Introduction to Time Series, Akita International University

Problem Sets

Felix Pretis
Programme for Economic Modelling, Oxford Martin School, University of Oxford

Introduction

The aim of the afternoon problem sets is to become familiar with real-world econometric analysis: from collecting the data to estimating and interpreting models using the tools learned during lectures and lab sessions. The skills and experiences gained during the problem sets can serve as a basis for your independent econometric project. The problem sets are centred around a single theme (the environmental Kuznets curve) and progressively build on each other.

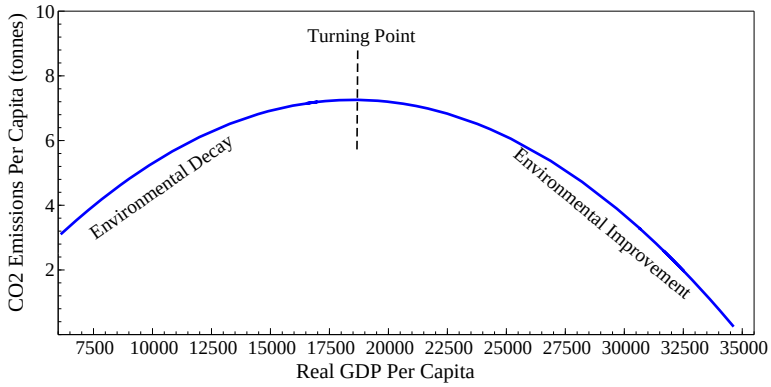
Assessment of the Problem Sets

Problem sets are to be completed every afternoon following the lecture and submitted the following morning (*before* the day's lecture (9:00 AM)). To encourage participation, **the short assignments are graded based on completion and submission alone, correctness will be checked but will not influence the grade.**

The Topic of the Problem Sets: The Environmental Kuznets Curve

The hypothesis of the environmental Kuznets curve suggests that, as economies grow, pollution and environmental degradation increases with income, however, beyond a certain level of income (a turning point) economic growth leads to a reduction in pollution (Stern 2004). This implies that pollution and environmental degradation are an approximate inverted U-shape function of income - see Figure 1. The idea behind the theory is that initial growth is often driven by pollutant-intense industries, then, as economies become more developed, production shifts away from polluting industries. Equally, as incomes rise, people may be able to afford to care more about the environment.

You will investigate this hypothesis in a simple setting by assessing the link between per-capita CO2 emissions and per-capita real GDP for Japan using time series spanning the last 50 years.



References

Stern, D. I. (2004). The rise and fall of the environmental kuznets curve. *World development*, *32*(8), 1419–1439.

Problem Set 1: Creating the dataset and initial empirical investigation

1) Create the Dataset

Build a dataset containing per capita CO2 emissions and per capita real GDP for Japan from 1960-2010. Obtain the data:

- Japanese Real GDP per capita: from FRED (Federal Reserve Economic Data). Go to `http://research.stlouisfed.org/fred2/` and download the time series of "Real GDP per Capita in Japan".
- Japanese CO2 emissions per capita: from World Bank. Go to `http://data.worldbank.org` and download "CO2 emissions (metric tonnes per capita)".

Organise the data:

- Combine the series of real GDP per capita and CO2 emissions per capita for Japan into one Excel file. The format should be organised such that the first column indicates the years, the second column lists real GDP and the third column lists CO2 emissions per capita (see Table 1).

Table 1: Data

Year	**RGDP_pc**	**CO2_pc**
1960	6109	2.516538
1961	6772	2.981979
1962	7285	3.059736
1963	7846	3.359321
1964	8633	3.673035
1965	9022	3.912906
.	.	.
.	.	.
.	.	.
.	.	.

- Generate a PcGive .in7 database by importing (or copy pasting the data into PcGive). Make sure the starting date of the database matches the data you have obtained. Choose sensible variable names, e.g. rgdp_pc for real GDP per capita for Japan, and co2_pc for CO2 emissions per capita.

2) Summary Statistics and Overview of the Data

1. Using the *Algebra* editor construct the variables:
   - log(RGDP per Capita)
   - log(CO2 Emissions per Capita)
2. Why are log transformations of the data useful?
3. Plot log(RGDP per Capita) and log(CO2 Emissions per Capita) over time in separate plots
4. Plot log(CO2 Emissions per Capita) against log(RGDP per Capita) using a scatter plot
5. Given the time series and scatter plots of the data, what can you say about possible relationships between the series?
6. Provide a short table of summary statistics: using the *Model-Descriptive Statistics* menu, report the mean and standard deviations of all data series (log and non-log transformed) together with their unit of measurement.

3) Initial Econometric Investigation

The theory suggests a link between emissions of CO2 per capita and real income (GDP) per capita. To investigate this, use the *Model-Single Equation Time Series* menu to estimate the following regression model and report the results:

$$\log(\text{CO2})_t = \beta_1 + \beta_2 \log(\text{RGDP})_t + \epsilon_t \tag{1}$$

1. Report the regression output in equation format showing estimated coefficients and standard errors.
2. Plot the fitted values and residuals and comment on the results
3. What values do the estimates $\hat{\beta_1}, \hat{\beta_2}$ take and what does this suggest?
4. How much variation of log(CO2 Emissions per capita) is explained by variation in log(real GDP per capita)?