

Influence of Different Information Sources of Innovation Performance: Evidence from France, Netherlands and Croatia

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Abstract

The analysis on the determinants of various kinds of innovation activities is one of the main issues that could help firm to advance its innovation activities. However, there is limited systematic knowledge about factors that motivate firms to improve innovation performance. What more, it is particularly important to learn more about information sources as the driving forces of different innovations intensity levels since they may vary in different countries. Community Innovation Survey (CIS) tracks the record of the usage of different information sources as the drivers of innovation activities in European Union Countries, as well as other European countries. Current research has been conducted usually on the usage of one country as the sample. Research that would investigate the differences among larger number of countries (three or more) is scarce. The goal of this research is to investigate to what extent the usage of different information sources influences the innovative activities in three countries: Croatia, France and Netherlands, by using CIS data, which covers the period from 2006 to 2008. Two dependent variables have been used in the research, measuring R&D internal activities, and R&D external activities. Following information sources are been used as explanatory variables: firm, suppliers, customers, competitors, consultants, universities, government, and conferences. Our results revealed that firm, supplier, customers, institutions and universities are important information sources for innovation activities in all three countries. In addition, competitors are not been found as the significant information source in any of the investigated countries. Governmental institutions and conferences have a different impact in different countries.

Keywords: information sources, innovation intensity, Croatia, France, Netherlands

JEL classification: O32, D83

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1. Introduction

Innovation is today considered as one of the main drivers of the contemporary economics. A vast number of researches have been conducted in order to investigate the drivers of innovation (e.g. Bigliardi & Dormio, 2009; Gronum et al., 2012; Waychal et al., 2011). Among those, information sources are one of the most important drivers of innovations (Quintane et al., 2011).

Information sources are one of the most important drivers of innovation (Varis & Littunen, 2010). Number of researchers has investigated different information sources that could impact the innovation activities of firms (e.g. Leiponen et al., 2011; Herstad et al., 2014). Community Innovation Survey (CIS), as one of the most important sources of knowledge on innovation activities, collects the data on the usage of different information sources for innovation (Tether, 2001; Fagerberg et al., 2012). CIS is the result of a significant increase in the importance given to innovation issues at the EU level. CIS is comprehensive in terms of the range of questionnaire items, including direct measures of innovation performance and a wide variety of factors influencing innovation (Salazar & Holbrook, 2004; Bloch, 2007). CIS tracks the usage of the following information sources as the drivers of innovation: firm, suppliers, customers, competitors, consultants, universities, government, and conferences. Research on the impact of different information sources on innovation activities is usually conducted on only one country (e.g. Segarra-Blasco & Arauzo-Carod, 2008). Research conducted on the sample of three and more countries is scarce. One example is the research conducted by Griffith et al. (2006) that revealed that the usage of information sources is somewhat different in France, Germany, Spain and UK.

Motivated by this issue, this paper presents an empirical examination of the influence of different information sources to innovation performance in three countries: France, Croatia and Netherlands. The data are derived from cross-sectional survey called 'Community Innovation Survey' (CIS8) which covers the period from 2006 to 2008 and is based on the Oslo Manual drawn up by the OECD. Additionally, we use CIS8 from three countries, France, Netherlands and Croatia. The CIS8 in France is carried out by Ministry of Economics, Finances and Industry while in Croatia CIS8 survey is carried out by Central Bureau of Statistics. The French sample contains 19,901 observations, Netherlands sample contains 10,612 observations, and Croatian sample contains 3,333 observations.

In order to examine the influence of different information sources related to innovation performance on R&D activities we use two indicators. The first called R&D internal is a binary variable indicating if during the three years 2006 to 2008, firm engaged in creative work to increase the stock of knowledge for developing new and improved products and processes. The R&D external is also binary variable which measure if during the three years 2006 to 2008, firm engaged in firm with other partners engaged in creative work to increase the stock of knowledge for developing new and improved products and processes.

Therefore, this paper will provide important insights into how the firms from different countries perceive and engage in using different information sources as the drivers of innovation activities, which may help firm's managers and policy-makers to improve targeting of their policies and strategies of acquiring information as the driver of innovation.

2. Methodology

The data are derived from cross-sectional survey called ‘Community Innovation Survey’ (CIS8) which covers the period from 2006 to 2008 and is based on the Oslo Manual drawn up by the OECD. The Community Innovation Survey is the result of a significant increase in the importance given to innovation issues at the EU level. The CIS surveys are comprehensive in terms of the range of questionnaire items, including direct measures of innovation performance and a wide variety of factors influencing innovation. Additionally, we use CIS8 from three countries, France, Netherlands and Croatia. The CIS8 survey in France is carried out by Ministry of Economics, Finances and Industry, the data from Netherlands is created by Statistics Netherlands while in Croatia CIS8 survey is carried out by Central Bureau of Statistics. The French sample contains 19,901 observations, Netherlands sample contains 10,612 observations, and Croatian sample contains 3,333 observations.

2.1. Dependent Variable

In order to examine the influence of different information sources related to innovation performance on R&D activities we use two indicators. The first called **R&D internal** is a binary variable indicating if during the three years 2006 to 2008, firm engaged in creative work to increase the stock of knowledge for developing new and improved products and processes. The **R&D external** is also binary variable which measure if during the three years 2006 to 2008, firm engaged in firm with other partners engaged in creative work to increase the stock of knowledge for developing new and improved products and processes.

Dependent variables are:

- **R&D internal:** During the three years 2006 to 2008, firm engaged in creative work to increase the stock of knowledge for developing new and improved products and processes; Dummy variable (=1 if yes)
- **R&D external:** During the three years 2006 to 2008, firm engaged in firm with other partners engaged in creative work to increase the stock of knowledge for developing new and improved products and processes; Dummy variable (=1 if yes)

2.2. Explanatory Variables

Since firms gain new ideas from a different variety of sources we use eight dummy variables that represent different types of information sources for firm’s innovativeness. More precisely, we use variable **Firm** which is a binary variable that takes value 1 if important information sources are firm; **Supplier** is a binary variable that indicates if a firm’s important information sources are suppliers of equipment, materials, components, or software; variable **Customer** indicates that customers are a firm’s important information sources; variable **Competitors** takes value of 1 if competitors are a firm’s important information sources; **Institutions** takes value of 1 if institutions are a firm’s important information sources; binary variable **Universities** equals 1 if universities are a firm’s important information sources; variable **Government** gives us an answer if government is a firm’s important information sources; finally **Conferences** present binary variable that takes value 1 if conferences are a firm’s important information sources.

Explanatory variables are:

- **Firm:** During the three years 2006 to 2008, important information sources were firm; Dummy variable (=1 if yes)
- **Supplier:** During the three years 2006 to 2008, important information sources were Suppliers of equipment, materials, components, or software; Dummy variable (=1 if yes)
- **Customer:** During the three years 2006 to 2008, important information sources were customers; Dummy variable (=1 if yes)
- **Competitors:** During the three years 2006 to 2008, important information sources were firm; Dummy variable (=1 if yes)
- **Consultants:** During the three years 2006 to 2008, important information sources were competitors or other firm in the sector; Dummy variable (=1 if yes)
- **Universities:** During the three years 2006 to 2008, important information sources were Universities or other higher education institutions; Dummy variable (=1 if yes)
- **Government:** During the three years 2006 to 2008, important information sources were Government or public research institutes; Dummy variable (=1 if yes)
- **Conference:** During the three years 2006 to 2008, important information sources were Conferences, trade fairs, exhibitions; Dummy variable (=1 if yes)

2.3. Control Variables

Following previous studies we use several control variables such as **Size, Holding, Market, Funding** and **Sector of Activity** that we are found to be important drivers of R&D activities (e.g. Harris et al., 2006; Harris & Trainor, 2011).

Control variables are:

- **Size:** Size of the firm; Continuous variable
- **Holding:** Belong to a holding group; Dummy variable (=1 if yes)
- **Local:** The firm has sold its products or/and services on local market during last three years; Dummy variable (=1 if yes)
- **National:** The firm has sold its products or/and services in France during last three years; Dummy variable (=1 if yes)
- **EU:** The firm has sold its products or/and services in other European Union (EU), EFTA or EU candidate countries during last three years; Dummy variable (=1 if yes)
- **Local – the most important market:** Local market as the most important market; Dummy variable (=1 if yes)
- **National – the most important market:** National market as the most important market; Dummy variable (=1 if yes)
- **Funding:** Public funding from local or regional authorities, central government, the EU, EU's 6th or 7th Framework Programme for RTD; Dummy variable (=1 if yes)
- **Sector of activity:** The main activity of the firm is active in particular sector; Dummy variable (=1 if yes)

The variables used in estimation and sample statistics for France, Croatia and Netherlands are presented in Table 1.

Table 1. Definition of variables and sample statistics

Variables	France		Netherlands		Croatia	
	Mean	SD	Mean	SD	Mean	SD
Dependent variables						
R&D internal	0.23	0.42	0.18	0.39	0.19	0.39
R&D external	0.10	0.30	0.10	0.30	0.14	0.35
Explanatory variables						
Firm	0.32	0.46	0.26	0.44	0.29	0.45
Suppliers	0.20	0.40	0.21	0.41	0.26	0.44
Customers	0.20	0.40	0.20	0.40	0.24	0.43
Competitors	0.13	0.34	0.13	0.33	0.17	0.37
Consultants	0.07	0.26	0.07	0.26	0.09	0.28
Universities	0.05	0.22	0.05	0.22	0.07	0.25
Government	0.04	0.19	0.04	0.19	0.04	0.20
Conferences, trade fairs and exhibitions	0.12	0.33	0.10	0.30	0.19	0.40
Control variables						
Size	268.56	2549.25	204.93	3314.00	127.49	441.67
Holding	0.63	0.48	0.54	0.50	0.26	0.44
Local	0.85	0.35	0.73	0.45	0.89	0.32
National	0.58	0.49	0.68	0.46	0.50	0.50
EU	0.34	0.47	0.43	0.49	0.37	0.48
Other	-	-	-	-	0.28	0.45
Local – the most important	0.58	0.49	0.36	0.48	0.60	0.49
National – the most import.	0.33	0.47	0.38	0.48	0.23	0.42
Funding	0.07	0.26	0.09	0.29	0.10	0.31
Manufacturing	0.29	0.45	-	-	0.42	0.50
Agrifoods	0.06	0.23	-	-	-	-
Services	0.23	0.42	-	-	0.19	0.40
Finance	0.02	0.15	-	-	-	-
Sales	0.22	0.42	-	-	0.11	0.31
Construction	0.05	0.22	-	-	0.16	0.37
Transport	0.12	0.32	-	-	0.06	0.24
Food, nutrition & flowers	-	-	0.08	0.26	-	-
High tech systems & materials	-	-	0.13	0.34	-	-
Life science	-	-	0.07	0.25	-	-
Main ports & logistics	-	-	0.35	0.48	-	-
Shipping	-	-	0.07	0.25	-	-
Chemical industry	-	-	0.11	0.31	-	-
Creative industry	-	-	0.13	0.34	-	-
Energy	-	-	0.04	0.21	-	-

Source: Authors' calculation based on CIS French, Croatian and Netherlands data

2.4. Empirical strategy

Following previous literature, the following econometric specifications are estimated to shed light on firm's characteristics that drive cross-country R&D activities:

$$Y_i^* = \alpha + \sum_{i=1}^{16} \beta_i X_i + \mu_i, \quad i = 1, 2, \dots, N. \quad (1)$$

where X_i represents the vector of variables for different source of innovation and control ones; $\beta_1 - \beta_{16}$ are slope coefficients to be estimated and α and μ are the intercept and the disturbance term, respectively. The model of firms' R&D activities is stated as a discrete-choice model, with the dummy variables indicating R&D activities, internal and external, as the dependent variables Y_i :

$$\begin{aligned} Y_i &= 1 \quad \text{if } Y_i^* > 0, \\ Y_i &= 0 \quad \text{otherwise.} \end{aligned} \quad (2)$$

We specified logistic distributions for μ and maximized the log-likelihood of the logit models (Greene, 2003) to estimate models' parameters up to a positive constant.

3. Results

The first goal of the present study is to examine the relationship between different types of sources of innovation on R&D performance. Tables 2, 3 and 4 provide this information.

Table 2. The impact of source of innovation on R&D – France Sample

	Internal R&D		External R&D	
	Estimate	SE	Estimate	SE
Intercept	-3.24***	0.13	-4.65***	0.15
Firm	3.10***	0.07	2.41***	0.10
Suppliers	-0.03	0.06	0.25***	0.06
Customers	0.83***	0.06	0.29***	0.07
Competitors	0.05	0.07	0.04	0.07
Consultants	0.24***	0.09	0.69***	0.07
Universities	0.62***	0.13	0.21***	0.10
Government	0.33***	0.14	0.35***	0.11
Conferences, trade fairs, exhibitions	0.49***	0.07	0.12*	0.07
Size	0.00***	0.00	0.00***	0.00
Holding	0.14***	0.06	0.71***	0.06
Local Market	-0.29***	0.07	0.05	0.07
National	0.26***	0.08	0.07	0.10
EU market	0.41***	0.07	0.17*	0.09
Local – the most important	-0.41***	0.11	-0.31***	0.11
National – the most import.	-0.06	0.10	-0.18**	0.08
Funding	1.30***	0.10	0.83***	0.07
Agrifood	-0.02	0.11	-0.31***	0.11
Services	-0.22***	0.07	-0.38***	0.08
Finance	-0.36***	0.15	-0.19	0.16
Commerce	-1.02***	0.08	-0.34***	0.09
Construction	-0.95***	0.14	-0.40***	0.17
Transport	-0.01	0.11	-0.27***	0.14
Tests of global quality				
Test of prediction model (concordant percentage)	94.4		90.7	
Test of global nullity (likelihood ratio)	1264.7319***		4718.6537***	
Number of observations	19 901		19 901	

Notes: (*), (**) and (***) indicate parameter significance at the 10, 5 and 1 percent level, respectively; reference for sector activity: manufacturing

We can notice from Table 2 that six out of eight examined sources influence positively and significantly internal R&D activities in French firms. More precisely, only suppliers and competitors are not relevant as sources for firm's internal R&D improvement. Interestingly, when looking at external R&D activities, we may conclude that suppliers play significant role as a source of external R&D activities. In this sense, it is obvious that only competitors are not significantly related to external R&D activities.

Table 3. The impact of source of innovation on R&D – Netherlands Sample

	<i>Internal R&D</i>		<i>External R&D</i>	
	Estimate	SE	Estimate	SE
Intercept	-4.58***	0.31	-4.81***	0.32
Firm	2.93***	0.12	2.10***	0.14
Suppliers	0.45***	0.10	0.43***	0.10
Customers	0.81***	0.10	0.53***	0.10
Competitors	-0.09	0.10	-0.09	0.10
Consultants	0.20 *	0.11	1.10***	0.10
Universities	0.46**	0.16	0.93***	0.14
Government	0.13	0.18	-0.17	0.16
Conferences, trade fairs, exhibitions	0.35***	0.10	0.14	0.10
Size	-0.00	0.01	-0.00	0.00
Holding	0.05	0.09	0.35***	0.10
Local Market	0.11	0.10	0.03	0.10
National	0.27**	0.14	0.04	0.15
EU market	0.22**	0.11	0.20*	0.12
Local – the most important	0.33***	0.11	0.20**	0.11
National – the most import.	-0.21	0.16	-0.27*	0.17
Funding	-0.00	0.13	-0.26**	0.12
Food, Nutrition & Flowers	0.07	0.17	0.28*	0.15
High Tech Systems & Materials	2.25	0.13	0.89***	0.10
Life Sciences	0.33	0.30	0.14	0.30
Main Ports & Logistics	0.77	0.28	0.20	0.28
Shipping	0.13	0.30	0.22	0.31
Chemical industry	-0.53	0.28	-0.14	0.28
Creative industry	-0.42	0.32	-0.07	0.33
Energy	0.44	0.29	-0.03	0.30
Tests of global quality				
Test of prediction model (concordant percentage)	95.9		93.0	
Test of global nullity (likelihood ratio)	2917.66***		2912.79***	
Number of observations	10612		10612	

Notes: (*), (**) and (***) indicate parameter significance at the 10, 5 and 1 percent level, respectively;

reference for sector activity: manufacturing

Source: Authors' calculation based on CIS Netherlands data

Turning to Netherlands sample (Table 3), the situation is slightly different comparing to French sample. Actually, we may notice that as for previous results, competitors are not significantly associated to both internal and external R&D activities. However, the findings suggest that government is not significant source of R&D activities (both internal and external) when looking at firms from Netherlands. In this sense, compared to French case where government should continue to provide incentives regarding R&D, firms in Netherlands are not dependent on these incentives. Furthermore, the impact of conferences, trade fairs, exhibitions disappears when we look at external R&D activities.

Table 4. The impact of source of innovation on R&D - Croatian Sample

	Internal R&D		External R&D	
	Estimate	SE	Estimate	SE
Intercept	-3.09***	0.34	-4.29***	0.39
Firm	1.93***	0.15	1.55***	0.17
Suppliers	0.60***	0.14	0.70***	0.15
Customers	0.80***	0.15	0.48***	0.17
Competitors	0.13	0.14	0.31**	0.15
Consultants	0.33**	0.17	0.94***	0.16
Universities	0.46**	0.19	0.52***	0.19
Government	-0.09	0.24	0.14	0.23
Conferences, trade fairs, exhibitions	0.48***	0.14	0.21	0.15
Size	0.00***	0.00	0.00**	0.00
Holding	-0.05	0.14	-0.01	0.15
Local Market	0.04	0.21	0.14	0.22
National	0.17	0.16	0.05	0.17
EU market	0.04	0.18	0.34*	0.19
Other	0.14	0.17	0.40**	0.18
Local – the most important	0.02	0.22	-0.13	0.23
National – the most import.	0.20	0.22	-0.19	0.23
Funding	0.41***	0.14	0.53***	0.15
Manufacturing	-0.46*	0.26	0.28	0.29
Construction	-0.34	0.27	0.36	0.29
Sales	-0.27	0.29	0.50	0.32
Transport	-0.74**	0.35	0.12	0.38
Services	-0.77***	0.27	0.37	0.30
Tests of global quality				
Test of prediction model (concordant percentage)	90.3		89.0	
Test of global nullity (likelihood ratio)	1211.26***		883.44***	
Number of observations	3333		3333	

Notes: (*), (**) and (***) indicate parameter significance at the 10, 5 and 1 percent level, respectively;

reference for sector activity: manufacturing

Source: Authors' calculation based on CIS Croatian data

Finally, when looking at Croatian firms, we may say that the important sources for R&D activities are more similar to those from Netherlands than results from France. Actually, Table 4 indicates that as for Netherlands firms, competitors and government do not influence positively internal R&D. Moreover, competitors do influence external R&D while the relationship is not significant for government and conferences, trade fairs, exhibitions.

Regarding control variables, we can suggest that their impact is dependent on national context. The variables size, holding, national and EU market, funding have positive and significant impact on R&D activities in France. On the other side, only variables national and EU market and the most important market influence positively R&D activities in Netherlands. Regarding Croatian case, only size and funding influence significantly R&D activities.

Table 5 presents the summary of our results.

Table 5. Summary of the results

Variables	France		Netherlands		Croatia	
	R&D Internal	R&D External	R&D Internal	R&D External	R&D Internal	R&D External
Explanatory variables						
Firm	(+) 1%	(+) 1%	(+) 1%	(-) 1%	(+) 1%	(+) 1%
Suppliers	None	(+) 1%	(+) 1%	(+) 1%	(+) 1%	(+) 1%
Customers	(+) 1%	(+) 1%	(+) 1%	(+) 1%	(+) 1%	(+) 1%
Competitors	None	None	None	(+) 1%	None	(+) 5%
Consultants	(+) 1%	(+) 1%	(+) 1%	None	(+) 5%	(+) 1%
Universities	(+) 1%	(+) 1%	(+) 5%	(+) 1%	(+) 5%	(+) 1%
Government	(+) 1%	(+) 1%	None	(+) 1%	None	None
Conference, fairs and exhibitions	(+) 1%	(+) 10%	(+) 1%	None	(+) 1%	None
Control variables						
Size	(+) 1%	(+) 1%	None	None	(+) 1%	(+) 5%
Holding	(+) 1%	(+) 1%	None	(+) 1%	None	None
Local	(-) 1%	None	None	None	None	None
National	(+) 1%	None	(+) 5%	None	None	None
EU	(+) 1%	(+) 10%	(+) 5%	(+) 10%	None	(+) 10%
Other	-	-	-	-	None	(+) 5%
Local – the most important	(-) 1%	(-) 1%	(+) 1%	(+) 5%	None	None
National – the most import.	None	(-) 5%	None	(-) 5%	None	None
Funding	(+) 1%	(+) 1%	None	(-) 5%	(+) 1%	(+) 1%
Manufacturing	None	(-) 1%	-	-	-0.46*	None
Agrifoods	(-) 1%	(-) 1%	-	-	-	-
Services	(-) 1%	None	-	-	(-) 1%	None
Finance	(-) 1%	(-) 1%	-	-	-	-
Sales	(-) 1%	(-) 1%	-	-	None	None
Construction	None	(-) 1%	-	-	(-) 5%	None
Transport	(-) 1%	-	-	-	None	None
Food, nutrition & flowers	-	-	None	(+) 10%	-	-
High tech systems & materials	-	-	None	(+) 1%	-	-
Life science	-	-	None	None	-	-
Main ports & logistics	-	-	None	None	-	-
Shipping	-	-	None	None	-	-
Chemical industry	-	-	None	None	-	-
Creative industry	-	-	None	None	-	-
Energy	-	-	None	None	-	-

Notes: (*), (**) and (***) indicate parameter significance at the 10, 5 and 1 percent level, respectively;
reference for sector activity: manufacturing

Two variables (Customers, Universities) have a positive impact to all of the countries as well for both R&D Internal and R&D External activities. Information gathered and processed from customers, as well as information gathered from Universities or other higher educational institutions also have a positive impact to both R&D Internal and R&D External activities.

Three variables (Firm, Suppliers, Consultants) have in most of the cases the positive impact to innovation activities. Information sources from within the enterprise or enterprise

group (variable Firm) has been proved as the important mechanism for all of three countries, both for R&D Internal and R&D External activities, with the only exemption is the negative influence of this variable to the R&D External activities in Netherlands. Information gathered and processed from suppliers of equipment, materials, etc. also has a positive impact to both R&D Internal and R&D External activities, with only one exemption in R&D Internal activities in France. Consultants have positive impact to both R&D Internal and R&D External activities in all of the countries, with the only one exemption in R&D External activities in Netherlands.

Two variables (Government and Conference, fairs and exhibitions) have somewhat mixed impact to innovation activities. Conferences seem to have the positive impact to R&D Internal activities in all of the countries, but do not have significant impact to R&D External activities in Netherlands and Croatia. Government or public research institutes have positive impact to both R&D Internal and R&D External activities in France. However, they do not have positive impact to R&D Internal activities both in Netherlands and Croatia. In addition, government or public research institutes do not have a positive impact neither to R&D Internal activities in Croatia.

4. Conclusion

The most prior studies on R&D focus mainly their attention on the firm's characteristics as drivers of firm's R&D activities instead on mechanism that promote R&D what calls for further investigation because it could help further improvement of R&D activities. In order to fill this important gap in the literature, we provide empirical analysis on the sources of information regarding innovation that could improve firm's R&D activities. Additionally, we use eight proxies for innovation sources, we distinguish between two types of R&D activities both internal and external and we confirm our results across three EU countries France, Netherlands and Croatia.

Our findings indicate that firm, supplier, customers, institutions and universities are important mechanism for R&D promotion in all three countries. Also, the non significant result of competitors is confirmed for three countries as well. However, while government is recognized as significant source for innovation in French firms it is not the case for Dutch and Croatian firms. Additionally, conferences are important source for Dutch and Croatian firms only when considering internal R&D activities. In addition, our findings have important policy implications. Actually, indentifying the successful sources of innovation may enable managers to define better R&D strategies.

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