Innovation Propensity in Croatian Enterprises:

Results of the Community Innovation Survey

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Abstract

Economic theory perceives innovation as a source of national competitiveness, and the literature dealing with innovation has flourished. In this paper we assess the determinants of innovation activities in Croatian enterprises and their implications for innovation policy. A Type-2 Tobit model is used for modelling the innovation behaviour of Croatian companies. Firm-level data are available from the results of the Croatian Community Innovation Survey (CIS) conducted for the period 2001-2003. The results of the econometric model provide implications for key aspects of a more effective innovation policy. The model results suggest insignificance of R&D activity and demand pull variable significance at 85%. Therefore, innovation policy needs to pay much more attention to the innovation diffusion processes, as a key mechanism that may facilitate advancements in innovation activities.

Introduction*

Innovation tends to be considered as a major driver of both economic growth and competitiveness of companies and industries. However, measurement and analysis of innovative activities and their impacts at micro-, meso-, and macro-levels have often been burdened with conceptual and applicative difficulties. Following the Oslo Manual (cf. OECD, 1997b), a methodology for collecting and interpreting enterprise-level data on technological and organisational innovation has been developed and applied to the countries of European Union, as well as accession countries. In addition to economic imperatives, transition economies of Central and Eastern Europe, have tended to embrace the innovation-related issues within their accession into the European Union, which defines the development of a knowledge-based economy as a crucial policy goal (CEU, 2000). This paper examines the innovation activity determinants in Croatia, which should help elucidate some of the key factors of the economic transformation required to fulfil the requirements of its expected EU accession and advancement of the Lisbon agenda in general.

The existing research into innovation (cf. Radas, 2003; Račić et al., 2005.), innovation policy (cf. Andrijević-Matovac, 2003; Švarc, 2004; Aralica and Bačić, 2005) and competitiveness (cf. NCC, 2003) indicates inadequate innovation performance of the Croatian economy and deficiencies in the processes supporting the development and commercialisation of new knowledge. However, these findings have not so far been supported by a comprehensive firm-level innovation surveys. The aim of the paper is to partially address this absence and to transcend the descriptive level analysis by econometric modelling, which will be a useful input into formulation of a more effective innovation policy.

Following a brief literature review, the paper reviews the structure of companies included in survey, according to the Oslo Manual methodology (OECD, 1997b) and tries to explore the link between the basic characteristics of these firms (such as firm

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size and industrial affiliation) and innovation propensity. The analytical framework presents preconditions required to design an effective innovation policy based on sound empirical foundations regarding the key factors that influence innovative activities. As the data source we are using the results of the first Community Innovation Survey (CIS) conducted in Croatia for the period 2001-2003. First, the dataset is briefly introduced and descriptive results are provided. That forms the basis for modelling the innovation behaviour using a Type II TOBIT model. This model consists of two phases. In the first phase the decision of the firm to introduce a new product/service is being modelled. The size of the firm measured by the logarithm of number of employees and 16 industry sector dummies are set as independent variables. Given the positive decision at the first step, the share of innovative sales is measured in the second phase by a regression model. There are seven variables which are included in the model as independent variables; size of the firm (measured again by the logarithm of the number of employees), share of highly qualified employees, share of capital held by foreign investors and the demand-pull indicator, which equals one if the aim of the product innovation has been to extend the product range or to open new markets (or zero if otherwise). Additionally, three dummy variables are included in model. The first one indicates whether the international market is the most important one. The second one indicates whether the firm is continuously engaged in R&D, whereas the third one indicates the existence of R&D cooperation with other firms or institutions such as universities. The results of the model are subsequently discussed. Finally, at the end some innovation policy implications of the analysis that has been undertaken are offered.

Literature review

The literature dealing with the innovation activity determinants is extremely extensive; it links innovation with diverse topics and places it within different contexts. Micro level activity, micro level characteristics, meso- macro level characteristics and other specific topics present four groups of determinants linked connected with innovation activity. Some of the differences in innovation performance will be related to differences in firm’s environment (which may include micro, meso and macro level characteristics), whilst others are attributable to differences in characteristics and innovation behaviour of firms.

The first group within the literature deals with the characteristics of innovation activities and connects innovation and other firm activities (cf. Dosi, 1988), pointing to the context and/or content of innovation-related processes. An important issue is whether innovation activities are related to the existence of research and development (R&D) activities. R&D activity is indispensable part of more complex innovation activities with longer-term effects on companies and markets, but innovation is by no means restricted to R&D. A significant amount of innovation and improvements originates from design improvements, 'learning by doing’ and 'learning by using’ (Arrow, 1962a, Rosenberg, 1982, Mowery and Rosenberg 1989) and such informal efforts are generally embodied in people and organisations (Teece 1977, 1986; Pavitt 1986). In the analysis of innovation patterns in Central and Eastern European countries (CEEC), Radosevic (1999) found that the companies from CEECs purchase relatively more embodied technology than companies from the EU; they also have a lower share of R&D expenditures in total innovation expenditures. Non-R&D sources of innovation also mean that the forms of protection of innovation are diverse and include formal (patents, copyright and trade marks) and informal (e.g. design complexity, trade secrets, faster market entry) means (cf. Crespi 2004).

Cohen, Nelson and Walsh (2000) found that the other ways of protecting intellectual property - such as being first in the market, using trade secrets and developing complex designs - are more effective than patents. Baldwin, Hanel and Sabourin (2000) find that the causal relationship is much stronger going from innovation to the decision to use patents than from the use of patents to innovation. However, innovation incentives are not entirely exogenous as innovation capability further stimulates companies to protect their innovation results by patents.

The second group of literature points out the link between innovation and firm level determinants of innovation characteristics such as firm size (Arvanitis, 1997) and the effects of foreign ownership, capabilities and competitiveness (cf. Hujer and Radic 2003). Cohen (2005) finds that larger diversified firms may benefit from economies of scope and scale and have greater likelihood to engage in risky projects relying on the prospective returns to innovation. Račić et al. (2005) find that the foreign-owned firms innovate more than domestic firms in Croatia, but Baldwin, Hanel and Sabourin (2000) assume that the foreign-controlled firms are not significantly more likely to innovate than national firms in Canada. So the relation between the nationality of foreign ownership and the innovation is not clear-cut. Those findings may indicate industry, country- or region- specific factors but the literature needs to investigate this topic further. Firm specific capabilities have recently become an important focus of determination studies analysing firm innovative activity and performance (Cohen, 2005: 201). The focus of these analyses has been on R&D and its relation to innovation activities. Moreover, there have been a great number of qualitative analyses of the importance of R&D-related capabilities in affecting the process and commercial outcomes of firm's innovative activities (Teece 1986, 1987, Mowery and Rosenberg 1989). Those analyses highlighted the importance of the links across marketing, manufacturing and R&D in conditioning innovative success (Cohen 2005: 202). The relation between innovation and competitiveness depends on meso- and macro- levels of analysis which cannot be easy evaluated via micro-econometric models. The relation between competitiveness and innovation can be evaluated via the Neoschumpeterian approach to international technological competitiveness, which implies a sustainable increase in the share of world trade for the most successful innovative efforts[1] (cf. Cantwell, 2004). This approach emphasizes international innovation which can produce win-win strategies, implying new sphere of value creation via the expansion of the overall magnitude of world trade and world market.

According to Crespi (2004), market structures, financial structure, human capital, technology policies and regulation belong to determinants of innovation activities on the macro and meso level, and present the third group of literature. The market structure is different from other variables since it may be considered as the determinant of the micro econometric models. In Schumpeter's view, the monopolistic market structure boosts innovative activity. Contrary to Schumpeter's theory, Arrow (1962a) found that the perfect competition presents an environment fruitful for innovation in relation to the monopolistic market structure. Furthermore, Kamien and Schwartz (1972, 1976) argued that intermediate market environment allows the best conditions for innovative activities. So the theoretical debate between innovation activities and market structure is far from being concluded. The financial structure refers to the role of financial systems in determining the pace of technological change (Crespi, 2004: 10). Previously, the question of financial structure and its influence on technological change had been oriented to the problem of investment in R&D (cf. Hall, 2003). In the last ten years the relation between the financial structure and innovation activities has been emphasised on a number of occasions, for instance by Canepa and Stoneman (2004)[2]. They argued that there are financial constraints to innovation in Europe and that those constraints are probably greater (a) for firms engaged in riskier activities (b) for small and medium sized firms and (c) for firms in market-based financial systems. Other variables (human capital, technology policies and regulation) may influence the interaction between firms and their environment and have an effect on innovation. However, these variables are heterogeneous, complex (includes institutional and organisational feature) and may inherently comprise other social elements (e.g. the research into

[1] At firm level, this means sustainable share of the relevant world market (Cantwell, 2004).

human capital includes the effects of education). In practice, all these complex interactions are usually synthesized into relatively simple models with only one explanatory variable[3].

The fourth group of literature indicates other specific topics including geography, country or region specific factors. According to Crespi (2004), the seminal work by Marshall (1920), further restated by Arrow (1962a, 1962b) and Romer (1986, 1990), claimed that geographical agglomeration of industries produces knowledge externalities which have positive effects on the rate of innovation and economic growth in specific regions. Therefore, the geography factor may have an impact on the innovation activities. Although the innovation activity determinants for the latecomer countries such as Croatia may consist of the country and region specific factors, similar innovation activity determinants in Croatia and neighbouring Central and Eastern European countries can be expected. According to Radosevic (1999), a relatively low share of innovative enterprises in the CEECs and specific structure of innovation expenditure of the CEECs[4] are findings that may be characterized as country or region specific.

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[2] In the majority of cases, the relation between the financial structure and the innovation activities has been empirically tested based on CIS data.

[3] The micro econometric model we are using does not take these variables into consideration – not only because of the lack of data, but also because combining such explanatory variables with firm characteristics would not be suitable.

[4] The CEECs purchase relatively more embodied technology than the EU; they spend relatively more on patents and licenses; and have a lower share of R&D expenditures in total innovation expenditures (Radosevic, 1999).

Definition of innovation, dataset and descriptive results

The definition of innovation was initially primarily oriented towards the relation between technology and innovation, and the issue of innovation tackled primarily the new technology in firms. In the last twenty years, the wider impact of innovation activity on technical change has been recognized, whereas technical change increased technological opportunities, with positive impacts on productivity, employment and wealth creation. Consequently, a redefined meaning of the technological innovation has been identified. According to OECD (1997b), a technological product innovation is the implementation/commercialisation of a product with improved performance characteristics such as delivering objectively new or improved services to the consumer. A technological process innovation is the implementation/adoption of new or significantly improved production or delivery methods. It may involve changes in equipment, human resources, working methods or a combination of these (OECD, 1997b: 9). Innovation propensity of firms can be tackled via measuring the completed product and process innovation activities. Namely, although the OECD (1997b) definition of innovation activities also includes unfinished or abolished innovation activities, innovation propensity includes only the realized innovative activities whereby a new product or process is introduced.

In continuation, we will briefly introduce the dataset used for the econometric analysis and present first descriptive results. We made use of the first firm innovation activity statistics in Croatia. In this survey micro-level data are collected in accordance with the Oslo Manual guidelines (OECD, 1997b) and the available literature on the implementation of CIS III (e.g. Kurik et al.2002; Boia et al. 2003a). The survey covers the period from 2001 to 2003.

In addition to general information about the enterprise, the survey covers the following aspects of innovation activities: product and process innovation, expenditures on innovation activities, intramural research and experimental development, innovation cooperation, sources for innovation, factors hampering innovation activities, innovation protection, and important strategic and organisational changes in the enterprises. The survey is based on a stratified representative sample of all Croatian enterprises in relevant manufacturing and service sectors.

Our sample consists of 1,272 firms. The following table shows the distribution of the firms according to the number of employees.

Table 1: Size, distribution and innovation propensity of Croatian firms[5]

Number of employees	Number of firms	Share of firms	Product innovation	Process innovation
< 10	540	0.42	0.27	0.19
[10 – 50)	253	0.20	0.32	0.28
[50 – 250)	145	0.11	0.37	0.27
≥ 250	334	0.26	0.12	0.10

There seems to be an inverted U-shape relation between size of the firms and their innovation propensity. The share of micro firms with less than 10 employees, which have introduced product or process innovations amounts to 27% and 19%, respectively. These shares increase with firm size. Consequently, firms with 50-250 employees are the most innovative ones regarding product innovations with 37%. However, in the case of firms with more than 250 employees, the share of firms with product innovations drops again markedly to 12%. Low innovativeness of largest enterprise may be reflecting (temporary) restructuring difficulties of several large enterprises, rather than a systemic feature of the economy. The relation between firm size and process innovations varies less, but, again, drops in the case of largest enterprises.

[5] We have earlier mentioned the difference between OECD (1997b) definitions of innovation activity and innovation propensity. The results presented here thus differ from the results of the overall survey of innovation activities (Racic et al., 2005), with the largest difference in the sample of the large firms.

The following table shows the industrial affiliation of Croatian firms. Most of them are retailers (12%), followed by the electrical equipment (10%) and wood industry (9%). Column two and three contain the share of innovative firms in the different industry sectors. We have considered two different innovation indicators, namely product and process innovations.

The figures in table 2 reveal that the machinery and food industry contain the highest share of firms which have introduced new products, whereas the plastic and food industry are the leading industry regarding the introduction of process innovations. What can also be observed is that the level of innovativeness of particular industries does not reflect their level of technology complexity, but, rather, other factors such as the level of competition in a given industry[6].

Table 2: Industrial affiliation and innovation propensity of Croatian firms

Industry Sector	Share of firms	Product Innovation	Process innovation
Mining	0.01	0.13	0.25
Food	0.06	0.47	0.36
Textile	0.07	0.22	0.16
Wood	0.09	0.27	0.19
Chemicals	0.03	0.39	0.23
Plastic	0.04	0.36	0.38
Glass	0.04	0.34	0.31
Metals	0.06	0.34	0.34
Machinery	0.04	0.51	0.28
Electrical equipment	0.10	0.34	0.28
Vehicle	0.02	0.33	0.17

[6] The results seem to reflect industry specific nature of innovation activities (e.g. process and product nature of innovation in food industry and product innovation in machinery industry). See more about s taxonomy of sectors of production/use of innovation in Pavitt (1984).

NEC	0.05	0.28	0.24
Wholesale trade	0.06	0.04	0.11
Retail	0.12	0.10	0.08
Transport	0.08	0.16	0.12
Finance	0.05	0.19	0.15
Other services	0.10	0.38	0.20

Econometric modelling

In the following we will model the innovation behaviour of Croatian firms using a Type-2 Tobit model. Such a procedure has become common for CIS-type data since most of the variables which might explain the innovation behaviour of firms are only available for innovative firms but not for their non-innovative parts (cf. Raymond et. al., 2004). As it has been noted by Mohnen and Dagenais, (2000: 10), 'there is little information in the CIS dataset regarding non-innovators'. We thus have very little information in the CIS database to discriminate between innovators and non-innovators. As a consequence, only a censored regression approach can be estimated which explicitly takes account of this data structure as will be explained in more details in the following.

Regarding possible dependent variables, the CIS dataset contains a number of indicators, which can be classified into input and output side oriented variables. Input oriented indicators of innovation activities included in the questionnaire are R&D expenditures and variables indicating whether firms are engaged in R&D-co-operation or not. Although widely used, indicators based on R&D bear several limitations as a measure of technological change (cf. Patel and Pavitt, 1989). First, they underestimate technological activities in manufacturing and service industries where much of the technical change takes place around design and manufacturing which is not captured by the concept of R&D. Second, small and medium sized firms often do not possess a separate business unit devoted to R&D. Using R&D expenditure or R&D personnel as a measure will therefore underestimate their innovation activities. And finally, as an input measure, R&D expenditures are only loosely connected with the output of technological change.

On the output side, the CIS questionnaire contains information on patents granted to firms, which are another often used as a measure of technological activity. However, several drawbacks have to be taken into account when considering patents as a measure of technological change. First, not every innovation is based on a patentable invention and not every patent results in a marketable product. Second, in certain industries - like the automotive industry - patents play only a minor role as a barrier to imitation and hence differences in patent activities across industries will not always reflect differences in innovation activities. Third, institutional, legal and economic factors related to the process of obtaining a patent will also have an impact on patent intensities (for a discussion on patents, cf. Griliches, 1990). Finally, simply looking at patents says nothing about the economic value of the innovation (cf. Patel and Pavitt, 2005).

We therefore decided to use an output-oriented measure, namely the declaration of whether a firm has introduced a new product/service and the percentage of sales due to this new product/service.[7] The advantage of such an approach is in direct measurement of the economic outcomes of the innovation process. Hereby the issue of introduction of a new product/service is only the first step towards tackling the percentage of sales as an indicator of economic relevance of new products or services. There are, however, also some disadvantages which should be mentioned. Although the questionnaire contained a detailed description of the notion of a new product/service, CIS surveys reflect the subjective view of firms, which have to decide what they regard as a product/service innovation. That is especially pronounced in the first applications of such surveys in a new environment.[8]

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[7] The CIS questionnaire contains also qualitative information whether firms have introduced process innovations or not. We decided, however, not to consider process innovations in the analysis since the questionnaire contains no quantitative measure of effects of process innovations. For an alternative approach, see e.g. Mairesse and Mohnen (2001) who substituted this missing information for process-only innovating firms with the smallest positive value of the share of innovative sales.

[8] Problem with innovation output data may come up as a consequence of misperception of innovation within firms especially in transition countries where the importance of innovation practice has not

A Type-2 Tobit model consists of two steps. In a first step, the decision of a firm i to introduce a new product/service is modelled using a simple Probit model. Given a positive decision at the first stage, the share of innovative sales, y_i, follows a simple regression model at the second stage. Formally:[9]

$$(1.1) \qquad y_i = \begin{cases} 0, \text{iff } y_i^* = x_i'\beta + \varepsilon_i < 0 \\ z_i'\gamma + \upsilon_i, \text{iff } y_i^* = x_i'\beta + \varepsilon_i \geq 0 \end{cases}$$

The latent variable, y^*_i, can be interpreted as the propensity to innovate.[10] In the first stage we use data on innovators and non-innovators: If y^*_i exceeds the threshold level, which is set to zero for identification, the firm decides to innovate and hence in the second step innovative sales as measured by y_i are modelled by the regression part of the Tobit model. If, on the other hand, y^*_i is below zero, the firm decides not to innovate and what we observe in the dataset is thus $y_i = 0$. It should be noted that for a type-2 Tobit model the first stage decision whether to be innovative or not depends on a set of explanatory variables x, whereas the decision about the amount of innovative sales is assumed to depend on another set of exogenous variables z. The set of these variables may not be identical. We further assume that the two error terms ε and ν follow a standard normal distribution.

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been embedded in the business practice. Innovation sales e.g. should be accounted separately from sales of other products but this is still not a common practice.

[9] Please note that 'iff' means 'if and only if'.

[10] y^*_i is called a latent variable since it is not directly observable in the dataset.

As already stated, due to the construction of the CIS questionnaire, the set of variables for the first stage decision is rather limited. We considered the following:

- Size of the firm measured by logarithm of number of employees
- 16 industry sector dummies.[11]

Size is a traditional explanation for innovative behaviour.[12] Larger firms have better access to capital markets or more internal funds to finance uncertain and risky innovation projects. They have better access to competent and specialised staff, which can foster the development of specific competences. R&D activities exhibit economies of scale and scope, i.e. larger firms have better opportunities to diversify the risks associated with innovation activities. Fixed costs associated with R&D investments can be distributed over a larger volume of sales. And finally, there might be complementarities between innovation and certain activities, e.g. marketing or planning, which are more pronounced among larger firms. There are, however, also counteracting effects. Larger firms tend to be more bureaucratic and hierarchical, which can hinder innovation activities. Associated with an increasing size is also a loss of managerial control of innovation activities. Hence, the impact of firm size on innovations is not clear-cut.

For transition economies another point becomes important in this context. During the transition period in Croatia a lot of formerly state owned enterprises were reduced through restructuring or split up into smaller units (cf. Koschatzky et. al., 2001). Moreover, new small and medium sized companies were founded. Therefore in the following we will take special account to micro and smaller firms.

[11] These include: mining, food, textile, wood, chemicals, plastic, glass, metals, machinery, electrical, vehicle, supply, retail, transport, finance and other services (OECD, 1997b).
[12] For a more thorough discussion on this topic see e.g. Radić (2005).

Due to missing data, industrial affiliation has to measure a set of different effects. First of all, different industries are characterized by different technological conditions and opportunities. Examples include the maturity of the used technology, the rate of technological advance, the 'closeness' to science and externally generated knowledge through R&D co-operation. If internal 'absorptive' capabilities are available, as measured e.g. by the number of R&D personnel, such external technological opportunities can be exploited for own innovations. Including industry dummies will also control for market characteristics in such industries, e.g. market concentration and differing demand conditions.

For the second stage, i.e. the amount of innovative sales, the following variables were included into the regression:

- Size of the firm measured by logarithm of number of employees
- Share of high qualified employees
- Share of capital foreign investors hold
- Dummy variable indicating whether international market is the most important
- Dummy variable indicating whether firm is continuously engaging in R&D or not
- Dummy variable indicating R&D cooperation with other firms or institutions such as universities
- Demand pull indicator which equals one if the aim of the product innovation was to extend the product range or to open up new markets.[13]

Economic reasons for the inclusion of the size variable are the same as for the first step. However, firms differ also in their specific technology capabilities. These capabilities may be are reflected in differences in the qualification structure of the employees, in the internal organization of R&D, manufacturing and marketing and the ways of information processing. Firms with better in-house R&D capabilities will more successfully pursue innovations and also have better 'absorptive' capacities to gain from outside technological opportunities. Therefore we additionally also include the share of highly qualified employees, i.e. employees with a university degree, and

[13] Industry affiliation turned out to be insignificant and was therefore excluded from the estimations.

continuous engagement in R&D as a proxy for the internal technological capabilities of a firm.

Better in-house technology capabilities are especially necessary when cooperating with other institutions in R&D since these firms have better absorptive capacities to gain from such outside technological opportunities. We therefore also include a dummy variable, which equals one if a firm engages in such R&D co-operation. Foreign direct investments are also pertinent to this point. A standard argument in this context is that increasing FDI also increases the inflow of external knowledge and technology. If this is the case we expect firms with a higher share of capital hold by foreign investors to be also the more innovative ones.

Since firms' innovation activities respond to economic incentives, especially to changing demand conditions, large and fast growing markets will increase the return on investment of innovations. We control for this by including a demand pull indicator which equals one if the aim of the product innovation was to extend the product range or to open up new markets. Another factor that might spur innovation activities is competition. Therefore, it might be expected that internationally oriented firms are the more innovative ones.

The estimation of the Tobit model was done using a simple two-step procedure. In a first step the parameters for the Probit model were obtained. Given these parameters, Mills ratio, $\phi(x_i'\beta)/\Phi(x_i'\beta)$, was calculated and plugged into the second stage regression conditional on positive shares of innovative sales.[14]

(1.2)
$$y_i \mid y_i^* > 0 = z_i'\gamma + \sigma \frac{\phi(x_i'\beta)}{\Phi(x_i'\beta)} + \upsilon_i$$

where $\phi(.)$ is the standard normal density and $\Phi(.)$ the standard normal cumulative density function.

[14] For more details see Maddala (1986).

The figures in Table 3 refer to the Probit equation, i.e. the decision whether to introduce an innovation or not, and indicate that – according to the previous reasoning – the number of employees increases the likelihood of introducing a new product or service.[15] Computing the marginal effects yields a value of 0.05 for ln(employees). Thus increasing the number of employees by 1 percentage point increases the probability to become innovative by 5 percentage points. Industry affiliation has also a highly significant joint effect.

Table 3: Probit regression results: Product innovation yes/no

	Parameter	SE	t-Value	p-Value
Constant	-1.08	0.10	-10.44	0.00
No. of ln(employees)	0.14	0.03	5.15	0.00
	χ^2-Value		**p-Value**	
Industry dummies	93.29		0.00	
Overall	121.92		0.00	
Number of observations	992			
Pseudo R^2	0.10			

Now we turn to the estimation results for the censored regression equation. Contrary to the previous results, the size of firms as measured by ln(employees) decreases the share of innovative sales (Table 4). Or to put it simple: The Tobit model shows that larger firms realize more product innovations but do not necessarily record higher sales based on innovations. The commercial relevance of innovation is not related to size though the frequency of innovation is so.

Qualification structure of firms, as well as continuous engagement in R&D and R&D cooperation, turn out to be insignificant, unlike foreign ownership. Increasing the

[15] We also included squared numbers of employees. However, we do not find non-linear size effects.

participation of foreign investors by 1% of the capital they hold increases innovative sales by 0.33%. Demand pull is statistically significant at an 85% level indicating that the share of innovative sales is higher if the innovation aims at extending the product range.

Table 4: Censored regression results: Share of positive innovative sales[16]

	Parameter	SE	t-Value	p-Value	VIF
Constant	33.97	10.59	3.21	0.00	-
No. of ln(employees)	-4.96	1.46	-3.39	0.00	1.94
Share of highly qualified employees	5.28	8.13	0.65	0.52	1.51
Share of capital of foreign investors	0.33	0.11	2.97	0.00	1.10
International market most important	9.59	4.82	1.99	0.05	1.08
Continuous engagement in R&D	5.29	4.24	1.25	0.21	1.20
R&D cooperation	5.72	4.43	1.29	0.20	1.21
Demand pull factors	7.73	4.42	1.75	0.08	1.21
Mills ratio	-5.22	6.25	-0.84	0.41	-
	F-Value			p-Value	
Overall	5.12			0.00	
Number of observations			149		
Adjusted R^2			0.20		

The statistical significance of the share of capital of foreign investors can be explained by innovative culture and competent management, as well as by the introduction of products and processes into local subsidiaries that are already known within the parent company. The statistical significance of the demand pull variable can be explained by increasing competitiveness which forces the Croatian companies to involve new innovative elements in their business strategies such as introducing new products or increasing capacity.

[16] Note that the total number of observations shrinks from 992 to 149 since in the second stage of the Tobit model we only use data information on innovating firms.

The insignificance of engagement in R&D and R&D cooperation can be explained by the low share of R&D expenditure (15.2%) as a share of total innovation expenditure and the low level of R&D cooperation within Croatian firms; many Croatian innovators do not undertake R&D at all or have a low R&D intensity.[17]

To check for multicollinearity, we also report the variance inflation factor (VIF) in the last column of Table 4. The VIF is defined as $(1 - R_i^2)^{-1}$ where R_i^2 is the R^2 obtained from regressing the i-th exogenous variable on all other independent variables. Consequently a high VIF indicates that R_i^2 is close to 1 and therefore suggest multicollinearity. However, the VIF values are all well below 2, showing that there is no serious multicollinearity problem among the independent variables and thus there is no need to compress the variation of the variables by the use of e.g. factor analysis.

[17] Low R&D intensity means that the share of R&D expenditures in total sales is less than 1 per cent.

The implications for innovation policy

When discussing policy implications of the model, one should tackle both the current innovation drivers (which have thus emerged from the model), as well as those drivers that have turned out to be insignificant in the current circumstances. The workings of the first group of drivers – such as enterprise size, foreign direct investment and export orientation - should be enhanced. The second group of drivers needs to be analysed in order to identify and remove the obstacles that hinder the contribution of these drivers to innovation. These obstacles should be identified and removed through a more effective innovation policy.

The significance of enterprise size, foreign direct investment and export orientation in relation to innovation is also linked to the demand pull variable that has somewhat lagged in significance. All of these issues should be tackled through a more effective enterprise policy that would ease market entry of new competitors, foster the development of growth- and export-oriented SMEs, as well as attract foreign direct investment and inclusion of aforementioned SMEs into international industrial networks. Given that market competitiveness, rather than technology level, seem to be crucial for innovation in a given industry (Račić et al., 2005), it is essential to increase competitiveness in order to stimulate the demand for innovation.

The current level of entrepreneurial activities and competitiveness of economy in general as well as particular sectors does not foster a rapid increase in competitiveness and exports, which are a foundation for enterprise growth. An important source of enterprise growth and export capabilities is in innovation activities. Growth of a larger and more competitive SME sector is likely to require reduction of administrative barriers and corruption, wider availability of financing instruments, as well as better entrepreneurship-related education at all levels. In other words, the facilitation of innovation activities should be complemented and reinforced by more effective support to growth-oriented SMEs. The problems with new product development and financing of exports (demand for working capital exceeds credit capability of many of the SMEs) should also be considered in this context. The support to financing innovation should not necessarily be restricted to subsidies, but it could also include normal or subordinated credits and guarantees, incentives to investments into equity, and access to required knowledge for the project implementation. Along with the projects at higher technology levels, measures and instruments of innovation policy should meet requirements of a wider circle of enterprises so as to increase productivity, quality and added value of their products (e.g. by co-financing product modifications, implementation of quality management system and technology transfers). Attraction of export-oriented foreign direct investments would also be beneficial to SMEs as suppliers and subcontractors, whereas public procurement can also increase demand for technology-intensive products and thus stimulate innovation.

On the basis of the model results, we may conclude that at the current level of technology capability and economic performance, R&D activity and employee education levels do not seem to be among the key innovation inputs. This can be explained by the marginal place of innovation within the business strategies of most Croatian firms (cf. Račić et al., 2005), as well as by persistently low competitiveness of many markets in which firms operate (cf. NCC, 2003, 2005). In such conditions competitive advantage is only weakly linked with knowledge-related factors, which also constrains the possible effects of many standard innovation policy approaches and instruments, unless further steps towards restructuring and competence upgrading of existing enterprises and emergence of the new ones are taken.

Analogously, increased investments into R&D are indispensable, but they need to be accompanied by enhancing diffusion of innovation, and creating favourable demand conditions. Hereby the processes and instruments stimulating innovation diffusion may be a key stimulus to advancement of innovation activities, as well as to the development and alignment of complex competencies within and between firms. Within the area of research and development, upgrading of the system of tax and financial incentives to research and development in the business sector is required. Attraction of research-intensive foreign direct investments in selected sectors could also be beneficial because of their possible spillover effects on the technology capability of domestic companies. In the area of innovation cooperation, possible solutions include stronger use of the institutions that support entrepreneurship and innovation and of academic institutions (e.g. by collaborative projects with the business sector, exchange of researchers between science and business sector and academic entrepreneurship). These areas of intervention are interconnected and can be mutually reinforcing. More intensive and complex interaction within national innovation system can be the driving force toward a more influential and effective innovation policy. Furthermore, this can stimulate transnational corporations that operate in Croatia (or consider doing so) within high and medium-high technology sectors to cooperate more intensively with domestic technologically competent small and medium-sized suppliers, as well as to develop stronger collaboration with universities and the other supporting institutions.

Concluding remarks

Although innovation tends to be considered as an important driver of economic growth, its dynamics seem only partially understood. In this paper we have attempted to analyse some of the main aspects of innovation activities in Croatian enterprises, based on the results of the Community Innovation Survey. We have observed a U-shape relation between size of the firms and their innovation propensity, whereby innovation propensity (i.e. the likelihood of introducing a new product or service) increases with firm size, measured by the number of employees, but then drops in the case of largest companies that have not undergone restructuring. Furthermore, the level of innovativeness of particular industries primarily stems from the characteristics of the markets they operate in, rather than from the characteristics of products and technologies prevalent in particular industries. Innovation activities tend to occupy a peripheral role within competitive strategies of most Croatian companies, which limits the resources and competences devoted to their development, and, correspondingly, their economic effects.

It has been observed that the increases in the size of firms (measured by ln(employees) are associated with decreasing shares of innovative sales. Larger companies seem to have greater problems in effective translating of innovation into favourable economic outcomes. Qualification structure of firms as well as continuous engagement in R&D and R&D cooperation have turned out to be insignificant in relation to the share of sales of innovative products, unlike the participation of foreign investors, and, to a lesser extent, demand pull factors.

All of the variables whose significance has been established (i.e. enterprise size, foreign direct investment, export orientation and the demand pull variable) are fairly interconnected. They can be tackled through a more effective enterprise policy that would foster SME emergence and growth, attract FDI, and stimulate the export capability of enterprises. Since market competitiveness, rather than technology level, seem to be crucial for innovation in a given industry, it is essential to increase competitiveness in order to stimulate the demand for innovation. On the other hand, the insignificance of R&D activity and employee education levels supports the available findings on the insufficient role of knowledge-related factors in building and maintaining competitive advantage, which currently constrains the possible effects of many standard innovation policy instruments. Consequently, increased investments into R&D and education are indispensable, but they need to be accompanied by enhancing diffusion of innovation, and creating favourable demand conditions.

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