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CONTENTS

DEACCESSIONING AND AGENCY COSTS OF FREE CASH FLOW IN MANAGER'S HANDS: A FORMAL MODEL[1]

ANDREJ SRAKAR[2]

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ABSTRACT: *The problem of agency costs of free cash flow in manager's hands has been firstly noted by Easterbrook and Jensen. We present one of the first attempts to formally model the problem in light of similar situation faced by managers of museums being allowed (or disallowed) to deaccession the artworks from their collections. We show that deaccessioning funds always lead to various forms of agency costs for the museum. This finding applies for any non-profit firm and its endowment. The task lying ahead is to formally prove the general conjecture also for the case of private for-profit firms.*

Keywords: *deaccessioning, agency costs, free cash flow, principal-agent problem, non-profit firms*
JEL Classification: G32, L14, Z11

1. INTRODUCTION

Deaccessioning is a problem which has been often discussed both in cultural economics as well as in the popular media and blogs, especially in recent years due to the rising economic crisis and attempts of deaccessioning the museum artworks by several American museums facing the crisis. Deaccessioning is sometimes proclaimed to be a possible panacea to financial problems of museums in economic crisis, as it still holds that museums have the larger part of their endowment in the form of artworks – highly valuable but also very often neglected and mostly unexhibited. So why shouldn't the museum's deaccession the redundant paintings, sculptures, photographs and other artworks in their collection if on the one hand they are left unused in the depos of the museums and on the other hand the museums are in dire need of additional financial resources? Some of the American museums (e.g. The Barnes Foundation, National Academy Museum, Brandeis University' Rose Art Museum) have tried to pursue the "deaccessioning path" yet have been mostly prevented by the rigorous action of the American Association of Museum Directors and American Association of Museums.

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The question obviously entails both strong legal and moral problems (summarized by e.g. Fincham (2011) and Rohner (2010)). In this article we will prove that there exists another pervasive and dire problem of deaccessioning practices: they lead to non-optimal museum management. We will prove that allowing deaccessioning leads to incentives for managers to excessively use the deaccessioning funds and that they are therefore demotivated to raise the revenues of the museum in the presence of deaccessioning possibilities.

Striking as this finding may appear, its message is simple and clear: allowing deaccessioning to substitute for museum revenues in times of economic crisis (or in any time) leads not only to legal and moral issues, but also entails excess economic, i.e. agency costs. The case for deaccessioning therefore appears to lose ground and one would question if there is any strong and sensible argument in favor of deaccessioning left over.

The article will be structured in the following way. The second section will provide a literature review and review of the most needed findings and concepts. In the third section we will present the model to be used for our purpose. In the fourth section we will present its solution and the main propositions for the case of risk-neutral principal. The proof of propositions for the risk-averse principal case will be presented in the fifth section. The final two sections will conclude with the discussion of the findings and their consequences.

2. LITERATURE REVIEW

Museums are a very special field of research in cultural economics, and they pose numerous microeconomic problems. These problems have been subject of research literature in past years. The research crystalized across several main topics: industrial organization of museums, superstar museums, charging for entrance to museums and deaccessioning practices.

One of the main facts from the literature in museum management and economics is that museums have been subject to change in their main characteristics and most of all in the mission they serve: they have come to be customer-oriented, and their main task has become education and not simply preserving the dedicated objects anymore (Whitting-Looze, 2010). This change is being reflected in theoretical considerations as well, and substantial literature has grown in the fields of museum management and marketing. The phenomenon of superstar museums has been researched a lot, following the rise of big museums and their franchises (e.g. Guggenheim, Tate). The topic of superstar museums is being explored in cultural economics as well (e.g. Frey & Pommerehne, 1989; Frey, 2003).

Charging for entrance to museums proved to be an extremely interesting topic for economists. According to welfare theoretical considerations, the appropriate charge for entrance should be zero, due to zero (or close to zero) marginal costs of every new entrant (Fernandez-Blanco & Prieto-Rodriguez, 2011). But the opinions vary because the fixed costs of museums should also be taken into consideration (as suggested by Frey & Meier, 2006) and most of all congestion costs should be accounted for, which accounts for marginal costs in the long run being possibly distinct from zero (Fernandez-Blanco & Prieto-

Rodriguez, 2011). A new proposal for museum pricing has been made by Bruno Frey and Lasse Steiner (Frey & Steiner, 2010) which proposes that the fee is charged when leaving the museum according to the time spent there (the so-called pay-as-you-go principle).
In the article we will explore another interesting and often quoted phenomena in the economics of museums, namely the deaccessioning practices, which denote "the permanent removal or disposal of an object from the collection of the museum by virtue of its sale, exchange, donation or transfer by any means to any person" (McKinney, in: Range, 2004). Deaccessioning has become a topic not only in US museums, but is also being considered in German, Dutch, French and UK museums and in other European states. Deaccessioning can of course be done in two most general ways: either the funds are spent to finance new collections which have been a common and mostly undisputed practice for decades, or the funds are spent to finance daily operation costs of a museum. It is the latter form that will be of interest in this article.

Deaccessioning as a practice brought to light many controversies. In one of the first cultural economics' articles on this topic, J. M. Montias (1973) advocates for its usage: "If the Metropolitan resources are as depleted as Mr. Hoving (the director) makes them out to be, and if the exhibition space is fixed to the present wall capacities for the foreseeable future, then his decision – to sell essentially duplicate items to make room for paintings and sculptures that will fill serious gaps in the museum's collection – appears largely justified" (Montias, 1973). Later works often advocated for its usage as well (e.g. Weil, 1990; Borg, 1991). There has been and is to this day also a considerable opposition to deaccessioning in the museum world (Besterman, 1991, Cannon-Brookes, 1991). It has to be noted, first, that the subject is not well researched, especially in light of economic modeling of actual situations and problems it brings for museum management, and second, that it indeed brings controversies, which can be seen in the fierce debates in contemporary American intellectual and art scene (Rohner, 2010; Whitting-Looze, 2010; Fincham, 2011; Rosenbaum, 2009-2012; Zaretsky, 2009-2012; Muñoz-Sarmiento, 2009-2012).

Some basic reasons for the debate on deaccessioning have been summarized by O'Hagan (O'Hagan, 1998):

1) Many art museums have trustee status, which protects art works given in trust from being sold to satisfy creditors; however, by blocking the most efficient use and allocation of its available resources, donor restrictions can seriously hinder the attempt of museum trustees to keep the museum solvent;
2) Because collections demand space, protection, and maintenance, it seems sensible for the museum with precarious finances to deaccession artworks that are unable to be exhibited and unwanted;
3) Once allowing deaccessioning the politicians might insist on the sale of further works of art as the quid-pro-quo of further subsidy (although the opposite is more likely to apply, namely a large public outcry against the use of the money from the sale for anything other than the purchase of more art);
4) The issues concerning the process of deaccessioning: what conditions apply, who decides how it is to be disposed of, and how the proceeds are to be allocated.

Finally, article by Di Gaetano and Mazza (2014) is one of the first to explore deaccessioning from a formal modelling viewpoint. It explores the situation of deaccessioning from the viewpoint of donations (and donors) and uses tools from game theory to explore the situation of uncertainty about the museum's choice of deaccessioning. The authors' main results are that when deaccessioning is allowed, this may reduce private donations also to those museums which do not sale portion of their collections; and that a reduction in public grants may benefit museums committed not to deaccess, which contrasts with the common wisdom that budget cuts hurt especially museums that choose to discard the option of selling their collections.

For our article, the key observation has been stated already by Montias: "The purpose of this discussion is to determine whether a rule barring the sale of major works would cause museum managers to accomplish their mission more efficaciously" (Montias, 1973). The problem of deaccessioning when considered in light of economics deals with questions of efficacy of museum management and with (appropriate) incentives posed to the managers. We will claim that when making decisions on deaccessioning, it is not only donors who are affected, but the managers of museums have strong incentives for non-optimal (from the principals and societal viewpoint) behavior and efficacy, as seen from either the level of effort or motivation to raise the revenues of the museum.

We will evaluate this hypothesis in light of microeconomic theoretical models, formed on the basis of contract theory and modeling of principal-agent problem. The debate of principal-agent modeling has been started in the 1960's and 1970's with articles by Arrow (1963), Ross (1973) and Shavell (1979a; 1979b). The theory has been developed in works by Mirrlees (1975); Grossman and Hart (1983; 1986) Holmström (1979), Holmström and Milgrom (1987), Laffont and Martimort (2002) and Bolton and Dewatripont (2006). Principal-agent problem in most general summarizes the situation between one principal (e.g. person offering a contract) and one agent (e.g. person being offered a contract). Principal and agent most commonly have conflicting objectives and decentralized information which stress the importance of incentives in the relationship. The essential paradigm for the analysis of such behavior by economists is one where economic agents pursue, at least to some extent, their private interests. What is proposed by incentive theory is that this major assumption be maintained in the analysis of organizations, small markets, and any other kind of collective decision-making. In the principal-agent relationship the principal is therefore interested in performance of the firm and the proper incentives given to the agent so that the latter can provide the utmost level of effort to his task, while the agent is motivated by his payment and to provide the minimal amount of effort required (it is usually supposed that the agent has disutility of provided effort – the more effort he provides, the less satisfied he is, ceteris paribus).

Certain main findings were provided already by the first researchers in the field. It has been often claimed that if one of the parties is risk-neutral (and the other risk-averse), this party should be "charged" with all the risk in the relationship meaning that the other (the risk-averse) party is being fully secured of its payment i.e. benefit. The latter is usually done by securing the risk-averse party a constant payoff with the risk-neutral party been given the residual rights of ownership (see: Grossman & Hart, 1986). In the economics

of principal-agent problem (and contract theory in general) one can have perfect and symmetrical information in which case usually the problem can be provided with an immediate, sometimes trivial solution. Most commonly though one encounters problems of asymmetrical information, either in the form of adverse selection, when the principal or the agent doesn't know the other party's type (this can lead to signaling models, where the informed and unobserved party is providing the signals of his type to the uninformed one, or to screening models where the uninformed party is providing the signals to the informed one) or in the form of moral hazard, when one of the party (most commonly the principal) cannot observe the actions of the other. It has been shown that both problems lead to inefficient equlibria and second-best or sometimes even worse solutions of the model (see: Laffont & Martimort, 2002; Bolton & Dewatripont, 2006).

A special subbranch of principal agent theory deals with agency costs of principal-agent relationship, most commonly related to financial theory. The main article is probably the contribution by Jensen & Meckling (1976) which started to talk about the concept of agency costs which could be attributed to monitoring expenditures by the principal, bonding costs of the agent and the residual loss (ibid.). Agency costs are therefore a special sort of transaction costs (being of course related to pioneering work of Coase and Williamson) which come out as a result of principal-agent relationship. A very special type of agency costs has been observed by Easterbrook (1984) and Jensen (1986): agency costs of free cash flow in hand of the managers of the firm. Jensen observes that free cash flow in the hands of the managers very often leads to poor management decisions either in the form of raising the perquisites of the managers beyond the optimal level or in the form of investing in project with negative net present value. Jensen sees debt as a device to discipline the managers in the presence of agency costs of this type (Jensen, 1986). Despite the thesis raising a lot of debate and econometric evidence (e.g. Crutchly & Hansen, 1989; Lang, Stulz & Walkling, 1991; Almeida, Campello & Weisbach, 2004; Fleming, Heaney & McCosker, 2005; Utami & Inanga, 2011) it has rarely been properly modeled and formally proved (for additional information see e.g. Tirole, 2006).

More or less the only attempt to model the problem of agency costs of free cash flow and its relationship to debt in firms is the article by Grossman and Hart (1982)[3]. In this article the authors observe and prove that debt can serve the role of bonding device in the relationship of principal and agent/manager in a firm and that including debt can be in the manager's interest as it can serve to increase the value of the firm, which is also in manager's interest (ibid.). Grossman and Hart prove that level of debt is beneficial to the level of investment and firm's profits and market value.

Several studies have explored the role of endowment and the economics and financing of non-profit firms in general. Papers by Hansmann (1980; 1990) and Fama and Jensen (1983a; 1983b) sketch some basic considerations regarding economics of non-profit organisations and role of non-profit endowments. First (lastingly more or less the only one so far) attempt on modeling the financial structure of non-profit organisations and their

3 The article was written before the Jensen's 1986 conjecture, therefore it does not address the Jensen's problem directly.

agency structure have been made by Wedig and colleagues (Wedig et al., 1988; Wedig et al., 1996) on the case of non-profit hospitals. In their 1996's paper their evaluate role of tax-exempt debt in non-profit hospitals and show some important results (e.g. that non-profit firms behave as if they were following a target ratio of tax-exempt debt). Capital structure of non-profit organisations has been also analysed by Bowman (2002), who tests whether capital structure of non-profit firms could be better analysed by refering to pecking-order theory (which states that different forms of capital always follow the same order of attractiveness and usage) or instead to a static trade-off theory which is more in accordance with mentioned Jensen's conjecture. Bowman (and several other authors, e.g. Fisman & Hubbard, 2003) finds evidence for the latter. Among the other contributions that would have to mentioned are studies on capital structure of non-profit hospitals by Calem and Rizzo (1995) and Brickley and van Horn (2002), econometric evaluation of agency costs of excess endowments by Core, Guay and Verdi (2006) and economic model of non-profit entrepreneur behavior by Glaeser and Shleifer (2001). Finally, in an influential article, Fisman and Hubbard (2003) observe the role of endowment and its similarity to debt in the contributions of Jensen (1986) and Grossman and Hart (1982). The general conclusion, confirmed by econometric evidence is that excess endowments lead to significant agency costs in the sense of Jensen and Easterbrook. Yet this conclusion has been so far supported only by econometric evidence and rarely by any formal modeling, similar to evaluation of Jensen's (and Easterbrook's) conjecture in general.

3. MODEL

In an important article in financial and principal-agent theory, Grossman and Hart (1982) show that debt can serve as a self-limitation device for a firm. Grossman and Hart analyze the model where there is no clearly defined principal and agent relationship - they are mainly interested in investment, its role in enhancing the market value of the firm and the impact on the expected utility function of the manager. On their account the manager optimizes the following function:

$$\max U(V-I)(1-F(D-g(I))) \qquad (1)$$

where U is the manager's utility function, V is the expected value of the firm, I is the investment itself, $g(I)$ is the expected profit from the investment, D are current debt obligations and F is the cumulative density function. This formula therefore describes the manager's expected utility in the presence of the danger of bankruptcy due to debt obligations of the firm – the manager's expected utility depends upon the utility from current consumption $V-I$, which depends on the market value of the firm less the investment needed for changing the value of the firm. The manager's utility also depends upon the probability of solvency $1-F(D-g(I))$ which is modeled as probability that the current debt obligations D don't surpass in value the revenues of the firm $g(I)$. The latter formula therefore measures the probability that the random variable s (which is defined as simply

a random variable with mean 0) is greater than $D - g(I)$ (total revenues are equal to $g(I)$ plus this random variable) which is equivalent to solvency condition of the firm.

We therefore propose to model the deaccessioning process in the following way. The budget function of the museum is:

$$Budg = R - w - FC = R_T - w \qquad (2)$$

where R are total revenues of the museum, consisting of fundraising (including donations), ticket sales and public grants, w is wage of the manager and FC are remaining costs of the museum (including both fixed costs as well as costs depending upon the level of service, e.g. cleaning costs, costs of collection maintenance). R_T denotes the difference between R and FC.

We model possible role of deaccessioning as having a preventing function over possible bankruptcy of the museum, following the model by Grossman and Hart. If the museum should remain solvent, the following inequality has to be satisfied:

$$dE \leq R_T - w + s \qquad (3)$$

where s is, again, a random variable with mean 0 and is simply denoting the random factors influencing the revenues of the museum and dE is the amount of endowment allowed for deaccessioning. Deaccessioning in this equation serves in the role of "reserve funds" available to prevent the possible bankruptcy of the museum (therefore if the budget is negative it has to be less in absolute value than the deaccessioning "reserve funds").

In our case, we use their model and extend it for a principal-agent situation. Our principal is the board of trustees of the museum, which hires the manager (the agent) to work for the benefit of the museum. Following Grossman and Hart, the following should be the specification of our principal-agent deaccessioning' problem in the risk-neutral principal case (if we assume that the main objective of the principal is the maximization of the expected budget in line with considerations of e.g. Niskanen, 1968; 1971):

$$\max \ (R_T - w)[1 - F(w - R_T - dE)] \qquad (4)$$

$$s.t. \qquad u(w)[1 - F(w - R_T - dE)] - \psi(e) \geq \underline{u} \qquad (5)$$

where $R_T - w$ is the net total budget, F is the cumulative distribution function, u is the manager's utility function, ψ is the manager's disutility from effort function and $\underline{u}$ is the minimal guaranteed level of manager's utility. The optimization problem is therefore to maximize the expected benefit of the principal (net revenues times the probability of no

bankruptcy) such that the agent's expected utility is bigger than some guaranteed value. This problem doesn't include deaccessioning funds among revenues of the museum yet takes them into account in their role as a »buffer« against insolvency of the museum, in accordance with findings by Fisman and Hubbard (2003).

The above discussion also shows two important considerations:

1) From the inequality (3) and from the model (4) & (5) we see that deaccessioning acts in exactly the opposite manner as debt in the model of Grossman and Hart. Is therefore serves as a sort of »negative debt«: as reserves that are a »buffer« against possible insolvency of the museum.

2) From the above it is also apparent that if we are able to prove that deaccessioning leads to non-optimal museum manager's/agent's decisions, this would be sufficient to show the Jensen's conjecture on agency costs of free cash flow in firms, if the free cash flow behaves in a similar manner as deaccessioning funds: it is not included in the budget function of the firm, yet can serve to cover the possible firm's insolvency.

In the following we also make the following assumptions on marginal effects:

$$\frac{\partial R_T}{\partial e} > 0, \frac{\partial^2 R_T}{\partial e^2} \leq 0, \frac{\partial w}{\partial e} > 0, \frac{\partial^2 w}{\partial e^2} \leq 0, \frac{\partial u}{\partial w} > 0, \frac{\partial^2 u}{\partial w^2} \leq 0, \frac{\partial \psi}{\partial e} > 0, \frac{\partial^2 \psi}{\partial e^2} \geq 0 \qquad (6)$$

We therefore assume that additional effort raises net non-labor revenues and that the net non-labor revenue function is concave in effort; that additional effort raises manager's wage and that the wage function is concave in effort; that the utility function of the manager is concave in wage; and that the manager's disutility function of effort is convex. All of the assumptions are common in principal-agent problems and will not be discussed here.

In our propositions, we will explore two possible relationships between deaccessioning and effort. Firstly, deaccessioning will be assumed as fixed and independent of the level of provided effort. In this case, museum manager takes the level of deaccessioning as predetermined by rules of the museum. Second case if when deaccessioning can be left to vary and is dependent on the invested effort from the manager. It is logical to assume that the higher the provided effort, the lower will be the need for deaccessioning to act as a buffer to remedy for financial problems of the museum.

4. THE RISK-NEUTRAL PRINCIPAL CASE

Solving the model leads to the following first order conditions and Lagrangian function:

$$\mathcal{L} = (R_T - w)(1 - F) + \lambda u(1 - F) - \lambda \psi(e) - \lambda \underline{u} \qquad (7)$$

where we write F and u as short terms for $F(w - R_T - dE)$ and $u(w)$.

F.O.C.:

$$\frac{\partial \mathcal{L}}{\partial w} = -(1-F) - (R_T - w)f + \lambda u'(1-F) - \lambda u f = 0 \qquad (8)$$

where f is the probability density function of the distribution with cumulative distribution function $F(w - R_T - dE)$.

Proposition 1: The constraint in (5) is binding or relying on funds from deaccessioning instead of on the raised revenues is optimal.

Proof.
We can express the value of λ from (8) as:

$$\lambda = \frac{(1-F) + (R_T - w)f}{u'(1-F) - uf} \geq 0 \qquad (9)$$

where the last inequality of course holds because λ is the Lagrange multiplier and therefore non-negative.

There are two possibilities: either $\lambda = 0$ or $\lambda > 0$.

In the first case, it should hold that:

$$(1-F) + (R_T - w)f = 0 \qquad (10)$$

and therefore

$$-\frac{f}{1-F} = \frac{1}{R_T - w} \qquad (11)$$

Because $0 \leq f, F \leq 1$, this would mean that the optimal value of the net revenues ($R_T - w$) is negative which means that in this case relying on deaccessioning is optimal for the manager which contradicts the basic supposition of optimality of the behavior of the manager. This shows that in order for the manager to act optimally, the constraint in (5) should be binding (i.e. $\lambda > 0$).

Q.E.D.

The F.O.C. over effort states that:

$$\frac{\partial \mathcal{L}}{\partial e} = \left(\frac{\partial R_T}{\partial e}\right)(1-F) + (R_T - w)\left(\frac{\partial R_T}{\partial e}\right)f + \lambda u\left(\frac{\partial R_T}{\partial e}\right)f - \lambda\psi'(e) = 0 \qquad (12)$$

Proposition 2: If the principal is risk-neutral and we make deaccessioning depend upon effort, the provided effort by the agent will be suboptimal.

Proof.
Let's firstly observe the case when deaccessioning is fixed and doesn't depend upon the effort in the model. By inserting the value of λ from (9) into (12) we get:

$$\left(\frac{\partial R_T}{\partial e}\right)(1-F) + (R_T - w)\left(\frac{\partial R_T}{\partial e}\right)f + \frac{(1-F) + (R_T - w)f}{u'(1-F) - uf}u\left(\frac{\partial R_T}{\partial e}\right)f - \frac{(1-F) + (R_T - w)f}{u'(1-F) - uf}\psi'(e) = 0 \qquad (13)$$

and finally after simplification:

$$\frac{\partial R_T}{\partial e} = \frac{\psi'(e)}{u'(1-F)} \qquad (14)$$

On the other hand, if deaccessioning depends upon effort (and we assume that $\frac{\partial dE}{\partial e}<0$, which simply means that higher effort, invested into work for the museum, leads to lower need to rely on deaccessioning, which seems a logical assumption), (12) transforms into:

$$\frac{\partial \mathcal{L}}{\partial e} = \left(\frac{\partial R_T}{\partial e}\right)(1-F) + (R_T - w)\left(\frac{\partial R_T}{\partial e}\right)f + (R_T - w)\left(\frac{\partial dE}{\partial e}\right)f + \lambda u\left(\frac{\partial R_T}{\partial e}\right)f + \lambda u\left(\frac{\partial dE}{\partial e}\right)f - \lambda\psi'(e) = 0 \qquad (15)$$

which after inserting the value of of λ from (9) can be simplified into:

$$u'(1-F)^2\frac{\partial R_T}{\partial e} + (1-F)f\frac{\partial dE}{\partial e}(u - u'w) - \psi'(e)(1-F) + u'(1-F)\frac{\partial R_T}{\partial e}(R_T - w)f - (R_T - w)f\psi'(e) = -u'(1-F)\frac{\partial dE}{\partial e}fR_T \qquad (16)$$

Again, some simplification yields:

$$\begin{aligned}0 = u'(1-F)\frac{\partial R_T}{\partial e}[(1-F)+(R_T-w)f] - \psi'(e)[(1-F)+(R_T-w)f] \\ + (1-F)\frac{\partial dE}{\partial e}fu'(R_T-w) + (1-F)\frac{\partial dE}{\partial e}fu \\ \leq u'(1-F)\frac{\partial R_T}{\partial e}[(1-F)+(R_T-w)f] - \psi'(e)[(1-F)+(R_T-w)f] \\ - (1-F)\frac{\partial dE}{\partial e}fu \\ < u'(1-F)\frac{\partial R_T}{\partial e}[(1-F)+(R_T-w)f] \\ - \psi'(e)[(1-F)+(R_T-w)f] \qquad (17)\end{aligned}$$

where the first inequality is due to negativity of $(1-F)\frac{\partial dE}{\partial e}fu'(R_T-w)$ (due to previously made suppositions) and the second is due to positivity of $u(w)$ in equilibrium – if it would be otherwise the signs of derivatives of (4) and (5) would be opposite and one would be able to increase (4) by going in the direction of its derivative while still being in the region of the constraint (5) which would contradict Proposition 1 that the constraint in (5) is binding.

From (17) and due to positivity of $(1-F)+(R_T-w)f$ we are finally able to conclude:

$$\frac{\partial R_T}{\partial e} > \frac{\psi'(e)}{u'(1-F)} \qquad (18)$$

Comparing (14) and (18) and taking into account our initial supposition that $\frac{\partial^2 R_T}{\partial e^2} \leq 0$, we conclude that the effort in (18) is lower than the effort in (14) which concludes our proof.

Q.E.D.

Let's shortly explain the intuition behind Proposition 2. Our main hypothesis of the article is that deaccessioning leads to worse performance of museum management. In Proposition 2 we therefore showed that if we allow effort to vary and have the influence on the level of deaccessioning funds (used as a buffer to remedy for financial problems of the museum), the invested effort will be lower than optimal (the marginal effect of effort to net revenues in equilibrium is higher when allowing deaccessioning to vary with effort and marginal effect of effort to net revenues is a monotonously decreasing function). This shows that usage of deaccessioning funds and invested effort are indeed inversely related and is the effect of including the (negative by assumption) marginal effect of effort to deaccessioning which has a negative marginal effect to derivatives of both (4) and (5) in the first order condition (15). In the following proposition we show another adverse effect of deaccessioning funds for performance of museum management.

Proposition 3: In the risk-neutral principal' equilibrium the marginal effect of deaccessioning to wage is greater than the marginal effect of additional net revenues to wage. Also the marginal effect of deaccessioning to net revenues in the equlibrium is negative and greater than minus one.

Proof.To calculate the marginal effect of deaccessioning over wage, we can use the second derivatives of the Lagrangian (using the implicit function theorem):

$$\frac{\partial w}{\partial dE} = -\frac{\frac{\partial^2 \mathcal{L}}{\partial w \partial dE}}{\frac{\partial^2 \mathcal{L}}{\partial w^2}} \qquad (19)$$

Similarly we can calculate:

$$\frac{\partial w}{\partial R_T} = -\frac{\frac{\partial^2 \mathcal{L}}{\partial w \partial R_T}}{\frac{\partial^2 \mathcal{L}}{\partial w^2}} \qquad (20)$$

$$\frac{\partial R_T}{\partial dE} = -\frac{\frac{\partial^2 \mathcal{L}}{\partial w \partial dE}}{\frac{\partial^2 \mathcal{L}}{\partial w \partial R_T}} \qquad (21)$$

The second order derivatives are:

$$\frac{\partial^2 \mathcal{L}}{\partial w^2} = 2f + wf' + \lambda u''(1-F) - 2\lambda u' f - \lambda u f' < 0 \qquad (22)$$

where the inequality holds because the Lagrangian is maximized at w,

$$\frac{\partial^2 \mathcal{L}}{\partial w \partial dE} = -f + (R_T - w)f' + \lambda u' f + \lambda u f' \qquad (23)$$

$$\frac{\partial^2 \mathcal{L}}{\partial w \partial R_T} = -2f + (R_T - w)f' + \lambda u' f + \lambda u f' \qquad (24)$$

From equations (20), (22) and (24) we have:

$$\frac{\partial w}{\partial R_T} = -\frac{\frac{\partial^2 \mathcal{L}}{\partial w \partial R_T}}{\frac{\partial^2 \mathcal{L}}{\partial w^2}} = \frac{2f - (R_T - w)f' - \lambda u' f - \lambda u f'}{2f + wf' + \lambda u''(1-F) - 2\lambda u' f - \lambda u f'} \qquad (25)$$

and from equations (19), (22) and (23) we have similarly:

$$\frac{\partial w}{\partial dE} = -\frac{\frac{\partial^2 \mathcal{L}}{\partial w \partial dE}}{\frac{\partial^2 \mathcal{L}}{\partial w^2}} = \frac{f - (R_T - w)f' - \lambda u' f - \lambda u f'}{2f + wf' + \lambda u''(1-F) - 2\lambda u' f - \lambda u f'} \qquad (26)$$

Therefore:

$$\frac{\partial w}{\partial R_T} = \frac{\partial w}{\partial dE} + \frac{f}{2f + wf' + \lambda u''(1-F) - 2\lambda u' f - \lambda u f'} \qquad (27)$$

Because of the inequality (22) the denominator in both (25) and (26) is strictly negative. This means that the last term on the right hand side of (27) is strictly negative (f – the probability density function – is of course strictly positive by assumption), which shows:

$$\frac{\partial w}{\partial R_T} < \frac{\partial w}{\partial dE} \qquad (28)$$

This proves the first part of the proposition. The second part is shown similarly using (21), (23) and (24):

$$\frac{\partial R_T}{\partial dE} = -\frac{\frac{\partial^2 \mathcal{L}}{\partial w \partial dE}}{\frac{\partial^2 \mathcal{L}}{\partial w \partial R_T}} = -\frac{f - (R_T - w)f' - \lambda u' f - \lambda u f'}{2f - (R_T - w)f' - \lambda u' f - \lambda u f'} > -1 \qquad (29)$$

Now let's observe the signs of $\frac{\partial w}{\partial dE}$, $\frac{\partial w}{\partial R_T}$ and $\frac{\partial R_T}{\partial dE}$. It is natural to assume that the marginal effect of additional net revenues less wage to wage is positive otherwise the manager wouldn't be motivated for the benefit of the firm at all. Therefore it is natural to assume:

$$\frac{\partial w}{\partial R_T} > 0 \qquad (30)$$

From (28) we also gain:

$$\frac{\partial w}{\partial dE} > \frac{\partial w}{\partial R_T} > 0 \qquad (31)$$

which means that the signs of both $\frac{\partial w}{\partial dE}$ and $\frac{\partial w}{\partial R_T}$ are positive. From equations (19) and (20) and the fact that $\frac{\partial^2 \mathcal{L}}{\partial w^2}$ is negative (as explained before) we gain:

$$sgn\left(\frac{\partial^2 \mathcal{L}}{\partial w \partial R_T}\right) = sgn\left(\frac{\partial^2 \mathcal{L}}{\partial w \partial dE}\right) = +1 \qquad (32)$$

and therefore:

$$sgn\left(\frac{\partial R_T}{\partial dE}\right) = -1 \qquad (33)$$

But this means that deaccessioning funds have negative marginal effect on the total revenues, therefore on the success of the firm. This proves that allowing deaccessioning leads to decisions leading to lower revenues than optimal. This also proves our proposition.

Q.E.D.

Again, let's shortly explain the intuition behind Proposition 3. We showed that deaccessioning is more tempting for the manager not merely due to its adverse effect on effort (allowing managers to be more "lazy"), which we showed in Proposition 2, but also because it raises the manager's perquisites in the form of manager's wage, as claimed in the original article by Jensen (see Jensen, 1986). We, therefore, showed that the effect of deaccessioning on the level of equilibrium wage is higher than the effect of revenues to equilibrium wage which clearly demonstrates adverse effect of deaccessioning to manager's perquisites (deaccessioning funds are more tempting for the manager than raising of the revenues because he secures higher wage by using deaccessioning). Furthemore, we showed that deaccessioning and net revenues are negatively related also when observed in a direct relationship.

5. THE RISK-AVERSE PRINCIPAL CASE

We next observe our model in the case of principal being risk-averse and prove the validity of our two main propositions also for this case. In this case, the model in (4) and (5) changes to:

$$\max\ B(R_T - w)[1 - F(w - R_T - dE)] \qquad (34)$$

$$s.t. \qquad u(w)[1 - F(w - R_T - dE)] - \psi(e) \geq \underline{u} \qquad (35)$$

where $B(R_T - w)$ (we will write it shortly as B) is the benefit function of the principal and we assume $B' > 0, B'' < 0$.

Solving the model in (34) and (35) leads to the following Lagrangian function:

$$\mathcal{L} = B(1-F) + \lambda u(1-F) - \lambda\psi(e) - \lambda\underline{u} \qquad (36)$$

The first order conditions over wage and effort are:

$$\frac{\partial \mathcal{L}}{\partial w} = -B'(1-F) - Bf + \lambda u'[1-F] - \lambda u f = 0 \qquad (37)$$

$$\frac{\partial \mathcal{L}}{\partial e} = B'\left(\frac{\partial R_T}{\partial e}\right)(1-F) + B\left(\frac{\partial R_T}{\partial e}\right)f + \lambda u\left(\frac{\partial R_T}{\partial e}\right)f - \lambda\psi'(e) = 0 \qquad (38)$$

From (37) we get:

$$\lambda = \frac{B'(1-F) + Bf}{u'(1-F) - uf} \geq 0 \qquad (39)$$

Again, due to $B' > 0$ we see that for $\lambda = 0$ (i.e. constraint in (35) to be non-binding), B would have to be negative in equilibrium and relying on deaccessioning would be an optimal strategy.

We next prove our Propositions 2 and 3 also in the case of risk-averse principal.

Proposition 4: If the principal is risk-averse and we make deaccessioning depend upon effort, the provided effort by the agent will be suboptimal.

Proof.
Again, firstly observe the case when deaccessioning is fixed and doesn't depend upon the effort in the model. By inserting the value of λ from (39) into (38) we get:

$$B'\left(\frac{\partial R_T}{\partial e}\right)(1-F) + B\left(\frac{\partial R_T}{\partial e}\right)f + \frac{B'(1-F)+Bf}{u'(1-F)-uf}u\left(\frac{\partial R_T}{\partial e}\right)f - \frac{B'(1-F)+Bf}{u'(1-F)-uf}\psi'(e) = 0 \qquad (40)$$

and finally after simplification:

$$\frac{\partial R_T}{\partial e} = \frac{\psi'(e)}{u'(1-F)} \qquad (40)$$

On the other hand, if deaccessioning depends upon effort (again, we assume that $\frac{\partial dE}{\partial e}<0$), (38) transforms into:

$$\frac{\partial \mathcal{L}}{\partial e} = B'\left(\frac{\partial R_T}{\partial e}\right)(1-F) + B\left(\frac{\partial R_T}{\partial e}\right)f + B\left(\frac{\partial dE}{\partial e}\right)f + \lambda u\left(\frac{\partial R_T}{\partial e}\right)f + \lambda u\left(\frac{\partial dE}{\partial e}\right)f - \lambda\psi'(e) = 0 \qquad (41)$$

which after inserting the value of of λ from (39) can be simplified into:

$$B'u'(1-F)^2\frac{\partial R_T}{\partial e} + B'u(1-F)f\frac{\partial dE}{\partial e} + Bu'(1-F)f\frac{\partial R_T}{\partial e} - \psi'(e)B'(1-F) - \psi'(e)Bf = -Bu'(1-F)f\frac{\partial dE}{\partial e} \qquad (42)$$

Again, some additional simplification yields:

$$0 = [B'(1-F)+Bf]\left[u'\frac{\partial R_T}{\partial e}(1-F) - \psi'(e)\right] + [B'u + Bu'](1-F)f\frac{\partial dE}{\partial e} < [B'(1-F)+Bf]\left[u'\frac{\partial R_T}{\partial e}(1-F) - \psi'(e)\right] \qquad (43)$$

where the final inequality is due to term $B'u + Bu'$ being positive, as B' and u' are positive by initial assumptions, B is positive by previous reasoning at the start of this section, and u is positive by the same reasoning as in proof of Proposition 2.

From (43) it is easily deduced that:

$$\frac{\partial R_T}{\partial e} > \frac{\psi'(e)}{u'(1-F)} \qquad (44)$$

Again, Comparing (40) and (44) and taking into account our initial supposition that $\frac{\partial^2 R_T}{\partial e^2} \leq 0$, we conclude that the effort in (44) is lower than the effort in (40) which concludes our proof.

Q.E.D.

Proposition 5: Proposition 3 holds also in the case of risk-neutral principal with the additional assumption

$$\frac{f}{1-F} = r > -\frac{B''}{B'} = ARA \qquad (45)$$

Proof.
The inequality in (45) can be interpreted in the following way. According to Pratt (1964), the Arrow-Pratt coefficient of absolute risk aversion (ARA) can be interpreted as willingness-to-pay the insurance (risk premium), i.e. willingness-to-pay to avoid risk. On

the other hand as interpreted by Grossman and Hart (1982) the hazard rate (r) in the model described by equation (1) can be interpreted as marginal cost of avoiding bankruptcy, therefore marginal cost of avoiding risk in our model. Inequality (45) therefore only means that the principal's willingness to pay the risk premium to avoid risk is smaller than the cost of avoiding risk, which is a necessary condition for the principal to be willing to take the risk of bankruptcy and therefore to participate in the game described by the model (34) and (35). Inequality (45) is therefore nothing else than the participation condition for the principal.

Calculating the second order derivatives and implicit function quotients in this case gives:

$$\frac{\partial^2 \mathcal{L}}{\partial w^2} = B''(1-F) + 2B'f - Bf' + \lambda u''(1-F) - 2\lambda u'f - \lambda uf' < 0 \qquad (46)$$

$$\frac{\partial^2 \mathcal{L}}{\partial w \partial dE} = -B'f + Bf' + \lambda u'f + \lambda uf' \qquad (47)$$

$$\frac{\partial^2 \mathcal{L}}{\partial w \partial R_T} = -B''(1-F) - 2B'f + Bf' + \lambda u'f + \lambda uf' \qquad (48)$$

$$\frac{\partial w}{\partial R_T} = -\frac{\frac{\partial^2 \mathcal{L}}{\partial w \partial R_T}}{\frac{\partial^2 \mathcal{L}}{\partial w^2}} = \frac{B''(1-F) + 2B'f - Bf' - \lambda u'f - \lambda uf'}{B''(1-F) + 2B'f - Bf' + \lambda u''(1-F) - 2\lambda u'f - \lambda uf'} \qquad (49)$$

$$\frac{\partial w}{\partial dE} = -\frac{\frac{\partial^2 \mathcal{L}}{\partial w \partial dE}}{\frac{\partial^2 \mathcal{L}}{\partial w^2}} = \frac{B'f - Bf' - \lambda u'f - \lambda uf'}{B''(1-F) + 2B'f - Bf' + \lambda u''(1-F) - 2\lambda u'f - \lambda uf'} \qquad (50)$$

$$\frac{\partial w}{\partial R_T} = \frac{\partial w}{\partial dE} + \frac{B''(1-F) + B'f}{B''(1-F) + 2B'f - Bf' + \lambda u''(1-F) - 2\lambda u'f - \lambda uf'} \qquad (51)$$

Because of inequality (45) it holds:

$$B''(1-F) + B'f > 0 \qquad (52)$$

And therefore again (as in the risk-neutral principal case) it holds:

$$\frac{\partial w}{\partial R_T} < \frac{\partial w}{\partial dE} \qquad (53)$$

All the other steps in proving the analogue of proposition 3 are the same.

Q.E.D.

6. DISCUSSION

It is apparent that we just showed several adverse effects of allowing deaccessioning funds. Firstly, deaccessioning has negative effects on the effort of the managers in equilibrium – managers will tend to work less in the presence of deaccessioning funds, being able to cover for the possible deficit of the museum, if we allow their effort to provide funds for the museum which could lower the need for deaccessioning. This finding was demonstrated in Propositions 2 and 4 for both risk-neutral as well as risk-averse case.

Secondly, using deaccessioning funds is more tempting for the manager than raising revenues. This shows that in the presence of deaccessioning the manager has less motivation to work for the benefit of the museum, but will be more tempted to rely on deaccessioning funds, leaving the work for the benefit of the museum (i.e. raising revenues of the museum) for others to come. This is finally and once more confirmed by the negative sign of marginal effect of deaccessioning to the revenues – the more we allow deaccessioning possibilities to cover the possible deficit of the museum, the lower will be the total revenues.

One would be tempted of course to generalize this finding to behavior of managers in non-profit as well as for-profit firms. For the non-profit firms the result is immediate: allowing firms to rely on endowment funds for covering their possible deficit is economically detrimental to the incentives of a non-profit firm. This goes in line with the econometric findings in the literature (e.g. Fisman & Hubbard, 2003; Core, Guay & Verdi, 2006) yet goes of course a step further by formally proving the detrimental effects of large endowment funds for the incentives in non-profit firms.

So how about the for-profit firms? In Section 2 we presented the conjecture by Jensen and Easterbrook which says that excess free cash flow in hands of the managers entails agency costs in the form of excessive perquisites and investments in negative net present value projects. We are unfortunately at this point not able to prove that free cash flow acts exactly like deaccessioning (and/or endowment) funds in non-profit firms. We hadn't addressed all the different forms of negative effects of deaccessioning: do they lead to more perquisites on the side of managers (that appears to be the case) or do they lead to investments in negative net-present value projects, or perhaps even both? To account for this one would need to have a more specified basic model, including separate measures for all these effects. Yet we are able to say that if the free cash flow in for-profit firms acts in a manner as deaccessioning funds in our case, therefore if it is not included among the firm-value raising funds, yet could be spent to finance the possible deficit of the firm, then we are able to formally show (and have shown in this article) that this leads to adverse effects in terms of the agency costs.

7. EXTENSIONS OF THE MODEL

The model describes the situation in which there is a clearly specified relationship between principal and agent. In this way it improves on the model of Grossman and Hart

who only use the optimization for the agent. Yet we specify manager's utility only in terms of his expected benefits from wage and disutility from effort. One could of course follow Grossman and Hart's logic further in specifying that the manager's utility depends also on bonding actions and value of the museum. In this way one would have to include in the manager's utility function also the utility from the value of museum (its revenues and most of all its endowment). As Grossman and Hart clearly state, the firm's market value is in the manager's own interest and therefore his utility function could (or should) be made dependent on the value of the museum. This would complicate the model further, yet would be more in line with original model and findings by Grossman and Hart.

Secondly, an apparent extension of the model would be to include the possibility of asymmetric information. One would expect that in the presence of deaccessioning, moral hazard problems would be extended and managers would tend to shirk to the expense of the principals and museum in general.

There are many other extensions that could be made to the specification of the principal-agent problem in our model. One could firstly argue about the choice of principal and agent. In one of the rare existing articles on principal-agent modeling in cultural economics Prieto-Rodriguez and Fernandez-Blanco (2006) consider the public agency (providing subsidies) to be the principal and the museum (or its board) to be the agent in museum financing decisions. One could also argue that museum has multiple principals: both the board of trustees as well as the donors can serve the role of principals. It would be interesting to include multiple principals (or even multiple agents) in our principal-agent problem following work of e.g. Bernheim & Whinston (1986), Li (1993), Martimort (1996), Waterman & Meier (1998) and Gailmard (2002), taking into account the externalities of one principal-agent relation for another principal-agent relation. One could furthermore argue that museums follow versatile objectives beside revenue maximization and are motivated by educational, aesthetic and other purposes as well. To this task, the extensions following Holmström and Milgrom's 1991 multitasking model would be most appropriate. One could also speculate that principal can follow a more general utility function and is not risk neutral as presupposed in our article. Yet we consider this observation would change nothing in the results of this paper which is demonstrated in the appendix.

One further extension of course concerns econometric evidence. Unfortunately the data on deaccessioning are not available presently in 990' non-profit organizations' forms, therefore an econometric study would be of only limited scope. One could of course try to gather the data by using questionnaires sent to museums. Still we consider that deaccessioning is considered as "barely legal" practice in American (and even more-so in other) museums, therefore the answers to questionnaires would be probably prone to a large non-response bias. Nevertheless, one would be able to show that excess endowment of museums in general contributes adversely to the benefit of the museum and positively to the perquisites of museum managers.

Another extension considers the solutions to the problems shown in the model. We were able to show the negative effects of deaccessioning to the incentives for managers in mu-

seums. One would be obliged to further explore if (and how) this problem could be prevented and if there is any mechanism to reduce the agency costs of allowing for deaccessioning. One would be tempted to use the literature in mechanism design theory to resolve this problem.

Finally, the proof in our article is still insufficient to prove the Jensen's agency costs of free cash flow conjecture for the case of for-profit firms. This question, therefore, remains open for future research, yet we believe the methods in our article should provide sufficient research directions for final solution to this problem in financial theory and theory of the firm.

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ANALYSIS OF THE EFFECTS OF INTRODUCTION OF AN ADDITIONAL CARBON TAX ON THE SLOVENIAN ECONOMY CONSIDERING DIFFERENT FORMS OF RECYCLING[1]

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ABSTRACT: *This paper outlines some of the environmental and economic implications of an additional CO2 tax of EUR 15/tCO2 in Slovenia in the period 2012-2030 in order to determine whether it yield a double dividend. Authors analyze (using E3ME model) different forms of revenue recycling by reducing the social security contributions of either the employers or the employees or by reducing the public deficit, in order to identify the optimal fiscal instrument for improving the environmental and economic welfare (double dividend). In this policy orientated paper authors argue that a reduction of employee social security contributions has more favourable effect than a reduction in employers' social security contributions.*

Keywords: *green tax, environmental tax reform, double dividend, carbon tax, recycling, E3ME model*
JEL Classification: E17, H23, Q50

1. INTRODUCTION – GREEN TAXES AND ENVIRONMENTAL TAX REFORM (ETR)

The idea of a green tax dates back to Arthur C. Pigou (1920); hence, green tax is also referred to as a Pigouvian tax. It is based upon a fundamental principle that the polluters should pay a tax in the amount equal to the damages resulting from their impact on the environment (i.e. negative externalities). The costs are namely not incurred only by the company whose emissions pollute the environment; rather, the costs are sustained by the entire society. It is then the task of the government to impose the green tax to internalize the pollution costs as much as possible. In such case, the polluting industrial activity is reduced to a socially desirable level (Turner, 1994).

Introduction of the green tax represents also an important development in the public finance reform since it involves also a reconsideration of the present tax system, aimed

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predominantly at taxing labour and capital. The environmental tax reform (ETR) argues in favour of green taxes in a revenue-neutral fashion to reduce other distortionary levies. Instead of taxing "good things" like labour, income and capital, the government should start taxing "bad things" like pollution, use of natural resources etc. (Bousqet, 2000; Patuelli et al., 2005). The main goal of an environmental tax reform is therefore an improvement in both environmental (first dividend) and economical aspects (second dividend). Environmental dividend involves reduction in emissions and economic dividend stems from lower costs, improved competitiveness, and higher employment. Therefore, the term "double dividend" is increasingly used to describe the environmental tax reform (Glomm et al., 2008; Ekins, 2009).

Experience from European countries has shown, that effects of a comprehensive ETR have been positive in most cases (Sweden, Denmark, Netherlands, UK, Finland, Norway, Germany). Therefore, the environmental tax reforms (ETR) have become a relevant instrument in the economic policies of the developed world in recent years.

Our primary goal is to determine the effect of an additional carbon tax (EUR 15 per ton of CO2 i.e. EUR 55 per ton of carbon) in the period 2012–2030 on the Slovenian economy, in order to determine whether an additional carbon tax would indeed yield a double dividend. We shall examine the possibilities of different recycling options either through reduction of budget deficit or reduction of employer/employee social security contributions, in the form of different scenarios (using E3ME model) in order to identify the optimal fiscal instrument for improving the environmental (first dividend) and economic welfare (second dividend).

The article is structured as follows. In section two the concept of double dividend is introduced. In section three we present the E3ME model and the impact of green taxes within the model. Results regarding the environmental and economic implications of an environmental tax reform are presented in section four. Finally, the last section deals with the conclusions and policy implications derived from the contents of the paper.

2. A DOUBLE DIVIDEND

The two central dilemmas regarding the green tax have to do with regressiveness and loss of competitiveness. Many authors have argued that incidence of green taxes falls largely on the low-income class (Roed, 2006; West, Williams, 2004; Labandeira, Labeaga, 1999; Tiezzi, 2001; Clinch et al., 2006). Negative effect on cost competitiveness of the economy will be greater when (1) elasticity of demand for a certain good is relatively high; (2) there is strong competition in the industry; (3) a particular sector is highly energy-intensive; (4) ecotax is introduced in a small number of countries; and (5) there is no option to substitute the polluting activity with an environmentally friendlier technology (Kosonen, Nicodème, 2009; Clinch et al., 2006; Patuelli et al., 2005; Baron, 1997; Envoldsen et al., 2009). Thus, if the government introduces ETR without recycling the tax revenue within the system, an economic downturn would likely occur.

Recycling in this case refers to targeted use of green tax revenue, especially for reducing the taxation of labour and social security contributions. Besides a reduction of social security contributions or personal income taxes, other forms of financial recycling are also possible by transfers to households/industries for greater energy efficiency[4] or interventions in corporate income taxes and value added tax. In case of total recycling, the total tax burden remains unchanged (fiscal neutrality) (Speck, Jilkova, 2009; Ludewig et al., 2010; OECD, 2007; Hoerner, Bosquet, 2001; Clinch et al., 2006; Patuelli et al., 2005; Hansen, Holger, 2000).

We expect an environmental tax reform to lead to an improvement from environmental aspects, e.g. owing to lower carbon dioxide emissions, as well as to improve the cost competitiveness of the economy as a result of lower labour costs and higher technological efficiency of businesses. Hence, economic growth and employment will actually increase (Benoit, 2000; Hoerner et al., 2001; Patuelli et al., 2005; Tuladhar, Wilcoxen, 1999). Not surprisingly, the European countries with the highest tax on labour were the first to implement the environmental tax reform and look for double dividend (Finland, Sweden, Denmark, Netherlands, Germany, and Norway).

The first (environmental) dividend of the double dividend hypothesis is widely accepted. Johansson (2000) argues that in Sweden the CO2 emissions were 15% lower than they would have been in the absence of the green taxes. Berkhout and Linderhof (2001) point out that in the Netherlands, the price of electricity and fuel for domestic use rose dramatically as a result of the green tax and ex-post studies show that consumers now use 15% less electricity and 5–10% less fuel. Baron (1997) pointed out that in Denmark recycling of tax revenues through investment in energy efficiency has led to about 4.7% reduction in CO2 emissions. Labandeira et al. (2004) show that in Spain a tax on CO2 emissions has resulted in environmental improvement. Ludewig et al. (2010) demonstrate that use of all motor fuels in Germany was decreasing in the period from 1995 to 2006 by an average rate of 0.3 percent per year. At the same time, use of public transport was rising. Based on an analysis of 139 simulation models, Bosquet (2000) found that a considerable drop in carbon dioxide emissions is among the expected effects of a green tax reform in the short to medium run.

The second (economic) dividend depends mainly on the structure of the economy (e.g. labour market, pre-existing tax structure), time lag and explicit model assumptions. Since the present tax system creates significant disincentives to work and hire, virtually any environmental policy can compound these existing distortions (Carraro et al., 1996; Morgenstern, 1995; Tuladhar, Wilcoxen, 1999; Schöb, 2003). Ludewig et al. (2010) find that 250,000 new jobs were created in Germany in this way. Experience from Denmark (Hansen, Holger, 2000) and Spain (Manresa, Ferran 2005) is similar. However, many authors argue that the "double dividend" theory oversimplifies a number of points and that certain conditions have to be fulfilled for a double dividend.

4 Alternative recycling method are: (1) improvements in the energy efficiency of the building stock, (2) grants for improving energy efficiency in buildings, (3) recycling into local environmental projects to foster community acceptance of ETR, (4) recycling to public transport, (5) subsidising renewable energy and combined heat and power production, (6) subsidising 'cleaner' technology in industry, (7) subsidising R&D (Clinch et al., 2006).

Firstly, ETR is expected to improve the quality of the environment and to reduce the distortions of existing taxes. This view has been questioned in several papers (Goulder, 1995; Benoit, 2000; De Mooij, 1999; Li, Ren, 2012). The basic point is that the double dividend hypothesis ignores the interaction between environmental taxes and pre-existing tax structure. If the initial tax system is suboptimal then ETR can generate a significant double dividend. Similarly Fraser and Waschik (2013) using a CGE model to empirically examine the double dividend hypothesis provide support for the existence of a strong double dividend when revenue is recycled through reductions especially in consumption taxes.

Secondly, the outcome depends very much on labour market conditions in the country (Clinch et al., 2006; Carraro et al., 1996; Schöb, 2003; Koskela and Schob, 1999; Holmlund and Kolm, 2000; Albrecht, 2006; Ciaschini et al., 2012). If there are labour rigidities (as in some countries of Europe), then there will be an employment dividend resulting from the recycled carbon tax revenue. But in the long run, such rigidities become less relevant.

Thirdly, green taxes represent, as a rule, a relatively small share of overall tax revenue of any given country[5]. Hence, a dramatic increase would be required to offset the lower personal income tax revenue. Thus, if green taxes are set high enough to achieve meaningful reductions in emissions, they may cause significant distortions in the tax system. Policy makers will then be forced to trade off cleaner environment against other policy targets (Coxhead, 2000).

Fourthly, Carraro et al (1996) find that the unions' negotiating strength affects the possibility of gains in employment. In the short run the employment may increase due to lower taxes; however, in the long run, net wages completely absorb the tax change, thus bringing employment back to its baseline value. Many authors argue that the effects of a green tax reform are doubtful in the long run.

Nevertheless, while the second dividend may be in doubt, the first dividend remains a powerful argument for the introduction of ETR. Obviously, a strong double dividend occurs under rather "constrained" circumstances. We do not go more into the details since the rise and fall of the double dividend hypothesis and conditions for it has been discussed at length elsewhere (Bovenberg and Goulder 1997; Parry and Oates, 1998; Goulder, 1995; Bosquet, 2000; Fraser and Waschik, 2013). All authors agree that validity of the double-dividend hypothesis cannot be settled as a general matter. In other words, each reform must be evaluated on its own merits by keeping in mind the characteristics of respective countries and the explicit model assumptions.

5 In most EU countries, revenue from green taxes is between 2% and 3% of GDP. There are only four EU countries where such share in lower than 2% (1.9% in Slovakia, 1.9% in Lithuania, 1.6% in Spain, 1.8% in France), and only three countries where this share exceeds 3.5% of GDP (4% in Denmark, 4% in the Netherlands, 3.6% in Slovenia). Green taxes represent the largest share of total tax revenue in Bulgaria (10.7%), the Netherlands (10.3%), and Slovenia (9.6%). The lowest contribution of green taxes to overall tax revenue was observed in France (4.2%), Belgium (4.7%), and Spain (5.2%). Slovenia is considerably above the EU27 average (6.2%) with its 9.6-percent share of green tax revenue in overall tax revenue (European Commission, 2012).

3. THE MODEL

There are two different methodological approaches to modelling the relation between the environment and the rest of the economy. The first approach is based on highly precise modelling of a certain sector; as a rule, however, such models do not yield the best explanations as to the interaction between the sector at hand and the economy as a whole. The other approach is based on structural macroeconomic models. A key advantage of these models, each of them is based on certain underlying assumptions, is that they allow a fairly accurate prediction of macroeconomic results in case of different scenarios. These models provide a better understanding of the economic consequences of environmental measures as they allow studying the economic processes that lead to final results. The downside of these models is that each sector is modelled at the aggregated level[6].

Our analysis is based on the latter approach. We employed the E3ME[7] model, widely used among European researchers in recent years. This is a dynamic simulation econometric model intended for analysis of the effects of E3 policies (economy, energy, environment), especially those pertaining to environmental taxes and regulation. The model allows examining the short-term (annual) and medium-term economic effects, as well as long-term effects of E3 policies for a period of 20 years. Hence, E3ME combines the features of short-term and medium-term sector models estimated using econometric methods with the features of computational general equilibrium models. The E3ME model includes 42 product/industry sectors (OECD classification), with energy sector further disaggregated to include energy-environment interaction and 16 service sectors. It is intended for analysis of macroeconomic effects (with emphasis on environmental components) of environmental economic policies, especially from the aspect of environmental taxation and regulation, for 33 European countries (EU27, Norway, Switzerland, Iceland, Croatia, Turkey, and Macedonia) as a whole. It also allows analysis of environmental effects in each country[8].

The structure of E3ME is based on the System of National Accounts (ESA 95), with additional links to demand for energy and environmental emissions. The model includes a total of 33 sets of econometrically estimated equations which also include components of the GDP (consumption, investment, international trade), prices, demand for energy, and demand for raw materials. Each set of equations is broken down by countries and by sectors. E3ME also allows analyzing the effects of particular scenarios as measured by numerous economic, energy, and environmental indicators. The model is based on the data for the period from 1970 to 2010 and annual projections until the year 2050. The main sources of data include Eurostat, AMECO DC ECFIN database, and IEA; this data set is further complemented by OECD STAN and other databases. Any gaps in the data are estimated using adjusted software algorithms. For a detailed description of the E3ME model, see E3ME Manual (2012).

6 For a detailed description of methodological approaches in modelling the relations between the environment and the economy, see Ščasný et al. (2009).

7 The model was developed and is maintained by the company Cambridge Econometrics.

8 See E3ME Manual (2012) for more detailed description.

3.1. EFFECTS OF ECOLOGICAL TAXATION (GREEN TAX) IN THE E3ME MODEL

One of the purposes of the E3ME model is to provide consistent and coherent analysis of fiscal policy and its relation to greenhouse gas emissions. The E3ME model allows examining how carbon and energy taxes affect the reduction of environmental emissions, as well as how other taxation and economic policies affect reduction of emissions.

The effect of a taxing carbon dioxide emissions (and energy consumption) in the E3ME model on prices and wages is based on two key assumptions. The first assumption is that the effect of tax is transmitted through the price of fuel and any use of subsequent tax revenue to reduce other taxes. Other effects are not modelled. The second assumption is that import of fuels and domestic production are taxed in proportion to the CO2 emission rate and energy value of the fuel, while fuel exports are not taxed. It is assumed that this tax is paid by the fuel producers and importers. This tax is then levied on the final users through higher fuel prices. Another assumption is that the industry will transmit these additional fuel costs on its buyers in the form of higher prices of commodities (goods and services). An increase in the final price is therefore a result of direct and indirect effect of tax on a particular good or service. If tax revenue is used to reduce the rates of taxes levied on the employers, this will result in a decrease of labour costs and, in turn, a drop in production costs. These changes, too, will then be transmitted forward within the E3ME model (E3ME Manual, 2012).

Net effect of tax on prices of products and imports will be transmitted to consumer prices, resulting in a change in the consumption of goods and services. Such change will depend on individual ecotax and the price elasticity of the affected commodities. Higher prices of goods and services will lead to demands for higher wages. Econometric studies have confirmed that in the long run, entire tax is levied on the consumers. This fact is integrated into the E3ME model as a part of its long-term solution.

In the E3ME model, ecotaxes indirectly influence (through direct effect on prices and wages) the macroeconomic parameters such as fuel consumption, production, employment in particular sectors etc.). Namely, a change in the price of fuels resulting from ecotax will, depending on the elasticity of substitution, lead to a change in fuel consumption. Increase of fuel prices due to higher taxes will cause changes in consumer prices, which will be reflected in substitution in consumer expenditure, change of export activity, and change in the relation between domestic production and imports. These changes will in turn affect, via feedback loop, the use of various types of fuel. A reduction in labour costs resulting from "recycling" of tax revenue will initially have a direct positive effect on employment, followed by an indirect effect through relative price competitiveness thereon as more commodities (goods and services) are produced in labour intensive industries.

4. RESULTS OF THE MODEL

Below we present the results of the introduction of the additional carbon tax. We firstly assume that all revenue generated from ecotax is allocated for reduction of the budget

deficit or increase of the budget surplus. In subsequent analyses, ecotaxes will be recycled in various ways, e.g. they will be used to reduce the taxes levied on labour costs.

The analysis will be based in section 4.2. on a comparison to a base projection (baseline scenario), and in section 4.3. on a comparison to a budget recycling projection. Results will be presented in the form of a deviation from the base projection and the budget recycling projection. Therefore, we continue by presenting the assumption underlying the base projection, and the way in which this projection was generated.

4.1. DESCRIPTION OF THE BASE PROJECTION (BASELINE SCENARIO) AND UNDERLYING ASSUMPTIONS AND THE ESTIMATION METODOLOGY TOGETHER WITH PARAMETER RESULTS

It is important that the baseline projection (baseline scenario) in the framework of the E3ME model is consistent with the forecasts used in other analyses. The underlying assumption of the baseline projection was that the E3ME projection was consistent with the slightly modified projection of the European commission (modified projection PRIMES BASELINE 2009). PRIMES BASELINE 2009 forecasts are also presented in Table A1 in the Appendix.

Following is a description of the key stages in modelling of the base projection. Inputs for the base projection include historical data (data on economic indicators, energy, and the environment, obtained from different sources (Eurostat, IEA etc.), estimates of parameters for endogenous variables, and fundamental assumptions.

Historical data on economic indicators for Slovenia (employment, output, consumption, exports etc.) is used up to and including 2010. The indicators were calculated from the data published by Eurostat in February 2012. Historical data on energy components (energy consumption by types of fuel etc.) and environmental components is derived from the World Energy Outlook for the period up to 2009.

Endogenous variables are determined using the functions estimated based on historical data. There are around 33 variables for which stochastic functions are estimated. However these variables may well be disaggregated in two dimensions (e.g. there are 19 fuel users and 33 countries) so we will not provide the specification of each variable. Below we first describe the general procedure how these stochastic functions are estimated and then show one example of such function and its parameters for Slovenia.

The functional form of the equations and the parameters are based on the cointegration and error-correction methodology (Engle and Granger, 1987, and Hendry et al., 1984). The process involves two stages. The first-stage is a levels relationship, where an attempt is made to identify the existence of a cointegrating relationship between the chosen variables, selected on the basis of economic theory and a priori reasoning. For example the aggregate energy demand (FRO) is specified as follows:

$$FR0_{i,j,t} = a_{i,j,0} + a_{i,j,1}FRY_{i,j,t} + a_{i,j,2}PREN_{i,j,t} + a_{i,j,3}FRTD_{i,j,t} + a_{i,j,4}ZRDM_t + a_{i,j,5ZRDTt+} + a_{i,j,6}FRK_{i,j,t+} u_{i,j,t}$$

where FRY is economic output of energy users i in region j, PREN is average fuel price (across all fuels) deflated by unit cost in region j, FRTD is R&D expenditure by energy user i in region j, ZRDM is EU investment of R&D in machinery, ZRDT is EU investment of R&D in transport, and FRK is investment by energy user i in region j

If a cointegrating relationship exists, then the second stage regression, known as the error-correction representation, is implemented. It involves a dynamic, first-difference, regression of all the variables from the first stage, along with lags of the dependent variable, lagged differences of the exogenous variables, and the error-correction term (the lagged residual from the first stage regression). Due to limitations of data size, however, only one lag of each variable is included in the second-stage. For example in case of aggregate energy demand the error correction equation is specified as:

$$\Delta FR0_{i,j,t} = b_{i,j,0} + b_{i,j,1\Delta}FRY_{i,j,t} + b_{i,j,2\Delta}PREN_{j,t} + b_{i,j,3}DFRTD_{i,j,t} + b_{i,j,4}\Delta ZRDM_t + b_{i,j,5}\Delta ZRDT_t + b_{i,j,6}\Delta FRK_{i,j,t} + b_{i,j,7}\Delta FR0_{i,j,t-1} + g_{i,j,}ECM_{i,j,t-1},$$

where Δ is difference and ECM is error correction.

Stationarity tests on the residual from the levels equation are performed to check whether a cointegrating set is obtained. Due to the size of the model, the equations are estimated individually rather than through a cointegrating VAR. For both regressions, the estimation technique used is instrumental variables, principally because of the simultaneous nature of many of the relationships (for example wage, employment and price determination).

E3ME's parameter estimate is carried out using a customised set of software routines based in the Ox programming language (Doornik, 2007). The main advantage of using this approach is that parameters for all sectors and countries may be estimated using an automated approach.

The estimation produces a full set of standard econometric diagnostics, including standard errors and tests for endogeneity. However all the estimation procedures and test are carried out by Cambridge Econometrics, the developer of the software[9].

In Table A2 in appendix we provide a summary of the model equations, giving an overview of which variables are used, units of measurement and functional form. A full list of the variables included in E3ME model is available on request. In Appendix 1 we also present in more detail the agregate demand for energy function and the estimated parameters for Slovenia. The other functions and parameters for Slovenia are available upon request.

9 A list of equation results can be made available on request. For each equation, the following information will be given: summary of results, full list of parameter results, full list of standard deviations.

The gaps in any of the E3ME time series was filled by software that was developed by the Cambridge Econometrics. This software uses growth rates and shares between sectors and variables to estimate missing data points, both in cases of interpolation and extrapolation. More precisely, " The most straightforward case is when the growth rates of a variable are known and so the level can be estimated from these growth rates, as long as the initial level is known. Sharing is used when the time-series data of an aggregation of sectors are available but the individual time series is not. In this case, the sectoral time series can be calculated by sharing the total, using either actual or estimated shares. In the case of extrapolation, it is often the case that aggregate data for a number of sectors are available, although the sectoral disaggregation at the E3ME level is not; for example, government expenditure is a good proxy for the total growth in education, health and defence. A special procedure has been put in place to estimate the growth in more disaggregated sectors so that the sum of these matches the known total, while the individual sectoral growth follows the characteristics of each sector. Interpolation is used when no external source is available, to estimate the path interval, at the beginning and end of which data are available". (E3ME, 2014, page 34)

Basic assumptions are derived from various sources. The sources are presented in Table A3 in the Appendix. For Slovenia, the values of these assumptions for the period 2010–2013 are presented in Table A4 in the Appendix. In the same table values of assumptions for particular commodities (e.g. energy prices, fuel prices etc.) are also presented. The baseline scenario is therefore based on all government measures implemented until mid 2010. For example, the CO2 price is determined on the measures introduced by the Slovenian government by mid 2010.

The process of ensuring compliance of the base projection in the E3ME model involves three stages. This is in fact a calibration process. The first stage in reconciling the E3ME projections with the published and slightly modified forecast PRIMES BASELINE 2009 (EU Energy trends to 2030, Baseline scenario 2009, European Commission, 2010). It includes ensuring consistency and transformation of the data into a suitable form. This means that different model dimensions have to be brought into line (geographic coverage, temporal aspect, sector coverage etc.). Transformed data are then saved in a separate file. In the next stage, the model is resolved in such way that model results match the slightly modified PRIMES BASELINE 2009 forecasts saved in a separate file. This is the calibrated forecasting process. In this forecast, the model solves its equations and compares the differences in results with the data saved in the database. Model results are substituted with values from the forecast database. Differences between results and forecasts are saved in a separate database called the "residual" database. In the last stage, the model is solved again using the "residual" database as well. This is the so-called endogenous baseline projection. According the theory, the final result should be the same as in the case of calibrated forecast. In practice, the match is not 100-percent (see, E3ME manual, pages 40–41).

In the E3ME model framework, the calibration process with modified PRIMES BASELINE 2009 forecasts is carried out based on the trends (growth rates) rather than based on levels. This is because historical data in the E3ME model are newer that the data from the modified PRIMES BASELINE 2009. Calibrations for PRIMES BASELINE 2009 forecasts are made for

the key economic variables and demand for energy (variables FRO, FRO1, FRO2 ... FRO12) and data on emissions (variables GHG, FCO2 etc.). However, since PRIMES BASELINE 2009 forecasts are based on the year 2010 and they do not include the most recent changes in the economic environment (the economic crisis), short-term calibration for macroeconomic variables is conducted based on AMECO short-term forecasts. Therefore, the baseline scenario is made based on the modified PRIMES BASELINE 2009 forecasts.

The key advantage of the endogenous baseline projection is that it allows us to analyse different scenarios in order to find out how the results change relative to the baseline scenario. There are two baseline endogenous projections: SI endogenous baseline projection and EU endogenous baseline projection. For the SI endogenous baseline projection, calibration is only carried out for Slovenia while other European regions are treated as exogenous. This projection is used in analysis of scenarios that only affect Slovenia (e.g. a change in domestic tax rate). EU endogenous baseline projection involves simultaneously solving the E3ME model for the entire Europe. This projection is used for scenarios that will affect the entire Europe (e.g. a change in oil prices). If this solution is used, results for Slovenia will also include secondary effects from other European regions, brought about through international trade.

Since the introduction of the additional carbon tax in Slovenia is only affecting the Slovenian economy, SI endogenous projection will be used. The remaining part of Europe is treated as exogenous[10].

It is important to stress, that all scenarios that will be presented[11] are based on (1) historical data up to and including the year 2009 (energy and environmental components) or the year 2010 (economic components); (2) on government measures implemented by mid 2010; (3) and on long-term and short-term trends energy and environmental components, that are based on the European Commission projections from 2009 (PRIMES BASELINE 2009). Long-term trends for macroeconomic components are also based on European Commission projections from 2009 (PRIMES BASELINE 2009) while short-term macroeconomic components are based on the AMECO projections. This means that the effects of the economic crisis are only partially included and, as a result, the below results should be used with caution.

4.2. ANALYSIS OF INTRODUCTION OF AN ADDITIONAL CARBON TAX ON THE SLOVENIAN ECONOMY

It is assumed within the E3ME model that payment of carbon tax (tax on carbon dioxide) is levied on the users of fuels based on their emissions; however, only sectors outside ETS are taxed in order to avoid double taxation. The cost, or burden, of the tax is then shifted to the consumers through higher fuel prices.

10 We have also introduced the additional carbon tax in Slovenia by using EU endogenous baseline projection. The results were very similar.

11 Values of particular variables for all scenarios to be used herein are presented in Table A5 in the appendix.

In consequence, this means that we can expect the prices to rise while demand for fuel drops. It is assumed that higher prices will lead to a drop in real income. We can expect household consumption expenditure to decrease, which will in turn decrease demand and cause a drop in gross domestic product. As we assumed this change would not affect the European economy, we expect this will result in a drop of export competitiveness of the Slovenian economy due to higher prices, which will lead to a further decrease in GDP.

According to economic theory, the amount of carbon tax should be equal to the social cost incurred as a result of carbon pollution. Yohe et al. (2007) reviewed the estimates and found that costs estimates are highly unpredictable as they range from USD 1 per ton of carbon (tC) up to USD 1,500 per ton of carbon (tC). Average estimate of social cost of pollution with carbon dioxide for 2005 was USD 43/tC, with a standard deviation of USD 83/tC. The authors found that these costs rise at a rate of 2 to 4 percent per year. Assuming 4-percent annual growth since 2005, carbon pollution cost in 2012 would amount to an average of USD 55/tC or EUR 42/tC (i.e. EUR 11.5/tCO2. We set the amount of extra carbon tax to EUR 15/tCO2 (i.e. EUR 55/tC)[12].

In the article we compare two scenarios: baseline scenario in which no extra carbon tax is introduced and the projection of an introduction of an additional annual carbon tax in the amount of EUR 15 per ton of CO2 (EUR 15 per ton of carbon) for sectors beyond ETS, where all ecotax is recycled into the government budget. Comparison between the two projections is made for some key economic (household consumption expenditure, exports, gross domestic product, total manufacturing output, employment), energy (average fuel prices, demand for energy), and environmental variables (greenhouse emissions) which are presented in detail below.

Average fuel prices including tax (PJRT[13]) change the most in the first year following the introduction of the carbon tax in the amount of EUR 15/tCO2 (EUR 55/tC) (2012) when they rise by 3.67% relative to the baseline scenario in which no extra carbon tax is introduced. After the initial price hike, the price reaches a steady state at a higher figure which is maintained throughout the examined period. The difference in the average fuel price between the baseline scenario and projection that assumes an additional carbon tax of EUR 15/tCO2 (or EUR 55/tC) is approximately 3.5% throughout the period at hand (until 2030).

As expected, the introduction of an extra carbon tax of EUR 15/tCO2 (EUR 55/tC) drives up the average prices of fuel, which in turn causes a decrease in demand for fuels for energy production (FRO[14]). This drop relative to the baseline scenario is relatively the largest in the initial period, after which the decrease in demand for energy is steadied or slowed down. In 2013, for example, demand for energy resulting from the introduction of the carbon tax was projected to be lower by 0.83% compared to the baseline scenario; in 2020 by

12 Determination of the size of the ecotax has been aligned with the Institute of Macroeconomic Analysis and Development (UMAR). We have also used other numbers for ecotax, but we do not report them in the article.

13 PJRT = Average fuel price including tax (in EUR/toe). The model assumes 12 different fuel consumers.

14 FRO = Total demand for energy is in E3ME model measured in thousand tons toe. Model assumes 12 different fuel consumers.

1.64%; and in 2025 by 1.9%. Initial increase in prices and a considerable drop in demand relative to the baseline scenario are followed by a higher and steady level of fuel prices and accordingly lower demand for energy throughout the period of examination.

Household consumption expenditure (RSC[15]) is one of the most important macroeconomic aggregates, since it takes the largest share of GDP structure. Introduction of extra annual carbon tax of EUR 15/tCO2 (EUR 55/tC) would lead to the highest relative drop of household consumption expenditure in 2013 when the decrease amounts to 0.45% relative to the baseline scenario with no introduction of carbon tax. In principle, higher average prices of fuel lead to a decrease in real income which in turn decreases household consumption expenditure. This would result in a drop in aggregate demand and cause a decrease in gross domestic product. After 2013, the difference relative to the baseline scenario gradually decreases and by 2020, for example, consumption is only 0.27% lower compared to the baseline scenario. As expected, the difference between the two scenarios is the largest at the beginning of the period; after 2013, it is gradually decreasing. Moreover, the data shows a relatively low effect of the introduction of the carbon tax on the change in consumption. The reasons can be found in the time lag as the consumers require some time to adjust their behaviour and consumption pattern.

If the extra annual carbon tax in the amount of EUR 15/tCO2 (EUR 55/tC) is introduced, exports (RSX[16]) will decrease relative to the baseline scenario in which no carbon tax is introduced in the short run (until 2017), and increase after 2018. Such development is expected as we assumed the change would not affect the European economy. Higher prices expectedly hinder the export competitiveness of the Slovenian economy; however, the export sector's agility and dynamic character in terms of development of new technological solutions and updates will allow it to neutralize relatively quickly such loss of competitiveness. It should also be noted that changes in exports relative to the baseline scenario are very small (up to a maximum of 0.009%), which points to a relatively low impact of the carbon tax on Slovenian exports.

Introduction of extra annual carbon tax in the amount of EUR 15/tCO2 (EUR 55/tC) would lead to the highest drop of Slovenia's GDP (RGDP[17]) in 2013 when the decrease would amount to 0.3% relative to the baseline scenario with no introduction of carbon tax. This is consistent with our expectations. It has been shown in our previous analysis that higher fuel prices lead to a decrease of real income. As a result, household consumption expenditure will decrease, which will in turn decrease demand and cause a drop in gross domestic product. As we assumed this change would not affect the European economy, higher prices would also result in a drop of export competitiveness of the Slovenian economy, which would lead to a further decrease in GDP. Moreover, the data shows a relatively low effect of the introduction of the said tax on the change in GDP. After 2013, the difference between the two scenarios gradually decreases and by 2020, for example, GDP is only

15 RSC = Household consumption expenditure is in E3ME model measured in EUR million. The model assumes 43 different types of expenditure.

16 RSX = Exports are measured in E3ME model in million euro.

17 RGDP = Gross domestic product is in E3ME model measured by the expenditure method in current market prices in millions of euro.

0.12% lower in case of introduction of the carbon tax compared to the baseline scenario. This conforms to our expectations and the theoretical findings as economic agents require some time to adjust to the new circumstances. Businesses need time to implement technological improvements and updates, and consumers need time to adjust their consumption behaviour and patterns.

We are also interested in the effect of an extra yearly carbon tax of EUR 15/tCO2 (EUR 55/tC) on manufacturing output (QR[18]). The highest drop relative to the baseline scenario would be in 2015. In that year, the difference would amount to 0.32%. Here too, it is evident that introduction of carbon tax in the amount of EUR 15/tCO2 (or EUR 55/tC) has a relatively small effect on production. The difference between the two scenarios is, expectedly, the highest at the start of the period. After 2013, this difference is gradually decreasing so that the deviation from the baseline scenario in 2015 is no more than 0.01%. Technological and organizational updates allowed the enterprises to adapt to the new conditions after a certain period of time. According to the projection, the latter effect prevails in the long run, after 2027.

Employment (YRE[19]) shows a similar dynamics as manufacturing output. Employment is gradually decreasing relative to the baseline scenario. The highest drop in comparison to the baseline scenario can be seen in 2016 when it amounts to 0.36%. There are hardly any differences between the two scenarios at the end of the period. The effect of an additional carbon tax of EUR 15/tCO2 (or EUR 55/tC) on employment appears to be relatively low, similarly to the effect on GDP and manufacturing output.

As expected, the introduction of an extra carbon tax of EUR 15/tCO2 (EUR 55/tC) gradually decreases greenhouse gas emissions (RGHG[20]) in CO2 equivalents. This includes emissions of CO2, CH4, N2O, HFCs, PFCs and SF6. For example, the highest drop in emissions relative to the baseline scenario is seen in 2012 (by 0.6%) and 2013 (by an extra 0.5%) to –1.2%. The decrease in emissions in comparison to the baseline scenario is steadied at approximately 2% after 2020.

4.3. ANALYSIS OF DIFFERENT FORMS OF REVENUE RECYCLING IN CASE OF EXTRA CARBON TAX IN THE SLOVENIAN ECONOMY

Introduction of an extra annual carbon tax of EUR 15/tCO2 (EUR 55/tC) on an annual basis for the period 2012–2030 would result in additional annual tax revenue ranging from a minimum amount of EUR 144.6 million in year 2012 to a maximum amount of EUR 160.1 million in year 2020. The additional tax revenue can be allocated to the economy through different revenue recycling options. We compare the following five revenue recycling options (in each option we have introduced a yearly carbon tax of EUR 15/tCO2 (EUR 55/tC), while other assumptions remain the same as in the baseline scenario):

18 QR = total manufacturing output (EUR million). The model is based on an analysis of 42 different sectors.

19 YRE = Employment (thousands). The model is based on an analysis of 42 different industries.

20 RGHG = Greenhouse gas emissions (in CO2 equivalent thousands of tons)

a) The first scenario analyses the effects of introduction of the extra carbon tax and revenue recycling through a decrease in the budget deficit and tax revenue.
b) In the second scenario, we study the effects of revenue recycling through a decrease in social security contributions for the workers/employees, equivalent to the amount of green tax revenue (fiscal neutrality). Although the yearly decrease of workers' social contributions varies by year, depending on the green tax collected, the average decrease in the period 2012-2030 was 0.6 percentage points i.e. the worker social contributions were on average equal to 18.0% in the observed period (2012-2030).
c) In the third scenario we analyse the effects of revenue recycling through a corresponding decrease in social security contributions payable by the employers subject to the principle of fiscal neutrality. Although the yearly decrease of employers' social contributions varies by year, depending on the green tax collected, the average decrease in the period 2012-2030 was 0.6 percentage points i.e. the employers' social contributions were on average equal to 13.0% in the observed period.
d) In the fourth scenario we allocate the green tax revenue for covering the budget deficit in the period from 2012 to 2016, and for a decrease in workers' social security contributions in 2017 and thereafter. Assuming fiscal neutrality, green tax revenue were first allocated to the budget (period 2012-2016) and for the period 2017-2030 we decreased the workers' social security contributions on average to 18.1%.
e) In the fifth scenario, revenue is recycled through a decrease in budget deficit in the first five years (2012–2016); then, social security contributions payable by the employers are decreased by the relevant amount. Applying the principle of fiscal neutrality, the latter were decreased on average to 13.1% (0.5 percentage points) in the period 2017–2030.

A comparison between different types of recycling will be made especially for some key economic variables (household consumption expenditure, gross domestic product, manufacturing output, employment). Analysis of revenue recycling will be based on a comparison of the second, third, fourth, and fifth scenario, respectively, to the first one. We wish to determine the existence of the double dividend based on a decrease of some social security contributions, improvement in cost competitiveness and the resulting rise in GDP and employment.

Effect on household consumption expenditure

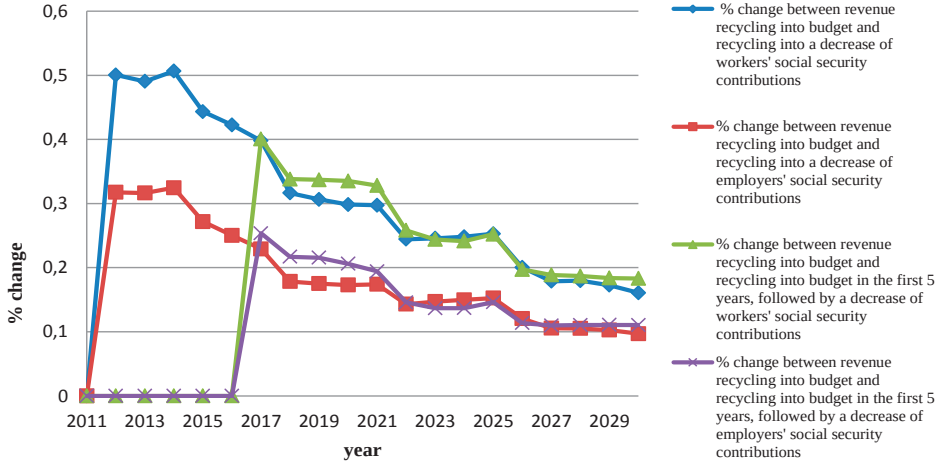
Figure 1 presents the effect on household consumption expenditure (RSC) in case of different options of recycling of the revenue generated by the extra yearly carbon tax in the amount of EUR 15/tCO2. In our analysis, four scenarios (2nd, 3rd, 4th, and 5th scenario) are compared to the projection in which all carbon tax revenue is allocated exclusively for covering the budget deficit (first scenario). Figure 1 shows that the positive effect on household consumption expenditure in all four scenarios is stronger than in case of the projection in which all generated tax revenue is allocated exclusively for covering the budget deficit (first scenario). This is expected as additional relief through lower social contributions may increase the general population's purchasing power as net wages rise.

Furthermore, it can be observed that revenue recycling through workers' social contributions has a higher effect on household consumption expenditure than recycling through

social security contributions payable by the employers in the entire period at hand (both relative to the first scenario). The difference in household consumption expenditure between the two revenue recycling options is decreasing through the years. The reasons can be found in the fact that a decrease in employers' social security contributions would translate to a lower extent into an increase in net wages and the resulting increase in consumption than it would be the case if social security contributions were decreased for the workers.

The result is similar in the case where we allocate the green tax revenue for covering the budget deficit in the period from 2012 to 2016, and for a decrease in workers' social security contributions in 2017 and thereafter. In this case, too, decrease of social security contributions for the workers has a stronger positive effect on household consumption expenditure than a decrease of social security contributions for the employers (both in comparison to the first scenario). Similar as before, the differences between the two scenarios through the years are gradually decreasing. Figure 1 also shows that the best scenarios from the aspect of revenue recycling are the ones that decrease social security contributions for the workers (scenarios 2 and 4). These two scenarios are only different in the first five years; after that, their results tend to match. Similar match can be seen between the two scenarios in which the employer's social security contributions are reduced. It should also be noted that the differences between all scenarios referred to are relatively small.

Figure 1: *Comparison between different forms of carbon tax revenue recycling from the aspect of effect on household consumption expenditure, RSC.*



Source: E3ME program and own calculations.

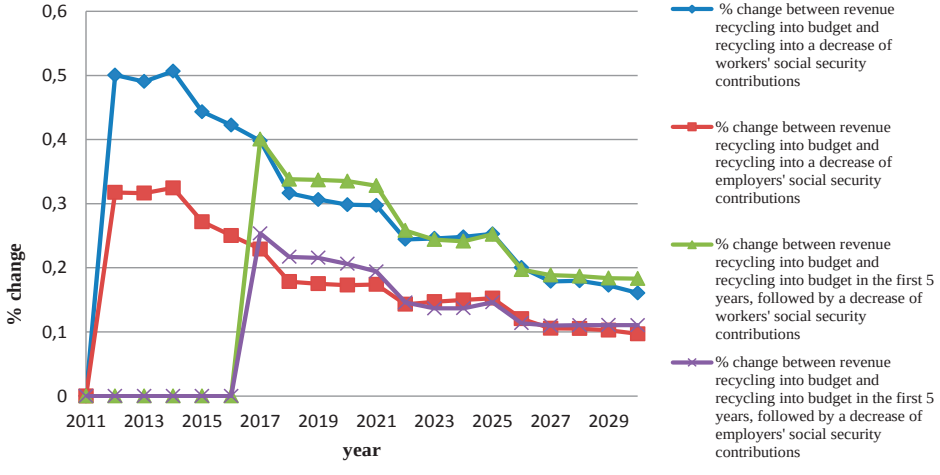
Effect on gross domestic product

Figure 2 shows the effect of introduction of a yearly carbon tax in the amount of EUR 15/tCO2 on GDP (RGDP) in different cases of tax revenue recycling. In our analysis, four scenarios (2nd, 3rd, 4th, and 5th scenario) are compared to the first scenario in which

all carbon tax revenue is allocated exclusively for covering the budget deficit. It is evident from Figure 2 that the positive effect on GDP in all four scenarios is stronger than in case of the projection in which all generated tax revenue is allocated exclusively for covering the budget deficit. This matches our expectations as additional relief of labour costs through a decrease in social security contributions payable by the employers or the workers translates into an increase in household purchasing power and in turn an increase in GDP. The positive effect is stronger in case of revenue recycling through a decrease in worker's social security contributions in the entire period at hand (both relative to the first scenario). The difference between the two revenue recycling options is decreasing through the examined period. The reasons for this can be found in higher household consumption expenditure (see previous section) which is the largest component of GDP.

The result is similar in the case where green tax revenue is allocated for covering the budget deficit in the period from 2012 to 2016, and for a decrease in social security contributions in 2017 and beyond. Decrease of social security contributions for the workers has a stronger positive effect on household consumption expenditure than a decrease of social security contributions for the employers (both in comparison to the first scenario). In this case, too, the differences between the two scenarios are gradually decreasing through the years. Figure 2 also shows that the best scenarios from the aspect of revenue recycling are the ones that decrease social security contributions for the workers (scenarios 2 and 4). These two scenarios are only different in the first five years; after that, their results tend to match. Similar match can be seen between the two scenarios in which the employer's social security contributions are reduced. It should again be noted that the differences between all scenarios in terms of discrepancy relative to the first scenario are relatively small.

Figure 2: *Comparison between different forms of carbon tax revenue recycling from the aspect of effect on gross domestic product, RGDP.*



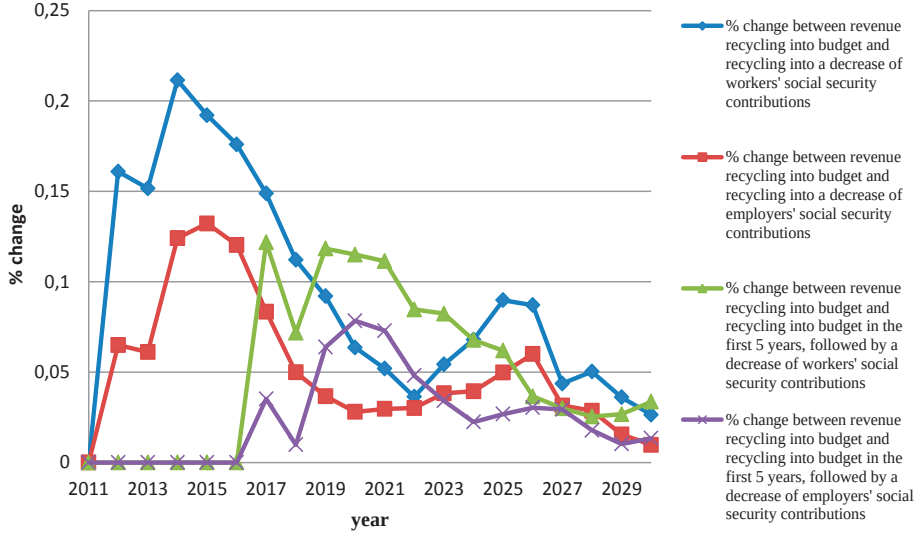
Source: E3ME program and own calculations.

Effect on total manufacturing output

Following is a presentation of the effect of carbon tax introduction on manufacturing output (QR) in case of different forms of recycling. Figure 3 compares four scenarios to the projection in which all carbon tax revenue, is allocated exclusively for covering the budget deficit (first scenario). It is evident from Figure 3 that the positive effect on manufacturing output in all four scenarios (2nd, 3rd, 4th, and 5th) is stronger than in case of the projection in which all generated tax revenue is allocated exclusively for covering the budget deficit. Higher cost relief through a decrease in social security contributions of the employer or the worker and the resulting improvement in cost efficiency appears to motivate total manufacturing output as well.

Recycling through a reduction in social security contributions of the workers has a more positive effect on production than recycling through decrease in social security contributions for the employers in the period 2012–2030 (both relative to the first scenario). The result is similar in the case where we allocate the green tax revenue for covering the budget deficit in the period from 2012 to 2016, and for a decrease in social security contributions in 2017 and thereafter. In both cases, decrease of social security contributions for the workers has a stronger positive effect on manufacturing output than a decrease in the employer's social security contributions. Again, the differences between all scenarios in terms of discrepancy relative to the first scenario are relatively small.

Figure 3: *Comparison between different forms of carbon tax revenue recycling from the aspect of total manufacturing output, QR.*



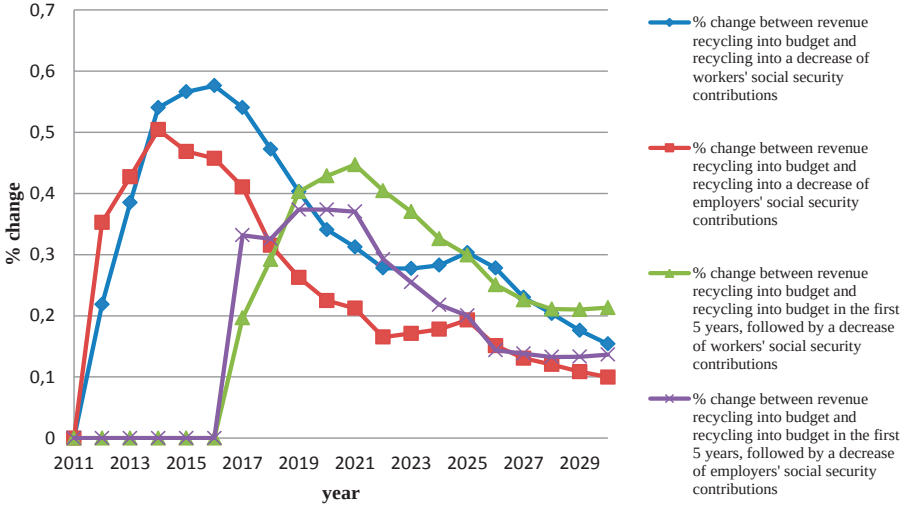
Source: E3ME program and own calculations.

Effect on employment

Following is a presentation of the effect of carbon tax introduction on employment (YRE) in case of different forms of recycling. Four scenarios are compared to the projection in which all carbon tax revenue, is allocated exclusively for covering the budget deficit (first scenario). Figure 4 shows that the positive effect on employment in all four scenarios (2nd, 3rd, 4th, and 5th) is stronger than in case of the projection in which all generated tax revenue is allocated exclusively for covering the budget deficit. Higher cost relief through a decrease in social security contributions (of the employer or the worker) evidently has a positive effect on employment, which is also consistent with the previous two figures.

Revenue recycling through a decrease of the employer's social security contributions has a stronger effect on employment than revenue recycling through worker's social security contributions, but only in the short run until the year 2014. In the long run, the opposite is true; after 2015, the difference between the second and the third scenario is constant. If carbon tax revenue is allocated for covering the budget deficit in the period 2012–2016 and for a decrease in social security contributions in 2017 and beyond, the conclusion is similar. In this case, too, revenue recycling has a stronger effect in the short run (until 2018) if the employer's social security contributions are decreased. Differences between all analyzed scenarios are relatively small in terms of discrepancy relative to the first scenario.

Figure 4: *Comparison between different forms of recycling in case of carbon tax introduction from the aspect of employment, YRE*



Source: E3ME program and own calculations.

5. CONCLUSION

The main goal of the environmental tax reform is economic and environmental improvement. Environmental dividend involves reduction in emissions, while economic dividend has to do with improved cost competitiveness, higher growth, and higher employment. Our primary goal was to determine the effect of an extra carbon tax (EUR 15 per ton of CO2 i.e. EUR 55 per ton of carbon) in the period 2012–2030 on Slovenian economy, in order to determine whether a carbon tax would indeed yield a double dividend.

In the first section, we analysed the effects of the introduction of a yearly carbon tax (EUR 15 per ton of CO2) relative to the baseline projection (in which no tax is introduced) in the period 2012–2030, using the E3ME model. Our analysis has shown that average prices of fuels will increase which will reduce demand for fuels. Higher prices will also lead to lower household consumption expenditure, which would decrease aggregate demand and result in a drop of GDP. GDP would be additionally decreased in the short run by lower export competitiveness of the Slovenian economy, resulting from higher prices, as we assumed that the change in prices would not affect the European economy. In the medium and long run, the effect of carbon tax on the change in GDP, relative to the baseline scenario (i.e. no carbon tax), is always lower. This conforms to our expectations and the theoretical findings as economic agents require some time to adjust to the new circumstances. The E3ME model has shown that Slovenian export sector would look to introduce new technological solutions and updates, thereby neutralizing relatively quickly the negative effects of the introduction of the carbon tax on the competitiveness of the Slovenian economy. Similar dynamics and oscillation as in GDP can be observed in manufacturing output and employment. Greenhouse emissions, too, are reduced in the model, at approximately the same rate.

Economic policy developers in Slovenia, as in many other European countries with implemented environmental tax reform, should be aware that introduction of a carbon tax in Slovenia would have more negative effects in the short run than in the medium and long run. It is therefore of key importance for the success of the green tax reform to introduce the extra carbon tax gradually, transparently, and predictably. This would allow enough time for economic agents to adapt, and for economic policy developers to evaluate the first effects of the green tax reform and to make any adjustments if discrepancies from the planned goals are identified in the course of the reform. This would also prevent recurring discussions as to the urgency of increase of some tax rates and political pressure to decrease such rates as a result of higher prices of oil and petrochemicals in the global market.

In the second section, we used the E3ME model to analyze the effects of different forms of tax revenue recycling, either through a decrease in the budget deficit or through a decrease of social security contributions payable by either the employers or the workers, in case of a yearly carbon tax in the amount of EUR 15 per ton of CO2 in the period 2012–2030. Our analysis has shown that recycling through lowering the social security contributions for workers (2nd and 4th scenario) and employers (3rd and 5th scenario) have a stronger positive effect on household consumption expenditure than the scenario in which all revenue is allocated exclusively for covering the budget deficit (first scenario). Differences between the

recycling scenarios are relatively small. Additional relief through a decrease in social security contributions in case of an extra carbon tax would increase the purchasing power of the general population (household consumption expenditure), which would in turn increase the GDP. Higher cost relief through a decrease in social security contributions also has a positive effect on total manufacturing output and employment. We have also shown that recycling through a decrease in social security contributions of workers has a stronger positive economic effect than recycling through a decrease in employers' social security contributions in the entire period at hand. The result is similar in the case where we allocate the green tax revenue for covering the budget deficit in the period from 2012 to 2016, and for a decrease in workers' or employers' social security contributions in 2017 and thereafter.

Policy implications for the Slovenian government are twofold. Firstly, scenarios in which all revenue is allocated exclusively for lowering the social security contributions for workers/employers have a stronger positive economic effect than the scenario in which all revenue is allocated exclusively for covering the budget deficit. Secondly, the optimal fiscal instrument for improving the environmental (first dividend) and economic welfare (second dividend) seems to be recycling through a decrease in social security contributions of workers. The reasons can be found in the fact that a decrease in employers' social security contributions would translate to a lower extent into an increase in net wages and the resulting increase in consumption than it would be the case if social security contributions were decreased for the workers.

However, an environmental tax reform cannot be successful if the political reality in Slovenia is disregarded. As a rule, economists design optimum policy mixes for the attainment of certain goals; however, politics often requires compromises. Experience from other countries has shown that the key to their success was the high rate of consent of all political parties and civil society regarding the urgency of an environmental tax reform. Therefore, the Slovenian government should inform the public about the negative effects of an extra carbon tax. Public support will be higher, if an effective system of measures is put into place to neutralize the harmful effects of the additional carbon tax.

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APPENDIX

Table A1: *PRIMES (Baseline 2009) for Slovenia.*

Slovenia: Baseline 2009										SUMMARY ENERGY BALANCE AND INDICATORS (A)			
ktoe	**1990**	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**'90-'00**	**'00-'10**	**'10-'20**	**'20-'30**
										Annual % Change			
Production	**2902**	**3020**	**3085**	**3492**	**3657**	**4019**	**4221**	**4801**	**4928**	**0.6**	**1.7**	**1.4**	**1.6**
Solids	1432	1216	1062	1184	1252	1505	1573	745	823	-2.9	1.7	2.3	-6.3
Oil	3	2	1	0	0	0	0	0	0	-10.4			
Natural gas	20	16	6	3	4	0	0	0	0	-11.4	-4.9		
Nuclear	1192	1245	1228	1518	1557	1557	1557	2904	2904	0.3	2.4	0.0	6.4
Renewable energy sources	254	542	788	787	845	957	1091	1152	1201	12.0	0.7	2.6	1.0
Hydro	254	279	330	298	338	353	365	366	368	2.7	0.2	0.8	0.1
Biomass & Waste	0	263	458	488	502	568	653	690	715		0.9	2.7	0.9
Wind	0	0	0	0	0	6	14	20	24				5.2
Solar and others	0	0	0	0	6	31	57	74	92			26.2	4.9
Geothermal	0	0	0	0	0	1	1	1	1			28.1	4.1
Net Imports	**2572**	**3063**	**3381**	**3825**	**4276**	**4824**	**5248**	**4846**	**4586**	**2.8**	**2.4**	**2.1**	**-1.3**
Solids	130	186	245	323	269	293	373	233	216	6.5	0.9	3.3	-5.3
Oil	1804	2239	2430	2804	3075	3546	3735	3645	3474	3.0	2.4	2.0	-0.7
- Crude oil and Feedstocks	598	589	151	0	1	1	1	1	1	-12.8	-38.2	1.9	-0.4
- Oil products	1206	1650	2278	2804	3074	3544	3734	3644	3473	6.6	3.0	2.0	-0.7
Natural gas	723	750	820	925	960	1073	1239	1153	1098	1.3	1.8	2.4	-1.2
Electricity	-85	-142	-114	-28	-58	-115	-135	-246	-270				
Gross Inland Consumption	**5523**	**6111**	**6427**	**7299**	**7904**	**8808**	**9431**	**9607**	**9473**	**1.5**	**2.1**	**1.8**	**0.0**
Solids	1645	1402	1306	1539	1521	1798	1946	978	1039	-2.3	1.5	2.5	-6.1
Oil	1754	2290	2393	2554	3046	3511	3698	3606	3434	3.2	2.4	2.0	-0.7
Natural gas	763	746	826	929	984	1073	1239	1153	1098	0.8	1.8	2.3	-1.2
Nuclear	1192	1245	1228	1518	1557	1557	1557	2904	2904	0.3	2.4	0.0	6.4
Electricity	-85	-142	-114	-28	-58	-115	-135	-246	-270				
Renewable energy forms	254	571	788	787	855	983	1127	1213	1299	12.0	0.8	2.8	1.2
as % in Gross Inland Consumption													
Solids	29.8	22.9	20.3	21.1	19.2	20.4	20.6	10.2	11.0				
Oil	31.8	37.5	37.2	35.0	38.5	39.9	39.2	37.5	36.2				
Natural gas	13.8	12.2	12.8	12.7	12.5	12.2	13.1	12.0	11.6				
Nuclear	21.6	20.4	19.1	20.8	19.7	17.7	16.5	30.2	30.7				
Renewable energy forms	4.6	9.3	12.3	10.8	10.8	11.2	11.9	12.6	13.4				
Gross Electricity Generation in GWh$_e$	**12440**	**12652**	**13622**	**15114**	**16193**	**18404**	**20168**	**22179**	**22930**	**0.9**	**1.7**	**2.2**	**1.3**
Self consumption and grid losses	1584	1497	1662	1943	1965	2244	2385	2400	2804	0.5	1.7	2.0	1.6
Fuel Inputs for Thermal Power Generation	**1543**	**1523**	**1342**	**1507**	**1622**	**1987**	**2248**	**1272**	**1349**	**-1.4**	**1.9**	**3.3**	**-5.0**
Solids	1296	1315	1253	1411	1431	1702	1849	886	959	-0.3	1.3	2.6	-6.4
Oil (including refinery gas)	155	119	12	9	2	7	2	6	5	-22.8	-15.5	-0.9	10.6
Gas	92	90	62	58	147	165	274	232	235	-3.8	9.0	6.4	-1.6
Biomass & Waste	0	0	15	30	42	114	120	148	151		10.5	11.1	2.3
Geothermal heat	0	0	0	0	0	0	0	0	0				
Hydrogen - Methanol	0	0	0	0	0	0	0	0	0				
Fuel Input in other transformation proc.	**596**	**582**	**253**	**90**	**93**	**175**	**225**	**315**	**343**	**-8.2**	**-9.5**	**9.2**	**4.3**
Refineries	542	505	170	1	1	1	1	1	1	-11.0	-38.9	1.9	-0.4
Biofuels and hydrogen production	0	0	0	0	39	106	173	212	238			16.0	3.3
District heating	53	76	83	89	53	68	50	102	103	4.7	-4.5	-0.5	7.4
Others	1	1	0	0	0	0	0	0	0				
Energy Branch Consumption	**122**	**121**	**112**	**104**	**112**	**131**	**137**	**134**	**166**	**-0.9**	**0.0**	**2.1**	**1.9**
Non-Energy Uses	**6**	**122**	**238**	**310**	**351**	**406**	**446**	**465**	**468**	**43.8**	**4.0**	**2.4**	**0.5**
Final Energy Demand	**3373**	**3948**	**4440**	**4892**	**5448**	**6167**	**6597**	**6576**	**6393**	**2.8**	**2.1**	**1.9**	**-0.3**
by sector													
Industry	1469	1180	1424	1657	1693	1835	1977	1908	1837	-0.3	1.7	1.6	-0.7
- energy intensive industries	729	587	840	1038	1046	1149	1248	1201	1152	1.4	2.2	1.8	-0.8
- other industrial sectors	740	593	585	619	647	686	730	707	685	-2.3	1.0	1.2	-0.6
Residential	853	1180	1124	1186	1205	1305	1355	1371	1365	2.8	0.7	1.2	0.1
Tertiary	122	259	580	575	569	604	610	609	593	16.9	-0.2	0.7	-0.3
Transport	930	1329	1312	1475	1981	2423	2655	2688	2598	3.5	4.2	3.0	-0.2
by fuel													
Solids	243	115	97	80	60	63	63	60	52	-8.6	-4.7	0.5	-1.9
Oil	1513	2106	2239	2404	2857	3283	3450	3334	3153	4.0	2.5	1.9	-0.9
Gas	603	468	569	665	655	695	753	679	630	-0.6	1.4	1.4	-1.8
Electricity	837	807	905	1096	1153	1263	1382	1441	1447	0.8	2.5	1.8	0.5
Heat (from CHP and District Heating) [A]	177	192	195	196	257	363	336	422	434	1.0	2.8	2.7	2.6
Renewable energy forms	0	260	435	452	466	500	612	640	675		0.7	2.8	1.0
Other	0	0	0	0	0	0	1	1	1			11.9	0.8
RES in Gross Final Energy Consumption [B]			**768**	**810**	**832**	**911**	**1093**	**1177**	**1230**		**0.8**	**2.8**	**1.2**
TOTAL GHGs Emissions (Mt of CO_2 eq.)	**18.1**		**18.6**	**20.1**	**21.3**	**24.1**	**25.6**	**20.8**	**18.9**	**0.3**	**1.4**	**1.8**	**-3.0**
of which ETS sectors GHGs emissions				9.0	8.8	10.2	11.2	7.1	5.7			2.5	-6.5
CO_2 Emissions (energy related)	**13.2**	**14.1**	**14.0**	**15.3**	**16.7**	**19.3**	**20.8**	**16.3**	**14.4**	**0.6**	**1.8**	**2.2**	**-3.6**
Power generation/District heating	6.2	6.2	5.5	6.2	6.4	7.6	8.4	4.4	3.2	-1.1	1.4	2.8	-9.1
Energy Branch	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	-0.9			
Industry	2.5	1.8	2.3	2.3	2.2	2.3	2.5	2.0	1.8	-0.7	-0.8	1.3	-3.1
Residential	1.7	2.1	1.3	1.4	1.5	1.6	1.6	1.6	1.5	2.5	1.3	0.8	-0.7
Tertiary	0.0	0.0	1.0	1.0	0.9	1.0	0.9	0.9	0.9	47.0	-0.1	-0.1	-1.0
Transport	2.7	3.9	3.8	4.3	5.8	6.9	7.4	7.4	7.0	3.5	4.3	2.5	-0.5
CO_2 Emissions (non energy related)	**1.1**	**0.9**	**0.9**	**1.1**	**1.1**	**1.2**	**1.4**	**1.4**	**1.4**	**-1.9**	**1.8**	**2.1**	**0.2**
Non-CO_2 GHGs Emissions	**3.8**		**3.7**	**3.7**	**3.5**	**3.5**	**3.4**	**3.2**	**3.1**	**-0.4**	**-0.6**	**-0.1**	**-1.0**
TOTAL GHGs Emissions Index (1990=100)	**100.0**		**102.8**	**110.8**	**117.6**	**133.1**	**141.2**	**115.1**	**104.4**				

SUMMARY ENERGY BALANCE AND INDICATORS (B)										Slovenia: Baseline 2009			
	1990	1995	2000	2005	2010	2015	2020	2025	2030	'90-'00	'00-'10	'10-'20	'20-'30
										Annual % Change			
Main Energy System Indicators													
Population (Million)	1.996	1.989	1.988	1.996	2.034	2.053	2.058	2.047	2.023	0.0	0.2	0.1	-0.2
GDP (in 000 MEuro'05)	20.0	19.4	24.0	28.7	32.7	38.4	44.0	48.2	50.7	1.9	3.1	3.0	1.4
Gross Inl. Cons./GDP (toe/MEuro'05)	276.7	315.3	267.9	254.2	241.6	229.5	214.3	199.5	186.8	-0.3	-1.0	-1.2	-1.4
Carbon intensity (t of CO_2/toe of GIC)	2.39	2.30	2.18	2.09	2.12	2.20	2.20	1.69	1.52	-0.9	-0.3	0.4	-3.6
Import Dependency %	46.6	50.1	52.6	52.3	53.9	54.5	55.4	50.2	48.2				
Total Energy-related Costs [C] (in 000 M€05)			3.6	3.9	4.8	6.2	7.9	8.9	9.2		3.0	6.0	1.6
as % of GDP			15.0	13.6	14.8	16.2	17.9	18.4	18.1				
Energy intensity indicators													
Industry (Energy on Value added)	109.1	109.6	100.0	92.4	82.7	76.8	73.2	67.1	63.9	-0.9	-1.9	-1.2	-1.4
Residential (Energy on Private Income)	99.0	123.5	100.0	92.2	85.2	79.3	71.5	65.3	60.7	0.1	-1.6	-1.7	-1.6
Tertiary (Energy on Value added)	27.6	54.1	100.0	82.4	72.6	65.0	57.1	51.6	47.0	13.7	-3.2	-2.4	-1.9
Passenger transport (toe/Mpkm)	33.4	45.5	38.5	32.6	32.1	31.2	30.3	27.5	24.6	1.4	-1.8	-0.6	-2.1
Freight transport (toe/Mtkm)	22.8	56.0	42.7	41.9	46.1	47.0	45.2	43.2	40.6	6.5	0.8	-0.2	-1.1
Carbon Intensity indicators													
Electricity and Steam production (t of CO_2/MWh)	0.42	0.41	0.34	0.34	0.32	0.32	0.34	0.16	0.11	-2.0	-0.7	0.5	-10.5
Final energy demand (t of CO_2/toe)	2.05	1.99	1.89	1.86	1.90	1.91	1.88	1.81	1.75	-0.8	0.0	-0.1	-0.7
Industry	1.72	1.55	1.65	1.39	1.28	1.23	1.25	1.06	0.96	-0.4	-2.5	-0.3	-2.4
Residential	1.98	1.81	1.17	1.21	1.24	1.23	1.19	1.14	1.11	-5.2	0.6	-0.4	-0.7
Tertiary	0.17	0.13	1.85	1.78	1.86	1.84	1.54	1.49	1.44	25.7	0.0	-0.8	-0.7
Transport	2.88	2.91	2.89	2.94	2.91	2.85	2.78	2.74	2.70	0.0	0.1	-0.4	-0.3
Indicators for renewables (excluding industrial waste) (%) [B]													
RES in gross final energy demand (%)			16.7	15.9	14.7	14.2	15.9	17.2	18.4				
RES in transport (%)			0.5	0.3	2.3	4.7	6.8	8.3	9.6				
Gross Electricity generation by fuel type (in GWh)			13622	15114	16193	18404	20168	22179	22930		1.7	2.2	1.3
Nuclear energy			4760	5883	6035	6035	6035	12480	12480		2.4	0.0	7.5
Coal and lignite			4630	5314	5179	6738	7501	3182	3777		1.1	3.8	-6.6
Petroleum products			40	34	9	19	8	14	13		-14.0	-0.8	4.6
Gas (including derived gases)			313	324	869	897	1604	1281	1306		10.8	6.3	-2.0
Biomass & waste			45	100	171	529	555	645	659		14.3	12.5	1.7
Hydro			3833	3460	3927	4100	4249	4256	4283		0.2	0.8	0.1
Wind			0	0	0	66	167	234	278				5.2
Solar, tidal etc.			0	0	3	20	48	86	135			32.5	10.9
Geothermal and other renewables			0	0	0	0	0	0	0				
Net Generation Capacity in MW_e			2748	3084	3293	4039	3971	4548	4846		1.8	1.9	2.0
Nuclear energy			696	696	706	706	706	1515	1515		0.1	0.0	7.9
Renewable energy			846	983	1041	1175	1388	1506	1623		2.1	2.9	1.6
Hydro (pumping excluded)			846	983	1038	1079	1147	1149	1166		2.1	1.0	0.2
Wind			0	0	0	75	191	267	317				5.2
Solar			0	0	3	21	50	90	140			32.5	10.9
Other renewables (tidal etc.)			0	0	0	0	0	0	0				
Thermal power			1206	1424	1547	2158	1877	1527	1707		2.5	2.0	-0.9
of which cogeneration units			453	389	448	614	589	649	644		-0.1	2.8	0.9
of which CCS units			0	0	0	0	0	0	185				
Solids fired			948	947	894	1495	1244	870	1039		-0.6	3.4	-1.8
Gas fired			223	446	624	626	552	573	585		10.8	-1.2	0.6
Oil fired			17	10	10	10	2	1	1		-5.2	-13.6	-12.0
Biomass-waste fired			17	21	19	27	79	83	83		1.4	15.2	0.5
Fuel Cells			0	0	0	0	0	0	0				
Geothermal heat			0	0	0	0	0	0	0				
Load factor for net electric capacities (%)			53.1	52.3	52.8	48.7	54.5	52.7	50.3				
Efficiency for thermal electricity production (%)			32.2	32.9	33.0	35.4	37.0	34.6	36.7				
CHP indicator (% of electricity from CHP)			7.2	8.2	12.5	18.7	19.0	16.9	16.4				
CCS indicator (% of electricity from CCS)			0.0	0.0	0.0	0.0	0.0	0.0	8.3				
Non fossil fuels in electricity generation (%)			63.4	62.5	62.6	58.4	54.8	79.8	77.8				
- nuclear			34.9	38.9	37.3	32.8	29.9	56.3	54.4				
- renewable energy forms and industrial waste			28.5	23.6	25.3	25.6	24.9	23.5	23.3				
Transport sector													
Passenger transport activity (Gpkm)	**21.6**	**21.4**	**25.0**	**26.9**	**29.5**	**32.8**	**35.6**	**37.1**	**38.0**	**1.5**	**1.7**	**1.9**	**0.7**
Public road transport	6.5	4.1	3.5	3.1	3.3	3.5	3.7	3.8	3.8	-6.0	-0.6	1.1	0.4
Private cars and motorcycles	13.5	16.5	20.5	22.7	24.9	27.8	30.1	31.4	32.1	4.3	2.0	1.9	0.6
Rail	1.4	0.6	0.7	0.8	0.8	0.9	1.0	1.1	1.1	-6.8	1.7	1.9	1.1
Aviation	0.2	0.2	0.3	0.4	0.5	0.6	0.7	0.9	1.0	3.7	4.9	4.7	3.3
Inland navigation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
Freight transport activity (Gtkm)	**9.1**	**6.4**	**8.2**	**14.3**	**22.4**	**29.8**	**34.8**	**38.6**	**40.9**	**-1.1**	**10.6**	**4.5**	**1.6**
Trucks	4.9	3.3	5.3	11.0	18.4	25.2	29.3	32.5	34.6	0.8	13.3	4.7	1.7
Rail	4.2	3.1	2.9	3.2	4.0	4.6	5.5	6.0	6.3	-3.8	3.4	3.3	1.3
Inland navigation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
Energy demand in transport (ktoe)	**930**	**1329**	**1312**	**1475**	**1981**	**2423**	**2655**	**2688**	**2598**	**3.5**	**4.2**	**3.0**	**-0.2**
Public road transport	51	33	27	23	25	26	26	26	25	-6.2	-0.9	0.3	-0.2
Private cars and motorcycles	642	918	909	829	892	961	1012	951	859	3.5	-0.2	1.3	-1.6
Trucks	181	329	316	570	1000	1362	1535	1625	1635	5.8	12.2	4.4	0.6
Rail	29	29	34	29	35	40	43	42	31	1.4	0.3	2.1	-3.2
Aviation	27	20	25	23	29	35	40	44	48	-0.8	1.6	3.3	1.9
Inland navigation	0	0	0	0	0	0	0	0	0				

Source: EU energy trends to 2030 – update 2009 (2010), pp. 114-115.

Table A2: *Equation summary.*

Equ'n set	Endog var	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	Units	NVAR 2
1	FR0	FRY	PREN	FRTD	ZRDM	ZRDT	FRK	RDEU				th.toe	9
2-5	FRF	FR0	PFRF	FRTD	ZRDM	ZRDT	FRK	RDEU				th.toe	9
6	RSCP	PRPDP	RRLR	CDEP	ODEP	RVD	RDEU	RUNR	RPSC			m euro 2000 prices	10
7	CR/RMAC	PRPDP	PRCR	RRLR	PRSC	CDEP	ODEP	RDEU				consumption ratio	9
10	KR	YR	PKR/PYR	YRWC	PQRM(3)	RDEU	RRLR	YYN				m euro 2000 prices	9
11	QEX	QWXI	PQEX	PQRW	YRKC	YRKN	SVIM	RDEU				m euro 2000 prices	9
12	QIX	QZXI	PQRX	PQRZ	YRKC	YRKN	SVIM	RDEU				m euro 2000 prices	9
13	QEM	QRDI	PQRM	PYH	EX	YRKC	YRKN	SVIM	RDEU	YYN		m euro 2000 prices	11
14	QIM	QRDI	PQRM	PYH	EX	YRKC	YRKN	SVIM	RDEU	YYN		m euro 2000 prices	11
15	YRH	YNH	YRKC	YRKN	RDEU	YYN						hours per week	7
16	YRE	YR	LYLC	YRH	PQRM(3)	YRKC	YRKN	RDEU				thousd	9
17	PYH	YRUC	PQRM	YRKC	YRKN	PQRM(3)	REDU	YYN				index 2000=1	9
18	PQRX	PQRY	PQRE	PQWE	EX	YRULT	YRKC	YRKN	RDEU			index 2000=1	10
19	PQRM	PQRF	PQRE	PQWE	EX	YRUL	YRKC	YRKN	RDEU			index 2000=1	10
20	YRW	LYWE	LYRXE	LYRP	RUNR	RBNR	LAPSC	ARET	RDEU	DLAPSC	YYN	th. Euro per person-year	12
21	LRP	RSQ	RWSR	RUNR	RBNR	RSER	RDEU					rate [0,1]	8
22	RRI	RWS	RPSC	VRYM	RLR	RDEU						m euro	7
23	RDW	RRPD	RRLR	CDEP	ODEP	RDEU	RUNR	RPSC				m euro 2000 prices	9
24	YRN	YRY	YRX	RDEU								m euro 2000 prices	5
31	MU	QR	PMAT	YRD	KR	MUM	RDEU					th. tonnes	

Source: E3ME Manual (2012).

Table A3: *Baseline assumptions, complete with sources.*

	DATA SOURCES
World assumptions	
1. Commodity prices	
- food	CE own assumptions
- beverages	CE own assumptions
- agricultural raw materials	CE own assumptions
- metals	CE own assumptions
- energy	IEA, PRIMES
- oil	IEA, PRIMES
- global inflation	CE own assumptions
Region specific assumptions	
1. Exchange rates	DG ECFIN AMECO database over historical, fixed afterwards

- euro exchange rates (WREX)	
- purchasing power standard (WRPX)	
2. Interest rates	DG ECFIN AMECO database over historical, fixed afterwards
- short-term rate (WRSR)	
- long-term rate (WRLR)	
3. Macro variables	Not use for E3ME regions (endogenous) forecasts calibrated to PRIMES 2009 projection Historical data stored in databank from Eurostat Other Regions (CE own assumptions + results from E3MG modelling)
- GDP (WGDP)	
- GDP deflator (WHUC)	
4. Government consumption (WRSG, GW01, GW02,GW03)	Eurostat, Cambridge Econometrics
- defence	- fixed after last year of historical data
- education	- fixed after last year of historical data
- health	- fixed after last year of historical data
5. Fiscal policy	DG ECFIN AMECO database, DG TAX AND CUSTOMS "Taxes in Europe" database over historical period, fixed afterwards
- taxes on goods and services (WITR)	
- standard rate on VAT (WSVT)	
- taxes on income and capital gains (WDTR)	
- taxes on international trade (WTTR)	
- subsidies and other transfers to households (WBNR)	
- social security taxes paid by employees (WSSR)	
- social security taxes paid by employers (WERS)	
6. Population (WRPO, PAR1…. PAR6)	Eurostat population projections
- total population	
- male/female split	
- children/working-age/ old-age pensioner split	

7. Labor force (LRP1, LRP2)	Not use for E3ME regions (endogenous) Historical data stored in databank from Eurostat LFS
- male/female participation rates	

Source: E3ME program.

Table A4: *Baseline assumptions for Slovenia and the world in the E3ME model.*

SLOVENIA

Code	Description	unit	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
WREX01	Exhange rate	local currency per euro	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
WRPY01	Exhange rate: PPP (not used)	local currency per euro	1.386	1.386	1.386	1.386	1.386	1.386	1.386	1.386	1.386	1.386	1.386	1.386	1.386	1.386	1.386	1.386	1.386	1.386	1.386	1.386	1.386
WRSR01	Interest rate: short run (not used)	percent	0.046	0.046	0.045	0.045	0.046	0.046	0.045	0.045	0.046	0.046	0.045	0.046	0.045	0.045	0.045	0.046	0.046	0.045	0.045	0.046	0.046
WRLR01	Interest rate: long run	percent	0.028	0.028	0.030	0.030	0.029	0.029	0.030	0.030	0.028	0.028	0.030	0.028	0.028	0.030	0.030	0.028	0.028	0.030	0.030	0.028	0.028
WGDP01_MA06	GDP (not used for E3ME regions)	year on year growth	1.379	1.937	2.452	3.240	3.240	3.541	3.541	3.541	3.541	3.541	3.541	3.541	3.541	3.541	3.541	3.541	3.541	3.541	3.541	3.541	3.541
WHUC01_MA12	inflation (not used for E3ME regions)	annual rate	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
WRSG01_MA02	Government spending	year on year growth	1.029	1.029	1.029	1.029	1.029	1.029	1.029	1.029	1.029	1.029	1.029	1.029	1.029	1.029	1.029	1.029	1.029	1.029	1.029	1.029	1.029
GWI1_DEFENCE	Government spending: Defence	share of total government spending	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
GWI1_EDUCATION	Government spending: Education	share of total government spending	0.245	0.245	0.245	0.245	0.245	0.245	0.245	0.245	0.245	0.245	0.245	0.245	0.245	0.245	0.245	0.245	0.245	0.245	0.245	0.245	0.245
GWI1_HEALTH	Government spending: Health	share of total government spending	0.297	0.297	0.297	0.297	0.297	0.297	0.297	0.297	0.297	0.297	0.297	0.297	0.297	0.297	0.297	0.297	0.297	0.297	0.297	0.297	0.297
WITR01_TAX_GBS	Tax Indirect	1+share of household spending	1.184	1.184	1.184	1.184	1.184	1.184	1.184	1.184	1.184	1.184	1.184	1.184	1.184	1.184	1.184	1.184	1.184	1.184	1.184	1.184	1.184
WSVT01_TAX_VAT	Tax VAT	Rate	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
WOTR01_TAX_INC	Tax Direct	Rate (wages)	0.174	0.174	0.174	0.174	0.174	0.174	0.174	0.174	0.174	0.174	0.174	0.174	0.174	0.174	0.174	0.174	0.174	0.174	0.174	0.174	0.174
WTTR01_TAX_TRADE	Tax Import tariffs (not used)	Rate	1.002	1.002	1.002	1.002	1.002	1.002	1.002	1.002	1.002	1.002	1.002	1.002	1.002	1.002	1.002	1.002	1.002	1.002	1.002	1.002	1.002
WBNR01_SUBSBTRANS	Benefit Payment	share of wage	0.366	0.366	0.366	0.366	0.366	0.366	0.366	0.366	0.366	0.366	0.366	0.366	0.366	0.366	0.366	0.366	0.366	0.366	0.366	0.366	0.366
WSSR01_SS_TOTAL	Soc. sec employees' contibution	rate	0.186	0.186	0.186	0.186	0.186	0.186	0.186	0.186	0.186	0.186	0.186	0.186	0.186	0.186	0.186	0.186	0.186	0.186	0.186	0.186	0.186
WSER01_SS_ERS	Soc. sec employers' contibution	rate	0.136	0.136	0.136	0.136	0.136	0.136	0.136	0.136	0.136	0.136	0.136	0.136	0.136	0.136	0.136	0.136	0.136	0.136	0.136	0.136	0.136
WRPO_POP_TOTAL	Population	year on year growth	0.276	0.237	0.208	0.198	0.168	0.14	0.116	0.097	0.056	0.03	-0.008	-0.032	-0.07	-0.104	-0.138	-0.163	-0.185	-0.208	-0.225	-0.245	-0.264
PAR1_M_CHILD	Population: male 0-15	share of total population	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.069	0.069	0.067	0.067	0.066	0.065	0.064	0.063
PAR2_F_CHILD	Population: female 0-15	share of total population	0.066	0.066	0.067	0.067	0.067	0.068	0.069	0.069	0.069	0.069	0.069	0.069	0.069	0.067	0.067	0.066	0.065	0.064	0.063	0.063	0.062
PAR3_M_WORK_AGE	Population: male 16-64	share of total population	0.327	0.327	0.326	0.324	0.322	0.32	0.317	0.315	0.315	0.319	0.316	0.322	0.321	0.324	0.327	0.325	0.324	0.323	0.32	0.319	0.317
PAR4_F_WORK_AGE	Population: female 16-64	share of total population	0.339	0.339	0.338	0.336	0.334	0.332	0.329	0.327	0.324	0.323	0.319	0.317	0.314	0.312	0.311	0.31	0.309	0.307	0.305	0.304	0.303
PAR5_M_OLD	Population: male 65+	share of total population	0.066	0.066	0.067	0.069	0.071	0.074	0.076	0.078	0.082	0.085	0.088	0.091	0.094	0.097	0.099	0.102	0.104	0.107	0.109	0.112	0.114
PAR6_F_OLD	Population: female 65+	share of total population	0.102	0.102	0.102	0.104	0.105	0.107	0.109	0.111	0.115	0.116	0.118	0.12	0.123	0.125	0.127	0.13	0.132	0.134	0.137	0.139	0.141
LRP1_M_PARTN_RATE	Participation rate: male (not used)	percent of male working population	0.761	0.761	0.761	0.761	0.761	0.761	0.761	0.761	0.761	0.761	0.761	0.761	0.761	0.761	0.761	0.761	0.761	0.761	0.761	0.761	0.761
LRP2_F_PARTN_RATE	Participation rate: female (not used)	percent of female working population	0.675	0.675	0.675	0.675	0.675	0.675	0.675	0.675	0.675	0.675	0.675	0.675	0.675	0.675	0.675	0.675	0.675	0.675	0.675	0.675	0.675

WORLD

Code	Description	unit	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
PFMG1(01)	Commodity Price: Food	year on year growth	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
PFMG1(02)	Commodity Price: Beverages	year on year growth	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
PFMG1(03)	Commodity Price: Agriculture Raw Material	year on year growth	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4
PFMG1(04)	Commodity Price: Metals & Minerals	year on year growth	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2
PFMG1(05)	Commodity Price: Energy	year on year growth	6.03	6.929	6.929	6.929	6.929	6.929	5.861	5.861	5.861	5.861	5.861	4.566	4.566	4.566	4.566	4.566	4.566	4.566	4.566	4.03	4.03
PFMG1(06)	Commodity Price: Brent oil	year on year growth	39.586	2.27	2.27	2.27	2.27	2.27	6.367	6.367	6.367	6.367	6.367	5.126	5.126	5.126	5.126	5.126	5.126	5.126	5.126	4.814	4.814
PFMG1(07)	Agregate Global Inflation	year on year growth	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

Source: E3ME program.

Table A5: *Values of economic, environmental, and energy variables in different scenarios for the period 2011-2030.*

SCENARIO	RECYCLING / YEAR	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Green revenues from a cabon tax																					
baseline scenario	/	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	all	0	144.639	147.335	150.279	153.514	154.514	155.882	157.703	159.536	160.94	159.514	158.126	157.011	156.118	155.148	153.213	151.235	149.65	148.493	147.099
Gross domestic product in million of euro (RGDP)																					
baseline scenario		28749.77	29436.21	30415.7	31443.8	32502.98	33411.88	34355.28	35349.36	36385.24	37449.73	38176.75	38926.43	39697.25	40507.05	41345.79	41865.08	42408.16	42959.87	43502.27	44051.21
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	budget	28749.77	29415.28	30322.49	31386.87	32439.38	33356.36	34305.07	35300.03	36336.85	37402.58	38133.77	38889.22	39663.53	40473.73	41309.04	41825.57	42374.68	42926.33	43462.15	44009.93
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	workers' social security contributions	28749.77	29478.9	30380.23	31450.78	32501.63	33419.58	34367.1	35350.45	36384.39	37445.14	38171.98	38916.3	39681.16	40504.11	41344.97	41858.34	42407.76	42959.18	43488.57	44029.78
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	employers' social security contributions	28749.77	29446.68	30353.49	31427.92	32481	33394.67	34337.66	35326.3	36362.72	37426.74	38155.76	38906.42	39681.3	40491.9	41329.51	41846.16	42394.95	42944.81	43476.59	44021.18
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	budget, workers' social security contributions	28749.77	29415.28	30322.49	31386.87	32439.38	33356.36	34360.18	35339.48	36378.32	37451.36	38185.97	38932.13	39706.17	40515.79	41349.45	41852.42	42399.23	42950.67	43487.95	44039.86
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	budget, employers' social security contributions	28749.77	29415.28	30322.49	31386.87	32439.38	33356.36	34328.9	35318.64	36363.46	37433.86	38163.37	38911.42	39684.97	40495.31	41331.45	41843.31	42391.35	42941.27	43476.87	44026.62
Household consumption expenditores in million of euro (RSC)																					
baseline scenario		16705.19	16945.31	17470.62	18004.52	18550.77	19074.5	19612.02	20159.48	20729.08	21316.29	21789.22	22266.06	22770.05	23289.98	23818.74	24183.24	24543.27	24956.55	25382.57	25810
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	budget	16705.19	16891.03	17392.22	17931.52	18477.28	19004.83	19545.53	20096.52	20667.77	21256.98	21732.45	22210.29	22713.19	23230.92	23758.01	24122.45	24485.48	24913.65	25332.61	25754.82
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	workers' social security contributions	16705.19	16975.57	17477.51	18022.34	18559.2	19085.13	19623.32	20160.12	20731.11	21320.4	21797.08	22264.55	22769.02	23288.56	23818.11	24170.78	24539.25	24958.42	25376.35	25796.2
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	employers' social security contributions	16705.19	16944.68	17447.24	17989.73	18527.51	19052.41	19590.35	20132.39	20703.96	21293.73	21770.3	22242.09	22746.8	23265.72	23794.24	24151.53	24521.36	24939.85	25358.64	25779.01
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	budget, workers' social security contributions	16705.19	16891.03	17392.22	17931.52	18477.28	19004.83	19623.81	20164.48	20737.44	21328.23	21803.74	22267.61	22768.59	23287	23817.9	24169.99	24541.67	24960.25	25379.2	25801.98
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	budget, employers' social security contributions	16705.19	16891.03	17392.22	17931.52	18477.28	19004.83	19595.12	20140.13	20712.34	21300.78	21774.67	22242.68	22744.26	23262.72	23792.73	24149.85	24522.38	24941.19	25360.65	25783.29
Export in millilon of euro (RSX)																					
baseline scenario		16705.19	16945.31	17470.62	18004.52	18550.77	19074.5	19612.02	20159.48	20729.08	21316.29	21789.22	22266.06	22770.05	23289.98	23818.74	24183.24	24543.27	24956.55	25382.57	25810
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	budget	16705.19	16891.03	17392.22	17931.52	18477.28	19004.83	19545.53	20096.52	20667.77	21256.98	21732.45	22210.29	22713.19	23230.92	23758.01	24122.45	24485.48	24913.65	25332.61	25754.82
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	workers' social security contributions	16705.19	16975.57	17477.51	18022.34	18559.2	19085.13	19623.32	20160.12	20731.11	21320.4	21797.08	22264.55	22769.02	23288.56	23818.11	24170.78	24539.25	24958.42	25376.35	25796.2
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	employers' social security contributions	16705.19	16944.68	17447.24	17989.73	18527.51	19052.41	19590.35	20132.39	20703.96	21293.73	21770.3	22242.09	22746.8	23265.72	23794.24	24151.53	24521.36	24939.85	25358.64	25779.01
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	budget, workers' social security contributions	16705.19	16891.03	17392.22	17931.52	18477.28	19004.83	19623.81	20164.48	20737.44	21328.23	21803.74	22267.61	22768.59	23287	23817.9	24169.99	24541.67	24960.25	25379.2	25801.98
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	budget, employers' social security contributions	16705.19	16891.03	17392.22	17931.52	18477.28	19004.83	19595.12	20140.13	20712.34	21300.78	21774.67	22242.68	22744.26	23262.72	23792.73	24149.85	24522.38	24941.19	25360.65	25783.29
Total manufacturing output in million EUR (QR)																					
baseline scenario		21531.41	22199.45	22996.59	23848.7	24729.97	25510.09	26305	27079.24	27880.9	28705.55	29188.84	29579.96	30044.5	30518	31034.2	31365.94	31634.17	31984.08	32330.69	32646.13
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	budget	21531.41	22214.99	22980.56	23826.07	24692.9	25477.39	26276.24	27057.75	27861.56	28683.53	29166.47	29562.1	30035.12	30511.67	31026.06	31348.3	31652.37	32012.02	32319.98	32665.44
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	workers' social security contributions	21531.41	22229.12	22990.89	23850.03	24719.05	25502.39	26295.74	27072.12	27872.67	28688.84	29167.51	29558.76	30035.01	30513.88	31034.17	31358.98	31651.61	32016	32318.01	32659.15
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	employers' social security contributions	21531.41	22211.22	22976.19	23839.81	24714.27	25495.8	26284.69	27062.03	27864.91	28685.39	29167.42	29564.31	30038.1	30513.06	31029.63	31359.26	31654.73	32013.31	32315.45	32658.35
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	budget, workers' social security contributions	21531.41	22214.99	22980.56	23826.07	24692.9	25477.39	26280.89	27055.07	27870.52	28696.19	29179.96	29571.86	30047.22	30522.01	31034.96	31350.33	31652.39	32008.75	32315.32	32662.03
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	budget, employers' social security contributions	21531.41	22214.99	22980.56	23826.07	24692.9	25477.39	26266.32	27043.07	27865.38	28694.51	29179	29566.49	30037.94	30513.28	31029.36	31355.16	31657.81	32011.4	32315.07	32660.95
Employment in thousands (YRE)																					
baseline scenario		936.692	950.436	955.094	955.764	958.411	952.612	946.927	938.577	932.254	925.688	920.588	913.883	909.383	905.041	901.945	894.97	887.232	880.346	873.976	869.069
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	budget	936.692	950.497	953.889	953.042	955.141	949.1	943.516	935.464	929.486	923.195	918.308	911.838	907.599	903.398	900.288	893.212	886.057	879.566	873.35	868.53
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	workers' social security contributions	936.692	952.573	957.562	958.191	960.549	954.568	948.615	939.884	933.233	926.34	921.176	914.372	910.114	905.951	903.019	895.697	888.096	881.357	874.887	869.867
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	employers' social security contributions	936.692	953.847	957.963	957.848	959.617	953.441	947.391	938.413	931.928	925.27	920.258	913.345	909.153	905.006	902.028	894.562	887.215	880.625	874.298	869.396
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	budget, workers' social security contributions	936.692	950.497	953.889	953.042	955.141	949.1	945.369	938.196	933.23	927.152	922.413	915.526	910.96	906.343	902.964	895.451	888.059	881.422	875.185	870.382
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	budget, employers' social security contributions	936.692	950.497	953.889	953.042	955.141	949.1	946.645	938.51	932.958	926.643	921.709	914.505	909.912	905.366	902.092	894.496	887.281	880.734	874.513	869.717
Greenhouse gas emissions in CO2 equivalent thousands of tons of carbon																					
baseline scenario		5588.252	5737.894	5874.773	5998.528	6122.417	6186.53	6258.1	6330.867	6398.466	6463.33	6332.618	6210.716	6091.337	5971.548	5854.552	5768.035	5689.808	5612.959	5535.926	5457.153
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	budget	5588.252	5699.225	5801.967	5910.516	6027.753	6082.999	6146.05	6218.732	6292.517	6359.086	6221.624	6089.353	5966.265	5851.087	5738.6	5651.438	5565.019	5486.641	5416.851	5343.681
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	workers' social security contributions	5588.252	5699.981	5805.95	5914.157	6031.337	6086.616	6150.177	6222.895	6296.066	6362.511	6224.386	6091.05	5966.674	5851.668	5740.395	5654.128	5568.177	5487.795	5416.669	5343.986
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	employers' social security contributions	5588.252	5703.375	5806.024	5908.469	6024.208	6085.302	6154.044	6224.437	6292.098	6356.679	6222.169	6092.201	5968.397	5851.377	5738.25	5651.396	5567.058	5489.025	5417.842	5343.073
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	budget, workers' social security contributions	5588.252	5699.225	5801.967	5910.516	6027.753	6082.999	6146.645	6223.044	6296.215	6362.05	6224.478	6092.933	5969.082	5853.194	5740.442	5653.166	5566.013	5487.111	5417.339	5344.526
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	budget, employers' social security contributions	5588.252	5699.225	5801.967	5910.516	6027.753	6082.999	6150.509	6222.179	6289.215	6355.302	6224.07	6095.759	5969.932	5849.961	5736.272	5651.136	5567.327	5489.403	5417.561	5342.396
Total demand for energy in thousand toe (FRO)																					
baseline scenario		6528.858	6735.286	6929.519	7113.139	7305.409	7421.845	7549.201	7677.035	7798.161	7916.722	7704.82	7521.981	7359.104	7208.643	7072.313	7047.299	7031.582	7019.494	7007.009	6991.417
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	budget	6528.858	6679.237	6836.475	7007.4	7193.944	7299.16	7414.321	7541.112	7670.133	7791.199	7571.272	7375.161	7207.594	7063.331	6933.324	6906.806	6879.445	6864.735	6861.453	6852.784
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	workers' social security contributions	6528.858	6680.491	6841.556	7011.197	7197.421	7303.375	7420.242	7547.516	7675.336	7795.493	7574.27	7376.883	7208.198	7064.885	6936.643	6911.035	6884.056	6866.505	6861.389	6853.399
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	employers' social security contributions	6528.858	6685.019	6841.814	7004.185	7188.617	7301.797	7425.046	7549.017	7669.717	7787.832	7571.796	7378.862	7210.618	7064.275	6933.412	6907.077	6882.391	6868.113	6862.943	6852.137
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	budget, workers' social security contributions	6528.858	6679.237	6836.475	7007.4	7193.944	7299.16	7415.302	7546.529	7674.064	7794.156	7574.749	7380.27	7211.954	7066.593	6935.68	6908.626	6880.418	6865.489	6862.725	6854.685
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	budget, employers' social security contributions	6528.858	6679.237	6836.475	7007.4	7193.944	7299.16	7420.551	7545.693	7665.209	7785.534	7574.371	7383.883	7212.714	7061.986	6930.139	6906.192	6882.481	6868.658	6862.821	6851.513
Average fuel (energy) price including taxes in EURO/toe (PJRT)																					
baseline scenario		3144.918	3140.383	3144.66	3156.688	3174.105	3182.884	3195.34	3212.91	3235.262	3260.783	3303.043	3347.844	3396.56	3449.189	3506.829	3552.643	3598.905	3642.847	3684.911	3730.16
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	budget	3144.918	3255.685	3262.142	3270.734	3287.534	3298.071	3312.47	3330.179	3351.101	3375.623	3418.701	3464.836	3514.412	3566.701	3623.994	3670.967	3719.383	3764.525	3807.132	3853.669
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	workers' social security contributions	3144.918	3255.151	3261.36	3271.114	3288.359	3298.943	3312.897	3330.404	3351.084	3375.115	3417.795	3463.749	3513.401	3565.553	3622.774	3669.708	3718.03	3763.33	3805.992	3852.584
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	employers' social security contributions	3144.918	3254.813	3261.43	3271.553	3288.754	3298.492	3311.932	3329.914	3351.437	3375.757	3418.011	3463.634	3513.341	3565.802	3623.334	3670.273	3718.387	3763.46	3806.219	3853.038
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	budget, workers' social security contributions	3144.918	3255.685	3262.142	3270.734	3287.534	3298.071	3312.327	3329.656	3351.071	3376.649	3419.513	3465.23	3514.767	3566.705	3623.515	3670.092	3718.496	3763.498	3806.108	3852.698
carbon tax of EUR 55 per ton of carbon (EUR 15 per ton of CO2)	budget, employers' social security contributions	3144.918	3255.685	3262.142	3270.734	3287.534	3298.071	3311.844	3329.706	3352.208	3376.789	3418.878	3464.365	3514.366	3567.033	3624.048	3671.382	3718.387	3763.411	3806.358	3853.222

Source: E3ME program and own calculations.

Appendix 1: *Aggregate demand for energy and its parameters for Slovenia.*

In Table A6 we show the specification of aggregated demand for energy that is used in the E3ME model. The equation is based on the work of Barker, Ekins and Johnston (1995), Hunt and Manning (1989) and Bentzen and Engsted (1993).

»The aggregate energy equation considers the total fuel used (summation of 12 fuel types) in thousand tonnes of oil equivalent (th.toe) by 19 fuel users. The demand for energy by a fuel user is dependent on the ‚activity' for the fuel user. This is chosen as gross economic

output for most sectors, but household fuel demand is a function of total consumers' expenditure. A restriction is imposed such that as activity increases then demand for energy use will not decline (all other factors being equal).

The average price ratio captures the effect of prices relative to the fuel used, and is deflated by unit costs. The equations have been tested so that relative price increases cause demand to fall but relative price decreases have no effect. Such asymmetrical price effects in aggregate energy demand equations have been the subject of other research (Gately, 1993; Walker and Wirl, 1993; Grubb, 1995). The idea is that because energy is used via capital stock with a long lifetime, and since technical change is progressive and is not generally reversed, when energy prices rise and energy savings are introduced, then when energy prices fall again, these savings are not reversed i.e. energy demand responds to rises in real prices, but not falls. The effect changes the properties of the model in a non-linear fashion: if in the base run real energy prices fall over the projection period, then increases in energy taxes will have no effect until they start to increase real prices (one year to the next, not compared to the base).

The long-run price elasticity for road fuel is imposed at -0.7 for all regions, also Slovenia, following the research on long-run demand (Franzen and Sterner, 1995) and (Johansson and Schipper, 1997).

The measures of research and development expenditure and investment capture the effect of new ways of decreasing energy demand (energy saving technical progress) and the elimination of inefficient technologies, such as energy saving techniques replacing the old inefficient use of energy. Research and development expenditure in industries 16-18 (machinery) and 19 (motor vehicles) for the EU as a whole take into account spillover effects from international companies.« (E3ME Manual, 2012, page 49-50).

Tabel A6: *Specification of agregate demand for energy.*

Co-integrating dynamic equation:		
DLN(FR0(.))		[total fuel used by fuel users]
=	BFR0(,.1)	[constant]
+	BFR0(.,2) * DLN(FRY(.))	[activity measure]
+	BFR0(.,3) * DLN(PREN(.))	[average price ratio]
+	BFR0(.,4) * DLN(FRTD(.))	[R&D by fuel user]
+	BFR0(.,5) * DLN(ZRDM)	[EU R&D in machinery]
+	BFR0(.,6) * DLN(ZRDT)	[EU R&D in transport]
+	BFR0(.,7) * DLN(FRK(.))	[investment by fuel user]
+	BFR0(.,8) * DRDEU	[German unification]
+	BFR0(.,9) * D09R	[2009 recession dummy]
+	BFR0(.,10) * DLN(FR0(-1))	[lagged changes in fuel use]

Co-integrating long-term equation:

DLN(FR0(.))		[total fuel used by fuel users]
=	BFR0(.,11) * ECM(-1)	[lagged error correction]
+	BFR0(,.12)	[constant]
+	BFR0(,.13) * LN(FRY(.))	[activity measure]
+	BFR0(.,14) * LN(PREN(.))	[average price ratio]
+	BFR0(.,15) * LN(FRTD(.))	[R&D by fuel user]
+	BFR0(.,16) * LN(ZRDM)	[EU R&D in machinery]
+	BFR0(.,17) * LN(ZRDT)	[EU R&D in transport]
+	BFR0(.,18) * LN(FRK(.))	[investment by fuel user]
+	BFR0(.,19) * RDEU	[German unification]
+	BFR0(.,20) * D09R	[2009 recession dummy]
+	ECM	[error]

Identity:

PREN	=	PFR0(.)/PRYM	[average price ratio]

Restrictions:

BFR0(.,3 .,4 .,5 .,6 .,7 .,14 .,15.,16 .,17 .,18) <=0	['right sign']
BFR0(.,2), BFR0(.,13) >=0	[modeling energy demand/activity ratio]
0>BRF0(.,11)>-1	['right sign']

Definitions:

BFR0	is a matrix of parameters
FR0	is a matrix of total fuel used by 22 fuel users for 33 regions, th toe.
PREN	is a matrix of average price used deflated by unit cost for 33 regions, euro/toe
FRY	is a matrix of activity for 22 fuel users and 33 regions, m euro at 2005 prices
FRTD	is R&D in machinery by the EU, m euro at 2005 prices
ZRDM	is R&D in transport by the EU, m euro at 2005 prices
ZRDT	is a matrix of investment by 22 fuel users for 33 regions, m euro at 2005 prices
FRK	is a matrix of prices of value added at market prices for each region (2005 = 1.0, local price)
PRYM	is a matrix of average prices in euro/tonne of all fuels used by each fuel user
PFR0	is a matrix of average prices in euro/tonne of all fuels used by each fuel user
RDEU	is a dummy matrix for German unification (=0 for other countries)
D09R	is a dummy matrix for 2009 recession (=0 until 2008, =1 from 2009 onward)
(.)	indicates that a matrix is defined across sectors
LN	indicates natural logarithm
DLN	indicates change in natural logarithm
ECM	[error]

Source: E3ME Manual (2012).

In Table A7 we show the values of estimated paramaters of agregated demand for energy for Slovenia.

Tabel A7: *Values of parameters of agregated demand for energy function for Slovenia.*

	COEFFICIENTS																		
FUEL USERS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1 Power own use & trans.	0.055	0	-0.328	0	-0.456	0	-0.473	0	0	-0.2	-0.95	7.964	0.247	-0.177	0	-0.088	-0.058	-0.027	0	0
2 O.energy own use & tra	-0.064	0	0	-0.031	0	-0.64	0	0	0	-0.2	-0.2	5.337	0.232	-0.331	-0.086	-0.019	-0.056	-0.044	0	0
3 Iron & steel	0.02	0	0	0	0	-1	0	0	0	0.6	-0.95	9.106	0.117	-0.263	-0.091	-0.249	-0.037	-0.013	0	0
4 Non-ferrous metals	0.005	0	-0.85	0	0	0	-0.169	0	0	0.095	-0.216	7.931	0.297	-0.311	-0.015	0	-0.184	-0.208	0	0
5 Chemicals	0.008	1.2	-1.3	0	0	0	0	0	0	0.093	-0.417	7.69	0.432	-0.253	-0.135	-0.073	-0.308	-0.011	0	0
6 Non-metallics nes	0.138	0.06	-0.273	-0.032	0	0	-0.021	0	0	0.01	-0.799	6.685	0.292	-0.279	-0.05	-0.027	-0.132	0	0	0
7 Ore-extra.(non-energy)	0.153	0	-1.3	0	0	0	0	0	0	-0.2	-0.2	9.544	0.751	-0.331	0	-0.166	-0.653	-0.026	0	0
8 Food, drink & tob.	-0.008	1.2	-1.3	0	0	0	0	0	0	-0.2	-0.936	4.555	0.609	-0.221	-0.003	-0.14	-0.061	-0.251	0	0
9 Tex., cloth. & footw.	-0.078	1.2	-0.504	-0.295	-1	0	-0.111	0	0	-0.2	-0.2	7.24	0.546	-0.269	-0.015	-0.049	-0.44	-0.08	0	0
10 Paper & pulp	0.049	0	-1.024	0	0	-1	-0.06	0	0	0.159	-0.2	4.684	0.635	-0.387	-0.005	-0.029	-0.106	-0.091	0	0
11 Engineering etc	0.065	0	-0.871	0	-1	0	-0.27	0	0	0.134	-0.2	6.39	0.406	-0.214	-0.005	-0.162	-0.155	-0.04	0	0
12 Other industry	0.076	0	0	0	0	0	-1.56	0	0	0.228	-0.95	12.476	0.709	-0.492	-0.02	-0.512	-0.278	-0.358	0	0
13 Rail transport	-0.042	0.844	-0.344	0	0	0	-0.024	0	0	-0.2	-0.723	5.764	0.19	-0.212	0	-0.136	-0.043	-0.016	0	0
14 Road transport	-0.107	0	-0.095	0	0	0	0	0	0	0.454	-0.574	6.184	0.602	-0.7	0	0	-0.021	-0.008	0	0
15 Air transport	0.035	0	0	0	0	0	-0.013	0	0	0.249	-0.2	5.399	0.457	-0.403	0	-0.174	0	-0.065	0	0
16 Other transp. serv.	0	0	0	0	0	0	0	0	0	0	0	0	0.146	-0.359	0	-0.08	-0.38	-0.327	0	0
17 Households	-0.004	0	0	0	0	0	0	0	0	-0.2	-0.2	3.875	0.718	-0.217	0	-0.026	-0.072	-0.258	0	0
18 Other final use	0.362	0	-0.91	-0.228	0	0	-3	0	0	0.6	-0.95	5.73	0.666	-0.248	-0.049	-0.085	-0.038	-0.361	0	0
19 Non-energy use	0.124	0	-0.681	0	-1	0	0	0	0	-0.2	-0.2	7.721	0	-0.221	0	-0.003	-0.133	0	0	0

Source: E3ME model.

The price elasticities of energy demand for fuel users are for example shown in column 3 and 14. Column 3 shows price elasticites of demand based on co-integrating dynamic equation, while column 14 shows long term elasticites of demand based on co-integrating long-term equation.. For example, 1% increase of average price ratio (variable PREN) causes decrease in quantity demanded for energy in road transportation for 0.7%.

THE RELEVANCE OF EMPLOYEE-RELATED RATIOS FOR EARLY DETECTION OF CORPORATE CRISES

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ABSTRACT: *The purpose of this study was to analyse whether employee-related ratios derived from accounts have incremental predictive power for the early detection of corporate crises and bankruptcies. Based on the literature reviewed, it can be seen that not much attention has been drawn to this task, indicating that further research is justified. For empirical research purposes, a database of Austrian companies was used for the time period 2003 to 2005 in order to develop multivariate linear discriminant functions for the classification of companies into the two states; bankrupt and non-bankrupt, and to detect the contribution of employee-related ratios in explaining why firms fail. Several ratios from prior research were used as potential predictors. In addition, other separate ratios were analysed, including employee-related figures. The results of the study show that while employee-related ratios cannot contribute to an improvement in the classification performance of prediction models, signs of these ratios within the discriminant functions did show the expected directions. Efficient usage of employees seems to play an important role in decreasing the probability of insolvency. Additionally, two employee-related ratios were found which can be used as proxies for the size of the firm. This had not been identified in prior studies for this factor.*

Keywords: *bankruptcy prediction, crisis indicators, discriminant analysis, ratio analysis*
JEL Classification: C12, C38, G33

1. INTRODUCTION

Fast-changing environmental conditions increase the challenges faced by enterprises to remain successful in today's markets. The insolvency statistics for Europe show that after the start of financial crisis in 2007/2008, insolvency rates increased and the situation continued to deteriorate thereafter. Nevertheless, the problem of business failures and the potential for insolvency is still an interesting topic within management science, as the damages on a macroeconomic level are significant. Therefore, it is both necessary and useful to direct research towards the early prediction of corporate crises and financial distress. It is generally accepted that prediction models should recognize potential economic and

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financial difficulties as early as possible. The best timing for the detection of crisis is at the strategic crisis stage, which is in practice very difficult to detect, due to the weak signals apparent during this stage (Pretorius, 2008, p. 416; Exler & Situm, 2013, p. 162). This type of crisis is not fully visible in financial statement figures and other non-financial ratios are therefore needed, such as market-based indicators and macroeconomic variables, to make them visible and to achieve stronger and more reliable early warning signals. If this is possible, sufficient time will then remain to induce turnaround activities, which are less costly and far more efficient than in the later stages of crisis.

Even if it is currently recognized that a properly functioning forecasting tool should include a combination of the aforementioned variables (Grunert, Norden & Weber, 2006; Altman, Sabato & Wilson, 2010; Madrid-Guijarro, Garcia-Perez-de-Lema & van Auken, 2011; Iazzolino, Migliano & Gregorace, 2013), the relevance of figures from financial statements as discriminating variables between failed and non-failed firms remains prominent. This paper focuses on this aspect and devotes special attention to accounting ratios related to employee data. An extensive review of 238 papers dealing with the search for potential variables for the differentiation between the two types of firms revealed that such ratios have not received much attention in this field of study.

Therefore, within this research, several ratios related to employees from prior research and several new ratios not found to be analysed in the past were tested to assess their ability to act as prediction variables. An analysis was made based on a database including accounting figures of Austrian firms for the years 2003 and 2004. The aim was to explore how solvent and insolvent firms differ in such ratios and whether the performance of insolvency prediction models based on multivariate linear discriminant analysis could be improved, when these ratios are included with traditional accounting ratios already known as prediction variables.

It was found that several employee-related variables showed discriminatory power between the two types of firms. Nevertheless, this ability could not be exploited to attain improved classification results. Despite this, signs of the variables indicated a direction which was consistent with expectations and can be interpreted economically. Summarized, it can be said that employee-related variables carry certain information which is relevant for discrimination between failed and non-failed firms, but their predictive power is somehow limited and therefore not sufficient in order to be included into a well-functioning forecasting model for bankruptcies.

This paper is organized as follows: First, a literature review is given about the origins of using accounting ratios for the prediction of insolvencies. This is followed by some insights into more recent research, where results concerning the usage of non-financial indicators within bankruptcy prediction are summarized. Additionally, some relevant papers are highlighted with reference to their main conclusions, where employee-related ratios were investigated concerning predictability. Second, three research hypotheses and three research questions are then presented. Third, a description about the database and the selection of samples for empirical tests is given. Fourth, a presentation about the ratios

applied within this work is provided, where some of them are based on literature review and some were not found to be used in previous studies. Fifth, the statistical analyses and results are presented, which are necessary to extract the most relevant variables for the construction of an insolvency prediction model. Sixth, the equations obtained for multivariate linear discriminant functions for the different years and combinations of ratios including their performance quality are presented. Seventh, the main conclusions of the result are summarized. At last, implications and limitations of the study are described, and recommendations for future research are given. Within this section the research hypotheses are tested and the research questions are answered.

2. LITERATURE REVIEW

Numerous research papers can be found in the field of business failure prediction which extracted a number of differing variables which are suitable for the prediction of business failures and bankruptcies. The most prominent variables are accounting ratios, which were derived from the financial statements of companies. Early research stated that accounting ratios show the potential to differentiate between bankrupt and non-bankrupt firms (Beaver, 1966; Altman, 1968). Several other papers confirmed these findings based on empirical results (Altman, Haldeman & Narayanan, 1977; Dambolena & Khoury, 1980; Zmijewski, 1984; Casey & Bartczak, 1985; Chalos, 1985; Gombola, Haskins, Ketz & Williams, 1987; Gilbert, Menon & Schwartz, 1990; Platt, Platt & Pedersen, 1994; McKee, 1995; Foster, Ward & Woodroof, 1998; Doumpos & Zopounidis, 1998).

Further research concluded that prediction models using only accounting ratios are inferior to models which combine accounting ratios with other financial and non-financial ratios. Financial ratios could comprise data not available from financial statements and replicate market data of e.g. stock prices, stock volatilities etc. Non-financial ratios can include factors such as management quality or efficiency, which are not directly observable, but can be estimated by appropriate quantitative measures. It is currently generally accepted that insolvency prediction models should include a mix of accounting, financial and non-financial variables as the accuracy of prediction can be increased in contrast to models including only accounting ratios (Thornhill & Amit, 2003; Grunert, Norden & Weber, 2006; Altman, Sabato & Wilson, 2010; Madrid-Guijarro, Garcia-Perez-de-Lema & van Auken, 2011; Iazzolino, Migliano & Gregorace, 2013).

The study by Thornhill & Amit (2003) found that deficiencies in general and financial management can be used as variables to explain why younger firms are more likely to fail. For older firms, failure is more dependent on external forces. A similar conclusion was made by Grunert, Norden & Weber (2006), where the factor of management quality displayed statistical significance to such an extent that this non-financial variable contributed to an improved classification. Furthermore, this research found in general that models incorporating financial and non-financial factors lead to significantly more accurate default probabilities than the single use of either financial or non-financial factors. This result was confirmed by the study of Altman, Sabato & Wilson (2010), where the inclusion of non-accounting data to

the basic z-score model significantly improved classification performance. This study concluded that needing a longer time to file accounts after the year end is associated with a higher probability of difficulties. It was also stated that firms which have an audit qualification are more prone to failure, based on the indication that the long-term viability is in some doubt.

The study of Madrid-Guijarro, Garcia-Perez-de-Lema & van Auken (2011) analysed factors affecting the external and internal environment of the firm and their impact on financial distress. They showed that high competition among existing firms in the industry and high bargaining power of customers increase the probability of distress. A higher technological level was negatively associated with bankruptcy. The overall conclusion of the study was that some strategic variables have a close association with financial distress. Iazzolino, Migliano & Gregorace (2013) investigated the contribution of intellectual capital (human capital, structural capital, relational capital) for the purposes of aiding prediction. Intellectual capital showed a contribution for credit risk decisions and was useful for the classification of defaulted and non-defaulted firms. The general conclusion followed that of the aforementioned studies, namely that a scoring model should include financial and non-financial information in order to improve prediction accuracy and model quality.

The inclusion of employee-related ratios – these are ratios where certain variables concerning employees and their associated costs (e.g. number of employees, ln(number of employees), sales/number of employees, EBIT/employee costs etc.) are considered – was not analysed extensively within research. The review of 238 papers related to the task of crises and insolvency prediction revealed that only in a few studies were such ratios included in the starting base (i.e. a catalogue of potential explanatory variables), but hardly any of these were detected as having discriminatory power to divide between failed and non-failed firms. In situations of financial distress or crisis, entrepreneurs try to improve the company´s results through various measures, and cost cutting seems to be one of the most effective measures undertaken in this regard. Firms which recovered from crisis had improved their operating performance through cost rationalization, lay-offs, closures and the integration of business units (Sudarsanam & Lai, 2001; Pretorius, 2008). Unsuccessful enterprises are mostly unable to exploit these opportunities due to different circumstances. This includes the inability to efficiently use employee resources.

The professional and economic use of staff seems important for corporate success and it also depends on management qualities as to how well these aspects are fulfilled. It is possible for companies to increase EBIT via tight control of labor costs (Kim & Gu, 2006). Therefore, ratios associated and related to employee-figures could be seen as a measurement of management efficiency. It is worth attempting to analyse this aspect by using employee-related ratios from prior research, but also with some new ratios which have not been used as potential explanatory variables in previous studies. Before this, some results from papers are presented where employee-related ratios were considered, where differing results were obtained concerning their suitability as predictors for insolvencies and crises.

Bruse (1978) conducted one of the first studies which considered employees for the prediction of the potential growth of a company. He explicitly analysed growing and non-

growing firms in Germany and developed a model that was able to distinguish between these two types of firms. The ratios sales/number of employees and staff costs/sales can be found within his starting catalogue. Only the second ratio showed the ability to forecast corporate growth alongside ratios of liquidity and turnover. Within the work of Gebhardt (1980), three employee-related ratios were defined as starting variables. These were staff costs/sum of costs, staff costs/revenues and value added/staff costs. None of these variables displayed statistical significance within univariate and multivariate analyses and were therefore not considered to act as predictors to distinguish between failed and non-failed firms.

Wilson, Chong & Peel (1995) analysed the ability of the ratio of directors remuneration/employee remuneration to act as a discriminatory variable within a logistic model for the distinction between failed and distressed acquired firms. The resulting negative sign signifies that the more directors earn relative to staff, the more likely it is that a firm can be assigned as distressed acquired. No specific explanation was given within their work for this occurrence. Within the studies of Lennox (1999a and 1999b), the number of employees appeared as a relevant variable for discrimination between failed and non-failed firms. This ratio can be seen as a proxy for the size of the firm. Small firms and indirectly, firms with a low number of employees, are more likely to fail. This aspect confirms results from studies before and after Lennox, where the size of the firm played a crucial role for discrimination between bankrupt and non-bankrupt firms, even if size was sometimes measured by using different variables (Altman, Haldeman & Narayanan, 1977; Ohlson, 1980; Theodossiou, Kahya, Saidi & Phillipatos, 1996; Dawley, Hoffman & Brockman, 2003; Bhattarcharjee, Higson, Holly & Kattuman, 2009; Chancharat, Tian, Davy, McCrae & Lodh, 2010; Pervan & Visic, 2012; Situm, 2014).

Within the work of Whitaker (1999), a more complex ratio was constructed for the prediction of a company's recovery from financial distress. The ratio was defined as number of employees/total assets (following year)/number of employees/total assets (pre-distress year). A decrease in the number of employees can help firms to recover and can therefore provide valuable signals concerning the economic health of a firm. Gudmundsson (2002) investigated the potential role of specific variables for the prediction of bankruptcy in the airline industry. Three non-financial ratios were included in the analyses: Number of pilots per aircraft, number of employees per aircraft and number of hours flown per pilot. Only the second variable showed statistical significance with a positive sign. This meant that non-distressed airlines exhibited a lower value compared to distressed ones. The fewer employees used per aircraft in action, the lower the probability of failure.

Neves & Vieira (2004) found that the ratio percentage of value added for employees and value added per employee were explanatory variables for the discrimination between bankrupt and non-bankrupt companies. The second variable was one of the most significant signals for financial distress. Distressed firms showed much lower values for value added compared to non-distressed firms. The ability of this variable to act as a predictor was also found within the studies of Nam, Kim, Park & Lee (2008) and Lin, Wang, Wu & Chuang (2009). Yim & Mitchell (2007) analysed the ratio of sales/employees within

their study to distinguish between failed and non-failed firms in the financial industry. It showed no significance and therefore did not appear as a predictor within their forecasting model. Nam, Kim, Park & Lee (2008) used the growth rate of added value/employee as a potential variable and recognized that it does not have any discriminatory power.

Wetter and Wennberg (2009) analysed the effect of human and social capital on a firm's performance and the ability of related measures to assist in the prediction of bankruptcies. Their conclusion was that these factors have the discriminatory power to divide between successful and unsuccessful firms. Bartual, Garcia, Gimenez & Romero-Civera (2012) began their analyses with two employee-related variables: sales/personnel expenses and sales/(financial expenses + personnel expenses). Only the second variable was statistically significant and therefore suitable to discriminate between failed and non-failed firms. Firms exhibiting a higher value of this ratio are more stable and therefore less vulnerable to problems. Resistance against crises and bankruptcies can be optimized by an increase in sales and the reduction of personnel expenses.

In summary, it can be concluded that the focus in research on employee-related ratios within business failure and insolvency prediction is relatively low when compared to the numerous studies conducted in this field. Due to this lack of analysis concerning these ratios as potential predictors, it is interesting and useful to conduct a separate study where some of the existing, but also some new, as-yet unanalysed ratios is investigated, which were not considered within prior research. From reviewing the literature, it can be expected that some variables will show discrimination ability whereas others will not. This will be the main task of this paper, but also attention will be given to the contribution of each variable concerning the identification of the corporate economic situation.

3. RESEARCH HYPOTHSES AND QUESTIONS

Based on the findings from previous literature, it seems that some financial statement figures and other employee-related ratios have a certain explanatory power for the event of bankruptcy. Firms in financial distress need to implement turnaround activities in order to recover. Employees are a cost factor affecting financial statement figures and it is generally possible from a practical viewpoint to improve different ratios through a reduction of the costs associated with employees. Generally, it is expected that firms with an ineffective use of employees and high staff costs are more likely to become bankrupt.

H1: The higher the proportion between staff costs to sales, the higher the probability of insolvency.

H2: When employee-related ratios are added to prediction models with "traditional" accounting ratios, then the prediction performance of such models can be improved.

H3: The number of employees and associated ratios with the number of employees are potential proxies for the size of the firm.

The third hypothesis is of relevance due to prior studies, where the variable number of employees and ln(number of employees) were found to be proxies for the size of the firm. In previous research, attempts to find other proxies for the size of the firm associated with the number of employees were not made, with the result that this approach is something new in comparison to prior research. Additionally, several research questions shall be answered with the empirical data of this study. First, how can employee-related ratios contribute to early detection of corporate crises and bankruptcies? Second, which of the employee-related ratios are potential predictors for the construction of a business failure prediction model? Last, can the inclusion of such factors be helpful to improve the prediction accuracy of an insolvency prediction model?

4. DATABASE

The database for this study consists of Austrian companies divided into the categories bankrupt and non-bankrupt. The observation period ranges from the years 2003 to 2004. The selected firms were not matched pairwise, as in many other previous studies due to several problems with this selection technique. An attempt was made to obtain a sample which is representative of the whole population. Thomas, Edelman and Crook (2002) propose such an approach. Nevertheless, this procedure also provides problems in terms of statistical estimation. If too few bankrupt firms are present in the sample, then their proportion is underestimated and developed models are much better at detecting non-bankrupt firms. First, a random initial sample was selected for the observation period. Here, 17 bankrupt firms were found from a database for the period 2003 and 2004. Then a random sample of non-bankrupt firms was chosen for the same period for 170 companies. Therefore, the proportion between non-bankrupt and bankrupt firms is 10:1. Similar proportions had also been used within different prior studies (Baetge, Beuter & Feidicker, 1992; Begley, Ming & Watts, 1996; Lennox, 1999a; Lennox, 1999b; Shah & Murtaza, 2000; Paradi, Asmild & Simak, 2004; Hol, 2007; Iazzolino, Migliano & Gregorace, 2013; Chaudhuri, 2013)

Second, a random test sample was obtained in order to assess the performance of the developed models and their ability to be used for practical purposes. Here, 10 bankrupt and 100 non-bankrupt firms were chosen randomly. The composition of the firms within the different samples is presented in *table 1*.

Table 1: *Composition of firms in initial and validation samples*

	2003 [two years prior to bankruptcy]		**2004** [one year prior to bankruptcy]	
	Bankrupt	Non-bankrupt	Bankrupt	Non-bankrupt
initial sample	17	170	17	170
test sample	10	100	10	100

5. METHODOLOGY AND RESEARCH DESIGN

In order to test the research hypotheses and research questions, different statistical tests and applications were applied within this study. First, descriptive statistics for the bankrupt and non-bankrupt companies were computed. Second, a test for normality based on Kolmogorov-Smirnov was applied, in order to determine whether the selected ratios were normally distributed. Normally distributed data are an important theoretical pre-condition for the application of multivariate linear discriminant analysis. Third, the differences in means, medians and variances for the two groups were analysed, in order to detect whether there are differences between the two groups in the variables. This analysis shall determine which of the variables are the most effective for discriminating between bankrupt and non-bankrupt companies. Fourth, a correlation analysis was computed to recognize how the variables are correlated with each other. This application was complemented by a factor analysis, where the loadings of the variables to certain factors were determined.

Last, multivariate linear discriminant functions were computed which are suitable to divide *a posteriori* between failed and non-failed companies two years and one year prior to the event of bankruptcy. In order to test the incremental informational content of employee-related ratios, three types of functions were computed for this purpose. These are functions containing only traditional ratios, only employee-related ratios and a combination of both. The validity of the models was then tested with the companies from the test group. The quality and accuracy of the models was evaluated using appropriate performance measures.

6. SELECTION OF VARIABLES

The variables for the purpose of this study were selected based on their appearance in previous literature. As already stated in this paper, variables related to employees have not been extensively analysed in prior studies. Some traditional ratios and some employee-related were therefore selected. Following accounting variables appeared relatively often in previous studies:

- **Total Equity/Total Assets**
  (Laitinen & Laitinen, 2000; Grunert, Norden & Weber, 2005; Pompe & Bilderbeek, 2005; Shin, Lee & Kim, 2005; Min & Lee, 2005, Muller, Steyn-Bruwer & Hamman, 2009; Bartual, Garcia, Gimenez & Romero-Civera, 2012)
- **Total Debt/Total Assets**
  (Ohlson, 1980; Zmijewski, 1984; Frydman, Altman & Kao, 1985; Pacey & Pham, 1990; Bryant, 1997; Doumpos & Zopounidis, 1998; Andandarajan, Lee & Anandarajan, 2001; Brabazon & Keenan, 2004; Neves & Vieira, 2006; Pervan & Kuvek, 2013; Chaudhuri, 2013).
- **EBIT/Total Assets**
  (Altman, 1968; Gilbert, Menon & Schwartz, 1990; Coats & Fant, 1993; Altman & Saunders, 1998; Grunert, Norden & Weber, 2005; Chen, Marshall, Zhang & Ganesh, 2006; Li & Sun, 2011; Bartual, Garcia, Gimenez & Romero-Civera, 2012; Iazzolino, Migliano & Gregorace, 2013)

- **Ln(Total Assets)**
  (Ohlson, 1980; Frydman, Altman & Kao, 1985; Barniv & Raveh, 1989; Whitaker, 1999; Chi & Tang, 2006; Pervan & Visic, 2012, Situm, 2014)
- **Ln(Sales)**
  (Chancharat, Tian, Davy, McCrae & Lodh, 2010; Situm, 2014)

Additionally, the following ratios were included within this study which were derived partly from previous literature. Also displayed are new ratios which have not been analysed in this form within prior research. Several of them contain figures related to employees.

Table 2: *Additional ratios for analysis*
Ratios on the right side are defined as "new", because these ratios were not found to be considered as potential prediction variables based on an extensive literature review of 238 papers related to the topic of crisis- and insolvency prediction

Ratios found in previous research	"new" ratios not found to be used in previous research
Sales/Total Assets [Altman, 1968; Brabazon & Keenan, 2004; Dietrich, Arcelus & Srinivasan, 2005; Bartual, Garcia, Gimenez & Romero-Civera, 2012; Tsai, 2013]	Ln(Sales/Total Assets)
Ln(Number of Employees) [Situm, 2014]	Ln(Sales/Number of Employees)
Staff Costs/Sales [Bruse, 1978; Gebhardt, 1980]	Ln(Staff Costs/Number of Employees)
EBIT/Sales [Marchesini, Perdue & Bryan, 2005]	EBITDA/Staff Costs
Sales/Staff Costs [inverse relation to the ratio staff costs/sales based on Bruse, 1978; Gebhardt, 1980]	EBIT/Staff Costs

7. STATISTICAL ANALYSES

7.1 Descriptive statistics

Table 3 provides the means, medians and standard deviations for the chosen variables for two years and one year prior to bankruptcy. The mean of total equity/total assets deteriorated for bankrupt firms from 2003 to 2004, which indicates that bankrupt firms incur additional losses as insolvency approaches. Firms in financial trouble are financing their operating business with liabilities, with the result that they are exhibiting much higher leverage ratios in mean and median than solvent firms. Ln(sales), ln(number of employees) and ln(total assets) are all measures associated with the size of the firm. All three variables showed higher means for the solvent firms in comparison to the bankrupt firms for the two observation periods. This indicates that bankrupt firms are in mean, but also in median, smaller than non-bankrupt ones. Staff costs/sales are much lower for solvent firms

in mean, which indicates that employee-resources are used more efficiently by financially healthy companies. Higher efficiency of non-bankrupt firms can also be argued by the ratios EBITDA/staff costs, EBIT/staff costs and EBIT/Sales. These variables showed in mean and in median higher values for non-bankrupt than for bankrupt firms.

Table 3: *Descriptive statistics*

		2003 [two years prior to bankruptcy]			**2004** [one year prior to bankruptcy]		
Ratio	**Class**	**Mean**	**Median**	**Stand.-Dev.**	**Mean**	**Median**	**Stand.-Dev.**
Total Equity/ Total Assets	0	-0.062	0.056	0.549	-0.851	-0.330	1.468
	1	0.153	0.177	0.510	0.223	0.193	0.295
Total Debt/ Total Assets	0	1.062	0.944	0.549	1.851	1.330	1.468
	1	0.848	0.823	0.510	0.777	0.807	0.295
Sales/Total Assets	0	2.492	1.694	2.492	1.832	1.238	2.068
	1	1.800	1.386	1.527	1.693	1.301	1.485
ln(Sales/Total Assets)	0	0.225	0.527	1.777	-0.007	0.214	1.271
	1	0.143	0.326	1.171	0.088	0.263	1.102
ln(Sales)	0	11.221	11.235	1.412	11.390	11.549	1.100
	1	12.071	11.988	1.243	12.237	12.031	1.205
ln(Number of Employees)	0	3.418	3.689	1.175	2.687	2.639	1.309
	1	3.834	4.025	1.715	3.749	3.912	1.537
ln(Sales/ Number of Employees)	0	11.221	11.235	1.412	11.390	11.549	1.100
	1	12.071	11.988	1.243	12.237	12.031	1.205
ln(Staff Costs/ Number of Employees)	0	10.346	10.409	0.542	10.481	10.627	0.591
	1	10.676	10.681	0.726	10.690	10.686	0.615
Staff Costs/ Sales	0	3.736	0.325	13.810	0.840	0.367	1.500
	1	0.430	0.274	0.843	0.347	0.262	0.474
Sales/Staff Costs	0	4.188	3.076	4.444	4.198	2.728	6.051
	1	7.130	3.653	11.442	11.982	3.817	34.833
EBITDA/ Staff Costs	0	-0.152	0.107	1.288	-0.503	-0.230	1.514
	1	0.509	0.221	1.571	1.184	0.324	4.072
EBIT/Staff Costs	0	-0.251	0.036	1.284	-0.695	-0.312	1.463
	1	0.021	0.102	2.070	0.770	0.162	3.354
EBIT/Sales	0	-17.311	0.017	71.301	-1.507	-0.058	4.217
	1	-1.254	0.027	15.052	0.043	0.033	0.291

		2003 [two years prior to bankruptcy]			2004 [one year prior to bankruptcy]		
Ratio	**Class**	**Mean**	**Median**	**Stand.-Dev.**	**Mean**	**Median**	**Stand.-Dev.**
EBIT/Total Assets	0	-0.077	0.024	0.292	-0.531	-0.040	0.994
	1	-0.048	0.034	0.909	0.056	0.045	0.163
ln(Total Assets)	0	14.415	14.831	1.126	14.084	14.735	1.783
	1	15.762	15.743	1.807	15.898	15.735	1.742

7.2 Test for normality of data

The test of normality based on Kolmogorov-Smirnov at the 5 percent level is reported in *Table 4*. Normality of data cannot be assumed for the majority of the variables. The only variable which showed normality for both groups and for both time periods is ln(number of employees). Similarly, ln(total assets) showed normal distribution for both groups of firms, but only two periods prior to the event of insolvency. As within this study multivariate linear discriminant analysis has been applied, the occurrence of non-normal data could be a problem for model building, due to the risk that classification accuracy can be affected (Hopwood, McKeown & Mutchler, 1988; Klecka, 1989; Subhash, 1996; Keasey & Watson, 1991). This is not an extreme problem however, when departures from normality are only at a low level (Hopwood, McKewon & Mutchler, 1988; Silva, Stam & Neter, 2002; Feldesman, 2002). For some constellations of probability distribution, a departure can also be beneficial for improved discrimination between both groups, so that better classification accuracies can be achieved in comparison to logistic regression (Pohar, Blas & Turk 2004).

Table 4: *Kolmogorov-Smirnov test for normality of data*
Values in bold denote normally distributed data at 5 percent significance level

		2003 [two years prior to bankruptcy]			2004 [two years prior to bankruptcy]		
Ratio	**Class**	**Statistic**	**Sign.**	**Skewness**	**Statistic**	**Sign.**	**Skewness**
Total Equity/ Total Assets	0	.361	.000	-3.344	.263	.003	-1.724
	1	.253	.000	-4.526	.123	.000	-0.672
Total Debt/ Total Assets	0	.361	.000	3.344	.263	.003	1.724
	1	.253	.000	4.527	.123	.000	0.672
Sales/Total Assets	0	.201	**.065**	1.963	.252	.005	2.010
	1	.120	.000	1.834	.142	.000	1.884
ln(Sales/Total Assets)	0	.209	.046	-2.486	.142	**.200**	-0.571
	1	.113	.000	-1.654	.116	.000	-1.153
ln(Sales)	0	.201	**.067**	-1.587	.182	**.138**	0.275
	1	.072	.030	0.579	.093	.001	0.755
ln(Number of Employees)	0	.135	**.200**	-0.969	.119	**.200**	-0.294
	1	.060	**.200**	0.199	.056	**.200**	0.075

		2003 [two years prior to bankruptcy]			2004 [two years prior to bankruptcy]		
Ratio	**Class**	**Statistic**	**Sign.**	**Skewness**	**Statistic**	**Sign.**	**Skewness**
ln(Sales/ Number of Employees)	0	.201	**.067**	-1.587	.182	**.138**	0.275
	1	.072	.030	0.579	.093	.001	0.755
ln(Staff Costs/ Number of Employees)	0	.137	**.200**	0.105	.131	**.200**	-1.156
	1	.128	.000	1.373	.101	.000	-0.652
Staff Costs/Sales	0	.519	.000	4.121	.420	.000	3.077
	1	.309	.000	8.385	.234	.000	6.871
Sales/Staff Costs	0	.277	.001	2.441	.370	.000	3.752
	1	.270	.000	5.465	.368	.000	6.974
EBITDA/Staff Costs	0	.365	.000	-3.745	.212	.040	-1.635
	1	.234	.000	4.662	.368	.000	6.120
EBIT/Staff Costs	0	.394	.000	-3.834	.249	.006	-1.869
	1	.313	.000	-5.735	.364	.000	6.536
EBIT/Sales	0	.536	.000	-4.123	.434	.000	-3.350
	1	.478	.000	-12.954	.280	.000	-4.890
EBIT/Total Assets	0	.268	.002	-2.275	.273	.002	-1.929
	1	.370	.000	-11.711	.174	.000	-0.320
ln(Total Assets)	0	.173	**.185**	-0.271	.172	**.196**	-0.690
	1	.067	**.060**	0.155	.076	.017	0.657

The problem of non-normal data appeared in several studies (Hauschildt, Rößler & Gemünden, 1984; Pacey & Pham, 1990; Barniv & McDonald, 1992; Baetge, Beuter & Feidicker, 1992; Lennox, 1999a; Chi & Tang, 2006; Yim & Mitchell, 2007; Samad, Yusof & Shaharudin, 2009), where this aspect was handled differently. Additionally, the approach of logistic regression should be more sound, as it does not demand normally distributed data, but several studies showed that this method is not generally able to deliver superior classification results when compared to multivariate linear discriminant analysis (Gentry, Newbold & Whitford, 1985; Gombola, Haskins, Ketz & Williams, 1987; Barniv & Raveh, 1989; Pacey & Pham, 1990; Barniv & McDonald, 1992; Neophytou & Mar Molinero, 2004; Kim & Gu, 2006).

The aim of this study is not to develop a forecasting model. This study aims to test the potential prediction power of employee-related ratios in order to differentiate between bankrupt and non-bankrupt firms. Despite the non-normality of data being a given, multivariate linear discriminant analysis can nevertheless be used for such an attempt (Feldesman, 2002; Neophytou & Mar Molinero, 2005; Kim & Gu, 2006). Therefore, further progress was conducted without outlier deletion techniques or attempts concerning the normalization of data. Nevertheless, it must be kept in mind that this theoretical pre-condition is generally violated and that this may be attributable to weaker model quality and classification results. This aspect is also discussed within the section covering the limitations of the study.

7.3 Tests for differences in means and variances

A test for differences in means and in variances at 5 percent level can be applied to detect the variables with the highest potential as discriminators between the two groups of companies. Mainly due to non-normally distributed data additionally, a U-test was considered (Ho, 2006, p. 357 and 368). In this case it is the more suitable method for decision and evaluation, and the results from the two aforementioned methods are displayed for informational purposes. The results are presented in the *Tables 5* and *6*. Many more variables can be found for the period one year prior to bankruptcy, which indicates that the signalling power increases as the event of bankruptcy approaches. This is in congruence with the generally accepted view that early detection is much more difficult (i.e. the signals are much weaker or less forthcoming) when the distance in time to the event of bankruptcy increases (Altman, 1968; Blum, 1974; Altman, Haldeman & Narayanan, 1977; Dambolena & Khoury, 1980; Mensah, 1984; Barniv & McDonald, 1992; Lennox 1999a; Laitinen & Laitinen, 2000; Chi & Tang, 2006; Korol & Korodi, 2011). According to the results, certain variables remain, which could act as potential predictors for the models.

Table 5: *Parametric and non-parametric test for differences two years prior to bankruptcy*
Values in bold denote statistically significant differences at the 5 percent level

	2003 [two years prior to bankruptcy]					
	t-test		**Levene-test**		**U-Test**	
Variables	**T**	**Sign.**	**F**	**Sign.**	**U**	**Sign.**
Equity/Total Assets	-1.646	0.102	0.118	0.731	914.000	**0.013**
Total Debt/Total Assets	1.644	0.102	0.119	0.730	914.000	**0.013**
Sales/Total Assets	1.664	0.098	5.483	**0.020**	1252.000	0.364
ln(Sales/Total Assets)	0.261	0.794	1.377	0.242	1252.000	0.364
ln(Sales)	-2.654	**0.009**	0.031	0.860	955.000	**0.021**
ln(Number of Employees)	-0.974	0.331	2.806	0.096	1237.500	0.329
ln(Sales/Number of Employees)	-2.654	**0.009**	0.031	0.860	955.000	**0.021**
ln(Staff Costs/ Number of Employees)	-1.817	0.071	0.136	0.713	916.000	**0.013**
Staff Costs/Sales	3.139	**0.002**	41.265	**0.000**	1176.000	0.206
Sales/Staff Costs	-1.050	0.295	1.877	0.172	1176.000	0.206
EBITDA/Staff Costs	-1.677	0.095	0.161	0.689	1014.000	**0.043**
EBIT/Staff Costs	-0.531	0.596	0.099	0.754	1132.000	0.141
EBIT/Sales	-2.482	**0.014**	25.694	**0.000**	1086.000	0.092
EBIT/Total Assets	-0.130	0.897	0.027	0.870	1200.000	0.250
ln(Total Assets)	-3.010	0.003	1.869	0.173	720.000	**0.001**

All of the significant variables in 2003 based on U-test (the only exception is ln(staff costs/number of employees) are also statistically significant at the 5 percent level in 2004. This indicates that these ratios are able to provide much earlier warning signals concerning the economic situation of the firm. In 2004, four additional ratios showed discriminatory power to make a distinction between the two types of firms (ln(number of employees), EBIT/staff costs, EBIT/sales and EBIT/total assets). All other ratios are insignificant and can therefore be excluded from further analysis. A more profound insight can be achieved using correlation and factor analysis.

Table 6: *Parametric and non-parametric test for differences one year prior to bankruptcy*
Values in bold denote statistically significant differences at the 5 percent level

	2004 [one year prior to bankruptcy]					
	t-test		**Levene-test**		**U-Test**	
Variables	**T**	**Sign.**	**F**	**Sign.**	**U**	**Sign.**
Equity/Total Assets	-8.194	**0.000**	119.091	**0.000**	574.000	**0.000**
Total Debt/Total Assets	8.194	**0.000**	119.091	**0.000**	574.000	**0.000**
Sales/Total Assets	0.353	0.724	1.818	0.179	1377.000	0.749
ln(Sales/Total Assets)	-0.334	0.739	0.827	0.364	1377.000	0.749
ln(Sales)	-2.784	**0.006**	0.639	0.425	853.000	**0.005**
ln(Number of Employees)	-2.748	**0.007**	0.430	0.513	870.500	**0.007**
ln(Sales/Number of Employees)	-2.784	**0.006**	0.639	0.425	853.000	**0.005**
ln(Staff Costs/ Number of Employees)	-1.340	0.182	0.067	0.796	1202.000	0.253
Staff Costs/Sales	3.065	**0.003**	23.353	**0.000**	1051.000	0.064
Sales/Staff Costs	-0.918	0.360	1.858	0.175	1051.000	0.064
EBITDA/Staff Costs	-1.693	0.092	0.375	0.541	846.000	**0.005**
EBIT/Staff Costs	-1.781	0.077	0.097	0.756	770.000	**0.002**
EBIT/Sales	-4.795	**0.000**	77.533	**0.000**	846.000	**0.005**
EBIT/Total Assets	-6.968	**0.000**	110.293	**0.000**	734.000	**0.001**
ln(Total Assets)	-4.085	**0.000**	0.667	0.415	699.000	**0.000**

7.4 Correlation analysis and factor analysis

The complete results of correlation analysis based on Pearson for the two years prior to the event of bankruptcy can be found in the appendix of this work. Within *Tables 7* and *8*, the correlations for the most relevant variables based on U-test are reported. The general results show some highly positive and significant correlations between variables, which imposes multicollinearity. This occurrence can affect the discrimination power of models when such variables are included within prediction models (Hosmer & Lemeshow, 2000; Thomas, Edelman & Crook, 2002; Silva, Stam & Neter, 2002; Wooldridge, 2006; Asteriou & Hall, 2007). Multicollinearity can therefore be assumed for the following constellations:

- Ln(sales) and ln(sales/number of employees) for both years
- Total equity/total assets and EBIT/total assets for 2004
- EBITDA/staff costs and EBIT/staff costs for 2004

This implies that not all of these variables should be used for model building, because information redundancy is taken as a given. Besides this, there are several negative correlations which are potentially interesting for model building.

Table 7: *Correlation analysis for two years prior to bankruptcy*
Values in bold denote statistically significant correlations at the 1 percent level

	Equity/Total Assets	Total Debt/Total Assets	ln(Sales)	ln(Sales/Number of Employees	ln(Staff Costs/ Number of Employees)	EBITDA/Staff Costs	ln(Total Assets)
Equity/Total Assets	1	**-1.000**	**.273**	**.273**	.087	**.343**	**.316**
Total Debt/Total Assets		1	**-.273**	**-.273**	-.087	**-.343**	**-.316**
ln(Sales)			1	**1.000**	**.547**	**.370**	**.334**
ln(Sales/Number of Employees)				1	**.547**	**.370**	**.334**
ln(Staff Costs/ Number of Employees)					1	.066	**.239**
EBITDA/Staff Costs						1	**.331**
ln(Total Assets)							1

Table 8: *Correlation analysis for one year prior to bankruptcy*
Values in bold denote statistically significant correlations at the 1 percent level

	Equity/Total Assets	Total Debt/Total Assets	ln(Sales)	ln(Number of Employees)	ln(Sales/Number of Employees	EBITDA/Staff Costs	EBIT/Staff Costs	EBIT/Sales	EBIT/Total Assets	ln(Total Assets)
Equity/Total Assets	1	**-1.000**	**.194**	**.237**	**.194**	.080	.103	**.488**	**.775**	**.360**
Total Debt/Total Assets		1	**-.194**	**-.237**	**-.194**	-.080	-.103	**-.488**	**-.775**	**-.360**
ln(Sales)			1	**-.253**	**1.000**	.285	**.251**	**.238**	**.198**	**.321**
ln(Number of Employees)				1	**-.253**	**-.273**	**-.242**	.076	.125	**.633**
ln(Sales/Number of Employees)					1	**.285**	**.251**	**.238**	**.198**	**.321**
EBITDA/Staff Costs						1	**.952**	**.172**	**.231**	.085
EBIT/Staff Costs							1	**.187**	**.276**	.048
EBIT/Sales								1	**.453**	.097
EBIT/Total Assets									1	**.195**
ln(Total Assets)										1

Further insight into the ability of the ratios is provided with factor analysis based on Varimax-rotation. For the period two years prior to bankruptcy, two factors were extracted. These factors are able to explain over 70.7 percent of the variances between the related variables. Ln(sales) shows a high loading on the first factor, which is the same for the ratio ln(sales/number of employees). As the first ratio is associated with the size of the firm, this factor could be assigned as a "size factor". Therefore the second ratio seems to be a good proxy for this aspect too. This is also valid for the variable ln(staff costs/number of employees).

The second factor is driven mainly by the variable equity/total assets ratio, which indicates that this factor can be assigned as the "capital structure". Here, total debt/total assets is loaded with the same value as the equity-ratio, but with a negative sign, which was expected based on correlation analysis. The relation between EBITDA/staff costs, which could be assigned as a measure of efficiency, is also loaded on this factor, so that here the aspects of profitability and efficiency are additionally included. It is interesting to note that ln(total assets) is mainly loaded on the second factor, even if it is a measure of size.

Table 9: *Factor analysis for two years prior to bankruptcy*

	Factors	
	1	**2**
Cumulated explained variances in %	35.9935564	70.7114292
Equity/Total Assets		,964
Total Debt/Total Assets		-,964
ln(Sales)	,924	,238
ln(Sales/Number of Employees)	,924	,238
ln(Staff Costs/Number of Employees)	,757	
EBITDA/Staff Costs	,309	,512
ln(Total Assets)	,374	,441

The results of factor analysis for one year prior to bankruptcy exhibited four factors. The first factor is related to "capital structure and profitability", where the equity-ratio showed the highest loading. The second and fourth factor can both be associated with the "size of the firm". It is interesting to note that ln(total assets) gained a higher value one year prior to the event of bankruptcy and showed a much higher loading. Here it is dominant and responsible for the formation of the fourth factor. The third factor shows "efficiency" in the usage of staff within the firm, where it is measured by different types of earnings. The general conclusion of factor analysis is in congruence with the results from correlation analysis in that certain variables will not appear within the models due to multicollinearity, even if they showed discriminatory power based on the U-test. To answer which variables these will be, several multivariate linear discriminant analyses based on a step-wise method were applied.

Table 10: *Factor analysis for one year prior to bankruptcy*

	Factors			
	1	**2**	**3**	**4**
Cumulated explained variances in %	30.3933421	51.9858626	72.080472	88.8199957
Equity/Total Assets	.938			.210
Total Debt/Total Assets	-.938			-.210
ln(Sales)	.134	.978	.132	
ln(Number of Employees)	.129	-.282	-.196	.872
ln(Sales/Number of Employees)	.134	.978	.132	
EBITDA/Staff Costs		.152	.971	
EBIT/Staff Costs	.119	.105	.972	
EBIT/Sales	.659	.156		
EBIT/Total Assets	.865		.184	
ln(Total Assets)	.150	.309		.901

8. MODEL BUILDING

Resulting from the preliminary analyses, it is now possible to construct prediction models based on multivariate linear discriminant analysis for the two periods prior to bankruptcy. This method is used here to determine the prediction ability of employee-related ratios as potential indicators for the distinction between bankrupt and non-bankrupt firms. It cannot be expected that the models obtained will provide good classification results nor that they will show a good model quality, due to the violations of certain theoretical assumptions for the correct application of linear discriminant analysis. Within this research, the technique of Mahlanobis distance is used for the construction of the classification functions, where a stepwise method is applied. First, only "traditional" ratios will be used for model building, which do not have any association with the number of employees or to staff costs. Second, models fed with all variables will be computed so that the incremental informational content of employee-related ratios for the task of prediction can be assessed. Third, only models containing employee-related variables were calculated in order to determine the predictive ability of these ratios. Last, the models were then tested on the firms of the validation group, in order to evaluate their potential for practical purposes and to assess model stability.

The relevant statistical ratios concerning pre-analysis for discriminant models are shown in *Table 11*. Based on Box-test, the significances are less than 0.05 for the first two model types, meaning that equality of variance-co-variance matrices cannot be assumed (Burns & Burns, 2008, p. 598). This is a violation of another theoretical pre-condition for the application of linear discriminant analysis, which can affect the prediction accuracy of classification functions (Feldesman, 2002). The only exception is apparent in the model using only employee-related ratios for the period 2003 and 2004. Here, this pre-condition was fulfilled so that a better model fit could be expected. Based on the Wilks-Lambda model, quality of discriminant functions can be assessed. The significances are all below 0.05, so that the discriminant functions are significantly discriminating between the two groups of firms. A classification with the functions is more reliable than a random assignment of the firms into the two groups.

Even if this aspect is taken as a given, based on the value of Wilks-Lambda there remains a large proportion of unexplained variances between the two groups of firms. For the model containing only "traditional" ratios/all ratios in 2004, the unexplained variance was about 73.4 percent, which is much lower than for the other models. This result indicates that the chosen ratios are not in the position to fully explain or describe how bankrupt and non-bankrupt firms differ in this regard. There is the need to consider additional ratios and variables, which need not be accounting ratios at all, so that model quality and performance can be improved. This conclusion is in congruence with the generally accepted views in research (Grunert, Norden & Weber, 2006; Muller, Steyn-Bruwer & Hamman, 2009; Altman, Sabato & Wilson, 2010; Madrid-Guijarro, Garcia-Perez-de-Lema & van Auken, 2011; Iazzolino, Migliano & Gregorace, 2013).

Table 11: *Pre-analysis for discriminant models*

	Models with "traditional" ratios		Models with all ratios		Models with "employee-related" ratios	
	2003	**2004**	**2003**	**2004**	**2003**	**2004**
Box-M	5.079	155.604	5.079	155.604	.511	2.335
Sign.	.026	.000	.026	.000	.479	.527
Wilks Lambda	.953	.734	.953	.734	.963	.894
Sign.	.003	.000	.003	.000	.009	.000

The related discriminant functions are shown in the following equations. These are the models with the best model fit. The abbreviations are defined as T = traditional model, A = all ratios model and E = employee-related model and the numbers in parenthesis denote the respective year:

$$Z_{T(2003)} = -6.568 + 0.435 \times \ln(Total\ Assets) \quad (1)$$

$$Z_{T(2004)} = 1.271 + 4.044 \times \frac{Total\ Equity}{Total\ Assets} \quad (2)$$

$$Z_{A(2003)} = Z_{T(2003)} \quad (3)$$

$$Z_{A(2004)} = Z_{T(2004)} \quad (4)$$

$$Z_{E(2003)} = -6.249 + 0.537 \times ln\left(\frac{Sales}{Number\ of\ Employees}\right) \quad (5)$$

$$Z_{E(2004)} = -12.165 + 0.849 \times ln\left(\frac{Sales}{Number\ of\ Employees}\right) + 0.664 \times ln(Number\ of\ Employees) \quad (6)$$

As can be seen above, functions two and four, but also one and three are the same. With discriminant analysis, it was not possible to include an additional employee-related ratio to total equity/total assets (in 2004) and to ln(total assets) (in 2003) in order to improve the prediction accuracy of the model. The classification results for initial and validation sample are presented in the *Tables 12* and *13*. Generally, the functions did not provide satisfactory results, which is attributable to the factors of non-normally distributed data, inequality of covariance matrices (for the first two model types) and the composition of the samples itself, which will be discussed in a later section. Here, it must once again be pointed out that these aspects were ignored, as the purpose of this study was not to construct a prediction model. The aim is rather to investigate the predictive power of employee-related ratios for the distinction between bankrupt and non-bankrupt firms.

Table 12: *Classification results of discriminant models for initial sample*
Models with "traditional" ratios and models with all ratios contain the same combination of prediction variables for the respective year, so that there is no difference in the classification results between these two types of discriminant functions

			2003 [two years prior to bankruptcy]		**2004** [one year prior to bankruptcy]	
			Assignment		**Assignment**	
	bankrupt non-bankrupt		**bankrupt**	**non-bankrupt**		
Models with "traditional" ratios	Number of firms	bankrupt	11	6	9	8
		non-bankrupt	54	116	8	162
	%	bankrupt	64.71%	35.29%	52.94%	47.06%
		non-bankrupt	31.76%	68.24%	4.71%	95.29%
Models with all ratios	Number of firms	bankrupt	11	6	9	8
		non-bankrupt	54	116	8	162
	%	bankrupt	64.71%	35.29%	52.94%	47.06%
		non-bankrupt	31.76%	68.24%	4.71%	95.29%
Models with "employee-related" ratios	Number of firms	bankrupt	11	6	11	6
		non-bankrupt	66	104	50	120
	%	bankrupt	64.71%	35.29%	64.71%	35.29%
		non-bankrupt	38.82%	61.18%	29.41%	70.59%

The most relevant measurement for practical purposes is a type I error, which occurs when a bankrupt firm is assigned by the model as being non-bankrupt. Therefore, it is of interest to minimize this type of error. Models with high type I error are normally not suitable for practical purposes. In the case of the models developed, it can be seen that type I errors are relatively high, which is implied by the fact that the cut-off value between the two types of firms was set at zero. A firm having a lower value than zero was assigned as being bankrupt and otherwise it was assigned as non-bankrupt. Literature provides different methods of adjusting this cut-off point in order to minimize type I error, which will not be examined further within this work as it is not the purpose of this study.

Nevertheless, it is of interest to analyse the signs of the ratios within the equations, as they can provide some information about the probability of bankruptcy. Within equation one,

the signs are consistent with expectations. The size of the firm was found in many studies to be a good discriminator between bankrupt and non-bankrupt firms (Ohlson, 1980; Theodossiou, Kahya, Saidi & Philippatos, 1996; McKee, 2007; Fitzpatrick & Ogden, 2011; Situm, 2014), and it is unsurprising that this variable also appeared as a discriminator within this study. Firms which are great in size are much less likely to go into bankruptcy.

The sign of total equity/total assets for equations two and four is also consistent with findings from prior literature (Laitinen & Laitinen, 2000; Grunert, Norden & Weber, 2005; Muller, Steyn-Bruwer & Hamman, 2009). Companies with a higher portion of equity are less likely to fail. The discriminatory power of this ratio in 2004 is not surprising, based on the preliminary U-test and its significance.

Table 13: *Classification results of discriminant models for validation sample*
Models with "traditional" ratios and models with all ratios contain the same combination of prediction variables for the respective year, so that there is no difference in the classification results between these two types of discriminant functions

			2003 [two years prior to bankruptcy]		**2004** [one year prior to bankruptcy]	
			Assignment		**Assignment**	
bankrupt non-bankrupt			**bankrupt**	**non-bankrupt**	**bankrupt**	**non-bankrupt**
Models with "traditional" ratios	Number of firms	bankrupt	4	6	5	5
		non-bankrupt	33	67	6	94
	%	bankrupt	40.00%	60.00%	50.00%	50.00%
		non-bankrupt	33.00%	67.00%	6.00%	94.00%
Models with all ratios	Number of firms	bankrupt	4	6	5	5
		non-bankrupt	33	67	6	94
	%	bankrupt	40.00%	60.00%	50.00%	50.00%
		non-bankrupt	33.00%	67.00%	6.00%	94.00%
Models with "employee-related" ratios	Number of firms	bankrupt	7	3	6	4
		non-bankrupt	40	60	29	71
	%	bankrupt	70.00%	30.00%	60.00%	40.00%
		non-bankrupt	40.00%	60.00%	29.00%	71.00%

The fifth equation, ln(sales/number of employees), appeared with a positive sign. This ratio indirectly replicates the size of the firm based on factor analysis, so that the direction of the sign follows the expectation. A higher value for this ratio improves the score of the discriminant functions and tends towards the assignment of a company as non-bankrupt.

Therefore, the greater the size of the firm, the less likely it will become bankrupt. This result is in congruence with the findings concerning the model comprising the traditional ratios. In equation six, ln(sales/number of employees) showed a positive sign. It can be defined as a measure of efficiency. The more sales with fewer employees that can be achieved, the more efficiently a firm can be said to be working. This efficiency contributed positively to discriminant value. Firms with higher efficiency are less likely to fail. Ln(number of employees) is a proxy for the size of the firm and therefore has a similar function to ln(total assets). Firms with a higher number of employees are greater in size and therefore have a lower probability of failure. This aspect is in congruence with results from previous literature (Situm, 2014). Therefore, the positive sign of this ratio satisfies expectations.

A significantly better comparison of the models can be reached when certain performance measures are computed (calculations were based on Metz, 1978; Fawcett, 2006; Anderson, 2007; Ooghe & Spaenjers, 2010). Based on AUC, it can be seen that the models one year prior to bankruptcy have a higher performance when compared to the models two years prior to bankruptcy. It is interesting to note that the results for validation sample in 2004 are quite good, and for the model with "traditional" ratios (and also for the model with all variables), they are better than for the initial sample. Nevertheless, type I error remains relatively high, but could be adjusted appropriately to achieve better results. The model containing only employee-related ratios in 2004 was slightly weaker in performance, but showed a better ability to correctly assign bankrupt firms due to lower type I error. The overall accuracy of this model in 2004 was relatively weak, which means that the model produced high type II errors. It must be emphasized again that the model with all variables is the same as the model with traditional ratios. Stepwise discriminant analysis was not able to include any of the employee-related variables in order to improve prediction accuracy. This occurrence leaves doubt about the incremental informational content of employee-related ratios for bankruptcy prediction.

Table 14: *Performance measures for the models*
Values in bold denote statistically insignificant values

	2004 [one year prior to bankruptcy]					
	Models with "traditional " ratios		**Models with all ratios**		**Models with "employee-related" ratios**	
	Initial	**Validation**	**Initial**	**Validation**	**Initial**	**Validation**
AUC	80,14%	83,60%	80,14%	83,60%	79,34%	76,60%
Accuracy	91,44%	90,00%	91,44%	90,00%	70,05%	70,00%
Type I Error	47,06%	50,00%	47,06%	50,00%	35,29%	40,00%
Type II Error	4,71%	6,00%	4,71%	6,00%	29,41%	29,00%

	2003 [two years prior to bankruptcy]					
	Models with "traditional " ratios		**Models with all ratios**		**Models with "employee-related" ratios**	
	Initial	Validation	Initial	Validation	Initial	Validation
AUC	50.59%	43.90%	50.59%	43.90%	54.19%	58.10%
Accuracy	67.91%	64.55%	67.91%	64.55%	61.50%	60.91%
Type I Error	35.29%	60.00%	35.29%	60.00%	35.29%	30.00%
Type II Error	31.76%	33.00%	31.76%	33.00%	38.82%	40.00%

For the period two years prior to bankruptcy, the models delivered a weaker performance and in contrast to the models in 2004, the results for validation sample are weak. The AUC measures were all relatively low and not statistically significant. Therefore, none of the models in 2003 are suitable for practical purposes in the apparent combination. They mainly exhibited Gini coefficients below 0.5, and based on this measure their usefulness can be dismissed (Anderson, 2007, p. 205). It is assumed that it would also be possible here to adjust cut-off values to achieve an improved performance. It is noticeable that accuracies in 2003 are much lower than for 2004, which indicates that the informational content of the ratios is not strong enough for early detection of corporate crises. This is true for all analysed ratios in the course of this study. Such a statement also confirms the results from previous literature that the signalling power of predictors is weaker as the distance to the event of bankruptcy increases (Altman, 1968; Dambolena & Khoury, 1980; Lennox, 1999a; Laitinen & Laitinen, 2000; Chi & Tang, 2006; Korol & Korodi, 2011).

9. CONCLUSIONS

The results of this study provide some interesting conclusions concerning the suitability of employee-related ratios for the task of prediction. The models developed within this study did not show a satisfactory performance, which is attributable to different factors which will be highlighted within the next chapter. The signalling power for the period two years prior to bankruptcy was limited and the performance of the models was clearly inferior to the models developed for the period one year prior to bankruptcy. Such an observation confirms the results from numerous prior research. It is remarkable that the model based on traditional ratios in 2004 provided a better performance in terms of classifying the firms from validation sample than it did from initial sample. This provides evidence that the model does have a certain discriminatory power and stability which could be exploited if cut-off values are appropriately adjusted in order to minimize type I error. Even if this is possible, it does not seem useful to make this attempt, as the function contains only one variable, in that it is a univariate approach. Several problems are associated with such a model, which deny a proper practical application.

The results show that it was not possible to increase the prediction performance of the models when employee-related ratios were incorporated within the models. It must be mentioned here that it was not possible to build a model containing traditional and employee-related ratios due to statistical restrictions. Models built solely on employee-related ratios are inferior with respect to their predictive power when compared to models using traditional ratios and a combination between classical and employee-related ratios. Generally, their ability to act as predictors seems questionable based on these results, although several ratios showed discriminatory power grounded on the tests for differences.

The signs of the independent variables within the discriminant functions are all in congruence with expectations. A closer look at the weightings and interpretation of the discriminators helps to draw some useful conclusions. The size of the firms seems to play an important role in the distinction between bankrupt and non-bankrupt firms, because this factor was implicitly inherent within the different functions replicated by different variables. Based on the results from factor analysis, the following proxies were found which were all related to the size of the firm. The final two proxies had not been found and attributed to this factor in previous studies until now.

- ln(total assets)
- ln(number of employees)
- ln(staff costs/number of employees)
- ln(sales/number of employees)

From a theoretical viewpoint, it is assumed that firms with a greater size have a greater chance of survival due to different factors such as less business risk per dollar of assets invested, easier access to borrowing markets or more tax offsets per dollar of assets (Castanias, 1983, p. 1628 – 1629; Theodossiou, Kahya, Saidi & Philippatos, 1996, p. 704). These theoretical statements were confirmed within different studies, resulting in firms with a greater size having a lower probability of bankruptcy (Ohlson, 1980; Chatterjee & Srinivasan, 1992; Theodossiou, Kahya, Saidi & Philippatos, 1996; Dawley, Hoffman & Brockman, 2003; Chava & Jarrow, 2004; Chi & Tang, 2006; Hol, 2007; Pervan & Visic, 2012; Situm, 2014). The same result was found within this study.

The factor of efficiency appeared within this study, but it was not as important a factor as expected. Ln(sales/number of employees) appeared as an independent variable within the functions containing only employee-related variables for the periods one and two years prior to bankruptcy. The respective weightings are relatively low, with the result that the contribution of the values to the score of the function is marginal. An argument can be made that the data set was not concentrated on a specific industry. Certain industries need comparatively much more employees than others to generate sales and results. Such an aspect cannot be directly associated with inefficiency to the extent that this can explain the small weightings of the related ratios. Despite this, the signs suggest that firms with a higher efficiency are less likely to fail. This result confirms the findings of previous studies (Chen, Marshall, Zhang & Ganesh, 2006; Yeh, Chi & Hsu, 2010). It is also a sign that firms are stable at the operational level, meaning that the pre-conditions for stabilization and profit generation are taken as a given (Sudarsanam & Lai, 2001).

The capital structure of the firm was replicated with the ratio of total equity/total assets, which was also a predictor in other studies (Laitinen & Laitinen, 2000; Grunert, Norden & Weber, 2005; Pompe & Bilderbeek, 2005; Shin, Lee & Kim, 2005; Min & Lee, 2005, Bahiraie, Akma bt Ibrahim & Azhar, 2009; Muller, Steyn-Bruwer & Hamman, 2009; Bartual, Garcia, Gimenez & Romero-Civera, 2012). The interesting finding from this study is that it appeared alone within the discrimination functions without any other supporting ratios for one year prior to bankruptcy. This is not surprising as this was also visible from the results of means and medians from descriptive statistics. This result supports the generally accepted view that companies with a high (positive) equity ratios are less likely to fail. Nevertheless, it is interesting that the ratio did not provide an early warning signal two years prior to bankruptcy. This aspect could be attributable to the database however, as the differences in means and medians for this ratio in 2003 were relatively low.

The overall conclusion of this work is that employee-related ratios cannot provide additional information which could be exploited for the task of prediction. Therefore, their inclusion within bankruptcy prediction models is neither recommendable nor beneficial.

10. IMPLICATIONS, LIMITATIONS AND RECOMMENDATIONS FOR FUTURE RESEARCH

10.1 Research hypotheses

The first hypothesis assumed that the higher the ratio of staff costs/sales, the higher the probability of insolvency. This statement can be confirmed by the findings of this study. The ratio was much higher in mean for bankrupt firms when compared to non-bankrupt firms. Nevertheless, the medians were not dispersed so much that the differences were not statistically significant based on the results from U-test. Therefore, it was also not considered within further model building, as it cannot provide incremental explanatory power to divide between the two types of firm. Consequently, hypothesis one must be rejected.

The second hypothesis assumed that a combination of traditional and employee-related ratios could improve the classification performance of prediction models. This hypothesis must be rejected based on the performance measures of the derived functions and the classification results. Employee-related ratios did not show incremental information content which could be exploited for improved prediction accuracy, even if some of them showed discriminatory power.

The third hypothesis assumed that the number of employees and related ratios could act as proxies for the size of the firm. This hypothesis can be accepted to a significant degree. Based on factor analyses, several ratios concerning employee-related figures were loaded on size factor. The ratios were ln(staff costs/number of employees) for two years, ln(sales/number of employees) for both years and ln(number of employees) for one year prior to bankruptcy. Therefore, these ratios showed the potential to act as proxies for the size of the firm. The first two variables had not been found in previous studies as proxies for the size of the firm, which is therefore a new finding from this study.

10.2 Research questions

The contribution of employee-related ratios for the task of prediction is limited due to the results of this study and the chosen variables did not show signalling power, which could have been exploited for improved classification accuracy of the models. Employee-related ratios are inferior concerning their ability to act as crisis indicators. Therefore, they did not contribute to the early detection of bankruptcies. Only some of the employee-related ratios were able to act as discriminators between the two types of firms. The respective variables mainly characterized the factors of size and efficiency. The size of the firm was found to be a relevant predictor within numerous previous studies and the theoretical considerations have already been highlighted within this work. Efficiency can be a relevant factor for the distinction between bankrupt and non-bankrupt firms, but the discriminatory power is somewhat limited. This may be attributable to the fact that the study included different industries with varying dependencies on the number of employees required for business success. Nevertheless, the inclusion of such factors was not able to improve the prediction quality of the models.

10.3 Limitations and recommendations for future research

The results of this study are based on a database of Austrian companies for the period 2003 to 2004. As a consequence, certain limitations concerning the generalizability of the results must be stated. Therefore, additional research for different countries and observation periods would be necessary to develop a more profound statement about the potential of employee-related ratios to assist in bankruptcy prediction.

The classification performance of the developed models was not satisfying. Here, several problems appeared which potentially affected classification accuracy. First, the theoretical pre-conditions for application of multivariate linear discriminant analysis were mostly violated by the database and the selected ratios. Several distributions showed a strong departure from normality, meaning that the proper application of multivariate linear discriminant analysis was theoretically not taken as a given. Additionally, the equalities of variance-co-variance matrices based on Box-test were not given, with the result that another important requirement was violated (this point was not true for the models including only employee-related ratios). These two aspects together can explain a significant proportion of the misclassifications assigned by the discriminant functions and the poor model quality. These points are additionally the reason why such a high proportion of unexplained variances remained, based on Wilks-Lambda.

Despite this, it was possible to realize the effect of employee-related ratios on the probability of insolvency based on the signs within the functions. All signs showed the expected direction. Therefore, multivariate linear discriminant analysis can be applied as an analytical tool to answer specific research questions, even if the theoretical pre-conditions for proper application of this method are violated. It remains a valuable instrument for researchers in order to analyse further ratios which could potentially be of interest in

explaining the differences between bankrupt and non-bankrupt firms. Nevertheless, due to the restriction problems, it does not appear to be the correct instrument for the future development of a perfectly functioning forecasting tool and the foundation of a theory for the explanation of crises and insolvencies.

The proportion between bankrupt and non-bankrupt firms was unequal, with the result that different prior probabilities were incorporated within the models. Even if the event of insolvency was overrepresented in the initial sample when compared to the real insolvency rate of the whole population, the models understated the event of bankruptcy as they showed a much higher ability to detect non-bankrupt firms. This is a general problem of sampling for the purpose of business failure prediction, which can only be overcome when a much larger sample size is used (Thomas, Edelman & Crook, 2002, p. 122; Anderson, 2007, p. 350), which was not possible within this study due to restricted data size.

Finally, the models were not adjusted concerning their cut-off values. The threshold for classification was set at zero, but it is possible for optimization of model performance to adjust this value with appropriate techniques. This means a reduction of type I error with an accompanied increase in type II error. Based on the results for performance measures, such an adjustment only makes sense for the model in 2004, which includes the traditional ratios, but makes no sense due to its univariate character. None of the other models developed are useful for practical purposes and are not suitable as crisis indicators.

APPENDIX

Table 15: *Correlation analysis for the year 2003 (two years prior to the event of bankruptcy)*
*) statistically significant correlations at the 5 percent level
**) statistically significant correlations at the 1 percent level

	EquityTotalAssets	TotalDebt/TotalAssets	Sales/TotalAssets	ln(SalesTotal/Assets)	ln(Sales)	ln(Number of Employees)	ln(Sales/Number of Employees	ln(Staff Costs/Number of Employees)	Staff Costs/Sales	Sales/Staff Costs	EBITDA/Staff Costs	EBIT/Staff Costs	EBIT/Sales	EBIT/TotalAssets	ln(TotalAssets)
Total EquityTotalAssets	1	-1.000**	.026	.113	.273**	.214**	.273**	.087	-.339**	.064	.343**	.342**	.340**	.160*	.316**
Total Debt/ TotalAssets		1	-.026	-.113	-.273**	-.214**	-.273**	-.087	.339**	-.064	-.343**	-.343**	-.340**	-.160*	-.316**
Sales/TotalAssets			1	.747**	.225**	.066	.225**	-.122	-.119	.249**	-.103	.080	.119	.060	-.291**
ln(SalesTotal/ Assets)				1	.287**	.242**	.287**	-.105	-.419**	.185*	-.154*	.327**	.495**	.071	-.256**
ln(Sales)					1	-.194**	1.000**	.547**	-.375**	.604**	.370**	.324**	.362**	.239**	.334**

	EquityTotalAssets	TotalDebt/TotalAssets	Sales/TotalAssets	ln(SalesTotal/Assets)	ln(Sales)	ln(Number of Employees)	ln(Sales/Number of Employees	ln(Staff Costs/Number of Employees)	Staff Costs/Sales	Sales/Staff Costs	EBITDA/Staff Costs	EBIT/Staff Costs	EBIT/Sales	EBIT/TotalAssets	ln(TotalAssets)
ln(Number of Employees)						1	-.194**	-.237**	-.120	-.201**	-.041	.124	.134	.165*	.629**
ln(Sales/Number of Employees)							1	.547**	-.375**	.604**	.370**	.324**	.362**	.239**	.334**
ln(Staff Costs/ Number of Employees)								1	.037	.024	.066	.015	-.036	.010	.239**
Staff Costs/Sales									1	-.086	-.304**	-.320**	-.906**	-.163*	-.091
Sales/Staff Costs										1	.122	.047	.066	.063	.115
EBITDA/Staff Costs											1	.586**	.302**	.223**	.331**
EBIT/Staff Costs												1	.588**	.217**	.122
EBIT/Sales													1	.120	.043
EBIT/TotalAssets														1	.275**
ln(TotalAssets)															1

Table 16: *Correlation analysis for the year 2004 (one year prior to the event of bankruptcy)*
*) statistically significant correlations at the 5 percent level
**) statistically significant correlations at the 1 percent level

	EquityTotalAssets	TotalDebt/TotalAssets	Sales/TotalAssets	ln(SalesTotal/Assets)	ln(Sales)	ln(Number of Employees)	ln(Sales/Number of Employees	ln(Staff Costs/Number of Employees)	Staff Costs/Sales	Sales/Staff Costs	EBITDA/Staff Costs	EBIT/Staff Costs	EBIT/Sales	EBIT/TotalAssets	ln(TotalAssets)
Total EquityTotalAssets	1	-1,000**	-,089	-,046	,194**	,237**	,194**	,179*	-,266**	-,014	,080	,103	,488**	,775**	,360**
Total Debt/ TotalAssets		1	,089	,046	-,194**	-,237**	-,194**	-,179*	,266**	,014	-,080	-,103	-,488**	-,775**	-,360**
Sales/TotalAssets			1	,802**	,334**	-,104	,334**	,050	-,181*	,307**	-,130	-,083	,082	,040	-,356**
ln(SalesTotal/Assets)				1	,218**	,078	,218**	-,074	-,347**	,180*	-,206**	-,138	,207**	,072	-,402**
ln(Sales)					1	-,253**	1,000**	,402**	-,505**	,482**	,285**	,251**	,238**	,198**	,321**
ln(Number of Employees)						1	-,253**	,077	,035	-,253**	-,273**	-,242**	,076	,125	,633**

	EquityTotalAssets	TotalDebt/TotalAssets	Sales/TotalAssets	ln(SalesTotal/Assets)	ln(Sales)	ln(Number of Employees)	ln(Sales/Number of Employees	ln(Staff Costs/Number of Employees)	Staff Costs/Sales	Sales/Staff Costs	EBITDA/Staff Costs	EBIT/Staff Costs	EBIT/Sales	EBIT/TotalAssets	ln(TotalAssets)
ln(Sales/Number of Employees)							1	,402**	-,505**	,482**	,285**	,251**	,238**	,198**	,321**
ln(Staff Costs/ Number of Employees)								1	,126	-,251**	-,166*	-,192**	-,098	,004	,380**
Staff Costs/Sales									1	-,160*	-,173**	-,166*	-,783**	-,310**	-,096
Sales/Staff Costs										1	,377**	,409**	,039	,053	-,003
EBITDA/Staff Costs											1	,952**	,172*	,231**	,085
EBIT/Staff Costs												1	,187*	,276**	,048
EBIT/Sales													1	,453**	,097
EBIT/TotalAssets														1	,195**
ln(TotalAssets)															1

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SCIENCE-INDUSTRY COOPERATION IN SLOVENIA: DETERMINANTS OF SUCCESS

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ABSTRACT: *Paper analyses barriers to science-industry cooperation in Slovenia through three detailed case studies. Each case tackles both sides, industry (firms) and science (university/research institute). Case studies confirm our assumption that it is the lack of companies with in-house R&D activities which is the main structural deficit for more science-industry cooperation. Strengthening of firms' in-house R&D departments and staff, and clustering of firms around the most propulsive ones is the precondition for more science-industry cooperation. Successful science-industry cooperation can only be developed gradually, most often on the basis of previous personal contacts between main actors on both sides. Case studies reflect no impact of the intermediary institutions on science-industry cooperation.*

Keywords: *science-industry cooperation, Slovenia, case studies*
JEL Classification: O32, O33, O38

1. INTRODUCTION

Science-industry cooperation, i.e. cooperation between universities and government or public research institutes (public research organisations - PROs), on one side, and firms, on the other, has attracted considerable attention in the literature as well as in the policy discussions[3]. From firms' perspective, it is a part of a broader process of innovation cooperation as an increasingly prominent feature of firms' innovation activity. Conceptually – Narula (2003) within the industrial organisation network, Chesbrough (2006) within the Open Innovation Paradigm, Cohen and Levinthal (1989, 1990) and Mowery and Rosenberg (1989 - the key issue of innovation cooperation has to do with explanatory mechanisms related to firms' in-house R&D versus external sourcing of knowledge, innovation cooperation being one mode of external sourcing. The literature points to the complementarity of internal, in-house R&D and external knowledge sourcing, i.e. to the optimal integration of external knowledge into internal R&D of (Radnor, 1991; Veugelers and Cassiman, 1999; Criscuolo and Narula, 2008).

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3 As found by Izsak, Markianidu and Radošević (2013:17) in the EU Report on Decade of innovation Policy, »during the course of 2000s, the ″mantra″ of innovation policies has been to foster industry science links with diverse efforts being made to gear research towards business…«

Along these lines empirical research on the impact of innovation cooperation on firm's innovation capacity, as a rule, finds a strong positive relationship between innovation networking and innovation output (see, for instance Cohen and Levinthal, 1989, 1990; Mowery and Rosenberg, 1989; Veugelers, 1997; Veugelers and Cassiman, 1999; Belderbos *et al*., 2004a; Kremp and Mairesse, 2004; Arvanitis and Bolli, 2009 etc.). Empirical studies specifically dealing with science-industry cooperation say that for firms cooperation with PROs may be as useful, sometimes even more, than cooperation with other firms (Arvanitis and Bolli, 2009; Belderbos *et al*., 2004b; Guliani and Arza, 2009; Bercovitz and Feldman, 2007). Still, science-industry cooperation does not seem to be among the most frequent or the most important types of firms' innovation cooperation.

In 2010, the share of Slovenian innovative firms engaged in innovation cooperation with universities was 49.1% and of those engaged in cooperation with government or public research institutes 31.9%.[4] This qualifies science-industry cooperation as less frequent type of innovation cooperation (see table in Appendix 1), in spite of the fact that the promotion of industry- science cooperation has been high on the innovation policy agenda. The situation in EU27 is similar and even at a lower level. It also seems that firms on average treat science-industry cooperation as less important than innovation cooperation with other partners. Only 16% of Slovenian firms with innovation cooperation claim that cooperation with universities is the most valuable to them while the corresponding share for cooperation with government or public research institutes is even lower, i.e. 10.3%.[5]

The objective of this paper is to analyse science-industry cooperation in Slovenia, more precisely to look at the motivation behind cooperation, to identify problems and obstacles on one and the other side, as well as in innovation policy and institutional framework. Finally, we suggest what should be done at science, business and government level to intensify the science-industry cooperation with the ambition to achieve long-term growth based on innovation. In an environment of a small transition country, where in comparison to the bigger, more developed economies, limited R&D resources are available, it is imperative that cooperation of all existing scientific potential is stimulated. Of the countries that have joined EU in 2004-2007, Slovenia was the first transition country, which managed to join the group of *innovation followers* according to the IUS (EC, 2011). Also, according to World Economic Forum (WEF), only Slovenia is classified as a country in the innovation-driven stage of growth (WEF, 2007) of the 27 CEE/CIS countries ranked. Yet, the degree of cooperation between the public science sector and business R&D has been identified as one of the weaker elements of the country's innovation system by OECD (2011), ERAC (2010) as well as national evaluations (RISS, 2011) and thus a focus of several policy actions. The experience of Slovenia can therefore be of relevance to other smaller, research & innovation less intensive countries.

Based on the relevant theoretical considerations and existing empirical evidence we will test the hypotheses that frequency and extent of science industry cooperation depends

4 This has been quite an increase from 2004-2006 CIS data, when the corresponding shares were 19.4% and 13.2% respectively, as well as from 2006-2008 CIS, when the shares were added.

5 For 20.5% of firms performing innovation cooperation, the most valuable is innovation cooperation with suppliers, for 18.6% with clients or customers, for 9.6% with other firms within the group and for 9.2% with the competitors.

on: (i) the extent and nature of firms' in-house R&D and innovation activity, which also determine their absorption capacity, (ii) the existence of quality research and scientific productivity in PROs, critical mass of knowledge in specific areas of expertise, and on motivation of researchers, (iii) the development of a portfolio of intermediary institutions and their quality, and on (iv) the adequacy of national policy and institutional framework, supporting science industry cooperation.

The analysis is based on the three detailed case studies of science industry cooperation[6]. Each case is approached from both sides, i.e. concepts, motivation, problems, barriers etc. in individual cases are analysed from the perspective of firms and of the university/ research institute. To the best of our knowledge this is the first such analysis for the transition countries of Central and Eastern European (CEE) countries and its conclusions may be of relevance for other small transition economies with a similar R&D potential.

The interviews convey two main messages. The first is that it is the lack of companies with in-house R&D activities which is the main structural deficit for more intensive science-industry cooperation. Strengthening of firms' in-house R&D departments and staff, and clustering of firms around the most propulsive ones is the precondition and possibly most effective measure for more science-industry cooperation. The second is that there are no fast breakthroughs in science-industry cooperation; successful cooperation can only be developed gradually, from specific small initial tasks to a more comprehensive collaboration. Also, case studies reflect no impact of the intermediary institutions on science-industry cooperation.

The paper is structured as follows. Introduction is followed by a short overview of theoretical considerations and empirical evidence on science industry cooperation in section two. Section three presents the cases, where each case first presents main features, motivation and development of innovation, then determinants and problems of cooperation. Section four concludes with suggestions of the measures for strengthening innovation capacity and science industry cooperation.

2. THEORETICAL CONSIDERATIONS AND EMPIRICAL EVIDENCE

Among the most prominent theoretical concepts of science industry cooperation is the so called Triple Helix Model by Etzkowitz and Leydesdorff (1997), and Viale and Etzkowitz (2010) which points to the new relationships between business, university and government, and claims that academia should be closely integrated with the industrial world (Eun *et al*., 2006). Yet we also have a different view of the New Economics of Science (Dasgupta and David, 1994) and some others (Mowery and Sampat, 2004; Lundvall, 2002) who are concerned by a too close integration of science into industry and opt for a proper division of labour between the two. The latter view is based on the recognition

6 Several other research projects have been implemented by the authors, where industry-science R&D cooperation has been analysed- from the perspective of public R&D organisations (Mali et al, 2004), analysis based on case studies of 22 export-oriented R&D intensive companies (Bučar, 2010), analysis of intermediary organisations and innovation policy measures (Jaklič et al, 2012), etc. The outcomes of these led to the approach applied in this paper: simultaneous analysis of three cases of R&D cooperation from the perspective of PRO as well as of the enterprise.

that science and industry are two distinctively organized and functionally differentiated spheres (Dasgupta and David, 1994), and that norms of science and industry differ very much. In this paper, we take a more pragmatic perspective of context-specific perspective of science-industry relationship developed by Eun *et al*. (2006) in which the relationship depends on country specific economic conditions and where the basic determinants of relationship are internal resources of university, absorptive capacity of industrial firms and existence of intermediary institutions.

2.1. Science-industry cooperation: firms' view

Existing studies identify one or more of the following benefits of science-industry collaboration for firms: (i) access to state-of-the art knowledge and information, (ii) developing new products/processes, (iii) maintaining relationship with university researchers, (iv) access to students as potential employees, (v) increased patenting (Lee, 2000; Venniker and Jongbloed, 2002; Belderbos *et al*., 2004a). For CEE countries, Radošević (2011:373) also cites that universities and research institutes provide access to equipment to test the raw materials and finished products' quality.

List of factors that determine the motivation of firms for science industry cooperation is quite long, far the most often quoted being in-house R&D and absorption capacity, appropriability conditions and the nature of firm's R&D and innovation activity. *Firms' in-house R&D and their absorption capacity in general* – denoted by own R&D, level of technology, human capital - is definitely the main determinant which increases firms' propensity for R&D cooperation with universities (Arvanitis and Bolli, 2009; Giuliani and Arza, 2009; Kodama, 2008; Bercovitz and Feldman, 2007).

Nature of firm's in-house R&D and innovation activity is the next determinant of its cooperation with university. Firms that are more engaged in basic exploratory research, have higher knowledge base and introduce more advanced innovations tend to cooperate with universities (see Bercovitz and Feldman, 2007; Giuliani and Arza, 2009). For Bolli and Woerter (2011) firms' university cooperation corresponds to product innovation and hence quality competition, while cooperation with competitors lead to process innovations and therefore relates to price competition.

A number of other firm- related factors are also claimed to have the impact on cooperation with universities, i.e. firm's size, firm's propensity to innovation cooperation as such and its openness to external environment in general, extent of public funding, industry specific characteristics, individual characteristics of the researchers involved, and institutional environment in which knowledge is produced and used (Arvanitis and Bolli, 2009; Cassiman and Veugelers, 2002; Veugelers and Cassiman, 2005). Extent of public funding or joint participation of universities and firms in national R&D projects have proved to be another factor in favour of more science industry cooperation (Arvanitis and Bolli, 2009; Jensen *et al*., 2010).

2.2. Science-industry cooperation: science's view

Universities may benefit from collaboration with industry in several ways: (i) getting access to additional research funding, (ii) additional equipment and facilities, (iii) additional information and data, (iv) increased number of publications and innovations, (v) better insights into their own research and access to new research problems, (vi) channel for knowledge transfer, (vii) improved quality of teaching and providing students with insights in industry research, (viii) securing funds and improved job opportunities for their students (Lee, 2000; Venniker and Jongbloed, 2002).

Quality of university research, motivation of academic researchers and intermediating mechanisms are the main determinants of science- industry cooperation on university side. Empirical evidence suggests a positive relationship between *academics' research quality* and commercialization of research activities (Perkman *et al*., 2011; Van Looy *et al*., 2011).

Motivation of universities, i.e. university researchers for cooperation with industry is often hindered by the fact that science and industry are still two distinctively organized and functionally differentiated spheres, where norms and values differ very much. Lam (2011) claims that a diversity of motivations exists, where many university researchers cooperate for the reputational and intrinsic reasons with financial rewards playing a relatively small part. D'Este and Patel (2007) add that individual characteristics of researchers may be more important than characteristics of their departments or universities.

2.3. Science-industry cooperation: the role of intermediary institutions

In analysing barriers to university-industry collaboration, Bruneel *et al.* (2010) distinguish orientation-related differences from transaction-related barriers (conflicts over intellectual property, dealing with university administration). They find that prior experience of collaborative research lowers orientation related barriers, that greater levels of trust reduce both types of barriers, and that breadth of interaction diminishes orientation-related but increases transaction-related barriers. Inter-organizational trust is claimed to be one of the strongest mechanisms for lowering the barriers to interaction between universities and industry. 'Building trust between academics and industrial practitioners requires long-term investment in interactions, based on mutual understanding about different incentive systems and goals. It also necessitates a focus on face-to-face contacts between industry and academia, initiated through personal referrals and sustained by repeated interactions' (Bruneel *et al*., 2006: 867). Similarly, Balconi and Laboranti (2006) find that university industry cooperation is based on teams of researchers on both sides; strong connections are associated with high scientific performance, cognitive proximity and personal relationships.

A number of other authors point to the importance of intermediary institutions between university and industry. Universities with established policies and procedures for the management of technology transfer (technology transfer offices, science parks) perform better as far as science industry cooperation is concerned (Caldera and Debande, 2010). Staff employed by the intermediaries is also important. Conti and Gaule (2011) claim that one of the reasons why US outperform Europe in university technology licensing is that US technology transfer officers employ more staff with experience in industry.

3. MAIN FEATURES OF THE ANALYSED CASE STUDIES OF SCIENCE INDUSTRY COOPERATION

The above overview puts forward the following propositions to be tested by the case studies. Frequency and extent of science industry cooperation depends on: (i) firms, i.e. on the extent and nature of firms' in-house R&D and innovation activity, which also determine their absorption capacity, (ii) universities[7], i.e. existence of quality research and scientific productivity in PROs, on critical mass of knowledge in specific areas of expertise, and on motivation of researchers, (iii) intermediaries, i.e. on development of a portfolio of intermediary institutions (such as technology transfer offices, technology parks and centres, incubators and development agencies) and their quality, and on (iv) adequacy of national policy and institutional framework, supporting science industry cooperation.

We analyse three cases of science-industry cooperation, one in chemical, one in pharmaceutical and one in food-processing industry. Each case can be characterised by a different level of research intensity of the firm as well as the size of firm. On the PRO side, we have both, a public research institute as well as university departments. In each case, partners from both sides have been interviewed, based on a semi-structured questionnaire covering six main topics:

a/ Main features of the cooperation project: (i) motivation, (ii) objectives, (iii) development of cooperation, (iv) realisation of expectations;
b/ Conditions for science-industry cooperation: (i) relevance of existing conditions for cooperation in the particular case, (ii) criteria in seeking cooperation partners, (iii) main strengths, weaknesses and difficulties of cooperation, (iv) do innovation system characteristics support science industry cooperation or not, (v) what is the explanation for the current state of science-industry cooperation;
c/ Guiding principles of science-industry cooperation: (i) who should set the targets of cooperation, (ii) the most important criteria for the success of cooperation, (iii) how should the success be assessed;
d/ What has been the most important knowledge in the particular case of cooperation: (i) which type of knowledge: tacit or codified – is more important for the particular case, (ii) how important are different ways of knowledge creation; do partners have different views on that;
e/ Measures for improving innovation capacities in a particular sector: (i) areas in a particular sector where the innovation capacity is assessed as weak and the reasons for this, (ii) what measures should/could be introduced in the particular company/PRO to improve innovation capacity;
f/ What must science and industry change/do in order to improve cooperation: (i) which strategies should be implemented at the level of national innovation system to improve the exchange between science and industry, (ii) good and bad examples of cooperation and the reasons behind them (iii) how supportive was the innovation infrastructure in facilitating cooperation?

7 The case studies include also cooperation with public research institutes, so we apply the term public research organisations- PROs throughout the text.

The interviews were carried out in 2009 and 2010. For the list of interviewees and partner institutions see Appendix 2.

3.1. Case 1: Cooperation in the field of structural determinations and texture analysis of pharmaceutical products

3.1.1. Main features, motivation and development of cooperation

Case 1 analyses cooperation between the Laboratory for Inorganic Chemistry and Technology of the National Institute of Chemistry Slovenia (referred in the text as the Laboratory) and Krka, a generic producer of pharmaceuticals, one of the largest companies in Slovenia with EUR 1,010 million of sales, EUR 171 million of net profit, 8,569 employees and 9.0% share of R&D expenditures in sales[8]. Chemical and especially pharmaceutical sectors are among the most R&D and innovation intensive sectors in Slovenia. For the pharmaceutical sector, permanent R&D and innovation is a *sine qua non* of existence. The same is true for chemistry and pharmaceuticals as a science. National Institute of Chemistry is the second largest research institution in Slovenia with 269 researchers, being among the most prominent in Slovenia in terms of publications and citations.

Krka has a big R&D department, clearly set R&D objectives and invests significant amount in R&D in pharmaceuticals. On the other hand, pharmaceuticals are not among the Laboratory's basic activities. This determines the nature of cooperation, which is focused on very specific tasks, i.e. the use of Laboratory's Nuclear Magnetic Resonance (NMR) in analysing structural determinations and texture analysis of pharmaceutical products. This is necessary to assess whether Krka's generic medicines fulfil the patenting requirements. According to Krka's Director of Research, the Laboratory is capable of providing Krka with specific analytical work, which is closely supervised by Krka's internal research team. Krka assesses Laboratory's cooperation as highly beneficial. The Laboratory possesses equipment for specific testing purpose not available in Krka, excellent knowledge of a specific analytical technique and has specific knowledge/ skills, which are insufficiently available in Krka. Basic principle of cooperation is team work of Krka's and Laboratory's staff; this leads to significant level of cross-fertilisation of knowledge. The nature of work dictates very close cooperation on a daily basis with continuous monitoring of progress and active participation of research teams. Officially the cooperation is regulated through five-year framework contract between the Laboratory (and not the National Institute of Chemistry) and Krka, which gets annexed with specific annual programme of cooperation.

Both Krka and Laboratory have comprehensive science-industry cooperation with other partners as well. Krka has a well-developed cooperation with various universities and R&D institutes in Slovenia and abroad. High R&D intensity of pharmaceuticals and the fact that R&D contents need to be well protected to avoid leakage of sensitive information determine company's cooperation with science. The nature of Krka's activity calls for a systematic development of all phases of the research process: (i) from the basic research, which is mainly done

8 Data for 2010, http://www.krka.si/media/prk/dokumenti/5200_krka_annual_report_2010_slo_200611.pdf

internally due to highly specific knowledge required, (ii) to several testing phases, which are carried out internally and/or in close cooperation with specialised scientific institutions, and (iii) to monitoring of the quality, where again very specific external knowledge is being sought.

The most important criteria in Krka's search and selection of partners from PROs are the type and quality of service/ specific knowledge, which can be provided. Krka's long experience in cooperation with PROs in Slovenia puts it in a position of a well-informed partner, who knows where the specific capacities and expertise is and how they can be best employed. Krka's systematic support of certain research areas has long-term effect in joint research projects development. In cases where the type of knowledge needed cannot be provided in Slovenia, Krka has a wide network of R&D partners in different countries. In each case of R&D outsourcing, cooperation is started on a relatively small, well defined topic, which, if results being satisfactory, has later evolved in a more permanent and broader cooperation. Since cooperations are carefully entered into and develop only after satisfactory 'trial deals', Krka experiences high satisfaction in cooperation with PROs. This was also the case with the National Institute of Chemistry, where Krka has cooperation agreements with several laboratories. Still, the PRO's responsiveness is sometimes less than required due to the relatively small size of human resources in public R&D sector in the specific topics that Krka needs.

3.1.2. Determinants and problems of cooperation

Krka's involvement in science-industry cooperation is decisively influenced by its own intensive R&D activity and by R&D nature of the sector in which cooperation with science is a must. Also, Krka needs to have a very active recruitment policy and uses several different ways to secure sufficient inflow of human resources: different scholarships, competitions for best research studies and diploma works at the universities as well as direct cooperation with professors and researchers.

The basic precondition for cooperation on the science side is the underlying philosophy of the Laboratory that it is its duty as a PRO to cooperate with industry, which differs from the more common approach of Slovenian PROs who often set their R&D priorities without taking into account the needs of the industry. Consequently, Slovenian researchers in PROs are often not specialised enough, which results in difficulties to respond to the specific needs of the industry.

Objectives setting and mutual understanding of partners. Krka's Director of Research is very well aware that industry and science have different objectives in cooperation. People from the science sector are pressed for the bibliometric results, while researchers in industry need to apply the research results in production as quickly as possible to secure competitive position. In its science-industry cooperation, Krka clearly is a dominant partner. The goals and the contents of cooperation contracts with PROs are set by Krka. For Krka, the ultimate aim of cooperation is that it contributes to the introduction of new and/ or improved products and processes. Krka expects its science partners to respond in reasonably short time, be flexible and have a high level of knowledge and expertise. Ability to participate in a team work in developing new knowledge and adjustability of the research-

ers is crucial; this is often achieved best by continuous exchange of personnel or by close interaction of the key personnel from both partners working on a particular issue.

In cooperation with industry, the Laboratory looks for establishment of joint R&D capacities, sharing of R&D costs, experiences for students and practical verification of theoretical findings. Of course, money is important as well: 20% of Laboratory's budget comes from cooperation with industry. Laboratory's experience is that the cooperation is based primarily on well-identified needs and objectives of firm, which is a starting point of any science-industry cooperation. Both Krka's Director of Research and Head of the Laboratory stress the importance of gradual building of cooperation. Most of Laboratory's cooperation with industry began rather informally/ spontaneously and has developed gradually.

The leading role of Krka in the cooperation is reflected also in its attitude to the knowledge resulting from the cooperation. In pharmaceuticals, the codified knowledge is of crucial importance. Krka has built in specific clause in all its cooperation agreements to protect the knowledge derived from joint R&D work. Krka expects its partners to act accordingly. In the case of science partners' research papers, their publication is often delayed to account for the time of obtaining the patent and is always pre-checked by the company.

3.1.3. Relevance of innovation policy measures

The cooperation in this case has developed with no support from the government, even though both partners apply to various programmes under R&D and innovation policy. Krka does not need outside intermediary institutions due to the strength of its in-house R&D unit who has, as already mentioned a good overview of the scientific capacities at PROs in the country. One of the key problems identified by both partners is the irregularity in government's announcements and funding of support measures like co-financing of joint R&D projects. For a firm, which strategically depends on research inputs, the stability, transparency and regularity of available support measures is a key determinant of their effectiveness. This is why the programme of financing Young Researchers[9] has been assessed as one of the most beneficial also from the science- industry cooperation point of view.

3.2. Case 2: Cooperation in the field of improving animal meat quality, with the aim of producing meat with enriched nutritive fatty acids

3.2.1. Main features, motivation and development of cooperation

Case 2 analyses cooperation between Department of Animal Science, Faculty of Agriculture of the University of Zagreb (Croatia) and Emona RCP - Nutrition Research and Development Department of Jata Emona, which employs 265 people and is involved in the production and distribution of feeds for all domestic animal species, including various

9 The scheme has financed postgraduate study and research training for young researchers and enabled people from firms to go into the science sector for a certain period of time for M.A. or Ph. D. A candidate had to work on a particular research project within a firm, but received mentorship support at the public R&D unit (for more see http://cordis.europa.eu/erawatch/index.cfm?fuseaction=search.resultList).

sorts of mixtures and vitamin enriched feeds. Cooperation was initiated by Emona RCP. The project looks into different impact feeds may have on the quality of meat with particular aim of enriching the animal feeds to produce more Omega 3 fatty acids in the animal's meat. Within cooperation Emona RCP has been primarily involved in the research on appropriate mixtures of feeds, while the task of the Department has been to investigate the influence of different corn varieties in the diet of pigs on pork fatty acid composition.

3.2.2. Determinants and problems of cooperation

The interviewees recognise the need for science-industry cooperation in food-processing industry and acknowledge that existing science-industry links in the sector are very weak. They identify a number of barriers to more science-industry cooperation within the industry and the science sectors, in their mutual perception and relationship.

Industry sector barriers. In Slovenia, agriculture and food processing have traditionally been treated as low-tech, low value-added industries where R&D has a limited role to play. There is no tradition of science-industry cooperation in Slovenian food processing sector and no dedicated intermediaries. The main barriers to more R&D and innovation in Slovenian agriculture and food processing firms are: (i) small size of firms, (ii) lack of R&D and innovation activities, of awareness of the need for R&D and of its potential contribution, (iii) small number of in-house R&D units in firms; (iv) inadequate financial instruments for R&D in food processing. Lack of R&D units seriously limits the opportunities for science-industry cooperation. The interest in most firms lies with cost reduction applications and relatively routine improvements in the processes. Their "R&D" or development departments mostly perform routine procedures, like quality control and testing. Investing in knowledge is not seen as a factor of competitive strategy. Jata Emona is no exception in this regard. Even the existing knowledge or capability to produce new knowledge by its own research unit-Emona RCP is not yet seen as company's competitive advantage.

Science sector barriers. On the science side, two distinctive factors inhibit science-industry cooperation. The first is that Slovenian food technology science is predominantly concentrated at the Biotechnical Faculty of the University of Ljubljana. The people there are overloaded with teaching and publishing, with little motivation to do research/ consulting work for industry. The second factor is the lack of opportunities for human resource flows from science to industry sector. Slovenia simply does not have sufficiently large food processing firms to offer attractive career to highly educated people who could form in-house R&D base.

Objectives setting and mutual understanding of partners. According to Emona RCP and the Department, objectives of cooperation are quite different for each partner. Science sector looks for good internationally published papers, participation at international symposia, some additional financing, maybe also some teaching material. The research team in a business R&D unit must always think of finding practical applicable solutions, and finally of the maximisation of economic returns. Therefore it is of crucial importance to

establish mutual understanding and trust between partners. In the case of cooperation between Emona RCP and the Department mutual understanding seems to be adequately established. At the science side, the empirical results of the project were used by the PhD candidate to complete his dissertation. At the business sector side, the expertise developed during the empirical research helped to develop new products and increase competitiveness. According to Emona RCP, successful cooperation projects work in the following way: testing enables the partner(s) at the university to generate empirically based research, suitable for publication, on one hand, and brings a working solution to the industrial process, on the other. The key determinant of the success is the ability of business R&D unit to act as an intermediary between the PRO and the firm. Cooperation of Emona RCP with different PROs has developed through years, first on the personal basis (researcher to researcher) and then upgraded into institutional cooperation in specific projects.

The messages of Emona RCP – Department cooperation are that: (i) productive cooperation does not develop quickly or easily. Good cooperation can only be found where the partnership has been developing over a longer period of time, where both sides have learned to understand each other; (ii) competent R&D unit in a firm, with a good understanding of the potential of theoretical advancements for practical purposes and a good knowledge of the complexity of production process and its economics is the main factor in establishing mutual understanding between science and industry; (iii) objectives and targets of science-industry cooperation should primarily be formulated and set by the industry side. Within this context partners must come to a clear understanding of each others' objectives. Objectives of each side need to be recognised and respected by the other side. Joint work should be designed in way that both sides meet their objectives. Only in such way both sides benefit.

3.2.3. Relevance of innovation policy measures

The awareness of the existence of policy measures, which could support their cooperation, was particularly low in this case. Partly, this can be attributed to the fact that often innovation measures exclude agriculture and food processing industry as the recipient sector. On the other hand, the interviewees mentioned that they believe their cooperation is so specific that it would not fit under standard joint-research project classification. According to Emona RCP, no intermediary institution is focusing on promotion of cooperation in the food processing sector or has the adequate knowledge in the field to act as such.

3.3. Case 3: Cooperation in the field of development of melamine-based foam

3.3.1. Main features, motivation and development of cooperation

Case 3 analyses cooperation between the Department of the Polymer Engineering, Organic Chemical Technology and Material at the Faculty of Chemistry and Chemical Technology, University of Ljubljana (referred in the text as the Department) and chemical company Melamin. The cooperation under current contract began in 2002. Melamin

manufactures melamine film sheets for finishing chipboards, resins, adhesives, synthetic sizing agents, impregnated textile materials for use in the footwear industry, has EUR 34.3 million of turnover and 192 employees. Cooperation is concentrated on the development of melamine-based foam and is formalised in a long-term contract.

Department at the University is involved in the basic research – collection of the relevant literature on the subject, analytical and laboratory phase of research – which is then used by Melamin's R&D Unit for the applied research. The cooperation includes human resource development aspect, i.e. Melamin's employees pursue their postgraduate studies at the Faculty of Chemistry and Chemical Technology, while young researchers from the Department can apply their theoretical research to empirical testing in Melamin for the purpose of their doctoral theses. The cooperation is characterised by its gradual evolvement around specifically agreed research topics.

Melamin has a long lasting cooperation with the University of Ljubljana, but initially the agreement was more a formality than contextually embedded in Melanin's production programme and Melamin's management was rather indifferent to science-industry cooperation. In 2002, today's Head of Melamin's R&D Unit joined the company. He completed his doctoral studies within the Young Researchers Programme under the mentorship of the Head of the Department. He proposed the establishment of cooperation of Melamin with the Department and succeeded to change the attitude of Melamin's management.

At approximately the same time, Melamin launched a new development concept, based on two basic premises. The first had been that all the products should be based on the same raw material to increase the amount of the raw materials purchased and consequently decrease per unit purchasing prices. The second premise had been to diversify end products and increase the value added. Here, the R&D Unit was expected to play the key role. The in- house R&D capability was insufficient to meet the new requests, therefore Melamin leaned on the cooperation with the Department. The crucial push was the previous acquaintance between the Head of Melamin's R&D Unit and the Department. The Head of the Department had previous experience in a business sector and was well aware of what kind of services a company needs from science. On the other hand, Head of Melamin's R&D Unit understood the motivation of science sector to enter into cooperation with industry. Mutual interest and acquaintance have been the crucial factors for launching and maintaining successful cooperation.

What the Department sees as the most beneficial aspect of the cooperation is the ability to earn extra resources for R&D equipment. The possibility to work on specific topics through the entire process, i.e. from the definition of the problem, search for the theoretical solutions to developing a response in practice and testing it, is also important. In short, researchers at the university have the opportunity to test their ideas in practice and to increase the quantity and quality of publishable results.

3.3.2. Determinants and problems of cooperation

Industry sector barriers. According to the Head of Melamin's R&D Unit, the main structural problem for strengthening science-industry cooperation in Slovenia is low R&D

capacity of Slovenian firms. Consequently, PROs in Slovenia find it difficult to get interested partners in the industry sector. Low industry R&D activity and limited existence of in-house R&D units in the business sector is a significant barrier to science-industry cooperation because it is precisely these units which provide a necessary impetus and absorption capacity for cooperation with science.

Another industry related barrier to more science-industry cooperation is prevailing short-term perspective in most Slovenian firms. Only a direct solution to immediate production problems is considered by the management as valuable research. They expect the cooperation to focus more on a day-to-day business and not as a process of opening up new venues for increasing competitiveness.

Science sector barriers. Structural problems of science sector are no less important barrier to science-industry cooperation. Systematic marketing of own knowledge is not at all present in PROs and existing institutional framework at universities does not support cooperation with industry. The current system lacks incentives and infrastructure for establishing the links with industry. The interviewees suggest that cooperation between universities and firms has to be established and coordinated at the highest level, if cooperation with industry is to be developed. Current attempts are far from satisfactory. The organisational set-up of, for example, the University of Ljubljana with its decentralised, highly differentiated and heterogeneous members (Faculties) cannot be served by a common Technology Transfer Office, which would coordinate marketing of university scientific capabilities[10]. At best, the University should have some broad long-term agreements with larger Slovenian firms which are important R&D investors. This would ease building up of specific science-industry partnerships at lower levels. The lack of university level support was identified as a problem also in negotiating the cooperation contract. For a single relatively small unit at one faculty it is very difficult to competently negotiate specific legal and commercial terms of the contract.

Objectives setting and mutual understanding of partners. Structural differences may result in problems of mutual understanding in setting of cooperation objectives, i.e. what kind of knowledge PROs can provide to firms. In a number of instances, the Department has been told by the firms that they received 'a lot of paper' with the results given at too theoretical level and were impossible to implement. Yet, one has to be aware that only the firms can be really specific in applied R&D work, developing innovative products for the market. Having in-house R&D department in a company is therefore necessary for successful science-industry collaboration.

Productive cooperation between science and industry does not develop quickly or easily. Much of the success in cooperation depends on good trustworthy personal relationships, which are even more important in the cases where there are few institutional guidelines for a more formalised agreement. The Department – Melamin case is the best example of this. Still, good mutual understanding is not a substitute for a more formal agreement, where issues like ownership of research equipment, patents, commercial impact of new findings etc. are more precisely defined.

10 The University of Ljubljana established in 2007 an office dedicated to promotion of cooperation with business firms, called Institute for Innovation and Development (http://www.iri.uni-lj.si/eng/). Yet the Institute is still not seen by the members of the University as their representative in dealing with the business sector, since at times even competes for the same public research sources.

The interviewees agree that the objectives of science-industry cooperation should be set by industry, but in cooperation with science. At the end of the day it is the industry who applies the innovation/ new technological solutions. PROs should assist the industry in setting these objectives. This, however, does not mean that science partner does not have its own cooperation objectives. The work should be shared and designed in a way that both sides are able to achieve their objectives. A clear understanding of each other's objectives, and respect for these, need to be a starting point in establishing the cooperation. The difference in the cooperation objectives of science and industry is clearly visible in the agreement between the Department and Melamin. The agreement specifies that all the knowledge resulting from the cooperation is the ownership of Melamin. The Department goes only up to the laboratory phase of product development, further on it is the Melamin who leads the game. The Department can publish all the results of its basic research arising from cooperation, but this includes only the data until the end of the laboratory phase. The Department always sends the scientific papers to be published for approval to Melamin. Melamin has patented some of its solutions. There have never been any ideas about joint patenting; the Department also does not have enough resources to assume financial obligations and risks of patenting and is not really interested in patenting. The interest of the Department is elsewhere, i.e. in getting additional financial resources, in publishing and in training of its staff.

3.3.3. Relevance of innovation policy measures

Melamin has been aware of some of the policy measures, but has seldom applied for support. Similar complaint was voiced as in Case 1: irregularity, frequent changes in the conditionality, heavy bureaucracy, selection criteria not adjusted to business needs. On the side of the Department, criticism was directed to the insufficient support of science-industry cooperation at the University, where the established intermediary institution is not seen as adequate. Also, broader research system conditions (research evaluation criteria) are not supportive, but in fact often negatively affect the motivation for cooperation.

4. MAIN FINDINGS AND CONCLUSION

The case studies confirm the propositions of existing literature as to the motivation for cooperation:

a/ Frequency and intensity of science-industry cooperation depends on the extent and nature of firms' in-house R&D and innovation activity;
b/ Absorption capacity of business sector is an important determinant of the intensity of cooperation;
c/ Nature of in-house R&D has important impact on the selection of cooperation partners: the more basic research is the more room is there for PROs as cooperation partners,
d/ Existence of critical mass of knowledge and quality research at the PROs, as well as PROS' flexibility to adjust to the needs of firms.

Table 1: *Summary of findings in case studies*

Case		Size	Motives	Benefits	Barriers	Specific comments
Case 1: Krka and Institute of Chemistry	Partner from industry	Large, high R&D intensive	A need for specific knowledge to complement in house resources	Possibility to tap into additional pool of knowledge on a regular basis	Response time	Systematic approach to development of several partnerships with PROs
	Partner from PRO	Large- second largest public research institute in Slovenia	Additional resources	Practical experience for young researchers; involvement in state of the art applied research	Need to maintain non-disclosure policy, causing certain lag in publishing scientific papers	Insufficient incentive for personnel in PROs to engage in cooperation with business sector
Case 2: Jata Emona and agriculture faculty	Partner from industry	Medium sized, less intensive R&D sector	A need to perform basic research to complement testing performed in company	Joint research and development of successful new formula	Lack of financial resources to implement knowledge transfer	High quality cooperation in R&D less intensive sector
	Partner from PRO	Large, yet underfinanced	Ability to participate in large-scale R&D project	Obtaining new knowledge	Low capital intensity of industrial partner prolonged application in practice	External factors (financial difficulties of parent company) nearly jeopardised entire project
Case 3: Melamin and Faculty of Chemistry and	Partner from industry	Medium, R&D medium intensive sector	Need to develop new products	Several new products, even patents	Distrust of top management towards PROs	A need fot restructuring of production process resulted in turning to R&D and innovation as sources of growth
	Partner from PRO	Small	Financial resources to renew research equipment	High quality scientific paper(s); young researcher	Difference in objectives of partners	Young research programme was detrimental for the start of cooperation

* While the Faculty/University should be classified as large, the cooperation was implemented with the Department as an independent partner/beneficiary.

In our cases, the motivation on the side of PROs is fully compatible with the theory: additional funding is the major motive, followed by access to specific empirical data which can result in publications. Also, a possibility to provide employment opportunity to graduate students is seen as important benefit of science- industry cooperation.

The case studies show remarkably high consensus among the interviewees on the determinants, problems and other aspects of science industry cooperation, regardless of the fact that they come from very different industrial sectors. The interviewed partners are relatively satisfied with the cooperation and the results have mostly met their expectations. Still, they notice a lot of barriers to more fruitful and intensive science-industry cooperation and have expressed quite a pessimistic view of science-industry cooperation in Slovenia in general. They propose a number of changes, improvements and novelties in measures for strengthening science-industry cooperation. Below, we briefly present the most important conclusions and suggestions.

Probably the strongest message of the cases is that increasing the number of companies with R&D activities is a precondition for strengthening of science-industry cooperation. R&D capacity of most of Slovenian firms is still low. To address this structural deficit, the government policy has been to offer R&D tax subsidies, yet this measure, while welcome by larger R&D investors (like Krka in our case studies), does little for the firms with no R&D units. Support to industry clusters was suggested by both the industry as well as science representatives. Clustering around the more propulsive firms may have a positive impact on other firms, which are their suppliers and customers. In the past, Slovenia had a measure co-financing cluster formation, but had decided to discontinue the support.[11]

Strengthening of firms' absorption capacity through in-house R&D departments and R&D staff is necessary to intensify the cooperation. Relatively small number of such units in Slovenian firms undermines the potential for science-industry cooperation. To address this, various measures have been designed by the government (mobility schemes, interdisciplinary research teams, young researchers from industry), but our finding was that these measures were not known to the business sector or were assessed as too bureaucratic. This inappropriate supportis of particular importance for the vast majority of small and medium-sized enterprises (SMEs), where one cannot expect them to have their own R&D departments. To increase innovation (cooperation) absorption capacity in SMEs without own R&D capacities, clustering around the more propulsive and R&D active firms may be promoted. Another possibility is to promote university spin-off firms for this particular function.

On the science side, there is a problem of insufficient capacities for cooperation with industry. PROs need more flexible institutional solutions in support of specific needs of science-industry collaboration. Possible solutions are: allow/ promote establishing of spin-off firm(s) by PROs for business oriented R&D; promote short-term mobility to solve a particular problem in a company (or even to introduce a mandatory mobility for certain professions); introduce 'non-technical' content in the S&T university programmes, in

11 See Inno Policy Trendchart Report on Slovenia, 2008.

particular economic, business and legal aspects of R&D. Improved and more transparent organisational set-up at the university level is needed, where systematic promotion of the science-industry cooperation should be undertaken at the top echelons; university promotion criteria should require practical experiences, resulting from work with companies. There is no systematic assisting of researchers or stimulating them in any way towards cooperation. Such initiatives are left entirely to individuals who have the ambition and personal affinity to work with industry.

Promotion of science-industry cooperation is also not incorporated in research projects evaluation. Evaluation of researchers, research programmes and/or projects and public research organisations is based primarily on the number of publications and citations. This results in a lack of interest among public researchers for co-operation with business sector. Current institutional framework also does not take sufficiently into account the specifics of the industrial R&D units. Such units cannot compete for the research project funding at the same public calls with the public R&D institutions, if the most important criteria in the selection process are the standard scientific criteria. At least for the applied research co-financing, the positive experience of implementing R&D projects and translating them to innovation should be valued as equally important as publishing activity for the public R&D units. Overall, the cooperation with industry should have a higher impact on the ranking of the researchers.

A common message in all analysed cases is that successful science- industry cooperation can only be developed gradually, from specific small initial tasks to a more comprehensive collaboration, most often on the basis of previous personal contacts between main actors on both sides. It is the industry who should have the main role in the cooperation objectives setting, but objectives should be set jointly in an atmosphere of mutual understanding, where both sides feel that the cooperation will help them fulfil their goals. The partners need to overcome the prejudice and move beyond stereotypes.

The case studies reflect no impact of the intermediary institutions on science- industry cooperation. While Slovenia has followed the example of other countries with a more developed innovation system and has established technology parks and centres, incubators and development agencies (Bučar, 2010), it seems that their overall impact is still not felt by either community: business or the science one. This confirms the findings of Radošević (2011), that the focus of CEE/CIS countries on providing support to "linkage capabilities" is a policy failure: …*"current bridging policies are basically trying to link weak enterprises with unreformed universities and PROs. Links are only as strong as the actors they connect*." (ibid; 376). Instead of copy-paste measures from advanced countries, Slovenia, as well as other CEE countries, needs to assess their own specifics and design measures in accordance with characteristics of their national innovation system. As identified through our case studies, strengthening in-house R&D capabilities of firms as well as reorganizing PROs so as to be better capable of cooperating with business sector is much more important in innovation policy then the support to intermediary institutions. This is especially relevant, if one tackles the innovation deficit of most SMEs by stimulating them to cluster around R&D active firms or spin-off firms or form joint research centres with PROs- like

this was done in 2010-2013 period with centres of competence[12]. Also, more detailed research in the future should examine the R&D and innovation capability in business sector and evaluate the factors determining its strengths and weaknesses.

Current Slovenian R&D and innovation policy seems to have serious delivery problems. The most important are the following:

- Low visibility of measures. The interviewees show little or no awareness of the available measures for strengthening science-industry cooperation, especially the business sector representatives.
- Heavy bureaucracy. The interviewees have complained of the bureaucracy accompanying R&D and innovation related measures. A significant mistrust is felt in the documentation required by the government agencies, asking for data not easily obtainable or of confidential nature. With the co-financing from the EU Structural Funds, the procedural details have gotten worse. Sometimes, the load of paper work turns away firms from application. Simplification, coordination and better visibility of the support measures is required.
- More specificity in policy measures creation. The nature of science-industry relationship is determined significantly by the development level of a particular sector (observe, for instance, differences between food and chemical sector in Slovenia), by the size of actors in a specific area (both the business and research capacities are highly heterogeneous in different areas) and by the very size of the country itself. Therefore, design of policy measure needs to be done with Slovenian specific needs in mind and not copy-paste from best practice in a more developed environment. One such example is the university technology transfer offices, which can be highly successful in the USA, but have only limited applicability in Slovenia (or other countries) due to different university system.
- The measures should focus not only on partnerships, but on support of capacity building as well. On one hand, increasing R&D and innovation capacity in business sector is needed, while on the other, strengthening the capacity for knowledge/technology transfer in PROs.
- Importance of mutual understanding and gradual building up of cooperation. Personal contacts, informal relationships, building alliances not through formal contracts, but step-by-step by acquiring cooperation experiences are of crucial importance. Support to various activities, where representatives of the two communities, science and business can meet each other and openly discuss the issues related to their cooperation, can be a valuable instrument.
- Policy stability and regularity of measures. Frequent changes in policies and support measures do not create a positive environment for cooperation. Stability in the innovation policy, in the evaluation criteria as well as in the support measures is what makes the framework more supportive to the risky undertakings like science-industry cooperation.

12 Within financial perspective 2007-2013 Slovenia with EU structural funds supported 7 centres of competence, where partners from industry formed joint research units with PROs to address their R&D needs.

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APPENDIX 1

Innovation activity and innovation cooperation by type of partners of Slovenian and EU27 firms in 2010 (CIS 7)

	Slovenia	*EU27*
Innovation active firms[a] as % of all firms	49.4%	52.9%
% of innovative firms engaged in any type of innovation cooperation	44.7%	25.4%
% of innovative firms engaged in innovation cooperation with[b]:		
Other firms within the firm group	30.2%	36.5%
Suppliers of equipment, materials, components or software	66.8%	59.5%
Clients or customers	60.6%	49.4%
Competitors or other firms of the same sector	30.0%	26.2%
Consultants, commercial labs, or private R&D institutes	49.3%	33.7%
Universities or other higher education institutions	49.1%	42.2%
Government or public research institutes	31.9%	24.1%

Source: Eurostat, http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=inn_cis7_coop&lang=en (access Aug.1st, 2013).

a/ Firms with any kind of innovation.

b/ Cooperation with multiple actors can be selected.

APPENDIX 2

List of interviewees and partner institutions

Case 1

Krka develops innovative generic medicines, i.e. generic medicines with value added, which are the product of their own in-house knowledge. It is by far the most important company in Slovenia as far as R&D activities are concerned. Company's R&D unit employs 550 researchers with EUR 88.3 million of R&D expenditures, which is 9.3% of sales (2009 data). We interviewed the Director of Research Department Aleš Hvala, Ph.D. For more on Krka and its R&D see http://www.krka.biz/en/about-krka/company-presentation/.

Laboratory for Inorganic Chemistry and Technology of the National Institute of Chemistry Slovenia employs five researchers and three young researchers, employed on the basis of the so called Young Researchers programme of the Slovenian Research Agency (the institute on the other hand employs 285 people). Research activities of the Laboratory are concentrated on the investigations of porous materials (zeolitic materials, mesoporous materials and cement research) and on materials structural analysis (x-ray diffraction, nuclear magnetic resonance spectroscopy and X-ray absorption spectroscopy). We interviewed the Head of the Laboratory, Venčeslav Kavčič, Ph.D. For more on the National Institute of Chemistry see http://www.ki.si/index.php?id=117&L=1.

Case 2

Emona RCP – Nutrition Research and Development Department, Ljubljana is a R&D unit of the enterprise Jata Emona and is involved in various R&D projects in the area of human and animal nutrition. It employs eight people involved in research, testing and development of different solutions for their own company as well as other companies. We interviewed Head of Emona RCP Matjaž Červek, Ph.D. For more on Emona RCP see http://www.e-rcp.si/o_podjetju_angla.html, and on Jata Emona http://www.jata-emona.si/about_us.html.

Animal Science Department of the Faculty of Agriculture in Zagreb which employs thirteen people is involved in R&D projects in the area of genetics, physiology, breeding, selection and nutrition of animal and meat science. We interviewed professor Ivan Jurić, Ph.D, who is the main coordinator of the cooperation project Emona RCP. For more on Faculty of Agriculture of the University of Zagreb see http://www.agr.unizg.hr/en.

Case 3

Melamin's R&D Unit employs 20 people, approximately 10% of company total employment. The work of R&D Department is based on: (i) development of new products, (ii) modification of existing products because of the demands of the market, legislation or other demands, (iii) co-operation with buyers, (iv) co-operation with production management and the inspection of quality. We interviewed the Head of company's R&D Unit Igor Mihelič, Ph.D. For more on Melamin seehttp://www.melamin.si/en/.

Department of Polymer Engineering, Organic Chemical Technology and Materials at the Faculty of Chemistry and Chemical Technology, University of Ljubljana employs seven researchers and three young researchers, employed on the basis of the so called Young Researchers programme of the Slovenian Research Agency. We interviewed Head of the Department, professor Matjaz Krajnc, Ph.D.. For more on the Department see http://www.fkkt.uni-lj.si/en/departments-and-chairs/department-of-chemical-technology/chair-of-polymer-engineering-organic-chemical-technology-and-materials/

THE EFFECT OF HRM QUALITY ON TRUST AND TEAM COHESION

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ABSTRACT: *The purpose of this study was to examine the relationships between the perceived quality of HRM, trust among athletes, their trust in head coach, and the perceived team cohesion in the context of basketball teams from four South East European countries. First, the modified version of HRM quality scale was verified on one sample of 277 athletes from 36 clubs. Then the model was developed with the theoretical fundamentals of social exchange theory and tested on data from other sample of 282 athletes from 37 basketball clubs. Results show that the perceived quality of HRM directly affects degree of athletes' trust in the head coach. However, it does not have a direct impact on trust among athletes, neither on team cohesion. However, athletes' trust in the head coach mediates the indirect effect between the perception of HRM and the perceived cohesiveness within the team, and it also plays the mediating role in the perceived HRM – trust among athletes' relationships.*

Keywords: *basketball, team, HRM, cohesion, trust*
JEL Classification: L31, M10

1 INTRODUCTION

The measurement of human resource management (HRM) effects is still a challenge for scholars from a whole spectrum of organizational fields. While the identification of practices which have positive impact on financial outcomes like earnings, ROA, ROE, etc. remains the most debated topic (Bowen & Ostroff, 2004; Ichniowski & Shaw, 2003; Položki-Vokić & Vidović, 2008), less attention is given to HRM effects on behaviour and attitudes on micro and mezzo organizational level. An impact of the perceived HRM policies and practices on team level is from that aspect still an under-researched area, especially in the segment of sport clubs from transition countries, which operate in non-profit environment. Assessing the HRM effects on financial results is not the most appropriate in case of non-profit clubs, since they are focused (or at least should be) on other aims like top sport result, contribution to local community, growth of organization, etc. At the same time, cohesiveness and trust within the organization are often considered as the key leverages for achievement of a whole spectrum of non-profit sport aims (Mach, Dolan, & Tzafrir, 2010; Paskevich, Estabrooks, Brawley, & Carron, 2001). Therefore, the degree of team cohesion and trust can have some kind of "common denominator" roles for HRM efficiency measures in non-profit sport clubs. This has been recognized among scholars,

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which resulted in intensification of trust and cohesion studies among sport clubs in the last fifteen years (Dirks, 1999; Dirks, 2000; Mach, Dolan & Tzafrir, 2010). However, while the majority of papers focus on the consequences of those two constructs, there is still a lack of research, which would try to identify their antecedents. Given the above, the aim of this research is to make a step further in the process of disclosing the so-called "black box" phenomenon in the HRM – trust and HRM – cohesion relationships. Our intention was to measure the importance of athletes' HRM quality perception and to identify paths through which HRM perception influences two crucial factors of team building. The major objective was to develop a framework for examining the relationships in the triangle of HRM, trust and cohesion, and then to examine the implications of the model using real-life data. This study will therefore have theoretical and practical impact. The first relates to the understanding of the relationship among observed variables, while (from practical point of view) the results should be useful to team managers in non-profit sport clubs in their ambition to increase the degree of trust and cohesiveness within their sport teams.

2 THEORETICAL FRAMEWORK AND HYPOTHESES

2.1 The context of sport clubs in South-East Europe and HRM specifics

When analysing a sport club, specifics of institutional and business context of particular organization should be considered. Despite the intensive process of globalization, we should be aware of the fact that sport clubs constitute a specific segment of organizations, which is more attached to its own local environment than other types. State regulations and tradition in a particular region play an important role especially in organizational process of sport clubs in Europe (Avgerinou, 2007; Fort, 2000). European sport clubs are affected by the fact that majority of European sport competition have preserved the traditional system, where the best clubs in the end of the season advance in higher ranked competition, while clubs with the worst sport result drop into lower level league. Consequently, there are no sport clubs with exclusive right to compete in particular competition which differentiates the so-called European "open" system from the system that is used in the United States. The "closed" system enables sport clubs to have a greater degree of certainty, while European sport clubs have to preserve flexibility, due to possibility of dropping into a lower level competition. At the same time, unlike in the United States, Europe does not have the system of athletes' development incorporated into the educational system. This means that every sport club also has the development function and produces young athletes who will eventually participate in top competitions. Consequently, the majority of European sport clubs have professional and amateur part of an organization. The dual nature results in mixed teams' structures, composed of professionals and amateurs (Boxall & Purcell, 2000; Auld & Godbey, 1998). Combination of them within a team can cause many difficulties, since one part of a team is being paid for its participation and the other part is not. Therefore, the achievement of trust among teammates and team cohesion seems to be more challenging for coaches and managements in those clubs.

Sport clubs in Europe are traditionally, unlike their North American counterparts, closer to the non-profit sector. This is in line with EU Commission statement that sport clubs should offer sport opportunities at a local level and thus promote the "sport for all" idea (Petry, Steinbach & Tokarski, 2004). However, highly professional non-profit sport clubs that compete at the highest-level sport competitions are the specific of transition countries. This is the consequence of the unique historical development. In the centrally planned economies, all sport clubs were formed by national sports societies. Therefore, all of them were declared as non-profit and amateur organizations. The opening of athletes' market in transition period stimulated professionalization of top sport clubs. However, in most cases, they preserved non-profit legal status. The heritage of particular historical development can be noticed in the ex-Yugoslavia countries where the vast majority of sport clubs still operate as non-profit organizations regardless of their budget size or level of professionalism. However, it is important to stress that non-profitability does not prevent organizations from having a surplus of income over costs (Podlipnik, 2010). It only has to be reinvested in organizational activities. In practice, the financial flows are often difficult to control and due to poorly developed legislation, regulators often fail to prevent profit sharing among organizational members in good times. In the context of this research, non-profitability could increase the importance of observed phenomenon for couple of reasons. First, the organizational ownership structures in non-profit clubs are more complex than in their profit-oriented counterparts. Interference of numerous stakeholders usually complicates the decision processes and often results with the ambiguities in strategic goals and HRM policy. As some authors claim the absence of clear ownership, structure also increases the importance of trust and trustworthiness in those organizations (Greiling, 2007). Secondly, non-profitability usually causes higher percentage of volunteers who are not driven by financial motives (Škorić, Bartoluci & Čustonja, 2012). Therefore, overall perception of human relations within organization should be more important factor from the aspect of building trust and cohesion in non-profit sport clubs. Additionally, from the HRM aspect sport clubs represent a special segment of non-profit organizations for couple of reasons. The most obvious is the fact that in sport clubs there are usually two separate parts of single HRM system. While the first is intended for administrative part, the purpose of other is to form competitive sport team. They differentiate regarding the role of head coach, which is significant in the second and usually minor in the administrative part. Therefore, when it comes to formation of sport team, sport clubs' managements delegate the responsibility and decision-making power on head coach, who, in accordance with the budget constraints, can choose between two sources of athletes. According to van der Heijeden (2012), sport clubs' teams can acquire athletes from youth selections (mostly amateurs) or athletes obtained on athletes' market (mostly professionals). Thus, from the aspect of team forming there are two crucial processes: development of young players and scouting. In line with Tuckman's (1965) theory of team formation, after "forming" phase, "storming" and "norming" phases follow. While the aim of "forming" is making a competitive team from the aspect of obtaining variety of skills, physical capabilities and tactical knowledge, the aim of "storming" and "norming" is to achieve as high as possible degree of team cohesiveness which produces synergy effects and enables athletes to achieve common goal.

The ambition of this study is to test the strength of causal relationships in the triangle of the perceived HRM quality, trust and cohesion in non-profit sport clubs. Placing the latter in the context of social exchange theory, which has often been criticised for reducing the social interaction to economic transaction (Zafirovski, 2005), will enable not only evaluation of how the observed variables influence each other, but also testing the capability of this theory to explain social interaction processes in non-profit organizations.

2.2 The HRM-trust-cohesion link

Every time an individual becomes a member of certain organization, he or she faces the HRM process. This is inevitable even in those organizations, which do not have formalized or planned HRM system. From the aspect of individuals, those practices and activities included in HRM system represent environmental factor, which affects their emotions, moods, feelings and should also have impact on their behaviour within particular organization. However, Alfes and others (2013) point out that every person is unique, so intended HRM system is not crucial from the perspective of HRM outcomes. The latter depend more on the fact of how the particular HRM system is being perceived among organizational members. This is in line with McShane and Von Glinow (2003) perceptual model, in which authors explained that every stimulator from the environment has to go through the filter of individual's perception, and only then it can have an effect on individual's emotions and behaviour. Therefore, in this study we examined how the perception of HRM affects two specific phenomena, which could be placed in the context of moods, attitudes and behaviour, trust and cohesive behaviour within the team.

Team cohesion is the degree to which team members work together as they pursue the team's goals. According to Carron and Brawley's (2000) definition cohesion is a dynamic process, which enables a group to stick together and remain united in the pursuit of its instrumental objectives and/or for the satisfaction of member affective needs. It is especially desirable in the team context where members are interdependent and generate a mutual output. Numerous studies have already confirmed that the cohesion significantly contributes to a more efficient and effective functioning of organization, which is particularly noticeable in team sports (Hall, 2007; Mach, Dolan, & Tzafrir, 2010). Previous researches have also confirmed the difference between social and task cohesion (Carless & De Paola, 2000). While the latter refers to the identification with the tasks and commitment to them, the social component refers to the extent to which individuals interact socially. Carron, Widmeyer and Brawley (1985) further divided the construct based on how individual members of a group are attracted to the group and how individuals are integrated into the group, which resulted with four aspects of cohesion, namely "Individuals Attractions to the Group-Task" (IAGT), "Individual Attractions to the Group-Social" (IAGS), "Group Integration-Task" (GIT), and "Group Integration-Social" (GIS).

Until now, scholars have been mostly focused on measurement of the degree of cohesion in teams and its contribution to the final result (either on team level or on the entire organization). On the other hand, few studies also tried to identify the factors that contribute to emer-

gence of cohesiveness. In that context, the construct of trust has been found as cohesion's accelerator from both (task and social) aspects. Especially strong connection was found between trust and task cohesion, which is the crucial dimension of cohesiveness in task-oriented groups like sport teams (Morgan & Hunt, 1994; Dirks, 1999; Mach, Dolan & Tzafrir, 2010).

Regardless of many similarities, it seems that trust is a bit more complex construct than cohesion. Trust research began in the 60s, when it was identified as a key element of teamwork (Argyris, 1962; McGregor, 1967; Likert, 1967). In the following decades, authors tried to disseminate studies and evaluate trust's impact on individual and organizational level (Roberts & O'Reilly, 1974; Kirkpatrick & Locke, 1996; Langfred, 2004). In the process of examining this phenomenon, scholars faced with the issue of its definition. Trust is obviously tightly connected to couple of other feelings and is directly influenced by many factors. Since it usually manifests in the risky situation, it is often considered as closely related to willingness of someone to take risk. Indeed, those people, who are more inclined to risk-taking, usually build trustworthy relationships quicker and easier than others (Mayer, Davis & Schoorman, 1995). Trust is also often confused with unclear distinction from cooperation. However, the latter has not the same meaning, as the cooperation can also arise out of the fear from potential punishment, which cannot be the source of trust. Further, trust is tightly connected with the construct of confidence in the sense that the individual must have confidence that the other individual has the ability and intention to produce it in order to develop trust relationship (Deutsch, 1960). On the other hand, someone can also have confidence because he or she does not consider alternatives, while the essence of trust is choosing an action in spite of possibility of being disappointed (Luhmann, 1988). This is emphasized by social exchange theory, which postulates that human relations are formed by the use of a subjective cost-benefit analysis and the comparison of alternatives (Blau, 1964). In line with this theory, the condition for trust is previous interaction of individual with other organizational subjects, where individual assesses more dimensions that form trust (Tzafrir & Dolan, 2004). The multidimensionality and domain specificity of trust has been confirmed in various studies (Zand, 1972; Zeffane & Connel, 2003). Throughout the years of examination, many scholars have tried to make a list of the most important conditions for its appearance. A short review of factors that lead to trust is presented in Table 1. Obviously the most often mentioned components of trust are ability, benevolence, and integrity.

Besides the extra-trustor factors every trust relationship also depends on intra-trustor characteristics. People differentiate and some of them are more likely to trust than others. According to Mayer, Davis and Schoorman (1995) propensity to trust is a stable within-party factor that affects the likelihood this party will trust, while "ability", "benevolence" and "integrity" are dimensions of trust that depend on trustee. Adams, Waldherr, and Sartori (2008) added predictability as another factor of trust to this model. It has often been considered similar to trust construct, but willingness to take a risk and the vulnerability are not present in the predictability concept. Predictability also does not imply that one person will trust the predictable person more, since the latter can be predictable in bad sense. However, in general predictability enhances trustworthiness by reducing uncertainty (Lewis & Weigert, 1985) and is not directly linked to other three factors. Therefore, Adams, Waldherr, and Sartori split the trust of military team members into four dimen-

sions, namely "competence", "benevolence", "integrity", and "predictability". Competence in this context represents the extent to which the person exhibits a group of skills, competencies and characteristics, which allow an individual to have influence. Benevolence, as the trustee's characteristic, is the extent to which the person is seen as kind, caring and concerned, while integrity is the extent to which the person is seen as honourable honest and having strong moral principles. Finally, predictability denotes he extent to which the trustee's behaviour is consistent and predictable.

Table 1. *Trust Antecedents*

Authors	**Antecedent Factors**
Solomon (1960)	Benevolence
Giffin (1967)	Expertness, reliability as information source, intentions, dynamism, personal attraction, reputation
Boyle & Bonacich (1970)	Past interactions, index of caution (based on prisoners' dilemma outcomes)
Kee & Knox (1970)	Competence, motives
Farris, Senner, & Butterfield (1973)	Openness, ownership of feelings, experimentation with new behaviour, group norms
Jones, James, & Bruni (1975)	Ability, behaviour is relevant to the individual's needs
Rosen & Jerdee (1977)	Judgement or competence, group goals
Larzelere & Huston (1980)	Benevolence, honesty
Cook & Wall (1980)	Trustworthy intentions, ability
Lieberman (1981)	Competence, integrity
Johnson-George & Swap (1982)	Reliability
Hart, Capps, Cangemi & Caillouet (1986)	Openness/congruity, shared values, autonomy/feedback
Butler (1991)	Availability, competence, consistency, discreetness, fairness, integrity, loyalty, openness, promise fulfilment, receptivity
Sitkin & Roth (1993)	Ability, value congruence
Mayer, Davis, and Schoorman (1995)	Ability, benevolence, integrity
Tzafrir & Dolan (2004)	Reliability, harmony, concern
Adams, Waldherr & Sartori (2008)	Benevolence, integrity, competence, predictability

Trust and cohesion are often considered as similar constructs, but close examination reveals a couple of differences between them. While cohesion is intergroup phenomenon, trust can be built upon a person, place, event or object, between two or more individuals (Johnson-George & Swap, 1982; Mayer, Davis, & Schoorman, 1995), between two or more organizations (Gulati, 1995), individuals and organizations (Zaheer, McEveily, & Perrone, 1998) etc. In other words, trust is context dependent phenomenon, which demands analysis from different perspectives, depending on relationship that is in the focus of particular research (Gillespie & Dietz, 2009; Laeequddin, Sahay, Sahay, & Waheed, 2010; Shockley-Zalabak, Ellis, & Winograd, 2000). Consequently, unlike cohesion trust construct can have several foci within the same team. This implies that cohesion is usually measured on team level, while trust is being measured in the context of various interpersonal relationships. Athletes within sport clubs also form trust relationships towards different positions in the organizational structure and sport literature suggests at least the differentiation between two inter-team relationships, namely trust among athletes and trust in the relationship athletes – head coach (Tzafrir, 2005). The second difference between cohesion and trust, which is in the context of this study even more important, is the fact that trust is a construct within individual upon other person or group of persons, while team cohesion is actually perception of how the group members behave within the group in relation with other members. Thus, trust can be denoted as emotional construct, while cohesion is more a behavioural phenomenon.

Trust in other organizational subjects is in positive relation with behaviour at the workplace and is also connected with the HRM system in particular organization. This has been confirmed by Tzafrir (2005), who found out that trust stimulates certain HRM practices and vice versa. The literature also provides empirical evidences that HRM and trust have similar positive effects on work behaviour, including organizational citizenship, employee performance, open communication, team commitment and finally also on team performance (Dirks, & Skarlicki, 2009; Hempel, Zhang, & Tjosvold, 2009; Tzafrir, 2005). Indicatively, scholars also proved that perception of HRM quality and high degree of trust cause similar consequences and positively affect organizational success (Becker & Huselid, 1998; Delaney & Huselid, 1996; Huselid, 1995; Mach, Dolan, & Tzafrir, 2010). However, it is still relatively unclear in which direction the relationship between perception of HRM and trust works. This causal relationship probably works in both ways, but the fact is that HRM policies and practices exist before individual becomes a member of a sport club. As Searle and Skinner (2011, p. 4) state: "HRM is about structuring the interaction of human beings within an organizational context in order to maximize performance". In other words, this means that HRM sets the context for building trust relationships. Indeed, the effectiveness of information flow from top management towards other organizational members depends on particular HRM system within the club. Therefore, this system is among else also responsible for maintaining good human relations in the organization, which includes building trustworthy relationships among organizational members. This can be presumed from Snape and Redman's (2010) definition of HRM system, which is according to them a set of interconnected activities, designed to ensure that employees have a broad range of superior skills and abilities. However, although usually the most important aim of HRM is to increase the level of competences and knowledge within organi-

zation, it has much wider spectrum of effects. The latter are usually divided on three segments, namely: employee skills, employee motivation and empowerment (Conway, 2004; Wright & Boswell, 2002). Thus, the perception of HRM should not have impact only on ability, but also on other trust factors as integrity, benevolence and predictability (Jackson & Schuler, 1995). In line with that, it is reasonable to presume that specific HRM practices in basketball clubs in the role of "environmental stimulator" influence the perception of HRM quality among athletes, which affects their trust in other organizational subjects. Therefore, we set the first two hypotheses.

Hypothesis 1: The perceived quality of HRM has direct positive effect on the degree of trust among athletes.

Hypothesis 2: The perceived quality of HRM has direct positive effect on the degree of athletes' trust in head coach.

In this study, we analyse the impact of the perceived HRM on athletes' trust in two specific trustees, namely other athletes and head coach. Since the latter do not have the same amount of responsibility for HRM implementation, it is reasonable to expect that the HRM impact will differentiate on those two relationships according to the trustee's responsibility for HRM implementation. Usually top managers are designers of organizational structure and strategy, including HR strategy (Creed & Miles, 1996). On the other hand, according to Lago, Baroncelli, and Szymanski's (2004) model of production process in sport clubs, head coach is the organizational subject with the highest degree of responsibility in day to day HR activities, which affect athletes, and has lot of manoeuvring space for shaping the nature of HRM system. Therefore, head coach should be (at least from athletes' perspective) the most important organizational subject for implementation of club's HRM policies, while athletes participate only in implementation phases as executors. In line with that assumption, head coach should get the largest part of athletes' gratitude or criticism for good or poor design and implementation of HRM practices. This consequently means that the perceived HRM should affect more athletes' trust in head coach than the degree of trust among athletes.

Hypothesis 3: The perceived quality of HRM has stronger effect on the degree of athletes' trust in head coach than on trust among athletes.

According to social exchange theory, organizations are forums for social (and economic) transactions (Cropanzano, Prehar, & Chen, 2002). Also in line with that theory team effectiveness is a result of interaction, coordination and collaboration between team members (Hackman & Morris, 1975), while trust is seen as the crucial factor in the processes of social exchange (Blau, 1964). In the context of sport teams, trust enables an individual athlete to have positive feelings and perceptions regarding other team members (athletes and head coach) and at the same time stimulates the subject to be open, reliable and concerned for others. This should also stimulate the positive cycle of reinforcement within the team, which could be the reason for the increase of team cohesiveness. The literature offers the explanation for the latter effect, saying that the degree of trust differentiate teams

with high level of trust from those teams with lack of trust at the time of increased risk. In those critical moments, trust affects team members to accept their role and to perform even those unpleasant tasks that are necessary to win (Dirks, 2000; Mayer, Davis, & Schoorman, 1995). Trust indeed provides the belief that one team member can predict and understand others and vice versa, it reduces perception of risk, vulnerability, and uncertainty, which helps every team member to focus on his task in the context of teamwork. Those, who do not trust in other organizational subjects, work less effectively (Dirks & Ferrin, 2001). Positive link between trust and cohesion has already been found in previous studies (Hansen, Morrow, & Batista, 2002; Luria, 2008), and has been confirmed in examination of team dynamics within sport clubs. Mach, Dolan, and Tzafrir (2010) examined the relationships in clubs from various sports industries and found that trust among team members is an antecedent for team cohesion. Dirks (1999) made a study among NCAA basketball teams and also confirmed the positive trust – cohesion relationship. In line with that, we also expect that perception of team cohesion is going to be positively affected by the degree of trust among team members (athletes and head coach). Therefore, we formulate the fourth and fifth hypothesis as follows.

Hypothesis 4: The perceived team cohesion is directly positively affected by degree of trust among athletes.

Hypothesis 5: The perceived team cohesion is directly positively affected by degree of athletes' trust in head coach.

In line our argumentation for previous five hypotheses, it would be reasonable to predict the positive relation between HRM and team cohesion relationship. The positive between those two constructs has already been indicated by previous studies. It was found that HRM and cohesion both correlate with the same constructs, namely: trust (Tzafrir, 2005), organizational success (Becker & Huselid, 1998; Huselid, 1995) and sport result (Mach, Dolan, & Tzafrir, 2010). The positive link can also be explained with argument that the HRM process is responsible for maintaining good human relations in the organization with the mission to stimulate group of people to achieve common goal. The latter is very close to the Carron and Brawley's (2000) definition of cohesiveness, so we can assume that one of the HRM aims should be also an achievement of higher degree of team cohesion. On the other hand, the fact is that by now, there has not been found a direct relationship between HRM perception and team cohesiveness, only indirect causal link has been proved. In that context, we should not forget that perceived cohesiveness is the perception of how good do team members work together. Therefore, team cohesiveness is actually perception of behavioural consequence, which is not the primary effect of HRM quality perception. This could be the explanation that the perceived HRM quality – team cohesion relationship works indirectly through the third construct, which is in direct causal relation with both constructs. Trust is within person construct, which we expect to be predictor of team cohesion and at the same time the perceived HRM quality consequence. Since athletes' perception of HRM quality is shaped through every day practices, it should also be linked to attitudes that athletes form in relation with subjects that implement HRM, namely head coach and other athletes within the team. Previous studies also reported sig-

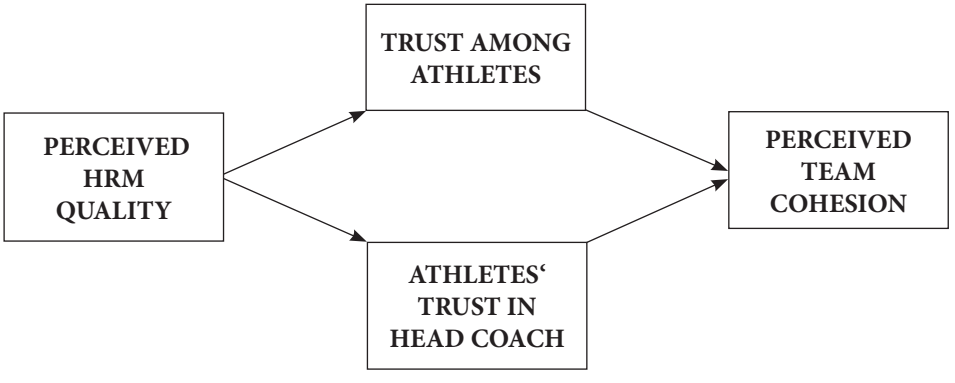
nificant relationship between coaching behaviour and team cohesion (Gardner, Shields, Bredemeier, & Bostrom, 1996). Therefore, we propose that the perception of HRM quality positively influences athletes' trust in those subjects that are responsible for implementation of tasks determined by HRM policy, and that trust mediates this effect and stimulates the degree of cohesiveness, especially its task dimension. Thus, we suggest the final two hypotheses.

Hypothesis 6: Athletes' trust in head coach mediates the effect between the perception of HRM quality and team cohesion.

Hypothesis 7: Trust among athletes mediates the effect between the perception of HRM quality and team cohesion.

All seven hypotheses form conceptual framework summarized in Figure 1.

Figure 1. *Hypothesized model of positive causal relationships*



3 METHODS

3.1 Sample and data collection

Recognizing the fact that each sport industry has its own HRM peculiarities, this research was performed on athletes only from male basketball teams. This improves usability of study results for basketball clubs' managements, and at the same time enables future identification of the differences between the characteristics among different sport branches. Since the objective of this study was to explore how the perceived quality of HRM influences the development of trust and cohesiveness on team level, the focus of research was on observation of the whole team as a unit. Before conducting a final research 30 interviews with basketball players were held to pre-test the survey questionnaire. Then, 108 men basketball clubs from Bosnia and Herzegovinian, Croatian, Serbian, and Slovenian national leagues (regardless of level of competition) were contacted by our researcher,

who explained the purpose and methods of research. Participation was completely voluntary and anonymous; each participant was free to withdraw at any part of the survey. The data collecting took place through the whole 2013/2014 season, in each team at the end of practice, never immediately after a competition in order to avoid competition-specific biases. The questionnaires were completed under supervision of researcher, who stressed the importance of independent responses. Consequently, basketball players completed their questionnaires on their own without communication with their teammates or their coach. Finally, athletes from 73 clubs were willing to participate in research (67.6 %). Since each basketball team consists of 12 athletes, we can suppose that there are 1296 basketball players altogether in 108 clubs. 559 or 43.13% (7.66 in average per team) of them completely filled out the questionnaire. This represents sufficiently large sample according to HRM literature (Pološki-Vokić, 2004; Huselid, 1995; Becker & Huselid, 1998). The participants were in average 22.17 (standard deviation (SD) = 4.73) years old and had in average 4.81 (SD = 4.62) years of experiences with playing for current club in senior competitions. Similarly, high variation was noticed in the athletes' average tenure with current head coach. It averaged 2.45 years with the SD of 2.49. Due to the fact the new HRM quality scale was used in this study, the sample of 73 clubs was randomly split into two subsamples, and then the sample A was used to verify new scale, while second sample was used to test hypothesized model. Sample A (for the HRM quality scale verification) consisted of 36 (277 athletes) and sample B (for testing hypothesised model) consisted of 37 (282 athletes) clubs. Athletes in sample A had 22.05 (SD = 4.72) years, were 4.40 (SD = 4.52) years in current club and cooperated with current coach for 2.20 (SD = 2.43) years. Athletes in sample B were in average 22.29 (SD = 4.77) years old, played for current club 5.04 (SD = 4.44) years and were 2.66 (SD = 2.34) years with current head coach.

3.2 Measures

Group cohesion

The perception of cohesiveness among team members was assessed on the basis of a "Group Environment Questionnaire" (GEQ) developed by Carron, Widmeyer, and Brawley in 1985. This is a self-report questionnaire that contains 18 items and assesses four aspects of cohesion, namely "Individuals Attractions to the Group-Task" (IAGT), "Individual Attractions to the Group-Social" (IAGS), "Group Integration-Task" (GIT), and "Group Integration-Social" (GIS). Previous studies (Carron & Brawley, 2000; Li & Harmer, 1996) provided evidence of the scale validity and its usefulness in the sport team context. However, when analysing sport teams, scholars suggest the use of only two task components (IAGT and GIT) (Li & Harmer, 1996; Hogg, Abrams, Otten, & Hinkle, 2004), since previous studies among basketball and other sport clubs have repeatedly stated that the other two social components of cohesion have significantly less impact on the performance of the team (Carron, Bray & Eys, 2002; Carron & Brawley, 2000). Consequently, 4 out of 9 claims in our questionnaire measured IAGT, while 5 claims measured GIT dimension. Responses were provided on 7-point Likert scale anchored at the extremes by "strongly disagree" (1) and "strongly agree" (7). 6 claims were reverse coded. The internal consist-

ency of particular cohesion scale for data obtained in this study was computed. Cronbach's alphas scored .77 (sample A) and .76 (sample B) (overall α = .77), which indicates that the cohesion scale possessed sufficient level of reliability (Nunnally, 1978). Then confirmatory factor analysis (CFA) was conducted on whole sample to test, if the scale really captures both task cohesion dimensions. Results did not support a single factor structure, since comparative fit index (CFI = .86), non-normed fit index (NNFI = .76) and normed-fit index (NFI = .84) were all below .9 threshold. Moreover, root mean squared error of approximation (RMSEA = .11) was above threshold of .10, which suggests that particular structure of the model doesn't represent a good approximation. On the other hand, a two-factor structure (CFI = .96, NNFI = .93, NFI = .94, RMSEA = .06) scored much better in all parameters. Therefore, we concluded that team cohesion in particular research was the construct of two factors.

Trust

For the purpose of this study, we used Adams, Waldherr, and Sartori's (2008) trust scale. It has been developed in the context of military units, which have been found to operate under similar conditions as sport teams. This scale was also preferred by basketball athletes who were included in pre-test survey, mostly due to inclusion of "competence" dimension, which is considered as crucial for trust measurement among task-oriented teams. Unlike some previous HRM studies (McAllister 1995; Dirks, 2000; Tzafrir & Dolan, 2004; Mach, Dolan & Tzafrir, 2010), the ambition of this research was to measure the same construct on two different relations. Therefore, we used single questionnaire tool and the scales were modified only by adjusting referent person to "teammates" and "head coach". Responses were provided on 7-point Likert scale anchored at the extremes by "strongly disagree" (1) and "strongly agree" (7). Once again, we conducted CFA to test, if two trust relationships form two different constructs. Results did not support a single (CFI = .62, NNFI = .55, NFI = .61, RMSEA = .17) or a two-factor structure (CFI = .83, NNFI = .80, NFI = .81, RMSEA = .11), but obviously the latter achieved better score in all parameters. However, relatively low fit indexes indicated poor fit and the possibility that those two constructs form more sub-constructs. Since original trust questionnaire included four dimensions of trust, we conducted second order CFA. This time the model was formed of two-second order factors with four first order factors each. Results (CFI = .91, NNFI = .89, NFI = .89, RMSEA = .08) were not perfect, since NNFI and NFI scored below .9 threshold, but were acceptable on the basis of CFI and RMSEA. Overall reliabilities in cases of all trust scales were much above recommended .75 thresholds. Cronbach's alphas for trust among athletes were .91 (sample A) and .92 (sample B), while alphas for athletes' trust in head coach scored .94 (sample A) and .95 (sample B).

Perceived HRM quality

Perceived HRM quality scale has been built according to Gould-Williams and Davies's (2005), and Gonçalves and Neves (2012) recommendations. They have developed two

different scales, which both proved high reliability and validity and showed applicability in various industries (Gould-Williams, 2003; Gould-Williams & Davies, 2005; Gonçalves & Neves, 2012; Alfes et al., 2013). However, since non-profit professional sport clubs in transition countries operate in specific circumstances, we wanted to develop special scale, which would be the most appropriate for capturing athletes' beliefs and attitudes in those organizations. Therefore, we organized a discussion between 11 basketball players and 11 experts from the field of HRM in sports clubs (5 head coaches, 5 sports directors and one sports psychologist). Each of them had at the time of discussion at least 5 years of work experiences in basketball clubs. Every member of work group got the Gould-Williams and Davies's as well as Goncalves and Neves scales, and then had to reconsider their statements and to modify them if necessary. Eventually every member came up with proposition of his measurement scale. The final list of ten distinct HRM phases was the result of combining similar phases: 1) scouting, 2) negotiating, 3) selection, 4) training, 5) game strategy, 6) game leadership, 7) performance evaluation, 8) financial compensation, 9) non-financial compensation and 10) way of leaving the club. Basketball players had to evaluate the quality of practices in each phase. They provided responses on 7-point Likert scale, where higher scores indicated a more positive response. The scale was anchored at the extremes by "the practices in this HRM phase are extremely poorly defined and poorly implemented" (1) and "the practices in this HRM phase are extremely well defined and perfectly executed" (7). In order to assure measurement of different constructs, we conducted bivariate correlation analysis between perceived quality of ten HRM phases (Appendix 1). Results showed that high correlations (correlation coefficient > .7) existed in the triangle of "trainings", "game strategy" and "game leadership", other significant correlation coefficients scored lower values. Moreover, only among those three variables the "variation inflation factor" calculation indicated potential for multicollinearity problem (VIF > 3). This indicated possibility that phases 4, 5 and 6 from athletes' perspective in fact form single HRM phase, so we conducted three confirmatory factor analyses (CFA) in order to test which structure of HRM construct fits best to our data. According to Hu and Bentler's (1999) recommendations results supported 8-factor structure (CFI = .99, NNFI = .96, NFI = .98, RMSEA = .07), where phases "trainings", "game strategy" and "game leadership" were aggregated in one variable (new variable was named "training and game leadership" (TGL)). On the other hand, single and 10-factor structures were found not to fit data well, due to low fit indexes (CFI, NNFI and NFI < 0,9) and high RMSEA (> .10). Cronbach's alpha (.91) confirmed reliability of the "TGL" factor, while overall HRM scale alpha scored .83.

Control variables

Athletes, who participate in sport teams, do not operate in a vacuum. When analysing feelings about their teammates, we have to be aware of variety of factors, which could influence those relations. Of course, it was impossible to include all of them in this analysis, so we decided to take into account two, which could (according to social exchange theory) have the strongest influence on the causal relationship between perceived HRM quality, trust and cohesion:

- *Number of seasons in a team* – the number of years that particular athlete has been member of current team. According to the definition of trust given by Doney and Cannon (1997), trust requires an assessment of the other party's credibility and benevolence. One party must have information about other party's past behaviour and promises, which usually takes some time. Thus, larger number of seasons that athletes participate in particular team, could enable each of them collecting more information about other athletes and head coach within this team;
- *Seasons trained by coach* – an average number of years that an athlete in team has been cooperated with current head coach. Similarly as number of seasons in the club, number of seasons trained by the coach might be related to the degree of trust between athletes and head coach.

3.3 Data analysis

Since data for all observed variables in our hypothesized model were collected from a single source, we had to consider the problems of common method variance and discriminant validity. In order to control the influence of common method bias, we decided to perform set of CFAs on both samples. Following the recommendations established in previous studies (Hu & Bentler, 1999; Hair et al., 2005; Alfes et al., 2013) we tested how the whole model with all latent variables fits our data according to three parameters: chi-squared, CFI and RMSEA. Overall the model exhibited good fit in both samples (A: $\chi 2 = 1693$; $df = 765$; RMSEA = .05; CFI = .96; B: $\chi 2 = 1531$, $df = 765$, CFI = .97, RMSEA = .05). Also all standardised regression coefficients in the model were highly significant at the .001 level. In the next step we conducted so called "common latent factor test" (also known as Harman's single-factor test) recommended by Podsakoff and others (2003). The new factor was included in the model and all variables were allowed to load onto one general factor. In this case the model exhibited extremely poor fit for both subsamples, which indicates that single factor did not account for the majority of variance in our data (A: $\chi 2 = 22285$; $df = 775$; RMSEA = .23; CFI = .46; B: $\chi 2 = 20503$, $df = 775$, CFI = .37, RMSEA = .28). In the next phase, the discriminant validity test according to Fornell and Larcker (1981) was conducted, in order to test if our constructs in proposed model are distinct from each other. According to Fornell and Larcker (1981) scale variables are enough different from one another, if each scale's average variance extracted (AVE) is greater than its shared variance with other variables in the same model. The test was conducted in both subsamples, which confirmed that all scales were distinct from each other (see Appendix 2 and 3). Finally, since the unit of observation in this study was team, we had to aggregate individual perceptions of team cohesion, trust and perceived HRM quality within each team. In order to justify the aggregation, we conducted an ICC analysis for each team. The latter uses one-way ANOVA test to compare within and between team variances and helps us to assess whether membership in a certain team leads to more homogenous answers (McGraw & Wong, 1996). The ICC coefficients ranged from .77 to .91, which suggests excellent reliability.

4 RESULTS

Following the aim of providing a clear overview of relationships between perceived quality of HRM, trust and team cohesion we first conducted the correlation analysis for all variables on team level for subsample B. Table 2 presents the means, standard deviations, correlation coefficients and p-values for observed variables.

The pair analysis provides a direct picture of the relationship between perceived team cohesion, overall the perception of HRM quality and two trust constructs. As expected, team cohesion showed strong correlation with trust among athletes ($r = .51$, $p < .01$) and trust in head coach ($r = .55$, $p < .01$), while the correlation coefficient with perceived HRM quality ($r = .36$, $p < .05$) was significant at level of .5. We can also see that both trust constructs showed significant positive correlation with perceived HRM quality. At the same time, we cannot claim that certain component of trust has significantly stronger correlation with HRM quality than others. Further, although both trust - HRM quality relationships were shown to be significant, it seems that association between perceived HRM quality and athletes' trust in head coach is stronger than HRM quality - trust among athletes relationship. Interestingly, except in the case of perceived HRM quality – "seasons with coach" ($r = .33$, $p < .05$), control variables did not show any significant correlation with main variables. However, as expected, they were in positive correlation with each other.

In general, these findings are consistent with reports on correlation from previous research, which claimed that trust within the team is related to the construct of team cohesion (Dirks, 1999; Morgan & Hunt, 1994; Mach, Dolan & Tzafrir, 2010; Costa, 2003; Schippers, 2003). Like Mach, Dolan, and Tzafrir's (2010) findings, our results also indicate strong positive correlation between trust among athletes and trust in head coach. However, correlation analysis did not provide strong evidence for the conclusions on the connection between team cohesion and perceived HRM quality.

Table 2. *Means, SD, correlation coefficients for sample B (N = 37)*

Variables	M	SD	1	2	3	4	5
1. HRM quality	4.48	.63					
2. Trust among athletes:	5.57	.48	.31*				
a) Benevolence	5.86	.51	.34*			.43**	
b) Integrity	5.64	.47	.10			.46**	
c) Predictability	5.20	.57	.29			.31*	
d) Competence	5.61	.58	.36**			.58**	
3. Trust in head coach:	5.85	.60	.50**	.51**			
a) Benevolence	6.06	.55	.51**	.48**		.51**	
b) Integrity	6.02	.61	.44**	.50**		.53**	
c) Predictability	5.32	.62	.25	.56**		.42**	
d) Competence	6.00	.87	.57**	.37*		.54**	
4. Cohesion	4.68	.69	.36*	.51**	.55**		
5. Seasons in club	4.42	2.86	.08	-.05	-.08	.16	
6. Seasons with coach	2.77	1.52	.33*	-.07	-.23	-.01	.37**

** P < .01

* P < .05

With ambition to understand the associations between observed variables better, we performed structural equation modelling (SEM) using maximum likelihood estimation in IBM AMOS 21, and followed recommendations of Bollen (1990), Hu and Bentler (1999), and Tzafrir (2005) for evaluating model fit. SEM was selected due to advantages over multiple regression analysis, mostly its ability to evaluate complex models. It enables testing model globally rather than coefficients individually and also enables inclusion of mediating variables into the model (Joreskog & Sorbom, 1993; Mach, Dolan & Tzafrir, 2010). The results showed that initial model did not fit data very well. NFI and NNFI were below .9 thresholds, while RMSEA was above .10. Moreover, the p-value was below .05, indicating that the model is not well specified for this data set (Keats & Hitt, 1988). Therefore, we followed the suggestions of Alfes and others (2013) and tried to find alternative model, which would improve the fit. First we wanted to find out whether there is a direct link between the perceived HRM quality and the perception of team cohesion, so we tested Model 2, in which we added a direct path from those two variables. As Table 3 shows the model fit did not improve at all, rather the opposite. Moreover, the standard regression coefficient between the perceived HRM quality and the perception of team cohesion was insignificant, so we abandoned the possibility of direct HRM quality impact on team cohesiveness. For alternative Model 3 the direct path from athletes' trust in head coach

to trust among athletes was added in order to test whether there was a direct association between those variables. This was suggested by Mach, Dolan, and Tzafrir (2010) and is in line with the argument that head coach has the most important role in process of team structuring, especially in the process of athletes' selection. Therefore, higher degree of trust in head coach and his/her decisions should lead also to higher degree in athletes that he or she selected. This time the model fit improved significantly and satisfied the conditions for the conclusion that the Model 3 is consistent reflection of the relationship between the perceived HRM quality, athletes' trust in head coach, trust among athletes and perception of team cohesiveness. However, regardless of good fit indices, this model showed that the standardized regression coefficient between perceived HRM quality and trust among athletes was not significant ($r = .09$, $p = .547$). Therefore, we removed this path from the Model 4, which caused the additional improvement of model fit.

Additionally, we also performed SEM for all other alternative models of relationship between observed variables and have not found one, which would show better fit to our data. Thus, results suggested that the Model 4 shown in Figure 2 is the best reflection of the relationship between observed variables for this data set. Figure display standardized parameter estimates, statistical significance tests for each path and squared multiple correlations for dependent variables.

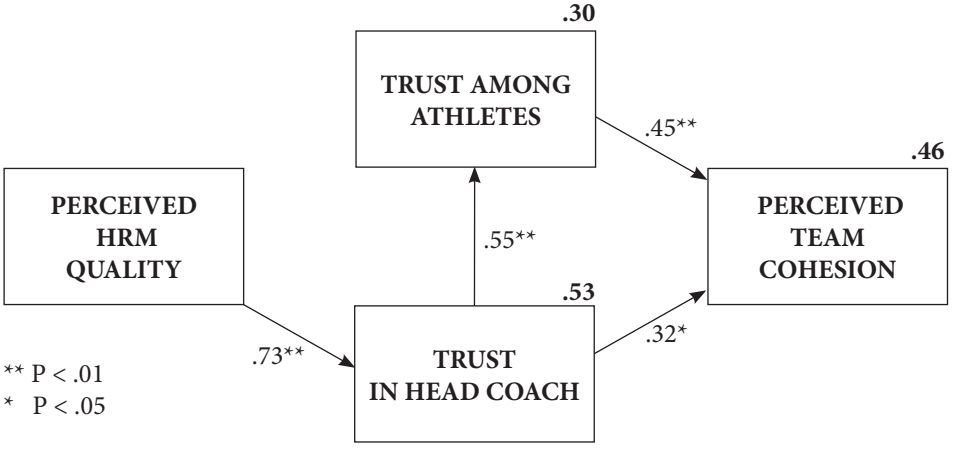
Table 3. *Structural Equation Model Comparisons – sample B*

Model	$\chi 2$**(df)**	**p**	**CFI**	**NFI**	**NNFI**	**RMSEA**
Initial	54.959(37)	.029	.93	.89	.81	.12
Model 2	54.114(36)	.027	.92	.82	.89	.12
Model 3	38.078(35)	.331	.99	.92	.98	.05
Model 4	38.472(36)	.360	.99	.93	.99	.04

Initial – hypothesised model
Model 2 – added direct path from the perceived HRM quality to perceived cohesion
Model 3 – added direct path from trust in head coach to trust among athletes
Model 4 – direct path from trust in head coach to trust among athletes and erasing the path from the perceived HRM quality to trust among athletes

Obviously, our findings undermined some of our hypothesized statements, but at the same time provided proof for some of predicted causal relationships between observed variables. Firstly, results confirmed strong influence of HRM quality on athletes' trust in head coach, which is in line with our hypothesis 2 and secondly, both observed trust relationships were found to significantly contribute to the perception of team cohesion, which confirms our hypotheses 4 and 5. Moreover, 46% of variance in team cohesion was explained by those two trust predictors. Further, the perception of HRM quality was found to have much stronger effect on athletes' trust in head coach than on trust among athletes as we had predicted in hypothesis 3. Although we did not find the direct impact of the perceived HRM quality on trust among athletes (which contradicts to our hypotheses 1 and 7) and team cohesion, Model 4 indicated that both causal relationships could work indirectly. It seems that the degree of athletes' trust in head coach plays the crucial mediating role in both cases.

Figure 2. *SEM results for Model 4 (sample B)*



In order to verify our hypothesis 6 and to test other potential mediation paths, we conducted additional mediation tests. When there is a full mediation in the relationship X-M-Y (where X is predictor, M is mediator and Y is dependent variable), all paths (X-M, M-Y and X-Y) are significant. Addition of the X-M and X-Y paths to the constraint model should not improve the fit (Mach, Dolan, & Tzafrir, 2010). On the other hand, when there is only indirect mediation effect, direct path X-Y is not significant. After analysis of each potential mediation relationship in the Model 4, we checked their significance with Sobel's test.

The results presented in Table 4 revealed that HRM quality indeed affected trust among athletes and team cohesion, but only indirectly through athletes' trust in head coach. However, the effect was significant only at level of .05. We also found that certain amount of athletes' trust in head coach's effect on team cohesion was mediated through the trust among athletes. Sobel's test showed that this was a full mediation.

Table 4. *Mediation tests for Model 4*

Mediator	X	Y	Type of mediation	Sobel's test
Trust in head coach	Perceived HRM quality	Team cohesion	Indirect	z = 2.27; p = .023
Trust in head coach	Perceived HRM quality	Trust among athletes	Indirect	z = 2.17; p = .030
Trust among athletes	Trust in head coach	Team cohesion	Full	z = 2.28; p = .022

Finally, we can summarise that our findings supported 5 out of initial 7 hypotheses as shown in Table 5.

Table 5. *Hypotheses verification*

	Hypothesis	Finding
1	The perceived quality of HRM has direct positive effect on the degree of trust among athletes.	Not supported*
2	The perceived quality of HRM has direct positive effect on the degree of athletes' trust in head coach.	Supported
3	The perceived quality of HRM has stronger effect on the degree of athletes' trust in head coach than on trust among athletes.	Supported
4	The perceived team cohesion is directly positively affected by degree of trust among athletes.	Supported
5	The perceived team cohesion is directly positively affected by degree of athletes' trust in head coach.	Supported
6	Athletes' trust in head coach mediates the effect between perception of HRM quality and team cohesion.	Supported
7	Trust among athletes mediates the effect between perception of HRM quality and team cohesion.	Not supported

* Not found a direct effect, but there was an indirect influence of the perceived HRM quality on trust among athletes with the trust in head coach in mediating role.

5 DISCUSSION AND CONCLUSIONS

The purpose of this research was to develop and test the model of how the perceived quality of HRM affects the degree of athletes' trust in their teammates and head coach in the context of basketball teams and, further, how the relationship between perceived HRM quality and perceived team cohesiveness is mediated through trust. Results did not completely support our theoretical framework, but, on the other hand, they confirmed the general thesis that perceived HRM quality affects athletes' trust and has indirect influence on team cohesion.

The findings confirm the positive relationship between HRM quality and athletes' trust and provide empirical support for the overall conclusion that better perception of HRM quality increases the degree of trust within teams. This is in line with previous findings on positive HRM quality - trust correlation (Huselid, 1995; Tzafrir, 2005) and with the thesis that high level of trust is related with the positive perception of HRM (Condrey, 1995). On the other hand, the results indicate that perception of HRM quality does not affect in the same manner trust among athletes and athletes' trust in head coach. The perceived HRM quality affects the process of trust building among athletes only indirectly, while trust in

head coach is influenced directly. The latter also plays mediating role between perceived HRM quality and trust among athletes. Since head coach implements the majority of HR practices on day-to-day basis, this finding seems reasonable and is also consistent with the results reported in previous studies (Dirks, 1999; Dirks, 2000; Mach, Dolan & Tzafrir, 2010; Webber, 2008).

From the aspect of trust – team cohesion relationship, this study confirmed that trust is indeed a strong predictor of team cohesion. Trust among athletes has been found to be in the tightest relation with the construct of team cohesion. At the same time athletes' trust in head coach showed significant impact on team cohesion, but only at the significance level of .05. Overall, we can conclude that higher level of trust among athletes is the strongest stimulator for athletes within the team to work more cooperatively in order to achieve common goals, which is in line with previous results that claimed trust is an important factor in the context of interactive teams (Costa, 2003; Dirks, 1999; Mach, Dolan, & Tzafrir, 2010; Schippers, 2003; Webber, 2008).

5.1 Theoretical implications

The major contribution of this study is that it explains how the perceived HRM quality contributes to the two crucial trust relationships from athletes' perspective and how do those effects reflect on team cohesion. It also operationalizes a multifocal conceptualization of trust, offers detailed insight in the construct and explores the mediating role of trust between perceived HRM quality and team cohesion. This study provided additional empirical support to the growing body of empirical literature on the trust – cohesion relationships within sport organizations. At the same time, this is one of only a few studies, which examined the HRM – trust relationship on team level and is, according to the knowledge of author, the first attempt of perceived HRM quality – team cohesion causal link analysis. This study accepted the call of some scholars (Alves et al., 2013; Nishii et al., 2008; Den Hartog, Boselie & Paauwe, 2004) and tried to capture the perception of HRM from the perspective of employees and was therefore focused on experiences and subjective opinions, rather than on intended HRM strategies and practices from the view of HRM managers. We brought together two separate bodies of literature (HRM - trust and trust - cohesion) and demonstrated that trust is the important element of the link between the experienced HRM and team cohesion.

This study placed the observed relations in the context of social exchange theory and confirmed that trust in direct superior plays the crucial role of mediator between the perceived HRM quality among employees and their trust in co-workers. Trust in head coach was found to be also the mediator in the causal relation between perceived HRM quality and team cohesion. Earlier research has shown that HRM has significant impact on beliefs of an individual employee (Sun, Aryee & Law, 2007; Allen, Shore, & Griffeth, 2003), and that the positive HRM practices positively correlate with trust within individuals (Tzafrir, 2005) and their perception of superiors (Alfes et al., 2013). In addition, several studies managed to prove the connection between trust on some elements of cohesive behaviour

on individual (Mayer, Davis, & Schoorman, 1995) and group level (Mach, Dolan, & Tzafrir, 2010). With merging those arguments together, we develop some hypotheses in the triangle HRM quality, trust and cohesion relationship on team level. Our data suggest that trust in superior is indeed the crucial mediator between perceived HRM quality and trust among athletes, and between HRM quality and team cohesion. This new finding is certainly not a surprise and is consistent with predictions made in HRM literature which assumed direct positive influence of HRM on emotions and attitudes (Snape & Redman, 2010; Searle & Skinner, 2011; Alfes et al., 2013) and indirect effect on behaviour (Tzafrir, 2005; Allen, Shore, & Griffeth, 2003). This is also in line with the theory of social exchange, which suggests that where members of an organization feel that the decision-makers within organization try to invest in them through the positive HRM experience, they are more willing to trust in their superiors. However, the only positive perception of HRM is not enough to directly influence the trust among co-working athletes on team level. The HRM quality effect is perceived through the construct of trust in direct superior, who implements the HRM practices on day-to-day basis and has influence on the rise of trust among co-workers and their cohesive behaviour.

In the context of social exchange theory, this research provided proof of its usefulness within non-profit sport clubs. Study results also indicate that social interaction between two subjects within organization does not have only reciprocal effects, but externalities on other relations as well. This is especially important within organizational units where, like in sport team, it is difficult to distinguish individual effects on team task and where unit members share responsibility for success. However, the theory does not give satisfying explanation about why the perception of superior behaviour from HRM aspect does not have direct influence on the perception of co-workers behaviour from the aspect of cohesion.

5.2 Practical implications

Several practical implications arise from this study. Although generally we can say that positive perception of HRM stimulates trust within teams, it is important to emphasize that the HRM quality effect on particular trust relationship differentiates regarding the HRM role that certain trustee has from the trustor's perspective. Therefore, the HRM - trust mechanism works different in each trust relationship. Since the head coach usually has more power than athletes do in determination of HRM nature, the effect on athletes' trust in head coach is bigger than the impact on trust among athletes. Obviously, in the context of sport teams, head coaches have important role in the process of HRM implementation, which is in line with claims of Bowen and Ostroff (2004). While positive experience of HRM by itself is insufficient to generate high degree of trust among athletes or high level of cohesiveness, athletes' trust in head coach helps to transfer its effects. This findings support the argument that head coach in competitive sport teams is much more than just direct superior, who only implements the HRM strategies and policies. Head coach has indeed a lot of manoeuvring space for shaping the nature of HRM, and has therefore the power to transfer the HRM effect on trustworthiness among athletes and

consequently on cohesive team-work. This is in line with some claims (e.g. Torrington, Hall & Taylor 2005) that those employees, who do not trust in their superiors, will make ineffectual the work of any HRM system.

Head coaches should be aware that quality of HRM practices that athletes experience on day-to-day basis appears to be a crucial factor for earning trust of their athletes. Moreover, head coaches should be aware of the importance of trust they enjoy among athletes within the team, because the latter is a generator of trust among athletes and team cohesion, which have been repeatedly proved as the stimulators of team success (Mach, Dolan & Tzafrir, 2010; Dirks, 1999). This is especially important for organizations where co-workers are in competitive-cooperative relations as is the case in basketball teams. Indeed, each athlete in a basketball team has to cooperate with his teammates, but in order to be in the position to participate in the game, athlete has to earn the minutes on the basketball court. Therefore, he has to prove that he is better than other teammates, if he wants to play more. In this process the head coach has the power to decide, who is going to get more playing minutes. If this decision is perceived as unfair, athletes will have less trust in their teammates and the vicious circle of distrust and lack of cohesion begins. Thus, from the aspect of within-team battle among athletes, trust in the head coach is a crucial characteristic of a successful team.

5.3 Limitations and suggestions

The use of subjective data, which were collected on individuals' self-reports is usually perceived as a limitation, as it raises concerns about common method bias. However, in particular case of trust, cohesion and perception of HRM quality measurement we couldn't avoid that, and, moreover, the analysis eliminated the common method bias problem in particular study. On the other hand, many authors (e.g. Wright & Boswell, 2002; Alves et al., 2013) argued that self-report measures are actually the most valid measurement method for examination of HRM effects, since the intended HRM is usually different from implemented, and the individuals are best placed to report their own perception of HRM quality, their degree of trust and the perception of team cohesion. Secondly, our data were collected at only one point of time, which might limit the conclusions regarding the causal order in examined relationships. Thus, it might, for example, be also possible that athletes' trust in head coach leads to better perception of HRM. Finally, data were collected only among basketball clubs in four countries with similar historical background, which may hamper the generalization of results.

In line with limitations stated above, we recommend further research on sport clubs over longer period of time, in different environments and from different sport branches. It would also be recommendable for future research to identify and assess which are other factors (beside perceived HRM quality) of trust among athletes and athletes' trust in head coach, and how does the strength of trust relationships differ among various groups of athletes (according to their age, playing time etc.). It would be certainly recommendable to examine, whether findings from this study are also valid for women sport teams.

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APPENDIX 1

Means, SD and correlation coefficients between perceived quality of HRM phases (N = 277)

Variables	M	SD	1	2	3	4	5	6	7	8	9
1. Scouting	4.7	1.62									
2. Negotiating	4.2	1.72	.56								
3. Selection	5.0	1.32	.57	.59							
4. Trainings	5.4	1.43	.54	.42	.58						
5. Game strategy	5.4	1.34	.54	.45	.56	.79					
6. Game leadership	5.4	1.42	.45	.32	.50	.78	.78				
7. Evaluation of performance	5.0	1.29	.40	.38	.54	.57	.64	.66			
8. Financial compensation	3.3	1.89	.32	.54	.39	.28	.31	.26	.34		
9. Non-financial compensation	3.8	1.86	.25	.43	.30	.28	.34	.29	.32	.52	
10. Way of leaving the club	4.0	1.71	.19	.34	.20	.10*	.18	.10*	.16	.37	.37

All correlation coefficients are significant at the level of .01 except *

APPENDIX 2

Means, SD, correlation coefficients and AVE for subsample A (N = 277)

Variables	**M**	**SD**	**1**	**2**	**3**	**4**	**5**
1. Perceived HRM quality	4.44	1.12	AVE = *.64*				
2. Trust among athletes	5.56	0.87	.43**	AVE = *.82*			
3. Trust in head coach	5.79	1.08	.51**	.51**	AVE = *.81*		
4. Perceived cohesiveness	4.85	1.03	.29**	.44**	.43**	AVE = *.71*	
5. Seasons in team	4.40	4.52	-.02	.06	.10	.12	
6. Seasons with current head coach	2.20	2.43	.21	.06	.15*	.12	.37**

** P < .01

* P < .05

APPENDIX 3

Means, SD, correlation coefficients and AVE for subsample B (N = 282)

Variables	M	SD	1	2	3	4	5
1. Perceived HRM quality	4.43	1.27	AVE = *.55*				
2. Trust among athletes	5.52	0.81	.41**	AVE = *.80*			
3. Trust in head coach	5.77	1.03	.45**	.50**	AVE = *.82*		
4. Perceived cohesiveness	4.66	1.01	.18**	.37**	.36**	AVE = *.62*	
5. Seasons in team	5.04	4.44	-.19**	.08	.09	.01	
6. Seasons with current head coach	2.66	2.34	-.02	-.04	.00	-.10	.50**

** P < .01

* P < .05

E/B/R

POVZETKI V SLOVENSKEM JEZIKU

DEACCESSIONING AND AGENCY COSTS OF FREE CASH FLOW IN MANAGER'S HANDS: A FORMAL MODEL

ODSVOJITEV MUZEJSKI DEL IN AGENTSKI STROŠKI PROSTEGA DENARNEGA TOKA V ROKAH MANAGERJEV: FORMALNI MODEL

ANDREJ SRAKAR

POVZETEK: *Na problem agentskih stroškov prostega denarnega toka v rokah managerjev sta prva opozorila Easterbrook in Jensen. V prispevku predstavljamo enega prvih poskusov formalnega, matematičnega modeliranja tega problema v luči podobne situacije, s katero se srečujejo managerji v muzejih pri odločanju o prodaji oz. odsvojitvi muzejskih del v njihovih zbirkah. V prispevku pokažemo, da odsvojitev muzejskih del vedno vodi do različnih oblik agentskih stroškov za muzej. Ugotovitev lahko neposredno prenesemo na primer katerekoli druge neprofitne organizacije in njenega premoženja. Izziv nadaljnjemu raziskovanju pa je dokaz splošne trditve tudi v primeru zasebnih, k dobičku usmerjenih podjetij.*

Ključne besede: *odsvojitev muzejskih del, agentski stroški, prosti denarni tok, neprofitne organizacije*

ANALYSIS OF THE EFFECTS OF INTRODUCTION OF AN ADDITIONAL CARBON TAX ON THE SLOVENIAN ECONOMY CONSIDERING DIFFERENT FORMS OF RECYCLING

ANALIZA VPLIVA UVEDBE DODATNEGA DAVKA NA CO2 NA SLOVENSKO GOSPODARSTVO OB UPOŠTEVANJU RAZLIČNIH OBLIK RECIKLIRANJA

ALEKSANDAR KEŠELJEVIĆ, MATJAŽ KOMAN

POVZETEK: *Članek opisuje nekaj okoljskih in ekonomskih posledic zaradi dodatnega davek na CO2 v vrednosti 15 EUR / t CO2 v Sloveniji v obdobju 2012-2030, da bi ugotoviti, ali je*

prinesla dvojno dividendo. Avtorja analizirata (z uporabo E3ME modela) različne oblike recikliranja prihodkov z zmanjšanjem prispevkov za socialno varnost, bodisi delodajalcev ali zaposlenih ali z zmanjšanjem javnofinančnega primanjkljaja, da bi opredelili optimalne fiskalne instrumente za izboljšanje okoljske in ekonomske blaginje (dvojne dividende). Avtorja v članku, prikazanem v luči takšne politike, trdita, da ima zmanjšanje prispevka za socialno varnost delavca ugodnejši učinek zmanjšanje delodajalčevega prispevka za socialno varnost.

Ključne besede: *zeleni davek, reforma okoljskih dajatev, dvojna dividenda, davek na CO2, recikliranje, E3ME model*

THE RELEVANCE OF EMPLOYEE-RELATED RATIOS FOR EARLY DETECTION OF CORPORATE CRISES

USTREZNOST ZAPOSLENEGA – POVEZANO RAZMERJE ZA ZGODNJE ODKRIVANJE KORPORATIVNE KRIZE

MARIO SITUM

POVZETEK: *Namen študije je bil analizirati, ali imajo razmerja povezana z zaposlenimi, ki izhajajo iz računovodskih izkazov, predpostavljeno napovedno moč za zgodnje odkrivanje korporativne krize in stečajev. Na osnovi pregledane literature, je mogoče videti, da še ni bilo veliko pozornosti usmerjene v to nalogo, kar kaže, da je nadaljnja raziskava utemeljena. Za empirične raziskovalne namene je bila uporabljena baza podatkov o avstrijskih podjetij v letih 2003-2005, da bi razvili multivariatne linearne diskriminantne funkcije za razvrščanje podjetij v dve skupini; tista, ki so v stečaju in tista, ki niso in za odkrivanje prispevka razmerja povezanega z zaposlenimi pri pojasnjevanju zakaj podjetja propadajo. Več razmerij iz predhodne raziskave je bili uporabljenih pri možnih napovedih. Poleg tega so bila analizirana tudi druga ločena razmerja, vključno s podatkom o povezavi z zaposlenimi. Rezultati študije kažejo, da medtem, ko razmerja zaposlenih ne morejo prispevati k izboljšanju učinkovitosti razvrščanja napovedovalnih modelov, znaki teh razmerij znotraj diskriminantnih funkcij pokažejo pričakovane rezultate. Učinkovita raba zaposlenih se zdi, da ima pomembno vlogo pri zmanjševanju verjetnosti stečaja. Poleg tega sta bili odkriti dve razmerji na zaposlenega, ki se lahko uporabita kot približka za velikost podjetja. To ni bilo opredeljeno v prejšnjih študijah za ta dejavnik.*

Kjučne besede: *predvidevanje stečaja, indikatorji krize, diskriminantna analiza*

SCIENCE-INDUSTRY COOPERATION IN SLOVENIA: DETERMINANTS OF SUCCESS

SODELOVANJE MED ZNANOSTJO IN INDUSTRIJO V SLOVENIJI: DEJAVNIKI USPEHA

MAJA BUČAR, MATIJA ROJEC

POVZETEK: *Članek analizira ovire sodelovanja med znanostjo in industrijo v Sloveniji s tremi podrobnimi študijami primerov. Vsak primer obravnava obe strani, industrijo (podjetja) in znanost (univerzo/raziskovalni inštitut). Študije primerov potrjujejo domnevo, da je odsotnost podjetij z lastno R & R dejavnostjo glavni strukturni primanjkljaj za več sodelovanja med znanostjo in industrijo. Krepitev oddelkov podjetij z lastnimi oddelki in zaposlenimi v R & R ter grozdenja podjetij okoli najbolj propulzivnih, je predpogoj za boljše sodelovanje znanosti in industrije. Uspešno sodelovanje med znanostjo in industrijo se lahko razvija le postopoma, največkrat na osnovi preteklih osebnih stikov med glavnimi akterji na obeh straneh. Študije primerov ne kažejo vpliva posredniških institucij za sodelovanje med znanostjo in industrijo.*

Ključne besede: *sodelovanje znanosti in industrije, Slovenija, študija primera*

THE EFFECT OF HRM QUALITY ON TRUST AND TEAM COHESION

UČINEK KAKOVOSTI HRM NA ZAUPANJU IN KOHEZIJO EKIPE

IGOR IVAŠKOVIĆ

POVZETEK: *Namen raziskave je bil preučiti odnose med zaznano kakovostjo HRM, zaupanjem med športniki, njihovo zaupanje glavnemu trenerju in zaznano ekipno kohezijo v okviru košarkarskih ekip iz štirih državah jugovzhodne Evrope. Spremenjena različica HRM lestvice kakovosti je bila preverjena na prvem vzorcu 277 športnikov iz 36 klubov.*

Nato pa je bil model razvit s teoretičnimi osnovami teorije družbene menjave in preizkušen na podatkih drugega vzorca 282 športnikov iz 37 košarkarskih klubov. Rezultati kažejo, da zaznana kakovost človeških virov neposredno vpliva na stopnjo zaupanja športnikov v trenerja. Vendar to nima neposrednega vpliva na zaupanje med športniki, niti na ekipno kohezijo. Vendar zaupanje športnikov v glavnega trenerja posreduje posredni učinek med percepcijo HRM in zaznano kohezijo v ekipi, in predvaja tudi posredniško vlogo pri zaznanem HRM - zaupanje med športniki.

Ključne besede: *košarka, ekipa, HRM, kohezija, zaupanje*