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EVALUATION OF RESEARCH AND DEVELOPMENT TAX INCENTIVES SCHEME IN CROATIA

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ABSTRACT

According to the European Innovation Scoreboard metrics Croatia belongs to the group of moderate innovators, i.e. a country with below average innovation performance in comparison to the EU average in the period 2009-2010. Government subsidies are frequently introduced to improve countries' innovation performance. Whether existing R&D tax scheme in Croatia produces expected results is the key research question analyzed in the paper. Based on the microeconometric analysis of individual firms' data, we confirm positive effect of the subsidies on expenditures in research and development as well as on product innovation. However, the significant effect on process innovation is not found.

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I. INTRODUCTION

Research and development (R&D) and innovation activities are characterized by significant heterogeneousness, with apparent diversities within both categories. This is explained by various types of knowledge that are created and used in innovation process, described by the concept of the learning economy (Lundvall and Johnson, 1994). Dominant presence of these activities within the firms' assets complicates investment activities as the investments' results are not easily predicted. The asymmetric information where the inventor has more appropriate knowledge about a project in relation to the investor causes the undervaluation of innovative projects by investors (Bergman and Friedl, 2008). Second, the cost structure of innovation is specific and relies on sunk costs (Cohen and Klepper, 1996). Finally, the social rate of R&D expenditure returns exceeds the private rate, leading to a socially suboptimal rate of R&D investment (Guellec and van Pottlesberge, 2003). All these issues result in diminishing investments in innovation and R&D within the business sector, thus requiring government initiatives aimed at promoting these investments.

R&D and innovation activities have been recognized as a crucial factor enabling profitability increases at firm level (Schumpeter, 1942) as well as a contributing factor of economic growth (e.g. Romer, 1986, 1990). Policy makers in developed and developing countries have been planning and implementing programmes aimed at enhancing R&D and innovation investments on the firm level. Thus, the goals of tax incentives for R&D are clear: facilitate additional investments into R&D and innovation of business entities, encourage investments and produce positive socio-economic impacts (e.g. increase employment in the investment area). A significant increase in the number of countries using R&D tax incentive schemes has triggered an interest in the evaluation of their effectiveness (e.g. EC, 2008).

R&D tax incentives in their current form were introduced into the Croatian tax system in 2007[1]. Assistance to research and development and innovation projects is managed by the Ministry of Science, Education and Sports (MSES)[2]. The process of the verification was regulated by the Regulation on State Aid for Research and Development Projects[3]. The value of the tax advantage as a state aid for research and development was 21.1 mil EUR in 2009, and at the same time period amounted to 1.6% of total state aid in Croatia. According to the MSES data the number of beneficiaries had been increasing in the period 2007-2009 and amounted to 77 in 2009. This information, although encouraging, is insufficient for assessment of current subsidy scheme effectiveness.

The evaluation of the public policy measures, in particular at the microeconomic level, is relatively scarce in Croatia. The main objective of the paper is to evaluate the result of introduction of R&D tax incentives in Croatia in order to assess whether the policy measures introduced actually achieved the desired effect, i.e. an increase in R&D expenditure. Using individual firm data, and by applying propensity score matching method[4] to estimate the average treatment effect of the

[1] Act on the Amendments to the Scientific Activity and Higher Education Act (OG, 2007a).

[2] The business entities apply their R&D projects to the MSES according to three categories: fundamental research, industrial research and development research. The positive decision from the MSES is taken into consideration when submitting profit and loss statement to the tax authority, within the annual profit tax payment obligation.

[3] Regulation on State Aid for Research and Development Projects (Official Gazette No. 116/2007 (OG, 2007b).

treated (ATT), we try to confirm three hypotheses. First, that tax incentives increase the number of R&D performers. Second, that tax incentives influence radical product innovation and finally, (third) that tax incentives do not influence process innovation. Therefore the contribution of this paper is twofold. Firstly, it will provide the answer to the question whether the public funds used produced desirable outcome. Secondly, the paper examines the relation between tax incentives and specified types of activities relating to technology use, i.e. innovation products, innovation processes as well as research and development activities.

The paper is organized as follows: we start with a literature review related to R&D tax incentives evaluation and present empirical findings from various countries. Section 3 introduces the dataset and presents the estimation strategy. Section 4 discusses the results and the final section draws concluding remarks.

II. R&D TAX INCENTIVES EVALUATION – EXPERIENCES FROM OTHER COUNTRIES

Two categories of instruments have been implemented within the innovation policy practice. The first category is aimed at increasing private returns on investments oriented towards encouraging intellectual property rights. Second category aims to decrease sunk costs and asymmetric information related to these projects, taking the form of e.g. tax incentives for R&D or R&D government subsidies. Empirical studies about tax incentives impacts on business R&D reveal that those depend on the characteristics of the R&D and innovation activities on the firm level. Main questions within empirical research include the relation between R&D tax incentives and propensity to receive R&D incentives as well as the relation between R&D tax incentives and R&D investments. Empirical studies differentiate the interdependence between tax incentives on the one hand and R&D investments (i.e. innovation input) and innovation activities (i.e. innovation output). This approach has been followed in present paper.

Köhler, Larédo and Rammer (2012) provide systematic overview of the empirical studies of R&D fiscal incentives. They review two groups of studies. The first one consists of those primarily interested in the impact on input additionality, to which the most reviewed studies belong to. This question is addressed in this paper through assessing the effect on R&D expenditures. The second group of studies are interested in output additionality and the authors further separate effects on innovation success (the issue we are dealing in the present paper by assessing the effect on innovation activity indicators) and the effect on productivity.

The main research question is whether existing tax incentives scheme in Croatia leads to more R&D expenditures (input additionality) and/or more innovation activities (output additionality). Experiences from other countries do not provide decisive answer. Comprehensive surveys of regression analysis at various level of aggregation have been provided by David, Hall, and Toole (2000) showing ambiguous results, where one out of three cases report that public R&D funding substitutes private R&D investments.

Evaluation methods can be broadly divided into four categories: performing surveys, creating quasi-natural experiment (Haegeland and Moen, 2007), statistically constructing control groups and structural economic modelling (Lokshin and Mohnen, 2012). Present paper methodology relies on the statistical methods to construct counterfactuals. However, it is

[4] Specific benefits of applying propensity score matching in policy evaluation studies are presented in Bryson, Dorsett and Purdon (2002).

important to notice that the chosen method cannot be directly related to the outcome of the evaluation exercise, as various studies use different methodology and come up with different conclusions. Non-exhaustive list of studies that have found positive effect of public spending on private R&D include following:

- Klette, Moen and Grilliches, (2000) focused on the effect of public R&D efforts on the R&D investments and in four out of five cases found that the subsidy schemes had positive effect on firm performance.
- Lach (2000) investigates the effects of R&D subsidies granted by the Israeli Ministry of Industry and Trade on local manufacturing firms and found evidence that the R&D subsidies have stimulated long-run company-financed R&D expenditures.
- Bloom, Griffith and Van Reenen (2002) examine the impacts of tax incentives on the R&D investment levels (thus primarily focusing on input additionality) for nine OECD countries in the period 1979-1997. By using the dynamic panel data model the authors conclude that tax incentives are effective in increasing R&D intensity in various time periods.
- Busom (2000) applied an econometric selection model on a cross-sectional sample of Spanish manufacturing firms. The author concluded that public funding induced more effort for the majority of firms in the sample, but for one of third the participants, complete crowding-out effects cannot be ruled out.
- Hussinger (2006) estimated parametric two-steps selection model and confirmed that public funding increases firms' R&D expenditure.
- Aerts and Czarnitzki (2004) examined the interdependence between R&D subsidy and R&D expenditure using matching estimator and found R&D subsidies support R&D investment in the Flemish sample which covers the manufacturing sector as well as the specific services sectors (computer services), R&D services as well as business related services.
- Duguet (2003) employs the matching methodology with a large panel of French firms, finding that tax subsidies stimulate private expenditure on R&D.
- Lööf and Heshmati (2005) evaluate the Swedish subsidy policy using matching estimation, and found public funds contribute to an increase in the total R&D efforts in Sweden, but small manufacturing and services firm are only beneficiaries.
- Ozcelik and Taymaz (2008) analyzed Turkish manufacturing industry and found that public R&D support significantly and positively influences private R&D investment. They stated the importance of the use of a combination of knowledge own R&D activities with external knowledge, as a result of technology transfer within the business entities.

Studies that were not able to confirm the positive effect of public spending on private R&D include following:

- Klette and Moen (1998) analysed Norwegian high-tech firms and found subsidies do not considerably stimulate private R&D.
- Wallsten (2000) found that Small Business Innovation Research Program (SBIR) grants crowd out private investment dollar for dollar in the USA. However, the results confirm that for SBIR grants only, the program could still has positive effects, as the recipient firms are able to keep their innovative projects while in the absence of a subsidy business entities might have to abandon them.

Previous non-exhaustive list of studies implies that we cannot a priori assume that the current tax scheme in Croatia will yield positive results, even though both policy makers and business community are in favour of such measures. Thus, empirical evaluation is necessary to reveal the effectiveness of the existing policy measures. The approach and the data used are presented in following section.

III. DATASET AND EMPIRICAL STRATEGY

The analysis in the paper is performed on the level of individual firms. The original database used for the analysis was the Community Innovation Survey (CIS) for the period 2006-2008, as conducted by the Croatian Central Bureau of Statistics (CBS)[5]. These had been amended by the MSES internal data on business entities that have applied for the tax incentives scheme in the period 2008 – 2009. Thus we have detailed information on the enterprises from CIS and information from MSES which of these enterprises have applied for tax incentives. Since CIS includes business entities with ten employees and more, this approach yielded a population of 65 firms. As a result of the comparison between CIS dataset and available data from MSES, 36 business entities out of 65 were included in the analysis.

The main goal is to establish if the examined enterprises had more or are more likely to have increased research and development expenditures. Additionally, even though the period since the introduction of the measure has been relatively short, we want to explore whether the treated enterprises already introduced innovative products or innovative processes.

This may appear as a result of mutual interdependence of activities related to use of knowledge and technology such as innovation activities and research development activities (c.f. Patel, Pavitt (2005: 20-23). Since we are not able to observe the before-after effect, we have opted for the creation of the counterfactual via propensity score matching method[6]. We have, consequently, three outcome variables – R&D expenditures (in two variations – value of expenditures and number of business entities with this type of expenditures), product innovation and process innovation. The treatment variable is participation in the tax incentives scheme.

The key question in policy evaluation is to prove the benefits of specific program under evaluation. The basic concepts are following. If Y0 is the outcome without treatment and Y1 is the outcome with treatment, D is an indicator of the recipient under the treatment (thus equals 1 if under the treatment and zero otherwise), the overall observed outcome is following:

$$Y = DY_1 + (1 - D)Y_0 \tag{1}$$

[5] Community Innovation Survey (CIS) is conducted according to the same methodology in EU Member States. Interested reader should refer to Eurostat website for more information (http://epp.eurostat.ec.europa.eu/portal/page/portal/microdata/cis) on methodology or the results comparable across countries (http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database). For the methodology application and specific results for Croatia, one should refer to Croatian Bureau of Statistics (www.dzs.hr).

[6] Due to the fact that we rely on previously developed methodology, detailed description of the propensity score method, its application in the evaluation as well as some methodological concepts utilized in the empirical section (such as average treatment effect of the treated) is not replicated in the paper to save the space. Readers requiring more details on the methodology could find Heckman and Vytlacil (2007a), Heckman and Vytlacil (2007b), Blundell and Costa-Dias (2008) or Gertler et al (2011) extremely helpful.

The treatment effect, which we cannot directly observe and thus must estimate with appropriate method, is:

$$\Delta = Y_1 - Y_0 \tag{2}$$

In evaluation, we would be typically interested in the overall effect of the program (on treated and untreated participant), but we would in particularly be interested in whether the treatment actually produces any results. That is, whether there is a desired effect of specific policy scheme, and whether it is significant. Thus, we are interested in average treatment effect of the treated (ATT), which theoretically is derived for X participants in the program from the following:

$$E(Y_1 1 - Y_1 0 \mid D = 1, X) - \tag{3}$$

The best approach in policy evaluation is to have the access to the random sample of participants in program that either received treatment or not. However, such cases are relatively rare in economic policy evaluation. Instead, we have to attempt to recreate such case in order to assess the policy effect. When using matching procedure, we first assume that we have data on individuals that are under treatment and those that are not (in our case we have the data on enterprises applying for tax incentives and other enterprises that participated in CIS). Another assumption is that we have the data on a set of variables X whose distribution is not affected by the participation in tax incentives scheme decision (D). In our case, we have the variables resulting from the CIS survey. In that case, matching estimators match up the treated enterprises with observably (according to the X set of variables) similar untreated enterprises. In cases when there is a large set of X variables, there could be present various points of similarity and dissimilarity.

To reduce this to a single measure, propensity scores - $\Pr(D = 1 \mid X) -$- can be assessed following Rosenbaum and Rubin (1983) theorem.

The propensity score matching algorithm entails estimation of probabilistic or logistic function of the treatment variable, resulting from the specific observable characteristics of the program participants (X variables). In our case, the goal is to determine the factors behind the probability to receive tax incentives. Since our population sample, which actually received tax incentives, is relatively small, we have included a larger set of independent variables in our specification in order to be able to detect the counterfactuals with similar characteristics. Furthermore, Heckman, Ichimura, and Todd (1997) warn against omitting important variables in the procedure, since this can seriously increase bias in resulting estimates. Following their reasoning, variables that influence both participation decision and the outcome variable should be included in the probit estimates. However, regarding the tax incentives scheme, little can be argued in relation to the participation decision of the enterprises. Since the cost of participation is negligible, the participation decision is probably related to the information of the programme availability.

The choice of independent variables in our probit equation is guided by the data source (i.e. CIS), but also by the notion that the choice of mutually uncorrelated independent variables must reflect the potential to receive the tax credits. Since the eligibility criteria are relatively wide, this implies that we have to rely on the previous research on the important characteristics of the innovation process development in Croatia, as well as studies in other countries. Having all these considerations in mind, we have finally chosen the following set of independent variables:

- The enterprise size variables. Based on the number of employees, we have created three dummy variables that represent the size of the enterprise. The small enterprises (with the number of employees below 49); medium size enterprises (between 50 and 249 employed), large enterprises (with more than 250 employees). The reason behind this segmentation is that the innovation performance is not evenly spread throughout the economy (see also Lokshin and Mohnen, 2012; Haegeland and Moen, 2007). Furthermore, larger enterprises might be more inclined to participate in the tax credit scheme, since they are more likely to have developed resources within the firm to respond more quickly to new policy measures.

- Employment change variable, which equals the change in employees between 2006 and 2008, based on the CIS data. The inclusion of this variable was guided by the descriptive statistics analysis of the innovative enterprises (Švaljek, 2012), which indicated that these are more likely to increase their employment.
- Participation on the international market, which is a dummy variable that takes value 1 if the enterprise sells goods and/or services on EU/EFTA/EU candidate countries or other countries markets[7]. The inclusion of this variable is related to the concept that enterprises oriented towards small domestic markets, such as Croatian, are less likely to pursue innovatwion activities and consequently seek government support for these activities.
- A dummy variable if the enterprise belongs to an enterprise group[8]. The motivation for the inclusion of this variable is related to the assumption that there might be some prior experience with the tax credit scheme within the group, which consequently acts as a positive incentive for the enterprise in question to participate in this specific economic policy measure.
- A set of innovation cooperation variables, also included as dummy variables in the specification. The innovation cooperation with other firms and/or specialised institutions might also have beneficial influence on increase of informal cooperation such as spreading information about the tax incentives scheme. Although this assumption would require additional testing.

CIS contains a large number of non-responses to specific questions, which leads to a large number of missing values, both in case of dependent variables and independent variables. Thus, although the number of CIS respondents is more than 3000, the final sample size used in the empirical section is reduced to 523. This sample is the basis for the analysis presented in following section.

IV. ESTIMATION RESULTS AND DISCCUSSION

The estimation strategy relies on propensity score method, which in its first step requires identification of the probabilities to receive tax incentive. The left hand side of the estimated equation is thus the dummy variable of whether the enterprise received tax incentive, and the right hand side variables are all the variables that appear in Table 1. The results of the estimated probit model are presented in the following table.

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[7] We have to clarify that we cannot directly measure firm's participation on the international market, but have to rely on the participant's answer to the following question in the CIS "In which geographic markets did your enterprise sell goods and/or services during the years 2006 to 2008?".

[8] We have to clarify that we cannot directly measure the belonging to the group of enterprises, but rather rely on the participant's answer to the following question in the CIS "In 2008, was your enterprise a part of an enterprise group?".

TABLE 1 – PROBABILITY TO RECEIVE TAX INCENTIVES

Variable	*Coefficient (standard error)*	*p-value*
Constant	-2.65*** (0.58)	0.00
Small size enterprises	0.29 (0.31)	0.34
Large enterprises	0.42 (0.29)	0.16
Employment growth	-0.12 (0.36)	0.73
Participation in international markets	0.38 (0.28)	0.18
Part of a group	0.61** (0.26)	0.02
Cooperation variables, cooperation with:		
National suppliers	0.48* (0.26)	0.07
National clients or customers	0.07 (0.27)	0.80
National competitors	-0.91*** (0.35)	0.01
National consultants, commercial labs, etc.	0.33 (0.26)	0.21
EU/EFTA/EU-CC suppliers	0.16 (0.26)	0.56
EU/EFTA/EU-CC clients or customers	-0.09 (0.31)	0.77
EU/EFTA/EU-CC competitors	0.03 (0.37)	0.94
EU/EFTA/EU-CC consultants, labs, etc.	-0.56 (0.39)	0.16
US suppliers	0.44 (0.36)	0.21
US clients or customers	0.16 (0.53)	0.76
US competitors or other firms	0.96* (0.55)	0.08
Diagnostics		
Number of observations	N=523	
Log likelihood	=-68.75	
Pseudo R^2	=0.19	
LR $Chi^2(16)$	=32.27*** (p-value=0.01)	

Source: Authors' estimates.

*Notes: Coefficients marked *** are significant at level of 1%, ** at level of 5%, and * at level of 10%. Restricted to common support. The balancing property of the propensity score procedure is satisfied.*

[9] We emphasize that other specifications have also been estimated. For example, we have specified aggregated variables for the types of cooperation. However, these specifications did not yield satisfactory results in terms of the desirable diagnostic properties of the estimates.

All the variables are jointly significant and the model has obtained satisfactory pseudo R^2. However, when it comes to individual variables, not many have been found significant. Since this issue has not been previously analyzed in Croatia, we briefly summarize the main results[9]. It seems that the probability of receiving a tax incentive is significantly related only to being part of a group of enterprises, having cooperation with national suppliers (positive predictor), having cooperation with national competitors (negative predictor), and having cooperation with US competitors. In order to substantiate these findings, a larger dataset with more identified cases of tax scheme participation would be required. For the purposes of identifying propensity scores, we consider this model satisfactory.

To further elaborate the relevance of our variables selection, we have performed matching covariates balancing property test (see Table A1 in the Appendix). The purpose of the test is to identify the differences between the treated and control group before and after the matching. Table A1 shows that reduction of the bias in the difference of the mean between target and control group is large as a result of the performed matching. Based on the performed t-test, we cannot reject the null-hypothesis that the mean differences between treated and control groups are equal for the selected covariates. Based on these tests, the choice of the covariates has been confirmed.

Relying on the available propensity scores, we have estimated the average treatment effect of the treated (ATT) for four outcome variables – research and development expenditures values, research and development expenditures (as dummy variable), introduction of new or significantly improved goods on the market (as dummy variable), introduction of a new or significantly improved method of production on the market (as dummy variable). Thus, we want to assess whether the introduced policy measure had significant effect on the R&D expenditures and on the innovation activity. Having in mind all the data restrictions, we have used several frequently used in the literature algorithms – nearest neighbour, calliper matching and kernel matching (Cochran and Rubin, 1973; Heckman, Ichimura and Todd, 1997).

The nearest neighbour algorithm iteratively finds pair of subjects with the shortest distance. This might not always lead to good matching results. The improvement can be achieved by caliper matching, which finds all the matched within a specified tolerance. We specify the standard radius frequently used in analysis (0.005). Finally, we also use Epanechnikov kernel function[10]. In all cases, the standard errors presented here were obtained by a bootstrapping procedure with 1000 replications.

Since we have no prior estimates to compare our results, and there is a priori no best matching approach, we present all the results to gain more insight from the empirical exercise.

[10] This has been obtained by following psmatch2 procedure in STATA 11.

TABLE 2–ATT ON THE SELECTED OUTCOME VARIABLES

	Outcome variable			
	Expenditures on R&D - value	***Exp. on R&D***	***Product innovation***	***Process innovation***
	Nearest neighbor (20 treated, 19 control)			
ATT	3817880	0.10	0.25	0.30
Standard error	2700000	0.126	0.175	0.188
	Caliper matching (17 treated, 174 control)			
ATT	1650000	0.18**	0.31**	0.20
Standard error	2060000	0.058	0.218	0.154
	Kernel matching			
ATT	37902655	0.14**	0.23**	0.17
Standard error	24100000	0.062	0.109	0.133

Source: Authors' estimates.

*Notes: bootstrapped standard (1000 replications) errors in parentheses. ATTs marked ** are significant at level 5%.*

The results presented in Table 2 show that we were able to identify positive effect of tax incentives scheme for research and development in Croatia on the product innovation and on the expenditures on research and development. Thus, it seems that this policy measure obtains desirable results. Since the expenditures on research and development are on average low in Croatia comparative to EU average, as well as the innovation activity, it seems important that current policy measures are able to enhance this important channel for growth prospects creation.

We were not able to establish the significant relationship between the participation in the tax incentive scheme and the amount of expenditures on research and development. However, further research, comprising of the amount of tax incentive received in the individual enterprise might give more insight into this link. Based on the additionality principle, we would expect that higher tax credits should lead to more R&D expenditures.

The encouraging results of the empirical exercise is that the difference in the estimated effect is not extremely different across matching methods, even though we had small number of identified tax credit beneficiaries. Presumably precisely due to the small sample, the nearest neighbour matching was not able to significantly identify the average treatment effect of the treated. However, also encouraging is that both calliper and kernel matching identified as significant the same ATTs and of approximately the same magnitude.

In order to address the sensitivity of presented results, we have relied on the Rosenbaum bounds testing procedure, which analyze the degree to which unobserved variables affect the treatment effects (Rubin, 1980). If we are having, for example, a significant positive bias, it may lead to an overestimation of the true treatment effect and therefore, reported test-statistic should be adjusted downwards. In case of initial values, that is when $\Gamma=1$ there is no hidden bias, while higher values of Γ indicates more influence of unobserved factors.

The results of this analysis are presented in Table A2 in the Appendix. Here, we will briefly summarize the main implications for the treatment effects found to be significant – expenditures on R&D and product innovation. In the case of first outcome variable, under the assumption of no hidden bias, the treatment effect is significant. Since the interpretation of the Q_mh+ statistics is that it adjusts the MH statistics downwards for positive (unobserved) selection, it would seem that those most likely to participate in the tax credit scheme would be more likely to have expenditures on R&D without tax incentives. Since we are having in our case positive estimated treatment effect and if we would look in more details on the bounds under the assumption that we have overestimated the treatment effect (Q_mh+), we would find that it becomes insignificant at 10 % level already for $\Gamma=1.4$. This implies that the possible unobserved variables could significantly affect our findings of the positive effect of the current tax credit scheme.

In case of product innovation, the general findings are similar. We have also identified positive treatment effect (which is desirable in our case), and also are more interested in the issue of overestimating our results. The MH statistics follows the same dynamics as in previous case, but here the Q_mh+ becomes insignificant (10 % level) at higher $\Gamma=2.05$. So it seems that our results that the tax credit scheme achieves significant positive effects is more robust to possible unconsidered covariates for the product innovation that the R&D expenditures.

The sensitivity analysis reveals that our results should be taken with caution. Since this is the first evaluation of tax incentive schemes with propensity score matching method in Croatia, we believe that this requires further research on the subject.

V. CONCLUSION

The main goal of the paper was to evaluate the effectiveness of the tax incentives for R&D in Croatia. We have confirmed that tax incentives have increased the number of firms having R&D expenditures, although not necessary the value of expenditures itself. These results in Croatia for the period under analysis are expected. A plausible explanation is the fact that innovation performances differ across countries as a result of interaction of innovation performance and different stages of economic development models applied within the national economies. Due to the fact that acquisition of foreign technologies by local firms (via new machinery and equipment) is dominant mode of technological capability building, the tax incentives in the field of R&D, i.e. fostering internal innovation capability, may generate positive results within a national economy.

Two additional hypotheses are also confirmed. First, the results confirm our initial assumption that it is highly relevant in case of transition and developing economies to consider not only the innovation activity in general, but to distinguish between product and process innovation. Furthermore, in case of Croatia, which is a relatively small market, these differences might be even more pronounced. We have been able to confirm that current tax incentives scheme has positive significant effect on product innovation, but in case of process innovation this effect is statistically not significant.

Finally, we speculate that the explanation for results lie in the nature of process innovation and possible foreign ownership of the firms involved in these activities.

Before offering more reliable conclusions additional empirical research is required. In Croatia the analyses of the tax incentive scheme for research and development in the near future should include the structure of research and development expenditures of the beneficiaries as well as more comprehensive dataset of the tax beneficiaries for the longer time period. Finally, due to the fact that the analyzed companies are the propulsive segment of the Croatian economy, an interesting topic for further research would be the analyses of human resources (especially research and development staff) and their linkage to the tax incentive scheme.

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APPENDIX

TABLE A1 – COVARIATES BALANCING PROPERTIES (KERNEL MATCHING)

Variable	*% reduction in bias*	*p-values*
Small size enterprises	47.0	0.776
Large enterprises	46.9	0.472
Employment growth	65.8	0.801
Participation in international markets	54.4	0.787
Part of a group	73.2	0.541
National suppliers	77.9	0.819
National clients or customers	50.1	0.862
National competitors	78.3	0.731
National consultants, commercial labs, etc.	-5.1	0.843
EU/EFTA/EU-CC suppliers	95.7	0.972
EU/EFTA/EU-CC clients or customers	40.7	0.828
EU/EFTA/EU-CC competitors	64.5	0.840
EU/EFTA/EU-CC consultants, labs, etc.	-109.3	0.897
US suppliers	93.4	0.933
US clients or customers	47.0	0.731
US competitors or other firms	55.7	0.595

Source: Authors' estimates.

TABLE A2 – MANTEL-HAENSZEL* BOUNDS FOR OUTCOME VARIABLES

Outcome variable	Test statistics	*Gamma Γ*			
		1	**1.5**	**2**	**2.5**
Expenditures on R&D-value*	t-hat+	2700000	-503427	-2100000	-2900000
	sig+	0.227	0.515	0.723	0.849
	t-hat-	2700000	9200000	12000000	17000000
	sig-	0.227	0.059	0.015	0.003
Expenditures on R&D	Q_mh+	1.606	1.209	0.956	0.773
	p_mh+	0.054	0.113	0.169	0.219
	Q_mh-	1.606	2.069	2.441	2.761
	p_mh-	0.054	0.019	0.007	0.003
Product (good) innovation	Q_mh+	2.561	1.830	1.353	1.002
	p_mh+	0.005	0.034	0.088	0.158
	Q_mh-	2.561	3.390	4.051	4.613
	p_mh-	0.005	0.000	0.000	0.000
Process innovation	Q_mh+	1.333	0.564	0.033	-0.197
	p_mh+	0.091	0.286	0.487	0.578
	Q_mh-	1.333	2.153	2.799	3.300
	p_mh-	0.091	0.016	0.003	0.000

Source: Authors' estimates

Notes: * In case of expenditures value, which is not a discrete variable, Rosenbaum bounds are used. t-hat+ is upper bound Hodges-Lehmann point estimate, sig+ is upper bound significance level (for "-" the analogy applies). Q_mh+ is MH statistics under the overestimation of treatment effect assumption, p_mh+ is the corresponding p-value (for "-" the analogy applies). Gamma represents odds of differential assignment due to unobserved factors. We calibrate the MH bound test for different values of Γ between 1 and 3 with an increment of 0.05 but only a selection is presented here. For the Rosenbaum test, Γ values are the same, but the increment is 0.1. More detailed results are available from the authors upon request.

EVALUACIJA SHEME POREZNIH POTICAJA ZA ISTRAŽIVANJA I RAZVOJ U HRVATSKOJ[11]

SAŽETAK

Sudeći po mjerenjima Europske ljestvice uspjeha u inoviranju Hrvatska pripada grupi umjerenih inovatora, odnosno zemljama u kojima je inoviranje ispod prosjeka u usporedbi s prosjekom u EU u periodu 2009-2010. Često se uvode vladini poticaji kako bi se popravila razina inovacija u pojedinoj zemlji. Ključno pitanje ovog rada je donosi li shema poreznih poticaja za istraživanje i razvoj u Hrvatskoj očekivane rezultate. Na osnovu mikroekonometrijske analize podataka pojedinih poduzeća, potvrdili smo pozitivni učinak poticaja na potrošnju za istraživanja i razvoj te za inovacije proizvoda. Ipak, nije uočen značajan učinak u inovaciji procesa.

Ključne riječi: porezni poticaji za istraživanja i razvoj, evaluacija, Hrvatska, sličnost u vjerojatnosti sudjelovanja u mjerama

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11 Analiza se bazira na podacima prikupljenima za projekt Evaluacija poreznih poticaja usmjerenih na stimulaciju projekata istraživanja i razvoja u poslovnom sektoru, koja je u Hrvatskoj provedena od ožujka do svibnja 2011 i koja je financirana sredstvima Svjetske banke i Ministarstva znanosti, obrazovanja i sporta. 2011. Autori se također zahvaljuju vrijednim komentarima dvaju anonimnih sudaca.