LOGISTICS INNOVATIONS DEVELOPMENT IN THE CEE REGION

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Received: August 23, 2019
Received revised: September 23, 2019
Accepted for publishing: September 24, 2019

Abstract

Although innovation in general and logistics innovation in particular have been discussed in various contexts, there has been a limited amount of empirically based research on logistics innovation and its determinants. The purpose of this paper is to investigate determinants behind the probability of introducing innovations in logistics, delivery or distribution methods for inputs, goods and services among manufacturing firms in eight Central and East European (CEE) countries during the 2012-2014 period using the bivariate probit analysis. To this end, the paper uses data from Community Innovation Survey (CIS), a confidential dataset compiled by Eurostat on innovation activities of firms in the EU member states. Findings reveal differences in innovation process among three groups of firms as well as different mediating effects of selected variables on creation of logistics innovations and combined effects of public subsidies and procurement. The paper adds to the knowledge of determinants of incremental and radical logistics innovations in the CEE region.

Key words: innovation, logistics innovation, firm performance, bivariate probit analysis, CEE region

1. INTRODUCTION

In order to survive and prosper in today's dynamic and competitive business environment, firms increasingly depend on the ability to innovate. Consequently, the concept of innovation is valued in most organizations to create and sustain

competitive advantage (Soosay & Hyland, 2004) and the same refers to logistics industry in general. Nowadays, many firms place emphasis on leveraging logistics capabilities as a source of competitive advantage (Esper et al., 2007). As argued by Chapman et al. (2002), the logistics industry is a service-based industry, transformed from the business concept of transportation to that of serving the entire logistical needs of customers. Although innovation is a key process for logistics service providers, Buse & Wallenburg (2011) highlight a high failure in logistics innovation in practice. According to Manners-Bell & Lyon (2019), logistics companies have often been accused by their customer of lacking innovation, while they in turn have levelled accusations that manufacturers and retailers have been more focused on cost cutting than creativity. Due to intense competitive and turbulent environment, logistics service providers have to continuously improve logistics service quality and firm performance (Panayides, 2007). In that context, Bellingkrodt & Wallenburg (2013) show that innovativeness is a strong driver of logistics service providers' firm performance. Furthermore, logistics service providers can evoke a higher level of customer satisfaction when being innovative (Bellingkrodt & Wallenburg, 2015).

In broad terms, logistics innovation itself can be defined as "any logistics related service from the basic to the complex that is seen as new and helpful to a particular focal audience" (Flint et al., 2005, p. 114). In that context, innovations can be internally or externally focused, depending on whether the focus is on operational efficiency or new or improved service to consumers. Therefore, logistics innovation can be considered service innovations triggered by technological innovations (Saatcioglu et al., 2014). As noted by Lin (2007), the innovation in logistics technologies can be significantly positively influenced by organizational encouragement, quality of human resources, environmental uncertainty, and governmental support for logistics service providers. In addition, technological innovation have to be complemented with non-technological innovation concerning services, people and organization in order to survive and prosper (De Martino et al., 2013). Although they can involve elements of technologic innovations, many of the innovations occurring within the supply chain and logistics industry are organizational. They mainly refer to relationships with customers and suppliers, operational processes or business models (Manners-Bell & Lyon, 2019). Additionally, Grawe (2009) stresses the importance of logistics innovations primarily due to their cost-cutting nature, which can be difficult for competitors to detect and imitate.

Although the issue of logistics innovations has attracted the interest of researchers and practitioners, the lack of knowledge base regarding empirically based research in logistics innovation has been frequently emphasized (Lin, 2007; Daugherty et al., 2011; Su et al., 2011; Björklund & Forslund, 2018). To fill this gap in the existing literature, the purpose of this paper is to investigate determinants behind the probability of introducing innovations in logistics, delivery or distribution methods for inputs, goods and services among manufacturing firms in eight Central and East European (CEE) countries during the 2012-2014 period using the bivariate probit methodology. The paper is divided into four main parts. After a brief introduction on logistics innovation, determinants of logistics innovation within the context of literature review are discussed. Following the literature review, the third

section explains the empirical strategy whereas the fourth section brings out the research findings. Finally, in the last section some conclusions have been drawn upon.

2. LITERATURE REVIEW

In general, logistics innovations have been discussed from different perspectives and in various contexts. Some examples include the following: the effectiveness of shipping knowledge on organizational innovation and logistics value (Lee and Song, 2015), logistics-driven packaging innovation in retail supply chains (Hellström & Nilsson, 2011), the process of a logistics innovation in a healthcare supply chain context (Su et al., 2011), outbound logistics services in the automotive supply chain (Rajahonka & Bask, 2016), the innovative strategies in the context of eco-efficiency innovation (Rossi et al., 2013), the influence of logistics process innovations on ambidexterity performance (Ardito et al., 2018), etc. However, despite this interest, there have been limited previous studies addressing empirical research in the context of logistics innovations.

It is generally accepted that firm's knowledge base is conducive to innovation activity (Petrou & Daskalopoulou, 2013) and that knowledge resources play an important role in development of innovations (Chapman et al., 2003; Nieves et al., 2014). As firms pursue strategies to innovate, the major resource lies in the people within the organization (Soosay, 2005). Therefore, the importance of learning in today's hypercompetitive global supply chain environment has been underlined (Esper et al., 2007). As stressed by Yazdanparast et al. (2010), the process of co-creation of value in a logistics context has three phases: learning, innovation and execution, and outcomes. In addition, Autry & Griffis (2008) suggest a positive relationship between logistics innovation and supply chain knowledge development. According to Hakansson & Persson (2004), the learning associated with the combination of resources across supply chains leads to increased levels of innovation. In addition, Panayides and So (2005) affirm that relationship orientation has a positive influence on organisational learning and innovation. Similarly, Kuhne et al. (2013) argue that the characteristics of the chain relationship quality may be important factors for the improvement of the innovation capacity in chains.

When examining the German transportation industry, Wagner (2008) outlined the importance of innovation for the competitiveness of logistics service providers. However, his findings revealed that only 30% of the logistics service providers' were innovators with innovation activities mainly including technological advanced infrastructure and equipment investments. Further, Germain (1996) examined manufacturers and the adoption of logistics process innovation. Size and environmental uncertainty were found to directly predict radical, but not incremental innovation while specialization predicted both. Additionally, the results revealed that decentralization of manufacturing operations did not predict logistics process innovation.

Flint et al. (2008) posit that supply chain learning and innovation processes are driven by processes aimed at studying changes in customer value and contribute to perceptions of superior organizational performance. Innovativeness is an important

determinant of logistics service quality and, consequently, customer value and firm performance. Panayides (2006) argues that relationship orientation in the logistics service providers-client relationship will lead to higher levels of innovativeness, improvement in the quality of logistics service and improved performance for the logistics service providers. Similarly, Grawe et al. (2015) highlighted a relationship between logistics innovation and performance of service providers and of customers. Additionally, Ralston et al. (2013) emphasize logistics salience as an important resource for firms looking to provide differentiated services and innovative logistics operations to their customers.

Empirical studies of logistics innovations have focused on the innovation process. In that context, Grawe et al. (2011) showed that innovative logistics processes could lead to greater operational flexibility, which could further lead to higher levels of logistics performance. Furthermore, Fugate et al. (2010) highlight that logistics performance positively affects organizational performance. Daugherty et al. (2011) confirm a positive relationship between logistics service innovation capability and market performance. However, the study by Hazen & Byrd (2012) suggests that adoption of a logistics innovation by itself may not necessarily produce a sustained competitive advantage. Instead, when combined with complimentary firm resources, the innovation may yield a sustained competitive advantage for the adopting firm. Additionally, Kwak et al. (2018) provide evidence for the importance of supply chain innovation and risk management capability in supporting competitive advantage. Golgeci & Ponomarov (2013) suggest that both firm innovativeness and innovation magnitude are positively associated with supply chain resilience.

The environment surrounding firms can affect the firm's ability to innovate. In order to turn environmental problems into business opportunities, many companies are beginning to consider the integration of environmental or green aspects into their service offerings (Isaksson & Huge-Brodin, 2013). In that context, Dai et al. (2015) suggest that green supply chain integration has a positive impact on developing incremental environmental innovation, while only customer integration has a significant positive impact on developing radical environmental innovation. Further, Björklund & Forslund (2018) explored the sustainable logistics innovation process emphasizing the process behind its successful implementation, critical factors as well as challenges whereas Andersson & Forslund (2018) addressed sustainable logistics innovation and performance measurement. In addition, the role of innovation in reverse logistics performance was analysed. Innovation in reverse logistics programs was found to be related to operational service quality at both small and large firms (Richey et al., 2005). Moreover, reverse logistics innovation was positively associated with environmental and economic performance (Huang & Yang, 2014).

3. EMPIRICAL STRATEGY

Our analysis aims to investigate determinants behind the probability of introducing innovations in logistics, delivery or distribution methods for inputs, goods and services among manufacturing firms in eight Central and East European countries

that have become largest European production hub over the past decades. Ability to handle business logistics in efficient and competitive manner requires from them continuous search for channels for improvement of this part of business activities either through indigenous pushing of knowledge and technology frontiers or through absorption and implementation of knowledge implementation of knowledge developed by others. Investigation of such kind then could help all those businessmen and policy makers interested in improvements over competitiveness of manufacturing industry in the region.

The problem with investigations of this type is that they are often faced with barrier in form of lack of relevant data. One exception from this rule is Community Innovation Survey (CIS), largest European firm level database on innovation behaviour of firms. The survey is compiled from data collected through biannual survey. It covers information on firm innovation behaviour in period of two years prior to survey and latest version of dataset is commonly released within two and half to three years after the completion. At the time of writing of this article, the latest available version of survey was the 2014 one. One characteristic of CIS is that it is highly confidential database accessible by researchers through either Eurostat's Safe Center in Luxembourg or through Eurostat's secure servers. Access to database is granted on the basis of research proposal by National Statistical Offices of each EU member state and information on some firms can be removed from the sample.

For the purpose of this analysis we were given access to data on eight Central and East European countries (Bulgaria, Estonia, Croatia, Hungary, Latvia, Lithuania, Romania and the Slovak Republic) covering a total of 17.999 firms. Table 1 presents distribution of enterprises across countries as well as information on firms that have been involved in logistics innovations. As it can be seen from there, the number of firms is largest in Bulgaria, Croatia and Romania but lowest in Latvia.

Table 1. Number of firms in the database

Country	Number of firms	Logistics innovators	Radical innovators	Incremental innovators
Bulgaria	7378	194	72	122
Estonia	928	48	15	33
Croatia	1303	146	36	110
Hungary	1121	62	15	47
Lithuania	1026	72	26	46
Latvia	562	40	17	23
Romania	4475	86	16	70
Slovak Republic	1206	66	17	49
Total	17999	714	214	500

Source: Eurostat Community Innovation Survey

The proportion of firms involved in logistics innovation is very small with only 4% of firms in sample being involved in such type of innovation. The majority of these innovations are of incremental type meaning that these logistics practices have been known elsewhere in the world but they have been first time applied in surveyed

companies. This should not come as a surprise since the majority of enterprises, in general, are involved in incremental type of innovation. It can be expected that such practice becomes even more pronounced in countries as CEE ones where domestic knowledge and technology capabilities are weak and foreign investment has been found only to raise indigenous production capabilities rather than innovation ones.

The above shows that our intention is to explore determinants of incremental and radical logistics innovations in the CEE region. For this reason, a model is constructed that takes into account number of innovation determinants recognised in the literature as important for decision of firms to innovate. Hence, we include two categorical variables for small and medium sized firms since small firms are known to lack human capital, technology and financial resources for undertaking of innovation on the one hand but also have been found to anticipate changes faster than large firms and thus may be also more inclined towards innovations. One categorical variable controls for membership of firms in enterprise groups. In less advanced countries like CEE such groups have been found as an important channel of knowledge and technology spillovers relevant for creation of innovations. Moreover, being member of a group in such countries often implies vertical backward and forward linkages with other group members at home and abroad that may increase pressure for creation of logistics innovations.

We also include two categorical variables for previously abandoned and ongoing innovations since previous innovation experience increases efficiency of existing innovation processes. One categorical variable controls for market orientation of firms and takes value of one if firm is an exporter. Participation in international markets has been often cited as a source of learning by exporting channel that provides firms with insights into novel business practices, enables realization of demonstration effects but also helps them integrate in production networks of foreign partners or integrate them into own production networks all of which should increase the need for creation of logistics innovations. One categorical variable controls for firms with 10% or more employees with tertiary degree. Quality of human capital is a common proxy for absorptive capacity of firms and their knowledge capabilities. It is expected that absorptive capacity helps firms implement incremental innovations present elsewhere but also more easily develop skills and competences required for development of radical innovations.

We also control for public support to creation of innovations. Ability of firms to innovate can be increased through public incentives from either supply (push) or demand (pull) side. Such incentives provide financial means, signal future market trends, help firms release their innovations in market in early stages of their development and generally provide shield from competition in early stages of innovation development. We include two categorical variables, one that takes value of one if firm received financial support in form of subsidies and another that controls for firms that received public support through public procurement of innovations, a novel incentive channel whose relevance in the European Union is on the rise. Overall, one would expect positive effects of public support but it is also known that in advancing economies such as those in our sample public policies place stronger emphasis on production than innovation capabilities and even when innovation

policies exist, they often are constructed in a way that does not yield desired outcome. For this reason, there are no a priori expectations on these variables.

Need for logistics innovations may also be increased among firms that recently introduced some new form of product innovation. To control for this we also include share of revenues coming from incrementally or radically new products. Our model also includes three variables controlling for different types of enterprise restructuring. First variable controls for introduction of marketing innovations such as changes in design and packaging, new techniques for product promotion, new methods of product placement and sales channels, and new pricing methods. Such changes may open new business opportunities that could lead to need for logistics innovations. Second controlling variable is the one on internal restructuring that takes value of one if firm introduced organizational innovations such as new practices of supply chain and quality management, new methods for organization of work responsibilities and decision making or new methods for organization of external relations since such practices may improve organizational efficiency, release funds that could be used in development of different types of innovations including logistics ones or they may create needs for changes in a way logistics affairs are handled.

Third restructuring variable takes value of one if firm experienced some type of external restructuring. Specifically, we control for two types of restructuring, mergers and takeovers of other enterprises and sales and outsourcing of some of own functions. Such practices may provide firms with new knowledge and resources required for pursuit of innovations. Finally, one variable controls for collaboration in development of logistics innovations. Specifically, we control for those firms that developed logistics innovations in collaboration with others or those innovations development has been assigned to external sources. Such practices help firms supplement the lack of own innovation capabilities and for this reason, a positive effect can be expected. Model also controls for country specific effects through inclusion of country time dummy variables. Detailed description of variables can be found in Table A1 in Appendix.

Although two types of innovation analysed in our research are distinctive, they also share many common points. For example, many knowledge and technology capabilities required for one type of innovations are also required for others, changes in institutional framework or business environment may affect decisions of firms to pursue both types of innovations etc. As not all such factors can be controlled for, it is likely that two processes will be codetermined with set of unobservable factors. The method capable of handling such estimations is bivariate probit methodology. This methodology allows for correlation in error terms between two equations but assumes that error terms are not correlated with any of explanatory variables. To control for heteroscedasticity we also employ robust standard errors.

4. RESULTS OF INVESTIGATION

4.1. Baseline specification

As a first step of our analysis, we run model with all previously mentioned explanatory variables in their original form and without consideration of their

potential interactions. Table 2 presents marginal effects for those firms that only introduce incremental innovations, those that introduce radical innovations only and firms that introduce both types of innovation. For categorical variables these effects refer to effect on probability of introduction of given type of innovation as a result of change from base level of variable in question while in case of continuous variables they refer to effect on probability of innovation from unit change in continuous variable.

Results from Table 2 reveal differences in innovation process among three groups of firms. Those firms that introduce only incremental innovations that can also be called imitation have lower chances of innovating if they are part of the group. This can be attributed to the fact that such activities are undertaken by other group members. Experience with innovation pro cess seems beneficial for the emergence of incremental innovations suggesting that core innovation capabilities are being developed this way. Strongest effects, however, are found from marketing and organizational innovations, collaboration and turnover from product innovations. Hence, under pressure of changes in product innovation and as a result of successful commercialization of such innovations firms look for ways to improve their business logistics through imitation of practices of other, more competitive rivals.

Table 2. Results of baseline specification

Variable	Incremental innovation only	Radical innovation only	Both types of innovation
Small	0.003	-0.003	-0.003
Medium	0.002	0.001	0.0001
Group	-0.01**	-0.001	-0.0001**
Abandoned	0.001	0.01***	0.0002**
Ongoing	0.01**	0.004**	0.0002**
Exporter	0.004	0.003	0.0001**
Hcapital	0.001	0.003**	0.0001**
Subsidies	0.003	0.004***	0.0002**
Procurement	0.003	0.006***	0.0002***
Marketinginno	0.02***	0.005***	0.0004***
Orginno	0.02***	0.01***	0.001***
Restructuring	0.003	0.002	0.0001
Collaboration	0.04***	0.01***	0.001***
Innovation turnover	0.03***	0.01***	0.001***
Number of observations	17.999		
Wald test rho=0	69.45***		

Note: ***,** and * denote statistical significance at 1%, 5% and 10% levels of significance. Country dummies and constant term included
Source: Authors' calculations

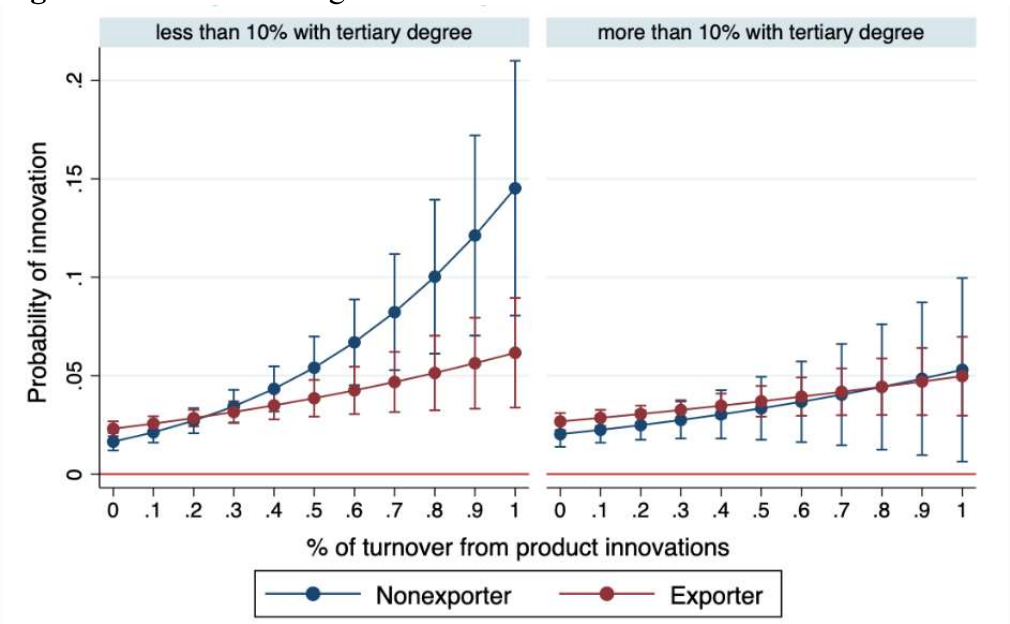
A far more interesting issue is the one of radical innovations. Here too we find highly significant and positive influence of previous innovation experience further

strengthening our belief that this channel improves indigenous innovation capabilities within business logistics. As expected, we find positive and significant coefficient on human capital. This signals that own absorptive capacity embodied in skilled and knowledgeable workers increases probability for creation of innovations that are not imitation of others but those that are truly novel at world level. In case of radical innovations, we also find positive effects from both channels of public incentives suggesting that all previously mentioned effects of public support here matter. Finally, internal restructuring, collaboration and production innovation commercialization turn out to be the strongest determinants of radical innovations as well. Findings among firms that practice both types of innovation are similar to those for radical innovations. The only exception is that for this group of firms exporting experience also matters.

4.2. Mediating effect of indigenous human capital and market orientation on commercialization of product innovations

We next turn to mediating effects that some of covariates might have on creation of logistics innovations. Learning by exporting may provide firms with superior knowledge that could result in success in creation of logistics innovations but this effect does not necessarily flow directly. Rather, learning by exporting may help firms in commercialization of their product innovations and in that way influence creation of logistics innovations. Both channels, however, depend on absorptive capacity of firms embodied in their human capital. To explore existence of such channels we enrich our model with three way interactions between exporting experience, human capital and share of turnover coming from incremental and radical innovations. As before, we present results for incremental innovators, radical ones and firms engaged in both types of logistics innovations.

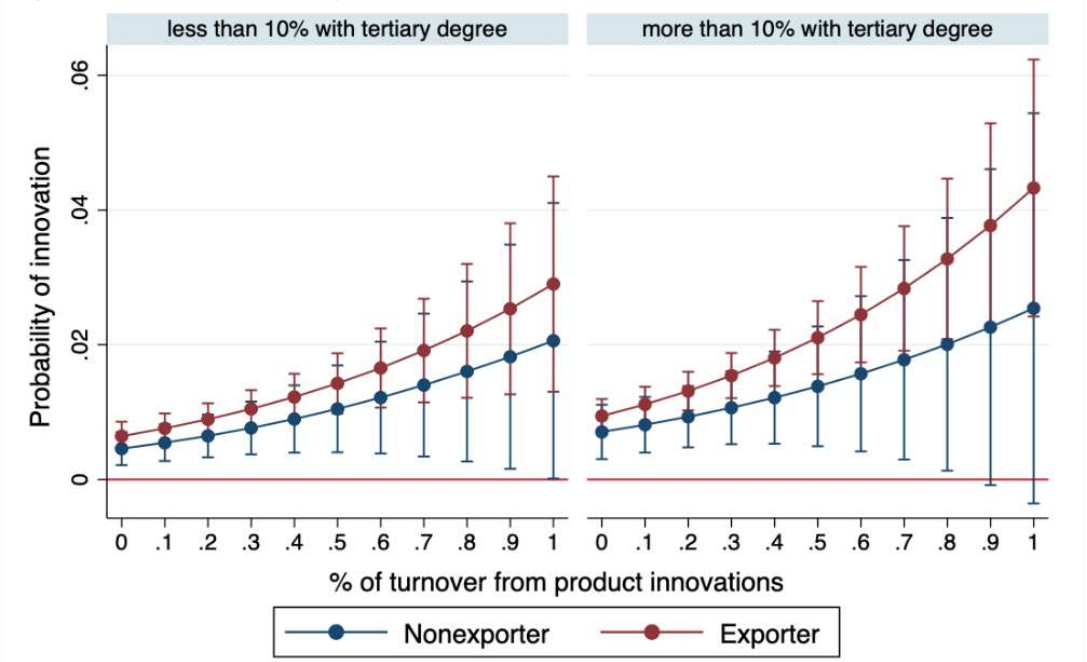
Figure 1. Predictive margins for incremental innovators



Source: Authors own calculation

Figure 1 presents predictive margins for incremental innovators from interaction between human capital, exporting experience and revenues from commercialization of innovations. For firms with both high and low levels of skilled human capital we find statistically significant and positive effects. The probability for introduction of logistics innovation increases as product innovation intensity of firms becomes higher and this is particularly strong among firms with lower levels of human capital but we do not detect significant differences among exporters and non-exporting firms in any group at all levels of product innovation revenue.

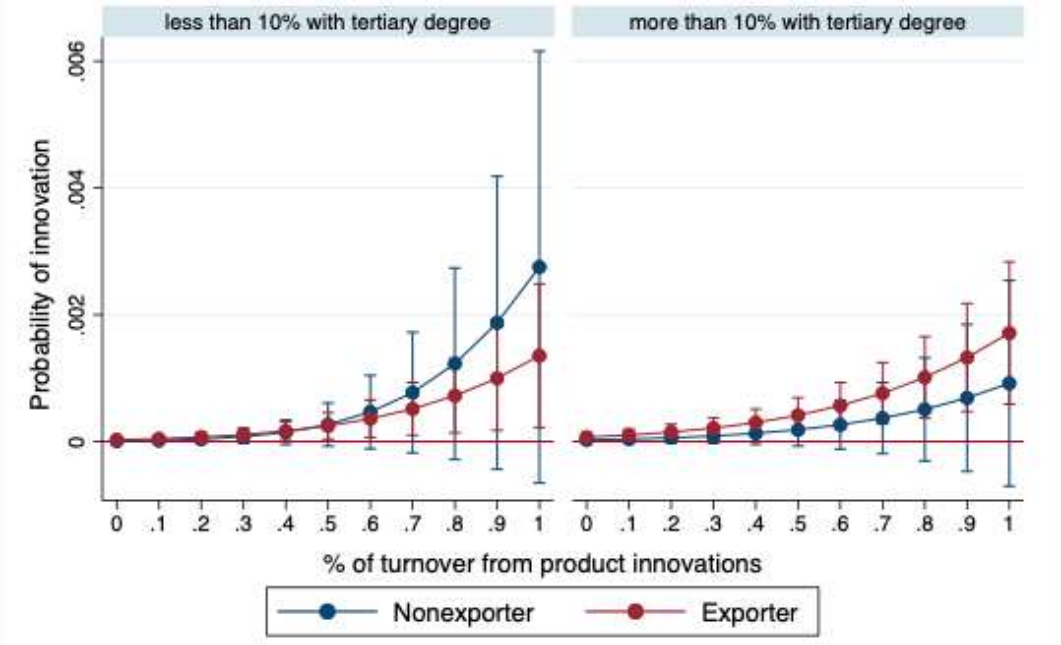
Figure 2. Predictive margins for radical innovators



Source: Authors own calculation

Effects among radical innovations are somewhat different (Figure 2). We can see that at lower levels of product innovation intensity in both groups of human capital we observe statistically significant and positive effects on introduction of radical innovations. However, for group of non-exporters this effect seems to vanish at very high levels of innovation intensity. At these levels, we observe that interaction between innovation intensity, human capital and exporting matters for introduction of radical logistics innovations.

Figure 3. Predictive margins for firms with radical and incremental logistics innovations



Source: Authors own calculation

Finally, findings for firms that are involved in both types of innovation do not find any effect for non-exporting firms but we do reveal positive effect of exporting at higher levels of product innovation intensity (Figure 3). Together, all these findings suggest that it is only among those firms most fiercely competing in product-innovation intensive market segment that absorptive capacity and learning by exporting play a decisive role in creation of business logistics innovations.

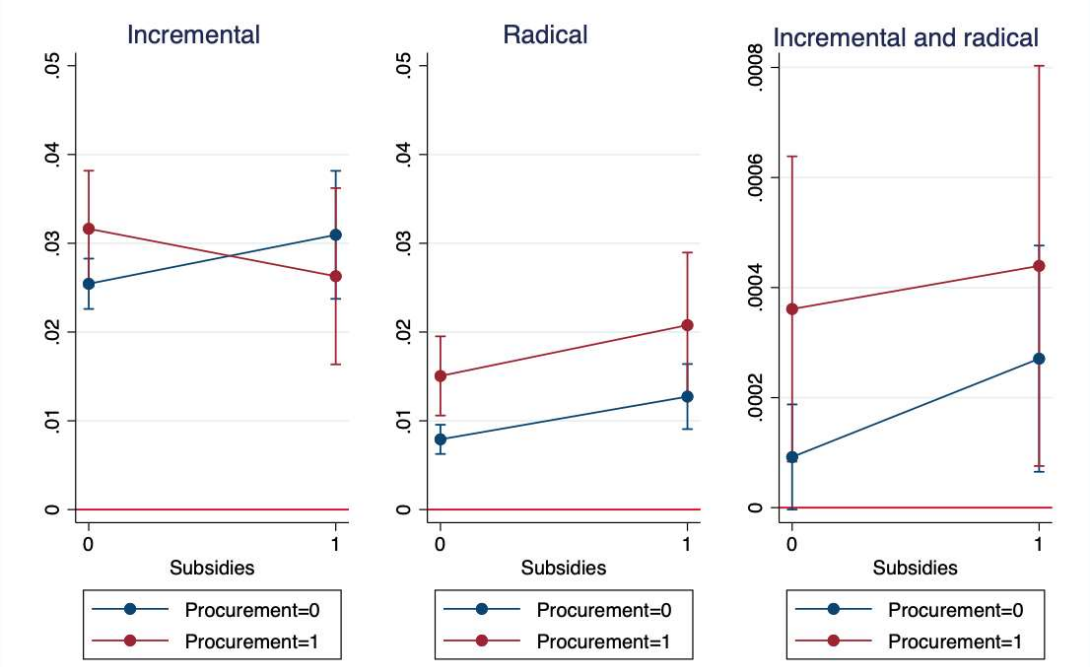
4.3. Effect of public push and pull channels

One channel that may bear particular relevance for creation of logistics innovations is public support. To explore its relevance we add to our model interaction terms between public push (subsidies) and pull (procurement) incentives for innovations. The reason for inclusion of such interaction lies in the fact that in theory these two measures should provide stronger effects when combined. However, the lack of coordination between policy makers, inappropriate construction of measures or information asymmetries may be reasons why they may produce inferior results than when treated alone.

Figure 4 presents combined effects of public subsidies and procurement for our three groups of firms. Starting with incremental innovators it is evident that the effect of public incentives is statistically significant and positive. It seems that even those that do and do not receive procurement have higher chances of introducing incremental innovations than those firms that do not receive subsidies. This finding questions the validity of subsidy schemes. Among those that receive subsidies for innovation, effect is again stronger for firms that complement it with public

procurement but also for those that do not receive such support although we do not detect differences between two groups.

Figure 4. Combined effects of public subsidies and procurement



Source: Authors own calculation

Similar findings can be observed among radical innovators. Here, however, we find that among non-recipients of subsidies firms that received support through procurement have higher chances of introducing radical innovation than firms without any form of public support. Finally, once again we find that recipients and non-recipients of procurement incentives have higher chances of introducing innovation if they also received push incentives. The last segment of investigation is related to the group of firms that introduces both radical and incremental innovations. We find complementarity effects from procurement suggesting complementarity of public measures for this group of firms.

5. CONCLUSION

Whereas the literature on innovation in general is well advanced, logistics innovations in particular have not been dealt with in depth. Although it can be argued that logistics innovations have attracted considerable interest, there is still a need for more empirically based research to broaden current knowledge of the field. Therefore, this presented the primary motivation for our research to fill the mentioned gap. Our research addressed the lack of empirical research in logistics innovations, placing emphasis on determinants of incremental and radical logistics innovations in the Central and Eastern Europe countries. Consequently, it expands the existing knowledge about logistics innovation and contributes to providing an empirical

understanding and valuable insights into the dynamic process of logistics innovations in the CEE region.

As regards the innovation process, our findings reveal differences among firms that introduce only incremental or radical innovations and the ones that introduce both types of innovation. Further, different mediating effects of indigenous human capital and market orientation on commercialization of product innovations were also found among the three groups of firms. Taken together, the results suggest that absorptive capacity and learning by exporting play a crucial role in creation of business logistics innovations among firms intensely competing in product-innovation intensive market segment. Finally, combined effects of public subsidies and procurement for our three groups of firms were also observed.

Overall, the findings provide grounds for managerial decisions on investments in logistics innovations and their improvement and development. Examining logistics innovation processes in general and such research in particular may be helpful to executives and policy makers interested in improvements over competitiveness of manufacturing industry in the region. However, there are some limitations that our research could not resolve. Primarily this refers to the inability to explore effects on particular types of logistics innovations such as inventory management systems, e-procurement, digital supply chain management, reverse logistics or new delivery models. Future research should also address the relevance of individual motives for introduction of logistics innovations such as costs, market opportunities or regulatory requirements as well as barriers to introduction of this type of innovations.

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APPENDIX

Table A1. Description of variables

Variable	Description
Radical	Categorical – 1 if firm introduced radical (new to the world) logistics, delivery or distribution method for their inputs, goods or services
Incremental	Categorical – 1 if firm introduced incremental (new to the firm) logistics, delivery or distribution method for their inputs, goods or services
Small	Categorical – 1 if firm is categorized as small firm
Medium	Categorical – 1 if firm is categorized as medium sized firm
Group	Categorical – 1 if firm is part of an enterprise group
Abandoned	Categorical – 1 if firm has previously abandoned innovations (innovation experience)
Ongoing	Categorical – 1 if firm has ongoing innovations (innovation experience)
Exporter	Categorical – 1 if firm sells all or part of its products in international market
Hcapital	Categorical – 1 if firm employs 10% or more staff with tertiary degree of education
Subsidies	Categorical – 1 if firm received public financial support for development of innovations in three years prior to survey
Procurement	Categorical – 1 if firm received public procurement for innovation contract in three years prior to survey
Marketinginno	Categorical – 1 if firm introduced marketing innovations
Orginno	Categorical – 1 if firm introduced internal organizational innovation
Restructuring	Categorical – 1 if firm experienced merger, take over, sale or contracting out of some of its activities
Collaboration	Categorical – 1 if firm developed logistics innovation in collaboration
Innovation turnover	Continuous - % of revenues from incremental and radical product innovations
Country1-8	Categorical – eight categorical variables for each of countries in the sample (Bulgaria as reference category)