The International Econometric Competition

29-30 March, 2010
Vilnius

Introduction

A couple of recent papers[1] state some interesting empirical facts:
- the electricity consumption per capita is linked to the national income per capita in an inverted-U-shaped form;
- in general, the correlation coefficient between the electricity consumption and gross domestic product is moderately-sized for the middle-income countries, whereas it takes lavues close to one for the high-income countries.

With your help we will give some economic explanation and interpretation of the observed phenomena avoiding also some problems of specification.

<u>The related files</u>:
- *data.** - a dataset (*csv* or *xls*);
- *description.txt* - a detailed description of the data.

Task 1

1) Leaning on the official EU data provided in the dataset, replicate the inverted-U-shaped relationship by applying the fixed effects estimation of the following supposed (regression) model:

$$y_{it} = \alpha_i + \beta_1 x_{it} - \beta_2 x_{it}^2 + \varepsilon_{it}, \quad \beta_1, \beta_2 > 0, \tag{1}$$

$y := \frac{el\_cons}{pop}$ - electricity consumption (in toe) per capita;
$x := y\_pps$ - gross domestic product per capita in purchasing power standard;

a) Hypothesise and establish empirically the problems of such an econometric specification or estimation and enumerate them, if any (note: the presentation of results should include a list of potential problems, the problems identified as statistically significant with a summary of the testing results).

b) If needed, propose your modification of the estimation method and/or the econometric specification (without including any other *economic* variables into the regression). Convince us that it is the best choice.

c) Calculate (and compare, if relevant) the 'threshold' value(s) of income per capita. Can the hypothesis be rejected that, taken individually, the income per capita level in Belorussia, Estonia, Latvia, Lithuania, or Poland differs insignificantly from the threshold income level? Define the statistical inference procedure that was applied. What are the implications for the demand of

[1] Yoo S.H. and J.S. Lee (2010). "Electricity consumption and economic growth: A cross-country analysis", *Energy Policy 38*, pp. 622-625.
Ferguson R., Wilkinson W., and R. Hill (2000). "Electricity use and economic development", *Energy Policy 28*, pp. 923-934.

electricity in the future for the listed countries?

2) Let us augment the above provided specification with other economic variables.

a) First, using the best model developed above and augmented respectively, test the following economic hypothesis: "there is a structural shift in the higher-income countries towards non-industrial sectors that are less energy-intensive". Does this completely and correctly explain the inverted-U-shaped income effect?

b) Propose your best model, where any variables and considerations are taken into account. How does it differ from the previous ones? Convince us that it is a good econometric model and the appropriate estimation method was applied. Did the inverted-U-shaped income effect survive?

c) Compare the threshold income per capita level with the previously determined one and evaluate whether the income per capita level in Belorussia, Estonia, Latvia, Lithuania, and Poland differs significantly from it.

Task 2

Now we turn to the importance of a shadow economy. Assume we investigate a time series process. For every period t, let R_t stand for the ratio of a shadow economy (S_t) to the officially registered national income (Y_t). Suppose that the data generating processes (DGP) of Y_t and R_t are given by

$$\frac{Y_t}{Y_{t-1}} = e^{\psi+\theta g_t+u_t}, \quad \psi, \theta > 0, \quad u_t \sim i.i.d.(0, \sigma_u^2), \quad Y_0 = const. > 0 \tag{2}$$

and

$$R_t = e^{\kappa+\eta\tau_t-\lambda g_t+v_t}, \quad \kappa, \eta, \lambda > 0, \quad v_t \sim i.i.d.(0, \sigma_v^2), \tag{3}$$

where the bounded mutually independent stationary random variables $g_t \in [0, 1]$ and $\tau_t \in [0, 1]$ represent the institutional quality of economic environment and the tax burden, respectively. The error terms u_t and v_t are mutually independent and also independent of any explanatory variable and ϵ_t defined bellow.

Consider the two alternative DGPs of consumption of electricity (E_t) given by

$$E_t = (\alpha S_t + Y_t)^{\beta} e^{\epsilon_t} \tag{4}$$

or

$$E_t = S_t^{\alpha} Y_t^{\beta} e^{\epsilon_t}, \tag{5}$$

where in both cases it holds $\alpha, \beta > 0$ and $\epsilon_t \sim i.i.d.(0, \sigma_\epsilon^2)$ is independent of all the defined explanatory variables.

a) Provided that S_t is unobserved, can you construct a consistent estimator of β? If yes, prove the consistency.

b) Suppose now that a country has fixed its tax rate at $\tau_0 = const.$ and the institutional quality is a non-stochastic variable. What is the impact on the coefficient of correlation between the logarithms of electricity consumption and national income, when g_t has increased e.g. from 0 to 1? Compare such an effect with the mean-preserving-decrease in the variance of a stochastic g_t.

c) It is well known in the economic growth theory that 'institutions matter'. Can the DGP described above and empirically unobserved S_t lead to an effect similar to that presented in eq. 1 or its log-linear analogue?

Final remark

If you still have plenty of time, obtain a forecast of the demand for electricity in the Bel-Pol-Baltic region and tell us, what is the total capacity of plants needed in order the region would become a net exporter of electricity in 2010?