Inzinerine Ekonomika-Engineering Economics, **2012, 23(2), 137-143**

Going Green versus Economic Performance

Kamil Makieła, Tomasz Misztur

Cracow University of Economic
Rakowicka ul. 27, 31-510, Krakow, Poland
e-mail: kamil.makiela@uek.krakow.pl,tomasz.misztur@uek.krakow.pl

crossref http://dx.doi.org/10.5755/j01.ee.23.2.1546

The purpose of this paper is to elucidate some information on what impact pro environmental actions have on countries' global economic performances. Is there really a trade-off on a macro scale between "going green" and economic performance?
The world economy has significantly expanded within the last four decades and started to exceed the Earth's resources capacity. Many forms of environmental degeneration such as soil erosion, aquifer deficiency, rangeland deterioration, air pollution, and climate change have huge negative impact on the ecosystem. If the world continues to move in this direction, it will eventually destroy its natural support system. The long-term solution to this problem is to apply ecological principles of sustainable economic development. It is commonly known that factors such as decreasing CO2 emission, water maintenance, forestry and agriculture preservation as well as properly managed production processes help preserve our planet's natural habitat and its climate, but how these activities are related to businesses?
During 1960s and 1970s, organizations have mostly rejected their impact on the environment. However, after experiencing international ecological problems, countries came up with a variety of regulations to prevent further environment degradation. Many organizations were forced to accept the responsibility to protect the surroundings they were operating in. Therefore, prevailing assumption appeared that there is a fixed trade-off between ecology and economy. Social benefits that come from strict environmental regulations are placed versus private costs, which are spent for prevention and cleanup activities. Succeeding in one field has to result in other's failure.
In the last decade, however, this view has been increasingly challenged. Moreover, in recent years there has been an increasing advocacy towards a notion that turning green is actually good for the business and thus for the whole economy. By preserving natural resources and creating new quality of environmentally aware management systems, a given country increases its productivity. This in turn allows achieving higher production output given inputs in relation to its less environmentally aware neighbour.
In order to check the validity of this theory we apply Bayesian frontier analysis to macroeconomic production function, and incorporate key environmental indicators as explanatory variables of productivity distribution. Our model is estimated based on data from 13 EU countries over the period of 1998-2007. The use of Bayesian inference allows us to check straightforward what explanatory power those indicators have on countries' productive efficiency and thus on their economic performance.

Keywords: *environment, economic performance, environmental performance index, productivity, stochastic frontier model.*

Introduction

The world economy has significantly expanded within the last five decades and started to exceed the Earth's resources capacity. Many forms of environmental degeneration such as soil erosion, aquifer deficiency, rangeland deterioration, air pollution, and climate change have huge negative impact on Earth ecosystem. If the world continues to move in this direction, it will eventually destroy its natural support system. The long-term solution to this problem is to apply ecological principles of sustainable economic development (Brown & Mitchell, 1999).

There are several factors influencing countries economic performances. Most commonly considered are economic openness & competitiveness, corruption level, economic regulations, geography and culture. Some of them, like geography or culture are inherent to the given economy; others like economic competitiveness or legal system can be augmented by the government to stimulate the economy.

Interestingly the same productivity determinants described above, are also influential to countries ecological performances. Moreover we can distinguish between fixed factors and those that could be stimulated by the policy makers. It is reasonable that countries rich in fossil fuels are far more likely to pollute the environment more than others and the legislature in those countries will be reluctant to impose any economic restrictions that would change that. However, if such a country is in close proximity to the countries imposing green policies its economy is also likely to be influenced by them. Such a trivial example shows how productivity factors can do both: shape the given country's economic policy and influence its ecological performance as well.

According to the theory of economic growth, fiscal as well as legal policy of the given country can be regarded as both: a part of, and a result of economic productivity determinants (Fried *et al.*, 2008). Additionally empirical studies have shown that there is "no general pattern which could form the basis of universal policy conclusions with respect to productivity growth" (Koop *et al.*, 1999). For example, it is not reasonable to compare ecologic policy systems and their impacts on economic performances between countries such as USA and Finland (which population is less than New York City). Both are shaped by very different economic circumstances. What we can do, however, is to pinpoint factors influential to the ecological status and study the impact they have on a macro scale (the whole economy).

Until 1970s there was no significant pro ecological activity regarding different countries' governments, but the first Earth Day brought about more public attention to widespread pollution of the environment. During 1960s and 1970s, organizations have mostly rejected their impact on the environment. However, after experiencing international ecological problems, countries came up with a variety of regulations to prevent further environment degradation. After requirements became legitimate, organizations were forced to accept the responsibility to protect the surroundings they were operating in. Eventually some of them realized that complying with environmental standards and following eco best practices can be beneficial to the organization as well. Thus, more and more companies started turning "green" not only to reduce pollution, but also to increase profits (Hart, 1997).

The common view is that fixed trade-offs between ecology and economic performance exist. Social benefits that come from strict environmental regulations are placed versus private costs, which are spent for prevention and cleanup activities (Porter & van der Linde, 1995). Succeeding in one field has to result in other's failure. That is why we can find a lot of examples of negative economic effects for companies that have been coerced to comply with environmental regulations (Jaffe *et al.*, 1995).

Economic difficulties related to becoming "green" can also be supported by consumer's market barriers (Bonini & Oppenheim, 2008). Consumers are saying to be eager to act green, but when it comes to the actual purchase of green goods, only one third keeps its word. Organizations have to face these obstacles and make an effort to break down five barriers with the solutions provided by Bonini and Oppenheim (2008).

In spite of prevailing assumption about inefficiency caused by environment regulations, the view is being increasingly challenged (Feiock & Stream, 2001). As organizations are functioning in a dynamic competitive world, they are constantly finding innovative solutions that lower their production costs and increase their products' values. By applying pro environment principles firms can benefit their resource productivity in many ways. Moreover, being environmentally friendly can reduce energy consumption, lessen risks, increase competitiveness, strengthen company's brand and increase its revenue (Bonini & Oppenheim, 2008).

Several studies found a positive correlation between state environment and economic indicators in the USA. The most environmentally friendly states occurred to also have strongest economies. Despite "trade-off challenging studies" being informative, some methodological and conceptual limitations exist and yet no advanced theoretical model, explaining the environmental polices' influence on growth, has been developed. There is no convincing empirical evidence that would deny the economical versus ecological trade-off idea (Feiock & Stream, 2001). This paper is trying to fill at least some of the gap that Feiock and Stream discuss and analyze the relationship between pro-environment activities and the economic performance.

Environmental Performance Index

During the last decade advancing technology had a huge impact on data-driven decision making. Quantitative research methods have changed significantly these processes in many areas: from economics, through business, health care, education, to biology. Environmental policymakers also realized the importance of analytically based approach in solving environmental problems. Unfortunately environmental planning was hampered by many gaps in available empirical data. To address the problem of lacking information, improve environmental policymaking, and measure current national environmental performance, Environmental Performance Index has been developed (Yale Center for Environmental Law & Policy, & Center for International Earth Science Information Network, 2008).

As EPI 2008 Main Report states, the EPI indicator:

"deploys a proximity-to-target methodology, which quantitatively tracks national performance on a core set of environmental policy goals for which every government can be – and should be – held accountable. By identifying specific targets and measuring the distance between the target and current national achievement, the EPI provides both an empirical foundation for policy analysis and a context for evaluating performance. Issue-by-issue analysis and aggregate rankings facilitate cross-country comparisons both globally and within relevant peer groups such as geography or economy" (Yale Center for Environmental Law & Policy, & Center for International Earth Science Information Network, 2008).

Environmental Performance Index tries to measure current national environmental protection efforts related to two core objectives Environmental Health and Ecosystem Vitality. The first one is oriented towards reducing environmental stresses to human health whereas the second one deals with ecosystems and natural resources protection.

Broad review of environmental science literature and consultations with many scientific advisors resulted in combining 25 indicators that reflect ecosystem's condition in each country. In order to show the performance in each category as best as it was possible, several selection criteria were applied: relevance, performance orientation, transparency, and data quality.

The index serves as a foundation for cross-country and cross-sectoral performance comparisons. Moreover, as EPI includes datasets from additional nations, the future EPI will permit worldwide data aggregations that will allow exploring world community's influence on the environmental sustainability.

Methodology

The framework used in this paper is based on production Frontier Analysis. The idea here is to estimate all maximum attainable output-given-inputs combinations and then compare them to the observed outputs. The difference between the two denotes the given country's efficiency. Since the efficiency of each unit is determined by the ratio of observed output to its potential, given the currently employed inputs, it allows us to benchmark the countries of different sizes against each other. Frontier Analysis has been extensively used in the field of ecology (Jeon & Sickles, 2004; Zaim, 2004; Arcelus & Arocena, 2005 or Henderson & Millimet, 2005) as well as macroeconomics studies (Cherchye, *et al.*, 2004; Despotis, 2005; Yoruk & Zaim, 2005 or Makieła, 2009).

In order to investigate the impact the environmental performance of the given country has on the macro scale productivity we implement Bayesian approach to Stochastic Frontier Analysis developed by Koop, Osiewalski and Steel (2000). In short, the method allows us to introduce additional explanatory variables to the basic macroeconomic productivity model and then to assess the impact they have on shifts within the frontier. These shifts determine impacts these additional variables have on countries performances.

Stochastic frontier analysis is largely based on production theory and its purpose is to trace changes to productive efficiency. Consider that:

$$Y_{it} = f(K_{it}, L_{it}; \beta) \cdot TFP_{it} = f(K_{it}, L_{it}) \cdot TP_{it} \cdot EF_{it} \qquad (1)$$

where $f(K_{it}, L_{it}; \beta)$ is the production function, here linear in respect of natural logs of Y, K and L (indicated by their lower case letters); Y_{it} is the macroeconomic production output; K_{it} and L_{it} are capital and labour inputs respectively, for *i*'s country in year *t*. The underlying assumption is that the change in macroeconomic output is the result of the change in the i) quantity of inputs and ii) the way they are used in production. The latter is broadly referred to as the change in productivity (TFP) and there are two ways to consider it. First, when the production technology is progressing (TP_{it}) it augments parameters of the function that describes it. This way, more products can be made given the same quantity of inputs. In our model this is denoted by $TP_{it} = \exp(\gamma \cdot t)$, where t is the year index and γ is the parameter to be estimated. Second, productivity may shift as a result of the change in country's technical efficiency. This may be due to a number of factors, like i) changes in work culture over time, ii) governmental policies, or even due to such incidents like iii) major natural disasters in the region. Thus, we specify $EF_{it} = \exp(-u_{it})$, where u_{it} (non-negative by construction) denotes *i*'s country inefficiency in year *t* (its distance from the frontier). The Bayesian normal-exponential model corresponding to the above assumptions is:

$$p(\beta)p(\varphi)f_N^{NT}(y|X\beta - u, \sigma^2 I_{NT}) f_G(\sigma^{-2}|\tfrac{a_0}{2}, \tfrac{b_0}{2}) \prod_{i=1}^{N} \prod_{t=1}^{T} f_G(u_{it}|1, \lambda^{-1} \qquad (2)$$

where $X = (x_{11}, \dots, x_{\mathrm{NT}})', x_{it} = (k_{it}, l_{it}, t, 1)', y = (y_{11}, \dots, y_{\mathrm{NT}})', \beta = (eK, eL, \gamma, \beta_0)'$,

eK and eL are factors' elasticity in the standard Cobb-Douglas production function[1], σ^{-2} is the inverse variance (precision) and $p(\beta) = 0$ if regularity conditions are breached. $f_N^{NT}(\cdot|\alpha, \Sigma)$ is an $N \cdot T$-varied normal distribution with α mean and Σ covariance matrix; $f_G(\cdot|\alpha, \nu)$ denotes gamma distribution with α being the shape parameter and ν the inverse scale parameter, so that the mean is α/ν. We set $a_0 = b_0 = 10^{-6}$ in order to make the prior on σ^{-2} close to the standard non-informative prior (Koop *et al.*, 1999 for a discussion). Furthermore, in order to try to explain patterns of efficiency behaviour across countries Koop *et al.* (2000) use Variable Efficiency Distribution model (VED), in which they allow the mean of inefficiency distribution (λ) to depend on a set of exogenous factors according to $\lambda_{it} = \prod_{j=1}^{m} \varphi_j^{-w_{itj}}$, where w_{itj} is the it'th element of W_j, W_1 is a matrix of ones, and $\varphi = (\varphi_1, \dots, \varphi_m)$ is a vector of unknown parameters. Here we implement this methodology to assess the impact of countries' Environmental Performance Index scores on efficiency distribution across them (m=2). Thus, the prior on φ_1 is $p(\varphi_1) = f_G(\varphi_1|1, -\ln(r^*))$ and for φ_2 it is, where r* is the prior median efficiency, here set at 0.8 (see, e.g., Greene 2008 for discussion). The Gibbs sampler, which we use in this study, requires drawing from full conditional distributions. Fortunately in this model they can be derived analytically, and can be found in the works of Koop *et al.*, (1999, 2000). Considering the arguments presented in Marzec and Osiewalski (2008), we use 0-1 variables instead of continuous random to reduce the computation burden[2]. One indicates that a country has scored above EPI country average, zero otherwise.

Results and analysis

The study is based on a set of 13 EU countries analyzed over the period of ten years (1998-2008). The data come from EU KLEMS database (see O'Mahony, & Timmer, 2009), and are complemented by Eurostat-OECD statistics on Purchasing Power Parities (PPP's) in order to account for differences in currencies' purchasing powers across countries. To estimate our macroeconomic production function we choose the following variables:

- "Gross Value Added (GVA) in constant international dollar, 1995 prices"[3] for our output indicator, "fixed capital stock in constant international dollar, 1995 prices" "total hours worked by persons engaged" as input indicators for capital and labour respectively,
- EPI estimates from 2008 edition as additional explanatory variable influencing efficiency distribution among the countries in question.

We ran 600 thousand draws, discarding the first 100 thousand. Application of Markov Chain Monte Carlo methods (MCMC), such as Gibbs sampler, requires us to

---

[1] Although this could be easily extended to a more complex functional form like translog, we have found that such an extension has no impact on inference about *posterior* efficiencies' distributions, and thus brings no insight into the subject of this research.

[2] Switching to continuous variables would have profound implications on conditionals as they would have a nonstandard form. Then one would require a more complex algorithm.

[3] Although we start our analysis from 1998, EU KLEMS uses 1995 as a reference year for their capital stock estimates. Thus, we decided to keep their reference year.

methods (MCMC), such as Gibbs sampler, requires us to monitor convergence of the chain to its limiting stationary distribution. In order to facilitate this, we use CUMSUM statistics proposed by Yu and Mykland (1998), and apply them after burn-in period. Figure 1 presents a plot of CUMSUM statistics for *eL* (labour elasticity) and β_0 (constant). The graph shows that the chains rapidly stabilize long before the end of the simulation.

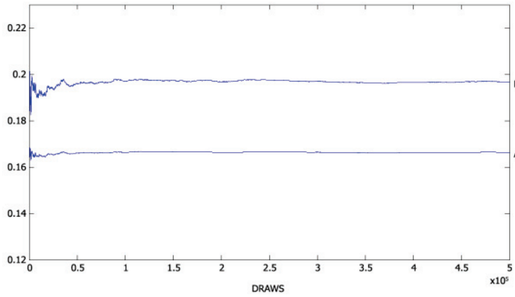

Figure 1. CUMSUM statistics for *eL* and β_0 (CUMSUM statistics for elasticity of labour; B: CUMSUM statistics for model's constant)

Based on the retained draws we calculate point estimates of placement and dispersion measures of posteriors efficiencies. Additionally, for the main model parameters (Table 1), we compute more detailed statistics of their posteriors. The results are summarized in Tables 1 and 2. Not to our surprise, the least efficient countries in the sample are Eastern Europe's post communist economies. As indicated by their posterior means, though Poland and Czech Republic's efficiencies have risen significantly within the analyzed period, both countries still have much to catch up in respect of their Western partners.

Table 1

Posterior characteristics of model parameters

	mean	Std	Median	IQR	skewness	kurtosis
	0.6122	0.0455	0.6127	0.0604	-0.0734	3.1605
	0.4046	0.0521	0.4043	0.0695	0.0347	3.1098
	0.0002	0.0047	0.0002	0.0063	-0.0217	3.0580
(const)	0.4021	0.1874	0.3996	0.2478	0.0982	3.2339
Scale	1.0168	0.0125	1.0169	0.0168	-0.0627	3.0611
	0.1098	0.0125	0.1097	0.0164	0.0805	3.2518
(priors)						
(intercept)	4.4746	4.4765	3.1022	4.9069	2.0055	9.0322
(EPI)	0.9985	0.9989	0.6922	1.0950	2.0055	9.0322
(posteriors)						
(intercept)	4.3051	0.6778	4.2550	0.8995	0.4626	3.4107
(EPI)	4.4700	1.3630	4.2434	1.7435	0.9493	4.2085

Note: IQR stands for interquartile range; std stands for posterior standard deviation; posterior skewness and kurtosis are calculated as third and fourth standardised moments respectively.

Table 2

Posterior efficiencies

Year / Country	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Average (count.)	EPI score
Austria	0.9401 *0.0502*	0.9416 *0.0491*	0.9440 *0.0476*	0.9415 *0.0493*	0.9398 *0.0505*	0.9391 *0.0509*	0.9406 *0.0500*	0.9412 *0.0497*	0.9453 *0.0470*	0.9482 *0.0452*	0.9421 *0.0490*	89.41
Czech Republic	0.5776 *0.0691*	0.5719 *0.0684*	0.5730 *0.0683*	0.5773 *0.0685*	0.5873 *0.0696*	0.6024 *0.0716*	0.6310 *0.0748*	0.6489 *0.0769*	0.6811 *0.0806*	0.7078 *0.0835*	0.6158 *0.0731*	76.80
Denmark	0.8640 *0.0776*	0.8674 *0.0766*	0.8748 *0.0744*	0.8653 *0.0765*	0.8549 *0.0784*	0.8451 *0.0800*	0.8496 *0.0793*	0.8538 *0.0787*	0.8615 *0.0775*	0.8597 *0.0782*	0.8596 *0.0777*	84.00
Finland	0.9529 *0.0415*	0.9544 *0.0404*	0.9570 *0.0385*	0.9582 *0.0376*	0.9560 *0.0392*	0.9533 *0.0412*	0.9570 *0.0385*	0.9568 *0.0387*	0.9610 *0.0355*	0.9645 *0.0327*	0.9571 *0.0384*	91.41
Germany	0.9420 *0.0493*	0.9416 *0.0495*	0.9415 *0.0496*	0.9391 *0.0512*	0.9363 *0.0531*	0.9321 *0.0558*	0.9329 *0.0553*	0.9310 *0.0566*	0.9347 *0.0544*	0.9346 *0.0546*	0.9366 *0.0529*	86.31
Italy	0.8814 *0.0727*	0.8776 *0.0735*	0.8850 *0.0713*	0.8873 *0.0704*	0.8829 *0.0719*	0.8754 *0.0739*	0.8737 *0.0744*	0.8658 *0.0765*	0.8605 *0.0779*	0.8631 *0.0777*	0.8753 *0.0740*	84.20
Netherlands	0.9279 *0.0555*	0.9302 *0.0541*	0.9347 *0.0517*	0.9314 *0.0533*	0.9260 *0.0560*	0.9206 *0.0584*	0.9199 *0.0586*	0.9248 *0.0563*	0.9305 *0.0538*	0.9349 *0.0515*	0.9281 *0.0549*	78.70
Poland	0.5543 *0.0673*	0.5594 *0.0678*	0.5648 *0.0684*	0.5592 *0.0678*	0.5595 *0.0680*	0.5855 *0.0712*	0.6315 *0.0766*	0.6519 *0.0791*	0.6899 *0.0835*	0.7090 *0.0858*	0.6065 *0.0736*	80.50
Portugal	0.9417 *0.0510*	0.9398 *0.0522*	0.9394 *0.0524*	0.9313 *0.0579*	0.9201 *0.0650*	0.9045 *0.0738*	0.8969 *0.0780*	0.8859 *0.0834*	0.8764 *0.0875*	0.8801 *0.0861*	0.9116 *0.0687*	85.81
Slovenia	0.9481 *0.0461*	0.9496 *0.0448*	0.9494 *0.0448*	0.9493 *0.0449*	0.9483 *0.0456*	0.9464 *0.0471*	0.9483 *0.0457*	0.9494 *0.0449*	0.9528 *0.0422*	0.9516 *0.0432*	0.9493 *0.0449*	86.31
Spain	0.9046 *0.0652*	0.9052 *0.0648*	0.9069 *0.0639*	0.9070 *0.0639*	0.9037 *0.0651*	0.8971 *0.0674*	0.8964 *0.0677*	0.8944 *0.0684*	0.8932 *0.0690*	0.8946 *0.0687*	0.9003 *0.0664*	83.60
Sweden	0.9711 *0.0271*	0.9725 *0.0260*	0.9739 *0.0248*	0.9727 *0.0258*	0.9724 *0.0261*	0.9723 *0.0262*	0.9731 *0.0254*	0.9738 *0.0249*	0.9752 *0.0236*	0.9756 *0.0234*	0.9733 *0.0253*	93.11
United Kingdom	0.9656 *0.0319*	0.9660 *0.0316*	0.9663 *0.0313*	0.9668 *0.0309*	0.9676 *0.0302*	0.9686 *0.0294*	0.9696 *0.0286*	0.9695 *0.0286*	0.9695 *0.0287*	0.9696 *0.0286*	0.9679 *0.0300*	86.31
Average (annual)	0.8747 *0.0503*	0.8752 *0.0499*	0.8778 *0.0491*	0.8759 *0.0499*	0.8734 *0.0513*	0.8725 *0.0534*	0.8785 *0.0538*	0.8806 *0.0545*	0.8871 *0.0544*	0.8918 *0.0542*	0.8787 *0.0521*	85.1

Note: Point estimates are posterior means; measures of dispersion are posterior standard deviations in italic.

Estimation results for Environmental Performance Index influence on countries' technical efficiency can be viewed in Table 1 and Figures 2, 3 – φ_1 (intercept) posterior did not change much its mean (nor median) in comparison to the prior, concentrating more around it and significantly decreasing its asymmetry. For φ_2 (EPI), on the other hand, the posterior mean has been significantly altered by the data in respect to the prior. The information within the sample has significantly pulled the posterior away from the neutrally positioned prior towards higher values. When comparing the posterior of φ_2 with its prior we can see that their probability masses do not overlap much (Figure 2). This provides us with the evidence that environmental performance tends to play a positive role in the economy and stimulates its productive performance. Countries that scored high in environmental protection and sustainability (according to EPI index) had on average better economic performance by 15% (see Figure 3).

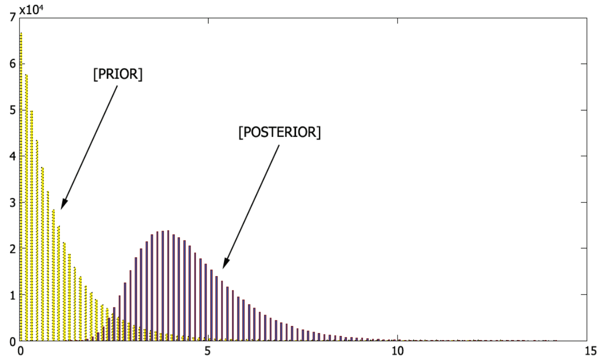

Figure 2. Histograms of φ_2 (EPI) prior and posterior distributions (calculated based on 500 000 draws from the prior and the posterior of φ_2 (EPI); for distributions characteristics see Table 1)

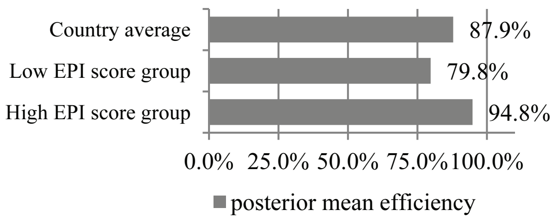

Figure 3. Posterior means of efficiencies

Conclusions

The aim of this paper was to provide information on environmental factors impact on countries' economic performances. The study allows us to draw several conclusions on the matter.

First of all, the results show that environmental performance seems to have significant influence on country's economic performance. Hence, pro environmental actions do seem to play a significant role in explaining the source of the given country's high productivity.

Second, the environmental factors play rather minor roles in comparison to production inputs (capital, labor) and technology. Nonetheless, even though economic benefits tend to be small we should remember that the main purpose of those factors is to influence sustainability of the environment in an economy.

Third, the fact that those countries which have high environmental performance also tend to have higher technical efficiency, primarily deals with the fixed trade-off notion. The sample does not provide any support to the fixed trade-off idea. What is more, it states otherwise. Going green does benefit economic performance.

To conclude, this research has a strictly quantitative character. It seems that framing the problem into the field of macroeconomic performance analysis allowed us to consider the issue in more detail and avoid any inconsistencies. Furthermore, considering model's advanced specification Bayesian inference seems to be the only proper way for empirical implementation. However, proving that environmental performance is positively correlated with economic performance can only contribute to stating governments' policy goals. To go beyond this area and draw detailed conclusions from particular actions requires further research. Specific procedures for policy makers on means to achieve particular policy goals have to be derived from additional qualitative studies that would include well performing (economically and ecologically) countries such as Sweden, United Kingdom and Finland. Moreover, it cannot be forgotten that many ecological determinants are specific to the given economy, and thus it is advised to pay great attention to their relationships with the given country's environment performance while coming to any conclusions.

References

Arcelus, F., & Arocena, P. (2005). Productivity Differences Across OECD Countries in the Presence of Environmental Constraints. *Journal of the Operational Research Society*, 56,12, 1352-1362. http://dx.doi.org/10.1057/palgrave.jors.2601942

Bonini, S., & Oppenheim, J. (2008). Cultivating the Green Consumer. *Stanfold Social Innovation Review*, 6(4), 56-61.

Brown, L. R., & Mitchell, J. (1999). Building a New Economy. In W M. V. Russo, *Environmental Management Readings and Cases* (pp. 15-32). Boston: Houghton Mifflin Company.

Cherchye, L., Moesen, W., & Van Puyenbroeck, T. (2004). Legitemately Diverse, Yet Comparable: On Synthesizing Social Inclusion Performance in the EU. *Journal of Common Market Studies,* 42(5), 919-955. http://dx.doi.org/10.1111/j.0021-9886.2004.00535.x

Despotis, D. (2005). Measuring Human Development via Data Envelopment Analysis: the Case of Asia and the Pacific. *Omega,* 33(5), 385-390. http://dx.doi.org/10.1016/j.omega.2004.07.002

Feiock, R. C., & Stream, C. (2001, May/June). Environmental Protection versus Economic Development: A False Trade-Off? *Public Administration Review,* 61(3), 313-321. http://dx.doi.org/10.1111/0033-3352.00032

Fried, H. O., Lovell, K. C., & Schmidt, S. S. (2008). *The Measurement of Productive Efficiency and Productivity Growth.* New York: Oxford University Press. http://dx.doi.org/10.1093/acprof:oso/9780195183528.001.0001

Greene, W. H. (2008). The Econometric Approach to Efficiency Analysis. In H. O. Fried, C. A. K. Lovell, S. S. Schmidt, *The Measurement of Productive Efficiency and Productivity Growth* (pp. 92-159). New York: Oxford University Press. http://dx.doi.org/10.1093/acprof:oso/9780195183528.003.0002

Hart, S. L. (1997). Beyond Greening: Strategies for a Sustainable World. *Harvard Business Review*, 75(1), 66-76.

Henderson, D., & Millimet, D. (2005). Environmental Regulations and US State Level Production. *Economics Letters*, 87(1), 47-53. http://dx.doi.org/10.1016/j.econlet.2004.08.013

Jaffe, A. B., Peterson, S. R., Portney, P. R., & Stavins, R. N. (1995, March). Environmental Regulation and the Competitiveness of US Manufacturing: What Does the Evidence Tell Us? *Journal of Economic Literature*, 33(1), 132-136.

Jeon, B., & Sickles, R. (2004). The Role of Environmental Factors in Growth Accounting. *Journal of Applied Econometrics*, 19(5), 567-591. http://dx.doi.org/10.1002/jae.769

Koop, G., Osiewalski, J., & Steel, M. F. (2000). Modelling the Sources of Output Growth in a Panel of Countries. *Journal of Business & Economic Statistics*, 18(3), 284-299. http://dx.doi.org/10.2307/1392262

Koop, G., Osiewalski, J., & Steel, M. F. (1999). The components of output growth: A Stochastic Frontier Analysis. *Oxford Bulletin of Economics and Statistics*, 61(4), 455-487. http://dx.doi.org/10.1111/1468-0084.00139

Makieła, K. (2009). Economic Growth Decompositon. An Empirical Analysis Using Bayesian Frontier Approach. *Central European Journal of Economic Modelling and Econometrics*, 1(4), 333-369.

Marzec J., & Osiewalski J. (2008). Bayesian inference on technology and cost efficiency of bank branches, *Bank i Kredyt [Bank and Credit]*, 39, 29-43

O'Mahony, M., & Timmer, M. P. (2009). Output, Input and Productivity Measures at the Industry Level: the EU KLEMS Database. *Economic Journal*, 119,538, F374-F403 http://dx.doi.org/10.1111/j.1468-0297.2009.02280.x

Porter, M. E., & van der Linde, C. (1995). Green and Competitive. *Harvard Business Review*, 73(5), 120-134.

Yale Center for Environmental Law & Policy, Y. U., & Center for International Earth Science Information Network (CIESIN), C. U. (2008). *Environmental Performance Index.* New Haven: Yale Center for Environmental Law & Policy.

Yoruk, B., & Zaim, O. (2005). Productivity Growth in OECD Countries: A Comparison with Malmquist Indices. *Journal of Comparative Economics*, 33(2), 401-420. http://dx.doi.org/10.1016/j.jce.2005.03.011

Yu, B., & Mykland, P. A. (1998). Looking at Markov samplers through cusum path plots: a simple diagnostic idea. *Statistics and Computing*, 8(3), 275-286. http://dx.doi.org/10.1023/A:1008917713940

Zaim, O. (2004). Measuring Environmental Performance of State Manufacturing Through Changes in Pollution Intensity: A DEA Framework. *Ecological Economics*, 48(1), 37-47. http://dx.doi.org/10.1016/j.ecolecon.2003.08.003

Kamil Makieła, Tomasz Misztur

Ekosistemos išsaugojimo ir ekonominės veiklos suderinamumo analizė

Santrauka

Darbo tikslas - paaiškinti tam tikrą informaciją apie tai, kokią įtaką daro mikroekonominiai aplinkosaugos veiksmai šalių ekonominei veiklai ir atsakyti į klausimą: Ar tikrai makroekonominėje skalėje egzistuoja kompromisas tarp ekosistemos išsaugojimo ir ekonominės veiklos? Ar šalys, kurios priima draugiškus aplinkai sprendimus, patiria išlaidų dėl sumažėjusio gamybos našumo ar visiškai priešingai?

Šio tyrimo tikslas - išsiaiškinti ar aplinkosaugos veikla daro kokią nors įtaką našumui ir jei tai tiesa, įvertinti jos dydį bei kryptį.

Per pastaruosius keturis dešimtmečius pasaulinė ekonomika gerokai išsiplėtė ir ėmė viršyti Žemės išteklių mastus. Dauguma tokių aplinkos pažeidimų formų, kaip dirvos erozija, vandens sluoksnio deficitas, ganyklų pablogėjimas, oro užterštumas ir klimato pokyčiai labai neigiamai paveikė ekosistemą. Jei pasaulyje nebus atkreiptas dėmesys į šias problemas, žemėje įvyks pokyčiai, kurie suardys savo natūralią sistemą. Šios problemos ilgalaikis sprendimas yra pritaikyti palaikomojo pobūdžio ekonominės plėtros ekologinius principus. Visiems yra žinoma, kad tokie veiksniai, kaip mažėjantis CO2 išskyrimas, vandens palaikymas, miškininkystės ir žemės ūkio išsaugojimas bei tinkamas gamybos proceso valdymas padeda saugoti mūsų planetos natūralią aplinką ir klimatą, tačiau neaišku kaip ši veikla susijusi su verslu. Per septintąjį ir aštuntąjį dešimtmečius, organizacijos nepripažino savo neigiamos įtakos aplinkai. Tik po patirtų tarptautinių ekologinių katostrofų, šalys pradėjo ieškoti įvairių būdų, kad būtų išvengta aplinkos irimo ateityje. Daugelis organizacijų buvo priverstos prisiimti atsakomybę dėl aplinkos, kurioje dirba, išsaugojimo. Todėl atsirado vyraujanti nuomonė, kad egzistuoja kompromisas tarp ekologijos ir ekonomikos. Socialinė nauda, kurią suteikia griežti aplinkosaugos reikalavimai palyginami su privačiomis išlaidomis, skirtomis apsaugos ir valymo veiklai. Paaiškėjo, kad sėkmė vienoje srityje baigiasi nesėkme kitoje.

Tačiau per pastarąjį dešimtmetį šiam požiūriui teko daug išbandymų, nes vis labiau palaikomas supratimas, kad jei ekologiškumas yra tinkamas verslui, vadinasi tinkamas ir visai ekonomikai. Saugodama gamtinius išteklius ir kurdama naujos kokybės aplinkos apsaugos valdymo sistemas, šalis didina savo našumą. Tai leidžia pasiekti didesnius gamybos pajėgumus su turimomis sąnaudomis (lyginant su mažiau aplinkosaugai nusiteikusiomis kaimyninėmis šalimis). Norint išspręsti konfliktą tarp dviejų sąvokų, reikia pasitelkti makroekonominę našumo teoriją. Šiame darbe naudota sistema yra pagrįsta Bajeso metodu atsitiktinei ribinei analizei, kitaip dar vadinama Bajeso riba. Ji įveda sudėtingą klaidą į standartinę gamybos funkciją, leisdama įvertinti nagrinėjamo vieneto techninį našumą. Makroekonomikoje gamybos funkcija apibendrina sąnaudų pavertimo į tam tikrą pramonės arba, šiuo atveju visos ekonomikos, produkciją procesą. Tokiu būdu, mes įvertiname maksimaliai galimus produkcijos su turimomis sąnaudomis derinius (gamybos technologija), o tada lyginame juos su nustatyta produkcija. Atstumas tarp nustatytos gamybinės produkcijos ir jį atitinkančios techninės ribos suteikia nagrinėjamai ekonomikai neveiksnumą, nuo kurio yra skaičiuojamas techninio našumo faktorius. Kadangi kiekvienos šalies techninis našumas nustatomas pagal nustatytos produkcijos santykį su galima gauti produkcija (esant dabartinėms sąnaudoms), tai leidžia mums pamatyti skirtingų dydžių ir gamybos apimčių šalis. Norėdami ištirti, kokią įtaką aplinkosaugos veikla daro makroskalės našumui, mes įtraukėme pagrindinius aplinkosaugos rodiklius (kaip papildomus paaiškinamuosius kintamuosius) į pagrindinį makroekonominį gamybos ribos modelį, kaip neveiksnumo paskirstymas Bajeso modelyje. Bajeso išvados panaudojimas leidžia mums paprastai patikrinti, kokią paaiškinamąją galią turi šie rodikliai šalių našumui ir jų ekonominei veiklai. Mūsų analizės objektai yra ES šalys narės, kurios buvo stebėtos dešimt metų (1998-2007). Duomenys gauti iš ES KLEMS duomenų bazės ir papildyti iš Eurostat-OECD statistikos. Informacija apie šalių aplinkosaugos veiklą yra pagrįsta aplinkosaugos veiklos indeksu (EPI – plg. angl. environmental performance index), kurį kartu sudarė Jeilio ir Kolumbijos universitetai, Pasaulio ekonomikos forumas ir Europos komisijos jungtinis tyrimų centras. Rezultatai rodo, kad aplinkosaugos veikla darė teigiamą ir statistiškai svarbią įtaką makroskalės našumui. Žinant tai, mes turėtume prisiminti, kad aplinkos apsaugos tikslas yra išlaikyti natūralią aplinką, o ne didinti kompanijų gamybos našumą. Tačiau darbe daroma išvada, kad makroskalėje naujų ir aplinką palaikančių sprendimų pateikimas tikrai gali skatinti ekonomikos našumą.

Raktažodžiai: *aplinka, ekonominė veikla, aplinkosauginės veiklos indeksas, našumas, atsitiktiniai ribiniai modeliai.*

The article has been reviewed.

Received in June, 2011; accepted in April, 2012.