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## **Building the innovation culture or increasing financial investments in hi tech companies – searching for the right balance**

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**Abstract:** The article addresses two crucial mechanisms influencing innovation and economic results of hi tech companies: innovation culture development versus innovation financial investments, i.e., investments into R&D capacities and concrete research and innovation projects in Slovenia. The results show that innovation culture development (non-financial factors) and innovation financial investments (financial factors) have comparable influence on innovation results. At the same time, raising innovation financial investments does not grant an improvement of the innovation culture. Therefore, it is crucial to improve the company's innovation culture rather than to increase financial investments. The main reason is also related to obstacles, which are significantly smaller when managing the innovation culture. The article also provides guidance for better management of these two groups of influential factors and, consequently, the increase of innovation and business results.

**Keywords:** hi tech; high and medium-high technology companies; financial innovation factors; non-financial innovation factors; innovation and economic results.

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Borut Likar is a Full Professor and Research Counsellor at the University of Primorska and the Director of the Institute for Innovation and Technology. His work encompasses management of creativity, R&D, technology, and innovation processes in the field of educational system and industry. He is an innovator, initiator and the head of several successful R&D – national and EU projects as well as the author of countless patents, models and copyright works, which many proved to be extremely marketable, in total approximately 700 bibliographic units. Among numerous lectures, he has given talks at the UN headquarters in Geneva and at the European Parliament in Brussels and were met with a particularly wide response.

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## **1 Introduction**

In the 2012/2013 period, Slovenia was placed 56th among 144 countries on the scale of competitiveness (measured by the so-called GCI – global competitiveness index); only one place higher than the previous year (World Economic Forum, 2012). The assessment of the innovation component places Slovenia in solid 32nd place, yet numerous factors show a certain lag in development. A more thorough overview of the innovation

component indicates Slovenia placed only as follows: companies resources for R&R 47th place, cooperation of universities and the industry in R&R 49th place, state procurement of modern technological products 106th place and availability of scientists and engineers 84th place (World Economic Forum, 2012). Innovativeness at the European level is presented using the Innovation Union Scoreboard, which places Slovenia in 12th place regarding the innovation potential (measured by the so-called summary innovation index – SII) among the EU-27. That ranks Slovenia below the EU-27 average and into to the group of innovation followers (European Commission, 2013). Likar et al. (2011) are drawing attention to the SII indicator as not being a relevant enough indicator of innovativeness, since it predominately measures the innovation inputs whilst only measuring the results to a smaller extent. Considering all of the above, the actual situation as regards innovativeness in Slovenia is even more critical. Especially in the challenging high and medium-high technology sector, where tangible innovation and economic results are more difficult to achieve than in the case of low and medium-low technology companies (Likar et al., 2011).

As a starting point in evaluating the reasons for Slovenian below-average innovation and economic results, we can cite the interesting findings of researchers concerning the amount of innovation financial investments. Heidenreich (2009) finds the innovation expenditures of EU high technology companies are reaching 7.1% and those of medium-high technology companies 5.1% of total turnover. At the same time, Likar et al. (2011) note that innovative high and medium-high technology companies in Slovenia spend nearly 7% of their total turnover for innovation. Based on the above data, it can be deduced that Slovenian high and medium-high technology companies' dedicate financial investments for innovation, comparable to EU-27 average, but at the same time, they are clearly below EU-27 average as regards achieved innovation and economic results. Proposals for the development and rise of innovation of high tech companies were made in the resolution on the research and innovation strategy of Slovenia for the period 2011–2020, which, in its analysis, paints a fairly realistic picture of the current state of research and innovation in Slovenia, while suggestions for improvements indicate insufficient ambition for change and progress. Obviously, proper financial investments into innovation are not a sufficient lever for achieving optimum innovation and economic results. In the current times of financial crisis and the troublesome financial sector, proper management of the non-financial innovation factors may also present a realistic opportunity for improvements. An accurate estimation of the innovation financial and non-financial factors, mainly influencing innovation and economic results is possible, based on scientific analysis. Unfortunately, the majority of innovation studies are not aiming at a holistic analysis of innovation factors, but rather focused on studying specific factors and fragments of the invention-innovation process (Likar et al., 2011; Wang and Ahmed, 2004; Bresciani, 2010). Therefore, in the paper, we will be focussed on comprehensively analysing both the financial and non-financial innovation factors: the factors influencing innovation and economic results, and the amount of obstacles concerning the optimisation of identified factors. Based on the thorough analysis, we will furthermore provide concrete guidelines, where innovation factors represent the main opportunity for improvements within the companies and also other factors, which due to major identified obstacles require additional national policy maker's support.

## **2 Structure of paper**

In the introduction of the paper, we present Slovenia's state of competitiveness and innovativeness in the international environment. Then we present the empirical research; firstly, we indicate the research objectives and hypotheses, and then present the methods of data acquisition and data processing. Furthermore, we present the research results: first financial and non-financial innovation factors, which significantly influence the innovation results, then the relations between financial and non-financial innovation factors, followed by key opportunities (least obstacles) for companies in improving their innovation management. In the discussion and conclusion, we support the relevance of the essential research results in the light of the findings of other researchers, thus exposing the key opportunities for companies and further measures to be made by national innovation policy makers.

## **3 Research methodology**

The aim of the research is to identify the innovation factors, influencing innovation results, and the main obstacles (opportunities) for their improvement in Slovenian high and medium-high technology companies.

Regarding the contents, we divided the research into two parts: the first part is focused on the study of innovation factors in companies, namely their influence on innovation results and the relations between the financial and non-financial innovation factors. The second part is aimed at assessing the amount of financial and non-financial obstacles for companies, hence implying key company opportunities in improving their innovation management and areas where additional national policy maker systemic measures are required.

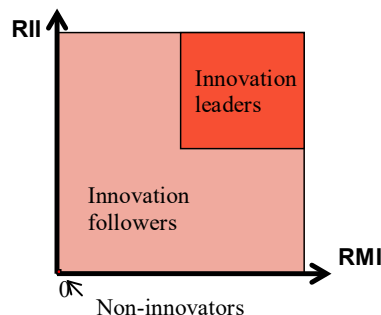
In the first part, the research was guided by Hypothesis 1: company's innovation results are influenced in comparable strength by financial and non-financial innovation factors, and Hypothesis 2: financial innovation factors do not significantly influence non-financial innovation factors. The corresponding data was obtained from two main sources. As for financial investments of companies (all high and medium-high technology companies encompasses), data was obtained from the primary database of the Slovenian Statistical Office (reference period: 2004–2006). Aside from innovation results, economic results were also included, representing the commercial end-result of innovation. The link between innovation and economic results was tested with Hypothesis 3: the innovation results significantly and positively influence company's economic results. The financial investments were defined based on the Oslo Manual Guidelines for collecting and interpreting innovation data (Mortensen and Bloch, 2005): intramural R&D expenditure, extramural R&D expenditure, expenditure in market introduction of innovations, expenditure in training, expenditure in acquisition of other external knowledge and expenditure in acquisition of machinery, equipment and software (all measured as a share of total turnover). Complementary to financial, researchers have also identified the need for a more in-depth understanding of the non-financial innovation factors (Smith, 2005). Consequently, we undertook a thorough literature review (over 100 units) following potentially relevant non-financial innovation factors related to innovation culture and climate: vision and strategic aspects of encouragement regarding

innovativeness, the role of support coming from managers, organisational culture and climate, innovation cooperation within a company and with the environment, the system of material and non-material rewards, the role of the protection of intellectual property, training and the development of staff competences, the identification of opportunities and idea generation. We performed our own web survey (reference year 2008), encompassing the non-financial innovation factors (seven-grade scale) and mailed it to all 182 high and medium-high technology companies in Slovenia. The response of the companies was 11.5%.

The second part of the research focuses on key innovation obstacles (hence, also main opportunities), faced by the companies. It is based on data from our own research regarding the condition of high tech entrepreneurship in Slovenia. Research in this part was guided by Hypothesis 4: financial innovation obstacles, faced by companies are significantly higher than non-financial innovation obstacles. The corresponding data sample included high and medium-high tech companies (non-financial investments) and a sample of companies, performing information and communication activities, processing activities and professional, scientific and technical activities (obstacles for business). Data was obtained by means of a web survey with 30 questions (reference year 2008), measured on a five-point scale. The subset of questions included the assessment of obstacles regarding possible optimisation of financial and non-financial innovation factors. Hence, the innovation factors representing company's main opportunities for improvements were emphasised and those where more national support would be desirable highlighted. The response of the 182 target companies was slightly over 33%.

The statistical analysis in the first part was conducted with a complementary use of factor analysis, regression analysis, classification into groups and descriptive statistics. Concerning the assessment of company's innovativeness, we have used established indicators of innovation results (RII – turnover from innovations as a share of total turnover, RMI – turnover from innovations new to the market as a share of total turnover from innovations). These two indicators, unlike other commonly used indicators (e.g., number of patents, number of introduced new innovations, etc.), not only measure the potential effects, but also the actual effects of the commercialisation of innovations. On the basis of previously tested methodology (Fatur and Likar, 2010), three groups of companies were defined (Figure 1); we list them by increasing degree of innovativeness: non-innovative companies (RII = RMI = 0), the innovation followers (RII or RMI under median value) and innovation leaders (RII and RMI over median value).

**Figure 1** Distribution of companies into innovation groups (see online version for colours)



In the second part of the research, slightly different methods of data analysis were applied. Firstly, we calculated the descriptive statistics and afterwards, by performing statistical tests (Wilcoxon signed ranks test, paired samples t-test), we compared the extent of financial and non-financial obstacles for better management of innovation. Based on the analysis, main opportunities for the optimisation of innovation management in companies were identified. Additionally, it was indicated which areas (factors) of innovation management should be supported by policy makers' activities in order to moderate the obstacles.

## **4 Research findings**

This chapter presents the findings of the research regarding the identified innovation factors that affect the innovation results and key business opportunities in the companies, as well as the role of governmental actions.

### *4.1 Which factors can contribute to an increase in a company's innovation results?*

The analysis of the manufacturing sector in Slovenia demonstrates the comparability with the EU-27 average concerning the share of the innovation active manufacturing companies. However, we need to be aware of the fact that this is an indicator measuring primarily inputs rather than results achieved in innovation. According to the latter, Slovenia is clearly behind the EU-27 group average; in terms of the share of turnover generated by innovation (RII), Slovenia achieves only 2/3 of the EU-27 average value.

A more detailed analysis of the branches or branch groups shows a similar situation. In the high and medium-high tech Slovenian companies, the innovation leaders group accounts for only 10% of companies. Meanwhile, half of the companies are placed among the innovation followers group whilst a third are categorised as non-innovative. Hence, innovation results are not much better than what the low and medium-low tech manufacturing companies achieve. It is therefore clear, that innovation of high and medium-high tech companies in Slovenia is low. As noted in the introduction, in spite of the high financial investments, these companies lack innovation results, thus non-financial investments seem to also be of great importance. Therefore, we are going to test the following hypothesis:

Hypothesis 1 Company's innovation results are influenced in comparable strength by financial and non-financial innovation factors.

The analysis of the hypothesis encompasses the complete manufacturing sector and not solely high and medium-high technology companies. The reason is, a relatively small sample size, relying only on high and medium-high technology companies, failed to show any significantly influential innovation factors.

#### *4.1.1 Financial innovation factors*

In this subchapter, we will analyse the first part of Hypothesis 1, which is based on a regression analysis and relates to the impact of the financial innovation factors on the innovation results. Interestingly, the results of the regression analysis (Table 1) show that

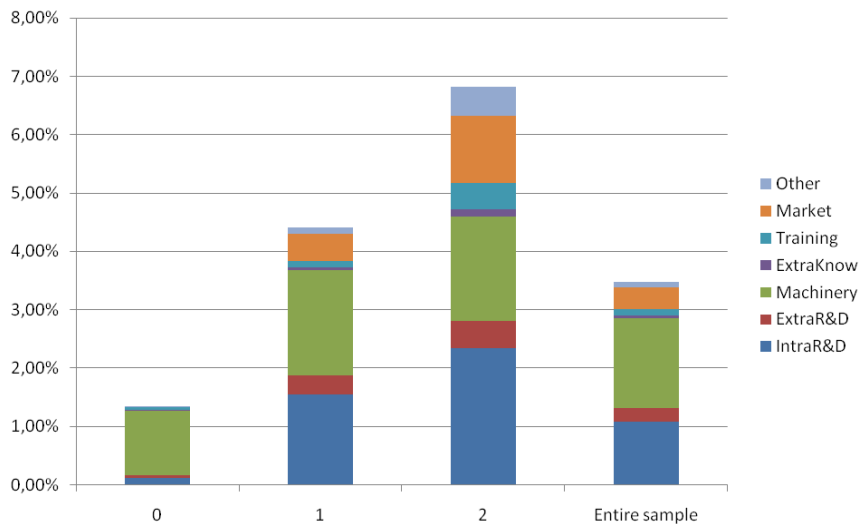
an increasing total of financial innovation investments do not bring a proportional increase in total financial innovation results. Namely, we have found that the level of total innovation investment (in terms of sales revenue) does not have a statistically significant impact on the share of achieved total innovation turnover (RII). However, the financial innovation investments are necessary for the achievement of market novelty financial impacts. This may be deduced based on the significant and positive influence of the rate of total innovation investments on RMI (stand.  $\beta = 0.24$ ).

**Table 1** The results of the regression analysis on the sample of manufacturing companies (the influence of financial investments on innovation results)

<i>Financial innovation factor (indep. variable)</i>	<i>Regression estimates</i>	<i>Innovation output (dependent variable)</i>	
		<i>RII</i>	<i>RMI</i>
F0 Total innovation expenditure as a share of total turnover	Standardised $\beta$	0.002	0.239*
	Sig.	0.987	0.088
	R square	0.000	0.057
	N	86	86

Note: The asterisk indicates statistical significance (two-tailed test) at  $\alpha = 0.1$ .

**Figure 2** Analysis on population of high- and medium-high tech companies: financial innovation investments according to the innovation groups (see online version for colours)



The importance of financial innovation factors in the manufacturing sector is largely supported by the innovation patterns in high and medium-high technology companies; the innovation leaders manage these factors differently than less innovative companies. The analysis shows that the leading innovation hi-tech companies invest several times more financial assets in innovation than the followers and non-innovators. Figure 2 demonstrates that leading innovation companies (2) invest almost 7% of turnover into the innovation process, whereas medium innovative companies invest around 4.5% (1) and non-innovative companies (0) little over 1%. Aside from high total financial investments, the innovation leaders differ from the other two groups in respect to the optimisation of

the innovation investment structure. The optimisation of the structure is an additional challenge beside the rate of investments; here, it is extremely important that the most innovative invest relatively little in machinery and equipment, whilst increasing innovativeness investments in training and marketing. Meanwhile, the non-innovators allocate 93% of all costs for the acquisition of machines and equipment, followers 40% and leaders only 25%. The investments into (internal and external) RR within the non-innovators add up to barely 8%, in the case of followers and innovation leaders to approximately 40% of the total innovation investments. That also represents a precondition for the rise of productivity, since the innovation leaders are able to generate EUR 7.7 of turnover from EUR 1 of investment in innovation, 4.1 times more than the innovation followers.

#### *4.1.2 Non-financial innovation factors*

In this subchapter, we will analyse the second part of Hypothesis 1, which is based on regression analysis and refers to the impact of non-financial innovation factors on innovation results. As non-financial innovation factors we have defined those related to the level of organisation and management of the innovation process (vision and strategic aspects of encouragement regarding innovativeness, the role of support coming from managers, organisational culture and climate, innovation co-operation within a company and with the environment, the material and non-material reward system, the role of intellectual property protection, training and development of staff competences, the identification of opportunities and idea generation).

We found that several non-financial innovation factors significantly influence the innovation results. Table 2 shows how a company can improve the share of innovation turnover in total turnover (RII). Regarding the effect on RII, the role of intellectual property (stand.  $\beta = 0.29$ ) and the assurance of vision and strategic innovation aspects stand out as the significant factors (stand.  $\beta = 0.25$ ). In order for a company to be an innovation leader, it also has to be successful when it comes to the commercialisation of market novelties (and not only innovations that are new for the company itself). When it comes to the turnover increase regarding market novelties in total innovation turnover (RMI) the two most significant effects are those regarding the role of intellectual property protection (stand.  $\beta = 0.28$ ) and the role regarding the assurance of the organisational culture and climate that is favourable to innovation (stand.  $\beta = 0.28$ ).

A somewhat smaller, but still significant influence on market novelty turnover share was identified for the role of the innovation cooperation within the company and the environment (stand.  $\beta = 0.19$ ). We can summarise the results of the regression analysis according to non-financial factors by stating the following: firstly, it is necessary to innovate the management; suitable strategic conditions have to be ensured, so that the company can become innovative. Secondly, the strategic goals have to materialise throughout the entire company – a more suitable culture and climate has to be formed, ensure cooperation within the company and the environment and form proper intellectual property protection.

The findings about the influential non-financial innovation factors in the whole manufacturing sector are largely confirmed by the innovation patterns of high and medium-high technology companies. Figure 3 shows what separates the less successful



companies from the innovation leaders when it comes to the management of non-financial factors.

**Table 2** The results of the regression analysis on a sample of manufacturing companies (the influence of non-financial investments on the innovation results)

<i>Innovation output (dep. var.)</i>	<i>Reg. estimates</i>	<i>Non-financial innovation factor (independent variable)</i>			
		<i>F1 Training and development of staff competencies</i>	<i>F2 Opportunity identification and idea generation</i>	<i>F3 Innovation collaboration inside the company and with company's environment</i>	<i>F4 Organisational culture and climate</i>
RII	Stand. $\beta$	0.060	0.083	0.106	0.153
	Sig.	0.675	0.468	0.356	0.180
	R square	0.004	0.007	0.011	0.024
	N	77	77	77	77
RMI	Stand. $\beta$	0.112	0.050	0.190*	0.248*
	Sig.	0.302	0.702	0.079	0.021
	R square	0.013	0.003	0.036	0.062
	N	85	85	85	85
<i>Innovation output (dep. var.)</i>	<i>Reg. estimates</i>	<i>Non-financial innovation factor (independent variable)</i>			
		<i>F5 System of material and intangible rewards</i>	<i>F6 Vision and strategic aspects of encouraging innovation</i>	<i>F7 The role of intellectual property protection</i>	<i>F8 The role of managers' support</i>
RII	Stand. $\beta$	0.070	0.250*	0.294*	-0.027
	Sig.	0.542	0.034	0.021	0.815
	R square	0.005	0.062	0.086	0.001
	N	77	71	60	77
RMI	Stand. $\beta$	0.065	-0.011	0.279*	0.200*
	Sig.	0.554	0.923	0.058	0.099
	R square	0.004	0.000	0.078	0.040
	N	85	79	68	85

Note: The asterisk\* sign indicates statistical significance (two-tailed test) at  $\alpha = 0.1$ .

The non-innovative high and medium-high technology companies, in comparison to followers, do not give enough attention to the identification of opportunities and generation of the inventions (5.0 vs. 3.9). Interestingly, the non-innovators pay somewhat more attention (than followers) to the material and non-material reward system (3.7 vs. 4.0), the role of IP (4.2 vs. 3.1) and the support of managers (4.2 vs. 5.6). They are also more dependent on the innovation cooperation (a less surprising finding regarding the last factor) (4.1 vs. 4.4). Despite the formal support of managers and the established formal material and non-material reward system, obviously, the non-innovators realise that the financial effects, particularly of smaller innovations, are negligible (since in the case of non-innovators the following fact applies: RII = 0, RMI = 0!).

**Figure 3** Analysis on sample of high- and medium-high tech companies: non-financial innovation investments by innovation groups (see online version for colours)



If we move from the innovation followers to the innovation leaders, we can identify that the innovation followers need significant improvements to achieve innovation leadership, especially regarding the three process innovation factors: innovation cooperation within the company and the environment (5.5 vs. 4.1), the protection of IP (6.0 vs. 3.1) and the assurance of material and non-material reward systems (5.0 vs. 3.7).

#### 4.1.3 Synthesis of the findings

Based on the analysis of financial (Table 1) and non-financial innovation factors (Table 2), we can deduce that both financial and non-financial innovation factors significantly affect a company's innovation results. At the same time, both financial and non-financial innovation factors have a comparable, weak influence on innovation results (stand.  $\beta \leq 0.30$ ). Therefore, Hypothesis 1 (company's innovation results are influenced in comparable strength by financial and nonfinancial innovation factors) can be confirmed.

As regards the main financial innovation factors, both non-innovators and innovation followers (compared to leaders) need to raise their financial innovation expenditures. As regards the non-financial innovation factors, non-innovative companies (compared to followers) primarily lack systematic approaches needed to identify innovation opportunities. For the transition from follower to innovation leader, the increase of innovation cooperation (not only within the company but also with the environment) and the protection of intellectual property prove to be very important. At the same time, it is essential for the high and medium-high tech companies to increase financial innovation investments in order to achieve leadership position (this applies for the non-innovative companies, as well as for the followers). The optimisation of the expenditure structure (particularly increasing R&D, training and marketing expenditure) is an additional challenge for the non-innovators and followers.

#### 4.2 *The relationships between financial and non-financial innovation factors*

As already emphasised in the introduction, in spite of the relatively high financial innovation investments, Slovenian companies are not particularly productive in generating innovation results. Hence, it may be assumed the financial innovation investments do not allow for significant improvements to companies' organisation and management of innovation. Therefore, in addition to the financial factors we assume the complementary role of the non-financial ones.

In order to test such inter-relationships between financial and non-financial innovation factors, the following hypothesis was tested:

Hypothesis 2 Financial innovation factors do not significantly influence non-financial innovation factors.

The results of testing the hypothesis are presented in Table 3. Interestingly, it can be observed that the financial innovation investments do not significantly influence any of the eight proposed non-financial innovation factors.

Consequently, innovation financial and non-financial factors are not related; solely financial innovation investments do not lead to improved non-financial investments – the innovation process. Holistic management of innovation therefore calls for attention to both, financial and non-financial innovation investments.

**Table 3** The results of the regression analysis on a sample of manufacturing companies (the influence of financial investments on the non-financial investments)

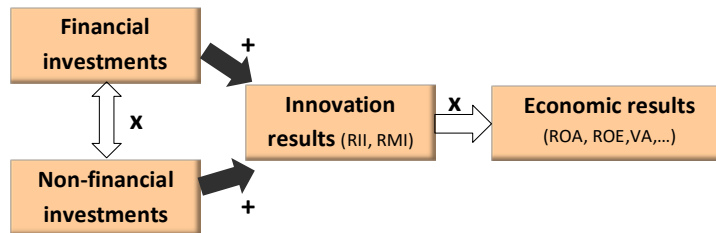
		<i>Non-financial innovation factor (dependent variable)</i>			
<i>Financial inno. factor (indep. variable)</i>	<i>Reg. estimates</i>	<i>F1 Training and development of staff competencies</i>	<i>F2 Opportunity identification and idea generation</i>	<i>F3 Innovation collaboration inside the company and with company's environment</i>	<i>F4 Organisational culture and climate</i>
F0 Total innovation expenditure as a share of total turnover	$\beta$	-0.025	0.070	0.120	-0.070
	Sig.	0.828	0.545	0.294	0.540
	R square	0.001	0.005	0.015	0.005
	N	78	78	78	78
		<i>Non-financial innovation factor (dependent variable)</i>			
<i>Financial inno. factor (indep. variable)</i>	<i>Reg. estimates</i>	<i>F5 System of material and intangible rewards</i>	<i>F6 Vision and strategic aspects of encouraging innovation</i>	<i>F7 The role of intellectual property protection</i>	<i>F8 The role of managers' support</i>
F0 Total innovation expenditure as a share of total turnover	$\beta$	-0.075	0.131	-0.139	-0.011
	Sig.	0.514	0.271	0.285	0.921
	R square	0.006	0.017	0.019	0.000
	N	78	72	61	78

Note: No statistically significant influences (two-tailed test) at 0.1 level were identified.

#### 4.2.1 Synthesis of the findings

Based on the findings (Table 3), we clearly demonstrated that an increase in innovation financial investments does not contribute to an improvement in the non-financial innovation factors.

**Figure 4** Innovation factors significantly influence innovation results (see online version for colours)



Notes: Two groups of innovation factors are significantly influential: financial (investments into R&D capacities and concrete research and innovation projects) and nonfinancial (innovation culture); in both cases positive and comparable significant influences on innovation were identified. Interestingly, no significant influence of innovation results on economic results was identified.

Hence, Hypothesis 2 (financial innovation factors do not significantly influence non-financial innovation factors) can clearly be confirmed. Only a holistic management of both important groups of factors; the innovation financial (height and structure of innovation expenditure) and non-financial investments (internal organisation and management) contributes to positive innovation results (Figure 4).

#### 4.3 The role of innovation results for improving company's economic results

It is widely assumed that innovation results lead to an improvement of economic results, because the product of innovative activities makes a company more competitive and the process of innovation transforms a company's internal capabilities (Neely and Hii, 1998). Yet the results from actual research are difficult to generalise, particularly as authors have focused on different types of innovation and used different measures of performance (Crossan and Apaydin, 2010).

To evaluate the relationship between innovation and economic performance, the following hypothesis is going to be tested:

**Hypothesis 3** The innovation results significantly and positively influence company's economic results.

The results (Table 4) indicate the improvement of innovation results significantly influences the company's value added per employee. Positive and comparable influence of RII – turnover from innovations as a share of total turnover (stand.  $\beta = 0.106$ ) and RMI – turnover from innovations new to the market as a share of total innovation turnover (stand.  $\beta = 0.121$ ) on economic results was observed. But, surprisingly, neither RII nor RMI had any significant influence on the majority of the other economic result indicators. Only in the case of ROE another significant influence was found – but it was a negative one, due to RMI (stand.  $\beta = -0.110$ ).

**Table 4** The results of the regression analysis on the population of manufacturing companies (the influence of innovation results on economic results)

<i>Innovation results (indep. variable)</i>	<i>Reg. estimates</i>	<i>Business results (dependent variable)</i>				
		<i>Value added per employee 08</i>	<i>Turnover per employee 08</i>	<i>Average growth of turnover per employee 06/08</i>	<i>Return on equity (ROE) 08</i>	<i>Average growth of ROE 06/08</i>
RII	$\beta$	0.106*	0.074	-0.061	-0.067	0.018
	Sig.	0.054	0.183	0.276	0.230	0.748
	R square	0.011	0.005	0.004	0.005	0.000
	N	328	328	323	322	316
RMI	$\beta$	0.121*	0.023	-0.087	-0.110*	0.001
	Sig.	0.028	0.682	0.120	0.048	0.990
	R square	0.015	0.001	0.008	0.012	0.000
	N	328	328	323	322	316

Note: The asterisk\* sign indicates statistical significance (two-tailed test) at  $\alpha = 0.1$ .

Reaping financial rewards from innovation in the high and medium-high technology sector clearly seems to be a challenging task: the high financial investments of innovation leaders do not bring appropriate economic results. While the innovation leaders are achieving value added per employee (EUR 28,000), comparable to followers and non-innovators, the index of the growth of pure incomes within the leaders is the lowest. Its value among the leaders is 8.37%, which is 35% less than non-innovators and 42% less than followers. Similarly, the capital growth index; despite the fact that the innovation leaders are placed at the same level as followers (and 10% above the non-innovators) regarding turnover per employee (EUR 92,283), they record a negative average growth of this indicator. All companies experience a negative growth of ROE in the observed time period, but it is highest within the innovation leading companies (-34.81%), which is four times as much as the decrease experienced by non-innovators and 13 times as much as by innovation followers. At the same time, the ROE is the lowest by innovation leaders – its value (0.03) is 70% less than non-innovators and 50% less than innovation followers.

#### 4.3.1 *Synthesis of the findings*

Based on the findings (Table 4) it is indicated that an improvement of innovation results does not guarantee an improvement of the company's overall economic performance. Hence, Hypothesis 3 (the innovation results significantly and positively influence company's economic results) cannot be confirmed. However, it must be noted, the international practice shows that it may be possible to further improve economic performance. Namely, the current innovation and economic results of Slovenian high and medium-high technology companies are still not up to the EU average – only 50% of the EU-27 countries have innovation leaders currently reaching the average gross value added per employee (some even less innovative than Slovenia). We could look for the main reasons for this weak innovation and poor economic results by identifying the

innovation obstacles faced by companies. The latter are going to be identified in the next part of the article.

#### *4.4 Key opportunities for companies and the role of state measures*

In the previous subchapter, we found that, in order to achieve innovation leadership, it is necessary to appropriately manage both financial and non-financial innovation factors. At the same time, the innovation and economic results of Slovenian companies are clearly below the EU-27 average. Therefore, we will be examining the main obstacles for companies (and also the main opportunities) in this part of the article. Furthermore, areas will be highlighted, where due to large obstacles, national policy holders need to assist the companies with appropriate forms of financial and non-financial support.

Since this part of analysis concerns both companies and policy makers, the financial and non-financial innovation obstacles are defined differently than the innovation factors, i.e., in a wider context. For example, as regards the financial innovation obstacles, not only the shortage of financial resources within a company is considered as a potential obstacle, but also, for example the payment indiscipline as an element mainly concerning policy makers. Likewise for non-financial innovation obstacles, where in addition to company-related obstacles, also the institutional infrastructure is analysed. Hence, a thorough analysis is possible, identifying the main opportunities (small obstacles) for improvements in company's innovation management, while at the same time areas are identified (large obstacles), where additional national policy maker support is needed.

We will examine the financial and non-financial obstacles (and consequently opportunities) for better management of innovation in companies with the following hypothesis:

Hypothesis 4 Financial innovation obstacles, faced by companies are significantly larger than non-financial innovation obstacles.

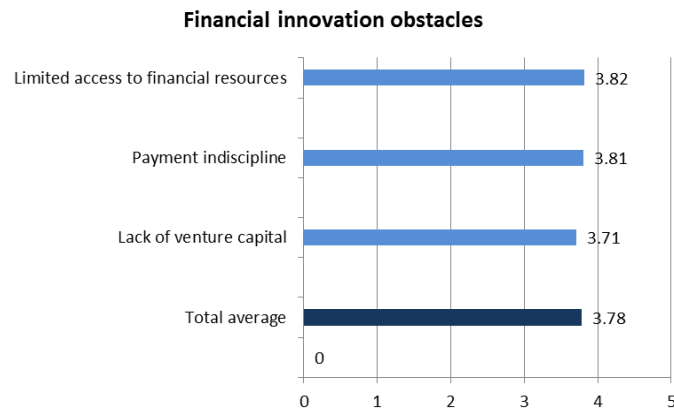
The field of innovation at the national level in Slovenia is partly governed by the Resolution of the research and innovation strategy of Slovenia 2011–2020, by application of which the state proposes to promote the culture of creativity, innovation and entrepreneurship (RS, 2011). Innovativeness represents the engine of economic development in the EU, which is clearly identified as a key element of the EU's development strategy Europe 2020. The titles of the EU and national strategies reflect thinking in the right direction, while at the same time; the real picture of innovativeness in Slovenia indicates insufficiently exploited opportunities at both a national and company level. In the following subchapter, 'financial opportunities for companies and the necessary national measures to raise financial innovation factors', we present the results of testing the hypotheses.

##### *4.4.1 Financial opportunities for companies and the necessary national measures*

In this subchapter, we will, based on the average assessment of innovation obstacles, analyse the first part of Hypothesis 3. The latter refers to the financial innovation obstacles. The results show that the chances for improving financial investments in innovation in Slovenia are very limited (Figure 5). This is reflected by the limited access to financial resources (average score 3.82), which represents the most prominent financial

obstacle. To demonstrate the payment culture in the country, we can also include an assessment of financial indiscipline that is assessed by an average assessment of 3.81. Slightly better assessed is the obstacle of the lack of venture capital, with an average assessment of 3.71. Based on the average ratings of obstacles, we calculated the overall average of assessments which adds up to 3.78.

**Figure 5** Average assessment of financial innovation obstacles (see online version for colours)



The situation is even more critical with regard to the findings of Sukič et al. (2012a). They note that the main source of companies' financing is their own (for 57% of companies), while only 14% of companies use short-term bank loans. The same research shows the underdeveloped banking system, with an average rating of 2.33 (1 – poor, 5 – very good). Also, the financial innovation obstacles indicate that the optimisation of financial innovation factors for companies is very limited and requires effective incentives from the state.

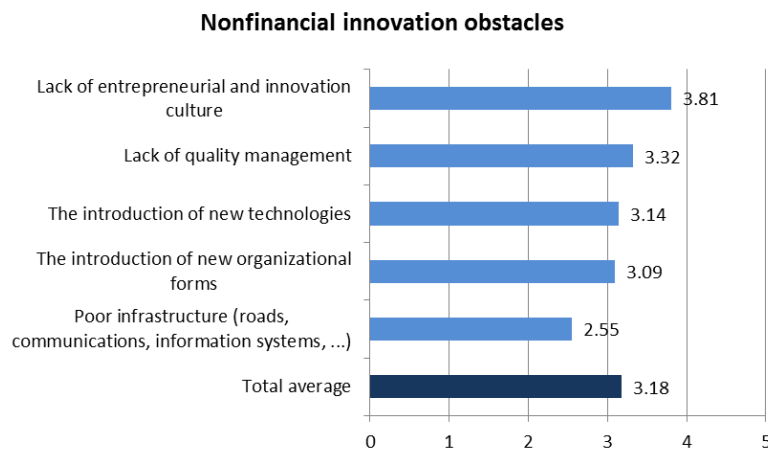
#### *4.4.2 Non-financial opportunities for companies and the necessary national measures*

In this subchapter, we will analyse the second part of Hypothesis 3 based on the average non-financial obstacles in the improvement of companies' innovation management. The results (Figure 6) show a slight negative deviation of the lack of entrepreneurial and innovative culture assessment, with an average assessment of 3.81. In other cases, the non-financial innovation obstacles are clearly smaller. Companies rate the lack of quality management as less hindering, with an average assessment of 3.32. Introducing new technology is assessed with an average value of 3.14 and the introduction of new organisational forms with an average assessment of 3.09. Poor infrastructure (roads, communications, information system ...) represents the best estimated factor with an average assessment of 2.55. Based on the average of the assessments, we also calculated the total assessment point average of 3.18.

According to the assessment of obstacles, infrastructure is obviously relatively well developed. Yet the obstacles, related to 'soft factors', namely innovation and creativity, are considerably greater. This is an important obstacle, especially as it concerns a broad range of innovation factors – most of the identified key non-financial innovation factors from the previous chapter. Also it fits well within modern innovative business practices,

particularly, the growing importance of innovation co-operation within a company and with the environment as well as related care to protect intellectual property. Business-innovation culture is a specific obstacle that is not directly related to organisational forms, but mainly to a change in values, which is usually difficult to achieve. Thus, higher indicated obstacles as regards the innovation culture are not surprising.

**Figure 6** Average assessment of non-financial innovation obstacles (see online version for colours)



#### 4.4.3 Synthesis of findings

Based on the analysis of company's financial (Figure 5) and non-financial innovation obstacles (Figure 6) for optimising the innovation management, it seems as if the financial innovation obstacles are significantly greater than non-financial innovation obstacles. This is indicated on the basis of the calculated total average assessment of both groups of obstacles: 3.18 for non-financial and 3.78 for financial innovation obstacles. We must consider; however, the difference in the values does not seem particularly high. Therefore, a more reliable evaluation of Hypothesis 4 requires performing additional statistical tests. In the continuation we present the result of two statistical tests: a non-parametric Wilcoxon test (Table 5) and a paired samples parametric test (t-test) (Table 6). The non-parametric test was included, because of its reliance on fewer assumptions regarding data distribution and hence increased robustness of the research results. Moreover, as data also supported the more demanding assumptions<sup>1</sup> for performing a parametric statistical test, the latter was also performed, mainly to support the results of the first, non-parametric test.

Based on the prevalent negative ranks of the non-parametric test (Table 5), it can be clearly observed that non-financial innovation obstacles are significantly smaller than financial innovation obstacles [assyp. sig. (two-tailed) = 0.024]. Similarly, the additional parametric test shows significant differences, highlighting that the financial innovation obstacles as more challenging than the non-financial ones [sig. (two-tailed) = 0.022].



**Table 5** The results of the Wilcoxon signed ranks test, estimating significance of differences (assymp. sig. (two-tailed)) as regards financial and non-financial innovation obstacles

<i>Test</i>	<i>Ranks</i>	<i>N</i>	<i>Mean rank</i>	<i>Sum of ranks</i>	<i>Z</i>	<i>Assymp. sig. (two-tailed)</i>
Non-financial innovation obstacles – financial innovation obstacles	Negative ranks	15	12.03	180.50	-2.26 <sup>a</sup>	0.024
	Positive ranks	6	8.42	50.50		
	Ties	0	/	/		
	Total	21	/	/		

Hence, the results of both tests clearly confirm Hypothesis 4 (financial innovation obstacles faced by companies are significantly higher than non-financial innovation obstacles).

The result is clearly in line with the analysis, carried out by Likar et al. (2011): they found that limited access to financial resources is the biggest obstacle of Slovenian manufacturing companies.

**Table 6** The results of the paired samples t-test, estimating significance of differences [sig. (two-tailed)] as regards financial and non-financial innovation obstacles

<i>Test</i>	<i>Paired differences</i>							
	<i>Mean</i>	<i>Std. deviation</i>	<i>Std. error mean</i>	<i>95% confidence interval of the difference</i>		<i>t</i>	<i>df</i>	<i>Sig. (two-tailed)</i>
				<i>Lower</i>	<i>Upper</i>			
Non-financial innovation obstacles – financial innovation obstacles	-0.70	1.13	0.25	-10.21	-0.19	-2.84	20	0.010

## 5 Discussion and conclusions

Both financial and non-financial factors are comparably and positively influential on innovation results. In practice, however, greater opportunity exists in the field of non-financial factors, since finances represent one of the biggest obstacles in business for companies. This has only increased with the current economic crisis.

The basis for the findings are the tested Hypotheses 1–4, through which we indicate possible improvements in innovation management within a company and at the government level, which consequently lead to improved innovation and economic performance. Confirmed Hypothesis 1 demonstrates the significant influence of financial and non-financial innovation factors on increasing a company's innovation results. Moreover, the results concerning Hypothesis 2 show financial and non-financial innovation investments represent independent but complementary innovation factors. Also, both groups are comparable as regards the positive and significant influence on innovation results. Hence, a holistic management of innovation must in practice address both financial and non-financial innovation factors. Performing relatively well as regards

financial innovation investments, but not as regards the non-financial factors proves insufficient for economically successful innovation (rejected Hypothesis 3). This is clearly in line with the modern dynamic capabilities theory. The latter emphasises management capabilities and resources that cut across all functions, including R&D, product and process development, manufacturing, human resources and organisational learning as the main factors, affecting company performance (Lawson and Samson 2001). Yet, one must take into account, innovation studies are generally known to focus only on fragments and not a comprehensive set of the influential factors, reflecting innovation as one of the most complex business processes (De Jong and Vermeulen, 2003; Wang and Ahmed, 2004). In this regard, our holistic approach, identifying the influential innovation factors and highlighting the significant ones, proves particularly valuable.

It has to be noted that financial investments are not easy to increase. This is confirmed by Hypothesis 4, which shows that current, financially-oriented state measures do not produce effects, since financial innovation obstacles remain significantly greater than non-financial ones. Similarly, the Institute of Macroeconomic Analysis and Development of the Republic of Slovenia (UMAR) notes that the state provides mostly financial incentives for companies, in particular for the category of R&D inputs (but much less the other key factors). Insufficient attention has been given to improve productivity or organisation of the innovation process itself (UMAR, 2012). The financial constraints were also noted as much higher than non-financial ones by other researchers (e.g., Gellatly and Peters, 1999). Yet, the studies did not focus on the high and medium-high technology sector. Consequently, it seems that overall financial constraints may be the main obstacle for innovation in a wide variety of the branches, especially in view of the current economic crisis and the underdeveloped banking sector.

Based on the research results, it is clear that a number of financial and non-financial innovation factors are influencing company's innovation results. But, where are the main practical opportunities for companies to address the numerous innovation factors effectively? One must not only recall the identified financial and non-financial innovation factors, but also the identified financial and non-financial obstacles. While financial and non-financial innovation factors were comparably influential on the innovation results, the non-financial innovation obstacles were significantly lower. Therefore, non-financial innovation factor (improvement of the innovation culture) improvements represent the companies' main opportunity for improving their innovation results. Managerial personnel, as well as their development and strategic vision/ideas are very important here, since this is a prerequisite non-financial factor which can help build an innovative company. Moreover, there must be the need for greater participation of companies in R&D and the business sphere. R&D activity and innovation collaboration contribute to the increase in company innovation results. In the case of almost all the aforementioned non-financial and financial innovation factors, the analysis has shown considerable potential for company improvements.

Due to the extent of changes needed, especially the lack of entrepreneurial and innovation culture (the highest non-financial obstacle); it is clear that in the future, a fundamental change of values is essential. This is not a trivial task and far exceeds the main short-term actions required within companies and responsible policy makers. It extends from overhauling the educational system to a thorough overhaul of the science sphere together with a comprehensive innovation support environment.

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## **Notes**

- 1 Normal distribution of mean differences, unequal variances of factors.