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Examining the Linkages between GDP Growth and Sustainable Development in the Eurozone

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ABSTRACT: The paper intends to investigate the link between sustainable development and GDP growth rate in the Eurozone. We utilize a defined set of eleven indicators of sustainability according to the European Commission, performing an econometric analysis focusing both on the Eurozone and on each country separately. Among others, "Employment rate of older workers", "Resource productivity", "Real GDP", "Energy consumption by transport mode", "Gas emissions" and "Total renewable electricity net generation" seem to be the indicators with the highest importance. However, the last three sustainable indicators are unfavorably connected with GDP growth rate, indicating the necessity for alterations on the current economic model. Apart from a general strategic plan that is required in the EU context, certain policies should be applied in each country due to distinctive characteristics in the social, economic and political levels. Particularly for those countries experiencing the current financial crisis, the idea of sustainable development constitutes an exceptional opportunity that could lead to significant economic achievements.

KEYWORDS: Sustainable development; Eurozone; Indicators; European Commission; GDP growth; Action plan.

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Introductory observations and the paper objectives

During the last decades, mankind has achieved considerable developments that have led to dramatically improved standards of living. Apart from the developed countries of the West, the developing and emerging economies have shown remarkable progress reflected in high levels of GDP growth rates. However, in that pace of ongoing growth, the natural resources were used thoughtlessly, while the legal framework and implementation of environmental issues were quite lax. Conventionally, wisdom in politics asserts that economic growth and environmental protection are conflicting concepts, composing a subject of controversy. In fact, many believe that an increase of economic activity inevitably evokes the degradation of the environment, which in turn could lead to a possible economic as well as ecological collapse. This conflict that inevitably affects the existing social and economic organization can be viewed as a reflection of the lack of robust empirical evidence regarding the impact of growing income levels on environmental quality. At that point, human needs required a new notion which would be able to merge economic growth and environmental issues; thus, the concept of *sustainable development* highly reflects the coexistence of environmental quality, economic growth and social prosperity.

The first steps towards an alternative growth model aligned with the rhetoric of natural resources and limited environmental contamination were made during the last quarter of the 20th century. During that period, countries from all over the world, inter-governmental agencies and many non-governmental organizations (NGOs) participated in well-known international meetings in order to determine the theoretical and practical considerations of the new established idea of sustainability. More specifically, in 1972 the United Nations organized the Conference on Human Environment in Stockholm, where the participants agreed on a joint Declaration containing 26 principles for the environment and the development, an action plan with 109 recommendations and a Resolution. The issue of sustainable development was the focal point in the 48th Plenary of the General Assembly in 1982, the International Union for the Conservation of Natural Resources (IUCN) in 1984 and the World Commission on Environment Development (WCED) in 1987. Indeed, the turning point for the establishment of sustainable development took place in Rio de Janeiro in 1992 during the United Nations Conference on Environment Development (UNCED). The highlight of that conference was the adaption of "Agenda 21: *"a program of*

action for sustainable development" that was composed by 40 chapters separated into four main sections: Social and Economic Dimensions, Conservation and Management Resources for Development, Strengthening the Role of Major Groups and Means of Implementation. A decade after the Rio declaration, the World Summit on sustainable development was held in Johannesburg in order to renew global commitment to the idea of sustainability. The achievement and further improvement of sustainability is an ongoing course and for that reason many international conferences, such as the Earth Summit held in Brazil in June 2012 happen on a regular basis.

Over time, the notion of sustainable development has not only changed but also evolved. According to the definition by the Brundtland Commission on Our Common Future, sustainable development is mentioned as *"Development which meets the needs of the present without compromising the ability of future generations to meet their own needs"*[4]. Another well-known definition of sustainable development was established in Rio de Janeiro during the UNCED: *"The right to development must be fulfilled so as to equitably meet developmental and environmental needs of present and future generations"*[5]. According to the European Commission, sustainable development stands for "*meeting the needs of present generations without jeopardizing the ability of future generations to meet their own needs – in other words, a better quality of life for everyone, now and for generations to come"*[6]. Despite the differences in the above definitions, common place constitutes the issues of growth, environmental protection, prosperity and equality.

The European Union (EU) poses increased emphasis on sustainability and in that direction the European Commission determines three basic pillars: economic efficiency, social cohesion and environmental protection. Taking into account the current financial crisis in the EU and its negative effects on employment, growth and poverty, the issue of sustainable development is of particular interest. Under the auspices of the EU certain strategies and action plans on sustainable consumption and production, sustainable cities and sustainable use of natural resources have been developed. However, there are unsustainable trends that have to be eliminated, while priority should be given to efforts made in the areas of climate change, transportation, biodiversity and natural resources.

The overarching objective of the present paper is to investigate the linkage between sustainable development and economic growth in the Eurozone

[4]Report of the World Commission on Environment and Development, 1987.
[5]Report of the United Nations Conference on Environment and Development, 1992.
[6]http://ec.europa.eu/environment/eussd/

countries. For that reason, we employ certain sustainable development indicators with the intention of identifying the critical indicators that particularly contribute to the GDP growth rate. Furthermore, we seek to highlight the differences among the Eurozone countries as far as the significance of each indicator is concerned. Based on alternative econometric models we seek to draw concrete conclusions for policy making so as to achieve high growth levels in the context of sustainability. The analysis of our paper focuses on the Eurozone due to the wide range of diversity of GDP growth rates among its countries despite the existence of a common monetary policy. Additionally, the recent financial crisis in the examined area raises further considerations for the policies that should be undertaken in order to abolish the imperfections of a common currency spotlighting the issue of sustainability.

Specifically, this paper is structured as follows: Section 2 analyzes the results of the previous research work in the field of sustainable development. Section 3 elaborates on the data under examination and analyzes the applied methodology. Section 4 presents the impact of sustainable development indicators on GDP growth rate for the selected Eurozone countries. Finally, Section 5 discusses the conclusions of the paper and suggests ideas for further research.

Literature review

The concept of sustainable development constitutes a particularly favorable research field among academics, researchers, government authorities and international organizations. Sustainable development is a relatively recent issue considering that it emerged in the last quarter of the 20th century, forming new grounds for improvements in standards of living. Indeed, it has a global perspective and sets new horizons for an alternative growth paradigm. In that frame, we could divide the available research work into two broad categories; the studies of the first category analyze the theoretical framework of sustainability, while the remaining studies apply statistical procedures in order to identify the linkages between sustainable development and social prosperity.

Taking into account the former, we observe alternative theoretical considerations of the examined issue of sustainability. For instance, Jeroen and Hofkes (1997) investigate different approaches of economic modeling of sustainable development such as neoclassical growth models, disaggregated models, integrated and co-evolutionary models Szabó (2011) refers to the evolution of sustainable development which contributes to the continuous improvement of life through the rational and efficient use of resources. Another important study has been performed by Banerjee (2003) analyzing the contradictions of the notion of sustainable development. The author explores the consequences of

sustainable development in the Third World, making particular reference to biodiversity, biotechnology and intellectual property rights. Additionally, Anagnoste and Agoston (2009) discuss the main causes of the current economic crisis and make proposals for possible solutions from the standpoint of sustainability. The relationship between the Lisbon agenda and the strategy of sustainable development adopted by the European Council is analyzed as well. In that line, the guiding principles of sustainable development that the EU has adopted are based on the revised Lisbon Agenda regarding economic growth and the creation of new jobs.

Sustainable development constitutes a general philosophy and in order to be assessed several indicators have been developed. Bossel (1999) defines the notion of sustainable development and the corresponding indicators of sustainability to facilitate the implications of sustainability with a matching set of indicators. Tasaki *et al.* (2010) identify 1,790 indicators of sustainability which are classified into 77 sub-categories and eventually into four headline categories. They also suggest a majority of tasks as far as the future development of these indicators is concerned. In particular, they suggest the creation of time-conscious indicators, the measurement of interactions between elements of a system, the confrontation of transboundary issues, the evaluation of quality and the revelation of the relationship between everyday life and sustainable development. Similarly, Tanguay *et al.* (2009) assess 17 studies evaluating the use of sustainable development indicators in an urban setting. Through this analysis a lack of consensus on the conceptual framework and on the selection and the optimal number of indicators is seen. Finally, several classifications of sustainable development indicators are given in order to acknowledge the problems that are caused by territorial practices.

A publication from the United Nations in 2007[7] presents the guidelines and methodologies of sustainable development indicators according to Agenda 21 and the Johannesburg Plan of Implementation. The outcome contains 96 indicators analyzing the methodology for each one. Also, it provides guidance on the way that national indicators of sustainability should be developed in order to better comprehend the various dimensions of the concept of sustainable development and their complex interactions.

Considering the empirical examination of sustainable development there is a limited number of research papers, considerably less than those that adopt a theoretical standpoint. In that framework, Rennings and Wiggering (1997) recommend that sustainable development and its indicators could be separated

[7]Indicators of Sustainable Development: Guidelines and Methodologies, 2007.

into two categories, the weak and the strong. Weak sustainability is based particularly on neoclassical theory and strong sustainability that does not accept the degree of substitution that weak sustainability assumes. Böhringer and Löschel(2004) refer to computable general equilibrium models as a methodological tool which is suitable for measuring the influences of policy interference on three dimensions of sustainable development, such as environmental quality, economic performance and equity. Important sustainable development indicators can be integrated into computable general equilibrium models allowing in that way further analysis.

Ziolkowska and Ziolkowski (2010) analyze the sustainable development strategy of the European Union that is currently being adjusted and updated to new ecological, economic and social challenges. They also provide suggestions for the future emphasizing the necessity for a more extensive discussion on a number of issues regarding sustainable development, mainly on 'Good Governance'. A similar approach has been made by Chistilin (2010), who formulates the fundamental principles of sustainable development as well as the basic equation of development. More specifically, the fundamental principles of sustainable development that the author expresses are the principle of minimum resource dissipation, the equation of self-organization and the law of conserving the economic potential of a social system. Furthermore, Costantini and Monni(2005) through their research work manage to find ways to design certain policy actions and to measure performance and results. Their goal is to identify a numerical measure of "sustainable human development" by enhancing the issue of human development with certain environmental aspects in the area of the European Union. Last but not least, Adelle and Pallemaerts(2009) construct a set of sustainable development indicators after a review of 40 research projects regarding the progress of sustainable development indicators. They also recommend rethinking and restructuring the landscape of sustainable development indicators in some areas, such as the governmental area as the organization of the existing indicators is highly contestable.

The European Commission examines regularly[8] the progress of the EU towards the implementation of sustainable development. Considering the last monitoring report published in 2011, the results of the examined indicators are mixed; some indicators reveal significant progress while the majority demonstrates unfavorable conditions. In addition, the emergence of the economic and financial crisis further complicates the situation, since it severely affects many of the relevant indicators. The EU faces a critical challenge; the existing growth model

[8] Every two years Eurostat publishes a report regarding the progress towards the objectives of the EU Sustainable Development Strategy.

proved to be insufficient and should be amended if the current crisis is to be overcome. At the same time, environmental waste has reached dangerous proportions and is on the verge of causing catastrophic damage to the environment thus there is no room for concession. Indeed, sustainable development provides a particular opportunity for growth and environmental planning.

Data and Methodology

Data

Taking into account that we intend to investigate the relationship between growth and sustainability, we consider GDP annual growth as the dependent variable. We analyze data from 2000 to 2009 for 16 countries of the Euro zone, particularly referring to Belgium, Germany, Ireland, Greece, Spain, France, Italy, Luxemburg, Estonia, Malta, the Netherlands, Austria, Portugal, Slovenia, Slovakia and Finland. Table 1 records the GDP growth rate for the selected countries from 2000 to 2009.

Table 1: **GDP growth rate (annual) of Eurozone countries (%)**

Country / *Year*	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Austria	3,7	0,9	1,7	0,9	2,6	2,4	3,7	3,7	1,4	-3,8
Belgium	3,7	0,8	1,4	0,8	3,3	1,7	2,7	2,9	1,0	-2,8
Finland	5,3	2,3	1,8	2,0	4,1	2,9	4,4	5,3	0,3	-8,4
France	3,7	1,8	0,9	0,9	2,5	1,8	2,5	2,3	-0,1	-2,7
Germany	3,1	1,5	0,0	-0,4	1,2	0,7	3,7	3,3	1,1	-5,1
Greece	4,5	4,2	3,4	5,9	4,4	2,3	5,5	3,0	-0,2	-3,3
Estonia	9,6	8,5	7,9	7,6	7,2	9,4	10,6	6,9	-5,1	-13,9
Italy	3,7	1,9	0,5	0,0	1,7	0,9	2,2	1,7	-1,2	-5,1
Luxembourg	8,4	2,5	4,1	1,5	4,4	5,4	5,0	6,6	0,8	-5,3
Malta	5,0	-1,6	2,6	-0,3	0,9	4,0	1,9	4,6	5,4	-3,3
Portugal	3,9	2,0	0,8	-0,9	1,6	0,8	1,4	2,4	0,0	-2,9
Slovakia	1,4	3,5	4,6	4,8	5,1	6,7	8,3	10,5	5,9	-4,9
Slovenia	4,3	2,9	3,8	2,9	4,4	4,0	5,8	6,9	3,6	-8,0
Ireland	9,2	4,8	5,9	4,2	4,5	5,3	5,3	5,2	-3,0	-7,0

Netherlands	3,9	1,9	0,1	0,3	2,2	2,0	3,4	3,9	1,8	-3,5
Spain	5,0	3,6	2,7	3,1	3,3	3,6	4,0	3,6	0,9	-3,7

Source: http://www.worldbank.org/

Selection criteria for sustainable development indicators

Considering that the fundamental purpose of our research is to assess the relationship between economic growth and sustainability, we should select a representative and reliable set of sustainable development indicators. Indeed, there is not a general consensus among the researchers as far as the defined set of sustainable indicators is concerned. International organizations and empirical and meta-analytic studies present an array of alternative sustainable development indicators, while in many cases the suggested indicators are hundreds. What is more, in almost all the published research work the need for a defined conceptual framework of sustainability and the determination of an optimal set of representative indicators are noted. Taking into account that we focus on the Euro zone countries, we opt to follow the guidance and methodology of the European Commission. Although many authors assess the theoretical basis and methodological background of the indicators and classification followed by the European Commission, our study is the first attempt to link the suggested indicators with growth rates through the application of an econometric analysis.

In fact, there are more than a hundred sustainable indicators held by the European Commission; however, eleven of them are defined as *headline indicators*. The European Commission separates indicators of sustainable development into nine basic categories: Socio-economic development, Sustainable consumption and production, Social inclusion, Demographic changes, Public health, Climate change and energy, Sustainable transport, Natural resources and Global Partnership. Therefore, each headline indicator is considered as the most representative of its category. Our study examines eight out of the eleven headline indicators due to data limitations. The selected indicators are Growth rate of real GDP per capita, Resource productivity, Official development assistance as a share of gross national income (GNI), Employment rate of older workers total females and males, Life expectancy at birth by sex, Greenhouse gas emissions, Total renewable electricity net generation and Energy consumption by transport mode and related to GDP. The three indicators on which there was no sufficient data and which were thus excluded from our analysis are People at risk of poverty, Common bird index and Fish catches taken from stocks outside safe biological limits. In order to facilitate the analysis of results we classify the above indicators into three

groups; the first group refers to *economic indicators*, the second includes *social indicators* while the third consists of *environmental indicators.* Table 2 depicts the categorization of the selected eight indicators.

Table 2. Classification of headline indicators of sustainability

Economic Indicators	a. *Growth rate of real GDP* per capita in PPS b. *Resource productivity* (ratio of GDP divided by domestic material consumption) c. *Official development assistance* as a share of gross national income (GNI)
Social Indicators	a. *Employment rate of older workers* total females and males (age group 55-64, as a share of total population of the same age group) b. *Life expectancy* at birth (females and males)
Environmental Indicators	a. *Greenhouse gas emissions*(base year 1990, the sin greenhouse gases used are weighted by their global warming potentials) b. *Total renewable electricity net generation* (in BTU, it measures the total production of electricity which comes from renewable sources)[9] c. *Energy consumption by transport mode* and related to GDP (finally energy consumption of transport, road rail, inland navigation and aviation, in toe)

[9]The European Commission uses a relevant indicator named "*Share of renewable energy in gross final consumption"* but its data did not satisfy all the requirements of our sample. As a result, we employed *"Total renewable electricity net generation".* Source: www.eia.gov.

Research methodology

Considering that the data set consists of cross sectional units that are surveyed over time we employ a panel data analysis in order to enrich our empirical findings. Specifically, the data represent a balanced panel, since each county in the sample has nine (9) observations. In general, the techniques of panel, by combining time series of cross section observations, provide more informative data, less collinearity among variables, more degrees of freedom and more efficiency. Furthermore, panel data analysis provides benefits in terms of stationarity. In particular, panel data unit root tests increase the power of usual unit root tests based on individual time series (Augmented Dickey-Fuller, Phillips-Perron etc.). In the present study Levin-Lin (Levin and Lin, 1992) panel data unit root test is performed with the intention to test the stationarity of the examined series. Last but not least, panel can take into account the countries' heterogeneity allowing for explicit comparisons between the examined Eurozone countries.

Our estimations generally rely on the following panel data regression model:

(model 1)

$$Y_{it} = a_i + b_{1i} real.gdp_{it} + b_{2i} respro_{it} + b_{3i} oda_{it} + b_{4i} emplrate_{it} + b_{5i} lef_{it} + b_{6i} lem_{it} + b_{7i} gasem_{it} + b_{8i} renew_{it} + b_{9i} transp_{it} + \varepsilon_{it}$$

Variable Y represents the dependent variable, specifically GDP growth rate. The independent variables represent the indicators of sustainable development. Table 3 describes the exact meaning of the symbols used.

Table 3: Abbreviations of the independent variables

Abbreviation	Explanation
real.gdp	Growth rate of real GDP per capita in PPS
respro	Resource productivity
oda	Official development assistance as a share of gross national income (GNI)
emplrate	Employment rate of older workers (total females and males): age group 55-64
lef	Life expectancy at birth (females)
lem	Life expectancy at birth (males)
gasem	Greenhouse gas emissions (base year 1990)
renew	Total renewable electricity net generation (in BTU)
transp	Energy consumption by transport mode and related to GDP

We employ three models in order to estimate the effect of sustainable development indicators on GDP growth rate. Model 1 and Model 2 rely on the following equation:

(Model 2)

$$Y_{it} = a + b_1 real.gdp_{it} + b_2 respro_{it} + b_3 oda_{it} + b_4 emplrate_{it} + b_5 lef_{it} + b_6 lem_{it} + b_7 gasem_{it} + b_8 renew_{it} + b_9 transp_{it} + \varepsilon_{it}$$

In Model 1 time and individuals are not taken into consideration since a pooled least square regression is employed. Therefore, the constant term and all the independent variables are considered to have common coefficients. In Model 2, a pooled least square regression is also employed, however this estimation omits the effects of sustainable development indicators on GDP growth rate that were not found to be statistically significant by Model 1 estimation. The non-statistically significant characteristic emerges from the fact that the *p-value* of these indicators is less than 5%. The omitted indicators are "Life expectancy of males", "Life expectancy of females" as well as "Official development assistance". In other words, Model 2 has exactly the same characteristics as

Model 1, without taking into account the non-statistically independent variables that existed in Model 1.

Model 2 provides a general idea regarding the linkages between sustainable development and GDP growth rate in the Eurozone countries. The findings of the analysis are particularly useful for the examined countries as a whole, considering that our sample represents a Union with common strategies and policies up to a certain level. However, each country has different social and economic characteristics, while the issue of sustainability has not been developed equally everywhere. For that reason, we perform another Model (Model 3) in order to examine the effect of each indicator in the selected countries separately. We believe that apart from policies on the EU level, each country should develop its own course of action. Model 3 relies on the following equation:

$$Y_{it} = a_i + b_{1i} real.gdp_{it} + b_{2i} respro_{it} + b_{3i} emplrate_{it} + b_{4i} lef_{it} + b_{5i} lem_{it} + b_{6i} gasem_{it} + b_{7i} transp_{it} + \varepsilon_{it} \quad \textit{(Model 3)}$$

In Model 3 a least square dummy variable estimation (LSDV) is performed, allowing for individual fixed effects and variant slope coefficients across cross sections. The fixed effect method is considered appropriate since the cross sectional units of the selected sample compose a closed sample (Eurozone countries) and are not random drawings from a larger one (Gujarati, 2004). In this way, the different influence of independent variables on each country's GDP is investigated. In order to specify this model we were forced to drop two independent variables which are "Official development assistance" and "Total renewable electricity net generation". This wastage was the direct result of statistical software limitations.

The above analysis assayed the selection of data used in our sample and clarified the components on which the separation of the models was made. Moreover, the methodology used is briefly analyzed. Subsequently, there is an immediate need to conclude into the preferable model in order to make our final estimation. In the Section that follows, a brief description of the preferred model will be made and further justification for the models rejected will be given.

Empirical Results

In this section initially are exhibited the Levin-Lin (LL) panel data unit root test's results (Table 4), while the following paragraphs present the empirical results of the econometric analysis regarding the influence of sustainable development indicators on GDP growth rate.

Table 4: Levin-Lin Unit Root Test

Series	LL-statistic	Prob.	Unit Root
Y	9.50	1.00	Yes
real.gdp	9.76	1.00	Yes
respro	-1.79	0.03	No
oda	-10.11	0.00	No
emplrate	-5.88	0.00	No
lef	-6.34	0.00	No
lem	-10.06	0.00	No
gasem	4.58	1.00	Yes
renew	-9.14	0.00	No
transp	-4.26	0.00	No

The Levin-Lin test indicates the presence of unit root in "GDP growth rate", "Growth rate of real GDP per Capita in PPS" and "Greenhouse gas emissions". The test fails to reject the null hypothesis of unit root in 5% significance level. Contrarily, in case of the other examined series we find strong evidence of stationarity (no unit root). The fact that there are non-stationary variables in our models and indeed the dependent variable "GDP growth rate" may affect the validity of the estimations. However, the empirical evidence implies that GDP growth rates especially in the case of developed countries exhibit low volatility and mean reverting behavior. As a matter of fact, we could consider that the observed non-stationarity does not reduce the estimations' robustness.

The Eurozone as one country

Our first step was to run a simple pooled regression without taking into account individual and time dimensions. In that model the countries of our sample are essentially being treated as one. According to the estimated results of Model 1 three independent variables, namely "Gas emission", "Official development assistance" and "Life expectancy of males", are not statistically significant as their *p-value* is more than 0.05. The rest of the independent variables are

statistically significant and each of them has a positive effect on GDP growth rate. Unique exception constitutes "Total renewable electricity net generation" which is negatively associated with GDP growth rate.

Table 5. Model 1 estimation

Dependent Variable: GDP growth rate

Independent Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
Constant term	6.21	4.39	1.41	0.16
Employment rate of older workers	0.04	0.01	3.29	0.00
Resource productivity	0.44	0.10	4.36	0.00
Gas emissions	0.01	0.01	1.33	***0.19***
Energy consumption by transport mode	0.02	0.00	4.72	0.00
Real GDP	1.01	0.01	100.03	0.00
Total renewable electricity net generation	*-1.12*	0.47	-2.40	0.02
Official development assistance	0.35	0.40	0.87	***0.39***
Life expectancy males	0.11	0.09	1.26	***0.21***
Life expectancy females	-0.23	0.10	-2.20	0.03

Regression Statistics

R-squared	0.99
Adjusted R-squared	0.99
F-statistic	716.98
Prob(F-statistic)	0.00
Durbin-Watson stat	1.02
Log likelihood	-5.53
Schwarz criterion	0.96

Considering the statistics of the performed equation, we observe satisfactorily high R-squared and Adjusted R-squared values (0.99). In addition, the value of the Durbin-Watson statistic could be considered adequate (1.02), indicating low probability of autocorrelation in the data.

In the estimation of Model 2 (Table 5) we drop the 3 insignificant independent variables of model 1 in order to improve the fitness of our model. In fact, all the independent variables are statistically significant apart from "Total renewable electricity net generation" which could be characterized as weakly statistical significant since its *p-value* is 0.06. In that estimation every independent variable has positive influence on GDP growth rate excepting "Total renewable electricity net generation" which negatively affects GDP growth, as observed in Model 1.

Table 6. Model 2 estimation

Dependent Variable: GDP growth rate				
Independent Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
Constant term	-3.22	0.66	-4.89	0.00
Employment rate of older workers	0.02	0.01	2.86	0.00
Resource productivity	0.40	0.10	3.96	0.00
Gas emissions	0.01	0.01	2.29	0.02
Energy consumption by transport mode	0.01	0.00	3.59	0.00
Real GDP	1.00	0.01	109.47	0.00
Total renewable electricity net generation	-0.83	0.45	-1.84	*0.07*

Regression Statistics	
R-squared	0.99
Adjusted R-squared	0.99
F-statistic	870.81
Prob(F-statistic)	0.00
Durbin-Watson stat	1.42
Log likelihood	-17.56
Schwarz criterion	0.92

Taking into account that both Models have been estimated with the same method, we compare them in order to select the most reliable. For that reason we compare the values of the Log likelihood statistic and the Schwarz information criterion, preferring the model with the higher value of the former and the lower value of the latter. Considering the Log Likelihood of Models 1 and 2 we

conclude that the second model has higher absolute value (17.56 versus 5.53) and thus it can be considered as the best choice. Likewise, the Schwarz criterion of Model 1 (0.95) is higher than that of Model 2 (0.92) and as a result Model 2 prevails against Model 1. In addition, the value of the Durbin-Watson statistic should be approximately 2 in order to avoid any sign of autocorrelation in the sample. Model 2 also satisfies this condition as its Durbin-Watson statistic is 1.42, while Model 1 has a corresponding value of 1.019. Therefore, taking into consideration all the above analysis Model 2 outperforms Model 1.

The empirical results of the prevailing model demonstrate the statistical significance of certain indicators to GDP growth rate, which are "Employment rate of older workers", "Resource productivity", "Gas emissions", "Energy consumption by transport mode", "Real GDP" and "Total renewable electricity net generation". Indeed, "Real GDP", "Resource productivity" and "Total renewable electricity net generation" present the highest coefficients, while the other three show negligible coefficients. This observation renders apparent the need for further improvements on "Resource productivity" through the minimization of the raw materials directly used by the Eurozone countries. An interesting finding derives from the negative sign of the "Total renewable electricity net generation" indicator, suggesting a dramatic weakness in the European economy to incorporate alternative sources of electricity into its production processes. Thus, the first step that should be taken by the European authorities is to alter the industrialized model as far as the use of electricity is concerned; stating alternatively, the coefficient of the examined indicator should be changed into positive.

The Eurozone countries separately

The above Models intend to investigate the relationship between growth and sustainability on the Eurozone level. Model 3 assesses the effects of sustainable development indicators on GDP growth rate of each Eurozone country. The applied Model is characterized by fixed effects, the intercept is assumed to be constant, while the slope coefficients vary among the countries of our sample. The idea for this model is to examine possible differences between each explanatory variable and GDP growth rate at country level. Considering the empirical results, we observe significant divergences among the coefficients of the independent variables, while not all the indicators of sustainable development are found to be statistically significant. For that reason, Table 7 presents the main findings derived from our econometric analysis. Particularly, we demonstrate the most important indicators for each Eurozone country separately.

Table 7. Model 3 estimation

Dependent Variable: GDP growth rate

Independent Variable		Coefficient	Std. Error	t-Statistic	Prob.
Constant term		-4.15	10.60	-0.39	0.70
Employment rate of older workers	Greece	0.15	0.08	1.92	0.06
	Malta	0.28	0.12	2.45	0.02
	Slovenia	0.10	0.06	1.75	0.09
Resource productivity	Greece	6.55	2.40	2.73	0.01
	Spain	-4.62	2.53	-1.83	0.08
	Malta	0.65	0.11	5.73	0.00
Gas Emissions	Ireland	0.08	0.05	1.72	0.10
	Malta	-0.10	0.02	-4.50	0.00
Energy consumption by transport mode	Malta	0.04	0.01	4.89	0.00
Real GDP	Belgium	0.95	0.11	8.91	0.00
	Germany	1.02	0.05	19.28	0.00
	Ireland	1.09	0.04	27.04	0.00
	Greece	0.93	0.04	23.33	0.00
	Spain	0.91	0.07	12.92	0.00
	France	1.02	0.11	9.66	0.00
	Italy	0.91	0.14	6.38	0.00
	Luxembourg	1.05	0.04	25.64	0.00
	Estonia	0.99	0.06	15.27	0.00
	Malta	1.24	0.03	35.86	0.00
	Netherlands	0.82	0.17	4.84	0.00
	Austria	0.99	0.06	17.69	0.00
	Portugal	0.97	0.04	23.35	0.00
	Slovenia	0.94	0.06	14.90	0.00
	Slovakia	0.99	0.03	28.84	0.00
	Finland	1.00	0.05	19.08	0.00
Life expectancy females	Greece	-2.17	1.15	-1.89	0.07

Regression Statistics	
R-squared	0.99
Adjusted R-squared	0.99
F-statistic	438.61
Prob(F-statistic)	0.00
Log likelihood	199.29
Durbin-Watson stat	2.88
Schwarz criterion	1.58

Taking into account the data of Tables 6 and 7 above, we observe that Models 2 and 3 demonstrate almost the same sustainable development indicators with statistical significance, while the indicator "Real GDP" has a similar coefficient very close to one in all the Eurozone countries. The only difference is the appearance of "Total renewable electricity net generation" in the former and "Life expectancy females" in the latter. As far as Model 3 is concerned, the indicators "Employment rate of older workers", "Resource productivity" and "Gas emissions" display particular diverging coefficients. In particular, the first one has a positive effect on GDP growth rate in Greece, Malta and Slovenia; nevertheless, in Malta its significance is almost triple (0.28) relative to Slovenia (0.1), while in Greece it is moderate (0.15). "Resource productivity" is, in fact, the most controversial indicator, since it deviates from -4.62 in Spain to 6.55 in Greece; in Malta the relative coefficient is slightly greater than zero (0.65). The indicator "Gas emissions" has remarkably low coefficients in Ireland and Malta, while the coefficients display different signs (0.08 and -0.1 respectively). Finally, the coefficients of "Energy consumption by transport mode" and "Life expectancy females" proved to be statistically significant in Malta (0.04) and Greece (-2.17) respectively.

Discussion of results

Interestingly, the sustainable development indicators have particular significance in countries such as Greece, Ireland and Spain, which are the core economies of the current European financial crisis. Indeed, the first two countries received a joint bailout program from the IMF, EU and ECB, while the Spanish banking system was injected with €100 billion in loans due to macroeconomic difficulties. Moreover, neither country with macroeconomic stability from central and northern Europe appears to be affected by any indicator of

sustainability. Indeed, the Eurozone countries in severe economic crisis should concede sustainable development as an opportunity through which they could improve their economic environment.

Although certain indicators proved to be statistically significant in a set of Eurozone countries, the variation among the coefficients demonstrates the need for different policies and initiatives that should be applied on a national level. In some cases, the tightening of regulatory framework could generate outcomes in the opposite direction; what is considered necessary, is an overall action plan of sustainable development based on the particular social, economic and environmental characteristics of each country.

The last two observations render clear the need for the Eurozone countries to move towards political and economic integration. The adaption of a single currency without solid political and monetary foundations is not enough for economic growth and social prosperity. In that frame, sustainable development should be cultivated and further incorporated centrally in the Eurozone. At the same time, the demographic, legal, economic and climatic conditions of each geographic area or country should be taken into account. To a certain extent, the applied policies should be harmonized with the local potentials and characteristics. The recent debt crisis that is still evolving demonstrates the necessity for a new European perspective where the ultimate objectives should be the elimination of poverty, further technological development and environmental sanitation.

Conclusions and suggestions for further research

The economic model of the last decades introduced significant improvements to the standard of living. The economies have become more open, international trade and capital flows increased dramatically, employee and capital mobility were facilitated under the ever-increasing concept of globalization. However, that economic growth caused severe consequences to the environment and the natural resources, since in the name of prosperity humans undermined the effects of the established economic development model. During the last quarter of the 20^{th} century, environmental concerns began to grow and a new idea of parallel economic growth and environmental protection emerged. Sustainable development formed the grounds for a paradigm shift, where further economic growth could be achieved through environmental sanitation.

The present study focuses on the linkages between GDP growth rate and sustainable development in an area of particular significance such as the

Eurozone. The concept of sustainability constitutes a controversial topic through which quantitative measures should be expressed; thus, we analyze a set of sustainable development indicators held by the European Commission. Our study constitutes an inventive attempt in the literature, since we intend to identify the critical parameters of sustainability that affect the economic growth in the Eurozone and in each country separately applying alternative econometric models. We attempt to draw reliable conclusions that could be the basis for policy making in the Eurozone. At the same time, we determine certain action plans that should be applied in particular countries due to specific economic conditions.

From the eleven examined indicators of sustainability, only seven of them proved to be statistically significant. The two models that assess the Eurozone as one country and the Eurozone countries separately show consensus on "Employment rate of older workers", "Resource productivity", "Real GDP", "Energy consumption by transport mode" and "Gas emissions". "Total renewable electricity net generation" and "Life expectancy females" present statistical significance in the Eurozone and in Greece respectively. Examining GDP growth rate and sustainable development in the Eurozone, we could argue that "Resource productivity" and "Total renewable electricity net generation" present the highest coefficients and, thus, should be considered with greater interest. Indeed, the negative sign of the last indicator together with the positive sign of "Gas emissions" and "Energy consumption by transport mode" demonstrate the distortions of the current economic model. This fact highlights the necessity for an overall alteration of the economic development fundamentals. Along this line, rigid legislative arrangements would prove meaningless. At country level, the significant deviations of the coefficients reveal the specific opportunities and weakness of each country based on the different socioeconomic frameworks. Interestingly, countries experiencing the current economic crisis could boost their growth rate through sustainable development.

The conclusions of the present paper could be the starting point for further research in the field of sustainable development and growth. Initially, apart from the selected set of indicators, the issue of sustainability in the Eurozone could be examined with alternative measures available in the literature. That procedure may reveal other areas of particular importance, where policy makers should focus. In addition, similar empirical studies could be performed in other developed and emerging economies in order to identify the linkages between sustainability and growth. The findings from these areas may reveal aspects of successful action plans as well as policies with limited efficiency. Considering the growing environmental considerations in the light of the current economic

crisis in the Eurozone, the issue of sustainable development is expected to be at the centre of interest in the following years.

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