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EU POLLUTION REDUCTION STRATEGIES AND THEIR IMPACT ON ATMOSPHERIC EMISSIONS IN LITHUANIA

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Abstract. This paper analyses the role of EU pollution strategies in reducing SO_2 and NO_X emissions in the EU. The environmental policies impact on the slope of Kuznets environmental curve is discussed. The use of economic mechanisms for SO_2, NO_X and other pollutants emission reduction is analysed based on experience of EU member states. The aim of the paper is to evaluate the impact of EU pollution reduction strategies on atmospheric emissions in Lithuania and to define the role of EU emission reduction policies on shifting environmental Kuznets curves of EU member states and Lithuania.

Keywords: Kuznets curve, pollution reduction, atmospheric emissions, Lithuania.

1. Introduction

Environmental Kuznets curves analysis allows a clarification of a few basic conditions to achieve pollution reduction with economic growth (Selden, Song 1994; Munasinghe 1999). These conditions can be met by implementing a systematic and strict environmental policy strategy aimed at shifting Kuznets relations downward.

The Gross Domestic Product (GDP) is an economic indicator that correlates with many parameters to be associated with living standard or quality of life. The environmental Kuznets curve plots the relationship between environmental quality factors and per capita income. The inverted "U" shaped Kuznets curve could be interpreted to suggest that some environmental impacts of economic development are declining over time. Technological developments and increase in the rate of the technology transfer from the developed to the developing countries could accelerate the rate of improving the environment quality and allow for improvement of air quality to take place at lower per capita income levels that predicted from historical data (Ekins 1997; Rothman, Bruyn 1998).

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EU has implemented the strict strategies to reduce atmospheric emissions. In its Tematic Strategy on Air Pollution (COM (2005 446 final)), the European Commission outlined the strategic approach towards cleaner air in Europe and established environmental interim targets for pollutants contributing to acidification, eutrophication and the formation of ground-level ozone in year 2020 compared to 2000 levels.

The aim of the paper is to analyze the EU emission reduction policies which are the main drivers for environmental Kuznets curve shifts down and evaluate the impact of these policies on emission reduction in Lithuania.

The main task of the paper are:

- To review EU emission reduction policies and their targets.
- To define the role of EU emission reduction policies on shifting environmental Kuznets curves of EU member states.
- To present Lithuanian case study of environmental Kuznets curve and evaluate the impact of EU policies on atmospheric emissions in Lithuania.

The methods applied: systematic analysis, analysis, comparison and generalization.

2. EU emission reduction policies

In its Tematic Strategy on Air Pollution (COM (2005 446 final)), the European Commission outlined the strategic approach towards cleaner air in Europe and established environmental interim targets for pollutants contributing to acidification, eutrophication and the formation of ground-level ozone in year 2020 compared to 2000 levels. As one of the main policy instruments, the Thematic Strategy announced the revision of the Directive on National Emission Ceilings (2001/81/EC) with new emission ceilings that should lead to the achievement of the agreed interim objectives. In the meantime, European Commission started the process to develop national ceilings for the emissions of the relevant air pollutants (Štreimikienė 2002). The EU global goal in 2020 would make for SO_2 – reduction by 87 %, for NO_X – reduction by 50 %, for PM2.5 by 41 %, for NH3 – by 25 % and for VOC – by 46 % compared to 2000.

The NEC baseline projections estimate future emissions on the basis of the development of emission generating activities, country and sector specific emission factors and the progressing implementation rate of already decided emission control legislation (including the transposition of EU-wide legislation) as of mid 2006. The main legislation is to be fully implemented in all Member states according to the foreseen time schedule.

The main EU legislation for pollutants contributing to acidification, eutrophication and the formation of ground-level are described bellow (Štreimikienė, Bubelienė 2004).

2001/81/EC Directive on national emission ceilings for certain atmospheric pollutants sets since 2010 the national emission ceilings for SO_2, NO_X, VOC and NH_3, which are very close to the limits of the same pollutants established by Gothenburg protocol to Long Range Transboundary Air Pollution Convention.

2001/80/EC Directive on the limitation of emissions of certain pollutants into the air from large combustion plants, amending directive 88/609/EK, establishes emission restrictions for SO_2, NO_X and dust for combustion installations with rated thermal input higher than 50 MW. According this Directive, all large combustion plants are grouped into 3 groups according to their age. For very new enterprise (which got licenses up to 27 November

2002) and which fully started their operation since 27 September 2003 very strict standards for the mentioned pollutants emissions will came in force since 27 September 2002. The second group enterprise, which got their licenses after 1 July 1997, will apply not such strict standards, but since 1 January 2008 all large combustion plants (including existing plants which were put into operation up to 1 January 2007) shall comply this stringiest standards used only for very new plans before.

1999/32/EC Directive relating to a reduction in the sulphur content of certain liquid fuels amending the directive 93/12/EC sets the limits for sulphur content in HFO and heating oils. The Directive requires Member States to take all necessary steps to ensure that from 1 January 2003 within their territory heavy fuel oils are not used if their sulphur content exceeds 1,00 % by mass. Several exemptions are foreseen in the directive. Provided that the air quality standards for sulphur dioxide laid down in Directive 80/779/EEC(10) are respected and the emissions do not contribute to critical loads being exceeded in any Member State, a Member State may authorise heavy fuel oils with a sulphur content of between 1,00 and 3,00 % by mass to be used where the emissions of sulphur dioxide from the plant are less than or equal to 1 700 mg/Nm^3. Exemption also applies for combustion in refineries, where the monthly average of emissions of sulphur dioxide averaged over all plants in the refinery, irrespective of the type of fuel used, are within a limit of 1 700 mg/m^3.

96/61/EC Directive concerning integrated pollution prevention and control aims to achieve integrated prevention and control of pollution (including emission of SO_2, NO_X, dust, CO etc. in atmosphere) arising from activities listed in Annex I (combustion installation with rated thermal input exceeding 50 MW, mineral oil and gas refineries, coke ovens, production and processing of metals, mineral industry, chemical industry, waste management etc. and lays down measures designed to prevent or to reduce emissions in the air, water and land from these activities. By the year 2004, integrated permits should be issued for enterprises, that impose the requirements concerning pollution limits, waste management, energy saving (taking into consideration the best available technologies) for each enterprise or each equipment. The existing enterprises will have to implement the requirements not later than 30 October 2007.

2003/17/EC Directive on quality of petrol and diesel fuels amending Directive 98/70/EC relating to the quality of petrol and diesel fuels aims at reduction of sulphur content of petrol and diesel fuels and introduces. Directive requires that Member States shall take necessary measures to ensure that in due time and no later than 1 January 2005 unleaded petrol with maximum sulphur content of 10 mg/kg is marketed in their territories. By no later than 1 January 2009, Member States shall ensure that unleaded petrol of a maximum sulphur content of 10 mg/kg. For diesel the same requirement is being applied by Directive. For gasoils used for non-road mobile machinery and agricultural and forestry tractors marketed within their territory contain less than 200 mg/kg of sulphur and by 2009 less than 1000 mg/kg.

1994/63/EC Directive on the control of volatile organic compound (VOC) emissions resulting from the storage of petrol and its distribution from terminals to service stations sets the limits for VOC based on the capacity (annual turnover) of installation for VOC. The requirements for installations came into force since 1 January 2001. As regards Directive 94/63/EC on control of volatile organic compound (VOC) emissions resulting from the storage of petrol and its distribution from terminals to service stations, a transitional period until

31 December 2005 and 31 December 2007 respectively, in accordance with the intermediate targets: Since 1 January 2004 the requirements were implemented only in the largest storage installations at terminals with capacity more than 50 thou t/y and in loading installations of mobile containers at terminals with capacity higher than 150 thou/y as well as in loading into storage installations at service stations with capacity more than 1 000 m^3/y and with capacity of more than 100 m^3/y situated in towns. For smaller installations the requirements shall be implemented since 1 January 2008.

Directive 2000/76/EC on the incineration of waste requires to apply new strict standards of SO_2, NO_X, dust, HCl and CO to new plants since 28th December 2002 and to apply standards to existing plants since 28 December 2005.

European Parliament and Council Directive 1999/96/EC provides the Euro 3 (from October 2000), Euro 4 (from October 2005) and Euro 5 (from October 2008) emission standards for road vehicles. The standards establish emission limits for CO, HC, NO_X, PM and Smoke depending on the type of approval (European Stationary Cycle or European Transient Cycle). For European Stationary Cycle emission standards are the following: CO – 1,5 g/kWh, HC – 0,46 g/kWh, NO_X – 3,5 g/kWh, PM – 0,02 g/kWh and Smoke – 0,5 m^{-1}. Heavy Duty Vehicles – Vehicles used for the carriage of goods and having a maximum weight exceeding 3,5 tonnes. Euro III requires implement new standards on 01.2001–01.2002 depending on vehicle type, Euro IV standard requires to implement stricter standards 01.2006–10.2006 depending on vehicle type and Euro V requires to implement stricter standards on 10.2008 only for heavy fuel vehicles.

3. Measures to reduce pollution

The draft guidelines for reporting under the NECD encourage Member States to consider a range of options of policy instruments for achieving their NECs. These include economic instruments as well as the more traditional regulatory instruments. Economic instruments may provide the opportunity to achieve a specific reduction in emissions in a more cost effective manner (Štreimikienė 2004). Examples of some economic instruments reported in NECD national programmes include:

- *Emissions trading:* e.g. in the Netherlands a NO_X trading scheme is being introduced for large installations in the industry, energy, refineries and waste processing sectors. Petrochemical plants, refineries and power plants >20 MWth capacity will trade in permits based on emissions per unit of energy, whereas permits for steel, aluminium, cement, saltpetre and phosphate plants as well as incinerators will be based on emissions per product unit. This trading scheme will be used to meet the industry specific emission ceiling for NO_X of 55kt by 2010 and will come into force in 2005.
- *Emission charges.* In Sweden, an aviation charging scheme is aimed at reducing emissions from the landing and take-off cycle. This has been in place since 1998. Sweden has also implemented a NO_X charge for emissions from large stationary sources in the form of the NO_X Act (1990).
- *Energy taxes* have been developed by a number of different Member States (for example, Finland has levied a tax on fossil fuels since 1997 calculated on the basis of SO_2 emissions).

- *Congestion charging.* Both Sweden and the UK are considering, or have already implemented, *congestion charging* and the establishment of *low emission zones* to reduce emissions from transport.
- *Higher taxes on more polluting vehicles.* Several Member States levy higher taxes on older and more polluting vehicles to encourage the purchase and use of cleaner vehicles (for example, Germany has implemented an emissions-based Motor Vehicle Tax).
- *Energy efficiency grants.* Several Member States provide energy efficiency grants to encourage the use of more efficient technologies and processes such as low NO_X domestic boilers, for example.

The review of flexible mechanisms for pollutants reduction in several EU member states is presented below.

National system for NO_X emission trading in Netherlands is based on a so-called Performance Standard Rate (PSR), which progressively reduces from 55 g/kJ to 40 g/kJ (for combustion) in 2010, in order to meet the sectoral ceiling set for industry. The trading market and the price per tonne of NO_X are low at the moment because the need to buy is low. The overall emission cap is not a constraint at the moment, which is expected to change when the PSR evolves, and for most installations the IPPC-obligations are applied in a strict manner.

NO_X tax was introduced on 1 January 2007 in Norway aiming to reduce a large part (almost 25 kton) of their obligation under the Gothenburg protocol to reduce 40 kton. The tax is on boilers and engines > 1Mw, ships, aircrafts and trains > 750MW and domestic shipping under all flags. The NO_X-tax includes 50 % of all NO_X emissions. Road traffic is not affected. The tax rate is about €2000 /tonne and will be adjusted every year.

Emission trading system which functions fully – after the introduction in 2002 – for sulphur dioxide and nitrogen oxides was established in Slovakia. The system covers 80 % of the sources and the trading period is one year (without a possibility of banking allowances to the following year). The allocation was the most problematic part because the political willingness of the decision-makers to reduce the quotas hardly exists. Thus, currently the SO_2 cap is not constraining emissions.

NO_X charge introduced in 1992 in Sweden. The charge is now €4400/tonne NO_X and covers about 8 % of the total NO_X emission. The charges are recycled back to the emitters depending on the energy produced. During the first years the total emissions went down significantly, at the moment the total NO_X emission increases in spite of the tax mainly due to the increase in energy consumption.

The Swiss VOC incentive tax can be treated as an example to abate diffuse VOC emissions. The tax appeared to be effective and the revenue of about 144 million CHF in 2007 will be redistributed through the 80 health insurance companies which provide the mandatory health insurance in Switzerland (19 CHF per capita per year).

The green tax on sulphur in Denmark was introduced in January 1997. The effect is that national emissions have declined drastically, that no heating oil is sold with a sulphur content lower above 500 pm and that power plants have achieved cleaning efficiencies above 99 %. A negative side-effect is the increased import of small amounts of pet-coal with high sulphur content. Denmark is now considering a tax on NO_X as well, but the implementation of such a tax will be more complicated due to monitoring and verification issues.

The London Congestion Charge is an interesting instrument to reduce air emissions from transport. At week days the charge is €12 /day to enter the zone. Payment is on the base of automatic registration of the license plate. Both air quality and traffic flow have improved in the zone.

There are also attempts in EU to establish EU-wide emission trading scheme based on EU GHG emission trading scheme experience (Andersen 2000). The study was carried out for European Commission to determine optimal control areas for NO_X or SO_2. Optimal control areas were considered to be a group of countries for which changes in emissions are expected to result in changes in the European average exceedence of critical loads for acidification, eutrophication and ozone within acceptable ranges. The criteria used for optimality was that the existing differences within (large) Member States were within acceptable limits. Based on this criterion, the study concluded that:

- For SO_2 two to three optimal emission control areas might emerge: one in the Northern and one in the Southern part of Europe; a third emission control area could lie in between.
- For NO_X, the zones would depend on the effect analyzed: acidification, euthrophication or tropospheric ozone. However, as NO_X is not reduced for one purpose only, the preliminary conclusion was that it could be possible to have only one bubble in the EU to control NO_X.

These preliminary conclusions need further analysis. This is now being conducted by the Commission. The environmental, health and cost implications of allowing this flexibility between Member States in a context of possibility of multi-country bubbles will be studied.

Implementation of these EU emission reduction goals have tremendous impact on the main pollutants (SO_2, NO_X etc.) emissions reduction and the change of Environmental Kuznets curve shape driving SO_2 and other pollutants emissions down. The policies and measures being implemented in EU member states described above had also a significant impact on the shape of Kuznets environmental curve, though EU member states have very different GDP/capita levels. The difference between countries exceeds 3 times, however the strict EU environmental policies requirements are the main drivers for changes in Kuznets environmental curve shape.

4. Lithuanian Kuznets curve

Lithuania is a new EU member state since 2004 and has implemented all the main EU environmental requirements including those for emission reduction discussed above. Implementation of these EU emission reduction requirements set by EU directives change the slope of Kuznets environmental curve significantly though Lithuanian GDP/capita level adjusted at PPP is more than 3 times lover than EU-15 average (Štreimikienė 2005).

Based on data of EU Statistics Division and targets set by EU Thematic Strategy (The EU goal in 2020 would make for SO_2 – reduction by 87 % compared with 2000 level), the Kuznets environmental curve showing the relationship between SO_2 emissions and GDP/capita was developed for Lithuania 1980–2015 (Fig. 1).

As one can see from Fig. 1, SO_2 emissions have reduced drastically since 1980 in Lithuania. Especially steep reduction in SO_2 can be noticed in 1992 (SO_2 emissions have reduced

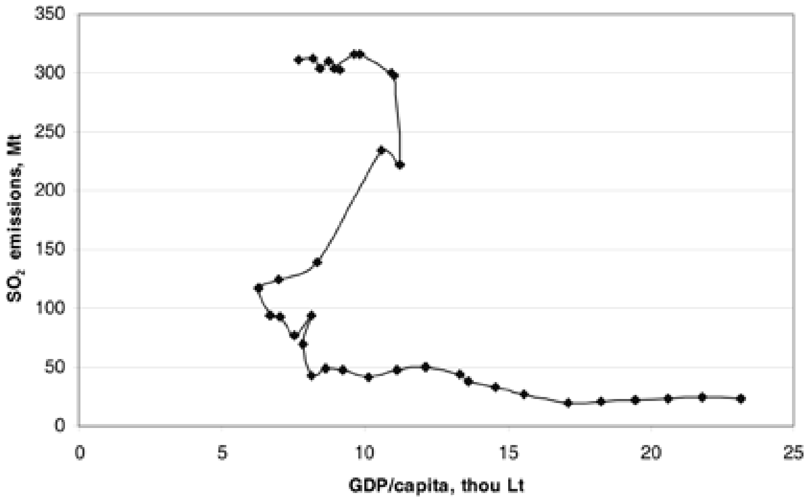

Fig. 1. Lithuanian environmental Kuznets curve, 1980–2015

twice comparing with year 1991). This was related with economic recession than production and GDP has also fallen more than twice. However, with the end of economic recession SO_2 emission has not shown the growth trends because strict EU environmental policies implemented in Lithuania caused the decoupling of economic growth from use of resources and the decoupling of atmospheric pollution from use of resources (primary energy supply). These trends in Lithuania show the sustainable development path which country is following now.

However, implementation of EU requirements for emission reduction will have negative impact on economy because of high costs (European Environment Agency 2006). However implementation of flexible emission reduction measures would help Lithuania to comply with commitments at lower costs, therefore new instruments should be implemented in Lithuania based on experience of other EU member states provided above.

The main tools for SO_2, NO_X, VOC and particulates emission reduction in Lithuania are pollution taxes. In 1999 new pollution tax system was implemented in Lithuania. Table 1 provides the tariffs of pollution taxes for 2003–2009 established in Lithuania. For emissions of pollutants exceeding standards the increased tariff is applied. This tariff is alculated by multiplying established rates by coefficient established for non-compliance (Table 1).

Table 1. Pollution taxes for emissions into atmosphere in Lithuania, Lt/t

Pollutant	Tariffs for pollutants emissions into atmosphere for stationary pollution sources Lt/t		Coefficient for the non-compliance with limits
	2003	2004–2009	
SO_2	288	311	1,5
NO_x	479	587	1,5
Va_2O_5	11 485	11 485	300
Dust	184	184	1,5

Table 2. Pollution taxes for emissions into atmosphere in some EU member states, EUR/t

	CO2 tax, EUR/t	Tariffs, EUR/t		
		SO_2	NO_x	Dust
Denmark		1342		
Poland	0,052	0.1	98	
Estonia	0,48	4.24	–	4.24
Latvia			18	8
Slovak Republic		46.12	34.59	115.3
Chech Republic		29.38	23.5	88.13
France			45.7	
Italy		53.2	104.8	–
Lithuania		62.8	107.7	53.7

For the comparison, the taxes for pollutants emission into atmosphere available in several EU member states is presented in Table 2.

As one can see from Table 2, SO_2 and NO_X pollution charges in Lithuania are quite high, especially comparing with other new EU member states (Poland and Estonia); however, SO_2 tax rates are significantly lower in Lithuania comparing with Denmark.

SO_2, NO_X, particulates etc. emission standards and pollution taxes implemented in Lithuania by passing the EU directives targeting emission reduction from large combustion sources and sulphur content of fuel have positive impact on increased use of renewables and atmospheric pollution reduction; however, the impact on greenhouse gas emission reduction is negative (Štreimikienė 2004). This is related to strict standards set by Directives targeting that air pollution reduction would require to install flue gas desulphurisation equipment in the biggest Lithuanian power plants and to burn high-sulphur heavy fuel oil and orimulsion both having a very high carbon content.

5. Conclusions

1. The EU pollution reduction policies and measures implemented in EU member states clearly indicate the main role of environmental policies in shifting Kuznets environmental curves down. The economic growth is precondition for emission reduction; however, the main drivers are strict policies.
2. The case study of Lithuania is a good example showing that even at quite low GDP/capita level, comparing with developed Western countries, Lithuanian SO2 emissions have reduced drastically and are expected to reduce in the future, however new flexible instruments needs to be implemented in Lithuania based on experience of other EU member states seeking to reduce negative impact of strict EU emission reduction requirements on economy.
3. However, EU pollution reduction strategies implemented in Lithuania would have negative impact on GHG emission reduction because of flue gas desulphurization equipment installed in the biggest power plants and switching to higher carbon content fuels – orimulsion and high sulphur HFO.

4. Therefore it is unrealistic to expect that economic growth per se would reduce environmental pressures. The main drivers turning the inverted "U" curves down in developed countries are strict environmental policies adopted in EU and being considered in the rest of the world.

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ES TARŠOS MAŽINIMO STRATEGIJOS IR JŲ ĮTAKA ATMOSFEROS TERŠALŲ EMISIJOMS LIETUVOJE

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Santrauka

Straipsnyje nagrinėjama ES atmosferos taršos mažinimo strategijų įtaka ekologinių Kuznets kreivių nuolydžiui. ES rūgštėjimą ir eutrofikaciją sukeliančių teršalų emisijų ribojimo politika yra pagrindinė varomoji jėga, keičianti Kuznets ekologinės kreivės nuolydį. Nubraižius Kuznets ekologinę kreivę Lietuvai, galima nustatyti, kaip ES atmosferos taršos mažinimo politika paveikė klasikinių atmosferos teršalų emisijos dinamiką Lietuvoje. Straipsnyje išnagrinėti ES šalyse taikomi taršos mažinimo būdai ir palyginti ES narėse taikomų mokesčių už pagrindinių teršalų emisijas tarifai su Lietuvoje taikomais tarifais analogiškų teršalų emisijoms. Pateikti siūlymai dėl taršos mažinimo priemonių plėtros Lietuvoje, pirmenybę teikiant lankstiems rinką imituojantiems mechanizmams.

Reikšminiai žodžiai: Kuznets kreivė, taršos mažinimas, atmosferos emisijos, Lietuva.

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