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ScienceDirect
Journal of Policy Modeling 38 (2016) 436–447
Journal of Policy Modeling
www.elsevier.com/locate/jpm

Econometric general equilibrium modeling

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Available online 26 February 2016

Abstract

The point of departure for the study of the impact of energy and environmental policies is the neo-classical theory of economic growth formulated by Cass (1965) and Koopmans (1967). The long-run properties of economic growth models are independent of energy and environmental policies. However, these policies affect capital accumulation and rates of productivity growth that determine the intermediate-run trends that are important for policy evaluation.

Heterogeneity of different energy producers and consumers is critical for the implementation of energy and environmental policies. To capture this heterogeneity it is necessary to distinguish among commodities, industries, and households. Econometric methods are essential for summarizing information on different industries and consumer groups in a form suitable for general equilibrium modeling.

In this paper we consider the application of econometric general equilibrium modeling to the U.S., the economy that has been studied most intensively. The framework for our analysis is provided by the Intertemporal General Equilibrium Model (IGEM) introduced by Jorgenson and Wilcoxen (1990). The new version of the IGEM presented in this paper is employed for the evaluation of proposed legislation on climate policy by the U.S. Environmental Protection Agency (2011).

JEL classification: C51; C68; D58; E13; O41; O51; Q43; Q50

1. Introduction

Economic growth is a critical determinant of U.S. demand for energy. Emissions from the combustion of fossil fuels are an important source of U.S. requirements for pollution abatement. An essential first step in modeling the impact of energy and environmental policies is to analyze

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http://dx.doi.org/10.1016/j.jpolmod.2016.02.004
0161-8938/

the growth of the U.S. economy. The appropriate point of departure for modeling U.S. economic growth is the neoclassical theory of economic growth, originated by Solow (1956, 2005). This theory has been developed in the form appropriate for modeling the interrelationships among energy, the environment, and U.S. economic growth by Cass (1965) and Koopmans (1967)[1].

Maler (1974) and Uzawa (1975) have presented neo-classical theories of economic growth with pollution abatement. A recent survey by Brock and Taylor (2005) summarizes the extensive literature on this topic. Solow (1974a,b) has provided a theory of economic growth that includes an exhaustible resource. The classic textbook treatment of this topic remains that of Dasgupta and Heal (1979), who also give a detailed survey of the literature. In this paper we focus on pollution abatement, since the U.S. economy is relatively open to trade in natural resources, exporting coal and importing oil and natural gas.

In the neoclassical theory of economic growth wage rates grow at the same rate as productivity in the long run, while rates of return depend on productivity growth and the parameters that describe saving behavior. These long-run properties of economic growth are independent of energy and environmental policies. The neoclassical theory of economic growth also provides a framework for analyzing intermediate-run growth trends. These trends reflect the same determinants as long-run trends, but also depend on energy and environmental policies through their effects of capital accumulation and rates of productivity growth. In this context the "intermediate-run" refers to the time needed for the capital-output ratio to converge to a long-run stationary value. This often requires decades, so that the impact of energy and environmental policies on intermediate-run trends is critical for policy evaluation.

The slowdown of the U.S. economy during the 1970s and 1980s and the acceleration of growth during the 1990s and 2000s are striking examples of changes in intermediate-run trends. Two events associated with the slowdown – the advent of more restrictive environmental policies and the increase in world petroleum prices – have led to a focus on the interactions of energy supplies and prices, environmental quality and its cost, and the sources of economic growth. Similarly, Jorgenson (2009a) has demonstrated that the rapid development of information technology is the key to more rapid growth in the 1990s and 2000s.

Nordhaus (2008, 2010) has applied the Cass–Koopmans theory of economic growth to the analysis of energy and environmental policies in his important studies of climate policy for the world economy. The necessarily schematic modeling of technology limits consideration of issues that are very important in implementation of energy and environmental policies at the national level, such as the heterogeneity of different energy producers and different consumers. To capture this heterogeneity we distinguish among commodities, industries, and households. We employ an econometric approach to summarize information on different industries and different consumer groups in a form suitable for general equilibrium modeling. We next consider the application of the econometric approach to the U.S. economy.

The framework for our econometric analysis of the impact of energy and environmental policies is provided by the Intertemporal General Equilibrium Model (IGEM) introduced by Jorgenson and Wilcoxen (1990) and summarized below[2]. The organizing mechanism of this model is an intertemporal price system balancing demand and supply for products and factors of production. The intertemporal price system links the prices of assets in every time period to the discounted

[1] Barro and Sala-i-Martin (2004) provide a standard textbook treatment.

[2] The G-cubed model of the world economy introduced by McKibbin and Wilcoxen (1999) and analyzed by McKibbin, Morris, and Wilcoxen (2010) is another important application of the econometric approach.