The Macro-Economic Perspective

Stanford Net Energy Analysis: April 1\textsuperscript{st}, 2015

Dr. Vlasios Voudouris
Research Collaborators

Project: The Economic Growth Enigma

Prof. Robert Ayres, INSEAD (Paris, France)

Dr. Daniil Kiose, Kingston University (London, UK)

Dr. Andre Cabrera Serrenho, University of Cambridge (Cambridge, UK)
EU 15: The distribution of economic growth is diverse – cannot be ignored
The economic growth enigma: Capital, Labour and Useful Energy?
NOTE: Mechanical drive seems is growing event for ‘efficient’ countries like Germany. When it declines this is because of the recent Great Recession. This is evident if you compare, for example, Greece or Portugal with Germany or Netherlands. What about the UK?
Beyond Mean Growth: The Generalized (semi-parametric) Production Function

\[ Y| (\mu, \sigma, \nu, \tau) \sim D(\mu, \sigma, \nu, \tau), \]
\[ g_1(\mu) = f_{m_1}(K) + f_{m_1}(L) + f_{m_1}(E), \]
\[ g_2(\sigma) = f_{m_2}(K) + f_{m_2}(L) + f_{m_2}(E), \]
\[ g_3(\nu) = f_{m_3}(K) + f_{m_3}(L) + f_{m_3}(E), \]
\[ g_4(\tau) = f_{m_4}(K) + f_{m_4}(L) + f_{m_4}(E), \]

**NOTE:** The generalized production function should not be understood as a tool for making point-estimates. Rather, the function should be understood as a tool for estimating the **predictive density** of economic growth. Moreover, the generalized production function uses **non-parametric smooth methods** in order to capture the economic diversity of the EU 15 countries given capital, labour and (useful) energy. Interaction effects are modeled, for example, \( f(K,L). \) \( D \) is a parametric distribution.
NOTE: The isoquant figures explore the interaction effects of capital, labour and useful energy. Each two-factor interaction is presented by assuming that the third factor is at the minimum.
NOTE: The isoquant figures explore the interaction effects of capital, labour and useful energy. Each two-facto interaction is presented by assuming that the third factor is at the mean.
EU 15: What drives economic growth? … maximum growth

NOTE: The isoquant figures explore the interaction effects of capital, labour and useful energy. Each two-factor interaction is presented by assuming that the third factor is at the maximum. Almost no substitution for capital.
What drives economic growth? ... decomposing useful energy

**NOTE:** It is evident the importance of capital, labour, mechanical drive, heating and lighting. Muscle work is the only one that has negative effect while “other electrical uses” is marginally positive. The slope indicates the magnitude of the effect of the factor of production on economic growth.
Isoquant: decomposing the effects of useful energy

NOTE: Substitution of the different energy categories of mechanical work, heating and electrical uses…
... what about Greece?

**NOTE**: Energy is by far the most important factor of production for Greece - reform the energy market first to boost economic growth!
High-level macroeconomic-energy policy recommendations

• The need for **natural resource taxation** (counterbalanced by reduced taxation of capital and labour) and the need for robust systems of natural resource governance towards sustainable economic growth trajectories (thinking of energy as an important component of natural resources that drive economic growth).

• Greater **availability and productivity of useful energy for mechanical drive and heating**. This is because these two categories of useful energy have the highest impact on economic activity as least since 1970s while resource scarcity will elevate resource productivity as an important driver for economic growth.

• Transition to **low carbon economic systems** should be done in a way that ensures higher availability and productivity of useful energy.

• Attention to problems of crude oil resource depletion (particularly the relatively inexpensive crude oil) is important to continuously evaluate any **foreseeable collision between increasing consumption of useful energy for mechanical drive and the inexpensive crude oil resources of the planet**.
Thank you

Dr. Vlasios Voudouris

Stanford Net Energy Analysis: April 1st, 2015