to promote the banking and financial sector and easing the credit conditions. It is worth mentioning that in 2010 domestic credit to private sector in Tunisia was 73.3%, which is lower that Morocco (104.24%), and Lebanon (172.72%).

The third important conclusion to be drawn from this paper is regards to trade openness. Broadly, the adoption of liberalization policies and reforms are intended to be effective measures for the attraction of massive foreign direct investments and relocation of foreign companies. This policy was expected to improve the market dynamic as well as the wellbeing of Tunisian households. However, our study reveals disappointing results. In fact, the Granger causality test results reveal a non-significant Granger causality from trade to real GDP per capita or from real GDP per capita to trade. This result support the one recently found by Belloumi (2009). Tunisian decision-makers should also

embrace the adequate policy to encourage further FDI inflows and to adopt new trade strategy that would improve the "doing business in Tunisia". Especially in the current transition period in which uncertainty remains and political instability persists.

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