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Dear Readers,

The most recent edition of *Argumenta Oeconomica Cracoviensia* confirms the wide range of issues the journal features, including research on economy, management, finance and other subdisciplines of economics. The journal provides a forum for theoretical research findings not only in the language of economics, but also of mathematics, informatics and other disciplines. The editorial board's aim is to publish work that accomplishes the goals of economics and the paradigms used in this science, as well as writing that presents the results of empirical research with the use of existing methods of analysis. Research results in which the authors have modified existing methods of analysis are published, and so too is work that offers original perspectives.

In their article "Innovative Mechanisms in a Private Ownership Economy with a Financial Market", Ilona Ćwięczek and Agnieszka Lipieta take a mixed approach to economic research. The authors use Schumpeter's concept of innovation in the economy to formalise interactions between financial markets and the real economy. These interactions are modelled using Hurwicz's method, hence the main results are presented in the form of mathematical theorems interpreted in the language of economics.

In the next article, "On the Need for Cognitive Closure and Judgmental Trend Forecasting", Marcin Czupryna, Elżbieta Kubińska and Łukasz Markiewicz discuss methodology that is crucial to modeling and forecasting economic phenomena. Among the factors determining the reliability of forecasts may be counted historical time series, the proper selection of these series, and the cleaning of the data involved. The approach the authors take to trend research is not only useful but also, in employing the concept of temporary closure that considers psychological inclinations, innovative.

The causes and effects of the recent financial crisis remain a matter of keen interest for economists. Initial measures taken by the state and supranational institutions to limit the risk of another crisis occurring are being assessed. In his article, "Restoring Balance in Public Finance in Europe in the Light of the Fiscal Compact", Piotr Ptak examines these issues in the context

of the public finance crisis. While the assessments presented here regarding the effectiveness of the Fiscal Compact adopted by the European Union in 2013 in an effort to address public finances are perhaps early, and perhaps debatable, the author's arguments deserve attention.

Expenditures on research and development and their impact on economic growth are the subject of analyses from both a macro- and microeconomic perspective. While empirical analyses of the entire national economy duly consider the impact of expenditures on R&D, a fact reflected in the large macroeconomic models that are used, the study of the relationship between expenditure on R&D and enterprise performance remains less developed, particularly the role of motivating factors. Decisions on R&D expenditures are made at a variety of levels in the hierarchy of economic organisations, so understanding the relationship between the decisions made and the benefits that managers derive from the expenditure incurred on innovative tasks is important. Barbara Grabińska and Konrad Grabiński examine these issues in their article "The Impact of R&D Expenditures on Earnings Management". The results they obtained are compelling because the research concerns a relatively large group of American enterprises.

In theoretical work, as well as in empirical analyses, connections are sought between specific public expenditures, including public aid expenditure and economic growth. Piotr Podsiadło takes up this issue in his paper "State Aid for Environmental Protection in EU Member States – the Perspective of the Economic Growth and the State of Public Finance". Expenditure promoting economic growth processes is understood here as public aid in all its forms – that is, not only subsidies for enterprises, economic sectors and particular geographical regions, but also tax breaks and other fiscal measures. The author also considers the impact of public aid expenditure on state budgets.

In reading this edition of the journal, may you take inspiration from the original texts, reports on important scientific events and reviews of outstanding books.

Prof. Stanisław Owsiak
Editor-in-chief

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Ilona Ćwięczek
Agnieszka Lipieta

INNOVATIVE MECHANISMS IN A PRIVATE OWNERSHIP ECONOMY WITH A FINANCIAL MARKET*

Abstract

Let a private ownership economy with a financial market be given. In this economy, innovations in Schumpeter's sense of the term can be modeled by the use of the Arrow and Debreu topological apparatus. This set-up reveals the impact of the relationship between the financial and the real markets in the economy on innovation.

The paper distinguishes and models innovations and different types of innovative mechanisms revealed within Schumpeterian evolution. Following Hurwicz's approach to modeling economic mechanisms, the main results take the form of mathematical theorems interpreted in the language of economics.

Keywords: Schumpeterian evolution, mechanisms, designing mechanisms, economy with a financial market.
JEL Classification: C60, D41, D50, O10, O31.

1. Introduction

This paper extends the research programme of modeling the Schumpeterian vision of the economic development (see e.g. Schumpeter

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1912) in the Arrow-Debreu set-up (see Debreu 1959) initiated by A. Malawski in the 1990s (see e.g. Malawski 1999).

J. Schumpeter distinguished five forms of change that characterise economic development:

1) the introduction of a new good,
2) the implementation of a new technology (method) into production,
3) the opening of a new market,
4) the conquest of a new source of supply of raw materials,
5) the re-organisation of any industry.

This five-part categorisation can be regarded as the classification of innovations (see Schumpeter 1912; *Innovative Economy…* 2013, Chapter 1). Schumpeter viewed innovation and innovators as the driving forces of economic development. On the other hand, according to the principle of creative destruction, innovating removes obsolete commodities, technologies and organisational structures from the markets. Hence, though they are essential to the long-term development of every economy, innovation can in the short run lead to negative effects for some economic agents. In his book (1912), Schumpeter also stresses the particular influence the financial sphere of the economy exerts on innovation, as easily accessible credit can initiate and intensify the processes of evolution as well as encourage a potential future innovator to begin to act. Readers will find some results of modeling the impact that the relationship between the real and financial sectors of the economy has on the innovation in (Ciałowicz & Malawski 2011; Ćwięczek, Lipieta & Malawski 2012; *Innovative Economy* 2013…, Chapters 2 and 3).

In this paper, innovations in Schumpeter's sense are analysed in a so-called private ownership economy with a financial market, which is an extension of the two-period financial economy with the production (see Magill & Quinzii 2002), while the innovative processes are modeled as economics mechanisms as L. Hurwicz handled them (see e.g. Hurwicz & Reiter 2006). This approach will enable us to stress the role the economy's financial sector plays in introducing innovations and to determine the relationship between signals sent by economic agents and their aims.

The paper consists of four parts. The next section defines the private ownership economy with a financial market. The third part models innovations in this economy, while the fourth part analyses innovative mechanisms in the economy with the financial market.

2. The Private Ownership Economy with a Financial Market

The (micro) economic system under consideration describes the activities of market participants on the financial and commodity markets in two consecutive time intervals, called periods. The model of the economy presented here is a modification of a two-period financial economy with production (Magiil & Quinzii 2002, pp. 329–56).

Time and uncertainty are described by an event tree, consisting of the initial period and the finite number of states of nature $s = 1, \ldots, S$ ($S \in \mathbb{N}$) in the next period $t = 1$. Since the period $t = 0$ is interpreted as the state of the nature of $s = 0$, the number of all states is $S + 1$.

In each state $s \in \{0, 1, \ldots, S\}$ there are ℓ ($\ell \in \mathbb{N}$) goods on the real markets. Therefore the commodity space is $\mathbb{R}^{\ell(S+1)}$, and the price vector of real commodities will be denoted $p = (p_0, p_1, \ldots, p_S) \in \mathbb{R}^{\ell(S+1)}$.

The financial market $F = (\mathbb{R}^J, q, V)$ is defined by the existence of J basic securities (assets). A security j, $j \in \{1, \ldots, J\}$, can be purchased for price q_j at date $t = 0$ and sell in state $s \in \{1, \ldots, S\}$ at date $t = 1$ to obtain payment v_s^j. Let $q = (q_1, \ldots, q_J) \in \mathbb{R}^J$ denote the vector of security prices at date $t = 0$ while matrix $V = [v_s^j]$ for $s \in \{1, \ldots, S\}$, $j \in \{1, \ldots, J\}$, with their payment at date $t = 1$. The row V_s, $s \in \{1, \ldots, S\}$, of matrix V determines the payoff of all assets in state s while column V^j, $j \in \{1, \ldots, J\}$, determines the payment of security j in every state at date $t = 1$. Let $z = (z_1, \ldots, z_J) \in \mathbb{R}^J$ denote a portfolio of securities. Then $qz = \sum_{j=1}^{j=J} q_j z_j$ means the price of the portfolio $z \in \mathbb{R}^J$ at date $t = 0$, in turn $\tau_s = V_s z = \sum_{j=1}^{j=J} v_s^j z_j$ its payment (the income from the sale of the portfolio) in state $s \in \{1, \ldots, S\}$ at date $t = 1$. In this way the purchase of a portfolio induces a stream of income $\tau^1 = \{\tau_1, \ldots, \tau_S\} \in \mathbb{R}^S$ at date $t = 1$. The collection:

$$\langle V \rangle = \{\tau^1 \in \mathbb{R}^S : \tau^1 = Vz \text{ for some } z \in \mathbb{R}^J\} \tag{1}$$

is called a set of contingent payments and describes the opportunities offered by the financial market. Since J is the number of basic securities, the columns of matrix V are linearly independent in space $\mathbb{R}^S$ ($J \leq S$). Therefore, $\dim\langle V \rangle = J$. We say that financial market F is complete if and only if $\langle V \rangle = \mathbb{R}^S$. This means that any contingent payment can be obtained as the payment of a portfolio $z \in \mathbb{R}^J$.

Let $W = \begin{bmatrix} -q \\ V \end{bmatrix}$ denote the matrix of security prices at date $t = 0$ and their payoffs at date $t = 1$. The collection of all income streams priced by the financial market is denoted:

$$\langle W \rangle = \{\tau = (\tau_0, \tau^1) \in \mathbb{R}^{S+1} : \tau = Wz \text{ for some } z \in \mathbb{R}^J\}, \tag{2}$$

where $\tau_0 = -qz$ and $\tau^1 = Vz$, and is called a market subspace. The set of all possible income transfers which can be obtained on the financial market is the subspace of $\mathbb{R}^{S+1}$ generated by the J columns of matrix W. The set of all vectors that are orthogonal to each of the columns of matrix W is called the space of state prices or the space of present-value vectors and is denoted:

$$\langle W \rangle^{\perp} = \{\mu \in \mathbb{R}^{S+1} : \mu W = 0\} = \{\mu \in \mathbb{R}^{S+1} : \mu\tau = \sum_{s=0}^{s=S} \mu_s \tau_s = 0 \quad \forall \tau \in W\}. \tag{3}$$

For the interpretation of vector $\mu = (\mu_0, \ldots, \mu_s) \in \mathbb{R}^{S+1}$ as a present-value vector it is convenient to assume that $\mu_0 = 1$. Then μ_s, for $s \in (1, \ldots, S)$, is the present value (at date $t = 0$) of one unit of income in state s at date $t = 1$. The market participants use the vector of state prices for discounting (at date $t = 0$) streams of income derived from date $t = 1$. Let $\mu^1 = (\mu_1, \ldots, \mu_s) \in \mathbb{R}^S$. By definition of space $\langle W \rangle^{\perp}$ the following is true: $q = \mu^1 V$ and in particular $q_j = \sum_{s=1}^{s=S} \mu_s v_s^j$ for $j \in \{1, \ldots, J\}$. Thus, the price of asset j at date $t = 0$ is the sum of the discounted payments of that security. If the financial market is complete, the vector of present-value is uniquely determined.

In the economy under consideration, a finite number of consumers and producers (firms) operate. We assume the following:

1) financial market F is complete;

2) in a commodity-price space $\mathbb{R}^{\ell(S+1)}$, price vector $p = (p_0, p_1, \ldots, p_S) \in \mathbb{R}^{\ell(S+1)}$ is given;

3) $A = \{a_1, \ldots, a_m\}$, $m \in \mathbb{N}$, is a set of consumers; for any consumer $a \in A$:

a) $X^a = (X_0^a, \ldots, X_S^a) \subset \mathbb{R}_+^{\ell(S+1)}$ is a consumption set,

b) $u^a : X^a \to \mathbb{R}$ is a continuous and strongly increasing utility function defined on vector of consumption $x^a = (x_0^a, \ldots, x_S^a) \in X^a$,

c) $\omega^a = (\omega_0^a, \ldots, \omega_S^a) \in \mathbb{R}^{\ell(S+1)}$ is an initial endowment vector;

4) $B = \{b_1, \ldots, b_n\}$, $n \in \mathbb{N}$, is a set of producers (firms). For any producer $b \in B$:

a) $Y^b = (Y_0^b, \ldots, Y_S^b) \subset \mathbb{R}^{\ell(S+1)}$ is a production set,

b) $y^b = (y_0^b, \ldots, y_S^b) \in Y^b$ is a feasible production plan (investment project);

5) the ownership structure of firms is defined as private ownership, where consumers are the owners. Their participation in the financing of the firms is determined by the function $\theta \subset (A \times B) \times \mathbb{R}$, $\theta: (a, b) \to \theta^{ab} \in [0, 1]$, satisfying: $\sum_{a \in A} \theta^{ab} = 1$ for all $b \in B$.

Let $u = (u^a)_{a \in A} = (u^{a_1}, \ldots, u^{a_m})$, $\omega = (\omega^a)_{a \in A} = (\omega^{a_1}, \ldots, \omega^{a_m})$ and $Y = (Y^{b_1}, \ldots, Y^{b_n})$.

Definition 2.1. When the economic system has the following features, it is called an economy with private ownership and a financial market:

– m consumers ($m \in \mathbb{N}$) and n firms ($n \in \mathbb{N}$) operate on the financial and commodities markets in the two periods;

– the shareholders are consumers characterised by the utility functions $u^a: X^a \to \mathbb{R}$ and initial endowment $\omega^a \in \mathbb{R}^{\ell(S+1)}$;

– sets of production $Y^b \subset \mathbb{R}^{\ell(S+1)}$ for the firms are defined.

Such an economy will be denoted $\mathcal{E}_F = (u, \omega, Y, \theta, V)$.

The structure of economy $\mathcal{E}_F$ can be described as follows. At price vector $p \in \mathbb{R}^{\ell(S+1)}$, security prices $q \in \mathbb{R}^J$ and payoff matrix V, every producer takes such actions on the commodity market and on the financial market that allow it to maximise the present-value of their income stream. In turn, every consumer takes actions on the commodity markets and on the financial market to maximise their utility function on the set of budget constraints by the initial endowment vector $\omega^a \in \mathbb{R}^{\ell(S+1)}$.

The choice and realisation of investment project $y^b = (y_0^b, \ldots, y_S^b) \in Y^b$ depends on how the investment is financed. We assume that every firm can borrow without limits on the financial market at date $t = 0$ and that it is responsible for repaying the debit at date $t = 1$. At date $t = 0$ the firm $b \in B$ realises the investment project $y_0^b \in \mathbb{R}^\ell$ at the vector of prices $p_0 \in \mathbb{R}^\ell$ and purchases the portfolio $f^b \in \mathbb{R}^J$ at security prices $q \in \mathbb{R}^J$. The firm's income in this period is equal to $d_0^b = p_0 y_0^b - qf^b$. In turn, at date $t = 1$ and state $s \in \{1, \ldots, S\}$ firm b receives its profit from the production plan at the vector of prices $p_s^b \in \mathbb{R}^\ell$ and sells portfolio $f^b \in \mathbb{R}^J$ at payoff matrix V. The income of firm b in the state $s \in \{1, \ldots, S\}$ is equal to $d_s^b = p_s y_s^b + V_s f^b$. In this way we get the income stream $d^b = (d_0^b, \ldots, d_S^b) \in \mathbb{R}^{S+1}$ of firm b.

It is said that portfolio (financial policy) $f^b \in \mathbb{R}^J$ finances production plan $y^b \in Y^b$ if the income stream equations are fulfilled. The choice of this policy depends on how the investment is financed at date $t = 0$. If $d_0^b > 0$, then the investment (project) is financed by borrowing on the financial market. Firm b's action plan can be written as a pair $(y^b, f^b) \in Y^b \times \mathbb{R}^J$, where f^b is the

policy financing y^b. Every firm chooses action plan (y^{b*}, f^{b*}) that maximises the present-value of the income stream $\mu d^b = \sum_{s=0}^{s=S} \mu_s d_s^b$ at the vector of state prices μ. Let $\mu d^{b*} = \max_{(y^b, f^b)} \mu d^b$ for all $(y^b, f^b) \in Y^b \times \mathbb{R}^J$. In every state $s \in \{0, \ldots, S\}$ the income d_s^{b*} is divided between the owners (consumers) of firm b according to the specified shares θ^{ab}.

At date $t = 0$ the consumer $a \in A$ receives part of the income d_0^b generated by firm b and sells the initial endowment vector $\omega_0^a \in \mathbb{R}^\ell$ at the price vector of prices $p_0 \in \mathbb{R}^\ell$. His initial income is equal to $p_0 \omega_0^a + \sum_{b \in B} \theta^{ab} d_0^b$. He chooses the consumption plan $x_0^a \in X_0^a$ at price vector $p_0 \in \mathbb{R}^\ell$ and purchases the portfolio $h^a \in \mathbb{R}^J$ at security prices $q \in \mathbb{R}^J$. Hence:

$$p_0 x_0^a \leq p_0 \omega_0^a - q h^a + \sum_{b \in B} \theta^{ab} d_0^b.$$

At date $t = 1$ and state $s \in \{1, \ldots, S\}$ consumer a pays $p_s x_s^a$ and receives income: $p_s \omega_s^a$, $V_s h^a$ and $\sum_{b \in B} \theta^{ab} d_s^b$. Hence:

$$p_s x_s^a \leq p_s \omega_s^a + V_s h^a + \sum_{b \in B} \theta^{ab} d_s^b.$$

Let the pair $(x^a, h^a) \in X^a \times \mathbb{R}^J$ denote the action plan of consumer a. Then the budget set of consumer a is of the form:

$$\beta(a) = \left\{ (x^a, h^a) \in X^a \times \mathbb{R}^J : \begin{array}{c} p_0 x_0^a \leq p_0 \omega_0^a - q h^a + \sum_{b \in B} \theta^{ab} d_0^b \\ p_s x_s^a \leq p_s \omega_s^a + V_s h^a + \sum_{b \in B} \theta^{ab} d_s^b, \quad s \in \{1, \ldots, S\} \end{array} \right\}.$$

If $(x^a, h^a) \in \beta(a)$, then portfolio $h^a \in \mathbb{R}^J$ finances the consumption plan $x^a \in X^a$. The system of inequalities at date $t = 1$ can be written as the inequality:

$$p(x^{1a} - \omega^{1a}) - \sum_{b \in B} \theta^{ab} d^{1b} \leq V h^a,$$

where $x^{1a} = (x_1^a, \ldots, x_S^a), \omega^{1a} = (\omega_1^a, \ldots, \omega_S^a), d^{1b} = (d_1^b, \ldots, d_S^b) \in \mathbb{R}^S$.

Thence, for $W = \begin{bmatrix} -q \\ V \end{bmatrix}$:

$$\beta(a) = \left\{ (x^a, h^a) \in X^a \times \mathbb{R}^J : p(x^a - \omega^a) - \sum_{b \in B} \theta^{ab} d^b \leq W h^a \right\}. \tag{4}$$

Every consumer chooses an action plan (x^{a*}, h^{a*}) that maximises its utility function subject to budget constraints.

Let $((x^{a^*}, h^{a^*}), (y^{b^*}, f^{b^*}))$ be an allocation in economy $\mathcal{E}_F$, where $x = (x^a)_{a\in A} = (x^1, \ldots, x^m) \in (\mathbb{R}_+^{S+1})^m$; $h = (h^a)_{a\in A} = (h^1, \ldots, h^m) \in (\mathbb{R}^J)^m$; $y = (y^b)_{b\in B} = (y^1, \ldots, y^n) \in (\mathbb{R}^{S+1})^n$; $f = (f^b)_{b\in B} = (f^1, \ldots, f^n) \in (\mathbb{R}^J)^n$. We can formally assume the following definition of equilibrium (see Magill & Quinzii 2002).

Definition 2.2. The sequence $((x^{a^*}, h^{a^*}), (y^{b^*}, f^{b^*}), p^*, q^*)$ satisfying the following conditions is called the state of equilibrium in economy $\mathcal{E}_F$:

1) $\forall b \in B \quad (y^{b^*}, f^{b^*}) \in \arg\max\{\mu d^{b^*}: (y^b, f^b) \in Y^b \times \mathbb{R}^J\}$,

2) $\forall a \in A \quad (x^{a^*}, h^{a^*}) \in \arg\max\{u(x^{a^*}): (x^a, h^a) \in \beta(a)\}$,

3) $\forall s \in \{0, \ldots, S\} \quad \sum_{a\in A} x_s^{a^*} - \sum_{b\in B} y_s^{b^*} = \sum_{a\in A} \omega_s^a$,

4) $\sum_{a\in A} h^{a^*} + \sum_{b\in B} f^{b^*} = 0 \in \mathbb{R}^J$.

3. Innovations in the Economy with a Financial Market

This part of the paper is devoted to modeling Schumpeter's vision of innovations in a private ownership economy with a financial market. The logical consequence of activities of economic agents in this economy is to distinguish two kinds of innovations: those on the real market (hereinafter real innovations) and those on the financial market (financial innovations). The real innovation is a new good (a source or a new product) or a new technology introduced on the real commodities market (see Lipieta & Malawski 2016), while a financial innovation is a new security occurring on the financial market.

To distinguish innovations in an economy modeled as a private ownership economy with a financial market, we have to compare both producers' plans of action and investors' securities portfolios in two different dates t_0 and t_0', where $t_0 < t_0'$. Date t_0 is assumed to be the initial period for the private ownership economy with a financial market $\mathcal{E}_F = (u, \omega, Y, \theta, V)$ with S states of nature considered at date t_1, where $t_0 < t_1$. Similarly, dates t_0' and t_1', where $t_1 \leq t_0' < t_1'$, denote the initial and the future date, adequately, of economy $\mathcal{E}'_F = (u', \omega', Y', \theta', V')$ with S' states of nature at date t_1', To sum up, economy $\mathcal{E}'_F$ models the activities of economic agents on the real markets and on the financial markets considered in economy $\mathcal{E}_F$. It may be therefore refered to the evolution of economy $\mathcal{E}_F$. This property will be denoted by $\mathcal{E}_F \subset \mathcal{E}'_F$.

Let $\mathcal{E}_F \subset \mathcal{E}'_F$. Following Schumpeter, it is assumed that:

1) the set of commodities in economy $\mathcal{E}_F$ are contained in the set of commodities of economy $\mathcal{E}'_F$; hence $\ell \leq \ell'$;

2) the set of securities in economy $\mathcal{E}_F$ is contained in the set of securities of economy $\mathcal{E}'_F$; hence $J \leq J'$;

3) the set of producers and consumers in both economies $\mathcal{E}_F$ and $\mathcal{E}'_F$ are the same, namely $A = A'$ and $B = B'$;

4) if $Y^b = \{0\} \subset \mathbb{R}^{\ell(S+1)}$ and $Y'^b \neq \{0\} \subset \mathbb{R}^{\ell'(S'+1)}$, then producer b enters the markets at date t'_0 or earlier, but after date t_1; if $Y^b \neq \{0\} \subset \mathbb{R}^{\ell(S+1)}$ and $Y'^b = \{0\} \subset \mathbb{R}^{\ell'(S'+1)}$, then producer b exits the markets at date t'_0 or earlier, but after date t_1; the same can be observed of consumers;

5) if $\mathcal{E}_F \subset \mathcal{E}'_F$, where $t_1 = t'_0$, then $\ell = \ell'$ and:

$$\exists s \in \{1, \ldots, S\}\ \forall b \in B\ Y^b_s = Y'^b_0 \text{ and } \forall a \in A\ X^a_s = X'^a_0.$$

Property 4 reflects the principle of creative destruction.

The next section introduces a number of essential definitions. Suppose that economy $\mathcal{E}_F$ is given.

Definition 3.1. An investment project $y^{\tilde{b}} = \left(y^{\tilde{b}}_0, \ldots, y^{\tilde{b}}_s\right) \in Y^{\tilde{b}}$ is called the innovative project of producer $\tilde{b}$ at date t_1 with respect to date t_0, if:

$$\exists \tilde{l} \in \{1, 2, \ldots, \ell\}: \left(\forall b \in B\ y^b_{0,\tilde{l}} = 0 \wedge \forall s \in \{1, \ldots, S\}\ y^{\tilde{b}}_{s,\tilde{l}} \neq 0\right) \tag{5}$$

or

$$\forall b \in B\ \forall s \in \{1, \ldots, S\}\ y^{\tilde{b}}_s \notin Y^b_0. \tag{6}$$

If condition (5) is satisfied for a producer $\tilde{b} \in B$, then a new commodity $\tilde{l}$ is introduced by producer $\tilde{b}$ on the real market at date t_1. Commodity $\tilde{l}$ is the real innovation at date t_1 with respect to date t_0. Condition (6) means that the productive abilities of producer $\tilde{b}$ at date t_1 go beyond the technological possibilities of all producers at date t_0. The innovations in this case are the new technology revealed in the innovative investment project of producer $\tilde{b}$ at date t_1. Such innovativeness is called technological innovativeness, which falls into the category of innovations on the real market. Hence, if condition (6) is satisfied for producer $\tilde{b} \in B$, then it is also said that producer $\tilde{b}$ introduces an innovation at date t_1. Producer $\tilde{b}$ satisfying conditions (5) or (6) is called an innovator.

Consider two economies $\mathcal{E}_F$ and $\mathcal{E}'_F$, where $\mathcal{E}_F \subset \mathcal{E}'_F$.

Definition 3.2. An investment project $y'^{\tilde{b}} = \left(y'^{\tilde{b}}_0, \ldots, y'^{\tilde{b}}_s\right) \in Y'^{\tilde{b}}$ is called an innovative project of producer $\tilde{b}$ at date t'_0 with respect to economy $\mathcal{E}_F$, if:

$$\ell < \ell' \Rightarrow \forall b \in B\ y'^{\tilde{b}}_0 \notin \left(Y^b_0 \times \{0\} \times \ldots \times \{0\}\right) \subset \mathbb{R}^{\ell'}, \tag{7}$$

or

$$\ell = \ell' \Rightarrow \forall b \in B \; y'^{\tilde{b}}_0 \notin Y^b_0 \subset \mathbb{R}^\ell. \tag{8}$$

If condition (7) is satisfied for a producer $\tilde{b} \in B$, then every commodity $l \in \{\ell + 1, \ldots, \ell'\}$ is introduced on the real market at date t'_0. It is the real innovation at this date with respect to economy $\mathcal{E}_F$. If condition (8) is valid, then the productive feasibilities of producer $\tilde{b}$ at date t'_0 go beyond the technological possibilities of all producers at date t'_0. The technological innovations are revealed in the innovative investment project of producer $\tilde{b}$ at date t'_0 with respect to economy $\mathcal{E}_F$. Hence, if condition (8) is satisfied for a producer $\tilde{b} \in B$, then producer $\tilde{b}$ introduces innovations on the real market. Producer $\tilde{b}$ is the innovator.

Remark 3.1. Let $\mathcal{E}_F \subset \mathcal{E}'_F$, where $t_1 = t'_0$. If an investment project $y^{\tilde{b}} = \left(y^{\tilde{b}}_0, \ldots, y^{\tilde{b}}_s\right) \in Y^{\tilde{b}}$ is the innovative project of producer $\tilde{b}$ at date t_1 with respect to date t_0, then the investment project $\left(y'^{\tilde{b}}_0, \ldots, y'^{\tilde{b}}_s\right) \in Y'^{\tilde{b}}$ is the innovative project with respect to economy $\mathcal{E}_F$.

Definition 3.3. If $\mathcal{E}_F \subset \mathcal{E}'_F$ and

$$J < J', \tag{9}$$

then every security $j \in \{J + 1, \ldots, J'\}$ is called an innovation on the financial market at date t'_1.

Definitions 3.1–3.3 cover all kinds of innovations distinguished by J. A. Schumpeter.

4. Mechanisms in the Economy with the Financial Market

Here we recall Hurwicz's understanding of mechanisms (Hurwicz & Reiter 2006). Let E be the set of all characteristics of economic agents in a given structure/process. This is called the set of environments.

Definition 4.1. The triple $\Gamma = (M, \mu, h)$, where:

– the set $M \neq \emptyset$, called the message space, contains the messages (signals) available to communications within agents,

– the correspondence μ: $E \to M$, called the message correspondence, associates with each environment $e \in E$ the set of messages $\mu(e)$,

– the function h: $M \to Z$, called the outcome function, assigns the outcome $z \in Z$ to every message $m \in M$,

is called the economic mechanism in the sense of Hurwicz.

Definition 4.2. Mechanism Γ is called the innovative mechanism, if the real or the financial innovations are components of the set of outcomes.

In the following theorem the mechanism, in which the set of environments consists of the characteristics of economic agents in the private ownership economy with a financial market, is defined. This mechanism in some cases is an innovative mechanism.

Theorem 4.1. Let $\mathcal{E}_F$ be the private ownership economy with a financial market, where consumption sets are compact, the utility functions are continuous and the condition:

$$\sum_{a \in A} \omega^a \in \left((X^{a_1} \times \ldots \times X^{a_m}) - (Y^{b_1} \times \ldots \times Y^{b_n}) \right)$$

is satisfied. The process of determining the equilibrium in economy $\mathcal{E}_F$ is then a Hurwicz-type economic mechanism.

Proof. The proof of the theorem is standard and relies on defining the compositions of the economic mechanism in Hurwicz's sense. Let $\mathcal{E}_F = (u, \omega, Y, \theta, V)$, the private ownership economy with a financial market, be given. The environment of agent $k \in A \cup B$ is defined by the formula:

$$e^k = (\tilde{Y}^k, \tilde{X}^k, \tilde{u}^k, \tilde{\omega}^k, \tilde{\theta}^k), \tag{10}$$

where $\tilde{Y}^k = \begin{cases} Y^k & \text{for } k \in B \\ \{0\} & \text{for } k \notin B \end{cases}$; $\tilde{X}^k = \begin{cases} X^k & \text{for } k \in A \\ \{0\} & \text{for } k \notin A \end{cases}$; $\tilde{\omega}^k = \begin{cases} \omega^k & \text{for } k \in A \\ 0 \in \mathbb{R}^\ell & \text{for } k \notin A \end{cases}$;

$\tilde{u}^k = \begin{cases} u^k & \text{for } k \in A \\ 0 & \text{for } k \notin A \end{cases}$.

The number $\tilde{\theta}^{k_1 k_2} = 0$, if $k_1 \notin A$, or $k_2 \notin B$ and $\tilde{\theta}^{k_1 k_2} = \theta^{k_1 k_2}$, if $k_1 \in A$ and $k_2 \in B$.

The set of all feasible environments of agent $k \in A \cup B$ form the set E^k. Denoting the number of all economic agents by K, the set of environments is given by $E = E^1 \times \ldots \times E^K$.

Due to the aims of economic agents in the economy $\mathcal{E}_F$, the set of outcomes is of the form:

$$Z \overset{def}{=} \left\{ \begin{array}{c} \left(\left(x^{a^*}, h^{a^*} \right), \left(y^{b^*}, f^{b^*} \right) \right) : \exists p^* \in \mathbb{R}^\ell, q^* \in \mathbb{R}^J \\ \text{conditions (1)–(4) by Definition 2.2 are satisfied} \end{array} \right\}.$$

It is readily apparent that under the assumptions of the present theorem, set Z is not empty. To conclude the proof, it is enough to define the set of messages, the message correspondence and the outcome function. The following yields the results. Put:

– the message space:

$$M \overset{def}{=} \left\{ \begin{array}{l} ((x^a, h^a), (y^b, f^b), p, q): \sum\limits_{a \in A} h^a - \sum\limits_{b \in B} f^b = 0 \wedge \\ \forall s \in \{0, \ldots, S\}: \sum\limits_{a \in A} x_s^a - \sum\limits_{b \in B} y_s^b = \sum\limits_{a \in A} \omega_s^a \end{array} \right\},$$

– the message correspondence: $\mu(e) \overset{def}{=} \cap_{k \in A \cup B} \mu^k(e^k)$,
where $\mu^k : E^k \to M$ is the message correspondence of agent $k \in A \cup B$, where:

$$k \in B \backslash A \Rightarrow \mu^k(e^k) = \{m \in M: (y^{b^*}, f^{b^*}) \in \arg\max\{\mu d^{b^*}: (y^b, f^b) \in Y^b \times \mathbb{R}^J\}\},$$
$$k \in A \backslash B \Rightarrow \mu^k(e^k) = \{m \in M: (x^{a^*}, h^{a^*}) \in \arg\max\{u(x^{a^*}): (x^a, h^a) \in \beta(a)\}\},$$
$$k \in A \cap B \Rightarrow \mu^k(e^k) = \{m \in M:$$
$$(y^{b^*}, f^{b^*}): \in \arg\max\{\mu d^{b^*}: (y^b, f^b) \in Y^b \times \mathbb{R}^J\} \wedge$$
$$(x^{a^*}, h^{a^*}): \in \arg\max\{u(x^{a^*}): (x^a, h^a) \in \beta(a)\}\},$$

– the outcome function:

$$h: M \to Z; \quad h\big((x^a, h^a), (y^b, f^b), p, q)\big) \overset{def}{=} \big((x^a, h^a), (y^b, f^b)\big). \qquad \square$$

If one of the conditions (5) or (6) is satisfied, then the mechanism defined in Theorem 4.1 is the innovative mechanism.

In the next theorem the mechanism of evolution of the private ownership economy with a financial market is defined.

Theorem 4.2. If $\mathcal{E}_F \subset \mathcal{E}'_F$, then the process of evolution of economy $\mathcal{E}_F$ into economy $\mathcal{E}'_F$ is the economic mechanism as Hurwicz's conceptualised it.

Proof. The environment of every agent $k \in A \cup B$ is of the form (10). The outcome z^k of every agent k is given by components of economy $\mathcal{E}'_F$ as it was given in the case of the environment of economic agents. That is, $z^k = (\tilde{Y}'^k, \tilde{X}'^k, \tilde{u}'^k, \tilde{\omega}'^k, \tilde{\theta}'^k)$. The set Z^k consists of the feasible outcomes of agent k. Consequently the set of outcomes is given by $Z = Z^1 \times \ldots \times Z^K$. Keeping in mind the aims of economic agents in the process of evolution of the economy under study, it is defined, for every $k \in A \cup B$, $m^k = z^k$ and consequently $M^k = Z^k$ and $M = Z$. The set of environment E^k of agent k as well as the set of environment E are defined in the same way as was done in

the proof of Theorem 4.1. Finally, the outcome function h: $M \to Z$ is given by $h \overset{def}{=} id_M$. The last one yields the result of the theorem. □

If at least one of the conditions (7), (8) or (9) is satisfied, then the mechanism of the financial economy's evolution defined in the proof of Theorem 4.2 is the innovative mechanism.

In the following theorem, another mechanism connected to innovation is formulated.

Theorem 4.3. The private ownership economy with a financial market is the economic mechanism in Hurwicz's sense.

Proof. For $k \in A \cup B$ we define e^k of the form (10) and $z^k = e^k$. The rest of the proof proceeds the same as the proof of Theorem 4.2. □

The mechanism defined in Theorem 4.3 is called the structural mechanism. If one of the conditions (5) or (6) is satisfied, then the above structural mechanism is the innovative mechanism.

The following theorem concludes our analysis of innovative mechanisms in the economy.

Theorem 4.4. Let $\mathcal{E}_F \subset \mathcal{E}'_F$, where $t_1 = t'_0$. If the structural mechanism of economy $\mathcal{E}_F$ is the innovative mechanism, then the mechanism of economy $\mathcal{E}_F$'s evolution into economy $\mathcal{E}'_F$ is also the innovative mechanism.

Proof. It is the immediate consequence of Remark 3.1. □

5. Conclusions

Using a private ownership economy with a financial market in modeling the innovations as Schumpeter conceived them enables to determine and to estimate the sources of funding of innovation – that is, the producers' profits, and income from the sale of financial securities and easily accessible credits. This approach corresponds with Schumpeter's concept of economic development.

Using the idea of the Hurwicz's economic mechanism reveals a very close relationship between signals sent by economic agents and their aims on the markets in conditions of perfect competition.

The mechanisms defined in the paper often have qualitative properties, especially if introducing innovation leads to an increase in profits or utility. If that occurs, the position of an adequate group of economic agents may be said to have improved (see *Innovative Economy…* 2013, Chapter 4).

Given the above, innovations in the economy with a financial market as well as innovative mechanisms in this economy would appear to merit further study.

Bibliography

Ciałowicz, B. and Malawski, A. (2011) "The Role of Banks in the Schumpeterian Innovative Evolution: An Axiomatic Set-up" in A. Pyka, M. da Graça Derengowski Fonseca (eds), *Catching up, Spillovers and Innovations Networks in a Schumpeterian Perspective*. Heidelberg–Dordrecht–London–New York: Springer.

Ćwięczek, I., Lipieta, A. and Malawski, A. (2012) "Dwuokresowy model dochodu jako mechanizm ekonomiczny w ujęciu Hurwicza" [The two-period income model as Hurwicz's economic mechanism]. *Zeszyty Naukowe Polskiego Towarzystwa Ekonomicznego* 12: 9–20.

Debreu, G. (1959) *Theory of Value*. New York: Wiley.

Hurwicz, L. and Reiter, S. (2006) *Designing Economic Mechanism*. New York: Cambridge University Press.

Innovative Economy as the Object Investigation in Theoretical Economics (2013) ed. A. Malawski. Cracow: Cracow University of Economics Press.

Lipieta, A. and Malawski, A. (2016) "Price versus Quality Competition: In Search for Schumpeterian Evolution Mechanisms". *Journal of Evolutionary Economics* 26 (5): 1137–71, https://doi.org/10.1007/s00191-016-0470-8.

Magill, M. and Quinzii, M. (2002) *Theory of Incomplete Markets*. Cambridge: MIT Press.

Malawski, A. (1999) *Metoda aksjomatyczna w ekonomii* [The axiomatic method in economics]. Wrocław: Ossolineum.

Schumpeter, J. A. (1912) *Die Theorie der wirtschaftlichen Entwicklung*. Leipzig: Duncker & Humblot; English edition: *The Theory of Economic Development*. New York: Oxford University Press, 1961.

Abstract

Mechanizmy innowacyjne w ekonomii z własnością prywatną i rynkiem finansowym

W ekonomii z własnością prywatną i rynkiem finansowym innowacje w ujęciu Schumpetera można opisać w topologicznym aparacie pojęciowym Arrowa i Debreu, dzięki czemu uwidacznia się wpływ wzajemnych powiązań między rynkami realnym i finansowym na procesy innowacyjne.

Celem artykułu jest modelowanie innowacji i różnych rodzajów mechanizmów innowacyjnych ujawniających się w procesie schumpeterowskiej ewolucji. Zastosowanie hurwiczowskiego aparatu pojęciowego sprawia, że główne rezultaty przybierają postać twierdzeń matematycznych interpretowanych w języku ekonomii.

Słowa kluczowe: schumpeterowska ewolucja, mechanizmy ekonomiczne, projektowanie mechanizmów ekonomicznych, ekonomia z rynkiem finansowym.

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ON THE NEED FOR COGNITIVE CLOSURE AND JUDGMENTAL TREND FORECASTING

Abstract

The paper considers the following hypothesis: humans' need for cognitive closure reduces the usage of historical observations in judgmental forecasts only in horizontal trends. To test this hypothesis, three studies were conducted. In each, participants forecasted the next, unknown observation using the previous time series. The analysis concentrated on trend analysis and how the trends in historical data are used as the basis for forecasting depending on psychological traits, in particular cognitive closure.

Keywords: judgmental forecast, need for cognitive closure, time series analysis, trend identification.
JEL Classification: G410, C580.

1. Introduction

A great deal has been written on whether a judgmental forecast provides value added to statistical forecasts (see e.g. Lawrence et al. 2006). Numerous factors may influence judgmental forecasts, including external factors such as how a time series is presented (Weber at al, 2005), its statistical properties (e.g. its variability) and the characteristics of the person giving

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the prognosis, including his or her expertise and psychological traits. In this research we concentrate on the influence individual differences exert on judgmental forecasting. Previous studies have shown that both individual differences and perception of the nature of the phenomenon that generates the outcome (i.e. whether it depends on human skills or randomness) influence the process of trend identification (Tyszka et al. 2017). While one would assume that higher expertise should lead to better forecasts, there is the empirical evidence to the contrary, e.g. J. F. Yates, L. S. McDaniel and E. S. Brown (1991). In their between-the-subject research, they showed that undergraduate students outperformed graduate students in forecast accuracy. Yates et al. explained that the graduates students had greater expertise in economics and were therefore more prone to include in their forecasts factors that in fact had no additional explanatory power. The other aspect of judgmental forecasting is historical data. Based on the literature and the results of multiple regressions, P. Goodwin (2005) reports that a heuristic for forecasting is to include the last observation and the mean of the most recent observations for untrended series, and to include the last observation and the trend for trended series.

We have simulated an experimental environment that takes into account different historical trends and different degrees of information availability. Instead of having two groups of participants with different levels of expertise forecast the same time series (between the subjects) as Yates et al. did, we asked the same group of participants to forecast two different time series (within the subject). One of them, the stock exchange index, would have been perceived as domestic, so additional information was available to them (macroeconomic, political, experts opinions) while for the other, a foreign stock exchange index, they had less information.

2. The Need for Cognitive Closure

Some individual differences may influence the forecast reliance on the historical time series data and thus its ability and correctness. A. W. Kruglanski (1989, p. 14) introduced to psychology the concept of the need for cognitive closure, which he defined as "the desire for a definite answer on some topic, any answer as opposed to confusion and ambiguity". Thus, one with a strong need for cognitive closure demonstrates a strong desire for a clear-cut opinion, reached by obtaining an answer – any answer – even one that is not the most optimal or correct. Thus, such individuals are assumed to refrain from processing further information as soon as they have

closure (any answer). As a result, individuals with a strong need for cognitive closure are more likely to use early information in forming judgments, rendering their information processing more superficial. On these grounds, we suspect that the need for cognitive closure leads to a tendency to skip trend analysis (as a method of information simplification) or at the very least a tendency to look for trends in short periods rather than long ones. These individuals finish processing information faster, after an initial check provides sufficient confirmation. Individuals with a strong need for cognitive closure have a strong preference for order and structure and a strong desire for predictability, feel discomfort when confronted with ambiguity and are close-minded – with respect to all of the aspects covered in Kruglanski's need-for-closure scale.

The goal of this paper is to verify how individual differences influence judgmental forecasting. We first analyse the relationship between inclusions of the historical observation in judgmental forecasts depending on individual differences. We then verify these relationships for time series moving in three directions: in an upwards, sideways or downwards trend. We hypothesise that the need for cognitive closure plays an important role in making judgmental forecast in sideways trends, but not in upwards or downwards ones: the need for cognitive closure reduces the usage of historical observations in judgmental forecasts only in sideways trends.

The paper is organised as follows. We first analyse the statistical properties of forecasted time series and present the study. We then analyse the relations between psychological traits and the forecasting process.

3. Method

We have conducted three independent studies; two of them were based on real data from the WIG and DAX indexes. These are, respectively, Study 1A and Study 1B. The last study (Study 2) was based on synthetic data generated using an assumption on the underlying autoregressive stochastic process for rates of return.

Participants

Students of the Capital Markets major of Cracow University of Economics participated in this study during a one-semester Technical Analysis course. Participation was voluntary; however, participating students were given bonus credits for the Technical Analysis course. Additionally, students were awarded extra bonus credits depending on their results. This was intended

to provide higher motivation than any minor monetary payoffs that might have been offered instead[1]. One group of students participated in Study 1A, while the second independent group of students participated in Studies 1B and 2. There was a two-year interval between Study 1 and the other studies in order to minimise the information flow to the next year younger students from their older colleagues. Table 1 presents the demographic characteristics of the participants. At an average age of 22, the participants were young. As can also be seen, men were in the majority in all three studies.

Table 1. Demographic Data on the Groups of Students Participating in Studies 1A, 1B and 2

Studies	N	Number of		Age	
		Women	Men	Mean	Standard deviation
1A	58	18	40	22,57	3,24
1B & 2	66	21	45	22,29	2,90

Source: the authors' own study.

Materials – Studies 1A and 1B

Participants of Studies 1A and 1B completed a battery of psychological tests on individual differences for the assessment of information processing and cognitive preferences. Among them there was a 15-item version of the Need For Closure Scale – NFCS (see Webster & Kruglanski 1994, Roets & Van Hiel 2011) covering the following subscales:

– desire for predictability (NFC_FP),
– preference for order and structure (NFC_OP),
– discomfort with ambiguity (NFC_MI),
– decisiveness (NFC_BD),
– close-mindedness (NFC_CC).

Procedure – Studies 1A and 1B

In studies 1A and 1B, the students were asked to regularly provide forecasts for the forthcoming week's rate of returns for the WIG and the DAX. Within each study the participants were randomly assign to two groups, one that forecast the WIG and the other the DAX. Study 1A was

[1] Students receive the monthly scholarship depending on their average grade, so there is a direct relationship between grades and payments. Moreover, a good average grade is very important for the third year students as it allows them to avoid taking the entrance exams for their MA studies.

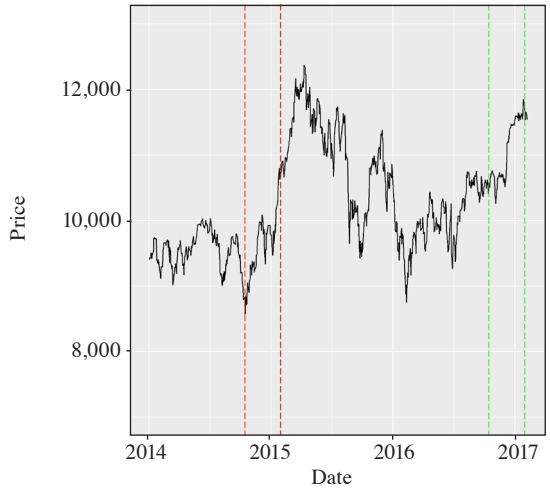

Fig. 1. DAX Index Time Series

Note: the red lines represent the timing of Study 1A, and the green lines the timing of Study 1B.
Source: the authors' own elaboration.

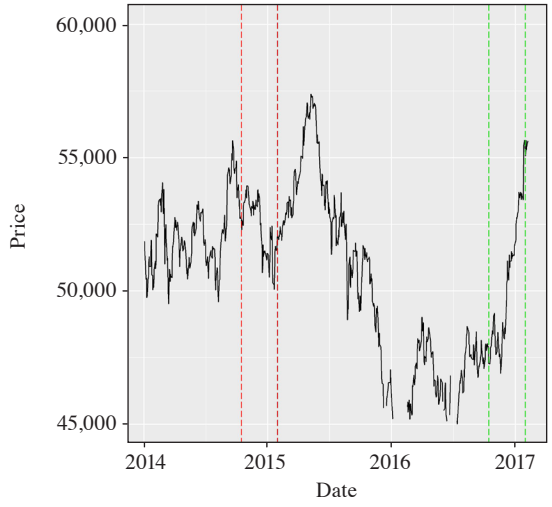

Fig. 2. WIG Index Time Series

Note: the red lines represent the timing of Study 1A, and the green lines the timing of Study 1B.
Source: the authors' own elaboration.

conducted each week, from 1 October 2014 until 8 February 2015, while Study 1B ran from 10 October 2016 to 30 January 2017. The time series to be forecast are presented in Figures 1 and 2. The time period of the Study 1A is shown between the red dotted lines and Study 1B between the green dotted lines.

The study was conducted in a LimeSurvey during the classes. The students had access to historical prices of the DAX and WIG. In particular, we asked for a point forecast r_f and the students were told that at the end of the semester the mean absolute deviation from the real observed rates of return would determine the number of extra credit points they received for the course. The top 30% of the students received 3 points, the next 40% 2 points, the next 20% 1 point, and the lowest 10% no extra points.

Materials and Procedure – Study 2

During the semester, between 6 November 2016 and 15 January 2017, we conducted five independent studies. The same group of students that participated in Study 1B was asked to provide forecasts for synthetically generated time series. The study was21 conducted in LimeSurvey. Students were presented graphs (like the one in Figure 3) and in some studies also histograms of the weekly rate of returns and data. The parameters in nine (three by three) studies are identical as the studies differed only with respect to information availability: graph, graph plus histogram and graph plus histogram plus raw data.

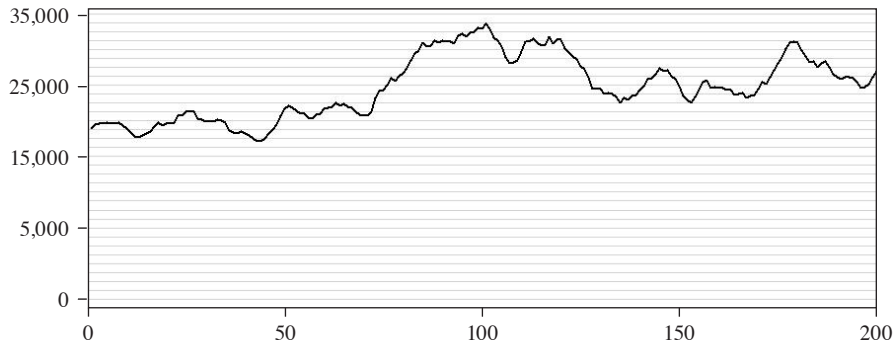

Fig. 3. Example of the Time Series Presented to the Students in Study 2

Source: the authors' own elaboration.

4. Results

Studies 1A and 1B

First we used Alexander filter (as implemented in R with ttr-package) with different parameters – 20%, 10%, 5% and 2.5% – to identify the trends in the forecast time series, for each index and each forecast period. The 20% parameter enabled the identification of the longer time trends while the 2.5% parameter enabled the identification of the shorer ones. We used different parameters as we did not know which time perspective the students were using for their forecasts. The filter enables the identification of local extremes (minimum and maximum). We have defined the current trend as the average daily logarithmic return from the last identified extreme price until the forecast day. If this period was too short (shorter than 10 days for 20%, 10% and 5% parameters and 5 days for 2.5% parameter), the second last identified extreme was considered instead. The correlations of forecast returns with identified last trend returns for different time perspective were then calculated. The trend with the highest absolute correlation with the forecast was finally chosen for further analysis. The absolute value of the correlation between the selected trend value and the relevant point forecast is denoted *RR*. The variable *PER.* denotes the correlation with the trend period (and has the following values: 1 – 20%, 2 – 10%, 3 – 5% and 4 – 2.5%) and relevant forecasting variable. A positive value means that the students tended to use shorter trends for their forecasts. Thus we could identify not only which time perspective (longer or shorter) the student considered for their forecast but also to what extent. Second, because we were only investigating if the students use trends for their forecast, and not how they use them, we used the absolute value in order to treat the momentum (the forecast with the trend) and contrarian (the forecast against the trend) strategies as equal.

Analogue results for Study 1B are shown in Table 3.

To combine the results, we apply Stouffer's *Z*-score method. The results of the one-sided test are shown in Table 4.

In Study 1A we can observe that students with higher levels of order preference (*OP*) and desire for predictability (*FP*) use the identified trends for prediction to a lesser extent. The results of Study 1B did not confirm this result, as the relationship between the NFC subscales and the use of trends for forecasting is not significant in Study 1B.

Table 2. Correlation Coefficients between the Analysed Variables for Study 1A

Study 1A	DAX			WIG			*OP*	*FP*	*MI*	*CC*	*BD*
	RR	*PER.*	*TIME*	*RR*	*PER.*	*TIME*					
RR	1	0.07	0	1	0	0.14	–0.22	–0.17	–0.18	0.09	0.14
PER.	0.07	1	–0.1	0	1	0.17	0.04	–0.14	–0.1	0.07	0.11
TIME	0	–0.1	1	0.14	0.17	1	–0.02	0.01	–0.03	–0.14	0.04
OP	–0.22	0.04	–0.02	–0.2	–0.09	–0.02	1	0.6	0.47	–0.17	–0.02
FP	–0.17	–0.14	0.01	–0.24	–0.05	0.01	**0.6**	1	0.64	0.03	–0.14
MI	–0.18	–0.1	–0.03	–0.19	–0.01	–0.03	**0.47**	**0.64**	1	–0.18	–0.16
CC	0.09	0.07	–0.14	–0.14	0.04	–0.14	–0.17	0.03	–0.18	1	0.25
BD	0.14	0.11	0.04	–0.17	0.16	0.04	–0.02	–0.14	–0.16	**0.25**	1

Note: *RR* – forecast value, *PER.* – period of the trend considered in forecasting, *TIME* – average time used to prepare the forecasts and the psychological trait measured by the need for cognitive closure subscales tests (*OP* – preference for order and structure, *FP* – desire for predictability, *MI* – discomfort with ambiguity, *CC* – close-mindedness, *BD* – decisiveness). Significant values of correlation coefficient are bold (p-value < 0.05).

Source: the authors' own study.

Table 3. Correlation Coefficients between the Analysed Variables for Study 1B

Study 1B	DAX			WIG			*OP*	*FP*	*MI*	*CC*	*BD*
	RR	*PER.*	*TIME*	*RR*	*PER.*	*TIME*					
RR	1	–0.04	0.2	1	0	0.1	0.13	0.02	0.1	–0.16	0.15
PER.	–0.04	1	–0.22	0	1	0.12	0.03	0.12	–0.07	–0.06	0.07
TIME	0.2	–0.22	1	0.1	0.12	1	0	–0.09	0.06	–0.03	–0.29
OP	0.13	0.03	0	0.21	–0.01	–0.05	1	0.55	0.42	–0.13	0.12
FP	0.02	0.12	–0.09	0.02	–0.1	–0.2	**0.55**	1	0.52	–0.05	–0.04
MI	0.1	–0.07	0.06	**0.25**	–0.25	0.07	**0.42**	**0.52**	1	–0.06	–0.25
CC	–0.16	–0.06	–0.03	0.03	–0.11	–0.07	–0.13	–0.05	–0.06	1	0.11
BD	0.15	0.07	**–0.29**	–0.08	0.09	**–0.3**	0.12	–0.04	**–0.25**	0.11	1

Note: *RR* – forecast value, *PER.* – period of the trend considered in forecasting, *TIME* – average time used to prepare the forecasts and the psychological trait measured by the need for cognitive closure subscales tests (*OP* – preference for order and structure, *FP* – desire for predictability, *MI* – discomfort with ambiguity, *CC* – close-mindedness, *BD* – decisiveness). Significant values of correlation coefficient are bold (p-value < 0.05).

Source: the authors' own study.

Table 4. One-sided *p*-values of the Estimated Correlation Coefficients between Absolute Values of Correlation Coefficients between the Observed Trend and the Forecast Value and the Need for Cognitive Closure Subscales Tests (NFCS) for Studies 1A and 1B

Study	Preference for order and structure (*OP*)	Desire for predictability (*FP*)	Discomfort with ambiguity (*MI*)	Close--mindedness (*CC*)	Decisiveness (*BD*)
1A	0.0443	0.0561	0.0796	0.3413	0.169
1B	0.1081	0.9553	0.0894	0.5202	0.3424

Source: the authors' own study.

Table 5. The Number of Local Optima (Minimum or Maximum) for Different Parameters of the Alexander Filter as Well as the Total Rate of Return in the Period Considered

Exp.	20%	10%	5%	2.5%	*RR*
1	4	9	18	22	0.29
2	4	7	21	29	–0.5
3	2	7	17	44	0.08
4	7	9	9	19	–1.12
5	2	8	13	31	1.08
6	2	6	14	34	0.01
7	4	10	14	26	0.05
8	4	8	12	26	0.92
9	2	9	17	33	–0.35
10	4	8	13	21	–0.73
11	4	7	19	27	0.28
12	1	5	11	32	0.29
13	7	15	23	45	1.05
14	5	16	24	34	1.36
15	7	17	33	57	0.35
16	7	15	23	45	1.05
17	5	16	24	34	1.36
18	7	17	33	57	0.35
19	7	15	23	45	1.05
20	5	16	24	34	1.36
21	7	17	33	57	0.35

Source: the authors' own study.

Study 2

The Alexander filter was used for the randomly generated time series used in Study 2. The number of single rounds of the experiment as well as the number of local optima (minimum or maximum of the time series, sometimes called support and resistance) for different parameters of the Alexander filter as well as the total rate of return in the period considered are presented in Table 5. The parameters in the last nine (three by three) studies are identical as the studies differed only with respect to the availability of information: graph, graph plus histogram and graph plus histogram plus raw data.

We next selected the study rounds for the sideways trends (the rate of return value in the whole period considered between –30% and 30%) and the rounds in dominating upwards or downwards trends (the rate of return value in the whole period considered lower than –70% or higher than 70%). The results are presented in Table 6.

Table 6. Correlation Coefficients between the Analysed Variables for Study 2

Study 2	Sideway trend			Up or down trend			*OP*	*FP*	*MI*	*CC*	*BD*
	RR	*PER.*	*TIME*	*RR*	*PER.*	*TIME*					
RR	1	0.02	0.23	1	0.64	–0.14	–0.02	–0.44	–0.11	–0.03	0.15
PER.	0.02	1	0.3	**0.64**	1	–0.04	0.51	0.17	0.2	0.2	–0.11
TIME	0.23	0.3	1	–0.14	–0.04	1	0.22	–0.12	0.1	0.11	–0.29
OP	–0.02	**0.51**	0.22	0.2	0.27	0.28	1	0.56	0.42	–0.15	0.14
FP	**–0.44**	0.17	–0.12	–0.09	0.04	0.09	**0.56**	1	0.53	–0.07	–0.06
MI	–0.11	0.2	0.1	–0.05	–0.01	0.28	**0.42**	**0.53**	1	–0.06	–0.25
CC	–0.03	0.2	0.11	–0.07	0.02	0.1	–0.15	–0.07	–0.06	1	0.05
BD	0.15	–0.11	–0.29	**0.48**	**0.49**	–0.18	0.14	–0.06	**–0.25**	0.05	1

Note: *RR* – forecast value, *PER.* – period of the trend considered in forecasting, *TIME* – average time used to prepare the forecasts and the psychological trait measured by the need for cognitive closure subscales tests (*OP* – preference for order and structure, *FP* – desire for predictability, *MI* – discomfort with ambiguity, *CC* – close-mindedness, *BD* – decisiveness). Significant values of correlation coefficient are in bold (p-value < 0.05).

Source: the authors' own study.

There are significant differences in the sideways and dominant up or downtrends. A desire for predictability (*FP*) compels students not to use trends in sideways trend situations as the basis for forecasting. However, that desire has no impact in dominant trends. This confirms the observation

we had when the WIG and DAX indices were forecast. In the timeframe of Study 1A, both markets were in sideways trends, while in the timeframe of Study 1B both were in a dominant uptrend. Finally, decisiveness (*BD*) led the students to use trends for forecasting to a larger extent.

5. Conclusions

We have confirmed the following hypothesis in this paper: the need for cognitive closure reduces the usage of historical observations in judgmental forecasts only in the case of side-ways trends. Using synthetic data, we have explained the phenomenon observed in this paper – the desire for predictability leads people to forego using trends or not to look for secondary trends when the market trend is sideways. On the other hand, when the trends are upward or downward, decisiveness compels people to use trends such as forecasting as a foundation, which may lead them to take too much risk. Further research will consider a study with synthetic data that differs with respect to the overall trend (rate of return) and frequency of local minima and maxima.

Bibliography

Goodwin, P. (2005) "Providing Support for Decisions Based on Time Series Information under Conditions of Asymmetric Loss". *European Journal of Operational Research* 163 (2): 388–402, https://doi.org/10.1016/j.ejor.2003.10.039.

Kruglanski, A. W. (1989) *Lay Epistemics and Human Knowledge: Cognitive and Motivational Bases*. New York: Springer.

Lawrence, M., Goodwin, P., O'Connor, M. and Önkal, D. (2006) "Judgmental Forecasting: A Review of Progress over the Last 25 Years". *International Journal of Forecasting* 22 (3): 493–518, https://doi.org/10.1016/j.ijforecast.2006.03.007.

R: A Language and Environment for Statistical Computing (2016). Vienna: R Foundation for Statistical Computing.

Roets, A. and Van Hiel, A. (2011) "Item Selection and Validation of a Brief, 15-item Version of the Need for Closure Scale". *Personality and Individual Differences* 50 (1): 90–94, https://doi.org/10.1016/j.paid.2010.09.004.

Tyszka, T., Markiewicz, Ł., Kubińska, E., Gawryluk, K. and Zielonka, P. (2017) "A Belief in Trend Reversal Requires Access to Cognitive Resources". *Journal of Cognitive Psychology* 29 (2): 202–16, https://doi.org/10.1080/20445911.2016.1245195.

Weber, E. U., Siebenmorgen, N. and Weber, M. (2005) "Communicating Asset Risk: How Name Recognition and the Format of Historic Volatility Information Affect Risk Perception and Investment Decisions". *Risk Analysis* 25 (3): 597–609, https://doi.org/10.1111/j.1539-6924.2005.00627.x.

Webster, D. M. and Kruglanski, A. W. (1994) "Individual Differences in Need for Cognitive Closure". *Journal of Personality and Social Psychology* 67 (6): 1049–62, https://doi.org/10.1037/0022-3514.67.6.1049.

Yates, J. F., McDaniel, L. S. and Brown, E. S. (1991) "Probabilistic Forecasts of Stock Prices and Earnings: The Hazards of Nascent Expertise". *Organizational Behavior and Human Decision Processes* 49 (1): 60–79, https://doi.org/10.1016/0749-5978(91)90042-r.

Abstract

O potrzebie domknięcia poznawczego i prognozowania trendu

W artykule została przedstawiona hipoteza, że potrzeba domknięcia poznawczego wpływa na ograniczone wykorzystanie informacji ujętych w historycznych danych podczas tworzenia prognoz tylko w przypadku trendów bocznych. W celu weryfikacji tej hipotezy zrealizowano trzy eksperymenty, w każdym z nich uczestnicy prognozowali przyszłą wartość na podstawie dostępnego szeregu czasowego. Skupiono się na analizie trendów. Zbadano, w jaki sposób trendy w danych historycznych są wykorzystywane jako podstawa tworzenia prognoz w zależności od psychologicznych inklinacji, w szczególności potrzeby domknięcia poznawczego.

Słowa kluczowe: prognozowanie, potrzeba domknięcia poznawczego, analiza szeregów czasowych, identyfikacja trendu.

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Piotr Ptak

RESTORING BALANCE IN PUBLIC FINANCE IN EUROPE IN THE LIGHT OF THE FISCAL COMPACT

Abstract

The aim of this article is to assess the extent to which Member States have achieved their medium-term budgetary objectives (MTOs) and the benchmark for government debt reduction in the light of the Fiscal Compact's provisions. It also identifies the risks involved in this process. By carrying out a statistical analysis and a review of the subject literature, the author shows that less than half of Member States have managed to meet the requirements imposed by the Fiscal Compact. The analysis suggests that the impact of fiscal consolidation on economic growth is seen as one of the main reasons for this state of affairs. The author regards the provisions of the Fiscal Compact as a welcome step towards anchoring fiscal discipline in Europe. If it is implemented and strictly enforced, they should strengthen the existing fiscal governance framework and foster its credibility in the future, substantially reducing the risk of another sovereign debt crisis.

Keywords: medium-term budgetary objective (MTO), debt-to-GDP ratio, fiscal consolidation, the Stability and Growth Pact, the Fiscal Compact.
JEL Classification: E61, E62.

1. Introduction

In the days before the outbreak of the Great Depression, when classical economics was still dominant, state budget policies were often related to family budgetary policy. As A. Smith said, what is prudence in the conduct of every private family can scarce be folly in that of a great kingdom (Smith 1954, p. 47). State financial responsibility was associated fundamentally

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with the determinants of family well-being. Saving was a virtue, which was reflected in the view that the state budget should, in the absence of a surplus, at least be balanced, and the deficit was allowed only in exceptional circumstances. Serious and persistent deficit was considered a sign of fiscal insanity (Buchanan, Burton & Wagner 1978). Indeed, until the 1930s it was commonly believed that a balance between expenditures and state revenue is normal while the lack of a balance – a budget deficit – was abnormal (see Cossa 1884).

Balancing the budget was certainly a good rule of fiscal policy – it was simple and completely stanched the problem of overspending. Of course, its being good did not prevent governments running up debt. For example, the UK's debt in 1820 came in at 132% of GDP (Rzońca 2008, p. 17). However, governments usually did not increase debt in good times. Public debt appeared during wars, when public spending rose dramatically or disaster – floods, pestilence, drought, and the like – struck, tanking tax revenue. Deficits were also caused by difficulties in creating an adequate revenue base for the growing need for expenditure amid civilization's rapid progress (Wernik 2011, p. 178). Despite the widespread recognition, the rule expressed in a balanced budget was broken in the 1930s. Economists began to see budget deficit as an instrument that could stimulate the economy in times of recession. The great English economist J. M. Keynes was among the leading proponents of using the deficit to this end, as were those who followed in his footsteps. However, he advocated increasing the deficit only in times of recession, because he was aware that during a cyclical recovery, which always takes place after the recession, higher public spending will drive up prices and crowd out private spending (Keynes 1985, p. 151). Hence, the budget should show a surplus when aggregate demand is excessive in relation to the state of full employment, which leads to economic imbalances. As economic history shows, Keynesian recommendations were roundly ignored.

Irresponsible fiscal policies pursued by governments in Europe before the crisis for purposes other than stabilising the economy constitute a good example of just how J. M. Keynes was ignored. Debt and deficit levels in many countries exceeded the acceptable limits, which were recorded in the Treaty on the Functioning of the European Union (TFUE) and in the Stability and Growth Pact (SGP)[1]. Further deepening of the fiscal imbalances, caused by the recent global financial crisis, led the most indebted countries to the very

[1] In years 1999–2009, Member States violated the deficit rule 74 times and the debt rule 93 times. Indeed, the system of fiscal discipline adopted in the EU did not work.

brink of bankruptcy. Exploding public debt together with the gradually ageing population has made clear the need to double down on fiscal discipline. Past mistakes, including a failure to balance public finance during periods of high economic growth (such as occurred during 2006–2007), are to be avoided, while the surplus should be a natural state, as Keynes himself advocated. He reiterated: "(...) The time for the Treasury to be severe is during a boom" (Skidelsky 2012, p. 161).

The financial and economic crisis, which became a sovereign debt crisis, forced European leaders to adopt solutions aimed at instilling sustainable fiscal discipline in Member States. In December 2011 a package of six legal acts strengthening economic governance in the EU was adopted. Known as the Six-Pack, it reforms the Stability and Growth Pact of 1997. The following year, 25[2] Member States signed the Treaty on Stability, Coordination and Governance in the EMU (TSCG), the so-called Fiscal Compact. One of the main provisions of the Treaty calls for national governments to balance their budget or run a surplus. This rule refers to the annual structural balance of the general government at its country-specific medium-term budgetary objective (MTO) as defined in the revised Stability and Growth Pact. The reformed Stability and Growth Pact and the Fiscal Compact represent the foundations of a new European economic system of governance. The several years since the rules came into effect encourage an evaluation of the solutions adopted to determine whether balance has been restored to Europe's public finance.

The main aim of the article is to assess the extent to which Member States have achieved their medium-term budgetary objectives and the benchmark for government debt reduction in the light of the Fiscal Compact's provisions. It also identifies the risks involved in this process and presents recommendations from legislative acts reforming the Stability and Growth Pact and the Fiscal Compact, the principal objective of which is to more effectively safeguard against the risk of irresponsible fiscal policy. Finally, the article seeks to prove that the financial and economic crisis, and subsequent sovereign debt crisis, is the ultimate evidence of the need to maintain continued fiscal discipline.

Section 2 points to the persistence of debt phenomena and examples of irresponsible fiscal policy pursued by governments in Europe, notably prior to the recent crisis. Section 3 presents the institutional reforms introduced in Europe as a response to the causes of the crisis, while Section 4 gives

[2] The United Kingdom and the Czech Republic did not sign the Treaty.

the general overview of the medium-term budgetary objective at the core of the preventive arm of the Stability and Growth Pact (European Commission 2016b). Section 5 examines the performance of Member States to determine whether they have achieved their medium-term budgetary objectives and the benchmark for government debt reduction in the light of the provisions of the Fiscal Compact. This section also includes an analysis of debt sustainability, which seeks to illustrate the potential the most highly leveraged countries have for pulling themselves out of debt in various macroeconomic circumstances. The last section offers concluding statements.

The methodology is based on my own analysis and assessment using research and professional experience. A review of the literature, empirical research, analytical reports (foremost from the European Commission but also the OECD and IMF), data and statistical analysis all figured in the overall methodology. Based on this methodology, the analysis of debt sustainability, including two sensitivity scenarios was conducted. The analysis conducted illustrates the changes that must be made to the structural primary balance in order for the most indebted countries to pull themselves out of debt. Deductive and inductive methods, analysis and synthesis, and comparative analysis were all used to achieve the objectives of the paper. Using this wide variety of methods enables the conclusion that the impact of fiscal consolidation on economic growth is one of the main reasons that less than half of Member States achieve the requirements imposed by the Fiscal Compact.

2. Persistence of Deficits

Statistics confirm that governments throughout the world persistently operate in debt, while Keynes's recommendations have been ignored. Fiscal data from OECD countries indicate that 45 of the 46 years between 1970 and 2015 showed a budget deficit, while a budget surplus occurred only once in Europe between 1995 and 2016.

For a striking example of irresponsible fiscal policy pursued by governments in Europe for purposes other than stabilising the economy, we need look no further than the years before the financial and economic crisis that began in 2008. The debt and deficit levels in many countries exceeded the limits laid down as acceptable in both TFUE and the SGP.

Structural weaknesses in public finance were covered by very high budgetary revenues fostered by the business cycle in a favorable phase, and in some countries by transactions in the asset market, particularly real

estate, driven by increased private sector debt. Such circumstances were not conducive to governmental reform efforts, which consisted in removing significant structural problems of public finance. They emerged with full force when the financial and economic crisis crushed budget revenues. In addition, the need to stimulate economies and support the financial sector during the world's biggest economic downturn since the Great Depression was so strong that many countries, including the richest, decided to introduce large-scale fiscal packages. As a result, the deficit-to-GDP and debt-to-GDP ratios both skyrocketed (see Figure 1).

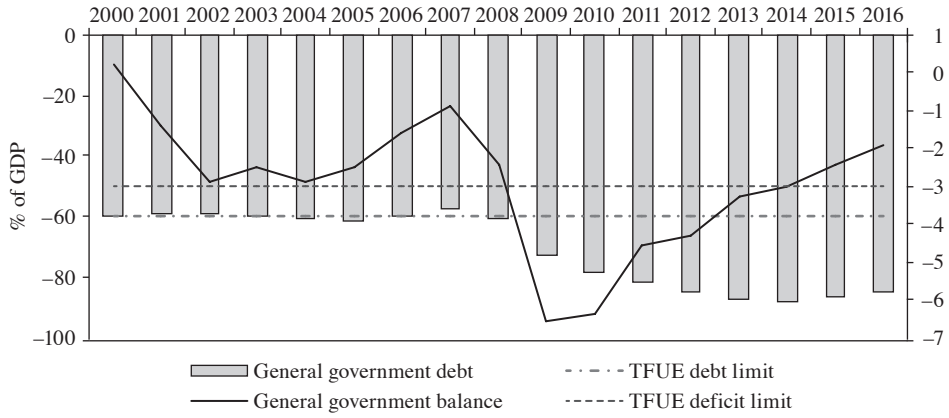

Fig. 1. General Government Debt and Deficit in Europe, 2000–2016, as a Percentage of GDP

Note: the right axis refers to general government balance; values are expressed as a percentage of GDP.
Source: AMECO database, European Commission.

The deepening fiscal imbalances caused by the crisis led the most indebted countries to the brink of bankruptcy. In the years 2008–2015, the debt-to-GDP ratio in Europe increased by no less than 26 percentage points. It was only fiscal consolidation undertaken by governments which gradually slowed the growth of debt relative to GDP. By 2015, the debt-to-GDP ratio was set on a downward path.

3. Institutional Reforms in Europe

The Stability and Growth Pact of 1997 lays down the fiscal criteria to which all Member States are bound. –3% of GDP is the threshold for the annual nominal balance of the planned or real general government sector. If a Member State exceeds that level, the European Council can, at the behest of the EC, threaten to impose the Excessive Deficit Procedure (EDP). Excessive deficit should be corrected in the year following its identification unless exceptional circumstances occur. In addition to the deficit criterion, there is also the general government debt criterion, which states that the general government debt should not exceed 60% of GDP. The financial and economic crisis turned sovereign debt crisis forced European leaders to adopt solutions aimed at establishing sustainable fiscal discipline in the Member States. In January 2012 a package of six legal acts (one directive and five regulations) strengthening economic governance in the EU came into force. This Six-Pack reforms the Stability and Growth Pact of 1997, setting down requirements for budgetary frameworks and indicating that Member States should have fiscal rules with clearly defined objectives and with mechanisms for effective and timely monitoring. It recommends that the fiscal rules should relate to the deficit and debt calculated according to EU-sanctioned methodology and relate to the entire general government sector. Member States should also set escape clauses and establish consequences for non-compliance. By applying rules in the annual budgetary process and in multi-annual budget planning, the Member States are to avoid pursuing pro-cyclical fiscal policies.

The provisions of the Six-Pack were grounded in the Treaty on Stability, Coordination and Governance in the EMU agreed in March 2012 at the European Union Summit. The Treaty specifies requirements for fiscal rules in the countries that are subject to the Treaty. The provisions oblige signatory States to introduce fiscal rules into national law in the form of legally binding and permanent norms set forth either in the Constitution or in any other form that guarantees their compliance. The two main elements of the Fiscal Compact are the mandatory balanced budget rule[3] and the benchmark for government debt reduction.

[3] The medium-term budget balance rule has been in force since 1998 under the Stability and Growth Pact, which states that the lower limit of the structural budget balance must be between 1% and 0% of GDP. This means that the Fiscal Compact's requirement to reduce the structural deficit to 0.5% of GDP does not bring anything new in practice, particularly given that in Member States with low debt the deficit can be increased up to 1% of GDP. However, this rule was not followed.

Mandatory Balanced Budget Rule

The signatory Member States commit themselves to implement in their legislation a fiscal rule which requires that the general government budget be balanced or show a surplus. The fiscal rule is considered to have been respected if the annual structural balance meets the country-specific medium-term budgetary objective and does not exceed a deficit (in structural terms) of 0.5% of GDP. If the government debt ratio is significantly below 60% of GDP and risks to long-term fiscal sustainability are low, the medium--term budgetary objective can be set as low as a structural deficit of at most 1% of GDP. In the event that the structural balance of a country deviates significantly from the medium-term budgetary objective or the adjustment path towards it, a mechanism will be automatically triggered to correct these deviations.

Benchmark for Government Debt Reduction

The Fiscal Compact includes the numerical benchmark for debt reduction for Member States with government debt exceeding the 60% of GDP reference value, as foreseen in the reinforced Stability and Growth Pact. A Member State with general government debt above 60% of GDP is obliged to reduce the "surplus of debt" (that is, debt above 60% of GDP) by one-twentieth annually. Countries that do not adhere to those rules may be subject to fines up to 0.1% of GDP.

The reformed Stability and Growth Pact and the Fiscal Compact represent the foundations of a new European system of economic governance. New regulations should substantially boost the chances of changing the irresponsible fiscal policies pursued by governments before the recent crisis.

4. Medium-term Budgetary Objective – General Overview

One of the basic instruments for coordinating the fiscal policies of the countries belonging to the Economic and Monetary Union, as defined in the Maastricht Treaty, is the condition that the general government deficit not exceed 3% of GDP. The practice has shown, however, that in many countries satisfying this criterion proved elusive, especially in times of economic slowdown. Consequently, Member States in the Stability and Growth Pact have committed themselves to achieving and respecting the medium-term budgetary objective, which (European Commission 2016a, p. 17):

(i) provides a safety margin with respect to the 3% of GDP deficit limit. For each Member State this safety margin is estimated in the form of a minimum

benchmark that takes into account past output volatility and the budgetary sensitivity to output fluctuations;

(ii) ensures sustainability or rapid progress towards sustainability. This is assessed against the need to ensure the convergence of debt ratios towards prudent levels with due consideration to the economic and budgetary impact of ageing populations;

(iii) in compliance with (i) and (ii), allows room for budgetary maneuvering, in particular taking into account the needs for public investment.

The medium-term budgetary objective is at the core of the preventive arm of the Stability and Growth Pact. The budgetary targets are set in structural terms, i.e. cyclically adjusted and net of one-off and other temporary measures to ensure that the underlying fiscal position of Member States is conducive to medium-term sustainability, while allowing for the free operation of the automatic stabilizers.

To set an MTO, a safety margin is first calculated for each Member State. The cyclical part of the budget is estimated by multiplying the output gap that would have been observed during very low economic growth by an average sensitivity of the nominal general government balance to cyclical fluctuations (Mourre et al. 2013, pp. 6–10). Subsequently, the absolute value of the cyclical portion is subtracted from the number 3[4], resulting in a structural balance (European Commission 2016, pp. 26–31).

The European Commission provides lower bound (minimum) MTOs, taking into account Member States' respective debt levels, the country-specific sustainability challenge posed by the costs of the ageing population and the specific dynamics of the automatic stabilizers every three years. In addition, countries undertaking structural reforms with a major impact on the sustainability of the public finances can also have their minimum MTOs revised on a case-by-case basis, in agreement with the European Commission. In particular, carrying out a major pension reform, which has an impact on long-term fiscal sustainability, could result in a revision of the minimum MTO. Euro area and ERM2 Member States must have an MTO that corresponds to at least –1% of GDP. In addition to the requirements set by the minimum MTOs, the signatories to the Treaty on Stability, Coordination and Governance in the Economic and Monetary Union in EMU, namely all euro area Member States plus Bulgaria, Denmark and Romania, have further committed themselves to MTOs of at least –0.5% of

[4] From 3% of the reference value of general government balance in relation to GDP.

GDP, unless their debt ratio is significantly below 60% of GDP and the risks in terms of the long-term sustainability of their public finances are low.

As part of the assessment of the adjustment path, the EU Council and the Commission examine whether the country is implementing the annual adjustment of the structural balance required to achieve the MTO, accounting for 0.5% of GDP for euro area countries and countries participating in ERM II as a benchmark for this adjustment. For all Member States with debt levels in excess of 60% of GDP or with significant long-term debt service risk, the Council and the Commission examine whether the annual adjustment of the structural balance exceeds 0.5% of GDP. Correction should be higher in good times and lower in bad times.

From a theoretical point of view, the structural balance rule is a useful tool in limiting fiscal discretion. Basing the rule on the structural balance requires isolating from the nominal balance a value representing the hypothetical balance, assuming no cyclical and one-off factors (Hers & Suyker 2014, p. 8). Since cyclical factors are considered as independent of the government and one-off factors in their nature do not affect the shape of long-term fiscal policy, the structural balance is that part of the nominal balance that is under government control. It is assumed that the structural balance reflects the fiscal policy conducted and changes in this category should, in principle, result from discretionary government action (Bedgoni & Meaney 2017, p. 4). Another advantage of using the structural balance is that it provides the motivation to adopt a medium-term perspective when planning fiscal policy. This approach, in turn, gives the policy greater anti-cyclicality by virtue of the automatic stabilizers, since the rule based on structural balance (when the output gap is positive) automatically forces a more restrictive policy and, in the long run, allows for a more expansive one than would be the case if the rule was based on the nominal balance.

It is important that the value of the MTO for the vast majority of Member States was set below zero. The zero target of the structural balance would be too ambitious for countries whose economies have strived to merely hit the EU average[5]. Until this level is reached, GDP growth is expected to be higher than the European average. At the same time it can be shown that, in the long run, public debt in relation to GDP roughly converges to the ratio of the nominal fiscal deficit expressed in percentage of GDP and the nominal GDP growth rate (Wernik 2011, p. 118). For example, with a deficit maintained

[5] For more on the disadvantages of using a structural budget balance as rule in fiscal policy, see e.g. (Kuusi 2017).

at 1% of GDP and with a nominal GDP growth rate at 3%, the debt would go down to 33% of GDP (assuming stable relation of deficit to GDP and nominal GDP growth). This means that a country whose GDP grows faster can reach correspondingly higher deficits and still maintain a debt-to-GDP ratio at the same level as a country with lower GDP growth.

5. Implementation of the Fiscal Compact

5.1. The Mandatory Balanced Budget Rule – Performance

For the years 2010–2016, the scale of the average fiscal adjustment in Europe should be considered high. The general government deficit was reduced on average by 4.5 pp (from 6.4% to 1.9% of GDP); however, the debt-to-GDP ratio increased by 6.6 pp and has been put on the downward path only since 2015. However, continued deficit reduction and stabilisation at a level consistent with the medium-term budgetary objective proved to be a challenge for most Member States. Figure 2 demonstrates the level of structural balance achieved in 2016 against required MTOs established for Member States in 2016. In total, eleven Member States met their MTOs.

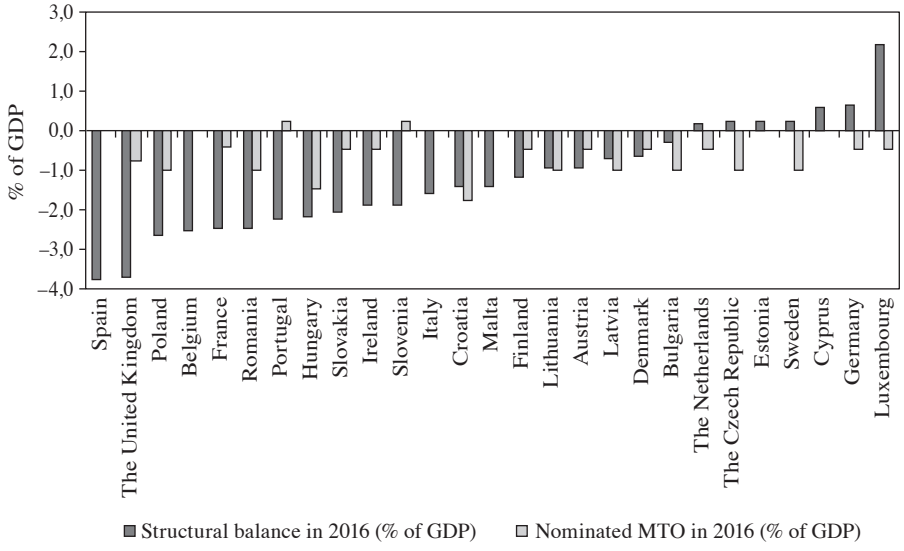

Fig. 2. Structural Balance against Medium-term Budgetary Objectives in 2016 in Europe

Source: AMECO database, European Commission.

Restoring budget balance in recent years likewise proved to be a difficult task, due mainly to weak growth prospects. These weak prospects were related, first, to high private and public sector debt and the need to reduce it and, second, to the persistently high unemployment and uncertainty vis-a-vis the further development of the labor market. On the other hand, efforts to accelerate economic growth with fiscal stimulus were limited by the high debt levels and consolidation efforts undertaken by the most leveraged countries.

In general, changes in fiscal policy have two main effects on the economy: they directly affect aggregate demand, and they impact trust and expectations about the future (see Rosati 2013, pp. 30–35). Over the first three years of fiscal consolidation, Member States tightened fiscal policy, assuming that the second effect would overlap the first. However, since 2014 there has been a change in direction. Even though many Member States are far from stabilising their debt-to-GDP ratio, the scale of fiscal savings has been limited. Figure 3 illustrates this clearly.

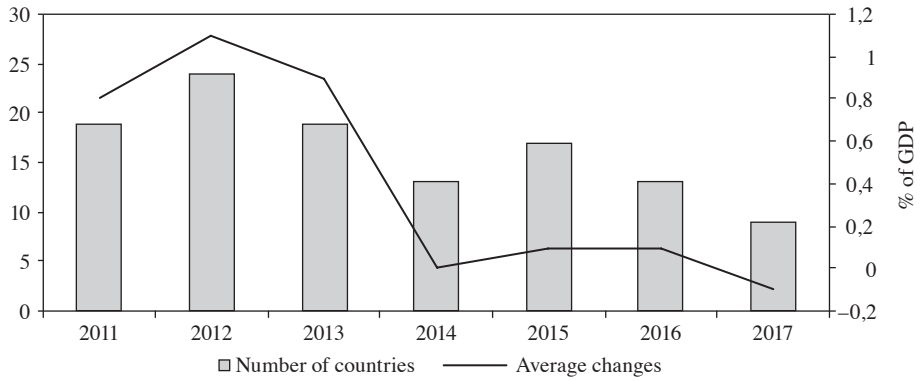

Fig. 3. Number of Countries Improving Their Structural Balance and Average Changes in Structural Balance as a Percentage of GDP in Europe

Note: the right axis refers to the average changes in structural balance as a percentage of GDP in Europe.

Source: AMECO database; the forecast for 2017 based on European Commission (2017).

Since 2014 noticeably fewer countries have managed to improve their structural balance, which is the key variable for assessing fiscal standing in the light of the Stability and Growth Pact and the Fiscal Compact. As a result, the scale of fiscal consolidation in structural terms has been considerably reduced as well. Furthermore, based on the most up-to-date European Commission forecast (European Commission 2017), the year 2017 will be

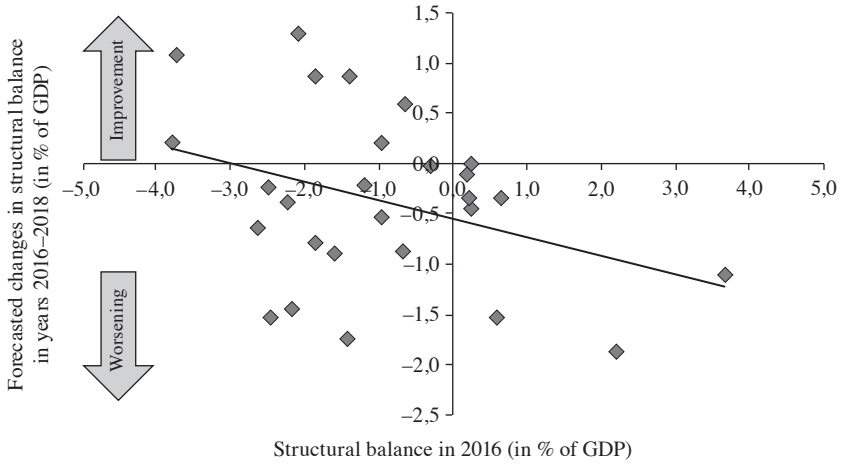

Fig. 4. Changes in Structural Balance in the Years 2016–2018 as a Percentage of GDP in Europe

Source: AMECO database and European Commission (2017).

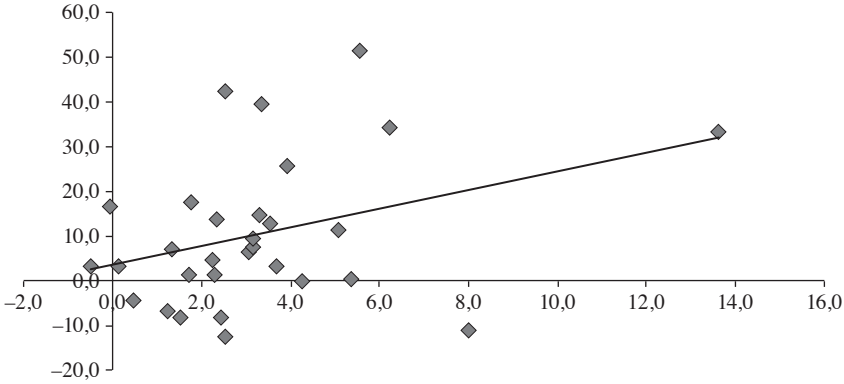

Fig. 5. Changes in Structural Balance and in Debt-to-GDP Ratio in the Years 2010–2016 as a Percentage of GDP in Europe

Note: the vertical axis refers to changes in the debt-to-GDP ratio; values in percentage of GDP.

Source: AMECO database, European Commission.

the first to see the structural balance worsen. In turn, Figure 4 shows the same forecast, according to which in the years 2016–2018, Europe as a whole will not improve its structural balance but actually worsen it. The structural balance is expected to improve in only eight countries.

Figure 5 demonstrates the reason for the change in fiscal policy in recent years: countries with the highest fiscal savings in structural terms have experienced on average the highest increase in debt-to-GDP ratio in Europe.

Certainly, the relationship between these variables may suggest that savings so drastically suppress the demand that the resulting effect of low economic growth prevents further reduction of the debt. Savings are halted as the largest and most indebted euro area countries (France, Italy and Spain[6]) have not moved to stabilise their debts (see Table 1: Current scenario).

5.2. Benchmark for Government Debt Reduction – Performance

While there is no formula for breaking down changes in the debt ratio into underlying factors such as interest rates, inflation, fiscal adjustment, among others, the following equation comes close (Escolano 2010, p. 6):

$$d_t - d_{t-1} = \frac{i_t}{1+y_t} d_{t-1} - \frac{y_t}{1+y_t} d_{t-1} + p_t, \tag{1}$$

where:

d_t – debt at the end of period t, as a ratio to GDP at t.

d_{t-1} – debt at the end of period $t-1$, as a ratio to GDP at $t-1$.

i_t – nominal interest rate in period t; paid in period t on the debt stock outstanding at the end of $t-1$.

y_t – nominal GDP growth rate between $t-1$ and t.

p_t – primary fiscal deficit[7] in period t, as a ratio to GDP at t.

This equation indicates that the change in the debt ratio equals the impact of interest (positive) and nominal GDP growth (negative), plus the contribution of the primary deficit. After simplification[8]:

$$d_t - d_{t-1} = p_t + d_{t-1}\left[\frac{i_t - y_t}{1+y_t}\right]. \tag{2}$$

Equation (2) shows that the change in the debt-to-GDP ratio is the sum of primary fiscal deficit and the snowball effect, which expresses the combined effect of the interest rate of government bonds and the growth rate of the nominal GDP in the debt-to-GDP ratio. If a constant debt-to-GDP ratio is

[6] In terms of the size of GDP, France, Italy and Spain are, respectively, the third, fourth and fifth largest European economies.

[7] In this equation the primary balance is expressed in structural terms.

[8] It was assumed that the impact of the stock-flow adjustment factor equals zero in this equation.

to be maintained, the left side of equation (2) must equal zero. The condition for stabilising the debt-to-GDP ratio at a specified debt level is ensuring that:

$$-p_t = d_{t-1}\left[\frac{i_t - y_t}{1 + y_t}\right]. \tag{3}$$

Equation (3) indicates that the condition for stability of the debt-to-GDP ratio requires that the relation of the primary deficit to GDP equals the snowball effect. Indeed, the public debt does not grow, if the primary deficit is compensated by the surplus of growth of nominal GDP above the average nominal interest of debt. In other words, the debt ratio will increase indefinitely if the nominal interest rate exceeds the growth rate of nominal GDP, unless the primary budget is in sufficient surplus to compensate for that (Bohn 2005, p. 7). This is the case many European countries are experiencing now. Hence, a sign of expression $(i_t - y_t)$ is crucial for the debt dynamic.

According to equation (3), the value of structural primary balance needs to equal its right side in order to stabilise the debt-to-GDP ratio. However, with a high and positive value of expression $(i_t - y_t)$, stabilising the debt-to-GDP ratio means that a primary balance must be maintained along with a sufficient primary surplus. Currently, France, Italy and Spain continue striving to achieve a structural primary balance and their medium-term budgetary objectives. In this respect, in the years 2010–2016, progress was somewhat evident, the fruit of fiscal consolidation, though the value of the structural primary deficit is still not sufficient to start decreasing the debt-to-GDP ratio. Apart from the current situation, Table 1 presents the sustainability of general government debt in France, Italy and Spain including two sensitivity scenarios intended to better illustrate the changes in relation to the required level of structural primary balance in accordance with equation (3).

Scenario 1 assumes lower inflation and real GDP rates by 1.0 pp compared to 2017 forecast. In this case, the value of the primary balance beyond which the debt starts to fall increases significantly, meaning France and Italy will both require a structural primary surplus. In turn, Scenario 2 assumes higher inflation and real GDP rates by 1.0 pp compared to 2017 forecast. In this case, the value of the primary balance beyond which the debt starts to fall decreases considerably, allowing even for some relaxation in the fiscal policy stance. The analysis in Table 1 only confirms that the sign and value of structural primary balance in accordance with equation (3) is highly sensitive about the sign and value of expression $(i_t - y_t)$. At present, the low nominal GDP growth (y_t), as it affects the rate of increase or decrease of the debt, makes reducing debt difficult. On the other hand, the European Central

Bank's highly expansive monetary policy enables interest rates (i_t) to be kept very low, thus keeping the cost of servicing debt low as well.

Table 1. Sustainability of General Government Debt in France, Italy and Spain

Country	Structural primary balance as a percentage of GDP		Threshold of structural primary balance beyond which the debt starts to fall (% of GDP)		
	2010	2016	Current scenario*	Scenario 1**	Scenario 2***
France	–5,8	–2,5	–1,4	0,2	–3,6
Italy	–3,4	–1,6	–0,3	2,3	–3,0
Spain	–7,1	–3,8	–2,2	–0,3	–4,1

* Level of debt since 2015 and long-term interest since 2016. ** Scenario 1 reflects lower inflation and real GDP rates by 1.0 pp compared to 2017 forecast (European Commission 2017). *** Scenario 2 reflects higher inflation and real GDP rates by 1.0 pp compared to 2017 forecast (European Commission 2017).

Source: the author's own calculations based on AMECO database and European Commission (2017).

In turn, the progress towards the second main element of the Treaty on Stability, Coordination and Governance in EMU, the benchmark for government debt reduction has also not been in line with the Fiscal Compact's provision. This means that the difference between the government debt-to-GDP ratio and 60% of GDP needs to be reduced at an average rate of one-twentieth per year. Table 2 demonstrates two paths to developing the debt-to-GDP ratio: the actual one and the one required by the Fiscal Compact.

Table 2. Changes of the Debt-to-GDP Ratio in Europe in the Years 2014–2016 (in Percentage of GDP)

Countries	Debt-to-GDP-ratio (base year)	Changes of debt-to-GDP ratio required by Fiscal Compact			Actual changes of debt-to-GDP ratio		
	2013	2014	2015	2016	2014	2015	2016
Spain	95.4	93.6	91.9	90.3	100.4	99.8	99.7
France	92.3	90.7	89.2	87.7	95.3	96.2	96.4
Italy	129.0	125.6	122.3	119.2	131.9	132.3	132.8

Source: the author's own calculations based on AMECO database and European Commission (2017).

Since the adoption of the Fiscal Compact, only Spain has managed to reduce – and slightly at that – its debt-to-GDP ratio, while France and Italy have allowed it to continue to rise. If these countries had respected the provisions of the Treaty, the debt ratio would now amount to, on average, 10 pp less than it does. Overall, in 2012–2016, fewer than half of Member States managed to reduce their debt.

Following the financial crisis, the European Commission demanded that the Member States take vigorous corrective measures as a response to the outbreak of the financial crisis, which nonetheless turned into a sovereign debt crisis. Furthermore, both the Stability and Growth Pact and the Fiscal Compact provide for penalties for breaking the rules. However, concerns about slowing economic growth led EU institutions to forego using these tools. Countries with budgetary problems including France, Portugal, Italy and Spain have several times been allowed to put off introducing corrective measures. This is due to fears that stronger fiscal tightening would lead in countries whose economy have been at the edge of recession for years, to both another economic slowdown and a heightened level of radical sentiment. A change in the attitudes of the European Union's authorities to fiscal problems can be seen in the draft of the European Parliament's *Implementation of the Stability and Growth Pact* of February 2017 (Angerer & Japunčić 2017) on the basis of decisions and recommendations of the European Commission. There is no announcement of taking action to discipline countries that do not fulfill the objectives, and even countries where debt levels have been growing deserve a positive rating.

6. Conclusions

Using rules to constrain fiscal policy is nothing new in Europe's system of economic governance. The Stability and Growth Pact of 1997 included permissible limits on general government deficit and debt, but they were frequently violated. The adoption of the reformed Stability and Growth Pact and the Fiscal Compact is intended to put a permanent end to this practice. The solutions adopted should avoid duplication of past mistakes, including the failure to reach the medium-term budgetary objective during periods of high economic growth (such as in the years 2006–2007) and a failure to treat a budget surplus as a natural state.

These several years since the rules came into effect demonstrate that the process of restoring balance in public finance in Europe has been relatively slow. Less than half of Member States have managed to meet the

requirements imposed by the Fiscal Compact, both in terms of achieving their MTOs and the benchmark of debt reduction. One reason for this failure is due to the impact of fiscal consolidation on economic growth. Drastic austerity measures have suppressed the aggregate demand while the resulting effect of low economic growth prevents further reductions to general government debt.

Compelled by fears that stronger fiscal tightening would lead, in countries whose economies have been on the edge of recession for years, to both another economic slowdown and a heightened level of radical sentiment, EU institutions have several times put off introducing needed corrective measures resulting from the Fiscal Compact. Note, however, that the halt to savings has taken place as the largest and most indebted euro area countries (France, Italy and Spain) have done little to stabilise their debt. The analysis conducted in this article confirms that.

Nevertheless, the Fiscal Compact was a welcome step towards anchoring fiscal discipline in the euro area and those non-euro area signatories that have declared themselves bound by the provisions of the Fiscal Compact (Denmark, Bulgaria and Romania). If strictly implemented and enforced, the fiscal compact should strengthen the existing fiscal governance framework and foster its credibility in the future. On the other hand, the resolutions enacted are nothing more than an attempt to return to the unspoken principle of a balanced budget and to treat the public finance deficit as at most temporary, and certainly not a normal state. Such was the case since the Great Depression until the outbreak of the financial crisis in 2008, which later turned into a sovereign debt crisis. Ultimately, the adoption of these solutions is an attempt to return to a state of sustained fiscal discipline.

Bibliography

Angerer, J. and Japunčić, T. (2017) *Implementation of the Stability and Growth Pact*. Briefing. Brussels: European Parliament.

Bedgoni, J. and Meaney, K. (2017) *EU Fiscal Rules and International Expenditure Rules*. Dublin: Irish Government Economic and Evaluation Service.

Bohn, H. (2005) *The Sustainability of Fiscal Policy in the United States*. CESifo Working Paper No. 1446. Munich: CESifo.

Buchanan, J. M., Burton, J. and Wagner, R. E. (1978) *The Consequences of Mr. Keynes*. Hobart Paper No. 78. London: Institute of Economic Affairs.

Cossa, L. (1884) *Początki nauki finansów* [The beginnings of finance science]. Warszawa: E. Wende i Spółka.

Escolano, J. (2010) *A Practical Guide to Public Debt Dynamics, Fiscal Sustainability, and Cyclical Adjustment of Budgetary Aggregates*. Washington, DC: International Monetary Fund.
European Commission (2016a) *Report on Public Finances in EMU*. Institutional Paper 045, December. Luxembourg: Publications Office of the European Union.
European Commission (2016b) *Vade Mecum on the Stability and Growth Pact*. Institutional Paper 021, March. Luxembourg: Publications Office of the European Union.
European Commission (2017) *European Economic Forecast – Winter 2017*. Institutional Paper 048, February. Luxembourg: Publications Office of the European Union.
Hers, J. and Suyker, W. (2014) *Structural Budget Balance. A Love at First Sight Turned Sour*. CPB Policy Brief No. 7. The Hague: CPB Netherlands Burreau for Economic Policy Analysis.
Keynes, J. M. (1985) *Ogólna teoria zatrudnienia, procentu i pieniądza* [The theory of employment, interests and money]. Warszawa: PWN.
Kuusi, T. (2017) "Does the Structural Budget Balance Guide Fiscal Policy Pro-cyclically? Evidence from the Finnish Great Depression of the 1990s". *National Institute Economic Review* 239 (1): R14–R31, https://doi.org/10.1177/002795011723900111.
Mourre, G., Isbasoiu, G. M., Paternoster, D. and Salto, M. (2013) *The Cyclically-adjusted Budget Balance Used in the EU Fiscal Framework: An Update*. European Economy – Economic Papers No. 478. Brussels: European Commission.
Rosati D. K. (2013) "Konsolidacja fiskalna a kryzys zadłużenia w strefie euro" [Fiscal consolidation and debt crisis in euro area] in L. Oręziak, D. K. Rosati (eds) *Kryzys finansów publicznych. Przyczyny, mechanizm, drogi wyjścia* [The public finance crisis – causes, mechanism and the way out]. Warszawa: Oficyna Wydawnicza Uczelni Łazarskiego, pp. 11–37.
Rzońca, A. (2008) *Paraliżujący deficit* [Paralysing deficit]. Zeszyty FOR 1. Warszawa: Forum Obywatelskiego Rozwoju.
Skidelsky, R. (2012) *Keynes. Powrót mistrza* [Keynes. Return of the master]. Warszawa: Wydawnictwo Krytyki Politycznej.
Smith, A. (1954) *Badania nad naturą i przyczynami bogactwa narodów* [An inquiry into the nature and causes of the wealth of nations], vol. 2. Warszawa: Państwowe Wydawnictwo Naukowe.
Wernik, A. (2011) *Finanse publiczne* [Public finance]. Warszawa: PWE.

Abstract

Przywracanie równowagi finansów publicznych w Europie w świetle paktu fiskalnego

Celem artykułu jest ocena stopnia, w jakim państwa członkowskie osiągnęły średniookresowe cele budżetowe (MTO) oraz punkt odniesienia (*benchmark*) w zakresie redukcji zadłużenia publicznego w świetle postanowień paktu fiskalnego, oraz określenie zagrożeń związanych z tym procesem. Na podstawie analizy statystycznej oraz badań literaturowych wykazano, że mniej niż połowa państw członkowskich zdołała spełnić

wymagania narzucone przez pakt fiskalny. Wynik przeprowadzonej analizy wskazuje, że wpływ konsolidacji fiskalnej na wzrost gospodarczy jest postrzegany jako jeden z głównych powodów tego stanu rzeczy.

Autor uważa, że wymogi paktu fiskalnego są właściwym krokiem w kierunku zakotwiczenia dyscypliny budżetowej w Europie, i stwierdza, że w przypadku ścisłego wdrożenia i egzekwowania przepisów paktu powinien on wzmacniać istniejące ramy zarządzania finansami publicznymi i przyczyniać się do zwiększenia ich wiarygodności w przyszłości, co znacznie zmniejszy ryzyko wystąpienia kolejnego kryzysu zadłużenia suwerennego.

Słowa kluczowe: średniookresowy cel budżetowy, wskaźnik długu publicznego do PKB, konsolidacja fiskalna, pakt stabilności i wzrostu, pakt fiskalny.

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THE IMPACT OF R&D EXPENDITURES ON EARNINGS MANAGEMENT

Abstract

The main goal of the paper is to investigate the relationship between R&D spending and earnings management. While R&D expenditures create some of the most precious assets in today's economy, in many accounting jurisdictions they either may not be recognised as an asset in the balance sheet or their recognition is very limited. The main obstacle is the measurement process's lack of reliability, which is the result of information asymmetry caused by the nature of R&D investments. Additionally technological breakthroughs do not necessarily translate into commercial success.

The results of studies conducted until now provide evidence that managers taking responsibility for high-cost R&D projects become more and more emotionally engaged as time passes. In this paper, it is theorised that this phenomenon is also an important factor in earnings management. The following hypothesis is put forward: R&D expenditures are a significant determinant of earnings management after a two-year time lag. The time lag is adopted on the basis of the average length of time a research project lasts.

The empirical study was done on the basis of a sample of US stock listed companies (more than 4,500 firm-year observations). The group was chosen because US GAAPs require all R&D costs (with a few exceptions) to be fully expensed. This enables one to easily determine R&D spending, which would not be possible in the case of companies reporting under IFRSs. Regression analysis shows that R&D spending is a statistically significant determinant of earnings management after two and three time lags. The hypothesis was verified, suggesting that R&D investments influence managerial behaviour with regard to earnings management.

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JEL Classification: M41, G30, O32.

1. Introduction

Accounting of R&D activity is one of the most controversial issues in contemporary financial reporting. The main controversy concerns the issue of capitalising vs. not-capitalising on the costs of R&D projects. The debate on this issue has been present in the accounting regulations at least since the mid-1970's. One side of the discourse stresses that the decision of whether to capitalise or not is to some extent discretionary in nature and allows managers to manipulate earnings, and because of that the R&D expenditures should be fully expensed as incurred. On the other hand, adversaries point out that R&D investment creates the most prized assets in the economy and not recognising them creates substantial off-balance sheet assets. In consequence, not recognising intangibles arising from R&D investments deteriorates the relevance of financial statements (Healy, Myers & Howe 2002, pp. 677–78).

The debate is also visible at the level of accounting regulations. IFRSs adopt a more liberal approach and allow the recognition of intangibles arising from the development phase if an entity is able to meet certain conditions. US GAAPs (SFAS No. 2) adopt more conservative accounting treatment and require all R&D expenditures to be expensed in the current period with some minor exceptions. The introduction of SFAS No.2 in the US has also had an impact on managerial behaviour. Several studies (Horowitz & Kolodony 1980, Cooper & Selto 1991) provide evidence that companies previously capitalising R&D costs reduced their spending on research after SFAS No. 2 was introduced. Critics of this accounting treatment argue that US companies are losing their competitiveness due to implied underinvestment in R&D (Mande, File & Kwak 2000, p. 269). Such underinvestment is described in the literature as a myopic investment behaviour or managerial myopia. J. Bushee (1998, p. 306) defines it as a situation in which managers face a trade-off between meeting earnings targets and maintaining R&D investment. However, there is reporting data that suggests this is not true. In 2016, according to PwC ranking (http://www.strategyand.pwc.com/innovation1000, accessed: 15 May 2017), 13 out of the 20 top global R&D spenders and 9 out of 10 top innovative companies were from the US.

The central issue of this problem is the nature of R&D assets, which are unique assets characterised by informational asymmetry. Companies report

R&D activity as discreetly as possible in order not to disclose too much to competitors. R. Guidara and Y. Boujelbene (2014, p. 26) and Holmstrom (1989) describe R&D expenditures as a firm-specific investment usually characterised by a high level of uncertainty and informational asymmetry. The character of intangibles arising from R&D activity, which potentially can be recognised, is usually a very technical issue, difficult to understand for outsiders, while its impact on the market position of the firm is even more difficult to grasp. As a result, users of financial information or even financial auditors are unable to correctly assess the probability of an R&D investment succeeding. R&D assets are unique also in that there is usually no active market for them – they are innovative but at the same time are not homogenous (comparable to each other). L. N. Davis (2001) provides the following reasons for why R&D activity increases information asymmetry: each research project is unique and not repeatable; there is no organised market for R&D activity (so it is difficult to measure the value of intangibles arising from R&D); and, finally, different accounting is allowed in different jurisdictions.

There is also the theory of the spill-over effect, which postulates that the benefits of research activity are accessible not only for the company initiating an R&D project but, with time, also for more and more other parties. The consequence of this diffusion of R&D benefits is that the value of intangibles' erodes. All of these arguments illustrate the difficulty in measuring R&D assets.

N. Seybert (2010) postulated that managers responsible for initiating R&D projects are more likely to overinvest when costs are capitalised. If the project fails, the resulting asset impairment may harm the manager's reputation. This provides a strong incentive for managers to achieve success in their R&D projects by putting more money on the table. For the same reason, managers are afraid to capitalise R&D expenditures and tend to expense them as incurred, leading to lower earnings being reported and consequently underinvestment in innovative projects. Both strategies – over- and underinvestment in R&D – may destroy a firm's value. Seybert conducted this study in an IFRS regime and cannot be replicated in a US GAAP environment, where R&D costs cannot by law be capitalised.

The relationship between R&D investment and its effect on revenue is an interesting one. While little research has been done on this issue, O. Lome, A. G. Haggeseth and Ø. Moen (2016) provide convincing evidence that, on average, the effect of investment is visible after two or three years. This accords with the widespread notion that a successful research project

takes an average of two years from start to commercial launch. Other studies (Leonard 1971, Rapoport 1971, Pakes & Shankerman 1984) provide results for different US industries showing the average time lag to be between 1.17 years in the electronics industry up to 2.40 years in the machinery industry. We assume that managers and company shareholders will expect financial results two years after the launch of a research project.

A research project can be counted among the riskiest investments. Business practice provides no lack of examples of failed R&D investments taking a toll on company profitability. In some cases the outcome of research activity is critical for the future of the company and determines the assessment of managerial performance. We theorise that intensive investment in R&D influences managerial behaviour. Managers take full responsibility for the research project and tend to more strongly identify themselves with the final result. Following this line of reasoning, we hypothesise that two years after initiating an intensive R&D project, managers will be inclined to manage earnings in order to demonstrate success or to adopt a big bath strategy in the event of failure. In both cases the absolute values of accruals should be higher and show more intensive earnings management.

The total investment is the sum of the amount reported in profit and loss and costs capitalised in the balance sheet as intangibles (in the case of companies reporting under IFRS). To avoid the problem of cost capitalisation, we limited our sample to US companies, where under US GAAP, R&D expenditures may not be capitalised. As a proxy for R&D intensity, we take first the ratio of R&D expenditures to total assets and, second, the proxy R&D expenditures to sales.

The results show that R&D intensity with a two-year time lag is a significant determinant of earnings management. Additional tests show that the effect is less or not significant for R&D intensity with a one-year time lag or without a time lag. We are inclined to conclude that R&D spending influences managerial behaviour after a period of two years.

The paper proceeds as follows. Section 2 reviews the relevant literature and presents the hypothesis. Section 3 demonstrates the research design and sample description. Section 4, while not fully developed, provides the anticipated results of the study.

2. The Literature and the Hypothesis

Earnings management is sometimes considered a symptom of agency problems. The conflict of interest between management and the providers of capital creates agency costs. The greater the asymmetry of information, the more difficult it is to control management and to prevent management from creating agency costs. R&D activity is reported as discreetly as possible, which further increases informational asymmetry between management and the company's stakeholders and creates an opportunity for earnings management.

The theoretical link between undertaking and reporting R&D investment and earnings management is not very soundly grounded in the accounting literature. Very few papers have investigated the issue from a theoretical or an empirical point of view. Two strands of research on R&D can be distinguished: accrual and real earnings management, the latter of which, surprisingly, is the more popular. Secondly, studies conducted on R&D expenditures are used either as a tool or as an incentive to manage earnings.

S. Roychowdhury (2006) carried out empirical research on real earnings management. The basic assumption of this form of management is that managers structure real transactions in order to manage earnings – or, in other words, to hit their earnings targets. The measurement of real EM is conceptually based on the difference between the real and expected (under normal conditions) scale of operating activities. In the case of R&D investment, a researcher must assume a "normal" level of research activity. It is very difficult to determine what the normal level of R&D expenditures is for those outside the company, making this approach controversial. One important result of Roychowdhury's study is the evidence it provides for some categories of costs being very frequently used for real EM, particularly the costs of advertising, promotion, maintenance and R&D. Yet, this should come as no surprise: these costs are usually the first to be cut when financial trouble rears its head.

A study conducted by S. Perry and R. Grinaker (1994) was probably among the first to observe that R&D spending is adjusted to improve firms' success in meeting their current earnings goals. They found a linear relationship between unexpected R&D spending and unexpected earnings on the basis of 99 large US companies. Prior year R&D expenditures and earnings were taken as proxies (a normal level of operating activity) for the current year after controlling the effects of selected economic changes during the current period.

J. Bushee extended previous research in a 1998 study that assumed there is a relationship between R&D budgets and the desire to hit earnings targets. He selected a very specific sample of companies with pre-R&D earnings that came in below the prior year's, but by such an amount that if it were reversed, the earnings goals would be met. Then he introduced another variable – institutional ownership. He hypothesised that if institutional ownership is low, managers will be likely to cut R&D costs in order to meet earnings targets. The study was performed on a sample of US companies from the period 1983–1994 (13,944 firm-year observations). The empirical part of the study provided evidence that high institutional ownership can persuade managers to adopt more long-term policy with regard to R&D investment while having no regard for achieving earnings targets.

Another study on this issue was conducted by V. Mande, R. G. File and W. Kwak (2000), though in a unique Japanese environment that made the research setting quite different. It is widely accepted that the economic growth in Japan was based on new technologies. In the 1990s Japan's economy was second only to the US in terms of its commitment to R&D. However, it is also commonly believed that, unlike their American counterparts, Japanese managers adopt a long-term perspective with regard to financial results and accentuate research activity as one of the key components of corporate strategy. With the stereotypical image of a Japanese manager in mind, one might expect there to be no link between R&D spending and achieving earnings targets. However, Mande, File and Kwak 2000 (2000, pp. 288–89) found that Japanese firms, at least in several industries, do in fact adjust R&D spending according to current period earnings performance.

A further paper on this topic was published by R. Guidara and Y. Boujelbene (2015), who on the basis of 800 firm-year observations (80 French companies qualified as R&D intensive in the reports within 2005–2014) showed that firms manage R&D expenditures to avoid earnings losses and decreases. The empirical part of the study provides evidence that decisions concerning R&D budgets are used to help achieve earnings targets. The dependant variable in the study was defined as "R&D cut", which was assigned a value of one if R&D spending was lower than it had been in the previous period, and a zero otherwise. This and other papers on the subject suggest that it is earning targets that determine the level of R&D investment. Overall the results of these studies provide evidence that R&D spending is subject to real earnings management.

The strand of research related to accrual earnings management is less robust, consisting of only a few papers. R. Guidara and Y. Boujelbene (2014) investigated the link between R&D and earnings management. Their sample of 302 French listed companies is divided into a test sample including R&D intensive companies (107 companies), and a control sample of non-R&D intensive companies (195 companies). The former sub-sample encompasses companies listed in the scientific project "The Economics of Industrial Research & Innovation", conducted by the European Commission. As a measure of EM, Guidara and Boujelbede used discretionary accruals estimated on the basis of Jones' model. Empirical analysis provides evidence that discretionary accruals (DA) in the sample of R&D intensive companies are, at a 5% significance level, statistically different from zero, while in the sample of non-R&D intensive companies DAs are statistically equal to zero. In their conclusion, the authors state that R&D increases informational asymmetry and provides an incentive for EM.

A study done by G. Markarian, L. Pozza and A. Prencipe (2008) was empirically tested on a sample of companies listed on the Milan Stock Exchange (43 firms, 86 firm-year observations). The Italian context is interesting from the regulatory point of view, because it allows for flexibility in how it accounts for R&D costs. The focus of the study is on the accounting choice of whether to capitalise R&D costs or not from the perspective of achieving earnings targets and smoothing earnings. The main variable is total R&D capitalisation divided by total assets while the control variable is total R&D expenditures divided by total assets in the current year. The authors hypothesise that the decision to capitalise R&D costs is related to a firm's change in profitability. The results of the study suggest that companies with lower return on assets are more likely to capitalise R&D costs, and the more profitable firms are, the more likely they will also be to expense R&D costs.

Accounting regulations can affect real decisions about underinvestment or overinvestment in R&D projects. Several studies provide evidence that obligatory expensing of R&D costs causes underinvestment in research and development activities (Oswald & Zarowin 2007). Analogically, N. Seybert (2010, p. 672) posits that capitalising R&D costs leads to overinvestment in R&D projects, and when a manager decides to, or is obliged to, capitalise costs, he opens up the possibility of the research project being abandoned. From the point of view of accounting, this directly impairs intangibles. R&D asset write-down is relevant information for users and may have

a profound impact on a manager's reputation, thus strongly incentivising the continuation of research projects.

Seybert empirically tested this with an experiment. His analysis provides evidence that the participants in his experiment were more likely to continue the original project when R&D costs were capitalised. On the basis of this result, we are going one step further: we hypothesise that managers who decide to undertake a substantial R&D project are motivated not only to continue the project, but also to report favourable results and, if necessary, manage earnings upward. In other words, we assume that deciding to undertake a research project makes decision-makers not only responsible for the success, but motivates them to manage the results of the project to show them in as favourable a light as possible. Therefore, the decision to invest in an R&D project affects managerial behaviour. Managers become more engaged and less objective and can, to some extent, be considered hostages of a project's success. Specifically we formulate the following hypothesis: companies reporting intensive R&D expenditures after a two-year period are more likely to engage in earnings management practices.

We assume a time lag of two years between the year when substantial spending on R&D was reported and the year when the effect on revenues is expected. O. Lome, A. G. Haggeseth and Ø. Moen (2016), W. N. Leonard (1971), J. Rapoport (1971) and A. Pakes and M. Shankerman (1984) all provide evidence that on average this lag is around two years and we assume that the main stakeholders expected to see the effect of an R&D project occur two years after the launch of the project. Additionally, we assume that managers' success depends on the research project succeeding in the case of companies initiating costly research projects and this will be a strong incentive to engage in earnings management.

3. Research Design, Sample Description and Results of the Study

The main focus of the study is on the relationship between R&D intensity and the accrual of earnings management. We use two proxies for R&D intensity:

– *RD_INT1* – R&D expenditures divided by total assets,

– *RD_INT2* – R&D expenditures divided by sales.

The latter occur more frequently in the literature and accounting research.

R&D intensity is a proxy depicting a company's involvement in research and development activities. These two measures take into consideration

the size of the company and the volume of its activity. Therefore they are assumed to be a good measure of R&D intensity and are comparable between entities.

Total accruals are calculated using the statement-of-cash-flows approach (*CA*) according to the formula: the difference between income before extraordinary items and cash flows from operations:

$$TA_{i,t} = \frac{NI\_b\_Ext_{i,t} - CFO_{i,t}}{A_{i,t-1}},$$

where TA_{it} is total accruals, $NI\_b\_Ext_{i,t}$ is net income before extraordinary items, $CFO_{i,t}$ is cash flows from operations and $A_{i,t-1}$ is lagged total assets.

To measure discretionary accruals we plan to use the cross-sectional Jones model (1991):

$$TA_{i,t} = \beta_{1i}\left[\frac{1}{A_{i,t-1}}\right] + \beta_{2i}\left[\frac{\Delta REV_{i,t}}{A_{i,t-1}}\right] + \beta_{3i}\left[\frac{PPE_{i,t}}{A_{i,t-1}}\right] + \varepsilon_{i,t},$$

where $TA_{i,t}$ is total accruals (scaled by lagged total assets), A is total assets, ΔREV is the change in revenues, and PPE represents property, plant and equipment (Ronen & Yaari 2008, p. 404). The proxy for earnings management is the discretionary accruals, estimated as absolute residuals from the cross-sectional Jones model.

We use the main model in two variants, employing *RD_INT1* and *RD_INT2* interchangeably and, in result, end up with two models to test our hypotheses:

Model I:

$$EM_{i,t} = \beta_0 + \beta_1 RD\_INT1_{i,t-2} + \beta_2 SIZE_{i,t} + \beta_3 LEV_{i,t} + \beta_4 ROA_{i,t} + \beta_5 IND_{i,t}$$

and

Model II:

$$EM_{i,t} = \beta_0 + \beta_1 RD\_INT2_{i,t-2} + \beta_2 SIZE_{i,t} + \beta_3 LEV_{i,t} + \beta_4 ROA_{i,t} + \beta_5 IND_{i,t},$$

where *EM* is a proxy for earnings management (discretionary accruals from the Jones model), *RD_INT1* is R&D intensity measured by R&D expenditures divided by total assets for the period ($t - 2$), and *RD_INT2* is R&D expenditures divided by sales for the period ($t - 2$). The rest are control variables: *SIZE* – the company's size calculated as a natural logarithm of total assets, *LEV* – the financial leverage calculated as total liabilities divided

by total assets, *ROA* – the company's profitability represented by return on assets, *IND* – industry affiliation – 17 industries represented by 17 dummy variables (the financial sector was excluded).

In the above models, we use the most commonly applied determinants of earnings management as control variables. All of them are firm-level variables: size, leverage, profitability, and sector affiliation. Company size is an empirically tested variable and at least several studies provide evidence that larger firms are less likely to manage earnings (Albrecth & Richardson 1990, Scott 1991, Lee & Choi 2002). Financial leverage is often used as a control variable. Theoretically, it is rooted in the debt covenant hypothesis, which postulates that management tends to manipulate accounting figures in order to avoid negative consequences of violating credit agreements. Many empirical studies (Duke & Hunt 1990, Bartov 1993, Beatty & Webber 2003) provide evidence that in more leveraged companies there is more pressure to manage earnings upward. The institutional framework and quality of the legal system are important determinants of *EM*. A rich body of research on this issue provides convincing empirical evidence.

The initial sample consists of US companies listed on the stock exchange (7,034 companies and 77,374 observations). The data were downloaded from Orbis database and acquired from yearly financial statements published by publicly traded US companies in the period 2007–2016. Financial information derived from yearly financial statements is considered to be of higher quality, since it is reviewed by an independent financial auditor. Observations from the financial sector, with negative equity and insufficient data on total assets, were excluded from the sample.

Table 1. Descriptive Statistics

Variables	Total sample								
	No. of observations	Min.	Max.	Mean	Median	St. Dev.	Variance	Skewness	Kurtosis
EM	11,436	0.000	100.00	2.515	0.085	10.06	101.40	7.16	60.758
RD_INT1	6,772	–0.731	100.00	1.917	0.069	10.85	117.76	7.75	65.466
RD_INT2	8,219	–28.83	100.00	0.988	0.064	7.309	53.419	11.937	154.319
SIZE	18,043	–2.000	8.90	4.315	4.633	2.004	4.015	–0.519	2.590
LEV	18,043	0.000	100.00	5.860	0.572	19.245	370.375	4.209	19.849
ROA	18,041	–100.00	100.00	–5.080	–0.025	19.159	367.050	–3.689	20.568

Source: the authors' own calculations based on Orbis database.

We ran OLS regression as well as panel regression for both models using lagged *RD_INT1* and *RD_INT2* ($t - 1$ and $t - 2$). Since the panel regression is considered to be superior to simple OLS, we presented results only for panel regression analysis. For each panel regression we used Hausman test to determine if a fixed or random model is more appropriate. In all cases, the model with fixed effects proved superior (see Tables 2, 4, 6 and 8). The results of the regression analysis are presented in Tables 3, 5, 7, 9, 11 and 13.

Table 2. Hausman Test for Panel Regression for *RD_INT1* (Two-year Lag)

Variables	Coefficients		$(b - B)$ Difference	sqrt (diag($V\_b - V\_B$)) S.E.
	(b) fixed	(B) random		
SIZE	–2.2740	–1.2631	–1.0109	0.3995
LEV	0.0310	0.1220	–0.0910	0.0172
ROA	0.2176	0.1932	0.0244	0.0117
L2.RD_INT1	0.0144	0.0382	–0.0239	0.0082

b = consistent under H_0 and H_a; obtained from xtreg
B = inconsistent under H_a, efficient under H_0, obtained from xtreg
Test: H_0: difference in coefficients not systematic
$chi^2(4) = (b - B)'[(V\_b - V\_B)^{\wedge}(-1)] (b - B) = 62.73$
Prob > $chi^2 = 0.0000$

Source: the authors' own calculations based on Orbis database.

Table 3. Results of Panel Regression with Fixed Effects for *RD_INT1* (Two-year Lag)

Independent variables	General sample			
	Coeff	Std. error	*t*-statistic	*p*-value
Constant	13.01417	2.17647	5.98	0.000
L2.RD_INT1	0.01436	0.01171	1.23	0.220
SIZE	–2.27396	0.40936	–5.55***	0.000
LEV	0.03100	0.02238	1.39**	–0.013
ROA	0.21761	0.02044	10.65***	0.000
IND	0.15206	0.02085	0.73	4.466
No. of observations	4 069			
Prob > F	0.0000			
R-squared	0.1316			
Ajusted R-squared	0.1305			
Root MSE	4.6646			

** 5% significance. *** 1% significance.

Source: the authors' own calculations based on Orbis database.

Table 4. Hausman Test for Panel Regression for *RD_INT2* (Two-year Lag)

Variables	Coefficients		(*b* – *B*) Difference	sqrt (diag(*V_b* – *V_B*)) S.E.
	(*b*) fixed	(*B*) random		
SIZE	–2.9932	–2.4319	–0.5614	0.4676
LEV	–0.0019	0.0145	–0.1641	0.0130
ROA	0.0991	0.0800	0.0191	0.0100
L2.RD_INT2	0.1389	0.1113	0.2761	0.0213

b = consistent under H_0 and H_a; obtained from xtreg
B = inconsistent under H_a, efficient under H_0, obtained from xtreg
Test: H_0: difference in coefficients not systematic
$chi^2(4) = (b - B)'[(V\_b - V\_B)^{\wedge}(-1)] (b - B) = 16.62$
Prob > $chi^2 = 0.0023$

Source: the authors' own calculations based on Orbis database.

Table 5. Results of Panel Regression with Fixed Effects for *RD_INT2* (Two-year Lag)

Independent variables	General sample			
	Coeff	Std. error	*t*-statistic	*p*-value
Constant	16.9453	2.49015	6.80	0.000
L2.RD_INT2	0.1389	0.03424	4.06***	0.000
SIZE	–2.9932	0.49624	–6.03***	0.000
LEV	–0.0019	0.02072	–0.09	0.928
ROA	0.0991	0.01847	5.37***	0.007
IND	0	(omitted)	×	×
No. of observations	4 651			
Prob > *F*	0.0000			
R-squared	0.4880			
Ajusted R-squared	0.3508			
Root MSE	7.0830			

*** 1% significance.

Source: the authors' own calculations based on Orbis database.

The results of panel regression for *RD_INT2* (see Table 5) suggest that R&D intensity is a significant positive determinant of earnings management. However, the results for *RD_INT1* are not statistically significant (see Table 3). We also want to test if this effect is true for R&D intensity with a one-year lag and without a lag. The results show that *RD_INT1* is, unexpectedly, a negative determinant of earnings management.

Table 6. Hausman Test for Panel Regression for *RD_INT1* (One-year Lag)

Variables	Coefficients		(*b* – *B*) Difference	sqrt (diag(*V_b* – *V_B*)) S.E.
	(*b*) fixed	(*B*) random		
SIZE	–2.2146	–2.0345	–0.1802	0.3428
LEV	–0.0399	–0.0025	–0.0374	0.0122
ROA	0.1190	0.1040	0.0151	0.0078
L1.RD_INT1	–0.0226	–0.0165	–0.0062	0.0057

b = consistent under H_0 and H_a; obtained from xtreg
B = inconsistent under H_a, efficient under H_0, obtained from xtreg
Test: H_0: difference in coefficients not systematic
$chi^2(4) = (b - B)'[(V\_b - V\_B)^{\wedge}(-1)] (b - B) = 18.80$
Prob > $chi^2 = 0.0009$

Source: the authors' own calculations based on Orbis database.

Table 7. Results for Panel Regression with Fixed Effects for *RD_INT1* (One-year Lag)

Independent variables	General sample			
	Coeff	Std. error	*t*-statistic	*p*-value
Constant	12.80752	1.97574	6.48	0.000
L1.RD_INT1	–0.02262	0.01130	–2.00**	0.045
SIZE	–2.21465	0.37463	–5.91***	0.000
LEV	–0.03991	0.02093	–1.91*	0.057
ROA	0.11904	0.01737	6.85***	0.000
IND	0	(omitted)	×	×
No. of observations	4 771			
Prob > F	0.0000			
R-squared	0.4993			
Ajusted R-squared	0.3828			
Root MSE	4.5413			

* 10% significance. ** 5% significance. *** 1% significance.

Source: the authors' own calculations based on Orbis database.

We repeated the regression analysis for *RD_INT1* and *RD_INT2* without a lag. The results show that *RD_INT1* and *RD_INT2* without a lag are not statistically significant (see Tables 6 and 7) as compared to the model with the two-year lag.

Table 8. Hausman Test for Panel Regression for *RD_INT2* (One-year Lag)

Variables	Coefficients		(*b* – *B*) Difference	sqrt (diag(*V_b* – *V_B*)) S.E.
	(*b*) fixed	(*B*) random		
SIZE	–2.1500	–2.5352	0.3853	0.4076
LEV	–0.6751	–0.0526	–0.0149	0.0115
ROA	0.0365	0.0281	0.0084	0.0088
L1.RD_INT2	0.0246	0.0269	–0.0023	0.0162

b = consistent under H_0 and H_a; obtained from xtreg
B = inconsistent under H_a, efficient under H_0, obtained from xtreg
Test: H_0: difference in coefficients not systematic
$chi^2(4) = (b - B)'[(V\_b - V\_B)^{\wedge}(-1)] (b - B) = 18.63$
Prob > $chi^2 = 0.0009$

Source: the authors' own calculations based on Orbis database.

Table 9. Results of Panel Regression with Fixed Effects for *RD_INT2* (One-year Lag)

Independent variables	General sample			
	Coeff	Std. error	*t*-statistic	*p*-value
Constant	12.92108	2.16733	5.96	0.000
L1.RD_INT2	0.02454	0.03173	0.77	0.439
SIZE	–2.14997	0.43720	–4.92***	0.000
LEV	–0.06751	0.01923	–3.51***	0.764
ROA	0.03648	0.01710	2.13**	0.033
IND	0	(omitted)	×	×
No. of observations	5 616			
Prob > *F*	0.0000			
R-squared	0.4521			
Ajusted R-squared	0.3194			
Root MSE	7.6834			

** 5% significance. *** 1% significance.

Source: the authors' own calculations based on Orbis database.

An additional OLS regression analysis for R&D intensity for a three--year time lag shows that these variables are still significant determinants of earnings management. Most of the models presented have a low determination coefficient (as measured by adjusted *R-squared*), whose values vary between 30% and 40%. However, the aim of these models is not

Table 10. Hausman Test for Panel Regression for *RD_INT1* (Without Time Lag)

Variables	Coefficients		(*b* – *B*) Difference	sqrt (diag(*V_b* – *V_B*)) S.E.
	(*b*) fixed	(*B*) random		
SIZE	–2.9595	–2.2309	–0.7286	0.3532
LEV	–0.0326	–0.0023	–0.0303	0.0139
ROA	0.1367	0.0835	0.0532	0.0092
RD_INT1	–0.0024	0.0010	–0.0034	0.0051

b = consistent under H_0 and H_a; obtained from xtreg
B = inconsistent under H_a, efficient under H_0, obtained from xtreg
Test: H_0: difference in coefficients not systematic
$chi^2(4) = (b - B)'[(V\_b - V\_B)^{\wedge}(-1)] (b - B) = 56.20$
Prob > $chi^2 = 0.0000$

Source: the authors' own calculations based on Orbis database.

Table 11. Results of Panel Regression with Fixed Effects for *RD_INT1* (Without Time Lag)

Independent variables	General sample			
	Coeff	Std. error	*t*-statistic	*p*-value
Constant	16.71889	2.05799	8.12	0.000
RD_INT1	–0.00239	0.01107	–0.22	0.829
SIZE	–2.95954	0.39068	–7.58***	0.000
LEV	0.03261	0.02342	–1.39	0.164
ROA	0.13672	0.01846	7.40***	0.000
IND	0	(omitted)	×	×
No. of observations	4 801			
Prob > F	0.0000			
R-squared	0.5310			
Ajusted R-squared	0.4203			
Root MSE	4.7446			

*** 1% significance.

Source: the authors' own calculations based on Orbis database.

to predict or forecast variability of the dependent variable, but to infer the causal relationship between independent and dependent variables, which in this case are R&D intensity and earnings management. Therefore the power of the model is of negligible importance in our case.

Table 12. Hausman Test for Panel Regression for *RD_INT2* (Without Time Lag)

Variables	Coefficients		(*b* – *B*) Difference	sqrt (diag(*V_b* – *V_B*)) S.E.
	(*b*) fixed	(*B*) random		
SIZE	–2.5672	–2.4115	–0.1557	0.3983
LEV	0.0010	0.0036	–0.0026	0.0127
ROA	0.0761	0.0491	0.0270	0.0095
RD_INT2	0.0747	0.0435	0.0313	0.0200

b = consistent under H_0 and H_a; obtained from xtreg
B = inconsistent under H_a, efficient under H_0, obtained from xtreg
Test: H_0: difference in coefficients not systematic
$chi^2(4) = (b - B)'[(V\_b - V\_B)^{\wedge}(-1)] (b - B) = 12.92$
Prob > $chi^2 = 0.0117$

Source: the authors' own calculations based on Orbis database.

Table 13. Results of Panel Regression with Fixed Effects for *RD_INT2* (Without Time Lag)

Independent variables	General sample			
	Coeff	Std. error	*t*-statistic	*p*-value
Constant	14.7963	2.09944	7.05	0.000
RD_INT2	0.07473	0.03564	2.10**	0.036
SIZE	–2.56719	0.42493	–6.04***	0.000
LEV	0.00101	0.01942	0.05	0.959
ROA	0.07610	0.01735	4.39***	0.000
IND	0	(omitted)	×	×
No. of observations	5 648			
Prob > F	0.0000			
R-squared	0.4454			
Ajusted R-squared	0.3099			
Root MSE	7.7992			

** 5% significance. *** 1% significance.

Source: the authors' own calculations based on Orbis database.

Table 14. Summary of Results

Time lag	Panel regression		Linear regression	
	*RD_INT*1	*RD_INT2*	*RD_INT1*	*RD_INT2*
0			(+)**	
1	(–)**		(+)*	
2		(+)***	(+)***	(+)***

* 10% significance. ** 5% significance. *** 1% significance.

Source: the authors' own calculations based on Orbis database.

The results of regression analysis in most cases (see Table 14) provide evidence that two and three years after undertaking intensive R&D investments (projects), company management is more willing to manage earnings. The output of the study also shows that the link between R&D intensity and earnings management is much less pronounced in the current period.

4. Conclusions

We want to contribute to accounting research by providing evidence that engaging in R&D investment impacts managerial behaviour. The nature of R&D investment is unique considering its indeterminacy and often finds expression in the realm of managerial ambitions, expectations and dreams. We argue that with the passage of time, managers lose objective distance with regard to an R&D project. They become emotionally tied to the research project, which alters their behaviour and in some cases motivates them to manage earnings.

Our findings provide evidence that the intensity of R&D influences managerial behaviour and is a significant determinant of the extent of earnings management. The more intensive investments on research projects become, the more prone managers are to manage earnings after a period of two or even three years. The results have much less or no significance for measures of R&D intensity with a one-year or no time lag.

Our study has at least two limitations. First, we use only four control variables, and do not take into account other factors influencing managerial behaviour. Second, we use the absolute value of discretionary accruals, as a proxy for earings management.

Bibliography

Albrecth, W. D. and Richardson, F. M. (1990) "Income Smoothing by Economic Sector". *Journal of Business, Finance and Accounting* 17 (5): 713–30, https://doi.org/10.1111/j.1468-5957.1990.tb00569.x.

Bartov, E. (1993) "The Timing of Asset Sales and Earnings Manipulation". *The Accounting Review* 68 (4): 840–55.

Beatty, A. and Weber, J. (2003) "The Effects of Debt Contracting on Voluntary Accounting Method Changes". *The Accounting Review* 78 (1): 119–42, https://doi.org/10.2308/accr.2003.78.1.119.

Bushee, J. (1998) "The Influence of Institutional Investors on Myopic R&D Investment Behavior". *The Accounting Review* 71 (3): 305–33.

Cooper, J. C. and Selto, F. H. (1991) "An Experimental Examination of the Effects of SFAS No. 2 on R&D Investment Decisions". *Accounting, Organizations and Society* 16 (3): 227–42, https://doi.org/10.1016/0361-3682(91)90002-v.

Davis, L. N. (2001) "R&D Investment, Information and Strategy". *Technology Analysis & Strategic Management* 13 (3): 325–42, https://doi.org/10.1080/09537320120088165.

Duke, J. C. and Hunt, H. G. (1990) "An Empirical Examination of Debt Covenant Restrictions and Accounting-related Debt Proxies". *Journal of Accounting and Economics* 12 (1–3): 45–63, https://doi.org/10.1016/0165-4101(90)90041-2.

Guidara, R. and Boujelbene, Y. (2014) "Earnings Management around Research and Development Manipulation". *International Journal of Academic Research in Accounting, Finance and Management Science* 4 (2): 26–37.

Guidara, R. and Boujelbene, Y. (2015) "R&D Expenditures and Earnings Targets: Evidence from France". *Journal of Economics, Finance and Accounting* 2 (2): 164–80.

Healy, P. M., Myers, S. C. and Howe, Ch. D. (2002) "R&D Accounting and the Tradeoff between Relevance and Objectivity". *Journal of Accounting Research* 40 (3): 677–710, https://doi.org/10.1111/1475-679x.00067.

Horowitz, B. N. and Kolodony, R. (1980) "The Economic Effects of Involuntary Uniformity in the Financial Reporting of Research and Development Expenditures". *Journal of Accounting Research* 18: 38–74, https://doi.org/10.2307/2490326.

Jones, J. J. (1991) "Earnings Management during Import Relief Investigations". *Journal of Accounting Research* 29 (2): 193–228, https://doi.org/10.2307/2491047.

Lee, B. and Choi, B. (2002) "Company Size, Auditor Type, and Earnings Management". *Journal of Forensic Accounting* 3: 27–50.

Leonard, W. N. (1971) "Research and Development in Industrial Growth". *Journal of Political Economy* 79 (2): 232–56, https://doi.org/10.1086/259741.

Lome, O., Haggeseth, A. G. and Moen, Ø. (2016) "The Effect of R&D Performance: Do R&D-intensive Firms Handle a Financial Crisis". *Journal of High Technology Management Research* 27 (1): 65–77, https://doi.org/10.1016/j.hitech.2016.04.006.

Mande, V., File, R. G. and Kwak, W. (2000) "Income Smoothing and Discretionary R&D Expenditures of Japanese Firms". *Contemporary Accounting Research* 17 (2): 263–302, https://doi.org/10.1506/qxbv-uy71-a6w1-fwt4.

Markarian, G., Pozza, L. and Prencipe, A. (2008) "Capitalization of R&D Costs and Earnings Management: Evidence from Italian Listed Companies". *The International Journal of Accounting* 43 (3): 246–67, https://doi.org/10.1016/j.intacc.2008.06.002.

Oswald, D. R. and Zarowin, P. (2007) "Capitalization vs. Expensing of R&D and Earnings Management". *European Accounting Review* 16 (4): 703–26.
Pakes, A. and Schankerman, M. (1984) "The Rate of Obsolescence of Patents, Research Gestation Lags, and the Private Rate of Return to Research Resources" in Z. Grillches (ed.) *R&D Patents, and Productivity.* Chicago: University of Chicago Press.
Perry, S. and Grinaker, R. (1994) "Earnings Expectations and Discretionary Research and Development Spending". *Accounting Horizons* 8 (4): 43–51.
Rapoport, J. (1971) *The Autonomy of the Product-innovation Process: Cost and Time* in E. Mansfield (ed.) *Research and Innovation in the Modern Corporation.* New York: Norton.
Ronen, J. and Yaari, V. (2008) *Earnings Management. Emerging Insights in Theory, Practice, and Research.* New York: Springer.
Roychowdhury, S. (2006) "Earnings Management through Real Activities Manipulation". *Journal of Accounting and Economics* 42 (3): 335–70, https://doi.org/10.1016/j.jacceco.2006.01.002.
Scott, T. W. (1991) "Pension Disclosures under SFAS No. 87: Theory and Evidence". *Contemporary Accounting Research* 8 (1): 62–81, https://doi.org/10.1111/j.1911-3846.1991.tb00834.x.
Seybert, N. (2010) "R&D Capitalization and Reputation-driven Real Earnings Management". *The Accounting Review* 85 (2): 671–93, https://doi.org/10.2308/accr.2010.85.2.671.

Abstract

Wpływ wydatków na badania i rozwój na zachowania menedżerów związane z kształtowaniem wyniku finansowego

Celem artykułu jest analiza wpływu wydatków na badania i rozwój na kształtowanie wyniku finansowego. Wydatki na badania i rozwój to najcenniejsze aktywa w gospodarce, a mimo to regulacje rachunkowości w wielu krajach nie dopuszczają możliwości ich kapitalizacji i ujęcia jako aktywów w bilansie lub też możliwości te są mocno ograniczone. Organy stanowiące regulacje rachunkowości (IASB i FASB) wskazują na brak możliwości wiarygodnej wyceny księgowej tego typu aktywów. Raportowanie wydatków wiąże się z licznymi problemami, do których można zaliczyć m.in. dużą asymetrię informacji pomiędzy jednostką sprawozdawczą a użytkownikami sprawozdania finansowego. Ponadto sukces projektu badawczego niekoniecznie przekłada się na sukces komercyjny.

Wyniki dotychczasowych badań wskazują, że menedżerowie podejmujący decyzję o rozpoczęciu projektu badawczego o znacznym budżecie wraz z upływem czasu coraz bardziej wiążą się z nim emocjonalnie. W artykule postawiono tezę, że zjawisko to ma również wpływ na kształtowanie wyniku finansowego. Przyjęto hipotezę badawczą, że wydatki na badania i rozwój są istotną determinantą kształtowania wyniku finansowego po okresie dwóch lat. Przyjęty okres opóźnienia wynika z faktu, że projekty badawczo-rozwojowe zazwyczaj trwają od półtora do dwóch i pół roku.

Badania zostały przeprowadzone na próbie amerykańskich spółek giełdowych (ponad 4500 obserwacji) ze względu na fakt, że US GAAP nie dopuszczają możliwości kapitalizacji wydatków na badania i rozwój (z małymi wyjątkami). W rezultacie na podstawie danych ze sprawozdania finansowego można łatwo ustalić całkowite wydatki na B+R. Analiza regresji wskazuje, że wydatki na badania i rozwój są istotną determinantą kształtowania wyniku finansowego po dwóch i trzech latach. Efekt ten nie jest widoczny w bieżącym okresie oraz po jednym roku. W rezultacie pozytywnie została zweryfikowana hipoteza badawcza, co dowodzi, że wydatki na badania i rozwój wpływają na zachowania menedżerów amerykańskich spółek giełdowych w zakresie kształtowania wyniku finansowego.

Słowa kluczowe: wydatki na badania i rozwój, kształtowanie wyniku finansowego, sprawozdawczość finansowa, teoria kosztów agencji.

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STATE AID FOR ENVIRONMENTAL PROTECTION IN EU MEMBER STATES – THE PERSPECTIVE OF THE ECONOMIC GROWTH AND THE STATE OF PUBLIC FINANCE

Abstract

The article presents the conditions of admissibility of State aid in the European Union, taking into account the rules governing horizontal State aid. It offers an analysis of State aid granted by EU Member States is carried out under the provisions of the Treaty and the rules of State aid admissibility on the basis of regulations adopted by the European Commission in 2008 and 2014 on State aid provided under the framework for State aid for environmental protection. The analysis made it possible to verify the influence of State aid on economic growth and public finance in EU Member States which provided State aid for environmental protection in the years 2000–2015. The analysis was based on a linear regression model. The response variable (dependent variable Y) is: 1) the size of the GDP and 2) the size of general government sector debt, while the explanatory variable (independent variable X) is the expenditure on environmental aid.

Keywords: State aid, the European Union, environmental protection, economic growth, general government sector debt.
JEL Classification: E62, K20, K33.

1. Introduction

Basic regulations of the competition law governing State aid in the European Union can be found in articles 107, 108 and 109 of the Treaty on

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the Functioning of the European Union – TFEU (Consolidated Versions of the Treaty… 2012). Article 107 establishes the EU regulations regarding State aid admissibility. The provisions of article 107 par. 1 TFEU establish the principle of general prohibition of granting State aid while the provisions of par. 2 and 3 allow for granting State aid by way of exemption from the general prohibition (Podsiadło 2016a, 2016b). These exceptions are respectively the categories of aid which are admissible as compatible with the internal market (art. 107, par. 2) and the categories of aid which may be permitted, or may be considered compatible with the principles of the internal market (art. 107, par. 3). Article 108 defines the powers of the Council and the European Commission with regard to the aid granted by Member States and compliance with the provisions of article 107. In turn, article 109 gives the Council the power to issue regulations establishing rules for the application of articles 107 and 108.

On the basis of article 107 par. 3 (c) of the TFEU, the European Commission may consider compatible with the internal market State aid designed to facilitate the development of certain economic activities, where such aid does not adversely affect trading conditions to an extent contrary to the common interest. The primary objective of State aid control in the field of environmental protection is to ensure that aid measures will increase environmental protection above levels that would prevail were the aid not given and to ensure that the positive effects of the aid outweigh its negative effects in terms of distortions to competition, while taking account of the polluter pays principle[1].

The purpose of this article is to analyse the State aid provided by EU Member States to finance environmental protection, specifically the aid's impact on economic growth and the general government sector debt of these

[1] Economic activities can harm the environment not least through pollution. In certain cases, in the absence of State intervention, enterprises can avoid bearing the full cost of the environmental harm arising from their activities. As a result, the market fails to allocate resources efficiently, since the negative external effects of production are not taken into account by the producer, but are borne by society as a whole. These negative externalities can be tackled by ensuring that the polluter pays for its pollution, which implies full internalisation of environmental costs by the polluter. In order to increase the level of environmental protection, Member States may want to use State aid to create incentives to achieve a higher level of environmental protection then required by the European Union standards or to increase the environmental protection in the absence of Union standards. They may also set national standards or environmental taxation at a higher level than required by Union legislation or they may use environmental taxation to implement the polluter pays principle unilaterally in the absence of Union legislation.

countries. Economic growth is measured by the size of gross domestic product in real terms (GDP), a synthetic measure of the state's economic well-being. Moreover, the level of public debt of the general government sector is useful information not only in studying how sustainable public finance given the weight of burdens with service costs in the short term. The amount of public debt also shows the implementation of the redistribution-intergenerational function. Growing public debt in the current period may destabilise public finance for future generations.

For this article, the years 2000–2015 were adopted as the test period, i.e. the period in which the two most important development strategies – the Lisbon Strategy and the Europe 2020 Strategy – of the European Union were implemented[2]. It was posited that the amount of State aid provided by the EU Member States should be positively correlated with the size of the economic growth of these countries, and negatively correlated with the size of their general government sector debt. If GDP is positively correlated with the size of State aid for environmental protection, then positive economic growth among Member States occurs as State aid is increased. When the size of the general government sector debt is negatively correlated with the amount of State aid for environmental protection, then increasing that aid should prompt a decrease in the debt of the general government sector of Member States providing such aid.

2. State Aid for Environmental Protection – Institutional and Legal Regulations

The most common market failure in environmental protection is related to negative externalities. Negative externalities cause overproduction of the good in a competitive market, while positive externalities cause underproduction of the good in a competitive market, in both cases leading to a deadweight loss. Enterprises acting in their own interest have no incentive to take into account the negative externalities arising from production, neither when they decide on a particular production technology nor when they decide on production levels. Confronted with this market failure, the State tends to use regulation in order to ensure that the negative externalities arising from production are accounted for (Quigley 2009). Through the introduction of standards, taxation, economic instruments and other regulation, polluters have to pay

[2] Taking the year 2015 as the closing period of observation was due to the available annual data on State aid, which is published by Eurostat.

society for the cost of polluting in accordance with the polluter pays principle. Internalising these negative externalities consequently raises the private costs borne by those enterprises, thereby negatively affecting their revenue[3].

In the absence of Union standards and market-based instruments fully reflecting the polluter pays principle, Member States may decide unilaterally to pursue a higher level of environmental protection. This may in turn create additional costs for the enterprises operating in their territory. For that reason, in addition to regulation, Member States may use State aid as a positive incentive to achieve higher levels of environmental protection. They can do this in two ways. First, Member States can create positive incentives for individual enterprises to go beyond Union standards. In this case, the beneficiaries of aid reduce pollution, because they receive aid to change their behaviour, and not because they have to pay for the costs of this pollution. The objective of State aid here is to address directly the market failure linked with the negative effects of pollution. Second, Member States can impose national regulation that goes beyond Union standards. However, this may strap certain enterprises with additional costs and thus affect their competitive conditions. In this case, State aid may be necessary to lessen the burden on the most affected enterprises and thereby enable Member States to adopt national environmental regulation that is stricter than Union standards.

The detailed criteria which the European Commission takes into account while evaluating the admissibility of aid have been defined in a number of normative acts and community soft law acts, which have no binding legal value on addressees (Chalmers et al. 2006). The Guidelines on State Aid for Environmental Protection and Energy 2014–2020 (2014) are based on the polluter pays principle, which article 191 par. 2 TFEU sets down as the foundation of the Union's environmental policy (*Energy Taxation*… 2016). A mere absence of internalised environmental costs should no longer be compensated. State aid should be approved if, on the one hand, it serves the objectives of environmental protection and follows the principles of environmental policy, such as the polluter pays principle; and on the other it does not unduly distort trade and competition among the Member States (Holmes 2004, 2006, Ezcurra 2014). The environmental aid guidelines trace

[3] Moreover, since the generation of pollution is unevenly spread among industries and enterprises, the cost of any environmentally friendly regulation tend to be differentiated, not only between enterprises, but also between Member States.

the development of environmental policy in recent years as it pertains to the regulation of State aid[4].

The environmental aid guidelines make clear how the Commission intends to exercise its discretion in the context of article 107 par. 3 (b) and (c) TFEU, and under what conditions it will deem aid for the benefit of environmental protection to be compatible with the internal market (Nicolaides & Kleis 2014). The transparency the guidelines thus achieve enables Member States and undertakings to see what criteria the Commission will apply in reviewing the compatibility of State aid, and to adapt their behavior accordingly (Sanden 2014). The guidelines are limited to determining the eligibility of State aid to approval (Scott 2011). They expressly assume the presence of State aid within the meaning laid down in article 107 par. 1 TFEU, and refrain from making any statement interpreting that term[5]. The guidelines apply to State aid granted for environmental protection or energy objectives in all sectors governed by the Treaty. They therefore also apply to those sectors that are subject to specific Union rules on State aid – i.e. transport, coal, agriculture, forestry, and fisheries and aquaculture – unless such specific rules provide otherwise (Szydło 2015). In the guidelines, the Commission has identified a number of environmental and energy measures for which State aid under

[4] While the environmental aid guidelines of 1994 (Community Guidelines… 1994) still permitted aid for adjustment to existing standards as a temporary alternative solution, failing the complete internalisation of environmental costs, the guidelines of 2001 (Community Guidelines… 2001) limited such aid to SMEs. In the guidelines of 2008 (Community Guidelines… 2008) the Commission took the position that Member States may no longer compensate for the insufficient internalisation of environmental costs with State aid. As a result, aid for adaptation to existing or new standards is in general no longer permissible. What remains permissible is aid intended to provide undertakings with an incentive to undertake voluntary measures for the protection of the environment or to meet the stricter requirements of future environmental legislation sooner than legally mandated.

[5] Of course, any statement made in a Union framework or Commission communication concerning interpretation of the concept of aid has a legal quality different from that of statements concerning an aid's eligibility for approval. The concept of state aid is determined by article 107 par. 1 TFEU in connection with the case law of the Union courts, while through publication of the conditions of eligibility for approval of aid, the Commission makes a commitment with respect to exercise of its broad discretion in reviewing the compatibility of certain aid with the internal market (Brown & Kühling 2008).

certain conditions may be compatible with the internal market under article 107 par. 3 (c) TFEU[6].

With its decision to issue the general block exemption regulation (GBER) (Commission Regulation (EC) No 800/2008…2008, Commission Regulation (EC) No 651/2014…2014), the Commission for the first time made use of the possibility of exempting certain categories of environmental aid (*European State Aid Law…* 2010). This normative act has become a special measure unifying and simplifying existing rules on block exemptions and applied by cross-section to all instruments and sectors (Nyssens 2008). The unquestionable advantage of GBER regulation is that there is no obligation to report a proposed aid measure to the European Commission and likewise no need for a Member State to obtain a positive decision from the Commission (an authorisation) before a Member State undertakes to grant the State aid. As a result, the environmental aid guidelines apply to aid subject to notification under the GBER, as well as to other aid notified by the Member States and all illegal aid (Maillo 2017).

3. Methodology of the Research

Statistical analysis will be carried out based on two source tables.

Table 1 shows the calculations for the linear regression model concerning the slope parameter (directional factor β)[7]. *t* Stat is a test of the occurrence of a linear relationship between expenditures on State aid for environmental protection and the size of the GDP/general government sector debt.

[6] These are: (1) aid for going beyond Union standards or increasing the level of environmental protection in the absence of Union standards (including aid for the acquisition of new transport vehicles), (2) aid for early adaptation to future Union standards, (3) aid for environmental studies, (4) aid for the remediation of contaminated sites, (5) aid for energy from renewable sources, (6) aid for energy efficiency measures, including cogeneration and district heating and district cooling, (7) aid for resource efficiency and, in particular, for waste management, (8) aid for CO_2 capture, transport and storage including individual elements of the Carbon Capture Storage (CCS) chain, (9) aid in the form of reductions in or exemptions from environmental taxes, (10) aid in the form of reductions in funding support for electricity from renewable sources, (11) aid for energy infrastructure, (12) aid for generation adequacy measures, (13) aid in the form of tradable permits, (14) aid for the relocation of undertakings.

[7] The factor *b* of the regression function II is the estimator of the parameter β of regression function I. The standard error *Sb* is the standard error of the estimator *b* of the parameter β. The designations "Lower 95%" and "Upper 95%" concern lower and upper limits of so-called confidence interval of numerical values for parameter β, where this parameter is with a probability of 95%.

This statistical test makes it possible to verify the authenticity of the null hypothesis that the parameter of regression function I type β is equal to zero, and the alternative hypothesis that it is not equal to zero (H_0: $\beta = 0$; H_A: $\beta \neq 0$) . The acceptance of the null hypothesis that parameter $\beta = 0$ would mean that the increase in the value of expenditure on State aid by €1 million does not cause any changes in the size of the GDP/general government sector debt. This in turn means the lack of a relationship between expenditure on State aid and the size of the GDP/general government sector debt[8]. Given the perspective taken in this paper, it will be essential to reject the null hypothesis in favor of the alternative – that is, there is a significant statistical relationship between expenditure on State aid and the size of the GDP/general government sector debt[9]. The *p*-value is the probability of making a type I error. This would involve, based on the results of the test, the rejection of the hypothesis that the value of parameter β is zero, when in fact it is zero in the entire population[10].

Table 2 contains regression statistics, including the correlation coefficient, determination coefficient, standard error and the parameters of the test *F* – that is, the value of test *F* and the probability of making a type I error, when it is verified that expenditure on State aid does not impact the size of the GDP/general government sector debt (the irrelevance of state aid expenditure in the regression model). Similar to the *t*-test described above, the test *F* is used to test the significance of linear regression coefficient β evaluation. Statistic *F* with *F*-Snedecor distribution of k_1 and k_2 degrees of freedom is used to check this test. When rejecting the null hypothesis, $F > F_\alpha$ of no relation between expenditure on State aid and the size of the GDP/general government sector

[8] In other words, the acceptance of the null hypothesis means the lack of the influence of environmental aid provided by the Member States of the European Union on the size of their GDP/general government sector debt.

[9] From the tables of critical values of *t*-Student it is seen that $\pm t_{\frac{\alpha}{2}} = \pm 2.1448$ for $\alpha = 0.05$ and $n - 2 = 14$ degrees of freedom. The null hypothesis can be rejected in favour of the alternative hypothesis only when: $t_b < t_{\frac{\alpha}{2}}$ or $t_b > t_{\frac{\alpha}{2}}$, that is when $-t_b < -2.1448$ or $+t_b > +2.1448$.

[10] In other words, a type I error is a rejection of a real null hypothesis. The higher the value of the *t*-test means, the lower the probability of a type I error occurring. In general, it is assumed that if the *p*-value is less than 0.05, the null hypothesis can be rejected in favour of the alternative hypothesis, and thus it can be claimed that there is a statistically significant relationship between the expenditure of EU Member States on state aid for environmental protection and the size of the GDP/general government sector debt of these countries.

debt and accepting the alternative hypothesis of the existence of a statistically significant relationship between the variables[11].

4. Results

The most important statistical test in the simple regression analysis is a test of whether the regression coefficient equals zero. If it can be concluded that the directional coefficient of the real regression line in the population equals zero, it will mean that there is no linear relation between expenditure on state aid and the size of GDP, or expenditure on State aid and the size of GDP are not linearly dependent. Therefore, there should be a test to determine the occurrence of the linear relation between expenditure on State aid for environmental protection in the Member States and the size of their GDP. Table 1 shows the statistics on this test.

Table 1. The Size of State Aid for Environmental Protection and the Size of GDP – Analysis of Variance: the Line "Variable *X*"

EU Member State	Regression coefficient *b*	Standard error *Sb*	*t* Stat *tb*	*p*-value	Lower 95%	Upper 95%
Austria	96.89	10.60	9.1443	2.8E–07	74.17	119.62
Belgium	212.04	66.38	3.1942	0.0065	69.66	354.41
Bulgaria	907.73	884.93	1.0258	0.3224	–990.26	2,805.72
Cyprus	38.55	36.30	1.0619	0.3062	–39.31	116.40
The Czech Republic	134.24	74.69	1.7973	0.0939	–25.95	294.44
Denmark	11.67	25.99	0.4489	0.6604	–44.08	67.42
Estonia	53.12	18.61	2.8540	0.0127	13.20	93.04
Finland	60.47	10.98	5.5080	7.7E–05	36.92	84.01
France	482.50	126.14	3.8251	0.0019	211.95	753.04
Germany	20.80	6.94	2.9985	0.0096	5.92	35.68
Greece	404.54	510.30	0.7927	0.4412	–689.95	1,499.04
Hungary	265.74	164.44	1.6160	0.1284	–86.96	618.44
Ireland	607.76	166.66	3.6466	0.0026	250.30	965.22
Italy	1,236.14	842.36	1.4675	0.1644	–570.54	3,042.81

[11] From the table of critical values of the *F*-Snedecor for $k_1 = 1$ (1 independent variable) and $k_2 = n - 2 = 14$ degrees of freedom and $\alpha = 0.05$ we read $F_{0.05} = 4.60$. Thus, the alternative hypothesis can be adopted only when: $F > 4.60$.

Table 1 cnt'd

EU Member State	Regression coefficient *b*	Standard error *Sb*	*t* Stat *tb*	*p*-value	Lower 95%	Upper 95%
Latvia	170.75	82.16	2.0783	0.0566	–5.46	346.97
Lithuania	192.95	82.98	2.3252	0.0356	14.97	370.92
Luxembourg	255.84	63.40	4.0353	0.0012	119.86	391.82
The Netherlands	232.29	19.37	11.9949	9.4E–09	190.75	273.83
Poland	163.43	59.02	2.7691	0.0151	36.85	290.02
Portugal	–293.09	1875.04	–0.1563	0.8780	–4314.65	3,728.47
Romania	105.29	31.71	3.3201	0.0051	37.27	173.31
Slovakia	486.53	161.54	3.0117	0.0093	140.06	833.00
Slovenia	60.73	23.74	2.5577	0.0228	9.80	111.65
Spain	262.80	100.50	2.6148	0.0204	47.24	478.35
Sweden	51.57	10.23	5.0419	0.0002	29.63	73.51
The United Kingdom	254.68	58.07	4.3860	0.0006	130.14	379.22
EU-28	97.39	24.66	3.9495	0.0015	44.50	150.28

Source: the author's own calculations.

Table 1 shows that for seventeen Member States – Austria, Belgium, Estonia, Finland, France, Germany, Ireland, Lithuania, Luxembourg, the Netherlands, Poland, Romania, Slovakia, Slovenia, Spain, Sweden and the United Kingdom – the regression coefficient takes a positive value, as it does at the level of the European Union (EU-28). Consequently, the increase in expenditure on State aid for environmental protection by €1 million is accompanied by an increase in GDP by an average of (by country): €96.89 million, €212.04 million, €53.12 million, €60.47 million, €482.50 million, €20.80 million, €607.76 million, €192.95 million, €255.84 million, €232.29 million, €163.43 million, €105.29 million, €486.53 million, €60.73 million, €262.80 million, €51.57 million and €254.68 million. At the level of the EU-28, the increase in the value of GDP is €97.39 million.

Bearing in mind, however, the confidence interval for the regression coefficient, it is nearly certain (95% probability) that an increase in state aid of €1 million will cause GDP to rise in the following countries: Austria from €74.18 million to €119.62 million, Belgium from €69.66 million to €354.41 million, Estonia from €13.20 million to €93.04 million, Finland from €36.92 million to €84.01 million, France from €211.95 million to €753.04 million, Germany from €5.92 million to €35.68 million, Ireland

from €250.31 million to €965.22 million, Lithuania from €14.97 million to €370.92 million, Luxembourg from €119.86 million to €391.82 million, the Netherlands from €190.75 million to €273.83 million, Poland from €36.85 million to €290.02 million, Romania from €37.27 million to €173.31 million, Slovakia from €140.06 million to €833.00 million, Slovenia from €9.80 million to €111.65 million, Spain from €47.24 million to €478.35 million, Sweden from €29.63 million to €73.51 million, the United Kingdom from €130.14 million to €379.22 million and at the overall EU-28 level from €44.50 million to €150.28 million.

It should also be noted that the probability of a type I error (p-value), involving the rejection of a true null hypothesis that, in the case of these seven countries providing State aid for environmental protection does not significantly affect the size of the GDP of the countries, is below the accepted level of significance – that is, 0.05. The consequence is that the result of the study in relation to these countries, may be considered important, and thus the null hypothesis can be rejected in favour of the alternative hypothesis.

The regression coefficient does not take negative values for any of the Member States, which means that the expenditure on State aid for environmental protection does not have a negative impact on these countries' GDP. Identical request as to the proposed hypothesis can be obtained by analysing the value of test F (83.62, 10.20, 8.15, 30.34, 14.63, 8.99, 13.30, 5.41, 16.28, 143.88, 7.67, 11.02, 9.08, 6.54, 6.84, 25.42, 19.24 and for EU-28: 15.60), and F significance (the probability of type I error is less than 0.05). Table 2 shows the test F parameters and regression statistics for the relationship between the amount of state aid for environmental protection and the value of GDP in the EU countries.

For both Austria and the Netherlands, there is a very strong and positive correlation between State aid for environmental protection granted to companies and the amount of the countries' GDP: 0.93 and 0.95, respectively. These models have a very good fit to the empirical data, as their coefficient of determination comes out to 0.856584 and 0.911323, also respectively. 85.66% and 91.13% of the variations in GDP in these countries were attributed to variations in expenditures on State aid for environmental protection, while the remaining 14.34% and 8.87% resulted from the impact of other factors. If the coefficient of determination takes values of less than 0.5, the regression explains only less than 50% of the variation in GDP and predictions based on such a regression model may be unsuccessful because the model then explains very little. This means that predictions can be created based on the Austrian and Dutch models, because the regression model is characterised

Table 2. State Aid for Environmental Protection and GDP – Regression Statistics and Test *F*

EU Member State	Regression statistics			Test *F*	
	Correlation indicator	Determination coefficient	Standard error	*F*	Significance *F*
Austria	0.9255	0.8566	16,344.61	83.62	2.8E–07
Belgium	0.6493	0.4216	39,798.16	10.20	0.0065
Bulgaria	0.2644	0.0699	11,050.65	1.05	0.3224
Cyprus	0.2730	0.0745	3,053.17	1.13	0.3062
The Czech Republic	0.4330	0.1875	33,456.42	3.23	0.0939
Denmark	0.1191	0.0142	31,141.97	0.20	0.6604
Estonia	0.6065	0.3678	3,876.57	8.15	0.0127
Finland	0.8272	0.6842	13,986.96	30.34	7.7E–05
France	0.7149	0.5110	164,368.30	14.63	0.0019
Germany	0.6254	0.3911	229,024.70	8.99	0.0096
Greece	0.2073	0.0430	30,674.75	0.63	0.4412
Hungary	0.3965	0.1572	16,416.52	2.61	0.1284
Ireland	0.6980	0.4871	25,243.34	13.30	0.0026
Italy	0.3651	0.1333	128,781.00	2.15	0.1644
Latvia	0.4856	0.2358	5,292.74	4.32	0.0566
Lithuania	0.5278	0.2786	7,489.98	5.41	0.0356
Luxembourg	0.7333	0.5377	6,680.93	16.28	0.0012
The Netherlands	0.9546	0.9113	22,943.17	143.88	9.4E–09
Poland	0.5949	0.3539	72,320.74	7.67	0.0151
Portugal	0.0417	0.0017	17,408.37	0.02	0.8780
Romania	0.6637	0.4405	32,745.36	11.02	0.0051
Slovakia	0.6270	0.3932	16,721.29	9.07	0.0093
Slovenia	0.5643	0.3185	4,893.70	6.54	0.0228
Spain	0.5728	0.3281	131,043.20	6.84	0.0204
Sweden	0.8030	0.6449	37,977.47	25.42	0.0002
The United Kingdom	0.7608	0.5788	152,496.00	19.24	0.0006
EU-28	0.7259	0.5270	1,076,201.00	15.60	0.0015

Source: the author's own calculations.

by a very good fit and is not burdened much by the estimation error, which provides grounds for precise forecasting.

At 0.83, 0.71, 0.73, 0.80 and 0.76, respectively, Finland, France, Luxembourg, Sweden and the United Kingdom all show a strong positive correlation between the amount of State aid provided and the level of GDP. However, the determination coefficients have a very low value – 0.684245, 0.511021, 0.537709, 0.644857 and 0.578786. For all of the countries of the European Union (EU-28) there is a strong positive correlation ($r = 0.73$) between the amount of State aid for environmental protection and GDP in real terms. The determination coefficient is 0.526999.

In the case of Belgium, Estonia, Germany, Ireland, Lithuania, Poland, Romania, Slovakia, Slovenia and Spain, the values of the correlation coefficient are included in the interval (0.53; 0.69). These countries demonstrated a weak and medium positive relationship between the amount of State aid they provided and GDP. Moreover, the regression line cannot be adjusted to the empirical data to a satisfactory degree. The determination coefficients for these countries are: 0.42, 0.37, 0.39, 0.49, 0.28, 0.35, 0.44, 0.39, 0.32 and 0.33.

Table 3: State Aid for Environmental Protection and General Government Sector Debt – Analysis of Variance: the Line "Variable *X*"

EU Member State	Regression coefficient *b*	Standard error *Sb*	*t* Stat *tb*	*p*-value	Lower 95%	Upper 95%
Austria	123.42	12.55	9.8354	1.15E–07	96.50	150.33
Belgium	205.42	81.92	2.5076	0.0251	29.72	381.12
Bulgaria	343.24	165.34	2.0759	0.0568	–11.39	697.87
Cyprus	172.77	28.25	6.1151	2.67E–05	112.17	233.37
The Czech Republic	103.62	37.27	2.7804	0.0147	23.69	183.55
Denmark	16.80	13.18	1.2742	0.2233	–11.48	45.07
Estonia	9.38	1.92	4.8852	0.0002	5.26	13.50
Finland	70.39	8.45	8.3326	8.5E–07	52.27	88.50
France	1,099.29	158.07	6.9545	6.71E–06	760.27	1,438.31
Germany	18.33	10.35	1.7705	0.0984	–3.87	40.53
Greece	1,549.54	1,105.35	1.4019	0.1827	–821.20	3,920.27
Hungary	282.66	170.79	1.6550	0.1202	–83.65	648.98
Ireland	1,710.73	216.84	7.8894	1.61E–06	1,245.65	2,175.80
Italy	1,644.64	1,941.65	0.8470	0.4112	–2,519.78	5,809.07

Table 3 cnt'd

EU Member State	Regression coefficient *b*	Standard error *Sb*	*t* Stat *tb*	*p*-value	Lower 95%	Upper 95%
Latvia	158.94	39.67	4.0067	0.0013	73.86	244.02
Lithuania	100.63	48.49	2.0755	0.0569	–3.36	204.62
Luxembourg	99.79	26.75	3.7304	0.0022	42.42	157.17
The Netherlands	226.38	42.30	5.3513	0.0001	135.65	317.11
Poland	85.67	39.06	2.1933	0.0457	1.90	169.45
Portugal	3,682.55	6,536.37	0.5634	0.5820	–10,336.60	17,701.66
Romania	66.88	8.39	7.9709	1.43E–06	48.88	84.87
Slovakia	176.69	106.90	1.6528	0.1206	–52.60	405.98
Slovenia	161.56	11.14	14.5019	7.95E–10	137.67	185.45
Spain	171.23	206.49	0.8293	0.4209	–271.64	614.10
Sweden	9.62	5.29	1.8164	0.0908	–1.74	20.97
The United Kingdom	688.52	122.67	5.6129	6.4E–05	425.42	951.61
EU-28	155.86	37.82	4.1209	0.001039	74.74	236.98

Source: the author's own calculations.

The calculations in Table 3 indicate that 15 Member States have a linear relationship between expenditure on state aid for environmental protection and the size of general government sector debt.

For Austria, Belgium, Cyprus, the Czech Republic, Estonia, Finland, France, Ireland, Latvia, Luxembourg, the Netherlands, Poland, Romania, Slovakia and the United Kingdom the regression coefficients take positive values. This means that expenditure on State aid for environmental protection has a positive impact on the state of public finance for these countries. This is true also at the level of the European Union (EU-28). An increase in expenditure on State aid by €1 million is accompanied by an increase in the size of general government sector debt, by an average of, respectively, €123.42 million, €205.42 million, €172.77 million, €103.62 million, €9.38 million, €70.39 million, €1,099.29 million, €1,710.73 million, €158.94 million, €99.79 million, €226.38 million, €85.67 million, €66.88 million, €161.56 million and €688.52 million. At the level of the EU-28, the value of general government sector debt increases by €155.86 million.

Taking into account the confidence interval for the regression coefficient, it is a near certainty (95% probability) that an increase in expenditure for State aid of €1 million will raise general government sector debt by the value

of the interval (€96.50 million; €150.33 million) for Austria, (€29.72 million; €381.12 million) for Belgium, (€112.17 million; €233.37 million) for Cyprus, (€23.69 million; €183.55 million) for the Czech Republic, (€5.26 million; €13.50 million) for Estonia, (€52.27 million; €88.50 million) for Finland, (€760.27 million; €1438.31 million) for France, (€1245.65 million; €2175.80 million) for Ireland, (€73.86 million; €244.02 million) for Latvia, (€42.42 million; €157.17 million) for Luxembourg, (€135.65 million; €317.11 million) for the Netherlands, (€1.90 million; €169.45 million) for Poland, (€48.88 million; €84.87 million) for Romania, (€137.67 million; €185.45 million) for Slovenia, (€425.42 million; €951.61 million) for the United Kingdom and (€74.74 million; €236.98 million) for the EU-28 overall. For these countries, the probability of making a type I error is very small, and does not exceed the accepted level of significance of 0.05. Such an error would be connected with the rejection of a real null hypothesis concerning the lack of a correlation between the size of the State aid for environmental protection and the size of general government sector debt. Such a conclusion also applies to the EU-28 level.

Analysis of the value of the test *F* (greater that 4.60) and *F* significance (lower than 0.05) bears out the hypothesis. Table 4 lists the test *F* parameters and regression statistics for the relationship between the size of State aid and the size of general government sector debt in EU countries.

Slovenia shows a very strong and positive correlation between State aid for environmental protection and the size of general government sector debt. The correlation indicator is 0.97. With Slovenia's determination coefficient at 0.937585, this model has a very good fit to the empirical data. 93.76% of the variations in the size of the government's general government sector debt were attributed to variations in expenditure on State aid, while the remaining 6.24% were the result of other factors (other non-aid variables, imprecise fit of a straight line to the empirical data).

Austria, Finland, Ireland and Romania also exhibit a very strong positive correlation between the amount of environmental aid they provide to undertakings and the size of general government sector debt (respectively, 0.93, 0.84, 0.92 and 0.89). However, the determination coefficient assumes lower values: 0.873571, 0.832199, 0.816374 and 0.819437.

Cyprus, Estonia, France, Latvia, the Netherlands and the United Kingdom likewise show a strong positive correlation (respectively 0.85, 0.79, 0.88, 0.73, 0.82 and 0.83). For all six countries, there is a satisfactory adjustment of the regression line to the empirical data. For example, in the case of France, the coefficient of determination is 0.775518. This means

Table 4. State Aid for Environmental Protection and General Government Sector Debt – Regression Statistics and Test *F*

EU Member State	Regression statistics			Test *F*	
	Correlation indicator	Determination coefficient	Standard error	*F*	Significance *F*
Austria	0.9347	0.8736	19,356.04	96.73	1.15E–07
Belgium	0.5567	0.3099	49,113.90	6.29	0.0251
Bulgaria	0.4851	0.2354	2,064.75	4.31	0.0568
Cyprus	0.8530	0.7276	2,376.37	37.39	2.67E–05
The Czech Republic	0.5964	0.3557	16,693.41	7.73	0.0147
Denmark	0.3224	0.1039	15,794.24	1.62	0.2233
Estonia	0.7939	0.6303	399.92	23.86	0.0002
Finland	0.9122	0.8322	10,762.81	69.43	8.5E–07
France	0.8806	0.7755	205,971.50	48.37	6.71E–06
Germany	0.4277	0.1829	341,708.80	3.13	0.0984
Greece	0.3508	0.1231	66,443.14	1.97	0.1827
Hungary	0.4045	0.1636	17,050.46	2.74	0.1202
Ireland	0.9035	0.8164	32,843.20	62.24	1.61E–06
Italy	0.2208	0.0487	296,843.20	0.72	0.4112
Latvia	0.7309	0.5342	2,555.47	16.05	0.0013
Lithuania	0.4851	0.2353	4,376.40	4.31	0.0569
Luxembourg	0.7060	0.4985	2,818.90	13.92	0.0022
The Netherlands	0.8195	0.6716	50,118.37	28.64	0.0001
Poland	0.5057	0.2557	47,864.78	4.81	0.0457
Portugal	0.1489	0.0222	60,685.35	0.32	0.5820
Romania	0.9052	0.8194	8,663.40	63.54	1.43E–06
Slovakia	0.4041	0.1633	11,065.83	2.73	0.1206
Slovenia	0.9683	0.9376	2,296.20	210.31	7.95E–10
Spain	0.2164	0.0468	269,232.80	0.69	0.4209
Sweden	0.4367	0.1907	19,657.45	3.30	0.0908
The United Kingdom	0.8321	0.6923	322,150.30	31.50	6.4E–05
EU 28	0.7404	0.5481	1,650,645.00	16.98	0.001039

Source: the author's own calculations.

that 77.55% of the variation in France's general government sector debt is attributed to the volatility of expenditure on State aid for environmental protection. The remaining 22.45% is the effect of random and non-random factors.

For Belgium, the Czech Republic, Luxembourg and Poland, the values of the correlation coefficient are included in the interval (0.51; 0.71). These countries exhibit a weak and medium positive relationship occurring between the amount of State aid and the level of their general government sector debt. Moreover, the regression line cannot be satisfactorily adjusted to the empirical data. The determination coefficients for these countries are lower than 0.50.

All EU countries (EU-28) exhibit a medium positive correlation (0.74) between the amount of State aid spent on the environment and the size of general government sector debt. This model has only a satisfactory fit to the empirical data, as its coefficient of determination is 0.548123.

Given all of the above results, predictions can be created based on the Slovenian, Austrian, Finnish, Irish and Romanian models, because the regression model is characterised by a very good fit and is burdened by the estimation error to only a small extent. The grounds are therefore there for precise forecasting.

The regression coefficient did not take negative values for any of the Member States, which means that the expenditure on State aid for environmental protection does not have a negative impact on the size of general government sector debt in any of the EU Member States.

5. Conclusions

Regulation and market-based instruments are the most important tools to achieve environmental objectives. Soft instruments, such as voluntary eco-labels, and the diffusion of environmentally friendly technologies may also play an important role. However, even if finding the optimal mix of policy instruments can be complicated, the existence of market failures or political objectives does not automatically justify the use of State aid. According to the polluter pays principle, the polluter should pay all the costs of its pollution, including the indirect costs borne by society. Using State aid in this context would relieve the polluter of the burden of paying the cost of its pollution. State aid may therefore not be an appropriate instrument in such cases. However, the European Commission accepts that, in the context of an unsatisfactory level of environmental protection, State aid may provide

positive incentives for enterprises to carry out activities or make investments which are not mandatory and would otherwise not be undertaken by profit-seeking companies.

The analysis of regression presented in this article indicates that expenditure on State aid for environmental protection and the size of the economic growth measured by GDP and the size of the general government sector debt are linearly dependent, respectively, regarding 17 and 15 Member States, which in the years 2000–2015 provided State aid for this purpose. The following regularities should also be noted:

1. For Austria, Belgium, the Czech Republic, Estonia, Finland, France, Ireland, Luxembourg, the Netherlands, Poland, Romania, Slovenia, the United Kingdom and the EU-28 level – there is a statistical basis for recognising the occurrence of a positive stochastic relation between both the size of economic growth (GDP) and the State aid for environmental protection and the size of the general government sector debt and State aid for environmental protection. This means that the increase in State aid leads to an increase in both GDP and national debt.

2. Germany, Lithuania, Slovakia, Spain and Sweden exhibit a stochastic relation between the size of GDP and State aid for environmental protection – a positive relation between the analysed variables. This means that the increase in environmental State aid to undertakings provided by these countries leads their economies to grow, while leaving their general government sector debt unaffected.

3. For Cyprus and Latvia there is a statistical basis for recognising the occurrence of positive stochastic relation between the size of the general government debt and State aid for environmental protection. This means that the increase in State aid leads to an increase in the size of the public debt, but does not affect the growth of their GDP.

6. Discussion

State fiscal policy and its consequences, particularly tax policy implemented within its frames (specifying the implementation of public revenue) and State aid policy (depending on the instruments of implementation – affecting both the expenditure and the revenue side of public finance sector), are closely linked with the real economy. The issue here is primarily about the relationship between the size of and changes in GDP, and changes in public funds. Changes in GDP affect changes in the revenue of the State budget and of other public funds – that is, the revenue of the entire general government

sector. These correlations result from the fact that taxes and other public levies are part of GDP in revenue terms. Revenue generated in the process of creating GDP thus affect its consumption, but this correlation is non-linear, because part of the revenue is spent on monetary savings of individuals and entities operating in the economic system, mainly household savings. If these savings are to be transformed into demand for goods, especially goods for investment purpose, many factors will come into play, particularly the credit policy of banks or other financial system players whose function is to transform savings into capital provided to enterprises.

In the process of creating and distributing GDP, the State plays a crucial role: by taking, in the form of taxes and other public levies, some part of the revenue generated by households and enterprises, it changes the structure of aggregate demand in the economy. The taxes imposed on enterprises limit their investment opportunities, but revenues from taxes and other levies are directed by the State to both households (social assistance, unemployment benefits, scholarships etc.) and to enterprises (State aid in the form of grants), forming the basis of demand for consumer goods and investment goods.

State expenditure policy, which includes the policy of State aid to enterprises, can thus boost GDP growth and increase GDP *per capita* (which means the national economy is becoming more competitive) even if the State spends more money than it has accumulated in the budget. This portends the appearance of budget deficits, the accumulation of which in the coming years leads to the formation of general government sector debt. Deficits and the public debt that attends them are financed through domestic monetary savings or foreign ones. The State accomplishes this process by taking a loan in the form of debt securities, which are bought by banks, investment funds, insurance companies and the like – that is, institutions that accumulate the monetary savings of entities participating in the economy, mainly households. Fiscal policy therefore plays an important role in economic growth, especially when enterprises and commercial banks will not support real economic processes (investment processes) and economic growth (the refusal happens for various reasons, including an increased risk of capital loss is among them). The savings accumulated in commercial banks and other financial institutions are thus borrowed by the State, which creates the demand for consumer goods and investment goods, consequently stimulating the processes of economic growth.

The above outlined description of the relation between the real sphere and the fiscal sphere is necessarily greatly simplified. It provides a subject for theoretical investigation and empirical analysis, while econometric models,

which aim to quantify these relations, combine them in a cause-and-effect structure. It is essential that these relations be ascertained with the analysis of such policy aid – concerning regional goals, sectoral and broadly understood horizontal goals – conducted within the framework of fiscal policy used by a given State or group of EU Member States. This analysis examines the relation between changes in fiscal policy (State aid policy) and changes in production and other real terms, and then in fiscal amounts (general government sector debt).

The regression analysis of State aid with horizontal objectives in environmental protection funding and the macroeconomic quantities indicated in the article contributes to comparative studies among countries conducting fiscal policy in the conditions of the single monetary policy and the countries outside of the euro area.

Bibliography

Brown, J. D. and Kühling, J. (2008) "Article 87 EC and the Community Courts: From Revolution to Evolution". *Common Market Law Review* 45 (2): 465–98.

Chalmers, D., Hadjiemmanuil, C., Monti, G. and Tomkins, A. (2006) *European Union Law: Text and Materials*. Cambridge–New York: Cambridge University Press.

Commission Regulation (EC) No 800/2008 of 6 August 2008 Declaring Certain Categories of Aid Compatible with the Common Market in Application of Articles 87 and 88 of the Treaty (General Block Exemption Regulation) (2008), OJ L 214/3, 9.08.2008.

Commission Regulation (EU) No 651/2014 of 17 June 2014 Declaring Certain Categories of Aid Compatible with the Internal Market in Application of Articles 107 and 108 of the Treaty (2014), OJ L 187/1, 26.06.2014.

Community Guidelines on State Aid for Environmental Protection (1994), OJ C 72/3, 10.03.1994.

Community Guidelines on State Aid for Environmental Protection (2001), OJ C 37/3, 3.02.2001.

Community Guidelines on State Aid for Environmental Protection (2008), OJ C 82/1, 1.04.2008.

Consolidated Versions of the Treaty on the European Union and the Treaty on the Functioning of the European Union, OJ C 326, 26.10.2012.

Energy Taxation, Environmental Protection and State Aid. Tracing the Path from Divergence to Convergence (2016) eds P. Pistone, M. Ezcurra. Amsterdam: International Bureau of Fiscal Documentation.

European State Aid Law. Handbook (2010) ed. M. Heidenhain. München–Oxford: Verlag C.H. Beck, Hart Publishing.

Evans, A. (1997) *European Community Law of State Aid*. Oxford European Community Law Series. Oxford–New York: Oxford University Press.

Ezcurra, M. V. (2014) "EU State Aid and Energy Policies as an Instrument of Environmental Protection: Current Stage and New Trends". *European State Aid Law Quarterly* 13 (4): 665–74.
Guidelines on State Aid for Environmental Protection and Energy 2014–2020 (2014) OJ C 200/1, 28.06.2014.
Holmes, S. (2004) "The Environmental Guidelines: Black Smoke or Sustainable Development? The Need for Reform". *European State Aid Law Quarterly* 3 (1): 17–26, https://doi.org/10.21552/ESTAL/2004/1/33.
Holmes, S. (2006) "Environmental Aid: A Case for Fundamental Reform (2)". *European State Aid Law Quarterly* 5 (4), https://doi.org/10.21552/ESTAL/2006/4/91.
Maillo, J. (2017) "Balancing Environmental Protection, Competitiveness and Competition: A Critical Assessment of the GBER and the EEAG". *European State Aid Law Quarterly* 16 (1): 4–10, https://doi.org/10.21552/estal/2017/1/4.
Nicolaides, P. and Kleis, M. (2014) "A Critical Analysis of Environmental Tax Reductions and Generation Adequacy Provisions in the EEAG 2014–2020". *European State Aid Law Quarterly* 13 (4): 636–49.
Nyssens, H. (2008) "The General Block Exemption Regulation (GBER): Bigger, Simpler and More Economic". *Competition Policy Newsletter* 3: 12–18.
Podsiadło, P. (2016a) "The Interference of Law and Economics: The Case of Guarantees for Bank Debt and Their Impact on the Competitiveness of the EU Member States". *European State Aid Law Quarterly* 15 (1): 72–90.
Podsiadło, P. (2016b) "State Aid and the Functioning of the Single European Market – The Crisis Perspective". *Ekonomia i Prawo. Economics and Law* 15 (3): 385–99, https://doi.org/10.12775/eip.2016.026.
Quigley, C. (2009) *European State Aid Law and Policy.* Oxford–Portland: Hart Publishing.
Sanden, J. (2014) "The EEAG 2014–2020 and the Remediation of Contaminated Sites". *European State Aid Law Quarterly* 13 (4): 650–64.
Scott, J. (2011) "In Legal Limbo: Post-legislative Guidance as a Challenge for European Administrative Law". *Common Market Law Review* 48 (2): 329–55.
Szydło, M. (2015) "How to Reconcile National Support for Renewable Energy with Internal Market Obligations? The Task for EU Legislation after Alands Vindkraft and Essent". *Common Market Law Review* 52 (2): 489–510.

Abstract

Pomoc publiczna na ochronę środowiska naturalnego w państwach członkowskich Unii Europejskiej w kontekście wzrostu gospodarczego i stanu finansów publicznych

W artykule przedstawiono warunki dopuszczalności pomocy publicznej w Unii Europejskiej z uwzględnieniem zasad regulujących horyzontalną pomoc państwa. Zaprezentowano analizę pomocy publicznej udzielonej przez państwa członkowskie UE na podstawie postanowień Traktatu o funkcjonowaniu Unii Europejskiej i zasad dopuszczalności pomocy publicznej uregulowanych przyjętymi przez Komisję Europejską w 2008 i 2014 r. rozporządzeniami w sprawie pomocy publicznej udzielanej zgodnie

z wytycznymi dotyczącymi pomocy państwa w zakresie ochrony środowiska. Analiza umożliwiła zweryfikowanie wpływu pomocy publicznej na wzrost gospodarczy i finanse publiczne w państwach członkowskich UE, które udzielały pomocy na ochronę środowiska w latach 2000–2015. Analiza została oparta na modelu regresji liniowej. Zmienna objaśniana (zmienna zależna *Y*) to: 1) wielkość PKB i 2) wielkość długu sektora instytucji rządowych i samorządowych, natomiast zmienną objaśniającą (zmienną niezależną *X*) są wydatki na pomoc w zakresie ochrony środowiska.

Słowa kluczowe: pomoc publiczna, Unia Europejska, ochrona środowiska naturalnego, wzrost gospodarczy, zadłużenie sektora *general government*.

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