Energy embodied in trade, 1970-2009

Viktoras Kulionis*

January 13, 2017

Introduction

Historical evidence shows that the relationship between energy use and economic growth in the developed countries has been tightly coupled until about 1970. The period after is marked by stabilization in energy use per capita and economic growth without a proportional increase in energy use.

Several factors have been put forward to explain this change: (i) structural changes in composition of national output toward lighter manufacturing industries and services that, on average, used less energy per unit of output than the heavy industries that had been dominant in the past; (ii) technological change and significant improvements in thermal efficiency of energy conversion; (iii) changes in the composition of energy supply, in particular relative increase of electricity inputs (electricity is high quality form of energy, thus less electricity is required to produce the same amount of output) and fluid fuels (petroleum and natural gas) which were in many ways more flexible than solid fuels in the uses to which they could be put into.

These factors turned out to be important, but they provide only partial explanation. Another element that is in general less obvious and often omitted but is crucial in explaining the trend change since the 1970s is energy embodied in traded goods. Trade entails the movement of goods produced in one country for consumption in another. This implies that a country can partially disconnect its domestic economic and ecological systems as some goods can be produced and imported from other countries.

Many studies have quantified energy and carbon content embodied in international trade. First focusing on one country and its major partners over specific years to one country over time, then to various countries over specific years and lately to global analyses of 10-15 year time period. However, due to limited data availability for the period before 1990 little attention has been devoted to study the changes of energy embodied in trade over long time period for multiple countries. This study seeks to bridge the gap by estimating energy embodied in trade for the UK, US, France and Denmark during the period 1970-2009. The analysis requires combination of several data sources and use of MRIO and SRIO models.

The main aim of this study is to examine to what extent the change in energy consumption can be attributed to the international trade (i.e., energy embodied in imported goods). The scope of this problem warrants more detailed questions that target specific aspects studied in this paper, such as: (i) What shares of energy are linked to production for export and how much is embodied in imported goods? (ii) Do countries exhibit similar decoupling trends?

*PhD Candidate, Department of Economic History, Lund University, Sweden
e-mail: viktoras.kulionis@ekh.lu.se

Data and Method

The study is split into two periods 1970-1990 and 1995 -2009. The World Input-Output Database (WIOD) is the main source of data for the period 1995-2009. For the period from 1970 to 1990 the data were extracted from two sources: IO tables from OECD IO database and energy balances from IEA. The OECD SRIO tables distinguish between 36 industrial sectors. However the data are only available for a limited number of countries and specific time periods. Due to data availability this study focuses on the UK, US, France and Denmark.

The WIOD database offers "ready to use" harmonized MRIO tables and energy accounts with the same sectoral classification. The OECD IO tables and the IEA energy balances, however use different industrial classification Typically, the IEA sectors are more aggregate than the OECD IO sectors. The connection of the physical IEA energy balances with the monetary IO tables follows the "minimum information method" as in WIOD, this allows for the results to be comparable.

The first part (from 1970 to 1990) is based on the SRIO model. The SRIO model estimates the energy associated with its total consumption by assuming that all other countries in the world have the same technological structure as the modeled country i.e. the imported goods and services are produced with the same technology as domestic technology in the same sector, hence this assumption is known as the domestic technology assumption (DTA). The second part from 1995 to 2009 is based on the MRIO model. This method overcomes the issues associated with the SRIO DTA by using different technology factors for different countries.

Results

The results show that energy use and economic growth among the selected countries have changed in similar ways. From 1970 to 2009 GDP per capita doubled while energy use had increased only by about 30%. This evidence supports relative decoupling hypothesis which has been common in previous studies.

Energy content embodied in imports and exports varies across countries and over time. The UK, France and Denmark have similar profiles in terms of embodied energy with about 1/3 of their total energy embodied in exports and between 20-60% in imported goods. The US, on the other hand display smaller shares, 6-11% of energy is embodied in imports and 9%-28% in exports. This is reflected in the balance of energy embodied in trade that is negative for the US, France and Denmark already in the 1970s. While for the UK the balance is positive in the beginning of the period but turns negative since 1980-1985.

Evidence also suggest that energy embodied in imports increased more rapidly than in exports, which in fact remained relatively stable over the period in all selected countries. After accounting for energy content in imports, decoupling becomes less pronounced in the UK and US, while in France it nearly disappears. These results only partially complement previous findings that the volume of trade is too small to account for the reduced energy use.

Moreover, the findings demonstrate that the energy intensity of imports and exports have been declining steadily over time, with the rate of decline seemingly greater in the latter case. This implies that exports from the UK, US, France and Denmark are more highly valued per unit of energy required to produce them.