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Determinants of innovation in Croatian SMEs: Comparison of service and manufacturing firms

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Determinants of innovation in Croatian SMEs –
comparison of service and manufacturing firms*

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Abstract

In this paper we focus on SMEs in Croatia operating in the manufacturing and services sectors and seek to compare them in terms of their involvement in innovation activities, the factors that determine their decision to innovate in general and in four types of innovations in particular: product/service, process, organisational and marketing innovations. The analysis relies on the Croatian Community Innovation Survey 2010 (CIS 2010) data. To find out whether innovations have a different pattern of drivers in manufacturing and in services, we estimate the probit and multivariate probit models separately on these two groups of firms. The findings reveal that despite some differences, service and manufacturing SMEs are not that different from one another when it comes to innovation activities. Service SMEs are somewhat less likely to introduce technological innovations, but manufacturing and service SMEs do not significantly differ from each other when it comes to non-technological innovations. One noteworthy difference between manufacturing and service SMEs is that the latter rely much more than the former on acquired knowledge.

Keywords: Croatia, innovation, services, manufacturing, SME, multivariate probit.
JEL Classification: O31, L80

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1. INTRODUCTION

Services nowadays play an important role in economies worldwide. Duchêne, Lykogianni and Verbeek (2009) point out that the share of services in total value added in both the EU and the US is approximately three quarters and growing. Even countries previously with a dominant focus on manufacturing are shifting toward services. Hanzl-Weiss and Stehrer (2010) found a structural change in five economies from manufacturing towards services (the Czech Republic, Hungary, Poland, the Slovak Republic and Slovenia).

In Croatia, the services sector, although somewhat smaller, is also very important. According to the World Bank development indicators, in 2013, the services sector of Croatia accounted for 69 per cent of GDP, while manufacturing accounted for 14 per cent. The average annual growth rate of the manufacturing sector from 2000 to 2013 was only 0.5 percent whereas the services sector average annual growth rate was 2.4 percent, which is above the average growth rate of GDP (1.7 percent). The same source reports that merchandise export in the year 2013 was 12,659 million USD while commercial service export was 12,794 million USD. Trade in services represented 27.9 percent of GDP in 2013.

Another important characteristic of nowadays economies is the prevalence of SMEs (small and medium size enterprises) in business structure. 99.7 percent of the firms in the non-financial business economy in Croatia in 2013 were SMEs (Croatian Bureau of Statistics). As SMEs dominate in business structure, improvement of innovation performance in Croatia depends largely on innovation activities in SMEs. The situation is the same in the EU where in 2012 99.8 percent of the firms active in the non-financial business economy were in the category of SMEs (Eurostat). How SMEs innovate is relevant for the Croatian context but also beyond, as SMEs are recognised for their importance worldwide regardless of the stage of development.

SMEs are considered as promoter of innovation ever since Schumpeter proposed his creative destruction model. His work initiated a great body of research and discussion on SMEs vs. large firms that concluded that firm size affects innovativeness (for a review see Becheikh et al. 2006).

Our intention is not to disentangle the size-innovativeness relationship. Our aim is to shed more light on what drives innovation activities in SMEs and whether there is a difference in this regard between manufacturing and services.

The nature of innovation in services compared to manufacturing has attracted the interest of many scholars (Cainelli, Evangelista & Savona, 2004 and 2006; Djellal & Gallouj, 1999; Gallouj & Weinstein, 1997, Hollenstein 2003). Generally, they find that innovation activities in services differ from manufacturing to some extent although not completely. According to Lööf (2005), differences in productivity of the two sectors are not due to innovation activities as these two sectors differ only slightly in that regard. Camacho and Rodriguez (2005) argue that services indeed innovate but also help other industries to exploit innovation opportunities. Due to the growing importance of the services sector and its considerable involvement in innovation activities, it is important to understand the characteristics of innovation activities in this sector. In this paper we compare innovation activities of manufacturing and service firms and seek to identify the determinants of innovation in services and manufacturing SMEs using the Croatian CIS (Community Innovation Survey) 2010 data.

Hoffman et al. (1998) recognised limitations in research on R&D and innovation in SMEs that emerge from not distinguishing manufacturing from services in the majority of studies. By covering separately the two sectors in our research we hope to contribute to a better understanding of the ways in which SMEs innovate. For instance, do SMEs in services tend to rely more on external factors compared to SMEs in manufacturing? The main focus of our research is on technological intensity of innovation in two sectors. First, we want to examine whether services SMEs differ from manufacturing SMEs in terms of engagement in technological innovation development and R&D. Subsequently, we explore the factors that determine the decision to innovate in the two sectors, (a) in general and (b) in particular types of innovation.

Extant studies provide evidence of the importance of both technological (new product/service and process) and non-technological (organisational and marketing) innovations as well as complementarities between them, motivating us to dig deeper in the analysis of the determinants

of SMEs in the two sectors at the innovation type level. Musolesi and Huiban (2010) indicate that product and process innovations in services are determined by different factors. So do Amara, Landry and Doloreux (2009) for different types of innovation in knowledge intensive business services. To our knowledge, differences in the determinants of organisational and marketing innovation in the manufacturing and services sectors have not been studied before.[1]

The structure of the paper is as follows. In Section 2 we review the extant literature that compares innovation in manufacturing and services. In Section 3 we present the data. In Section 4 we examine the statistics on the level of innovative efforts and innovation outputs in service and manufacturing SMEs in Croatia. In Section 5 and 6 we proceed to an econometric analysis of the determinants of innovation, in general and in particular kinds of innovation. In Section 7 we summarise the results obtained.

2. THEORETICAL BACKGROUND AND HYPOTHESIS DEVELOPMENT

Certain features of services make this sector different from manufacturing in various aspects and could also show up in their innovation activities. Thus, it could be difficult to understand how and why innovation in services occurs by relying on findings originating from manufacturing. Gallouj and Savona (2009) argue that innovation in services is underestimated due to current approaches and definitions of innovation in the literature.

However, some of the extant literature provides evidence that the two sectors show similarities in innovation. Castellacci (2008) proposes a taxonomy of innovation patterns that analyses manufacturing and service sectors within the same framework. Arvanitis (2008) reports that the explanatory factors that hold for manufacturing are not inappropriate for explaining innovation activities in services. Forsman´s (2011) findings testify that the innovation capacity is not extremely different among small firms in manufacturing and services; the differences are more pronounced across industries within both manufacturing and services. This indicates that the two sectors are not so different that they would require a completely different framework of analysis.

[1] Arvanitis (2008) compares services and manufacturing firms but not for non-technological innovations. Schmidt and Rammer (2007) present some descriptive statistics on technological and non-technological innovations in manufacturing and services firms but do not systematically compare their determinants in the two sectors.

We acknowledge these findings in our research and model innovation in both sectors relying on the same set of variables.

However, the existing body of knowledge also suggests some aspects that make services different from manufacturing and that should not be ignored. Castro et al. (2011) have found that manufacturing firms are more inclined to technological and services to non-technological innovations. Hollenstein (2003) writes that innovation patterns in services differ from those in manufacturing precisely because of the importance of non-technological innovations in services, albeit not in all service sub-sectors.

Considering the findings of the above cited research, seeking for differences between the two sectors would require going beyond new products/services definition of innovation. The importance of understanding and studying innovation in a broader sense has been widely recognised (see Schmidt and Rammer, 2007). The attempt to comprehend innovation activities in full is evident in the Oslo Manual (OECD, 2005). That document distinguished technological and non-technological innovations. Technological innovation refers to product and process innovations. A product innovation refers to new or significantly improved goods or services. Examples are the introduction of a 4G smart phone or of banking services. Products or services can be new to the market or just new to the firm and not necessarily to the market. They can be developed by the firm itself or by other firms and institutions. A process innovation refers to the implementation of a new or significantly improved manufacturing method, logistics, delivery and distribution method or supporting activities. Examples cited in the Oslo manual are bar-coded goods-tracking systems or GPS-based delivery methods.

Both types of technological innovation are related to development of new technology and significant modifications of existing technologies. The key word in this case is technology. However, innovation can also refer to new solutions and changes that are not technological in nature, in particular organisational and marketing innovations. Organisational innovations include new business practices for organising procedures, new methods of organising work responsibilities and decision making and new methods of organising external relations with other subjects. Allowing for remote working or moving from a hierarchical to a horizontal

management style are examples of organisational innovations. The other non-technological innovation, i.e. marketing innovation, refers to changes in design and packaging, new media or product promotion techniques, new methods for product placement and sales channels and new pricing methods. For example selling milk in plastic bottles rather than in glass bottles would be considered as a marketing innovation.

These definitions explain each type of innovation. However, innovations are complex and sometimes it is difficult to distinguish clearly between them. Oslo manual (2005) provides instruction on how the borderline cases should be treated (see Oslo manual (2005) pp. 53- 56). Technological and non-technological innovations are not separate from each other and firms are likely to innovate with both types. Non-technological innovations are beneficial for the full exploitation of technological innovations (Baranano, 2003). Levitt (1960) argues that creativity in marketing methods enables innovators to profit fully from product innovations, underscoring the importance of marketing innovations in the overall innovation activities. Both types of non-technological innovations increase firms' capacity to introduce product innovation (Mothe and Nguyen-Thi, 2011). It is the combination of both technological and non-technological innovations that has the biggest impact on employment growth in manufacturing as well as in services according to Evangelista and Vezzani (2011). The organisational innovation impacts persistence in technological innovation especially for firms that develop both new products and new processes (Haned, Mothe & Nguyen-Thic, 2014). Particularly small firms benefit the most from undertaking organisational innovations in combination with technological innovation (Sapprasert & Clausen, 2012). Evidence on complementarities between technological and non-technological innovation is also provided by Schubert (2010).

The main question to be explored in this paper is whether innovation activities in services differ from those in manufacturing in terms of occurrence of innovation types and technological intensity. If service firms do not innovate in terms of technological innovations to the same extent and in the same way as manufacturing firms, it is worth to explore and compare their efforts in terms of non-technological innovation, that is organisational and marketing innovation. Taking into account previously cited research of Castro et al. (2011) and Hollenstein (2003) we can expect that technological innovation is more pronounced in manufacturing and non-

technological innovation in service firms. A lot of changes introduced by service firms have to do with changes in marketing, rearrangement of service provisions, but not so much changes in the types of services offered and even less so changes that have a technological content.

Hence, we hypothesise that:
H1: Service SMEs innovate more with non-technological innovation while manufacturing SMEs innovate with technological innovation.

R&D activities are an area that possibly differentiates the two sectors, even more so in the case of SMEs. SMEs are less likely to initiate R&D activities on their own. They innovate in a more informal manner without having formal R&D departments and laboratories, and thus they do not report the R&D activates they perform (Kleinknecht, et al. 2002). R&D in SMEs is difficult to capture but not completely absent. As for sectorial differences, the importance of R&D for innovation is not the same in services as it is in manufacturing. Hipp and Group (2005) found that R&D played a minor role in services compared to manufacturing, and they concluded that the knowledge generation in service firms differs from the knowledge generation in manufacturing firms. Manufacturing firms are more prone to perform in-house R&D, the results of which are new technologies, whereas service firms focus more on improving the technology developed by other firms and are accordingly less involved in in-house R&D (Gallaher & Petrusa, 2006).

On the basis of the extant literature, we hypothesise that:

H2: Service SMEs engage less in in-house R&D and more in other forms of R&D in comparison to manufacturing SMEs.

As explained in the introductory section, we aim to explore which variables are behind the decision to innovate in general in SMEs. Considering the role of innovation for business success, it is also important to better understand differences between manufacturing and services in Croatia. Innovations are acknowledged for their contribution to improving business performance and market position. It is confirmed by Cainelli, Evangelista and Savona (2006) that innovators

report better results, but also that better performing firms are more likely to innovate. There are a number of reasons to explain this finding. Firms that are leaders in their industries have sufficient financial and other resources to invest in innovation and/or less difficulties to obtain them from external sources. More efficient firms are in a position to attract more qualified experts to work for them. Firms that do not have to struggle to survive are more likely to devote more time and effort to a complex and risky activity such as innovation. In other words, they have more resources inside the firm to employ for innovation development. We also have to emphasise the pressure from competition due to which firms are more likely to innovate extensively and push the technological frontier outwards. Firms further away from the technological frontier can benefit from following and imitating leaders (Alder, 2010), and by doing so they encourage better performing firms to protect their position by introducing innovations of various types. It is interesting to see how SMEs in both sectors respond to the pressure from competition. This is perhaps more inherent to manufacturing whereas service SMEs to compete and maintain their competitive position without relying on innovation. In that case their performance in comparison to other firms is likely to be less triggered by innovation. In this study the indicator of firms' performance and development in comparison to the leader is the proximity to the frontier. It measures labour productivity compared to the most productive firm in the sector at the national level. Innovation is more likely to be conducted by firms closer to the frontier because they can no more rely on catching up.

Higher pressure of competition is faced on international market. Globally engaged firms report a higher innovation output both in terms of number of patents and self-reported innovations (Criscuolo, Haskel & Slaughter, 2010). Generally, firms' presence on foreign markets has been found to be beneficial for innovation (Hitt, Hoskisson & Kim, 1997) as it offers more opportunities. Love and Roper (2015) in their review discuss the relationship between innovation and exports (and vice versa) in SMEs. We expect that exporters are more likely to be innovators because they face fiercer competition abroad than producers serving only the domestic market.

For service SMEs, we expect their opportunities to get an access to external resources to be an important determinant in the decision to innovate. Belonging to a group of firms gives access to a wide set of skills and resources including those relevant for innovation development. Firms that

operate as part of group may be more prone to initiate innovation activities due to the support and synergy available in the group. They can benefit from intra-group knowledge spillovers and financial support. We can expect this to be more relevant for service SMEs.

Thus, we define following hypothesis:
H3: The decision to innovate in manufacturing SMEs is enhanced by the pressure of competition while in service it is enhanced by group synergies.

If services are indeed less likely to invest in R&D and create their own knowledge, as we hypothesise in H2, they might be more prone to rely on external resources and to try and benefit more from external sources of knowledge when it comes to develop both technological and non-technological innovations. However, this assumption is contrary to Musolesi and Huiban (2010) who find that in knowledge intensive business services external sources of knowledge and information are less likely to influence innovation while inbound R&D positively affects product innovation. In any case, our focus goes beyond knowledge intensive business services.

Firms can get access to external knowledge for innovation development through various channels. One possible way is collaboration, which refers to interactions with cooperation partners for the purposes of sharing knowledge and sharing the risks and costs of innovation. Its role in innovation has attracted lots of attention in the literature. It is not just a driver of technological innovation but also of organisational innovation (Schmidt & Rammer, 2007). Partnering with other subjects, for instance, is of high importance for small firms, and it enables them to innovate more than firms with no partnerships (Hausman, 2005).

Formal cooperation is only one way of getting access to external factors crucial for innovation. The existence of an information exchange that operates separately from formal cooperation should be acknowledged because the value of some exchange is not high enough to be worth establishing a formal cooperation (e.g. informal know-how trading identified by von Hippel, 1987). External sources are relevant not just for innovation development but also for improving business performance and growth of service innovative firms (Mansury & Love, 2007). The

benefit of using a larger number of information sources in innovation is evident in innovation success (Leiponen & Helfat, 2010).

Some external sources such as customers are very important as they increase the probability of market success especially for innovations with a high level of novelty (Lin & Germain, 2004). Primarily due to the involvement of customers in the provision of goods or services, customers may be even more crucial for services than for manufacturing. On the other hand, suppliers are interested in providing information as the innovation can enable them to increase their own sales. For some sectors such as ICT the most important source are precisely members of the distribution channel (Hyland et al., 2006). Den Hertog (2000) integrated customers and suppliers in the patterns of service innovation and emphasised the existence of supplier dominated and customer led innovations in services. Conversely, firms can be more prone to resist ideas and information originating outside of the firm, i.e. they can suffer from a "not invented here" syndrome (Katz & Allen, 1982; Laursen & Salter, 2006).

Taking into account the above findings, we hypothesise that:
H4: Formal cooperation and external sources of information are more relevant for development of product, process, organisational and marketing innovation in services than in manufacturing SMEs.

It is important to explore if services SMEs benefit the same way from public innovation programs as manufacturing SMEs. Public schemes and grants for innovations are likely to enable R&D activity and affect its scope. Common characteristics of innovative SMEs in the mechanical and electric engineering sectors identified by Keizer et al. (2002) include participation in government innovation schemes, along with higher investment in R&D and links to knowledge centres. It is possible that, if indeed in-house R&D is less important for innovation development, the public funding that aims at fostering and enabling R&D is less important for services. Lack of efforts to perform R&D would make service SMEs not eligible to apply for public grants in the first place and to receive them in competition with manufacturing SMEs. Public funding can most certainly make it easier for a firm to perform R&D and to perform it on a larger scale, but firms that apply for public funding for innovation need to propose a project,

which implies that they have already decided to initiate R&D activity. In line with our hypothesis, we can expect less public funding in service SMEs. However, it is interesting to explore to what extent R&D and public funding of R&D are relevant for innovation development in this sector.

H5: In-house R&D and public funding of R&D are both more likely to determine product and process innovation in manufacturing than in service SMEs.

3. DATA

The analysis relies on data from the Community Innovation Survey 2010 (CIS 2010), the latest wave of CIS that contains information on non-technological innovation. This wave provides data on innovation activities taking place during the period 2008 to 2010. The CIS in Croatia is conducted by the National Bureau of Statistics; it fully follows the Eurostat methodology based on the Oslo manual, and it is mandatory. Data were collected employing mail survey. The harmonised survey questionnaire used to collect data asked questions on product and process innovation, ongoing and abandoned innovation activities, R&D expenditures, sources of information and cooperation for innovation, innovation objectives, factors hampering innovation activities, organisational innovation, marketing innovation and creativity and skills[2].

A basic group for the CIS was extracted from the Statistical Business Register and it was stratified according to the activities, the number of employees and regions. The questionnaire was sent to 4504 firms, and the response rate was 75.3 percent. Thus, the total number of responses in CIS databases is 3390. This includes both SMEs and large firms operating in all sectors covered in the survey. As our focus is on SMEs in manufacturing and service sectors only, the sample consists of 1236 manufacturing and 1195 service firms. A multivariate probit model is estimated on the sub-sample of innovative and R&D performing SMEs. Due to rather low level of innovation activities in Croatian firms, but also the CIS harmonised questionnaire structure the sample was reduced to 480 manufacturing and 380 service SMEs. Questions on R&D expenditures, sources of information and cooperation are answered by firms that have had

[2] More on CIS methodology is available on Eurostat web page http://ec.europa.eu/eurostat/cache/metadata/en/inn_cis2_esms.htm#meta_update1418758699064

successful development of technological innovation and/or ongoing and abandoned innovation projects. Thus, in our case this includes 455 successful innovators and 25 abandoned/ongoing projects among manufacturing SMEs and 365 successful innovators and 15 abandoned/ongoing projects in SMEs operating in the services sector.

4. LEVEL OF INNOVATION IN MANUFACTURING AND SERVICE SMES IN CROATIA

We begin our analysis with descriptive statistics. The purpose is to identify whether the occurrence of innovation differs in the two sectors. The two sectors are compared on the basis of the following variables: presence of innovation (regardless of type), presence of product, process, organisational and marketing innovations, engagement in in-house R&D, type of engagement in R&D, as well as presence of other innovation activities. The definitions of the variables are given in Appendix table A1.

The figures presented in Table 1 show that service SMEs lag behind manufacturing SMEs in terms of innovativeness. In CIS 2010, 47.7 percent of manufacturing SMEs reported having some kind of innovation activity in the previous three years, in services only 42.6 percent of them, i.e. a statistically significant difference of 5%.

The difference is more pronounced for technological than for non-technological innovations. The percentage of service firms that report organisational innovation is similar to the percentage of manufacturing firms that successfully implemented organisational innovations (24 percent in manufacturing and 24.9 percent in services). The same applies to marketing innovation, which was implemented in 26.7 percent of manufacturing SMEs and 25.6 percent of service SMEs. The t-statistics thus reveal no difference between manufacturing and service SMEs as far as non-technological innovations are concerned. However, for technological innovations the differences between manufacturing and services are statistically significant. The greatest difference is found in the case of product innovations: 27.8 percent of manufacturing SMEs report having developed

a product innovation compared to 19.6 percent of service SMEs. Manufacturing SMEs are also more involved in process innovation: 31.4 percent of them had this type of innovation in the analysed period against only 26 percent of the firms in services. We also consider as innovative those firms that report ongoing and abandoned technological innovation projects. Here again manufacturing SMEs are more involved in technological innovation: 16.99 percent of manufacturing SMEs compared to 10.38 percent of service SMEs have tried or are still trying to develop technological innovations.

[Table 1 near here]

As we expected, service SMEs in Croatia are indeed less involved in the development of technological innovation. The percentage of firms that develop these innovations as well as the percentage of firms that have attempted to develop them (indicated by abandoned and ongoing projects) is lower in the services sector. However, compared to manufacturing, they do not report more non-technological innovation either. By contrast, the non-technological innovation activities are not significantly different between SMEs in the two sectors in Croatia. Based on these results we cannot conclude that service SMEs engage more in non-technological innovation, as suggested by Castro et al (2011). However, we can conclude that manufacturing firms lead in technological innovations. So, H1 hypothesis is only partially supported by the results.

If we look at the input side of the innovation activities (table 2) there is little difference between SMEs operating in the manufacturing and those operating in the services sectors, at least no statistically significant difference. Roughly 64 percent of the innovating firms perform in-house R&D, 83 percent of them on a continuous basis, 32 percent perform extramural R&D, 83 percent report acquiring new machinery connected to innovation, 55 percent have training expenditures connected to innovation, 42 percent incur costs related to getting the new products/services on the market and around 44 percent have design costs (the reported numbers are averages for manufacturing and services). The only expenditure item where there is a notable difference

between the two types of firms is in the acquisition of knowledge: 37.4 percent of the service SMEs report having spent money on acquiring knowledge (by purchasing patents, licenses, know-how) against only 26.6 percent of the SMEs in manufacturing.

[Table 2 near here]

The results do not provide enough evidence to support H2. Contrary to what was argued in some previous studies in the literature, Croatian manufacturing and services SMEs do not significantly differ in terms of engagement in in-house R&D. The percentage of firms that perform in-house R&D is higher in manufacturing but the difference is not statistically significant. As for the other forms of innovation, the two sectors differ only in the acquisition of knowledge. This indicates that services are somewhat more oriented toward obtaining external knowledge. Apart from that, service and manufacturing SMEs are rather similar.

This result is actually in line with some recent findings that uncover the importance of R&D in the services sector. Nijssen et al. (2006) identified a stronger importance of R&D for radical services than for radical products, while Sirili and Evangelista (1998) find that innovation expenditures per employee in service firms are close to the average of manufacturing firms. A low involvement of services in R&D activities was the trend in the past, but recently the share of services in business R&D has shown an upward trend (Miles, 2007).

A cursory overview of the descriptive statistics on innovation inputs and outputs in the two sectors indicates that service SMEs are less oriented toward technological innovation and more prone to seek inputs for innovation from outside the firm. These findings motivate further research on the factors that encourage these sectors to innovate, and to innovate in particular types of innovation.

5. DRIVERS OF INNOVATION IN MANUFACTURING AND SERVICE SMES

In this section, we examine what determines the decision to become an innovator in manufacturing and service SMEs whatever the kind of innovation achieved.

For exploring the factors that influence the decision to become an innovator or the factors that allow a firm to be successful in innovating in each sector, we estimate a probit model. The choice of the econometric model is dictated by the available data. As the dependent variables are binary, we can only use qualitative models explaining the occurrence of certain types of innovation. If we had data on the number of innovations by type, we would be able to better grasp what determines the intensity of innovation. This is one of the avenues for future research.

The explanatory variables are proximity to the frontier, technological intensity, belonging to a group, presence on foreign markets and number of employees. The definition of these variables is given in Table A1 together with some descriptive statistics of the means of these variables in the two sectors. In Table 3 we present the estimated coefficients and the marginal effects of the explanatory variables for manufacturing and services firms of the probit model for innovation (of any kind). The chi-square statistics show that the estimated coefficients as a whole are statistically different from zero.

The overall rate of correct classifications for manufacturing SMEs is 61.04 percent (64.59 percent of innovators and 57.78 percent of non-innovators are correctly classified). As for service SMEs, 58.68 percent of innovators and 62.24 percent of non-innovators are correctly classified, giving an overall rate of correct classifications of 60.71 percent[3].

Manufacturing SMEs are more likely than service SMEs to operate on a foreign market, not to belong to a group, to benefit from public R&D support and to have a larger size. The sources of information for innovation do not differ drastically between the SMEs in the two sectors.

[3] The cut-off points for correct predictions are the observed proportions of positive outcomes (for manufacturing 47.89 percent and for services 43.08 percent). A predicted probability of being innovative above that cut-off point corresponds to a correct prediction for an innovator and predicted probability below that cut-off point corresponds to a correct prediction for a non-innovator.

[Table 3 near here]

The results of Table 3 support our hypotheses of the direction of the effects of the explanatory variables and on the resulting differences in the importance of the drivers of innovation in manufacturing and service SMEs in Croatia. Manufacturing SMEs that are closer to the frontier (i.e. above the median productivity level) have a 9.2 percent higher chance to be innovators whereas proximity to the frontier is not at all related to innovation for service SMEs. Not surprisingly firms in the high-tech sectors are more likely to be innovators.[4] The synergy of belonging to a group of firms has no significant effect on innovation occurrence in manufacturing but well in services, where it increases the likelihood to be an innovator by 8.3 percent. Being active on a foreign market increases the likelihood to be an innovator by 17.6 percent in manufacturing SMEs and only by 9 percent in service SMEs. Perhaps somewhat unexpected is the marginal size effect, which is almost twice as high in services as in manufacturing (9.3 percent versus 4.9 percent).

From this first look at the determinants of innovation in general we conclude that the higher incidence of innovation in manufacturing SMEs compared to service SMEs in Croatia is related to the pressure of competition (proximity to the frontier and presence on foreign markets) and that service SMEs rely more on group synergy. More of them are affiliated to a group than in manufacturing, and the innovators are more often part of a group. These findings support hypothesis H3.

In the next section we now turn to the determinants of particular kinds of innovation.

[4] We also ran the regression controlling for 2-digit industry dummies. The main results are basically the same as those reported in table 3 and therefore we prefer to report the results with only a control for technology-intensive sectors.

6. DRIVERS OF PARTICULAR KINDS OF INNOVATION IN CROATIAN MANUFACTURING AND SERVICE SMES

To study which factors influence the introduction of technological (product and process) and non-technological (organisational and marketing) innovations among innovating firms we estimate a multivariate probit model[5]. This model explains the determinants of the four binary variables by maximising the likelihood of observing the combinations of zero-one observations. The binary variables (product, process, organisation and marketing innovation occurrences) are modelled as taking value 1 when their corresponding latent variable is positive and value 0 otherwise. The four dependent variables are interrelated through the correlated error terms that are supposed to be jointly normally distributed.

To explain what determines each kind of innovation output we use the following set of explanatory variables: formal cooperation, public funding, R&D intensity, firm size and four sources of information that lead to the innovation(s) - internal sources, suppliers, clients, and competitors and technological intensity. It is worth noting that, in our case, the importance of external sources is not conditional on having established any form of cooperation.

[Table 4 near here]

The results reported in table 4 suggest that there is not a huge difference between the determinants of innovation in manufacturing and in services. Whenever a variable has a significant marginal effect in both sectors the sign and even the order of magnitude of the marginal effect is the same. Formal cooperation in innovation increases significantly all types of

[5] We estimate the multivariate probit model using the Stata program mvprobit developed by Cappellari and Jenkins (2003).

innovation in both manufacturing and service SMEs. We expected it to be more relevant for service SMEs. However, there are no differences between the two sectors regarding the role of cooperation for innovation development. There are some differences in the significance of some of the external sources of information for innovation. For instance, information from suppliers is negatively correlated with product innovation in manufacturing and positively with organisational innovation in services, and information from competitors is positively correlated with organisational innovation in manufacturing and with product (service) innovation in services. Internal sources of information are positively correlated with organisational and marketing innovations in services but not in manufacturing. Information from clients has the most similar impact in both sectors. It affects positively the development of product, organisational and marketing innovation in manufacturing as well as in services. However, the magnitude of marginal effects is higher in services. This is somewhat expected given that clients participate actively in the provision of services. Therefore, it would be difficult for service SMEs to neglect the information from the clients in innovation development, probably more so in services than in manufacturing as services are more customer-designed.

If we compare the determinants across the four types of innovation, we notice the following pattern, quite similar in manufacturing and services: R&D is an important driver only for product innovations, not for process innovations, information from clients is determinant for product, organisational and marketing innovations whereas it is information from suppliers that is determinant for process innovations. As already mentioned cooperation is always a significant, positive driver.

Our results reveal that R&D is relevant for product innovations in service SMEs as it in manufacturing SMEs. The importance of R&D in service firms is supported by Amara, Landry and Doloreux (2009), although they show its relevance for all innovation types. However, their focus was on knowledge intensive business services. As for the external funding, assuming it is exogenous, it boosts process innovation by 9.2 percent but has no effect on product innovation in manufacturing. In services it boosts product innovation by 15.7 percent but has no effect on process innovation.

These results confirm that service SMEs engage in in-house R&D just as much as manufacturing SMEs, as the descriptive statistics reveals. The engagement in R&D is an important determinant of their innovation output.

Contrary to our assumptions, public funding is a significant determinant of product innovation in services. Despite the fact that the percentage of service SMEs that received public funding is low (16 percent) and most certainly significantly below public funding of manufacturing SMEs (40 percent), the analysis reveals that service SMEs benefit from this form of support. Those that report having received public funding of local, national or international level are more likely to introduce product innovation, unlike in manufacturing. Manufacturing SMEs recipients of public funding are more likely to deliver process innovation.

In these models we controlled for size and technological intensity. Size measured by the number of employees in SMEs ranges from 10 to 250. We expected that those that have more employees are in a better position to innovate in comparison to small firms. However, size does not affect any of the innovation types in any of the sectors. A firm that operates in a technology intensive sector has a higher propensity of innovating to stay abreast of competition. SMEs in technology intensive sectors are expected to be more prone to introduce various types of innovation. Results reveal that hi-tech firms are more likely to introduce organisational innovation. Services operating in technology intensive sectors are more likely to develop new services and less likely to introduce marketing innovation. For the other innovations, the technological intensity of the industry does not affect their probability of occurrence.

Many of the correlations between the error terms are significantly different from zero, justifying the choice of specifying a multivariate choice model. Most of these correlations are positive, indicating either the presence of complementarity between the different types of innovation confirming Schubert (2010), if we believe that no other explanatory variable exists, or then as the possible omission of common compounding effects that influence all innovations in the same direction.

In order to assess the goodness-of-fit of the multivariate probit model we compute the rates of correct classifications for each of the four innovation types by computing the proportions of observed innovators (resp. non innovators) that have a predicted probability to be (not to be) innovative above a certain cut-off point.[6] For manufacturing SMEs 51.60 percent of the product innovators and 78.83 percent of non-product innovators are correctly classified. For the other types of innovation the proportions are respectively 64.08 percent and 60.22 percent for process innovation, 9.09 percent and 95.60 percent for organisational innovation and 5.03 percent and 97.73 percent for marketing innovation. For service SMEs, the ratios are 40.60 percent and 89.04 percent for product innovation, 67.85 and 47.83 percent for process innovation, 37.95 percent and 87.89 percent for organisational innovation, and 18.48 percent and 95.27 percent for marketing innovation.

7. CONCLUDING REMARKS

In this paper we analyse the determinants of innovation activities in small and medium sized firms operating in the service and manufacturing sectors in Croatia. We first explore the level of innovation in two sectors, then what determines that SMEs innovate and finally what distinguishes four ways of innovating: coming up with new product/services or processes, so-called technological innovations, or coming up with organisational or marketing innovations, so-called non-technological innovations. We estimate the four decisions jointly. To find out whether innovations have a different pattern of drivers in manufacturing and in services, we estimate the model separately on these two groups of firms.

[6] The cut-off points for the correct predicted percentages are the observed proportions of innovative firms for each innovation type. In the manufacturing sector these are: 72 percent for product innovation, 81 percent for process innovation, 48 percent for organizational innovation and 51 percent for marketing innovation. For services, the proportions are 62 percent for product innovation, 82 percent for process innovation, 59 percent for organizational innovation and 56 percent for marketing innovation.

The three stages of research reveal interesting findings on differences between two sectors. Firstly, the descriptive statistics show that manufacturing and services are involved in innovation activities to a different extent. Service SMEs differ from manufacturing mostly as regards technological innovations. They are less likely to introduce product and process innovations. As far as the incidence of organisational and marketing innovations is concerned, manufacturing and service SMEs do not significantly differ from each other. In terms of inputs to the innovation process, the only noteworthy difference between manufacturing and service SMEs is that the latter rely much more than the former on acquired knowledge.

Secondly, when we compare the drivers of innovation in general between manufacturing and service SMEs, we notice that the higher incidence of innovation in manufacturing SMEs is related to determinants that reflect the pressure of competition (proximity to the frontier and presence on foreign markets), and that service SMEs rely more on group synergy.

Thirdly, the analysis of the determinants of particular innovations, technological and non-technological, revealed that apart from differences in the marginal effects of funding on product and process innovations in manufacturing and service SMEs and from the fact that some sources of information for innovation are more useful for particular types of innovation in the two sectors, there are more similarities than differences in the drivers of innovation for innovating firms in manufacturing and service SMEs.

The multivariate analysis of the determinants of innovation shows that R&D is relevant for product innovations only, size never and collaboration always, and that among the sources of information leading to the innovation clients play a role for product and non-technological innovations and suppliers for process innovation. Our findings on the determinants of the four types of innovation thus indicate that different factors are relevant for the development of different types of innovation.

Our findings show that innovation activities are present in service firms. Their level is not necessarily the same as in manufacturing (in case of technological innovations) but we see significant efforts of service SMEs to become innovators. This is especially evident in their

engagement in R&D. We expected the two sectors to be different in that respect, and what we found is rather unexpected. Service firms perform R&D, not just in-house R&D but also other forms of innovation activities. For business practitioners this finding implies that innovativeness in service firms requires a significant effort devoted to R&D. Our study did not examine R&D expenditures in services vs manufacturing. It is likely that R&D expenditures in manufacturing are higher than in services. This question could be further explored in prospective studies.

Considering that R&D is a significant determinant of technological innovation development just as much as it is in manufacturing, a point could be made that service firms in Croatia should be more supported through public funding. The current situation is that more manufacturing firms participate in these programs in comparison to service SMEs. This is another issue that would be worth investigating in the future.

One limitation of our study relates to the nature of the CIS data. Namely, most of the variables, including those on innovations, in the CIS dataset are binary. The data indicate the presence or absence of innovation of a particular type, but not the number of innovations developed. Having a continuous measure of innovation would enable us to understand in more detail the differences between innovation in manufacturing and service SMEs in Croatia. In addition, the data pertain to the time period 2008 to 2010, which was a period of economic downturn in Croatia. Future studies will tell whether the specific time period covered affected the results obtained.

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Appendix

[Table A1 near here]

Table 1 Frequency of innovation activities in Croatian SMEs by sector, in percent

	Manufacturing (n=1236)	Services (n=1195)	p-values of t-test of equality of means
Innovators	47.65	42.59	0.01
Product innovation	27.83	19.58	0.00
Process innovation	31.39	26.03	0.00
Technological (product and/or process)	36.89	30.54	0.00
Firms with ongoing and abandoned technological innovation	16.99	10.38	0.00
Organisational innovation	24.03	24.94	0.60
Marketing innovation	26.70	25.61	0.54
Non-technological (organisational and/or marketing)	36.00	34.90	0.56

Table 2 Incidence of R&D and other innovation expenditure in manufacturing and service SMEs, in percent of total number of firms

	Manufacturing (n=480)	Services (n=380)	p-values of t- test of equality of means
In-house R&D	66.32	62.37	0.23
Continuous R&D (% of those that report in-house R&D)	82.45	85.23	0.38
Extramural R&D	30.56	33.95	0.21
Acquisition of machinery	85.03	81.84	0.21
Acquisition of knowledge	26.61	37.37	0.00
Training for innovation	53.22	56.32	0.37
Market introduction of innovation	41.58	42.89	0.70
Design	46.78	43.95	0.41

Table 3 Determinants of innovation in manufacturing and service SMEs in Croatia (probit model)

	Manufacturing		Services	
	Coefficients	Marginal effects	Coefficients	Marginal effects
Proximity to the frontier	.233 ***	.092***	.013	.005
Technological intensity	.335 ***	.133***	.349 ***	.137***
Belonging to a group	.097	.039	.211 **	.083**
Foreign market	.447 ***	.176***	.230 ***	.090***
Log of nb of employees	.122 ***	.049***	.238 ***	.093***
Intercept	-.970***		-1.305	
LR chi2(5)	97.05		81.18	
Prob > chi2	0.0000		0.0000	
Log likelihood	-788.41641		-754.35908	
Number of observations	1209		1163	

Note: *** Significant at the 1% level. ** Significant at the 5% level. Innovation means introduction of or attempt to introduce a new product, process, organisational change or marketing method. We lose some observations because labor productivity in 2008, used in measuring proximity to the frontier, was missing for some of the firms.

Table 4 Determinants of product, process, organisational and marketing innovations in manufacturing and service SMEs in Croatia (multivariate probit model)

	Manufacturing				Services			
	Product innovation	Process innovation	Organisa-tional innovation	Marketing innovation	Product innovation	Process innovation	Organisa-tional innovation	Marketing innovation
Technological intensity	-.195 (-.061)	-.094 (-.024)	.235* (.089)	-.141 (-.054)	.308** (.101)	-.245 (-.061)	.064 (.023)	-.416*** (-.152)
Formal cooperation	.556*** (.172)	.322** (.084)	.442*** (.167)	.398*** (.153)	.450*** (.148)	.382** (.100)	.467*** (.164)	.422*** (.154)
Internal information	.156 (.048)	.203 (.053)	.228 (.086)	.006 (.002)	.118 (.039)	.169 (.042)	.406** (.143)	.438** (.160)
Information from suppliers	-.467** (-.144)	.550*** (.143)	.024 (.009)	-.024 (-.009)	-.262 (-.086)	.433** (.109)	.537*** (.189)	-.011 (-.004)
Information from clients	.457** (.141)	-.090 (-.023)	.357* (.135)	.323* (.124)	.515*** (.170)	-.254 (-.064)	.584*** (.206)	.422** (.154)
Information from competitors	-.004 (-.001)	.023 (.006)	.201 (.076)	.250* (.096)	.320* (.105)	.082 (.021)	-.205 (-.072)	.176 (.064)
Number of employees (in logs)	.012 (.004)	-.048 (-.012)	-.081 (-.030)	-.069 (-.026)	.065 (.021)	.071 (.018)	.030 (.011)	-.015 (-.005)
External funding	.013 (.004)	.354** (.092)			.477** (.157)	-.017 (-.004)		
In-house R&D/employee (in logs)	.095*** (.029)	-.016 (-.004)			.057** (.019)	-.015 (-.004)		
	ρ_{21}=-.045				ρ_{21}=-.326***			
	ρ_{31}=.107	ρ_{32}=.308***			ρ_{31}=.085	ρ_{32}=.050		
	ρ_{41}=.346***	ρ_{42}=.241***	ρ_{43}=.405***		ρ_{41}=.254***	ρ_{42}=.139	ρ_{43}=.407***	
	Likelihood ratio test of all ρ_{ij}=0: chi2 (6) = 68.2869***				Likelihood ratio test of all ρ_{ij}=0: chi2 (6) = 47.8936***			
No of observations	480				380			
Wald chi2 (32)	101.87				137.27			
Prob > chi2	0.0000				0.0000			
Log likelihood	-1086.5277				-842.36996			

Marginal effects in parentheses. The ρ_{ij}'s are the correlation coefficients of the error terms in each equation. Product innovation in services corresponds to service innovation.

*** Significant at the 1% level

** Significant at the 5% level

* Significant at the 10% level

Table A1: Definition of variables

		Manufacturing	Services	p-values of t- test of equality of means
Dependent variables				
Innovators	1 if firm reports development of any of the four types of innovation, 0 otherwise	47.65	42.59	0.01
Product innovation	1 if firm developed new products/services in the period 2008-2010, 0 otherwise	27.83	19.58	0.00
Process innovation	1 if firm developed new or significantly improved methods of manufacturing, producing products/services, logistics, delivery or distribution methods, and/or supporting activities in the period 2008-2010, 0 otherwise	31.39	26.03	0.00
Organisational innovation	1 if firm reports introduction of new business practices for organising procedures, new method of organising work responsibilities and decision making, and/or new methods of organising external relations in the period 2008-2010, 0 otherwise	24.03	24.94	0.60
Marketing innovation	1 if firm reports introduction of new design and packaging, new technique for promotion, new methods of product placement and/or pricing methods in the period 2008-2010, 0 otherwise	26.70	25.61	0.54
Independent variables				
Proximity to the frontier	1 if labor productivity of firm is above the median of labor productivity of all firms in the sample in the sector the firm belongs to in 2008, 0 otherwise	48.80	49.87	0.60
Technological intensity	1 if firm belongs to the KIS sector*, for services, or to the high- and medium high technology industries** in the case of manufacturing, 0 otherwise	18.37	37.24	0.00
Foreign market	1 if selling product/services on foreign markets (other EU countries, EFTA and EU candidate countries and all other countries) in 2008-2010 , 0 otherwise	59.71	45.69	0.00
Number of employees+	Log of number of employees in year 2010	60.48	48.97	0.00
In-house R&D/employee (in log)+	Log of in-house R&D investment in 2010 per number of employees in 2010	1.85	1.66	0.37
Group	1 if firm was part of a group in 2010, 0 otherwise	22.65	29.87	0.00
External funding	1 if firm received local, national or EU finding during 2008-2010, 0 otherwise	39.58	15.53	0.00
Formal cooperation++	1 if firm established a formal cooperation on innovation development (regardless of subject) , 0 otherwise	30.15	35.79	0.08
Internal sources++	1 if firm reports using information from sources within the company in innovation development , 0 otherwise	84.41	81.84	0.32
Suppliers++	1 if firm reports using information from suppliers in innovation development, 0 otherwise	87.73	83.42	0.07
Clients++	1 if firm reports using information from clients in innovation development, 0 otherwise	83.78	82.11	0.51
Competitors++	1 if firm reports using information from competitors in innovation development, 0 otherwise	70.06	68.68	0.66

+ Mean

++ Percent of innovative firms

***** The firms are selected in the group of knowledge intensive services according to EUROSTAT aggregation of services based on NACE Rev 2. The following sectors defined as producing knowledge intensive services (KIS) are present in the sample: water transport, air transport, publishing activities, motion pictures, Video and television production, Sound recording and music publishing activities, Programming and broadcasting activities, telecommunication, computer programming, consultancy and related activities, Information service activities, financial and insurance activities, activities of head offices, management consultancy activities, architectural and

engineering activities, technical testing and analysis, scientific research and development, and advertising and market research.

** This variable in our sample includes industries defined in EUROSTAT NACE Rev 2 as high-tech and medium-high tech. Those are manufacture of basic pharmaceutical products and pharmaceutical preparations, and manufacture of computer, electronic and optical products as well as manufacture of chemicals and chemical products, manufacture of weapons and ammunition, manufacture of electrical equipment, manufacture of machinery and equipment, manufacture of motor vehicles, manufacture of other transport equipment and manufacture of medical and dental instruments and supplies.

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