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Renewable energy consumption, International trade, oil price and economic growth inter-linkages: The case of Tunisia

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ABSTRACT

This paper contributes to the small but growing literature on the linkages between renewable energy consumption, international trade, oil price and economic growth. It aims to investigate such dynamic relationships using the bounds testing approach to cointegration and the ARDL methodology for Tunisia over the period 1980–2011. The main empirical findings reveal the presence of a bidirectional relationship between renewable energy consumption and international trade in the short-run. Indeed, an increase in oil price may imply an increase of renewable energy consumption. Furthermore, a unidirectional relationship between renewable energy and oil price is proven in the short-run.

1. . Introduction

Over the past four decades, the lion's share of the literature on energy consumption has focused on the causal relationship between energy consumption and economic growth. Four testable hypotheses can be distinguished to examine such relationship: growth, conservation, feedback, and neutrality hypothesis [2,30,41,38]. The growth hypothesis regards economy strongly linked to energy. According to this assumption, any reduction in energy use will lower automatically economic growth. Under the second hypothesis (conservation hypothesis), it's assumed that unidirectional causality runs only from economic growth to energy use. Thus, any attempt to diminish energy consumption may not have much influence on economic growth. The feedback hypothesis presumes the existence of bi-directional causality between energy consumption and economic growth. Under the fourth hypothesis (neutrality hypothesis), it's assumed that any change in energy consumption might not have any effect on economic growth, and vice versa [8].

The first study on the growth-energy relationship was conducted by Kraft and Kraft, [18] who found unidirectional causality from gross national product (GNP) growth to energy consumption using US data from 1947 to 1974. Yet, reducing two years from the initial dataset, Akarca and Long [1] did not find, surprisingly, any association between the two variables. They argue that the 1973 oil embargo is the responsible for the contamination of used data series. Using data from six industrialized countries and with a time period of 30 years (1952–1982), Erol, Yu [13] found feedback causality running between economic growth (EG) and energy consumption (EC) for Japan, unidirectional causality from EC to EG for Canada, from EG to EC for Germany and Italy, and none for France and England.

Focusing on a set of developing countries, Masih and Masih [26] postulated unidirectional causality from EC to EG in India, and from EG to EC in Pakistan and Indonesia, but none for Malaysia, Singapore and the Philippines. Soytas and Sari [40] postulated that economic growth Granger affects energy use in Italy and Korea, while a unidirectional causality runs from energy use to economic growth in other developed countries such as France, Germany, Japan and Turkey. Huang et al. [16] supported the neutrality hypothesis for low-income countries, but found unidirectional causality from EG to EC for middle and high-income countries, similarly to Aqeel and Butt [7], Shahbaz and Lean [39], Shahbaz and Feridun [37] for Pakistan, Lee [21] for France, Italy and Japan, and Lee and Chien [22] for France and Japan. The reverse causal relationship running from EG to EC was postulated by Lee [21] for Canada, UK, Germany, Sweden, and Switzerland; Narayan and Smyth (2008) for G-7 countries; Bowden and Payne [10] for the US.

The disagreement among the aforementioned studies can be due mainly to methodological and data differences and countries hetero-

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geneity in climate, degree of development and energy use patterns. On the other hand, other studies have explored the relationship between EG and EC in the case of renewable energy (see for instance [3,4,5,6,38]). A consensus has emerged about the vital role of renewable energy consumption for increasing economic growth and reducing greenhouse gas emissions [37].

Recently, some centers and organizations such as the International Trade Centre (ITC), and the World Trade Organization (WTO) have shown an increasingly open approach towards economic growth, energy and trade inter-linkages. The latest literature suggested that trade openness can be involved in the production function to elucidate the growth of gross domestic product (GDP). In this regard, several papers have emphasized on the relationship between total energy use, trade and real GDP. Lean and Smyth [19] were the first to investigate the dynamic relationship between economic growth, electricity generation, exports and prices for Malaysia. Their main findings from Granger causality tests demonstrate the existence of a unidirectional causality running from economic growth to electricity generation. In their second study on Malaysia, Lean and Smyth [20] investigated the causal relationship between aggregate output, electricity consumption, exports, labor, and capital by using multivariate model. A feedback causality is found between aggregate output and electricity consumption. As policy implication, they recommend that Malaysia should implement a dual strategy of rising investment in electricity infrastructure and promoting electricity conservation policies to diminish the unnecessary wastage of electricity.

Similarly, Narayan and Smyth [28] found nearly the same conclusion for a set of Middle East countries. A bidirectional effect was postulated between electricity consumption, exports and real GDP. Using panel cointegration techniques, Sadorsky [35] demonstrated how trade can influence energy consumption for eight Middle East countries. He found, in the short-run, a Granger causality running from exports to energy consumption, and a feedback relationship between imports and energy consumption. While in the long-run, he postulated that a raise in both exports and imports may influence the demand of energy. In subsequent study, Sadorsky [36] strengthened the long-run relationship between trade and energy consumption for a sample of seven South American countries.

The aim of this study is to investigate the relationship between renewable energy consumption, international trade, oil price and economic growth for Tunisia for the period of 1980–2011 using autoregressive distributed lag (ARDL) approach of Pesaran et al., [31] and Granger causality tests. The current study extends the existing empirical literature on the relationship and causality between renewable energy consumption and economic growth for Tunisia. To our knowledge, there have been no studies focusing on this causal relationship. In fact, Jebli and Ben Youssef [17] have investigated only the dynamic causal relationship between per capita CO_2 emissions, real GDP, renewable and non renewable energy consumption and international trade for the case of Tunisia, without considering the oil price variable and the impact of aforementioned variables on economic growth. In addition, to contributing to the broader empirical literature, this paper has significant policy implications in the field of sustainable energy use. The remainder of the paper is structured as follows: Section 2 gives an idea about the renewable energy sector, international trade and economic growth in Tunisia. Section 3 describes the data and the methodology used. Section 4 deals with the empirical models and results, and Section 5 concludes.

2. Energy, international trade and economic growth in Tunisia

Since the mid-1980s, Tunisia has conducted a proactive policy for the promotion of renewable energy (RE) and energy efficiency (EE). This was made through several initiatives including the creation in 1986 of the Agency of Energy Management (called National Agency for Energy Conservation (ANME) today)[1] that aims to develop a mechanism for the rational use of energy as well as the promotion of renewable energies. This policy gained special momentum starting in the mid-2000s, in the context of spiraling international oil prices and the development of a steadily growing energy deficit [15]. The year 2000 was the turning point in the Tunisian's energy balance, where the country became a net importer of energy due to stagnation of the production and the rapid growth of domestic demand (Fig. 1). As Fig. 1 demonstrates, energy consumption increased at an average annual rate of 3.3% between 1995 and 2000, compared to an annual rate of 1.4% between 2005 and 2010. The demand recorded sustained growth, reaching 8.2 million toe in 2010, while the resources stagnated at around 7.5 million toe.

Since 2009, primary energy consumption in Tunisia is dominated by natural gas that reached 52.85 percent in 2014 and oil products with 46.62 percent share. Other primary energy sources, more specifically the renewable energy, do not feature as significant energy inputs (Fig. 2). Fig. 2 shows that, between 1990 and 2012, natural gas increased its share of energy consumption from 20 to 55 percent, while oil fell share decreased from 80 to 44 percent. The increase in the natural gas share can be explained by the fact that Tunisia receives natural gas from a pipeline between Algeria and Italy that runs across its territory. In addition, significant natural gas deposits have recently been discovered in southern Tunisia and in the Kerkenna Islands. The hydrocarbons reserves at the end of the 2010 were estimated to be 430 million barrels of crude oil and 65 billion cubic meters of natural gas. The majority of Tunisia's natural gas output come from Miskar field located about 125 km offshore in the Gulf of Gabes. According to British Gas (the largest investor in Tunisia's energy sector that owns 100% interest in the Miskar field and 50% in the Hasdrubal field) the Miskar field contains 1500 Bcf (about 42.5 $\times 10^8 m^3$) of natural gas reserves in Tunisia and provides more than 50% of Tunisia's total natural gas demand [9].

In Tunisia, industrial sector is the largest energy end-user, which accounted for 36% of total final energy consumption in 2010 followed by the transportation sector at 31%, buildings at 27% and finally agriculture at 6%. The distribution has not changed much compared to 1990: industrial sector 41%, transportation sector 30%; buildings 22% and agriculture 7%.

Aiming to reduce the economic burden of energy costs, the government introduced a series of laws and programs to support the development of renewable energy and to increase the industrial energy efficiency (RE & EE). Hence, Tunisia is bestowed with a high potential for both solar (more than 3,600 hours of sunshine per year) and wind (7–10 m/s) energy due to its large coastal area and southern desert. In this framework, three main sustainable programs have been adopted by the government: the 2005–2007 three-year program (accompanied by the creation of National Fund for Energy Saving (FNME)), the 2008–2011 four-year program and the 2011–2016 Tunisian Solar Plan. The first program has resulted in the following actions [15]: About 230 EE program contracts were established between the government and companies in the industrial sector; Around 120,000 m² of solar water heaters in the residential sector were installed (PROSOL program) and the distribution of around 1 million energy-saving lamps in the residential sector. The impacts of this program are significant resulting to a cumulative energy saving of 770 ktoe (where 92% from EE actions and 8% from renewable energy development actions). Following those encouraging results, a new four-year program for energy conservation for the period 2008–2011 was established with the main objective of increasing the share of renewable in primary energy consumption of 4% in 2011 (ANME). In order to strengthen national renewable energy policy, the government has launched in 2009 the Tunisian Solar Plan (PST) covering the period

[1] The ANME was established in 2004 under the Ministry of Industry.