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The Causality Link Between Energy Prices, Technology and Energy Intensity

1. INTRODUCTION

This chapter deals with a field of renewed interest in energy economics: the relationship between energy prices and energy intensity, which is measured by the ratio of final energy consumption to total output (GDP)ⁱ. For years, economic papers have been studying energy intensity through the decomposition of the energy demand (Wing & Eckaus, 2004 and Liu, 2005). The link between energy prices and energy intensity has not really been analyzed and is nowhere nearly as well established as other relations. A third variable, technological progress, may interfere in this relation. In a first analysis, it appears that technological changes can be stimulated by energy price increases and more efficient equipment reduces the energy demand. At the same time, an increase of energy demand is possible through a change in habits of consumption (changes in energy services, or energy use...). The causality link is complicated by this variable technology and its effects on energy consumption.

Consequently, the purpose of this chapter is to assess the link between energy prices and energy intensity, taking into account the role of technological progress. This discussion is stimulated by the recent energy price increase, especially in the oil market. Looking at past experience, since the two oil price shocks, should make it possible to assess the current impact in the different countries of the current price increase on energy efficiency and energy consumption. This subject is currently of crucial concern, given the importance of the environmental costs related to the production and consumption of energy and proposals to reduce greenhouse gas emissions. Today climate change and security of energy supply are amongst the greatest challenges to the growth of the economy and the well-being of citizens. The present energy system is undergoing transformations on the supply side as well as on the demand side to satisfy sustainability criteria. A main underlying political question is how to reduce greenhouse gas emissions through reduction in energy consumption. Whether or not energy efficiency is effective in reducing energy consumption is the subject of an ongoing debate (see Howarth, 1997).

The chapter is focused on the oil market. This choice is motivated by the importance of oil in the total energy consumption in countries of the Organization for Economic Cooperation and Development (OECD). Since the beginning of the last century, oil has been the major source of energy. It has replaced coal for the production of heat and for transport. Today, oil consumption accounts for 40 per cent of total primary energy production (EIA, 2004). Oil consumption is responsible for about 40 per cent of the carbon emissions and about 30 per cent of the greenhouse gas production (EIA, 2004). Furthermore, the recent increase in the oil price, which rose to near seventy US dollar a barrel during the summer of 2005, motivates the study of the interactions between oil prices, technical progress and oil consumption.

To this end, we use the multivariate Johansen's (1988) cointegration framework and Granger causality tests. More specifically, we use a vector error correction model (VECM) and test for the direction of the causality among the three variables. Such a framework has several

advantages over traditional techniques, which consist of testing causality in vector autoregressive models (VAR) specified in first differences if the variables are integrated of order one. From a technical view point, a VAR specified in first differences is incorrectly specified if the variables are cointegrated. Moreover, using a VECM rather than a VAR model allows us to distinguish between short-run and long-run causality among the variables.

We implement this approach in trivariate models. We could have performed the causality tests considering each pair of variables separately in bivariate models. This approach is widely used in the literature when examining causal relationships among variables, such as energy consumption and economic growth (Hondroyannis et al., 2002, Soytaş & Sari, 2003, Jumbe 2004). However, causality tests could lead to spurious conclusions if an important explicative variable is omitted (see, for example Glasure, 2002, for an illustration of this point in the energy field). Our results suggest that there is a clear dependence among the three variables. For this reason, a trivariate framework seems more relevant.

The analysis is applied to fifteen major industrialized OECD countries over the last 40 years. In this framework, we find a long-run relationship between oil intensity, oil price and technological progress in most countries. Moreover, the Granger causality tests reveal a causality running from prices to technical efficiency and from prices and technical efficiency to oil consumption in most OECD members. However, oil prices are found strongly exogenous except in major countries like the United-States. These results show that the actual price increase induces energy conservation through an increase in energy efficiency. This result stimulates discussions on energy taxes by governments for the promotion of energy efficiency and energy conservation programs.

The organization of this chapter is as follows. The following section presents an overview of the literature. Section 3 describes the data and the methodology used. Section 4 presents the empirical results. In the last section, the conclusions of the analysis are summarized and the policy implications are discussed.

ⁱ We do not analyze the link with economic growth presented in chapter 5.