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Carbon emissions growth and road freight: Analysis of the influencing factors in Tunisia

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ABSTRACT

Based on data on total CO_2 emissions and freight transport, we determine and analyze the effects of main driving factors of total CO_2 emissions in Tunisia during the period 1990–2006. We have decomposed the annual emission changes into components representing changes in average emission of fossil fuels, fossil fuel share from road freight transport, fossil fuel intensity from road freight transport, road freight transport intensity and gross domestic production. The decomposing analysis results have shown that economic growth is the principal factor driving the CO_2 emission growth. Changes in average emission of fossil fuels is the primarily factor driving the CO_2 emission changes. For road freight transport-related components, effects of fossil fuel share, fossil fuel intensity, and road freight transport intensity are all found secondary responsible for CO_2 emissions changes. They have a main role especially in driving CO_2 emissions increase. This study also shows that, given the drastically decline of economic growth since the popular revolution in 2010, the reduction of CO_2 emissions become more difficult by the absolute decoupling of road freight transport from economic growth. The relative decoupling by switching to less emission intensive transportation modes, may the adequate solution. To this end, sustainable freight transport policy in Tunisia could apply some fiscal, economic and technical instruments to reduce fossil fuels consumption and CO_2 emissions related to the road mode.

1. Introduction

Tunisia has encountered environmental issues during the past three decades. Nevertheless, its environmental policies started with the founding of the National Agency for Energy Conservation (NAEC) in 1985, the National Agency for Environment Protection (NAEP) in1988, and the Ministry of Environment and Land Use Planning in 1991. Air pollution is the main concern, and reduction is the paramount objective. It is worth noting that Tunisia ranks 59th among 149 countries, before Arab and African countries, in terms of a low Environmental Performance Index (EPI), according to the report submitted by The Davos Environmental World Economic Forum (2008). However, carbon dioxide (CO_2) emissions, commonly known as pollutant gas, continue to increase in Tunisia (National Institute of Statistics, 2013). Consequently, Tunisian environmental policies need to identify the direct factors influencing changes in CO_2 emissions in order to identify the corresponding instruments and curb gas emissions growth. Official reports show that the transport sector is one of the main sources of CO_2 emissions in Tunisia, but they provide a superficial analysis of its contribution to total emissions.

Petroleum remains one of the principle sources of CO_2 emissions in Tunisia. Because of its higher consumption by the transport sector, we need to identify the transport-related factors that directly or indirectly affect CO_2 emissions growth. We are generally interested in road transportation, which has the highest modal share in terms of fuel consumption, and in particular, to road freight because of its strong relationship with economic activity in Tunisia[2]. Because of the competition in the road transport industry that started in 1980 and the large investments in road infrastructure, the road mode offers more advantages for freight carriers, such as supply flexibility, low costs and high accessibility to every region in the national territory. However, the increased use of road freight can increase fuel consumption and contribute

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[2] The choice of road freight is also motivated by the availability of data concerning its activity. For road passengers (public and private), data are not available for all variables and for the study period.

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to total CO_2 emissions. In this context, this study aims to examine the relationships between CO_2 emissions and road transport in Tunisia by decomposing the emissions into driving factors and analysing their effects.

Transportation is strongly related to economic activities. The traffic realized enables a link between the production and consumption markets and permits satisfaction of the transport demand of travellers and freight. Nonetheless, the transport industry is often associated with many issues that affect the economy, society and the environment. Negative externalities occur, especially if the economic activity requires additional transportation services. Without any transport policies, vehicles travel more kilometres, use more energy, and produce more CO_2 emissions. In this context, transport intensity[3] is often used to measure the transport demand and to analyse the negative consequences of the coupling relationship between economic growth and transport activity. CO_2 emissions are considered one of the most important environmental externalities of transport activity and are often related to road traffic (passenger or freight) and analysed in the context of the coupling approach.

Many available studies have analysed the relationship between CO_2 emissions growth, transport energy intensity, share of fossil fuels in total energy consumption and economic growth by using the decomposition approach. Decomposition analysis is one of the most effective tools implemented to investigate the factors influencing energy consumption and therefore CO_2 emissions (Liu and Ang, 2007). It dates back to studies undertaken in the 1980s and has been used particularly in the industrial context (Howarth et al., 1991; Park, 1992). However, in the1990s and 2000s, this technique has been generalized to be applied in other sectors and to analyse the relationship of energy-related greenhouse gas emissions because of the growing concerns about climate change. For example, Paul and Bhattacharya (2004) used the decomposition method in the sectors of agriculture, industry and residential areas in India. Ang and Zhang (1999) decomposed the gas emissions produced from fossil fuels into energy efficiency and GDP for three OCDE member countries. Viguier (1999) decomposed the emissions of NO_x, SO_2 and CO_2 for six countries and showed that energy efficiency and emissions are positively correlated. Lise (2006) decomposed total gas emissions growth for Turkey and showed a positive correlation for the economic structure change and a negative correlation for energy efficiency.

In the case of the transport sector, most studies focused on the decomposition of CO_2 emissions growth and analysed the impacts of several transport-related factors on emissions growth. Examples include the use of vehicles, the travelling distance and the related energy consumption that can contribute to CO_2 emissions growth and thus, are integrated in the decomposition (Webster et al. 1986a, b; Schaïfer, 2000; Kown, 2005; Lu et al., 2007). Types of fuels, fuel mix and fuel carbon content can also impact emissions growth (Herzog et al., 2006). The transport activity (ton-km or passenger-km), the modal structure and the transport energy intensity are often integrated as transport influencing factors (Scholl et al., 1996; Kiang and Shipper, 1996; Shipper et al., 1997; Timilsina and Shrestha, 2009a, b). These factors also include the logistic efficiency, vehicles' efficiency, driver efficiency, and route efficiency (Léonardi and Baumgartner, 2004). Numerous other factors are integrated in this context, such as demographic factors (population), economic factors (GDP), social factors (per capita GDP, motorization), and urban factors (urban density, urban population).

Energy studies have addressed freight transport. The majority of this research has demonstrated that the trucking energy intensity is much higher than those of other modes (rail and water) for most countries. Several studies on freight transport energy have focused on the trucking mode. Shipper et al. (1997) showed the tremendous role of freight transportation on the transport industry and the domestic energy consumption in total CO_2 emissions changes. The authors decomposed the CO_2 emissions from the transport activity for the developed countries using the ASIF approach.[4] Sorrell et al. (2009) studied the main driving factors of the road freight energy growth for the UK from 1989 to 2004 using decomposition analysis. They found that the reductions in domestically manufactured production were the main driving factors. Yet, the authors emphasized that the reductions of this specific production have been substituted for by imported production and that the net effect on energy consumption and CO_2 emissions in the UK depended on the distances travelled by the imported goods. Moreover, the relocation of the manufacturing companies to other countries moves these environmental impacts with them. Sorrell et al. (2012) also studied the decoupling of road freight energy consumption from the GDP during the 1989-2004period in the UK. They showed that the decoupling was applied because of the decline in the manufactured production share of GDP, which has led to improvements in several indicators, such as the average payload weight, the amount of empty running and the fuel use per vehicle kilometre. Tapio (2005) put forth a theoretical framework for the decoupling of road transport from economic growth. He studied for the fifteen EU member countries, the relationships between GDP, traffic volumes and transport CO_2 emissions during the 1970-2001 periods with a deeper insight into Finnish road traffic. The empirical findings showed a difference decoupling relationship between the countries surveyed. Kamakate and Schipper (2009) highlighted that the differences in road transport energy intensity between the countries depended on the technical characteristics of trucking (size and engine power) and the trucking capacity. Eom et al. (2012) have sought to determine and analyse the drivers of freight CO_2 emissions by using the ASIF approach. They introduced the activity intensity as an influencing factor along with GDP, fuel mix, modal structure and energy intensity. In the case of Finland, Liimatainen and Pöllänen (2013) proposed and applied a new method for analysing the transport energy efficiency and the carbon dioxide emissions that provides a serious comparison between the countries while taking into account their national and international objectives. This method uses the details in the different economic sectors that use the road freight mode in the analysis of the relationships between economic activity, transport intensity and negative environmental externalities. They found that, despite the use of rail transport for goods in bulk, energy efficiency has maintained a constant level, and the total CO_2 emissions of the road freight transport have increased.

Interestingly, no study has ever been conducted in Tunisia on either the decomposition or the total amount of CO_2 emissions or on those related to transportation issues. For example, Fodha and Zaghdoud (2010) aimed to analyse the correlation and causality relationships between total emissions and GDP. This investigation explores the problem of CO_2 emissions growth by the identification of the major drivers, especially those related to road freight, the analysis of associated effects, and the proposition of key options required improvement in the emissions efficiency of the road freight in Tunisia. As energy consumption is considered to be the

[3] This indicator is defined as the ratio of the gross mass movement to GDP and measures the demand for transport per dollar of GDP. It can be measured separately for the passengers and freight activity.

[4] This approach supposes that transport CO_2 emissions can be influenced by the effects of four components: transport activity (A) (freight or passenger), the modal share (S), modal energy intensity (I) and the CO_2content of the fuel (F).