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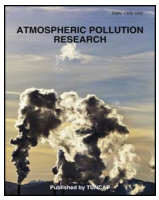

How economic crisis influence air quality over Portugal (Lisbon and Porto)?

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ABSTRACT

The aim of this specific study is to discuss the impact of the economic crisis on air quality in Portugal, with focus on particulate matter and nitrogen dioxide. For this purpose, a long-term period of economic and air quality monitoring data was analysed, including both periods before and after the crisis (2004–2015). The analysis was focused on the main urban areas of Portugal – Lisbon and Porto municipalities.

All the economic indicators highlight a decreasing trend since 2007, which is also evident for energy consumption, while for Gross Domestic Product (GDP) and disposal income there are signs of recovery after 2010. In terms of pollutants concentration, there is a negative trend since 2007 with reductions in the annual values higher in Porto (about 40% for NO_2 and PM10) than in Lisbon (25–30% of NO_2 and PM10). Correlations were found between pollutant concentrations and energy consumption, with a correlation factor superior to 0.7, for both Lisbon and Porto municipalities. No evidence of a linear relationship was found for the disposable income per capita. The results presented in the study support the notion that a significant alteration is undergoing to the air quality in Portugal, directly related to the reduction of energy consumption, consequence of the economic crisis, that starts to be registered after 2007 and after 2012 stops decreasing. While the economic indicators like GDP and disposable income reveal an increase after 2010–2102, no positive trend was found on the annual average of pollutants concentration.

1. Introduction

Improvement of air quality related to economic crisis has been defined recently in several works, mainly relating both emission and ambient air pollution levels (Sánchez de la Campa and de la Rosa, 2014; Cusack et al., 2013; Lyamani et al., 2011). Recent studies have reported several, both positive and negative, impacts of economic crisis on air quality. Several methodologies have been used to identify the relationships between economic crisis and air quality, such as satellite imaging (Castellanos and Boersma, 2012; Vrekoussis et al., 2013), contaminant gas levels (Santacatalina et al., 2011), and chemical composition of PM (Arruti et al., 2011; Cusack et al., 2013). Castellanos and Boersma (2012) analysed satellite observations and reported a reduction of at least 20% in NO_2 emissions throughout Europe for the period 2004–2010, attributed to both the global economic recession and environmental emission controls. Similarly, large reductions in NO_2 concentrations have been detected across the US during the respective US economic recession period [2007–2009] and over urban areas and power plants (Russell et al., 2012).

Castellanos and Boersma (2012) showed that in many large European cities, the reduction in NOx emissions during 2009 (recession year) outweighed approximately 4 years of policy improvements. Possibly due to the economic recovery in Europe, the NO_2 reductions slowed down in 2010. Vrekoussis et al. (2013) also used satellite observations of tropospheric NO_2 columns and reported significant reductions in large parts of Greece between 2008 and 2011 (the country is still facing the crisis that started in 2008). In the capital, the overall NO_2 decrease was in the range of 30–40%. The authors also analysed the temporal variability of surface concentrations of CO, NOx, SOx, and O_3 from 2004 to 2011 and identified two distinct periods (from 2004 to 2007 and from 2007 to 2011) where a sharp decrease in all primary pollutant levels occurred during the second period (economic crisis period). The significant differences reported by Vrekoussis et al. (2013) since 2008 are well correlated to various economic indicators of the anthropogenic activity and are attributed to the economic crisis. Karagiannidis et al. (2015) analyzed air quality data in a Greek city, Patras, between 2008 and 2011. They also argued that the economic crisis contributed to a significant reduction in particulate matter and several trace gases, namely CO, NO, and NO_2, due to a decrease in the anthropogenic activities. According to Russell et al. (2012), in the USA, large reductions in the observations of tropospheric NO_2 vertical column densities were detected, due to regulatory efforts and to the

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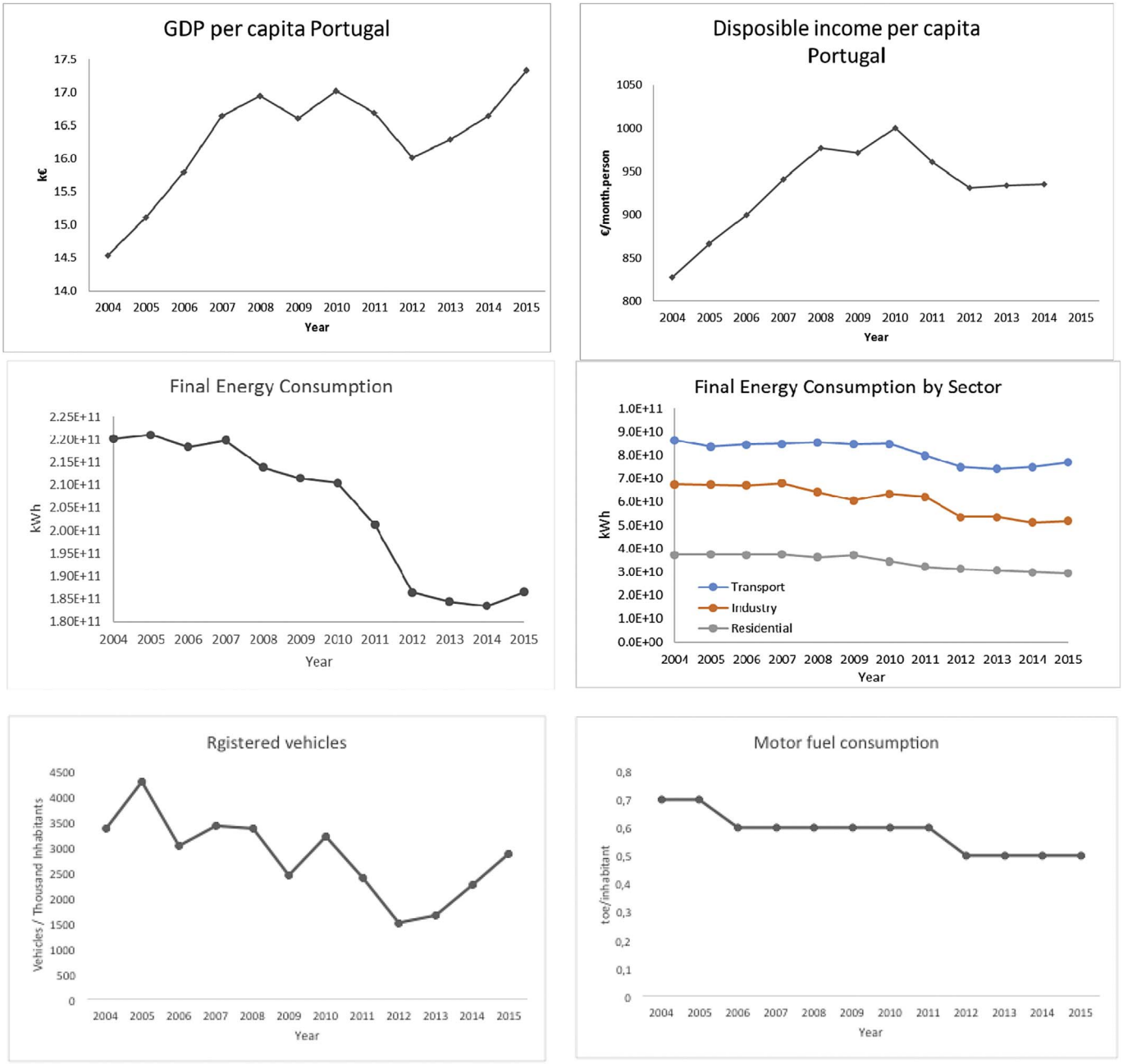

Fig. 1. Economic indicators (GDP per capita; Disposable income per capita; final energy consumption and per sector; Registered vehicles and Motor fuel consumption) at national level, for the period 2004–2015.

economic recession of 2008–2009. These authors showed that emission reductions from light-duty vehicles dominated the NO_2 decreases prior to the recession and a reduction in diesel truck activity has had a larger impact on emissions reduction since the start of the recession. Saffari et al. (2013) also conducted a wintertime sampling campaign for fine particles (PM2.5) in Thessaloniki during the winters of 2012 and 2013. These results indicate that the increase in airborne fine particles was mostly due to the replacement of fuel oil by the cheaper wood for domestic heating, as the price of fuel oil has nearly tripled.

The abovementioned articles mainly report a positive impact of economic recession on air quality. However, other studies have shown that the economic crises can also result in serious air pollution episodes. The impact of economic crisis in terms of air pollutants concentrations is twofold. On the one hand, the emissions are reduced due to the significantly lower consumption of diesel and the reduction of vehicle utilization for personal needs. On the other hand, people try to find cheaper ways in order to satisfy their heating needs such as timber and biomass heating systems, which are characterized by notably higher PM emission levels per kWh_{th} (Gaidajis et al., 2014). Despite its potential use as renewable and sustainable energy source, wood-fired winter heating is considered as one of the major emission sources of local air pollution (Bari et al., 2011; McNamara et al., 2013). For example, in previous studies over the city of Athens (Malico et al., 2017), where a decrease of NOx was registered, an increase in the ozone concentrations was reported.

Portugal is also among the European countries facing a serious financial/economic crisis in the aftermath of the 2008–2009 global recession, which affected its energy consumption profile due to the increased price of domestic heating oil and gasoline. According to Eurostat, the country's real gross domestic product (GDP) growth rate was negative from 2011 to 2013 and no real growth was verified in the last 12 years (Eurostat, 2016). The country seems to be recovering, with