

Linking Economic Performances to the Environmental and Social Sustainability

the decomposition approach and econometric analysis

Fusako Tsuchimoto (co-authored by Milan Scasny)

Charles University Environment Center, Prague

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3. Summary

Econometric Analysis of Emission of Air Pollutants

- Econometric analysis identify the causality between the environmental variables and economic variable
- Environmental Kuznets Curve Hypothesis - Grossman and Krueger (1995) - relationship between Per capita income (PCY) and emission level →we test if there is EKC phenomina at sector level in the Czech Republic
- We also control for other factors which possibly can affect the environmental variables, e.g. labor productivity - measures efficiency of a certain sector



- Our research question
 - Does emission of air pollutants show EKC pattern in the Czech Republic?
 - Are firms' investment or effort effective in decreasing emission level?
- Specifically we estimate following function using sectoral level data:

$$E_{s,t} = f(AirINV_{s,t}, GVA_{s,t}, GVA_{s,t}^2, LaborP_{s,t}, X_s, Z_t),$$

where s -sector, t -time, $E_{s,t}$ -the emission released from the production process of sector s at time t , $GVA_{s,t}$ -output level sector s at time t ,

$AirINV_{s,t}$ —investment to decrease air pollutant by sector s at time t ,

$LaborP_{s,t}$ - labor productivity measure in czk, X_s , Z_t -sector fixed effect and time dummies

- Estimated with fixed effect model

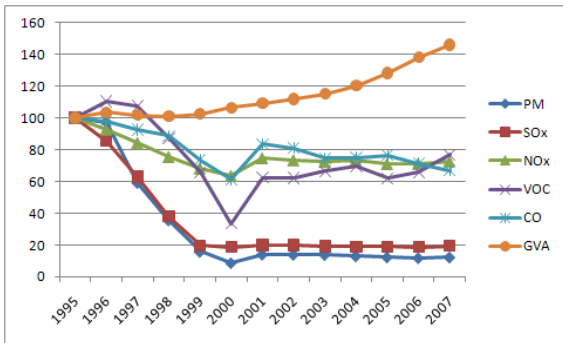
Data

- Economic data are obtained from Czech Statistical Office
- We restrict our analysis after 1995: consistency with economic data
- Air pollutant emission data (SO_2 , NO_x , PM, VOC, CO) is obtained from Czech Hydrometeorological Institute
 - originally firm level data set which on average consists of 2200 observation each year, collapsed into 60 sectors
 - our focus is on Rezzo 1 firms combustion process: large stationary sources of emission, whose thermal output are greater than 5 MW



Summary Statistics

Figure 1 : Emission of the air pollutants (R1combustion process) ,
1995-2007 in Czech Republic



the value of the base year (1995)=100

Main Findings

- The level of emissions of some pollutants (SO₂) shows EKC pattern at sector level in the Czech Republic
- Air investment has a negative effect on the emission of air pollutants
- Stronger negative effect of air investment is seen in manufacture sector
- However, we cannot tell, through which channel, investment in air had a negative effect on emission level → need for statistical decomposition analysis

Decomposition Analysis of Air Pollutants in the Czech Republic

- What derives the EKC is not clear because of reduced form analysis
→ needs further decomposition
- Statistical decomposition analysis enables us to take a closer look at the factors which contribute the air pollutant emission
- We statistically analyze the emission level of various type of air pollutants in Czech Republic in the period of 1995 - 2007

Research Question and Main Findings

- Research Question: What was the driving force of decline in the emission level of air pollutants during 1995 - 2007?
- Findings:
 - Main reduction occurred during the period where the emission limit of the EU regulation was binding: 1995-2000
 - We find that the main factor which contributes to the decline the emission level of pollutants was the change in emission intensity
 - Further more refined analysis tells us that end of pipe type of technology seems the prominent driving factor in the period of 1995 - 2000

Literature Review

- Stern (2002) compares two model (1) standard EKC model (2) the model based on decomposition analysis → finds that decomposition model fits and explains better than standard EKC
- The decomposition studies on CIS countries - Viquier (1999) and Cherp et al. (2003)
 - Cherp et al. - which analyzes the quality of air in Russia from 1990-1999
 - Viquier - analyzes the SO₂, NO_x, CO₂ emissions in 3 Central and Eastern European countries (Hungary, Poland, Russia) and 3 OECD countries, (U.S., U.K., France) from 1971-1994, using bottom - up method - variation comes from only fuel amount used

→ our analysis is richer in a sense that we use both value derived from actual data, emission level and emission coefficient

Methodology

- 3 factor analysis - emission level can be decomposed into:

$$\Delta_t E = \sum_i \Delta_t \frac{E_i}{Y_i} + \sum_i \Delta_t \frac{Y_i}{Y} + \Delta_t Y,$$

where i - sector, t - time, E_i - the emission level in the sector i , Y_i - the gross value added (GVA) in the sector i , Y - sum of GVA across the sectors

- Captured contribution

$\Delta_t \frac{E_i}{Y_i}$	the change in the emission intensity (intensity)
$\Delta_t \frac{Y_i}{Y}$	the change in the composition of economic activity (composition)
$\Delta_t Y$	the effect of the economic growth (scale)

5 factor analysis

- Further we decompose the intensity effect into 3 factors:

$$\Delta_t \frac{E_i}{Y_i} = \sum_j \Delta_t \frac{E_{i,j}}{F_{i,j}} + \sum_j \Delta_t \frac{F_{i,j}}{F_i} + \Delta_t \frac{F_i}{Y_i},$$

where $E_{i,j}$ - emission level of sector i , by fuel type j , $F_{i,j}$ - amount of fuel type j used in sector i , F_i - total amount of fuel used in sector i

- Captured contribution

$\Delta_t \frac{E_{i,j}}{F_{i,j}}$	the change in amount of emission released by each type of fuel (emission coefficient)
$\Delta_t \frac{F_{i,j}}{F_i}$	the change in the share of the each type of fuel (fuel composition)
$\Delta_t \frac{F_i}{Y_i}$	the change in the fuel amount used to produce unit of output (fuel intensity)

Laspeyres and Divisia Index

- The conventional Laspeyres index is not recommended because it can create huge residuals unexplained
- The modified versions of Laspeyres index as used in Sun (1998, 1999) or DE-COIN - possess the perfect decomposition property

→however the residuals are arbitrary allocated and further, it is not clear the linkage of multiplicative and additive property with Laspeyres index
→in this task, we focus on Divisia index, especially due to the problem of logarithmic approximation sensitivity, we use Divisia Additive method

Results of 3 factor analysis

Figure 2: decomposition - SO₂

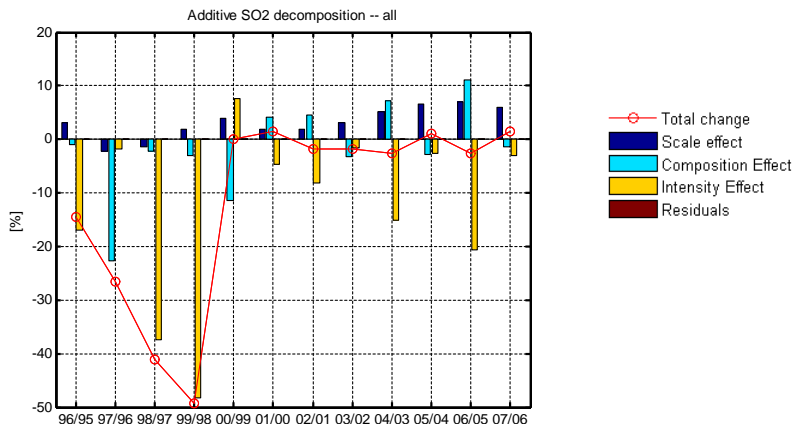
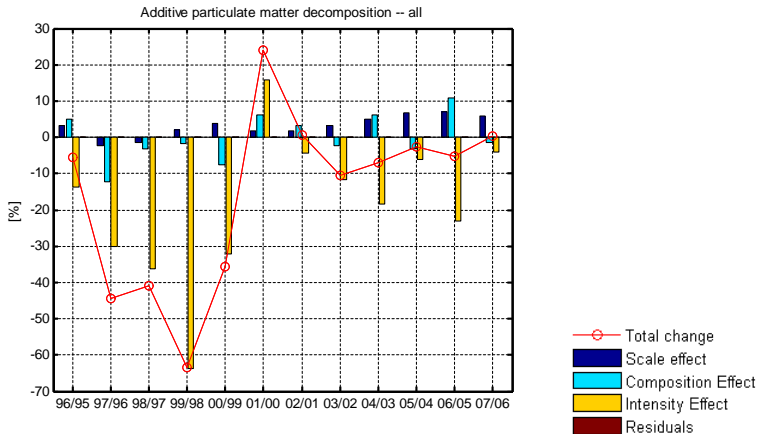


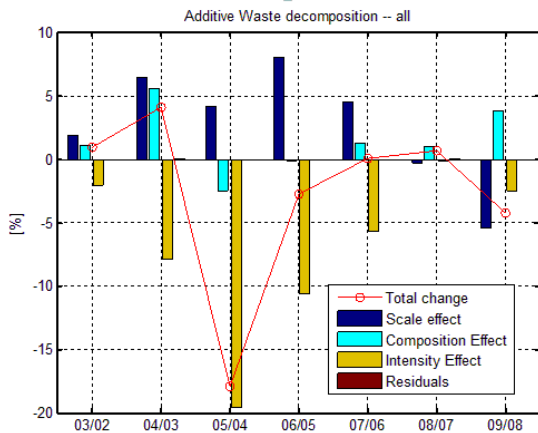
Figure 3: 3 factor decomposition (PM), 1995 - 2007



Note: the average fraction of emission in technological process is 22.6 %



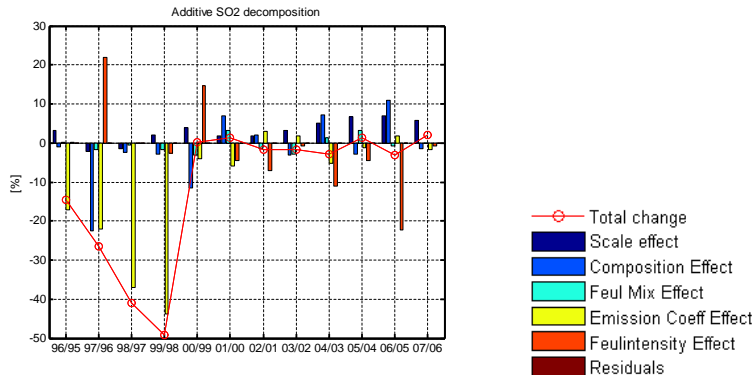
Figure 4 : 3 factor decomposition (Waste), 1998 - 2009





Results of 5 factor analysis

Figure5 :decomposition - SO₂



Conclusion

- 3 factor analysis shows that in the period 1995- 2000, the intensity effect is the most significant cause of the decline in the air pollutant emission, which suggests that change in environmental technology of the firms
- Further, the composition effect did not contribute the much to the decline of the emission level, which suggests that Czech Economy structure is (still) not environmental friendly- in Poland or Hungary the strongest contributor was composition effect (ref. EXIOPOL)
- 5 factor analysis shows that emission coefficient effect was most prominent during the period studied. It suggests that among the environmental technology, the environmental technology which is represented by the end of pipe technology (especially in the case of PM) seemed progressed
- Decomposition analysis is statistical decomposition and thus it does not capture the causality relationship → need for the econometric analysis

- We conduct econometric and statistical analysis on the emission amount of the air pollutant in the Czech Republic - find that main driver of reducing the emissions were the technological investment which is represented by end of pipe technology
- The level of emission of some pollutants such as SO₂ shows the EKC pattern in the Czech Republic
- Decomposition analysis and econometric analysis are complementary
 - Decomposition analysis-weakpoint that it does not verify the causality or causality is assumed ex ante
 - Econometric analysis - reduced form usually does not allow to identify the driving force of causality
- Future perspective
 - Other specification in econometric analysis - different controls, different definition of variables, different set of variables