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The Impact of Public Environmental Protection Expenditure on Economic Growth

Wpływ wydatków publicznych związanych z ochroną środowiska na wzrost gospodarczy

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Abstract

The article analyzes the impact of public environmental protection expenditure on economic growth. Estimating the strength of this relationship is of particular importance in the context of the recent global economic crisis. The paper is organized as follows. Firstly, theoretical model showing the mechanism of public environmental protection expenditure impact on GDP is presented. Then the results of an empirical study are shown. The study is conducted for the eleven countries of Central Europe. Econometric panel model is applied, which takes into account both time and cross-sectional dimension of the analyzed phenomenon, because, as indicated in the article, relying only on the variation over time may lead to misleading conclusions. The estimations based on panel model, conducted for the years 2001-2012, shows that the increase in public environmental protection expenditure has a positive effect on economic growth. Due to the fact that the analyzed period is heterogeneous, that is it covers both the period before the global economic crisis, and during its lifetime, calculations were also performed for two sub-periods. Results reveal that public environmental protection expenditure has stronger influence on GDP during crisis. Hence, the study shows that public environmental protection expenditure have no negative impact on economic growth, and its positive effects are strongest in case of economies affected by the global financial crisis.

Key words: environmental protection, public expenditures, economic growth

Streszczenie

W pracy poddano analizie wpływ wydatków publicznych związanych z ochroną środowiska na wzrost gospodarczy. Oszacowanie siły oddziaływania tego typu wydatków nabiera szczególnego znaczenia w kontekście ostatniego kryzysu gospodarczego na świecie. W pierwszej kolejności przedstawiono model teoretyczny, ukazujący mechanizm oddziaływania wydatków publicznych związanych z ochroną środowiska na PKB. Następnie ukazano wyniki badania empirycznego. Badanie przeprowadzono dla jedenastu krajów Europy Centralnej. Wykorzystano ekonometryczny model panelowy, który uwzględnia zarówno zmienność badanego zjawiska zarówno w czasie, jak i pomiędzy poszczególnymi krajami. Jak wykazano bowiem w artykule, oparcie się jedynie na zmienności w czasie może prowadzić do mylnych wniosków na temat badanego zjawiska. Z przeprowadzonych na podstawie modelu panelowego estymacji dla lat 2001-2012 wynika, że zwiększenie wydatków publicznych związanych z ochroną środowiska wpływa pozytywnie na wzrost gospodarczy. Ze względu na fakt, że analizowany okres jest niejednorodny, tj. obejmuje zarówno okres sprzed kryzysu gospodarczego na świecie, jak i w trakcie jego trwania, obliczenia wykonano również w rozbiciu na dwa podokresy. Uzyskano, że wydatki publiczne związane z ochroną środowiska oddziałują na PKB silniej w okresie kryzysu gospodarczego. Zatem z przeprowadzonych badań wynika, że wydatki publiczne związane z ochroną środowiska nie wpływają negatywnie na wzrost gospodarczy, a ich pozytywne skutki ekonomiczne są szczególnie silne w przypadku gospodarek dotkniętych światowym kryzysem finansowym.

Słowa kluczowe: ochrona środowiska, wydatki publiczne, wzrost gospodarczy

1. Introduction

The main objective of public environmental protection expenditure is encouraging the sustainable use of natural resources and protecting the environment. However, at the same time, this expenditure may affect the economic growth. On one hand, public environmental protection expenditure is a part of total public expenditures, which in short run usually stimulate economy (see for example Auerbach and Gorodnichenko, 2012; Blanchard and Leigh, 2013). On the other hand, this kind of expenditure may increase costs in some manufacturing industries (Gray and Shadbegian, 1995; Morgenstern, Pizer, and Shih, 1997; Joshi, Krishnan and Lave, 2000), and in effect decrease economic activity.

The verification of the effects of public environmental protection expenditure is significant in the context of the discussion concerning the impact of fiscal policy on sustainable development. It shows, whether the increase in public spending, which have a positive effect on the environment, may also positively affect economic growth, which in turn is associated with economic and social development. As a result, it is verified in the paper, whether fiscal policy by means of public environmental protection expenditure may simultaneously reinforce three pillars of sustainable development, that is economic development, social development and environmental protection.

The macroeconomic effects of public expenditure is of particular importance in the context of the recent crisis in Europe[1]. For this reason, the impact of the public environmental protection expenditure impact on GDP is analyzed in the paper. Empirical analysis is conducted for countries of Central Europe. Countries, which are selected for the analysis, are relatively homogeneous, what is highly important for the econometric estimation accuracy.

The paper is organized as follows. Firstly, theoretical model, which explains potential macroeconomic effects of public environmental protection expenditure is presented. Then, results of empirical research, based on econometric panel model are shown. The last paragraph of the paper concludes.

2. Theoretical model

The impact of public environmental protection expenditure on economic growth can be illustrated on the basis of a dynamic general equilibrium model[2]. Environmental protection expenditure, as well as other government spending (Turnovsky, 2000), affects the productivity of factors of production. Thus, if the production function is a power function we obtain:

$$Y_t = K_t^{\varepsilon_K} L_t^{\varepsilon_L} E_t^{\varepsilon_E}$$

where:
E_t – public environmental protection expenditure,
Y_t – output,
K_t – capital,
L_t – labour.

If production function has constant returns to scale, that is:

$$\varepsilon_K + \varepsilon_L + \varepsilon_E = 1$$

above production function can be written as:

$$Y_t = r_t K_t + w_t L_t + \varphi_t E_t$$

where :
r_t – marginal product of capital,
w_t – marginal product of labour,
φ_t – marginal product of public environmental protection expenditure,
$r_t, w_t > 0$.

Empirical studies indicate that government spending generally increases the productivity (see Linnemann and Schabert, 2005), that is usually φ_t is higher than zero. However, in the case of public environmental protection expenditure the direction of public environmental protection expenditure on GDP is not so clear (Pearce and Palmer, 2001).

At the same time, public environmental protection expenditure has an influence not only on productivity but also on the level of households utility[3]. Taking this effect into account we obtain that households maximize the following expected value of the discounted sum of utilities:

$$U = E\left(\sum_{t=0}^{\infty} \beta^t u(C_t, L_t, E_t)\right)$$

where:
U – expected value of the discounted sum of utilities,
β – discount factor,
C_t – consumption.

In case of public environmental protection expenditure we have $\frac{\partial u_t}{\partial E_t} \geq 0$.

The public environmental protection expenditure impact on households utility can be described by the following utility function:

$$U = E\left(\sum_{t=0}^{\infty} \beta^t \left(C_t + \phi E_t\right)^{\alpha} L_t^{1-\alpha})\right)$$

[1] More about the role of sustainable development during crisis see Kossecki and Wachowicz, 2013; Lietaer et al., 2014.

[2] Dynamic general equilibrium models, which include public expenditures others than environmental protection expenditures are described among others in Krajewski, 2014.

[3] More about utility function in dynamic general equilibrium models see for example Dejong and Dave, 2007.

where:

$\alpha \in (0,1), \phi \in <0,1>$.

The parameter ϕ determines the strength of the impact of public environmental protection expenditure on utility. This parameter is not lower than zero, similarly as in case of others kinds of government spending (Amano and Wirjanto, 1997).[4]

The overall impact of public environmental protection expenditure on households assets is described by the following expression:

$$S = -1 + \varphi + \phi$$

On one hand, public environmental protection expenditure causes that economic resources are taken by the state from the private sector (this impact is shown by -1). On the other hand, public environmental protection expenditure provides following benefits to households:

- public environmental protection expenditure increase the utility of household consumption (the strength of this effect shows parameter ϕ),
- public environmental protection expenditure has impact on productivity (the strength of this effect shows parameter φ).

If S is lower than zero, public environmental protection expenditure has negative wealth effect (Barro, 1981). Otherwise it generates positive wealth effect.

Wealth effect, caused by an increase in public environmental protection expenditure, has an impact on GDP through two channels. Firstly, in a period of higher government spending demand increases. The change of aggregate demand is given by the formula:

$$\Delta AD_t = \Delta C_t + \Delta E_t$$

where:

AD_t – aggregate demand.

Under assumed utility function households take into account the level of effective consumption EC_t (Christiano and Eichenbaum, 1992), that is:

$$EC_t = C_t + \phi E_t$$

So we obtain:

$$\Delta AD_t = \Delta EC_t + (1-\phi)\Delta E_t$$

Under constant interest rate households does not change decisions concerning the effective consumption and the amount of work (Aschauer, 1988), therefore:

$$\Delta AD_t = (1-\phi)\Delta E_t$$

Thus, the change of aggregate demand, resulting from an increase in environmental protection expenditure, depends on parameter ϕ. On the other hand, an increase in aggregate supply, resulting from the growth of government spending, is given by the following formula (Aschauer, 1988):

$$\Delta AS_t = \varphi \Delta E_t$$

where:

AS_t – aggregate supply.

Thus, public environmental protection expenditure increases aggregate supply if marginal product of this kind of expenditure is positive.

3. Empirical analysis

The empirical analysis of the impact of public environmental protection expenditure on GDP was carried out on the basis of panel model. This kind of econometric model is based on two-dimensional data, which includes both cross sectional and time dimension (Wooldridge, 2010).

All data comes from European Commission database Eurostat. According to Eurostat methodology public environmental protection expenditure includes all expenditures aimed at prevention, reduction and elimination of environment degradation and consist of the following domains:

- protection of air and climate;
- protection of biodiversity and landscape;
- protection and remediation of soil and water;
- waste management;
- wastewater management;
- noise and vibration abatement;
- protection against radiation;
- research and development concerning environment;
- other environmental protection activities[5],

The empirical study covers Central European countries which have joined European Union since 2004 (so called new member states), that is the following countries: Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia. Due to data availability the study covers period 2001-2012.

Firstly, before the results of panel model are described, the correlation analysis is presented and its limitations in the analysed case are discussed. Table 1 presents the correlations coefficients between the economic growth and public environmental protection expenditure for each country.

The obtained results may suggest that for most of the analyzed countries there is the inverse relationship between the economic growth and the level of public environmental protection expenditure. However, it should be stressed that in analyzed period two phenomena occured simultaneously:

- the increase of the importance of environmental protection, resulting in higher public environmental protection expenditure;

[4] However, it is worth noting that estimates of parameter ϕ are not homogenous (Ismail, 2010).

[5] More about Eurostat methodology concerning environmental protection expenditure see http://epp.eurostat.ec.europa.eu.

- the economic crisis in the world, which led to a decline in GDP growth in the countries of Central Europe.

Table 1. Correlation coefficients between growth rate of GDP and public environmental protection expenditure in relation to GDP, source: own calculations based on Eurostat data.

Country	Correlation
Bulgaria	-0,65
Czech Republic	-0,17
Estonia	-0,19
Croatia	0,13
Latvia	-0,37
Lithuania	-0,53
Hungary	0,76
Poland	-0,37
Romania	-0,45
Slovenia	-0,51
Slovakia	-0,13

The scale of changes in the level of public environmental protection expenditure and economic growth in Central Europe show figures 1 and 2.

Figure 1. The average level of public environmental protection expenditure in Central Europe in years 2001-2012 (in % of GDP), source: own calculations based on Eurostat data.

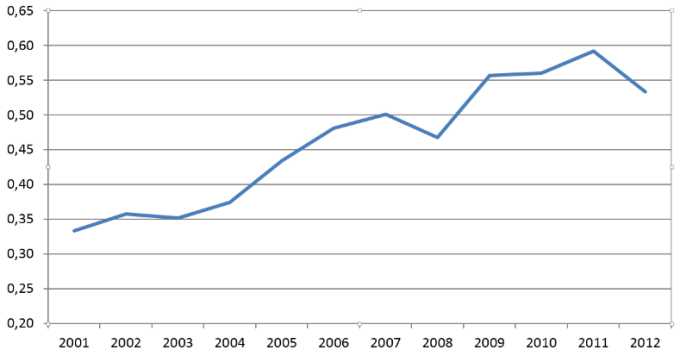


Figure 2. The average growth rate of GDP in Central Europe in years 2001-2012 (in %), source: own calculations based on Eurostat data.

Since a rapid decline in economic growth in 2009 resulted from the global crisis, not from domestic policy, the correlation analysis based only on time series may give misleading results. It means that such analysis show only spurious correlation, not real relationship between analyzed economic categories.

Therefore, in order to estimate the impact of public environmental protection expenditure on GDP the panel model was applied, which takes into account the diversity of the phenomena between countries. The average level of analyzed variables for each country is shown in figures 3 and 4.

There are relatively large differences between countries both in case of economic growth rate and public environmental protection expenditure. The advantage of panel model is that it takes this cross-sectional variability into account.

Including both time and cross-section dimension 132 observations were included in the analyzed panel (that is 12 time observations for each of 11 countries). The parameters of the following equation were estimated:

$$GDP_{t,k} = \alpha_0 + \alpha_1 \Delta EnvExp_{t-1,k} + \alpha_2 X_{t-1,k} + \xi_{t,k}$$

where:

$GDP_{t,k}$ – growth rate of GDP in country k in year t,

$\Delta EnvExp_{t,k}$ – first difference of public environmental protection expenditure in relation to GDP in country k in year t,[6]

$X_{t,k}$ – vector of other exogenous variables,

$\xi_{t,k}$ – random factor,

α_0, α_1, α_2 – parameters,

$t = 1,\ldots 12$ – time dimension (observations from 2001 to 2012),

$k = 1,\ldots 11$ – cross-sectional dimension (observations for: Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia).

Public environmental protection expenditure is nonstationary variable (what can be observed on figure 2)[7], so the first difference of this variable is applied.

The estimation of parameter α_1 is the most important in the context of this study. It shows the impact of increase in public environmental protection expenditure on economic growth rate in analyzed countries.

The estimate of parameter α_1 is equal 59,68 and t-student statistic shows that this parameter is statistically significant. The estimate of parameter α_1 higher than zero means that public environmental protection expenditure has positive impact on economic growth.

[6] That is, expenditure's increase in time:
$\Delta EnvExp_{t,k} = EnvExp_{t,k} - EnvExp_{t-1,k}$

[7] Nonstationarity was also formally verified by Im, Pesaran and Shin test (Im, Pesaran and Shin, 2003).

Figure 3. Environmental protection expenditure in countries of Central Europe (average for 2001-2012, in % of GDP), source: own calculations based on Eurostat data.

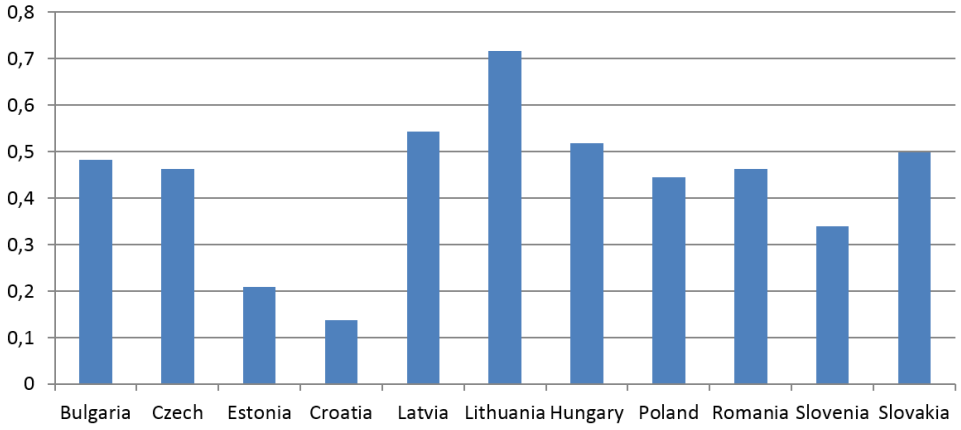
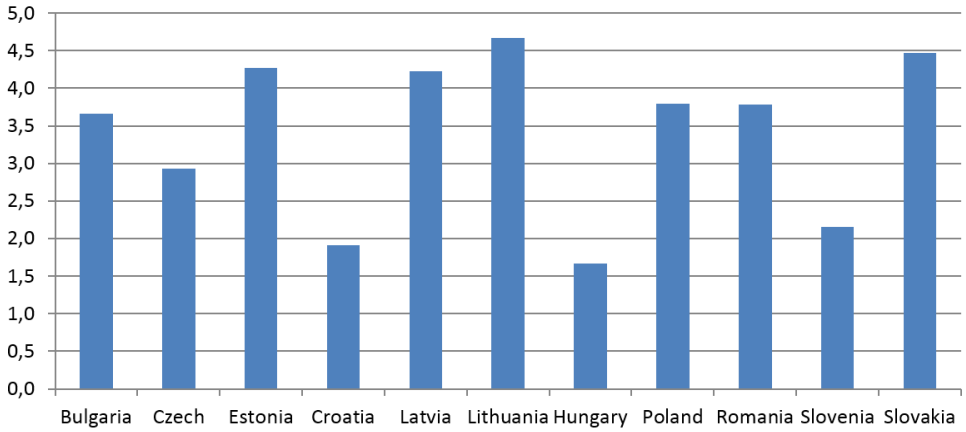


Figure 4. GDP growth rate in countries of Central Europe (average for 2001-2012, in %), source: own calculations based on Eurostat data.



In order to check the potential effects of the occurrence of time trend, the parameters of the following equation were also estimated:

$$GDP_{t,k} = \beta_0 + \beta_1 \Delta EnvExp_{t-1,k} + \beta_2 X_{t-1,k} + \\ + \beta_3 t + \zeta_{t,k}$$

where:

$\zeta_{t,k}$ – random factor,

$\beta_0, \beta_1, \beta_2, \beta_3$ – parameters,

$\beta_3 t$ – the effect of time trend.

Obtained results confirm that adding a time trend does not significantly change previous estimates. In particular, as before, it was obtained that an increase in public environmental protection expenditure has a positive impact on economic growth (the estimate of parameter β_1 is equal 66,23 and statistically significant).

Due to the fact that the analyzed period is heterogeneous, that is it covers both the period before the global economic crisis, and during its lifetime, calculations were also performed for two subperiods. That is, the parameters of above equations were estimated for pre-crisis (till 2007) and crisis subperiod (since 2008).

Estimates of the parameters showing the impact of public environmental protection expenditure on GDP (i.e. α_1 and β_1) are much lower for the pre-crisis period, than after the outbreak of the financial crisis. For the model without time trend the parameter which measures the effects of public environmental protection expenditure increased from 19,55 before crises to 71,26 during crisis. For the model with time trend this parameter increased from 6,39 to 71,21 respectively. It means that during the global financial crisis the impact of public environmental protection expenditure on GDP was much stronger. The obtained results are consistent with the surveys for the overall level of public spending, which indicate that during the crisis fiscal policy is more effective (Baum and Koester, 2011; Eggertsson, 2011; Blanchard and Leigh, 2013).

4. Conclusions

The impact of public environmental protection expenditure on GDP in Central European countries was analyzed in the article. Eurostat methodology was applied, according to which public environ-

mental protection expenditure includes all expenditures aimed at prevention, reduction and elimination of environment.

Because, as shown in the paper, relying only on time series analysis may lead to misleading conclusions, econometric panel model was applied. This model takes into account both time and cross-sectional dimension.

The estimations, conducted for the years 2001-2012 for eleven countries of Central Europe, shows that the increase in public environmental protection expenditure has a positive effect on economic growth. The obtained results are stable regardless of the model specification, that is similar both for model without and with time trend.

Due to the fact that the analyzed period is heterogeneous, that is it covers both the period before the global economic crisis, and in the time of its duration, calculations were also performed for two subperiods. Results show that public environmental protection expenditure much stronger affected GDP during global financial crisis. The obtained results are consistent with recent studies concerning fiscal policy, which indicate that effects of public expenditure is usually stronger during economic slowdown.

On the basis of the analysis it can be claimed that increasing public environmental protection expenditure brings not only positive results for environment but has also positive impact on economy.

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