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INDUSTRY-SCIENCE COLLABORATION IN CROATIA: FIRM'S PERSPECTIVE*

INTRODUCTION

The role of research cooperation between industry and academic institutions has received increased attention in recent years. Industry-science relationship is considered to be one of the important parts of innovation system, because of the expected positive impact on commercial performance. Among other things, by collaborating with scientists firms are expected to introduce more innovative products, and to create more efficient and innovative processes. This should positively reflect on the firm's ability to successfully compete in the market.

This paper is partly based on a larger study whose goal was to determine incentives for improving industry-science collaboration in Croatia.[1] In order to see if university-industry collaboration can indeed be a vital and sustainable part of innovation system, we need to understand what motivates each of the partners to enter the collaboration. Firms are likely to enter collaboration for different reasons that research institutions, and their decision to collaborate may be explained by using different criteria than would be valid for research institutions.

This paper focuses on firm's point of view. It explores the intensity of the collaboration between business sector and research institutions in Croatia, and industry's satisfaction with this collaboration. In order to understand industry's decision to enter research collaboration, firms' motives for collaboration were explored. Apart from motivations, this study explored how some characteristics of firms and their environment influence the decision to collaborate. In particular, firms were asked about their technology and innovation orientation, their customers, their financial resources and support, and their opinion of academics. These factors can impact both how closely companies cooperate with research institutions, and how they are satisfied with the outcome of that collaboration.

This paper seeks to develop understanding of determinants of collaboration intensity and industry's satisfaction

with the collaboration. This is accomplished by investigating firms' motivations and firms' perceptions about themselves and their environment.

LITERATURE REVIEW

In the last ten years there have been a number of empirical studies regarding various aspects of industry-science collaboration. Carayol (2003) systematizes this literature in five streams: the study of the various forms of interactions, the study of collaboration agreements, the analysis of academics' aims for collaborating, the negative consequences on the academics' behavior, and finally firms' aims for collaborating.

Here we focus on literature review pertaining to the last topic, since this paper examines industry-science collaboration from firm's point of view focusing on firm's motivations and perceptions of themselves and collaboration environment.

Several empirical studies have explored firms' motivations for industry science collaboration and firms' view of that collaboration. Caloghirou et al. (2001) investigated the characteristics of university-industry collaboration in a large set of research joint ventures established in the context of European Framework Programs over a period of fourteen years. They found that firms collaborate with universities with the aim to achieve research synergies, to keep up with major technological developments, and to share R&D cost. The same study found that the major benefit that firms enjoy from that collaboration is enhancing their knowledge base, followed by improvements in production processes. Interestingly authors did not find significant impact of collaboration on product development.

Lee (2000) built a survey of 140 companies collaborating with universities. The study showed that firms collaborating with universities on R&D projects benefited in several ways. In particular, firms gained "increased access to new research and discoveries", the collaboration helped in making "significant progress toward the development of new products and processes", and finally firms were maintaining a closer relationship with the university.

Hall et al. (2001) studied contractual data from the US government ATP research program accompanied by questionnaires. The study explored whether intellectual property rights present an impediment to university-industry collaboration. The findings point out that intellectual property rights indeed can present an obstacle, depending

on intellectual property characteristics of the research project, expected results of the research project, and firm's previous experience collaborating with universities.

In a related study Hall et al. (2000) researched ATP projects data again. They found that the research projects involving universities were less likely to be prematurely ended than the other projects. From here authors concluded that such collaborative projects create certain "research awareness".

Adams et al. (2001) investigated firms that were involved in Industry University Cooperative Research Centers, and found that firms collaborate on projects where academics' research complements firm's own research.

Zucker and Darby (2000) studied university-industry collaboration in the setting of biotech firms, and showed that cooperating with "star scientists" had a positive impact on the number of patents granted, number of projects completing all three stages of pharmaceutical process and finally on the market.

Most studies to date are performed on developed economies. There are few empirical studies that investigated industry-science relationship in transition countries. Koschatzky (2002) investigated knowledge transfer between research and industry in Slovenia, and finds that although collaboration between large research institutes and companies is satisfactory, cooperation between universities and companies is weak. The only published study on the theme of industry-science cooperation in Croatia is by Švarc et al. (1996). Authors investigated science-industry links in Croatia and reported similar findings as Koschatzky (2002). In particular, their paper focuses on survey of academics and shows that Croatian academics have weak overall collaboration with industry.

DATA

The data for this study, which focuses on industry-science relationship in Croatia, was collected in spring of 2002. Survey work was preceded by exploratory research, during which in-depth interviews were conducted with R&D directors from ten firms and with scientists from ten academic institutions. The topics of interviews were industry-science collaboration, motivations, perceptions of the other partner, and perceived impediments for collaboration. The purpose of exploratory research was to address the specific features of industry-science collaboration in Croatia. In the preparation for exploratory interviews current literature (Lee, 2000 and Caloghirou et al., 2001) was

used as a guide. On the bases of exploratory research a survey instruments was constructed. Questions that were asked in the large survey were based on the exploratory in-depth interviews. We can say that the questionnaire was "written" by firms themselves, and as such reflect the specifics of Croatian environment.

Two hundred and thirty (230) firms were chosen for the survey. Those firms were registered as performing some technology-related activities, and also as having invested in R&D in the time period between 1997 and 1999[2]. This later condition ensured that only active firms were included. Out of 230 firms that were targeted, 190 responded. This represents the response rate of 82.6%. The survey instrument was a questionnaire, and respondents were R&D directors of selected companies who were surveyed over telephone.

In the remainder of this section I will explain variables used in the study, starting with variables that measure some basic facts about collaboration, continuing with variables pertaining to perceptions, and closing with variables describing motivations.

Collaboration intensity, quality and commercial effect

One of the first indicators of industry-science collaboration is how intensely firms engage in collaborative projects. Respondents were asked to indicate how intensely their company collaborates with researchers in Croatia; answers were offered on a Lickert scale from 1 (does not collaborate at all), to 5 (collaborates very intensely).

Except for the information about how closely firms collaborate with academics, we would like to know how satisfied firms are with that collaboration. To explore that issue, respondents were asked about quality and commercial effect of collaboration. The reason for separating collaboration quality and commercial benefit came from exploratory interviews. Some R&D directors said that although they find Croatian academics to be professional and willing to do their best, there are limitations when it comes to how much they can contribute to firm's bottom line. Since the absence of commercial benefit can impact company's propensity to engage in cooperative relationships, this variable was included in the analysis.

R&D directors were asked how they perceived the quality level of collaboration with research institutions in Croatia. Answers were offered on the Lickert scale starting from 1 (completely unsatisfactory), ending with 5 (exceptionally good). Market benefit of the cooperation was ex-

plored by a question asking respondents to rate commercial effect of the collaboration. Again a Lickert 5-point scale was offered, starting from 1 (completely unsatisfactory), ending with 5 (exceptionally good).

Some Croatian firms collaborate with foreign research institutions and consultants. In fact, Croatian academics believe that this is quite prevalent practice among companies that do engage in cooperation. In order to determine the magnitude of this cooperation, two questions were asked. One asked if respondent's company collaborates with foreign research institutions, and the other question investigates whether they collaborate with foreign consultants. Both questions offered only yes and no answers.

Motivations

In exploratory interviews with firms and subsequent questionnaire preparation, current literature was used as a guide (Lee, 2000 and Caloghirou et al., 2001). However, in-depth interviews conducted during the exploratory phase showed that some of the motivations that firms have in developed economies (EU and USA), were not considered important by Croatian firms, or respondents did not think they applied to Croatian situation. In addition, some motives, that were not present in other studies, were discovered during exploratory interviews. For example, cooperation in Croatia can happen quite often purely because of formal regulations. Another specificity of Croatian study is that in some cases collaboration exists because firms need the name of the research institution as a proof of quality and/or reliability of their products (for example if a product is tested at a well-respected research institute, customers are more likely to believe in its quality)[3].

As a result of exploratory interviews, five motivation statements were formulated. These statements are presented in table 1. Respondents were presented with motivation statements from table 1, and asked to indicate their agreement on a Lickert scale starting from 1 (completely disagree), ending with 5 (completely agree).

• Access to new technologies which bring competitive advantage
• It is more efficient to use existing potential then to develop own
• The name of research institution can be used as a proof of quality (the product is tested by...)
• The need to solve a concrete problem
• Collaboration happens only because it is enforced by regulations, laws or other legal reasons

Table 1
Firms' motivations for collaboration with research institutions

Firm perceptions of themselves, academics, and business environment

In order to fully understand the firm's point of view in industry-university collaboration, we need to have more information about the firms. In literature, firm characteristics that are linked with collaboration include mostly size, sector and country of the plant (Carayol, 2003; Hall et al., 2001). Some studies also include R&D budget, and number of R&D staff (Adams et al., 2001). Zucker and Darby (2001) in their study of collaboration in biotechnology industry also specify variables like the number of patents, number of products in development, and number of products on the market. Although in this study we also collect information like firm size, R&D budget, number of patents and number of new products on the market, in order to gain deeper understanding we go beyond descriptive statistics to include firm's perceptions on themselves, academics, and their environment as it concerns collaboration.

In this study there are 18 questions investigating firm's perceptions about various issues regarding their industry-science relationships (please see table 2 for the list of questions). The questions were presented as statements; respondents were asked to indicate their agreement with the statements on a five-item Lickert scale starting from 1 (completely disagree), ending with 5 (completely agree). As was the case with motivations statements, the literature was a starting point for exploratory interviews with R&D directors. The mentioned 18 questions were formulated on the bases of these interviews.

In order to reduce the quantity of information, factor analysis was performed. The result of the factor analysis is five factors presented in table 2.[4] Considering the items that load on particular factors, the factors were named *Innovation and technological capacity, Ability of research institutions, Banks investors and taxes, External orientation* and *Customers*.

Factor *Innovation and technological capacity* explains the largest percent of variance. This factor deals with the importance of innovation and technologies, the existence of long-term vision in the firm, and the existence of well-trained people who have the ability to hook up with academics and make the collaboration happen.

Ability of research institutions speaks to the applicability of research performed in academia and adequate level of equipments in research institutions. Another statement that loads on this factor is preference for foreign consul-

tants over domestic research institutions. This last statement also speaks to the ability of researchers because it is indicative of how companies view capability of domestic researchers to resolve companies' actual problems.

Financial environment is addressed in the third factor *Banks investors and taxes*. The factor includes firm's own financial resources, the propensity of banks and investors to finance firm's innovation efforts, and the tax incentives for innovation. Interestingly, this factor also picks up whether the firm is oriented toward solving mostly short-term problems. When financial support does not exist, firms do not have sufficient resources to engage in long-term projects, and consequently they are occupied by resolving the most pressing problems.

Factor *External orientation* refers to things that firms receive from their environment. This includes advanced technology and highly skilled employees. This factor also includes the importance of networking for innovation.

Factor *Customers* addresses how supportive customers are of innovation efforts, and how demanding of innovation they are.

Table 2
Firm perceptions of themselves, academics and business environment: perceptions factors[5]

Factor	
Innovation and technological capacity	• Your company has a long term vision • Innovations are considered very important in your company • New technologies are considered very important in your company • There are people in your company who have knowledge to serve as liaison between the company and research institution • Your company has access to advanced technologies
Ability of research institutions	• Research institutions are not adequately equipped • Academics work on things that are not applicable • Your company prefers to hire foreign consultants than local research institutions
Banks, investors and taxes	• Banks and investors are mostly ready to support your innovation efforts • Tax system in Croatia gives incentives to innovation efforts in your company • Your company has sufficient financial resources for research and development • Your company is oriented mostly to solving short-term problems
External orientation	• Easier access to advanced technologies would help your company to become more innovative • Your company has no difficulties in attracting highly educated employees • Networking for innovation is considered very important for your company
Customers	• Your customers are very interested in innovative products and services • Your customers are supportive of your innovation activities

DATA ANALYSIS AND RESULTS

Intensity of collaboration

The most basic information one can collect about industry-science collaboration is whether firms collaborate and how intensely they collaborate with research institutions. An obvious question that arises here is why some firms collaborate more closely than the others. One would expect that there are differences between firms that cooperate closely, and those that cooperate less closely; the important question is where these differences lie. For example, we would expect that firms where innovations and technologies are more important have closer ties with academics, as improvements in new products and access to new technologies were found to result from such collaborative relationships (Caloghirou et al., 2001; Lee, 2000). We would expect firms that have good opinion of academics to have more intense contact with them. Firms that are oriented toward networking possibly also have closer contact with research institutions. Financial resources are another factor that can determine the level of collaboration. Also, it is possible that firms that have more intense collaboration do so because they have very demanding customers who by asking for new and innovative products instigate innovation efforts that involve collaboration with research institutions.

To investigate which of the above issues has bearing on the collaboration intensity, regression analysis was conducted with intensity as dependent variable and factors *Innovation and technological capacity, Ability of research institutions, Banks investors and taxes, External orientation*, and *Customers* as independent variables. Best subsets polynomial regression method was employed (adjusted R^2=0.12, F=7.42). The only significant factor yielded by this analysis is *Innovation and technological capacity* (t=4.69, p=0,000005). To confirm that result, ordinal probit was used with the same dependent variable and predictors. Again, the only significant factor is *Innovation and technological capacity* (Wald stat.=19.12, p=0.000012). Interestingly, neither ability of researchers, financial resources nor customers have any significant impact on collaboration intensity. The only significant effect came from *Innovation and technological capacity*, meaning that firms which see themselves as innovation and technology oriented are more likely to engage in cooperation with research institutions.

To understand what compels some companies to collaborate more closely with academics than other compa-

nies, we need to look into their motivations. We have seen that companies seek collaboration with research institutions for various reasons (the list of motivations is presented in table 1), and it is possible that some of these reasons can result in a more intense collaboration. To explore this question, relationships between intensity of collaboration and motivations were investigated. Intensity of collaboration was used as the dependent variable and motivation variables were used as predictors in polynomial regression, best subsets method (adjusted R^2 is 0.16, F=8.39). Three motivation variables were significant, namely *access to new technologies and processes*, *effectiveness of using existing research resources instead of developing own*, and *need to resolve concrete problems*. Ordinal probit analysis was used to verify these results. Again, *access to new technologies and processes* (estimate=–0.23, Wald st.=8.19, p=0.004), and *need to resolve concrete problems* (estimate=–0.2, Wald st.=0.08, p=0.02) are significant, while effectiveness of using existing research resources is not significant to 10% level. This result is in tune with existing literature, as both *access to new technologies and processes* and *need to resolve concrete problems* were indeed found in other studies (Lee, 2000 and Caloghirou, 2001). Please see table 3 for details.

Table 3
Collaboration intensity as a function of motivation factors

Motivation variables	Estimate	Statistics
Access to new technologies and processes	0.18 linear term	Linear term t=2.78, p=0.006
Effectiveness of using existing research resources instead of developing own	0.97 linear term	Linear term t=3.14, p=0.002
	-0.14 quadratic term	Quadratic term t=–2.89, p=0.004
Need to resolve concrete problems	0.02 quadratic term	Quadratic term t=2.81, p=0.006

Without doubt, we can say that *access to new technologies and processes* is one of the main predictors of collaboration intensity. The more important it is to the firm to have this access, the more it will collaborate with academics. Regarding *need to resolve concrete problems*, the more important that issue is to the firms, the more intensive will be the collaboration with academics.[6] Both these results support findings of Lee (2000) and Caloghirou (2001). We need to be careful in interpretation of the *effectiveness of using existing research resources instead of developing own*, as it comes out as significant in regression but not in ordinal probit. This might be due to the non-linear relationship.

More precisely, as the importance of using existing resources increases, the intensity increases to some point, but after that collaboration intensity declines. This indicates that by itself, the need to substitute own resources by those owned by academics is not sufficient to explain very high collaboration intensity levels. Formal reasons for collaboration like regulations and using institution name do not appear to be significant in predicting collaboration intensity.

Satisfaction with collaboration

Except for collaboration intensity, another indicator that can give us insight into the collaboration is satisfaction with collaboration quality and satisfaction with commercial benefit of that collaboration. We would expect to observe that firms, which have closer relationship with academics, are more satisfied with its quality, because otherwise there would be no reason for them to keep up that partnership. Correlation analysis shows that collaboration intensity is significantly correlated with collaboration quality ($r=0.4$, $p=0.000$).

As expected, quality and commercial effect are also correlated ($r=0.55$, $p=0.000$), indicating that firms that are happier with the quality of cooperation also give higher ratings to its commercial outcome. Interestingly, commercial effect of collaboration (rating 2.94) is rated significantly lower than collaboration quality (rating 3.52, t-test statistics $t=7.73$). Although it may be difficult for R&D directors to correctly assess commercial effect of academic collaboration due to the fact that industry projects are based on teamwork where academics participate in certain phases (instead of being involved continually from the beginning to the end, as mentioned in Lee 2000), the significantly lower score of commercial effect merits attention. This interesting finding requires special consideration in a country like Croatia, which is trying to improve industry-science relationships. One reason for that discrepancy might be the poor choice of projects (non-ambitious or routine projects with no commercial impact). Another reason may be inability of academics to offer solutions to problems that would have real commercial impact (either due to lack of equipment, the lack of relevant knowledge and information about the most recent research in that area, etc.).

We have seen that firms differ in their rating of collaboration quality. We can argue that firm's rating would depend on how advanced the firm is in technology and in-

novations, on firm's financial resources, on firm's opinion of academics etc. To explore that issue, the relationship between collaboration quality rating and factors *Innovation and technological capacity, Ability of research institutions, Banks investors and taxes, External orientation*, and *Customers* was examined. Methods of analysis were again polynomial regression, and ordinal probit, where quality was used as dependent variable. Best subsets regression method yields two significant factors, *Innovation and technological capacity*, and *External orientation* (adjusted R^2=0.12, F=5.17). Please see table 4 for details.

Table 4
Collaboration quality as a function of firm and environment factors

Motivation variables	Coefficient	Statistics
Innovation and technological capacity	Linear term estimate=0.34	Linear term t=4.36, p=0.00002
External orientation	Linear term estimate=0.15	Linear term t=2.07, p=0.04

This relationship is re-checked using ordinal probit analysis, which yields one significant factor *Innovation and technological capacity* (coefficient=–0.35, Wald=14.7, p=0.0001). Factor *External orientation* is somewhat significant (coefficient=–0.15, Wald=3.37, p=0.066). Probit analysis confirms the findings from regression analysis. These findings show that the only significant impact on collaboration quality is due to the factor *Innovation and technological capacity*, and to some extent to the factor *External orientation.* This indicates that those firms where innovation and technology are important, that have long-term vision and high quality employees, tend to rate quality of collaboration higher. Also firms that are more oriented toward networking tend to rate their collaborations as higher quality. Interestingly, perceived ability of academics does not have significant influence on collaboration quality rating.

As seen in exploratory interviews, although firms can be satisfied with collaboration quality, they need not rate commercial effect very highly. We have shown that indeed companies regard commercial benefit of collaboration as significantly lower than collaboration quality. To gain deeper insight into what could drive this result, we seek to find a relationship between commercial effect rating and factors *Innovation and technological capacity, Ability of research institutions, Banks investors and taxes, External orientation*, and *Customers.* Polynomial regression best subset method was performed (adjusted R^2=0.08, F=4.33), and it yields that the only significant factor is *Innovation and technological capacity*. Factor *Banks, investors and taxes* is somewhat significant. Please see table 5 for details.

Table 5
Commercial effect as a function of firm and environment factors

Motivation variables	Coefficient	Statistics
Innovation and technological capacity	Linear term estimate=0.27	Linear term t=3.31, p=0.001
Banks investors and taxes	Linear term estimate=0.14	Linear term t=1.77, p=0.08

Ordinal probit analysis was conducted to confirm significance of the two mentioned factors. *Innovation and technological capacity* is significant (coefficient=–0.28, Wald=10.33, p=0.001), and *Banks, investors and taxes* as well (coefficient=–0.17, Wald=4.02, p=0.04, log-likelihood=–223.9). This means that firms that see themselves as innovation and technology oriented are more satisfied with commercial benefit of cooperation. Interestingly, the only other factor that has implications on commercial benefit is availability of financial resources for innovation. How can we explain these findings? Firms that are more innovation and technology oriented are able to engage in more demanding and innovative projects, where contribution of outside researchers is crucial. Projects of that type have potentially greater market impact. Being more research savvy, such firms can also better define the contribution that they expect from academics. Taking this in account, it is not surprising that this contribution would be rated as commercially more valuable than in other firms. In similar vain, companies that have sufficient financial resources and support from banks, investors and tax system are more likely to engage in challenging and innovative projects where faculty input is crucial and potential market impact is greater.

To explore whether satisfaction with collaboration quality depends on motivations for entering into collaborative relationship, quality of collaboration was regressed on motivations using polynomial regression, best subsets method (adjusted R^2=0.15, F=6.54). There are three motivations that are significantly related to quality rating. More precisely, these are *using the name of research institution, the need to solve a concrete problem,* and *enforcement from outside.* As the first two motivational factors increase, the quality rating increases as well. Interestingly, as *enforcement from outside* increases, the quality rating decreases, indicating that as the enforcement from outside gains in importance, the collaboration will be perceived as lower quality. Please see table 6.

Motivation variables	Estimate	Statistics
Using the name of research institution (The name of research institution can be used as a proof of quality (the product is tested by...)	Linear term estimate=0.18	Linear term t=2.78, p=0.006
The need to solve a concrete problem	Quadratic term estimate=0.03	Quadratic term t=2.77, p=0.006
Enforcement from outside (Collaboration happens only because it is enforced by regulations, laws or other legal reasons)	Linear term estimate=-0.1	Linear term t=-2.02, p=0.04

Table 6
Collaboration quality as a function of motivation factors

It is conceivable that firms rate commercial benefit of collaboration with academics differently depending on their motivations for cooperation. Exploring this connection between commercial effect and motivation could potentially shed some light on the discrepancy between quality rating and commercial benefit rating. To establish a connection between commercial effect of collaboration and motivations, commercial effect of collaboration was used as dependent variable while motivations were used as predictors. Polynomial regression, best subsets method, was employed (adjusted R^2=0.20, F=11.17). Please see table 7 for details.

Motivation variables	Estimate	Statistics
Using the name of research institution (The name of research institution can be used as a proof of quality (the product is tested by...)	Linear term estimate=0.86	Linear term t=2.68, p=0.008
	Quadratic term estimate=-0.11	Quadratic term t=-2.21, p=0.03
The need to solve a concrete problem	Linear term estimate=0.23	Linear term t=3.5, p=0.0006
Enforcement from outside (Collaboration happens only because it is enforced by regulations, laws or other legal reasons)	Quadratic term estimate=0.03	Quadratic term t=2.94, p=0.004

Table7
Commercial effect as a function of motivation factors

Interestingly, the same motivations appear to be significant both for commercial effect rating and for quality rating, but in slightly different way. The relationship between *using the name of research institution* and commercial effect rating is non-linear, more precisely as using institution's name increases in importance commercial effect will

be perceived as better, but only up to a point after which this trend reverses. Motivational variable *enforcement from outside* is positively related to commercial effect, indicating that although being forced in collaboration negatively reflects on perception of quality, fulfilling these requirements from outside may enable the firm to cash in on results (by gaining access to some markets for example), which reflects positively on perception of commercial benefit.

Collaboration with foreign research institutions

In exploratory interviews with academics, a lot was said about propensity of Croatian industry to seek academic expertise in foreign research institutions. To test whether that is true, we counted firms that do collaborate with foreign academics and those firms that collaborate with domestic research institutions. Croatian academics seem to think that out of firms that do have collaborative relationships, many more collaborate with foreign instead of domestic institutions. However, the data does not support that (Pearson chi square is 1.39, p=0.24).

One reason why firms would cooperate with foreign institutions is if they are not happy with what they can get from research institutions at home. If that is true, then those firms that cannot find a suitable domestic institution indeed can be expected to form research partnerships abroad. In other words, collaboration with foreign research institutions can depend on intensity and satisfaction with domestic partners. To examine whether domestic collaboration has any effect on relationships with foreign researchers, we use information on collaboration intensity with domestic institutions, satisfaction with quality and satisfaction with commercial effect of such collaboration. When collaboration intensity with domestic institutions, quality and commercial effect of such collaboration were used as predictors, only intensity has significant bearing on collaboration with foreign institutions. Since collaboration with foreign institutions was a yes-no question, logit analysis was used (estimate=0.51, p=0.01, loglikelihood=–102).

The findings indicate that satisfaction with domestic collaboration is not a significant predictor. In other words, if a company is unhappy with domestic researchers, we cannot predict that it will try to find a better partner abroad. Although the satisfaction does not impact foreign collaboration, the data shows that intensity of domestic collaboration does have bearing on foreign collaboration. In other words those firms that collaborate more intensely

with academics at home are also more likely to collaborate with foreign researchers.

To understand better the above results, we need to investigate whether propensity to cooperate with foreign researchers depends on some firm characteristics. Firms that do collaborate with foreign institutions may have different characteristics from those that do not engage in that practice. A natural thought is that, since foreign researchers are more expensive, larger firms will be more likely to partner with them because they have more resources. Interestingly, logit analysis shows that the firm size is not significantly related to collaboration with foreign institutions. Although size is the easiest thing to explore, richer source of information are firm's perceptions about innovation, financial support, customers, etc. contained in the five perception factors. To explore if companies that do have such cooperation differ in those factors, the foreign collaboration was explored against factors *Innovation and technological capacity, Ability of research institutions, Banks investors and taxes, External orientation*, and *Customers* using logit analysis. The only significant factor is *Innovation and technological capability* (estimate=0.56, p=0.002, loglikelihood=–113.6). Factor *Banks, investors and taxes* is significant to 10% level (coefficient=0.28, Wald st.=2.89, p=0.09). This indicates that companies that perceive themselves as innovation and technology oriented tend to collaborate with foreign researchers (these companies tend to cooperate with academics at home as well). To some extent financial resources are also important because the cost of such cooperation is higher. Interestingly, companies' opinion of academics' ability has no bearing on whether they hire foreign researchers.

To explore the foreign collaboration further, firms were asked about cooperation with foreign consultants. Interestingly the same factors *Innovation and technological capacity* (coefficient=0.43, Wald st.=7.81, p=0.005) and *Banks, investors and taxes* (coefficient=0.33, Wald st.=4.53, p=0.03) appear as significant in logit analysis. Overall fit is given by log-likelihood=–122.7. Again we observe that innovation and technology-oriented firms tend to work with foreign consultants. Since consultants are hired on projects of lesser research complexity, financial matters become more important here than in cooperation with foreign researchers.

CONCLUSION AND RECOMMENDATIONS

This study focuses on industry-science collaboration in Croatia from firms' point of view. This paper attempts to shed more light on intensity of collaborative relationships and resulting satisfaction by considering firms' motivations and characteristics.

The most significant predictor of collaboration intensity, satisfaction with collaboration quality and satisfaction with commercial effect of collaboration is innovation and technological capacity of the firm. Possessing that capacity includes attributing high importance to innovations and technology, having access to advanced technologies, having long-term vision and highly skilled employees. Such firms are more likely to intensely collaborate with researchers in Croatia, and they tend to be satisfied with the collaboration quality and commercial effect. Such firms are also inclined to have collaborations with foreign researchers and consultants. The strongest motivation for firms with innovation and technological capacity is access to new technologies and processes.[8] In general (for all firms) data shows that except for access to new technologies and processes, the need to resolve concrete problems is another important motive. The more important either of these two motives is to the firm, the more intensely it will collaborate with academics. Contrary to expectations, factors like ability of researchers, financial resources, and demanding customers do not have any significant impact on collaboration intensity. It is surprising that perceived ability of academics does not have significant influence neither on collaboration quality rating, nor on commercial benefit rating.

Another factor that contributes to collaboration quality rating is firm's networking orientation. Firms with stronger external orientation are more satisfied with collaboration quality, but this does not carry through to satisfaction with commercial benefit. Firms that have better financial backing will express more satisfaction with commercial results.

Although firms that are motivated by access to new technologies and the need to resolve concrete problems are likely to have more intense collaboration with researchers, only the need to resolve concrete problems is linked both to the perception of quality and to the commercial benefit. Firms recognize that solving concrete problems does bring commercial results. Except for solving problems, both measures of satisfaction are positively related to using institution's name as a proof of quality. If firm is

forced into collaboration by some regulations or legal requirements, it is likely that this will reflect negatively on the perception of collaboration quality. Although being forced in collaboration negatively reflects on perception of quality, fulfilling formal requirements imposed from outside may enable the firm to cash in on results (by gaining access to some markets for example), which reflects positively on perception of commercial benefit.

An interesting result is discrepancy between average rating for collaboration quality and average rating for commercial effect of collaboration, where commercial effect is significantly lower. This interesting finding requires special consideration in a country like Croatia, which is trying to improve industry-science relationships.

These insights can be useful to policy makers in situations when they have to make decisions on which actions to take to promote industry-science relationship. This study indicates that incentives aimed at strengthening firm's innovation and technological capacity may have positive impact on intensity of collaborative relationships. In other words, helping firms to become more innovation and technology oriented might induce them to form more intense relationships with researchers.

This study also shows that policy makers should use caution when promoting collaboration through regulations, or through other formal and legal means. Promoting collaboration by means of formal requirements directed at firms does not have significant impact on how intensely firms collaborate with researchers. These interventions tend to lower the perceived quality of collaboration, which in turn might further weaken firms' intention to collaborate. Resources spent in formulating and enforcing regulations might fail to yield desired outcome. Instead, resources might be better spent for incentives aimed at improving industry's innovation and technological capability.

FOOTNOTES

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[1] The study was financed by Ministry of Science and Technology, and performed by Ekonomski institut, Zagreb

[2] Those 230 firms represented total population of firms in Croatia which satisfied both conditions.

[3] Interestingly both formal regulations and using institution's name were mentioned by academics as well.

[4] By eigenvalue criterion 6 factor solution was chosen. Since the last factor had eigenvalue almost equal to 1, five factor solution was compared to 6 factor solution. Since the last factor in the 6 factor solution was difficult to interpret, 5 factor solution was chosen.

[5] Number of variables: 18

Method: Principal components, Varimax normal rotation

log(10) determinant of correlation matrix: -1.9043

Number of factors extracted: 5

Eigenvalues: 3.93621 1.80007 1.55676 1.39979 1.33195

[6] We need to be cautious in using this finding, as the coefficient is rather low although it is significant.

[7] Correlation r=0.28, p=0.0000

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