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# World Oil Depletion Models: Price effects compared with strategic or technological interventions

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**Abstract**

World oil depletion, including natural gas liquids, was modelled in the past by many authors. Recently, Guseo and Dalla Valle have introduced and Guidolin has applied a new approach following perturbed life-cycle diffusion models. Here we examine joint effects of economic and strategic or technological interventions using a Generalized Bass Model (GBM). Statistical analysis takes into account three different hierarchical levels: natural diffusion, long memory interventions and stochastic components. The main results confirm the statistical significance of historical 1970s shocks and highlight a strong long memory effect due to an increase in oil production after World War II. The estimated peak-date, 2007, and the 90% depletion time, 2019, are determined under an equilibrium intervention hypothesis.


*Keywords:* Oil peak; Depletion times; Oil price elasticity; Diffusion process; Generalized Bass model; Nonlinear models; ARMAX

## 1. Introduction

The powerful worldwide economic growth after World War II has been sustained by surplus capacity in hydrocarbon fuels, in particular by crude oil intensive production. If we look at Fig. 1 we can observe

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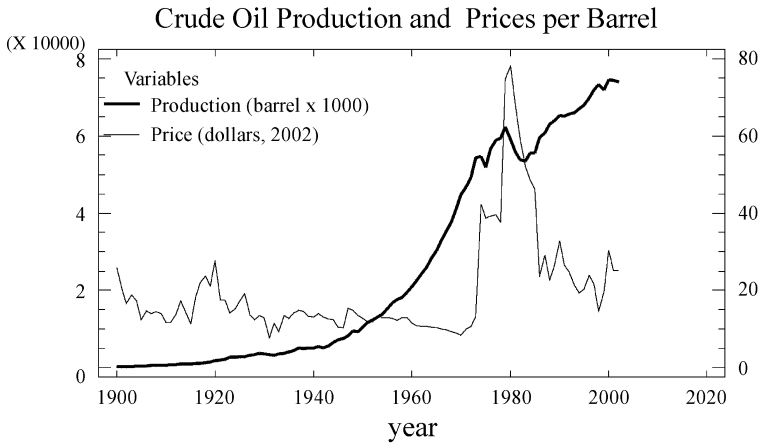


Fig. 1. World oil daily production (thousands of barrels) and prices per barrel (dollars, 2002). Source: Industriedatenbank and British Petroleum, BP.

that world daily crude oil extraction increased with a weak proportional shape from the beginning of the 20th century until the end of World War II. We note that, after this long period, there was an exponential deviation of daily oil production sustained for at least two decades until the well-known international crude oil shocks of the 1970s. Growth and development of efficient new technologies within transport, heating, cooling, chemical products for industry and agriculture are essentially based upon crude oil transformations.

Emerging economies such as China, India and other countries are now increasing the new global demand for more energy (see, for example, Fig. 8). China is strongly engaged in coal extraction in order to sustain the internal electric increasing demand of a day by day expanding economy.

The expansion of world economy interacts with the evolution of population.

The demographic effects of the over rapid economic growth are well described by Cohen [3]. The trend toward urbanization is clear. The rural population of the rich countries peaked around 1950 and has slowly declined since then. World average length of life rose from about 30 years at the beginning of the 20th century to 65 years at the beginning of the 21st century. Current global population growth rates are far higher than any experienced before World War II. The world population of 6.3 billion will peak, around 2050, at 8.9 billion (medium variant scenario of United Nations Population Division, World Population Prospects: the 2002 Revision, Highlights). At the same time, 30 of the more developed countries are expected to have a lower population in 2050 than today (Japan −24%, Italy −22%, FSU −29%). Migrations, food, housing, education, health, employment and public order pose formidable challenges to economies, and to social and political governance, that should conceive efficient technological innovations to overcome these crucial problems.

This issue was previously examined by Marchetti (see Refs. [4–6]). He highlighted that *niche* of mankind is expanding under the new advances of technology even if diffusion of population is not homogeneous, especially in Europe. Nevertheless, some regularities in the evolution of inventions and innovations in waves–supported by new energy resources–are strongly promising and contrary to Malthusian approaches. Information, knowledge and science, as analyzed by Marchetti [6], are the new paradigm of *Logos*.