INNOVATION IN LOW-TECHNOLOGY INDUSTRIES–THE SAME ACROSS EUROPE

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Abstract- The paper aims at deepening understanding of innovation in low-technology enterprises. It describes diversification of innovation behaviour among low-technology industries using data from the eighth Community Innovation Survey (CIS 2012). The results of the cluster analysis reveal polarization in innovation across European countries. The differences in performance among the European Union members put into question the existence of a single innovation pattern of low-technology industries.

Index Terms- CIS Data, Innovation, Low-Technology Industries.

I. INTRODUCTION

This paper focuses on innovation in low-technology industries. This sector is non-research intensive and comprises traditional (also called "mature") industries. The focus on this sector is motivated by the situation, in which there is strong emphasis on knowledge and research-intensive economic sectors in European public policymaking [3], while the traditional industries still contribute significantly to employment and production in the EU [5]. The role of low-technology industries in contemporary economy stems also from their interconnectedness with high-tech industries, as low-technology companies buy high-tech products from industries with high R&D intensity being also important partners in innovation processes of high-tech firms [3], [10].

This paper contributes to deepening the understanding of the innovation processes of low-technology industries by describing its current heterogeneity in the EU. Cluster analysis was employed to identify homogeneous groups of countries. In addition, results of this analysis were compared with the country ranking based on the Innovation Union Scoreboard (IUS) [6] and the question whether innovation behaviour of European countries measured at the meso-economic level of low-technology industries follows a comprehensive benchmark tool for assessment of innovation at a macroeconomic level has been answered.

European Union is quite heterogeneous in terms of research and development (R&D), innovation performance and technology gaps [1] (as cited in [7]). The polarization of innovation performance raises question about effectiveness of economic policy. As shown in [7], national policy mixes are similar and relatively stable across the EU member states even though these countries differ significantly in terms of their distance to the technology frontier and therefore face different technological challenges. It is argued that effective economic policy should be tailored to the needs of particular country's technological position.

The paper is organized as follows. Section 2 provides a theoretical framework for analysis and briefly discusses the specificity of low-technology manufacturing industries. In Section 3 the data and the methodology are presented. In Section 4, the eighth Community Innovation Survey (CIS) 2012 data of the European Union are used to analyze the heterogeneity of innovative behaviour in low-technology industries across European countries. Section 5 summarizes the findings and presents the conclusions.

II. THEORETICAL BACKGROUND

Substantial part of innovation-related activities of low-technology industries goes beyond research and development (R&D) outlays. The enterprises derive knowledge from sources other than basic research [12]. The importance of "formal learning" is rather limited. On the other hand, their innovation activities are related to gaining knowledge through practical and experience-based learning-by-doing, learning-by-using, learning-by-interacting, learning-by-producing and learning-by-searching [3], [12]. The innovations emerge as a result of incremental product development, customer-oriented activities or optimization of process technologies [5]. Most of low-technology industries form Pavitt's (1984) taxonomy supplier dominated sector [9]. This sector is made of firms which receive technology they use from external suppliers – production-intensive and science-based firms [9]. Their own in-house R&D and engineering capabilities are weak. The prevailing means of appropriation are non-technical ones: trademarks, marketing, advertising and aesthetic design. Their technological trajectories are aimed at cutting cost [9]. The new technologies are mostly

developed by companies from other sectors, but the low-technology industries need to possess the absorptive capacity to make use of these technologies [12].

The produced goods are usually necessities for which demand is rising less than proportionately to income (i.e. the demand in low-technology industries is usually inelastic) [12]. Due to market segmentation, the competitiveness of companies depends greatly upon product differentiation, cost efficiency and control of complementary assets [10]. The pace of changes in market demand and competition is less intense in low-technology industries due to brand loyalty which is achieved and strengthened by marketing activities [12].

As identified in [5], there are three widespread innovation strategies typical for the low- and medium-technology sector: (1) step-by-step product development which is based on a continuous improvement of the product, (2) customer-oriented strategy which assumes combining existing knowledge in new ways in order to develop tailored products and solutions, and (3) process specialisation, focusing on improvement of the technical and organisational structure of the production process.

The following analysis is based on the typology of industrial sectors according to Eurostat. Because the CIS data can be disaggregated only at the 2-digit NACE level, the list of low-technology industries comprises manufacture of food products, beverages, tobacco products, textiles, wearing apparel, leather and related products, wood and products of wood, paper and paper products, printing and reproduction of recorded media (NACE rev. 2 codes 10-18), manufacture of furniture, and other manufacturing (codes 31-32)[1].

III. METHODOLOGY

In this paper cluster methodology was employed in order to describe the diversity among innovation activities in 22 of European low-technology sectors. The objective of the cluster analysis is to identify homogeneous groups of objects (in this case, countries) and assign them into clusters. To evaluate the distances between clusters we employ the Ward's method and Euclidean squared distance which is one of most commonly used type in analysing ratio data [8]. This method is suitable for quantitative data and does not require a priori determining the number of clusters.

The analysis employs data from the eighth wave of CIS (2012), the latest available one. This survey is based on harmonised questionnaire[2], which follows concepts of the Oslo Manual [11] and provides information on characteristics of innovation activity at enterprise level. The population of the CIS covers enterprises with 10 or more employees in any of the Core NACE categories that include Industry and selected Services sectors. The survey covers the EU member states, EU candidate countries, Iceland and Norway. Most indicators from CIS 2012 cover the 3-year period from the beginning of 2010 to the end of 2012.

In order to adequately measure innovation activity in low tech industries a more detailed perspective is needed. To properly describe their innovation behaviour we concentrate on the non-research intensive activities. Intentionally we skipped variables associated with expenditure on innovation activities from the analysis, because we expected these indicators to be strongly affected by the recent financial crisis. In our opinion the omission of expenditure-related variables would also help the results not being directly influenced by each of the countries' development levels (measured e.g. by income per capita).

Selection of diagnostic variables is based on the paper of Heidenreich [4] who pointed that low- and medium-low-technology industries "are characterised mainly by process, organisational and marketing innovations, by weak internal innovation capabilities and a strong dependence on the external provision of machines, equipment and software. Suppliers are the most important source for their information and knowledge." Given the relatively small sample size, we decided to pre-select the most relevant variables for further analysis. Accordingly, a following set of indicators was chosen in order to track the innovation record in European low-technology industries: process innovative enterprises (regardless of any other type of innovation), marketing innovative enterprises (regardless of any other type of innovation), organisation innovative enterprises (regardless of any other type of innovation),and enterprises engaged in acquisition of machinery, equipment and software.

The data on types of innovation are expressed as percentage of total population of enterprises, while the indicator of enterprises engaged in acquisition of machinery, equipment and software is measured as a percentage of product and/or process innovative enterprises.

[1] http://ec.europa.eu/eurostat/cache/metadata/Annexes/htec_esms_an3.pdf

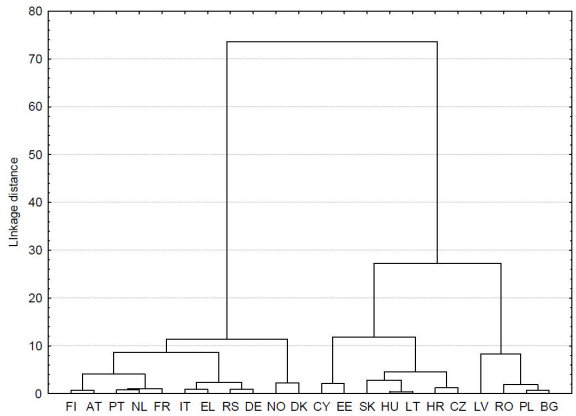
[2] However, countries may deviate from the harmonised questionnaire by modifying the existing questions and/or introducing additional questions.

Because of limited data availability at 2-digit industry level, the scope of the analysis is narrowed to a group of 22 countries comprising 9 EU-15 countries (Denmark, Germany, Greece, France, Italy, the Netherlands, Austria, Portugal, Finland[3]), 11 EU-13 countries (Bulgaria, Czech Republic, Estonia, Croatia, Cyprus, Latvia, Lithuania, Hungary, Poland, Romania, Slovakia), Serbia and Norway.

We decided not to include data on sources of information because the data gaps would further limit the sample size. Moreover, to ensure valid results, every additional variable requires an over-proportional increase in observations. Basing on the work of Formann [2] the minimal sample size should include at least 2^m observations, where m equals the number of clustering variables [2] (as cited in [8]). With the assumption of four variables, we needed a minimum of 16 countries [8]. Adding another clustering variable would require doubling the sample size, therefore we remained with 4 indicators. As recommended in [8] all the variables had been standardized before launching the procedure.

IV. EMPIRICAL ANALYSIS

The cluster analysis enables to identify groups of countries with similar innovation behaviour of low-technology industries. The algorithm starts with every country forming its own cluster and then fuses other most alike countries. The process stops when only one cluster (containing all the observations) is formed. The logic of the algorithm is to form group of countries based of their similarity. Fig. 1 shows the result of a hierarchical cluster application. This dendrogram visualizes the hierarchical structure of clusters and reveals three groups of countries.



Source: Authors' own calculations.

Figure 1. Innovation behaviour clusters: hierarchical cluster application dendrogram

[3] Spain was omitted from the analysis due to using the single year 2012 as a reference period to collect the number of enterprises engaged in innovation activities. This difference in definition significantly lowered the number of enterprises engaged in acquisition of machinery, equipment and software.

The 1st cluster contains 11 countries: Finland, Austria, Portugal, the Netherlands, France, Italy, Greece, Serbia, Germany, Norway and Denmark. The 2nd cluster comprises: Cyprus, Estonia, Slovakia, Hungary, Lithuania, Croatia, and Czech Republic. The 3rd cluster covers: Latvia, Romania, Poland, and Bulgaria. Table 1 briefly summarises identified clusters of countries. The descriptions of the clusters were based on the outstanding features of innovation behaviour of the cluster group. For instance, cluster 1 contains countries with relatively high innovation intensity in terms of introducing new or significantly improved production processes as well as marketing and organizational changes. The share of low-technology enterprises which introduced process innovation in this cluster is in the range 14.2-33.8%, the rate of marketing innovative enterprises is between 23.1-41% and the rate of organisational innovative firms is between 20-34.1%. However, the share of enterprises engaged in acquisition of machinery, equipment and software is rather moderate and stays between 54.6-77.1%.

The above contrasts with the intervals for process, marketing and organizational innovations in cluster 3, which are: 4.1-11.8%, 10-15.4%, 6.8-12.2% and 49-75.3% respectively. The share of enterprises engaged in acquisition of machinery, equipment and software is rather moderate (similarly to the case of cluster 1)[4]. The 2nd cluster contains countries with "moderate" share of process innovative enterprises (between 7.6 and 27.3%), marketing innovative firms (20.9-30.3%), and organizational innovative firms (the data ranges from 11.7 to 21.6%). At the same time the share of enterprises engaged in acquisition of machinery, equipment and software in cluster 2 was relatively high and was in the range of 69.6-88.5%.

Table 1. Clusters of countries and the Innovation Union Scoreboard 2013 scores

Countries	Description	IUS 2013
	Cluster 1	
DE, DK, FR	High process innovation	Innovation Leaders
AT, FI, NL	High marketing innovation	Innovation Followers
EL, IT, NO*, PT, RS*	High organizational innovation	Moderate Innovators
	Moderate engagement in acquisition of machinery, equipment and software	
	Cluster 2	
CZ, EE	Moderate process innovation	Innovation Followers
CY, HU, HR*, LT, SK	Moderate marketing innovation	Moderate Innovators
	Moderate organizational innovation	
	High engagement in acquisition of machinery, equipment and software	
	Cluster 3	
BG, LV, PL, RO	Low process innovation	Modest Innovators
	Low marketing innovation	
	Moderate engagement in acquisition of machinery, equipment and software	

[4] It is worth mentioning that this indicator showed relatively little variance in comparison with other diagnostic variables.

* Norway and Serbia are classified as Moderate Innovators, as well as Croatia which accessed the EU after publication of UIS 2013.
Source: Authors' own calculations.

The analysis points to a relative similarity between cluster membership and country ranking in the IUS 2013[5]. Cluster 1 contains, i.a., all countries labelled as "Innovation Leaders", cluster 3 comprises solely all the "Modest Innovators", while in cluster 2 there is a mix of "Moderate Innovators" and "Innovation Followers". What is particularly interesting is that in cluster 1 there are also countries considered as "Moderate Innovators" in addition to the technological leaders and their followers. This shows that there is no one-to-one relationship between innovativeness performance at the macroeconomic and meso-economic level.

CONCLUSION

In summary, our analysis shows that the diversity of European low-technology industries in terms of their innovation behaviour is to a large extent consistent with the ranking of countries according to the level of innovation. The groups of least innovators overlap perfectly with each other and the cluster of best performers in terms of process, marketing and organizational innovations includes all the IUS leaders. However, some countries placed in the lower part of the IUS ranking did surprisingly well in terms of innovation of their low-technology industries, this refers primarily to Greece, Portugal and Serbia.

The heterogeneity in innovation across European countries is substantial even at the low-technology industry level. Revealed differences in innovation performance in the European Union can be seen as symptoms of divergence in Member States' innovation performance. Given the results of the analysis, the division into the "Old" and "New" EU still remains, also at the level of low-technology industries. Cluster 1 comprises the EU-15 countries, Norway and Serbia, while clusters 2 and 3 contain the EU-13. The polarization is particularly striking given the indicator set. Taking into account the capital gap between the EU-15 and the EU-13 countries, the indicators related to the innovation expenditure were deliberately omitted from the analysis. The polarization between the EU-13 and the EU-15 countries remains visible even after exclusion of process innovation indicator[6] from the analysis, which was done as it is one of the indicators of technological innovation typically associated with the development or application of new technologies and therefore depending inter alia on financial capabilities of the enterprises.

Substantial disparities of the innovation capabilities observed at meso-economic level of low-technology industry seem to question the relevance, appropriateness and effectiveness of launching common innovation strategies in the EU (such as setting common EU-wide targets).

On the other hand, the huge differences in behaviour of low-technology industries question the existence of common innovation pattern across Europe. One can doubt whether the innovation behaviour of low-technology industries depends on the level of development of the whole economy. For example – if the production is relocated to low-cost countries [4], does it affect its innovation pattern? And is the potential change solely a result of product's moving through its life cycle? These issues should be subject to further investigation.

There are some limitations to this study and therefore future investigations should focus on the following issues. First of all, restricting the study's sample limits generalization of its findings. The current sample was drawn from European low-technology industries covering 22 countries over single 3-year period. Hence, the research model should be tested further using other samples.

Secondly, due to limited data availability, only selected variables were employed. Future studies could examine the findings using broader set of innovation indicators – i.a. gradual product innovation and customer orientation strategy as suggested in [5]. It would also be particularly interesting to examine the causality and interrelationships between innovation patterns in low-technology firms.

Finally, it is recommended to focus future studies on low-technology industries solely. This would offer greater insight than analyses covering low- and medium-low technology industries at the same time.

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