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Product and Process Innovation - A Cross Country Comparison Between Croatia, Poland and the UK

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ABSTRACT

This paper focuses on the determining the product and process innovation in three different countries: Croatia, Poland and the UK. The purpose of this study is to investigate significant differences among companies that report product and process innovation relative to different market contexts that they operate in and their reported R&D intensity. Using the survey data of 380 entrepreneurs and business executives from three countries: Croatia, Poland and the UK three regression models have been tested as well as significant differences among groups. The empirical results indicate conditional similarities in Croatian, Polish and British firms and respective investment into R&D. Related to product innovation, this study confirmed that UK is significantly better than Croatia, and for process innovation results revealed that UK has significantly better score than both Croatia and Poland. Regarding R&D intensity results indicate that Croatia reports higher levels than Poland.

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1. INTRODUCTION

Innovation is the pathway towards competitiveness, where companies have to be capable of the creation and commercialization of new products and processes (Porter and Stern, 2001).
The product innovation denotes the process of opportunity identification, product design and testing, commercialization and the market control for the purpose of realizing competitive advantage (Urban and Hauser, 1993).
New product development process refers to the activities of opportunity identification, product design and testing, commercialization and the control on the market implemented in order to achieve competitive advantage, therefore superior business performance (Urban and Hauser, 1993). According to Skarzynski and Gibson (2008), besides innovation inputs and outputs, it is important to evaluate the activities related to innovation processes.
The decision about a firm's innovation activity is associated with its purpose of maximizing value in order to sustain competitive advantages (Martínez-Ros and Labeaga, 2009).
The Oslo Manual (OECD, 2005) indicates that the organizational innovations are intended to increase a firm's performance by reducing administrative or transaction costs, improving workplace satisfaction (and thus, labour productivity), gaining access to non-tradable assets (such as non-codified external knowledge) or reducing the cost of supplies.
Firms with a great deal of innovation persistence develop routines (Martinez-Ros and Labeaga, 2009), and capabilities among their departments and employees, which increase the probability of success and foster further innovation. The purpose of this paper is to investigate the differences in the level of product and process innovation, R&D expenditure, internationalization and marketing innovation compared between Croatia, Poland and the UK.

Taking into account that firms in transition economies find the adoption of advanced business practices and adoption of new technologies and their integration into existing activities is very challenging (Radas & Bozic, 2009). Moreover, we investigate the relationship between product and process innovation with selected firm characteristics and other, already mentioned elements relevant to the innovation process; both on the whole sample and country specific.

2. LITERATURE REVIEW

According to the OECD (2015) there are four distinct types of innovation: product, process, marketing and organization.
This research is build around the notion of product and process innovation that is best described by Porter (1983., p 22.):

"Initially... product design is fluid, and substantial product variety is present. Product innovation is the dominant mode of innovation and aims primarily at improving product performance. Successive product innovations ultimately yield a "dominant design" where the optimal product configuration is reached. Process innovation is initially minor in significance, and small-scale, flexibility, and high labour skill levels characterize early production processes. As product design stabilizes, increasingly automated production methods are employed and process innovation to lower costs takes over as the dominant innovation mode. Ultimately, innovation of both types begins to slow down."

Product innovation stands for the market introduction of a new or significantly upgraded good or a service in terms of tis characteristics or usage (Mohnen & Hall, 2013); such innovation can be implemented through the improvement of components and materials, software, usage experience, technical specifications etc. Very similarly according to the OECD (2005) the term "product" in the construct refers to both goods and services that are offering significant improvements in the functional or user characteristics of existing goods and services.

A process innovation is the implementation of a new or significantly improved production or delivery method (OECD, 2005). This includes significant changes in techniques, equipment and/or software. Previous research in the area of innovation alludes to the notion that firms choose strategically between the two alternatives of innovation (product and process), usually avoiding a complete specialisation in one. As Milgrom and Roberts (1990) have pointed out, product and process innovations are complements, because they mutually reinforce each other: an increase in the level of any process leads to increases of the marginal profitability of innovations, and vice versa.

Organizational innovation involves the development and implementation of new intra-organizational or inter-organizational structures and proceedings to offer the consumer more efficient, effective and flexible solutions (Armbuster et al., 2006). Organizational innovation refers to changes in the hierarchies, routines and leadership of an organization that result from implementing new structural, managerial and working concepts and practices in order to improve coordination of work streams and employee motivation (Osterloh et. al., 2001). An organisational innovation is the implementation of a new organisational method in the firm's business practices, workplace organisation or external relations (Mohnen and Hall, 2013). Strategic focus towards innovation in terms of creating comparative advantage is crucial for product innovation success (Hadjimanolis, 2000) and organizational innovation is referred to

in terms of new management practices, new organization, new corporate and new marketing strategies (Battisti and Stoneman, 2010).

Lastly, a marketing innovation represents the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing standing for marketing methods (OECD, 2005). They are oriented towards better understanding of customers' needs, new markets or different market positions. Accordingly, a marketing innovation can be implemented for both new and existing products and services. The most prominent marketing innovation is product design that indicates significant changes that are part of a developing marketing concept of product form and appearance but do not alternate product's functional or user characteristics. New promotional activities consider the use of new concepts in promotion such as the first use of a significantly different media or technique. Other marketing methods relevant for marketing innovation include product placement in terms of new sales channels as well as new pricing strategies for company's goods and services.

Marketing innovations differ from the product ones, as they do not change product's function or uses. Recognizing the importance and potential value of marketing innovation Bartow (2000) investigated radical marketing innovation with the intention to proof its great benefits to companies' success.

More radical innovation tends to ensure growth much more prominently than new to business innovation (Freel and Robinson, 2004); which in the end is the ultimate goal of implementing innovation. Apart from incremental and radical there are also exploitative innovations (Lewin, Long and Carroll, 1999) that refer to incremental innovations that arise from capabilities development within the current set of activities, skill, knowledge and processes. This paper models marketing innovation as exploitative innovation.

Porter and Stern (2001) argue that companies must be able to create and commercialize a stream of new products and processes that extend the technology frontier, while at the same time keeping a step or two ahead of their rivals. Innovativeness is a derivative of companies that cooperate with knowledge centres, have easy access to financing and heavily invest into R&D (Keizer et al., 2002). For a long time R&D has been considered as the driving factor of innovation (Mairesse & Mohnen, 2005) that is further enhanced with intangible factors. Innovation leads towards growth, therefore employment (OECD, 2001) but the relationship between the intensity of research and development (R&D) and growth is not very blunt (Račić, Radas, Rajh, 2004). This paper, among other things, investigates the influence of R&D intensity on the probability of product and process innovation. The main reasons for the cross-country comparison is the reality of country specific factors that substantially influence firms' innovative capacity (Stern, Porter and Furman, 2000). R&D is only one dimension of the national innovative culture, infrastructure, national policies and laws, entrepreneurial culture and the market atmosphere significantly influence the national innovation prospects. Therefore, the innovation success and the influence of the R&D intensity on the process and product innovation should be considered market specific. Devoting large amounts of R&D leads to potential jeopardy for the whole company in case of failure. In case of not having available funding and opt for risk averse position, companies may substitute R&D by innovation managing practices which demand less investment and bear less insecurity. (Rammer, Czarnitzki & Spielkamp, 2009).

As for the analysis of innovation patterns of countries in the sample Radosevic (1999) found that companies from Central and Eastern Europe report less R&D expenditures and tend to purchase more technology than other companies in the EU. The same author concluded that in the region there could be recognized low levels of innovative companies.
Also Račić, Radas nad Rajh (2005) proved that companies in Croatia are more prone to innovating than nationally owned firms.

Europe remains today the main knowledge production centre in the world, accounting for almost a third of the world's science and technology production. The EU has managed to maintain its competitive knowledge position to a greater degree than the United States and Japan and is making progress towards its R&D intensity target of 3% by 2020. The EU also remains a very attractive location for R&D investment. In 2011, the EU was the main destination of FDI in the world, receiving around 30% of FDI inflows worldwide, more than the United States or Japan (Innovation Union Competitive Report, 2013, pg. 8). Three EU countries are selected for this research: Republic of Croatia (as the European Union accession country until July 2013), Poland as the European Union recent member state, and the United Kingdom as the established European Union member state.

3. METHOD

In order to answer the research question variables in the model were derived from the related research including product and process innovation– all of them being dichotomous variables.
Product innovation is a dummy variable that has the value of 1 if the company reports an innovation of a product and 0 when it does not. Similarly, process innovation is a dummy variable that has the value of 1 if the company reports an innovation of a process and 0 when it does not. The model also included R&D intensity being the most prominent predictor of innovation that was tested on between 1 being low and 3 being high.

Two control variables were considered firm age and its size in terms of employees that are commonly used in related research (Camison and VIllar-Lopez, 2011). Young market participants tend to see innovation as something innate as themselves are new to the market or larger time on the market can induce more experience therefore greater efficiency in innovation launch. The relationship between innovation and size can be interpreted the both ways – some scientists claim that smaller companies are more innovative due to their flexibility while other say that the larger the size companies get more effective and efficient and have more resources to invest into innovation (Lin and Chen, 2007). Cohen (2005) finds that larger firms benefit from the economies of scale therefore having a better chance profit from risky projects.

The survey originates from the 'Stimulating Learning for Ideas to Market' (SLIM) project, which is part of the European Leonardo de Vinci 'Lifelong Learning' education and training program. Its aim is to develop idea-to-market learning for a community of around 400 businesses from the Republic of Croatia (as the European Union accession country until July 2013), Poland as the European Union recent member state, and the United Kingdom as the established European Union member state.

The survey was performed from 12th May 2013 to 28th May 2013 in the Republic of Croatia and it was made online, in the Croatian, Polish and English language. It was translated from English to Croatia and Polish and back to English in order to check for its consistency. It was

aimed at entrepreneurs and it was distributed to the internal database of entrepreneurs obtained by the local sources in each country predominantly National Chambers of Commerce. In Croatia 213 businesses have completed the survey. Polish sample had 100 respondents and UK 67. There was total of 380 questionnaires.

Table 1: Sample composition

	All		Croatia		Poland		UK	
	n	%	n	%	n	%	n	%
Industry sector								
Art	3	0,8%	3	1,4%	0	0,0%	0	0,0%
Manufacturing	72	20,4%	47	22,2%	22	22,7%	3	6,8%
Inovation technology	37	10,5%	24	11,3%	10	10,3%	3	6,8%
Sevices	84	23,8%	46	21,7%	24	24,7%	14	31,8%
Entertainment/Hospitatlity	18	5,1%	12	5,7%	3	3,1%	3	6,8%
Communication	1	0,3%	0	0,0%	0	0,0%	1	2,3%
Electronic	12	3,4%	5	2,4%	6	6,2%	1	2,3%
Transportation	6	1,7%	3	1,4%	3	3,1%	0	0,0%
Software	13	3,7%	9	4,2%	3	3,1%	1	2,3%
Helthcare	9	2,5%	4	1,9%	3	3,1%	2	4,5%
Consulting	22	6,2%	15	7,1%	4	4,1%	3	6,8%
Finance	10	2,8%	7	3,3%	0	0,0%	0	0,0%
Non-profit organization	5	1,4%	4	1,9%	3	3,1%	1	2,3%
Energy	7	2,0%	5	2,4%	1	1,0%	1	2,3%
Other	45	12,7%	28	13,2%	15	15,5%	11	25,0%
Total	353	100,0%	212	100,0%	97	100,0%	44	100,0%
Missing	27		1		3		23	
Total	380		213		100		67	
Age of the business								
Less than year old	16	4,49%	13	6,13%	3	3,03%	0	0,00%
1-2 years old	14	3,93%	8	3,77%	5	5,05%	1	2,22%
3-5 years old	6	19,10%	33	15,57%	25	25,25%	1	22,22%

Table 1: Sample composition								
	8						0	
6-10 years old	78	21,91%	37	17,45%	27	27,27%	14	31,11%
More than 10 years old	180	50,56%	121	57,08%	29	29,29%	20	44,44%
Total	356	100,00 %	212	100,00 %	99	100,00 %	45	100,00 %
Missing	24		1		1		22	
Total	380		213		100		67	
Organization size								
1 employee	38	11,1%	21	10,0%	6	6,8%	11	25,6%
1-10 employees	46	13,5%	96	45,5%	27	30,7%	23	53,5%
11-50 emloyees	9	2,6%	67	31,8%	35	39,8%	7	16,3%
51-250 emloyees	40	11,7%	21	10,0%	17	19,3%	2	4,7%
More than 250	9	2,6%	6	2,8%	3	3,4%	0	0,0%
Total	342	100,0%	211	100,0%	88	100,0%	43	100,0%
Missing	38				12		24	
Total	38				100		67	

If we analyse the sample relative to the two crucial questions regarding the product and process innovation 276 businesses introduced a new product or service (73%) whereas 194 businesses introduced a new processes (52,7%). 149 Croatian firms reported a product innovation, 73 Polish companies and 58 UK ones. In terms of process innovation there are 101 companies in Croatian share of the sample reporting it, 46 Polish ones and 41 companies in the UK.

4. RESULTS

In order to evaluate the results we conducted ANOVA test for the whole sample for the variables of Product innovation, Process innovation and R&D intensity. The results of ANOVA were significant for Process innovation and R&D Intensity for $p<0,01$ and for Product innovation for $p<0,1$.

Table 2: Results of ANOVA

Product innovation

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1.078	2	.539	2.933	.054
Within Groups	67.602	368	.184		
Total	68.679	370			

Process innovation

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2.594	2	1.297	5.310	.005
Within Groups	86.955	356	.244		
Total	89.549	358			

R&D Intensity

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	5.699	2	2.849	4.835	.008
Within Groups	215.081	365	.589		
Total	220.780	367			

In order to further investigate significant differences in the level of reported process innovation and R&D intensity $p<0,01$ and for Product Innovation $p<0,1$; we need to take a better look at the descriptive values and at the post-hoc test.

For product innovation we can confirm that UK scores significantly higher than Croatia. For process innovation results reveal that UK scores significantly higher than both Croatia and Poland. As for R&D intensity ANOVA results indicate interestingly that Croatia reports higher levels than Poland.

Table 3: ANOVA Descriptives

Product innovation

	N	Mean	Std. Deviation	Std. Error	95% Confidence Lower	95% Confidence Upper	Min	Max
Croatia	207	.72	.450	.031	.66	.78	0	1
Poland	97	.75	.434	.044	.67	.84	0	1
UK	67	.87	.344	.042	.78	.95	0	1
Total	371	.75	.431	.022	.71	.80	0	1

Process innovation

	N	Mean	Std. Deviation	Std. Error	95% Confidence Lower	95% Confidence Upper	Min	Max
Croatia	207	.49	.501	.035	.42	.56	0	1
Poland	95	.48	.502	.052	.38	.59	0	1

Table 3: ANOVA Descriptives

UK	57	.72	.453	.060	.60	.84	0	1
Total	359	.52	.500	.026	.47	.58	0	1

R&D Intensity

	N	Mean	Std. Deviation	Std. Error	95% Confidence Lower	95% Confidence Upper	Min	Max
Croatia	213	2.13	.732	.050	2.03	2.23	1	3
Poland	96	1.84	.838	.085	1.67	2.01	1	3
UK	59	1.95	.775	.101	1.75	2.15	1	3
Total	368	2.02	.776	.040	1.94	2.10	1	3

Table 4: Result of post hoc multiple comparisons (Tukey HSD)

Product innovation

(I) Country	(J) Country	Mean Difference (I-J)	Std. Error
Croatia	Poland	-.033	.053
	UK	-.146*	.060
Poland	Croatia	.033	.053
	UK	-.113	.068
UK	Croatia	.146*	.060
	Poland	.113	.068

* The mean difference is significant at the 0.05 level.

Process innovation

(I) Country	(J) Country	Mean Difference (I-J)	Std. Error
Croatia	Poland	.004	.061
	UK	-.231*	.074
Poland	Croatia	-.004	.061
	UK	-.235*	.083
UK	Croatia	.231*	.074
	Poland	.235*	.083

* The mean difference is significant at the 0.05 level.

R&D Intensity

(I) Country	(J) Country	Mean Difference (I-J)	Std. Error
Croatia	Poland	.283*	.094
	UK	.178	.113
Poland	Croatia	-.283*	.094
	UK	-.105	.127
UK	Croatia	-.178	.113
	Poland	.105	.127

* The mean difference is significant at the 0.05 level.

To determine the effects of R&D Intensity onto the product and process innovation we estimated a model of binary regression that is suitable for dichotomous dependent variables.

Table 5: Binary logistics regression results – Product innovation
Product innovation

	Total sample		Croatia		Poland		UK	
Parametar estimates (B)	Sig.	Exp(B)	Sig.	Exp(B)	B	Sig.	B	Sig.
log (Size)	.842	1.000	.667	.999	.876	1.001		
log (Age)	**.096**	**1.222***	**.067**	**1.305****	.745	1.092		
R&D intensity	**.000**	**3.774****	**.000**	**4.885****	**.002**	**4.655****	**.031**	**5.348***
Intercept	**.000**	**.114****	**.000**	**.039****	.137	.173	.535	.495
Model fit:								
-2 Log likelihood	314.638**		197.970**		75.467**		36.209**	
Cox & Snell R Square	.162		.204		.199		.108	
Nagelkerke R Square	.240		.293		.294		.209	
n	332		202		76		59	

The binary logistic regression models available in the Table 7 show the values for the total sample as well as for each country individualy. It has to be noted that UK model lacks control variables due to smaller sample size and better model fit. All of the models in the table are statistically significant and following the fit statistics Δ-2 log likelihood indicates statistically significant contribution of the proposed prediction. Nagelkerke's pseudo R-Square shows small but reasonable amount of variation. The parameter b represents the likelihood of company reporting larger levels of product innovation. It is important to note that R&D is proved to have a statistically significant impact on the product innovation in the total sample as well as in each country individually. Moreover, age has a relevant impact in the whole sample and in Croatia.

Table 6: Binary logistics regression results – Process innovation

	Total sample		Croatia		Poland		UK	
Parametar estimates (B)	Sig.	Exp(B)	Sig.	Exp(B)	B	Sig.	B	Sig.
log (Size)	.881	1.000	.698	1.001	.918	1.000		
log (Age)	**.005**	**1.357****	**.063**	**1.279***	**.010**	**2.090****		
R&D intensity	**.000**	**2.414****	**.000**	**2.641****	**.002**	**2.650****	**.074**	**2128'**
Intercept	**.000**	**.052****	**.000**	**.042****	**.000**	**.008****	.435	.513
Model fit:								
-2 Log likelihood	408.030**		257.997**		92.326**		60.785*	
Cox & Snell R Square	.127		.125		.229		.063	

Table 6: Binary logistics regression results – Process innovation				
Nagelkerke R Square	.169	.167	.305	.089
n	327	206	82	52

The model available in the Table 8 presents the binary logistics regression values with process innovation as dependent variable. Here again has to be noted that UK model lacks control variables due to smaller sample size and better model fit. All of the models in the table are statistically significant and following the fit statistics Δ-2 log likelihood indicates statistically significant contribution of the proposed prediction. Nagelkerke's pseudo R-Square shows small but reasonable amount of variation. The parameter b represents the likelihood of company reporting larger levels of process innovation. It is important to note that R&D is proved to have a statistically significant impact on the process innovation in the total sample as well as in each country individually; as it was in the previous table, with product innovtion. Moreover, age has a relevant impact in the whole sample and in Croatia and in Poland.

5. CONCLUSION AND LIMITATIONS

The purpose of this study was to investigate significant differences among companies that report product and process innovation relative to different market contexts that they operate in and their reported R&D intensity. Using the survey data of 380 entrepreneurs and business executives from three countries: Croatia, Poland and the UK three regression models have been tested.

Related to product innovation, this study confirmed that UK is significantly better than Croatia, and for process innovation results revealed that UK has significantly better score than both Croatia and Poland. Regarding R&D intensity results indicate that Croatia reports higher levels than Poland. This conclusion is in line with Račić, Radas and Rajh (2005) who noted that companies in Croatia are more prone to innovating than nationally owned firms. But, Croatia does not have a mature innovation system with a core of highly innovative business as a driver. R&D expenditures is low at 0.8% of GDP, compared to 2% in EU and 2,4% in the OECD area. Moreover, it has been stagnating during the last decade – in sharp contrast to many emerging economies (OECD Reviews of Innovation Policy: Croatia 2013).

The interesting finding of this study is related to R&D activities. We can conclude that R&D is proved to have a statistically significant impact on the product innovation in the total sample as well as in each country individually. Moreover, age has a relevant impact in the whole sample. This means that management in companies are aware of importance of R&D activities and product innovation. Similarly, R&D is proved to have a statistically significant impact on the process innovation in the total sample as well as in each country individually. In the same way, age has a relevant impact in the whole sample and in Croatia and Poland. This conclusion is also stated by Milgrom and Roberts (1990) who found that product and process innovations are complements, because they mutually reinforce each other. Furthermore,
extant literature shows that new products and processes are connected, namely the firms that develop new processes also develop new products (Koschatzky et al., 2001; Radas, 2003, Radosevic, 1999). This relationship is confirmed again in this study, where we find a and significant relationship between products and processes innovation. This reflects the fact that

to realize new products, especially those of higher novelty, firms have to improve outdated technologies and processes (Račić, Radas & Rajh, 2004).

The paper support the finding from Racic, Aralica, & Redzepagic (2008) who found that the 'ideal type' of a Croatian export-oriented SME tends to operate in medium high-technology manufacturing and services, produce specialised capital and consumer goods servicing specific market niches, export independently, sell products directly to specialised customers of special products, cooperate with foreign enterprises, perform intramural Research and Development (R&D) activities, innovate product mix by including products with a higher value added and introduce new technologies, but without limiting their innovation activities on the acquisition of technology.

Main limitation of our study relates to the dichotomous variables and to the fact that UK model sample size was smaller than in Croatia and Poland. Having a bigger sample size in UK would enable us to understand better the relationship between product and process innovation.

Further research should involve longitudinal studies and more complex definitions of product and process innovation. It would also be useful to improve the methodology by strengthening the linkages between the characteristics of entrepreneurs and firms.

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