Cátedra
ECONOMÍA DE LA ENERGÍA Y DEL MEDIO AMBIENTE

UNIVERSIDAD DE SEVILLA

1st AIEE Energy Symposium
Current and Future Challenges

Industry level production functions and energy use in within a

growth framework

María Pablo-Romero Gil-Delgado

Milan, 1December 2016

Cátedra
ECONOMÍA DE LA ENERGÍA Y DEL MEDIO AMBIENTE

There is no widely accepted theory which shows the relationship between energy and economic growth.

Studies show results:

- without causality;
- with a causal direction running from energy to production;
- with a causal direction running from production to energy consumption;
- and that double causality exists.

Although many of these studies suggest the existence of at least a causal relationship running from energy to economic growth, the inclusion of the energy factor in the production function has been scarce

Cátedra
ECONOMÍA DE LA ENERGÍA Y DEL MEDIO AMBIENTE

The industrial sector uses more delivered energy than any other end-use sector, consuming about 54% of the world's total delivered energy.

Additionally, industrial sector energy consumption is projected to increase by an average of 1.2%/year worldwide.

Despite the importance of energy use by industry, there are few studies examining the effect of energy consumption on industrial output by sectors.

Cátedra
ECONOMÍA DE LA ENERGÍA Y DEL MEDIO AMBIENTE

OBJETIVE

The aim of this study is to analyse the role of energy in the industry sector economic growth

With that purpose

Industry-level translog production functions are estimated including an energy variable as independent variable

Panel Data techniques are used to estimate it

Cátedra
ECONOMÍA DE LA ENERGÍA Y DEL MEDIO AMBIENTE

DATA SAMPLE

18 EU countries- depending on available data

Austria, Belgium, Bulgaria, Czech Rep., Denmark, Estonia, France, Germany, Greece, Hungary, Ireland, Italy, Netherlands, Poland, Slovenia, Spain, Sweden and the United Kingdom

Period analyzed 1997 to 2007

The translog production functions are estimated for ten industry levels:

Food and beverages, textiles, wood, pulp and paper, chemicals, non-metallic, transport equipment, other manufacturing, mining and construction.

Cátedra
ECONOMÍA DE LA ENERGÍA Y DEL MEDIO AMBIENTE

Variables Used

- **Gross Value Added**
  data came from the Economic Data by Enerdata
- **Physical capital**
  data came from the WIOD Socio-Economic Accounts sub-base
- **Human capital**
  Measured as the percentage of hours worked by highly and medium qualified workers.

  This variable has been constructed from WIOD Socio-Economic Accounts sub-base
- **Employment**
  Data came from the WIOD Socio-Economic Accounts sub-base.
- **Energy**
  Data came from the Global Energy Statistical by Enerdata

Cátedra
ECONOMÍA DE LA ENERGÍA Y DEL MEDIO AMBIENTE

DATA BASE

World Input-Output Database (WIOD): for 40 countries

Provides
• time-series of world input-output tables for the period from 1995 to 2011.
• data on labor, capital inputs (only until 2007) and energy indicators

Enerdata database.

Provides, among others, detailed and temporal energy statistics

Cátedra
ECONOMÍA DE LA ENERGÍA Y DEL MEDIO AMBIENTE

Modelling

Starting point

$$Y_{it} = A_{it} + \beta_l L_{it} + \beta_k K_{it} + \beta_h h_{it} + \beta_p E_{it} + \beta_{kl} K_{it} L_{it} + \beta_{kh} K_{it} h_{it} + \beta_{kp} K_{it} E_{it} + \beta_{hl} h_{it} L_{it} + \beta_{hp} h_{it} P_{it} + \beta_{lp} L_{it} E_{it} + 1/2\beta_{kk} K_{it}^2 + 1/2\beta_{hh} h_{it}^2 + 1/2\beta_{pp} E_{it}^2 + 1/2\beta_{ll} L_{it}^2$$

Y is the sum of the logarithm of the TFP (Ait) and total input

Total input is determinated by a translog production function with four arguments (K, E, L and h),

Cátedra
ECONOMÍA DE LA ENERGÍA Y DEL MEDIO AMBIENTE

Modelling

We assume: constant returns to scale. Variables are expressed in per employee

Data were converted to deviations from the geometric mean of the sample. In order to avoid multicolliearity between variables

Data were converted to first differences to avoid spurious estimates.

We include: the evolution of the technological progress

$$\delta t - \lambda (yit - yLt)$$

equal to the sum of a common temporal effect for all the countries (δt) and a technological catch-up term

Cátedra
ECONOMÍA DE LA ENERGÍA Y DEL MEDIO AMBIENTE

Modelling

$$\Delta y_{it} = \delta_t - \lambda(y_{it} - y_{Lt}) + \beta_k \Delta k_{it} + \beta_h \Delta h_{it} + \beta_e \Delta e_{it} + \beta_{kh} \Delta k_{it} h_{it} + \beta_{ke} \Delta k_{it} e_{it} + \beta_{he} \Delta h_{it} e_{it} + \frac{1}{2}\beta_{kk} \Delta k_{it}^2 + \frac{1}{2}\beta_{hh} \Delta h_{it}^2 + \frac{1}{2}\beta_{ee} \Delta e_{it}^2 + \beta_c C_{it}$$

Coefficients of terms with cross-products

Positive values indicate complementarity
Negative values indicate substitutability

Coefficients of the quadratic terms

Negative values indicate decreasing returns to scale

We have done several estimates and some coefficients are removed if there are not significant

Cátedra
ECONOMÍA DE LA ENERGÍA Y DEL MEDIO AMBIENTE

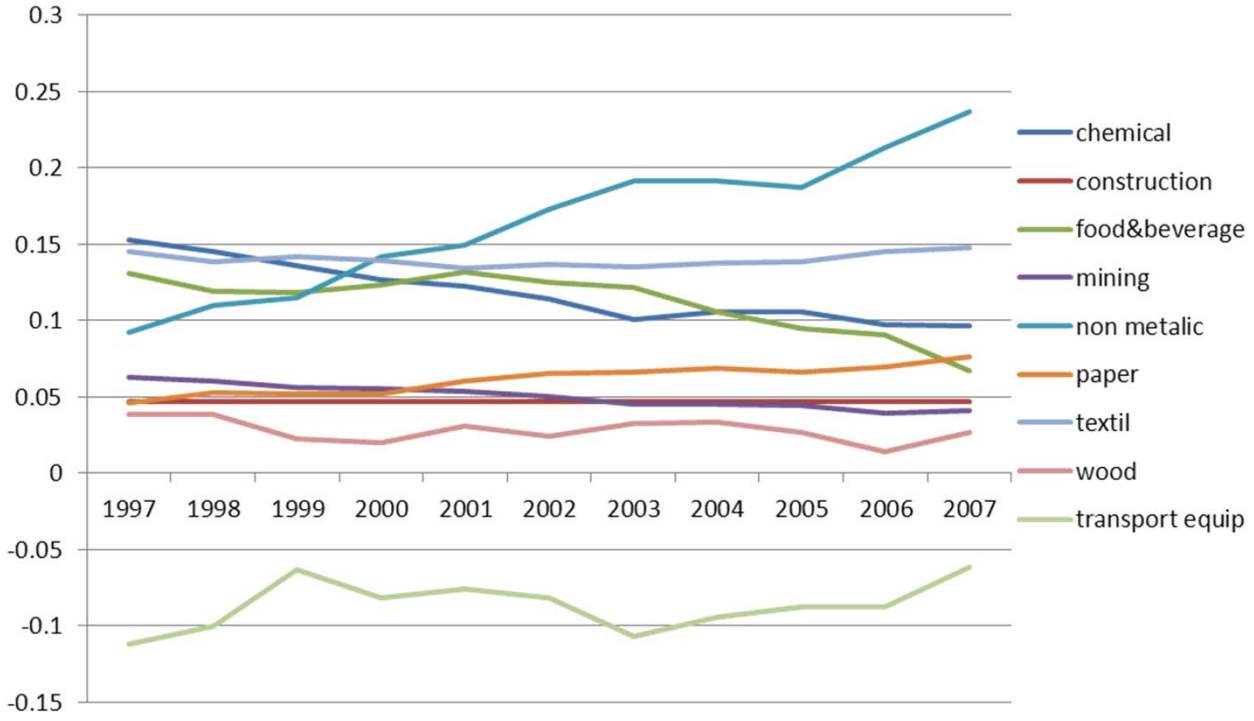
SOME RESULTS

	Chemi.	Const	Food	Mining	Non-met.	Others	Paper	Textil	Wood	Tran
E	0.12***	0.04***	0.11**	0.05***	0.16***	-	0.06***	0.14***	0.02**	-0.85**
K	0.11*	0.40***	0.22***	0.47***	0.75***	0.45***	0.58***	0.75***	0.28***	0.29***
H	0.54***	-0.16***	0.32***	0.20***	-0.86***	-0.24***	0.28***	0.13*	0.31***	0.33***
EK	-0.15***	-	-0.28***	-0.02***	0.39***	-	0.11***	-	-0.11***	0.12***
EH	-	-	-	-0.11***	-	-	-	-	-	-
KH	0.17***	0.14***	-	-	-0.16***	-	0.05***	-	-	-
E2	-	-	0.31***	-	-	-	-0.03***	-0.04***	0.04***	-0.19**
K2	-0.049*	-0.03***	-0.12***	-	-0.01***	-	0.45***	0.10***	0.03***	-0.13**
H2	-	-	0.16***	-	-0.78***	-	-	-	-	-
TP	-	-0.005**	0.008***	-	-0.01***	-0.01***	-0.01***	-0.01***	-0.001*	-

Cátedra
ECONOMÍA DE LA ENERGÍA Y DEL MEDIO AMBIENTE

SOME RESULTS

Average productivity elasticity with respect to energy use by industrial sector



Cátedra
ECONOMÍA DE LA ENERGÍA Y DEL MEDIO AMBIENTE

Conclusions

Mostly, energy is a factor that influence industry production growth in all sector except for *others* and *transport equipments*

Energy and Stock of capital are substitutes factors in *Food and beverages, wood, chemicals* and *mining*

Energy and Stock of capital are substitutes factors *pulp and paper* and *transport equipment*

Decreasing returns to scale for Energy are observed in *transport equipment*

Increasing returns to scale for Energy are observed in *Food and beverages* and *wood.*

Cátedra
ECONOMÍA DE LA ENERGÍA Y DEL MEDIO AMBIENTE

Thank you for your attention