rede
research in economics, business and the environment

Another look at CO_2 emissions modelling

The role of energy prices in developed countries

Yolanda Pena-Boquete

Miguel Rodríguez

Universidade de Vigo

rede

(Research **in E**conomics**, B**usiness and the **E**nvironment**)**

www.rede.uvigo.es

Departamento de Economía Aplicada

Universida de Vigo

Motivation

- The Environmental Kuznets Curve (EKC) theoretical foundations based on three effects:
  - ✓ the scale effect, the structure effect and the abatement effect
- EKC Implications:
  - ✓ Legitimate strategies for no-action against climate change (mainly on Non-Annex I countries)
  - ✓ Reductions in CO_2 emissions will occur during the normal course of development
- Global CO_2 emissions might rise by 27% from 2010 to 2030 with an average annual growth rate of 1.2%
- Policy makers should consider to use economic tools (as taxes) that impact on energy prices in order to control the CO_2 emissions.

Objectives

- To highlight that economic growth in itself does not reduce CO2 emissions.
- To show the influence of energy prices on the CO2 emissions
- To analyse the substitution effects between energy prices.

Evidence on EKC

- The vast research on the existence of an EKC for per capita CO_2
  - ✓ The literature was not able to come out with robust conclusions.
  - ✓ When papers do not found evidence of EKC they do found a positive relationship between per capita income and emissions.
- Traditional variables (to explain CO2 emission growth)
  - ✓ GDP and population growth.
- Additional variables
  - ✓ international trade, globalisation, energy intensity, economic structure of the economy, primary energy use in final energy consumption, the share of fossil fuels…
- There are only 3 papers including energy prices

EKC and energy prices

- Some authors have included the energy price in the EKC (Agras and Chapman (1999), Heil and Selden (2001) & Richmond and Kaufmann (2006))
  - ✓ EKC for carbon emission is weakened when energy prices and trade variables are included.
  - ✓ Price variable does not show variability between countries
    - Agras and Chapman (1999) & Heil and Selden (2001) use the same variable for all countries (real gasoline prices in the $US)
    - Richmond and Kaufmann (2006), they use the same deflator for all countries.
  - ✓ They do not account for energy substitution effects
  - ✓ They do not consider the renewable energy

Empirical analysis (IPAT equation)

$$d_{it} = \delta d_{it-1} + \beta_1 y_{it} + \beta_2 y_{it}^2 + \beta_3 e_{it} + \beta_4 p_{it}^{oil} + \beta_5 p_{it}^{coal} + \beta_6 p_{it}^{gas} + \beta_7 o + u_{it}$$

- Y_{it} GDP per capita
- pop_{it} Population
- E_{it} Total primary energy consumption per capita
- P_{it} prices of primary energies
- O_{it} capacity for production of renewable energy (output)
- U_{it} the error term

➢ We also include:

- ✓ Specific-year dummies accounting for economic changes affecting all countries.
- ✓ country-specific trend accounting for changes in the behavior over time, for example efficiency over time.

System GMM

(Blundell and Bond, 1998)

- System GMM performs better than others estimators for estimating dynamic models even for small number of individuals (Soto, 2009)
  - ✓ OLS and FE estimators are biased and inconsistent
    - Lagged variable is correlated with the error term
- System GMM requires a stationarity restriction on the initial conditions
  - ✓ CO2 per capita contains a unit root
    - Including time dummies is enough to satisfy the stationarity condition (Bond, et al. 2001)
- Roodman (2009) recommendations:
  - ✓ In order to reduce excessive numbers of instruments, to “collapse” the instrument set into a single column

OUR DATA

- Two IEA data bases for 15 OECD countries in the period 1980-2004:
  - ✓ "CO2 emissions from fuel combustion 1971-2004"
  - ✓ "Energy balances 1960-2005"

OUR HYPOTHESIS

- We consider the energy prices as a key factor explaining the CO2 emission trends in OECD countries.
- We have also estimated the IPAT model as a sort of comparability with other methodologies performed previously in the literature.

Departamento de Economía Aplicada

Universidade de Vigo

rede research in economics, energy and the enviroment

What does the statistic analysis tell us?

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
ln(GDPpc)	0.101	-0.778	0.155*	-0.555*	-0.083	-0.34	-0.336	-0.074	-0.57
Lag_ln(GDPpc)		0.802		0.483*		0.016	0.258		0.472
ln(GDPpc)2	-0.018	0.004	-0.047**	0.02	0.001	0.265	0.003	0.011	0.021
ln(Epc)			0.824***	1.121***	0.659***	1.394***	0.650***	1.358***	0.268
Lag_ln(Epc)				-0.933***		-1.200***		-1.112***	
D_ln(Epc)									0.863**
ln(Oil prices)			-0.006*	-0.008*	-0.016***	-0.010*	-0.018***	-0.009	-0.013**
ln(Coal prices)					0.019***	0.007	0.020***	0.008	0.009
ln(Gas prices)					0.028***	0.01	0.027***	0.012	0.012
ln(Renewables)			-0.090***	-0.037*	-0.070***	-0.036***	-0.071***	-0.038***	-0.042***
Lag_ln(GHGpc)	0.967***	0.974***	0.288***	0.820***	0.458***	0.823***	0.458***	0.788***	0.761***
Constant	-0.037	-0.046	5.597***	1	4.452***	1.266	4.368***	1.629	1.767
Observations	390	390	390	390	387	387	387	387	387
Instruments	47	46	53	54	51	62	55	59	55
p value AR(1)	0	0	0.006	0	0.001	0.001	0.003	0.001	0
p-value AR(2)	0.295	0.961	0.45	0.563	0.584	0.206	0.917	0.27	0.682
p-value Sargan	0.142	0.891	0.016	0.499	0.336	0.49	0.191	0.276	0.276

* p<.1; ** p<.05; *** p<.01,

Year-specific dummies and country trends included

MAIN LESSONS (1/2)

- The IPAT modelling approach is useless in order to explain the past and even to anticipate the evolution of CO2 emissions in the near future.
  - ✓ Neither the GDP per capita nor its square appears to be significant, i.e. we do not find evidence for the EKC.

- Energy consumption per capita is always an important element explaining CO2.
  - ✓ CO2 dynamics are better explain by changes in per capita energy consumption instead of its level counterparts (current and lagged).

MAIN LESSONS (2/2)

- The results show that oil prices appear to be significant in all specifications
  - ✓ They present a negative sign (an increase in prices lead to a decrease in emissions).
- Coal and gas prices do not appear to be significant even in cases they show a substitution effect with oil prices.
- Production of renewals shows a negative effect on CO2 emissions
  - ✓ The possibility of using renewable energy is an important tool to decrease the CO2 emissions.

Policy implications

- Policy makers should concentrate their efforts in giving the correct signals to the markets.
  - ✓ They should not rely on the normal curse of development in order to curb emissions as a result of any improvement on energy efficiency.

- Prices and renewable energy are important tools to decreases the CO_2 emissions.
  - ✓ Before using prices as a tool they should analyse the effects on welfare and income distribution.

rede
research in economics, energy and the enviroment

THANKS!!!!!!

Yolanda Pena-Boquete

Departamento de Economía Aplicada
Universidade de Vigo

y.penaboquete@uvigo.es
rede (Research in Economics, Business and the Environment)
www.rede.uvigo.es

Departamento de Economía Aplicada
Universidade Vigo