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Digital Ecosystems

Smart Economy and Innovation

Digital Economy Lab

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Smart Economy and Innovation

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Introduction

Started by the Internet expansion in the 1970s and the subsequent large-scale adoption of the World Wide Web in the 1990s, information revolution has drastically changed business models and gave the birth to the new economic players. On the one hand, the Internet yielded remarkable implications on economies involved, once allowing creation of the new markets characterized by a large scale, increased customization, rapid innovation and collection and usage of detailed consumer and market data. On the other hand, digital tools have created the new economic players - the Internet platforms represented by, for instance, e-commerce, online media, job matching, financial trading or social networking. The latter provided the powerful tools to considerably decrease transaction and other costs related to creating and distributing certain types of products and services, acquiring information about these goods, or most remarkably collecting and using data on consumer preferences and behavior. Consequently, in our century, digitisation, information communications technology (ICT) and the Internet have become key drivers of global wealth creation and socio-cultural development.

While describing the above-mentioned economic trends, one may reasonably argue that the recent literature on economic growth should put the research focus on building the common comprehensive understanding of new economic mechanisms and the ways in which new technologies change economies involved. This e-book is such an attempt to join the efforts and bring the new insights in the literature on digital ecosystems that are commonly created by the usage of the Internet and uptake of other digital tools. While inquiring the main elements, characteristics and the structure of digital ecosystems, this e-book refers to start-ups, high-tech sectors, ICTs, innovations, intellectual property rights and the efficiency of market regulated by algorithmic financial operations.

The economic part of this e-book starts by the paper of Skala and Giezynska. Based on their pilot study covering a sample of start-ups, the authors discuss whether we should translate digital criteria into high-technology. High-tech industries, as the fastest growing sectors in economy, are further addressed by Akhvlediani and Sledziewska. Namely, the authors examine the export performances and intra-industry trade of the core and the new EU member states in the high-tech sectors and find considerable gap between these two groups of countries. The analysis is further extended by the paper of Brodzicki, who, based on a large firm-level survey, finds strong positive correlation between innovation and exporting potential of firms and thus highlights that the export performance of a given firm, may be linked to its superior innovation performance. While discussing the other possible ways for improved performance of enterprises, the paper of Gołuchowski and Szarański puts the research focus on the importance of ICTs and suggests that broader uptake of ICT advantages and therefore the development of enterprises depends on possible cooperation at the market. As an illustration the authors consider clusters to gather companies for both competing and cooperating.

Furthermore, Grodner reports the results of her own market research elaborating the importance of mobile marketing in building a company's competitive advantage. Other digital tools for information distribution are addressed by Ratajczak. The author discusses the aspects of information distribution at high-frequency trading and challenges the efficiency of market regulated by algorithmic financial operations. Finally, Mika refers to the recent global information transmission by outlining the main causes of ambiguities and inconsistencies of the concept of intellectual property rights. Based on the "rental theory of ownership", the author convinces a reader that legally guaranteed socio-economic relation, arising on the occasion of the creation of information commodities, is indeed an ownership.

To conclude, the papers presented in this e-book introduce the new perspectives and original approaches to conceptualize implications of information revolution and digitization on recent economies. We believe that the authors' efforts should contribute the literature on digital ecosystems by bringing new insights and raising new research questions to explain current puzzling digital trends in the economies involved.

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Translating Digital into High-Tech Economy

Translating Digital into High-Tech Economy

In the mid-1990s, Don Tapscott popularized the term "digital economy", defining it as a set of actions whose driving force the Internet was only beginning to become (Tapscott, 1996). There has been almost 20 years of dynamic development of digital economy and research on its phenomenon (Brynjolfsson & Kahin, 2000; Brynjolfsson & McAfee, 2012; Carlsson, 2004; Christensen & Maskell, 2003; Fingar & Aronica, 2001; Malecki & Moriset, 2007; OECD, 2013; Tapscott, Lowy, & Ticoll, 1998). This research, including the context of economic growth (Moulton, 2000) and new business models (Fingar & Aronica, 2001; Zimmermann, 2000), powered the question of the relationship between the "digital" economy and economy based on “high-technology" (“high-tech”) which still remains open.

The classic division of economy sectors based on the level of technology used separates industrial production into four groups: low, medium-low, medium-high and high technology. In the field of service production, there is also a division into low knowledge-intensive and knowledge-intensive, whereas knowledge-based services in the field of high technology (high-tech) are also distinguished among the latter. The classification scheme of industrial and service production with marked "high-tech" subsectors is shown in Figure 1.

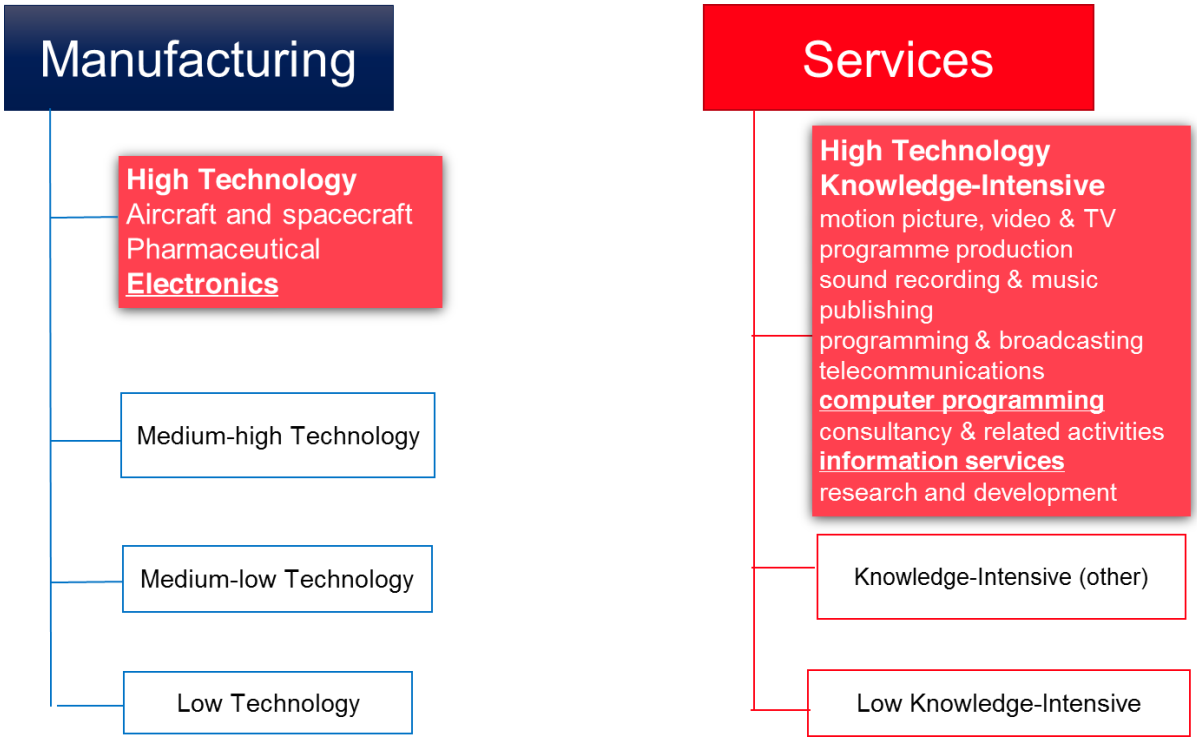

Figure 1. High-tech manufacturing and services in the classification of industrial and service production due to the level of applied technology and knowledge (Eurostat, 2014; OECD, 2011; Rostek & Skala, 2014a).

Intuitively, it is assumed that projects with the application of digital technologies are regarded as high technology and, with reference to the classification shown in Figure 1, concentrated in the fields of software services and production of electronics. For example, software for high-tech industry is an essential element of ecosystems which will constitute the integrated environment 4.0 Industry in the near future (Brettel, Bendig, Keller, Friederichsen, & Rosenberg, 2014; Kopp, 2014; Lee, Kao, & Yang, 2014). However, the relationship between "digital" and "high-tech" is not clearly defined in the literature and is sometimes the subject of both analysis (Brynjolfsson & McAfee, 2012) and scientific disputes (Arthur, 2000). For example, there is research indicating that traditional sectors, in theory not filled with high technology, tend to be at the forefront of applying advanced digital solutions (Mendonça, 2009). It is also known that there are exactly opposite situations, when high-tech industries use rather more traditional technologies (Matusiak, 2011).

This ambiguity was recognized by the authors of this study as an interesting area of research. Therefore, the main aim of this article is to examine to what extent selected digital companies fulfil the criteria of belonging to the high-tech sector. For this purpose, the results of research concerning the Warsaw high technology business sector were used (Rostek & Skala, 2014c). These studies served to develop a method to identify companies active in the field of high-tech production, as well as to indicate the features distinguishing this sector from other sectors (Rostek & Skala, 2014b; Skala, 2014). These criteria include: employment, export activity and broadly understood cooperation with science (including the patent activity).

Cooperation with the Start-up Poland foundation was established during the preparation of the survey, which is the basis for the research discussed in this article. The foundation has been recently created to bring together and represent the interests of the start-up environment in Poland. Another purpose of the undertaken studies appeared as a consequence of consultations, resulting from the lack of comprehensive analysis of the Polish start-up environment. Therefore, the survey included additional questions, which led to deeper characteristics of this sector being revealed. The survey thus serves as a pilot before a wide-ranging surveying action, which will soon be undertaken with the support of the foundation. It will result in a report concerning micro, small and medium-sized enterprises forming the digital industry in Poland. Therefore, although the subject of the survey does not justify it, more emphasis is put on general information, not directly related to the field of high technologies. However, the author of the article believes that additional information serves to enrich the captured material.

Methodology

The developed survey (in its pilot version discussed in the article) was based on the knowledge gathered on the basis of a five-year observation of the market of small digital companies in Poland (the so-called start-ups), using the method of participant observation, as well as over two years of analytical research on high technology entrepreneurship. Several challenges had to be overcome in the course of formulating survey questions. The first was the selection of the sample, which raised the problem of defining a start-up. The definitions functioning in the literature tend to focus more on philosophy, as well as terms and methodology of conducting this type of activity (Blank, 2013; Osterwalder & Pigneur, 2010; Ries, 2011), rather than on indicating a means of distinguishing them from the projects which

should not be referred to as "start-ups". Prior to the creation of the survey, the author also conducted a preliminary study, which consisted in checking the numbers of Polish Classification of Activities (PKD)[1] declared by 138 start-ups at the time of registration in the National Court Register (KRS). Generally available data from websites was used for this purpose (www.krs-online.com.pl). The conclusions of these studies were as follows:

- For more than 40% of the surveyed companies (82), the type of declared core business was not found[2].
- Among the start-ups which declared the type of business (56 companies), the most common (68% of cases, e.g. 38 start-ups) were: PKD 62: "Computer programming, consultancy and related activities" and PKD 63: "Information service activities".
- The above indicates that in 100 cases out of 138 surveyed start-ups (almost three-quarters of the cases), the type of PKD was either undetermined, unavailable, or not related to PKD 62 or 63.
- Therefore, it was concluded that with the currently existing legal status, the type of PKD can be neither a sufficient nor a reliable criterion for identifying digital companies.

This problem was solved in the following manner: invitations to complete the survey were sent only to those projects who had participated in start-up industry competitions (in Poland or abroad), or there was a person among their founders who again started a company in -the high-tech industry. Start-up was also understood as a single project - in the sense of a separate product (service). Projects which had not been registered at that time were also regarded as start-ups, provided that they met the aforementioned conditions. A start-up was recognized as Polish when it had been (or was to be) registered in Poland, or at least one of its co-founders was a Polish citizen.

Seventy-two requests to fill in the survey were sent and 38 responses were received, which indicates high efficiency of over 50%. It was achieved due to sending a request to complete the survey exclusively through a network of personal or professional contacts. It was noted that the survey should be filled in by a person who was the (co)founder or CEO[3] of the start-up (the project manager). Only in one case the survey was filled in by the marketing manager, and in all other cases - in line with the recommendation. All the answers, apart from the questions about the name and function of the respondent, were voluntary. Despite this, only in few individual (or justified) cases certain questions remained unanswered.

The survey was divided into three parts. The first was intended to determine the general characteristics of the surveyed projects and was the most extensive (15 questions). The second

[1] Polish Classification of Activities (PKD) is in accordance with NACE Rev. 2 (Eurostat, 2008)

[2] These companies are registered abroad (two instances), or simply they did not declare the type of planned core business. The obligation to declare the type of planned core business in the National Court Register entry was only imposed by an amendment to the Act on the National Court Register, which became effective on 1 December 2014 (Act of 26 June 2014 on amending the act on the National Court Register, and amending certain other acts (Journal of Laws of 2014, Item 1161)). Until then, such entries had only been applicable with reference to the classified reports for GUS (Polish Central Statistical Office) and tax administration. Companies incorporated prior to this date have five years for completing the data (i.e. until 1 December 2019). The amendment does not introduce mechanisms to verify the declared types of core business.

[3] CEO: Chief Executive Officer, the name more frequently used by startups than its Polish equivalent: Chairman of the Board.

touched issues related to the subject of the article and explored the convergence between the surveyed projects and the characteristics of the high-tech sector (nine questions). The first two parts consisted of answering closed or predefined questions, whereby whenever possible, the option of adding an own answer or comment by the respondent was provided. Open-ended questions were used in the case of requests to provide the name of the start-up, website address, as well as to define the essence of business in one sentence, etc. The last part of the survey was dedicated to innovations and ways of developing them into start-ups. For this purpose, four open questions were asked about the nature of innovations created by the start-up, as well as about the character and manner of performing research and development activities. The results of this part will not be discussed in this article. A full survey form is provided as an attachment to the article.

Results

Part one: general characteristics of the population.

As already mentioned, the survey was filled in by 38 start-ups. The Table with full results is in Appendix 1. Among 37 start-ups who responded to the question about the location of company headquarters, sixteen indicated Warsaw, four - Krakow, three - Łódź, Gdańsk and Poznań. Two of the surveyed companies are registered in Great Britain, but they both operate only in the Polish market. As many as two-thirds of the surveyed population are commercial (limited) companies, whereas none are a joint stock company or a limited partnership. Six projects are carried out in the form of a sole proprietorship, and two as a registered partnership. Only one of the surveyed projects has not yet been formally registered.

With regard to the declared core business, 20 out of 28 responses indicated PKD 62 or 63, that is, typically digital activities. Other companies either did not provide a response , or declared a different type of core business (e.g.: publishing, advertising agencies, professional, scientific and technical activities). Due to the fact that identification of the sector of digital companies by PKD was the subject of the discussed analyses, in the next question start-ups were asked about their own assessment of the correctness of the declared PKD or potential comments. As many as 35 entities responded to this question: 43% (15) evaluated the compatibility of performed and declared activity positively, 32% (11) negatively, whereas one in four companies (9) chose the answer "no opinion". However, the comments to this question (6) indicate problems with finding the relevant PKD category, changeability of business that was not reflected in the declaration, as well as declaring activity in the *ex post* mode (e.g. after one year of operation), rather than *ex ante*.

In the examined population (33 respondents), five start-ups were founded before 2010, 10 in years 2010-2012 and 18 since 2013 (Fig. 2).

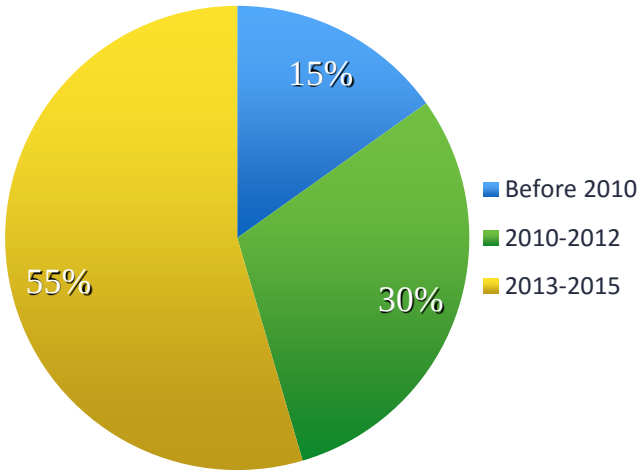

Figure 2. The age of start-ups: answers to the question about the company's year of foundation

Almost two-thirds of start-ups claim that prior to the registration they had been working on their project for several months, for about half a year (23 replies), whereas one-third of them (12 replies) answered that it had taken them one to two years, and only one answer indicated a longer period. Another question concerned the period required for the start-up to start making profit on a regular and predictable basis. In as many as 11 cases (30%), this happened immediately, before the registration. For one in four projects up to one year was enough to start earning, but the same number of projects declared that they did not earn on a regular basis yet. However, short-lived projects prevailed in this group (created from 2014 onwards). The survey also asked about the current stage of start-up development. For this purpose, investment stages and approximate value of the company were used. One-fourth of the start-ups defined their current stage of development as rather "initial" (valuation under PLN 1 million), whereas more than a half of start-ups described it as a stage qualifying for seed-stage investments, with the valuation at the level of up to PLN 10 million. Less than 20% of respondents assessed the value of the start-up at more than PLN 10 million and stage of development eligible for Series A Investment Round or higher (EVCA, 2015; Smus, 2014). In the following question, the respondents were asked about the expected increase of the company's value over the next two years. Only 3 of 38 start-ups expect a value similar to present, or twice as high, in two years. Other respondents (as many as 90% of responses) aim at more than threefold increase in the value of the company in two years, and more than a half of respondents expect more than fivefold increase. These aspirations should be considered as remarkably high. The detailed distribution of answers concerning development ambitions are shown in Figure 3.

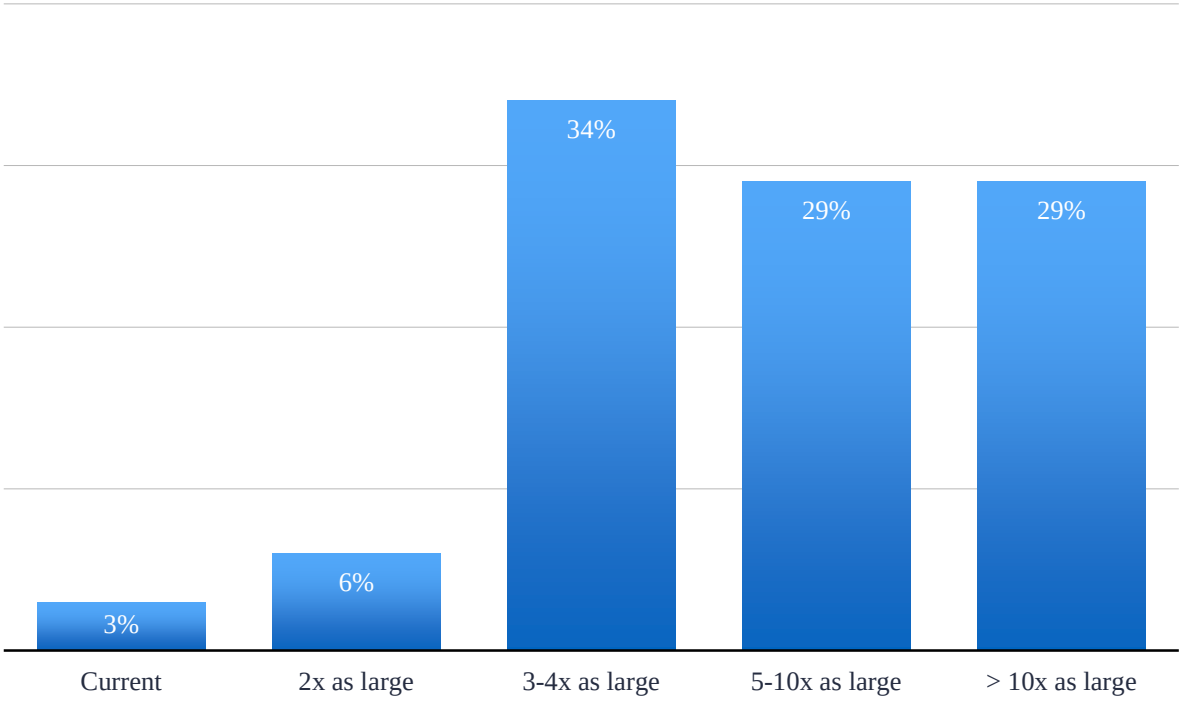

Figure 3. Development aspirations of start-ups: answers to the question about the expected value of the company in two years (in comparison with the present value)

The following question concerned the area of operation and the business model in which the project functions. The dominant form of start-up business is the production of software for business (B2B) in SaaS model (Software as a Service), as well as activities associated with electronic commerce (e-commerce). The detailed distribution of responses has been shown in Figure 4.

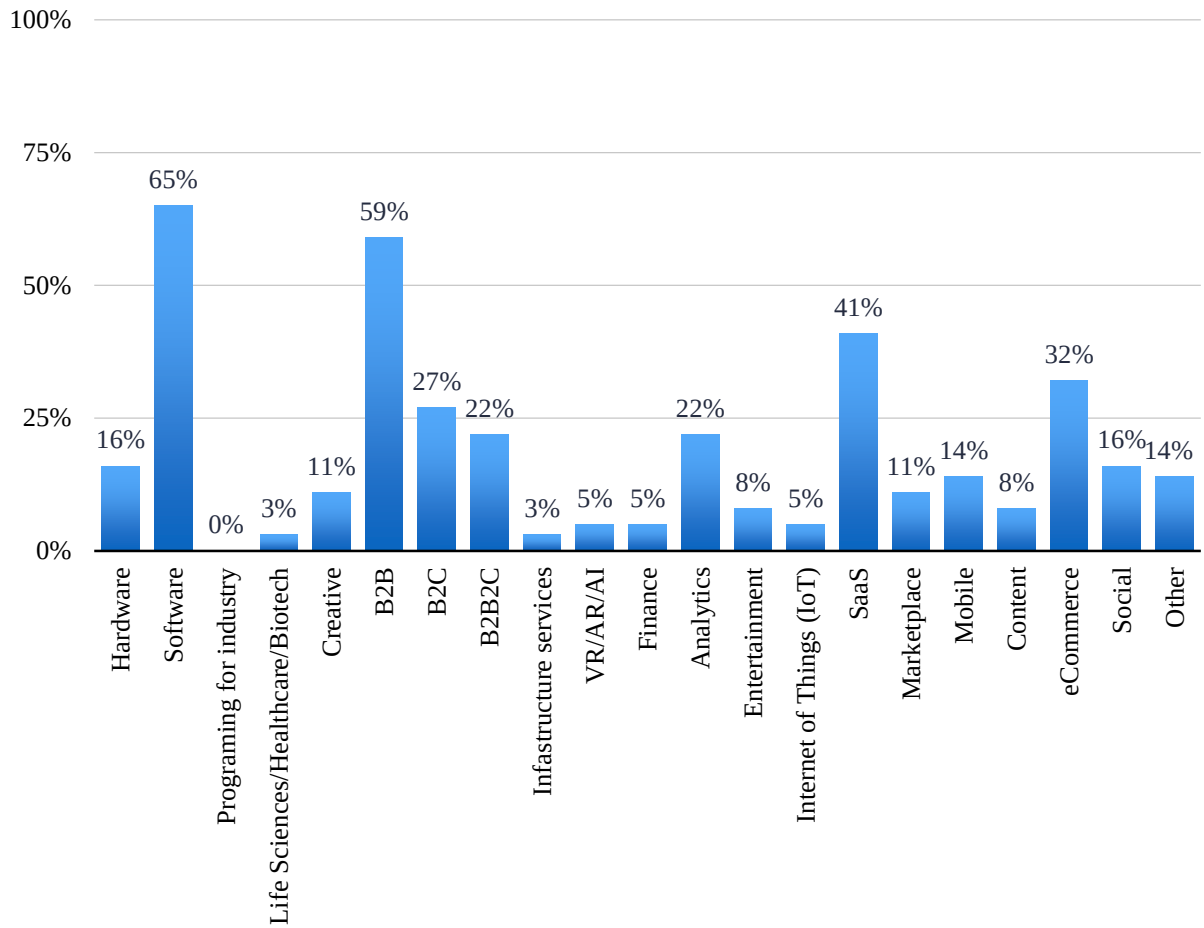

Figure 4. The activities and business models indicated by 37 surveyed start-ups

The following question concerned the sources of resources used by the start-up, including the sources of financing. With regard to the latter, 60% of respondents (20 start-ups) indicated own funds as the sole source of financial resources. More than one-third of start-ups (12) are supported by a national venture capital fund, whereas 12% (4) are financed by business angels. Every fourth start-up (8) was or is a beneficiary of an EU grant (OP IE 8.1 or 8.2). Only one start-up has benefited from an incubator or technology park, whereas four start-ups participated in acceleration programs.

The final general questions were related to customers and essence of production. As regards customers, based on the results, it may be concluded that every third start-up sells to individual customers, the major customers for more than half of start-ups are companies (especially micro or large), and the customers of approximately 10%-15% of start-ups are institutions: offices, local governments, schools, hospitals, services, cultural institutions, etc. In terms of production, the start-ups were asked about the nature of the product:

- Does the company manufacture tangible products?
- Does the company program for tangible production?
- Does the company program at all?

In six start-ups (16%), no specified type of production occurs, which may mean that the digital nature of their activity is located in a different element of the business model than the product

itself. Four start-ups produce tangible objects, while eight start-ups program for such production. Twenty-three start-ups, two-thirds of the surveyed population, program on their own, which may be recognized as their characteristic feature. Start-ups are also willing to outsource programming or production services, mainly in the territory of Poland.

Part Two: digital as a part of high-tech

The first criterion related to the market of high technology is the issue of employment and its increase. The respondents answered the question about the employment status, understood as constant cooperation, rewarded regardless of the legal form in which it is conducted. Partners do not count as employed. Among the surveyed sample of enterprises, the level of employment must be regarded as high: 15% of them (six companies) employ more than 10 people, and two-thirds of them have at least one employee. Every third start-up employs only its founder. The largest group among employers are the companies employing 5-10 people. Detailed data distribution is shown in Figure 5.

Unfortunately, the survey did not include a question about company plans regarding a potential increase of employment. We can only assume that high development ambitions are favourable for an increase in the number of employees, or may even be a necessary condition for fulfilling these ambitions.

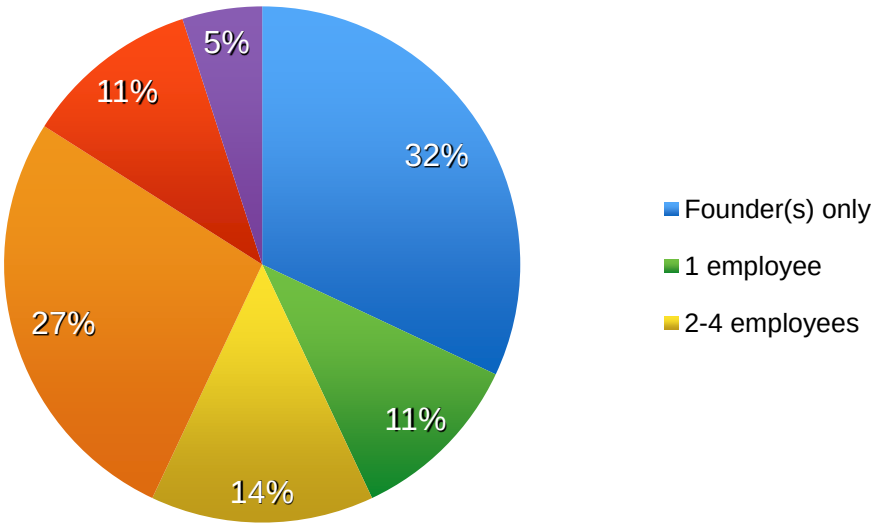

Figure 5. Employment in startups : answers to the question about the number of permanent and salaried employees

Another criterion of belonging to high-tech is global competition, i.e., conducting export activity. First, start-ups answered the question about having foreign branches (understood broadly, not necessarily formally, e.g. “permanent resident” was regarded as the positive answer to this question). Exactly every third company confirmed the existence of a foreign branch, or has taken a decision to open a foreign branch in the near future.

Exactly half of the surveyed start-ups sell abroad. This is a very high score, given that in the entire Polish SME sector only 7% of enterprises are involved in export activity (Starczewska-Krzysztoszek, 2012). Fifty per cent export index is applicable for medium-sized companies in Poland, i.e. employing 50 persons or more. It can therefore be argued that, in relation to export

activity, start-ups behave as if they had medium business potential and assess their competitive strength accordingly. Among the exporting start-ups, as much as 22% carry out more than 50% of their total sales abroad. Detailed data are shown in Figure 6. For half of them, the main country for export is the United Kingdom, whereas for 30% it is the United States. They are very demanding markets, so these facts may prove a high level of services offered by Polish start-ups.

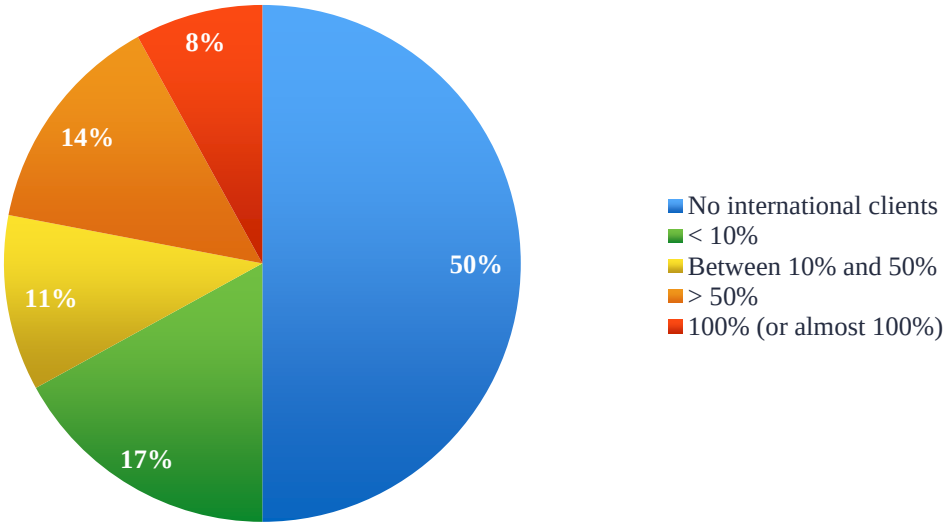

Figure 6. Export in start-ups: answers to the question about the percentage of sales carried out abroad

The last criterion is collaboration with science. In 4 of 38 start-ups, one of the founders was a person with an academic degree, or a doctoral student, which is a very good result. It gets even better further on: as many as 16 start-ups (42%) answered positively to the question about the ownership of patents, registered trademarks, or performing transactions related to licenses for technologies. In view of the extremely low activity of Polish enterprises in the field of patents (*Raport o stanie patentowania w Polsce*, 2014), this is again a very high result (Fig. 7).

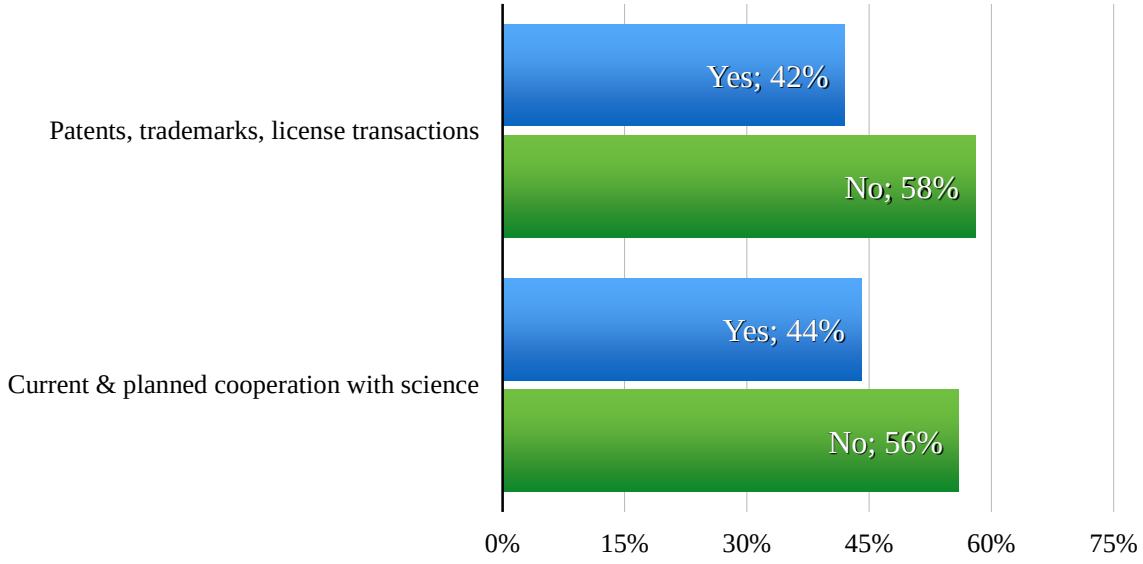

Figure 7. Science in start-ups: answers to questions about the ownership of patents, registered trademarks or performing license transactions and current and planned cooperation with science

The final question in this part of the survey was concerned with cooperation with science in a broad sense. It was emphasized that this referred to public or private universities, institutes, laboratories, regular contacts with them, even informal, as long as they were related to the activities carried out by the start-up and served to improve its condition. Again, as many as 37% of respondents said that they carried out this type of activity, and additionally, two start-ups declared that they intended to undertake such activity (in such case, the percentage of start-ups collaborating with the science sector regularly would rise to 44%) (Fig. 7).

The third part of the survey concerned the phenomenon of innovation and the manner of developing innovation in start-ups. A detailed analysis of the answers to these questions provided by start-ups will be the subject of another article. However, even a cursory initial analysis of these results already shows that in each response to the question about the main vehicle of innovation in start-ups, respondents indicated the product. In second place they mentioned marketing, and particularly the method and channel for reaching customers. This "sharp" nature of innovation centred on the product allows the surveyed population to be regarded as a group of companies with great innovative and market potential. However, an additional objective for further research will be to evaluate to what extent start-ups are aware of the difficult competitive conditions in which they function and how they are going to face major challenges that such competition puts before them.

Summary

The article discusses the results of a survey, which was conducted with two purposes:

- To examine to what extent start-ups representing digital economy meet the criteria for belonging to the business sector of high technology;
- To obtain basic information about start-ups, as well as to verify survey questions in the context of a wide-ranging surveying action of the Polish start-up scene.

The surveys were filled out by 38 start-ups at an advanced stage of development, which was the result of a special sample selection. This is due to the fact that the survey included both the projects which had participated in competitions for the best start-ups and those founded by people already experienced in the industry.

Eighty-five per cent of companies were established after 2010, two-thirds of them operate as limited liability companies, and three-quarters of them are registered in the largest Polish academic cities. More than half declare to carry out their operations under PKD 62 or 63, but the other half either do not find it important (e.g. did not declare the activity in KRS), or do not believe that the selected number properly reflects the character of their activity. It is a serious problem that can result in serious mistake of any analyses carried out on the basis of the sector belonging criterion (i.e. PKD). This is confirmed by similar problems that were faced on the occasion of performing research concerning the high-tech sector. A typical surveyed start-up produces business software independently, selling it on the basis of the Software as a Service (SaaS) model, or is active in the field of e-commerce. Considerable interest in the production of hardware can also be noticed.

The development ambitions of start-ups should be regarded as impressive: over 90% of respondents expect at least a threefold increase in the company's value in the space of just two

years. In the case of every third surveyed start-up, these ambitions are definitely justified, because this is the number of companies which began to make a profit immediately after the start-up, or even before its official registration. However, every fourth start-up admits not to be making a profit on a regular basis yet. Moreover, we do not know the sources of financing this potential growth. With reference to the sources of financing current activity, 60% of companies rely on their own financing. The others are willing to seek investment from a venture capital fund (VC), business angel or EU grant. The least popular forms of support are science and technology parks.

Start-ups employment structure: people other than partners work in two out of three start-ups. The average employment rate among employers is a minimum eight people. More than half of the start-ups sell their products abroad, mainly in the very demanding British and American markets. Every fifth start-up conducts more than half of its sales abroad. These results may be compared with indicators characterizing Polish medium-sized companies, which demonstrates that Polish start-ups are entering the best foreign markets as boldly as if they had similar resources and potential.

Start-ups achieve the best results in terms of cooperation with science: almost half of them patent their products (also abroad) and regularly consult on product development with representatives of universities or research institutes. These indicators probably contribute to the fact that the main carrier of innovation in start-ups is the product, while marketing and channels to reach customers are considered less important.

The results of this pilot study indicate that “digital” perfectly meet the criteria of belonging to high technology. Further research on a larger scale and with a more representative sample will verify hypotheses related to the difficulty of industry analysis based on GUS statistics, start-up contacts with academic centres, involvement of women in start-ups, and employment and growth.

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Appendix 1

The results of a survey conducted for the purpose of:

- Gathering basic knowledge of Polish startups;
- Examining to what extent they fulfil the criteria of high technology, "high-tech".

The survey was divided into two parts, in line with the objectives. All the answers were voluntary, allowing for disparity between the number of responders and responses to each question. If applicable, some questions allowed for more than one answer to be given. A value of "text" or "image" was given where there was individual and extensive written answers or answers where the responder could be identified to preserve anonymity of the study

	Distribution of value		
Question	Value	Percentage of respondents	Number of responders
Name of the company/project	Text		38
In one sentence: what is your offer?	Text		37
Company's website (URL)	Text		37
City where the company is registered	Warszawa	43.24%	16

	Kraków	10.81%	4
	Łódź	8.11%	3
	Gdańsk	8.11%	3
	Poznań	8.11%	3
	Lublin	2.70%	1
	Katowice	2.70%	1
	Ożarów Mazowiecki, Mazowieckie	2.70%	1
	Żary	2.70%	1
	Elbląg	2.70%	1
	Białystok	2.70%	1
	London (UK)	2.70%	2
Please provide your company's legal form	joint-stock company	0.00%	0
	limited liability company	64.86%	24
	general partnership	5.41%	2
	partnership	2.70%	1
	limited partnership	0.00%	0
	partnership limited by shares	2.70%	1
	sole proprietorship	16.22%	6
	branch of a foreign company	0.00%	0
	other form	2.70%	1
	registered abroad	2.70%	1
	Not yet registered	2.70%	1
Does the company have an international branch?	Yes	19.44%	7
	No	63.89%	23
	Other	16.67%	6
	sales person	2.78%	1
	web project	2.78%	1
	it's complicated	2.78%	1
	somewhat	2.78%	1
	in the process of opening	5.56%	2
If you remember, what is the primary PKD of your company?	PKD 47	3.57%	1
	PKD 58	3.57%	1
	PKD 62	35.71%	10
	PKD 63	35.71%	10
	PKD 64	3.57%	1
	PKD 73	3.57%	1
	PKD 74	7.14%	2
	PKD 91	3.57%	1
	Not registered	3.57%	1
	Yes	42.86%	15

In your opinion, was the declared PKD adequate to the essence of your business?	No	31.43%	11
	don't know or have a comment	25.71%	9
When was your company registered? (year)	2015	12.12%	4
	2014	15.15%	5
	2013	27.27%	9
	2012	12.12%	4
	2011	15.15%	5
	2010	3.03%	1
	2009	3.03%	1
	2008	3.03%	1
	2005	3.03%	1
	1997	3.03%	1
	1992	3.03%	1
How long have you worked on the project before it was formalized?	about six months	63.89%	23
	about a year	11.11%	4
	about a year and a half	13.89%	5
	about two years	8.33%	3
	more than two years	2.78%	1
How long did it take for your company to have a stable income?	before it was registered	21.62%	8
	immediately	8.11%	3
	about six months	16.22%	6
	about a year	10.81%	4
	about a year and a half	13.51%	5
	about two years	5.41%	2
	no regular income	24.32%	9
In what industry do you operate in and what business model do you execute?	Hardware	16.22%	6
	Software	64.86%	24
	Programming for industry	0.00%	0
	Life Science / Healthcare / Biotech	2.70%	1
	Creative	10.81%	4
	B2B	59.46%	22
	B2C	27.03%	10
	B2B2C	21.62%	8
	Infrastructure services	2.70%	1
	VR / AR / AI	5.41%	2
	Finance	5.41%	2
	Analytics	21.62%	8
	Entertainment	8.11%	3
	Internet of Things (IoT)	5.41%	2
	SaaS	40.54%	15

	Marketplace	10.81%	4
	Mobile	13.51%	5
	Content	8.11%	3
	e-commerce	32.43%	12
	Social	16.22%	6
	Other	13.51%	5
On the scale 0-10 (where 0 is an idea and 10 is Stage A financing), how advanced is your project?	0	2.86%	1
	1	8.57%	3
	2	8.57%	3
	3	5.71%	2
	4	5.71%	2
	5	17.14%	6
	6	17.14%	6
	7	17.14%	6
	8	5.71%	2
	9	5.71%	2
	10	5.71%	2
What do you expect will be the expected value of your company in two years?	current	2.63%	1
	2x as large	5.26%	2
	3-4x as large	34.21%	13
	5-10x as large	28.95%	11
	over 10x as large	28.95%	11
How did you finance your company/project? Please list all forms of financing from the beginning	Only own capital (bootstrapping)	-	20
	VC domestic	-	12
	VC international	-	0
	Angel investor domestic	-	3
	Angel investor international	-	1
	Domestic accelerator	-	1
	International accelerator	-	3
	Domestic incubator or science park	-	1
	International incubator or science park	-	0
	Domestic competition (e.g. Startup Weekend)	-	7
	International competition (e.g. Startup Weekend)	-	2
	UE grants (OP IE)	-	8
	Other financing (formal and informal loans, friends and family, etc.)	-	8

How many people are employed in your company?	founder(s) only	32.43%	12
	1 employee	10.81%	4
	2-4 employees	13.51%	5
	5-10 employees	27.03%	10
	11-20 employees	10.81%	4
	over 20 employees	5.41%	2
What percentage of sales is generated outside of Poland?	No international Clients	50.00%	18
	Up to 10%	16.67%	6
	10% - 50%	11.11%	4
	over 50%	13.89%	5
	100% or almost 100%	8.33%	3
Where, outside of Poland, do you generate the greatest income?	USA	29.41%	5
	UK	35.29%	6
	UK, Ireland, Portugal, Germany, Austria, The Netherlands	5.88%	1
	Russia	5.88%	1
	India	5.88%	1
	UK, USA, Germany, The Netherlands	5.88%	1
	Hungary	5.88%	1
	Czech Republic	5.88%	1
Who are your clients?	individuals	36.36%	12
	micro companies (<10 employees)	57.58%	19
	small companies (10-50 employees)	54.55%	18
	medium companies (50-250 employees)	51.52%	17
	Large companies (250+ employees)	57.58%	19
	institutional clients: government, schools, hospitals	9.09%	3
	don't know yet who the clients are	6.06%	2
Does the company work with an academic institution?	Yes	34.21%	13
	No	63.16%	24
Is/was there among the shareholders (founders) someone with an academic title?	Yes	10.53%	4
	No	89.47%	34
	Yes	36.84%	14

Does the company have ownership of patents, registered trademarks or performing license transactions?	No	55.26%	21
	Other options/details: patent PL/EU/US, licenses, trademarks	13.16%	5
What do you produce? 1. Are you a manufacturer? 2. Do you produce software for manufacturing? 3. Do you write code?	Neither	16.22%	6
	We are a manufacturer	10.81%	4
	we program for hardware	21.62%	8
	we create software	35.14%	13
	we manufacture in-house	8.11%	3
	we outsource production in Poland	13.51%	5
	we outsource production abroad	5.41%	2
	Italy and Germany	2.70%	1
	China	2.70%	1
	we program in-house	62.16%	23
	we outsource programing in Poland	35.14%	13
	we outsource programing abroad	2.70%	1
Assess your business's relationship with technology and industry KET (on the scale 0-10, where 0 is no relationship)	0	72.22%	26
	1	5.56%	2
	2	0.00%	0
	3	2.78%	1
	4	2.78%	1
	5	0.00%	0
	6	0.00%	0
	7	8.33%	3
	8	2.78%	1
	9	2.78%	1
	10	2.78%	1
What is INNOVATION to you and how would you describe it?	Text		34
Company logo	Image		21
Comments	Text		22

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Visegrad Countries: Evidence from the High-Tech Industry Data

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Introduction

As the recent literature outlines the high-technology sectors present the fastest growing sectors in international trade and provide the necessary grounds for economic growth in nowadays globalized world economy. Already in 1997, Hatzichronoglou stated that in the context of economic globalization, technology is a key factor in enhancing growth and competitiveness in business. Firms which are technology-intensive tend to innovate more, penetrate new markets, use available resources more productively and as a result offer higher remuneration to the people that they employ (Hatzichronoglou, 1997).

Due to the importance of the development of the knowledge-based economy, investments in research, development, innovation and skills constitutes a key policy area for the EU. According to the data of Eurostat (2015), in 2012, the EU had almost 46 000 enterprises in high-tech manufacturing. Four countries, i.e. Germany, the United Kingdom, Italy and the Czech Republic, together account for around 53 % of the high-tech sector in the EU-28. In terms of the total value of exports, Germany was the leading exporter of high-tech products in 2013, followed by the Netherlands, France, the United Kingdom and Belgium. Thus, within the EU-28 the main exporters in high-tech are presented by the core EU 15 countries. The latter indicates the gap in high-tech exports performances between the core and the new member states (NMS) of the EU. As Baesu, Albulescu, Farkas and Draghici (2015) outline, the performance of high-technology sectors might play the essential role in catching-up of NMS with the core EU 15 countries.

However, the trade performance of NMS in high-tech sectors is not systematically studied. The literature only highlights some general conclusions concerning the case of V-4. Namely, Hornok, (2010), Hunya and Richter (2011), Foster (2011), Brodzicky (2011), Akhvlediani and Sledziewska (2015) have found that surprisingly the trade among these four countries after the EU enlargement has increased relatively to a greater extent than the one with the other European countries. Aiming to cover the gap in the literature that lacks elaboration of high-tech performances of NMS, the authors of this study decided to focus on V-4 and based on the data sourced by Eurostat (NACE Rev.2, at the 3-digit level) the statistical analysis of the high-tech exports, R&D expenditures and intra-industry trade (IIT) of V-4 and the EU 15 separately will be provided.

The statistical analysis indicates that V-4 falls behind the EU 15 in both human capital stock and R&D accumulation, however, we find some positive trend in the latter over the past several years following the EU enlargement.

The rest of the paper is organized as follows: section 2 presents statistical analysis on high tech exports and R&D expenditures, section 3 provides IIT statistics and finally section 4 delivers main conclusions.

High-tech exports and R&D expenditures

In this section, based on the data sourced by Eurostat (NACE Rev.2, at the 3-digit level) the R&D expenditures and the shares of different technology groups in the overall exports as well as the structure of the high-tech exports for the EU15 and V-4 separately[4]is briefly reviewed.

The data on the export and trade flows in high technology manufacturing industries sectors comes from the Eurostat based on the Statistical Classification of Economic Activities in the European Community (NACE Rev.2) at the 3-digit level for compiling groups. Namely, statistics on high-tech industry (HT) comprises of economic, employment and science, technology and innovation (STI) data which describe manufacturing applied based on the technological intensity. Three approaches are used to identify technology-intensity: sectoral, product and patent approach. To analyze the significance of HT in trade, the sectoral approach is here used. It is a particular aggregation of the manufacturing industries, more precisely, according to the level of their technological intensity (R&D expenditure/value added), manufacturing activities are grouped to 'high-technology' (HT), 'medium high-technology' (MHT), 'medium low-technology' (MLT) and 'low-technology' (LT)[5].

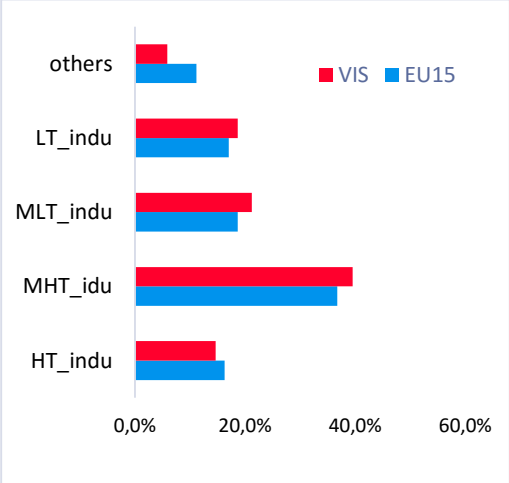
Figure 1 and Figure 2 present the share of high-tech products in the overall exports of the EU15 and V-4. As the figures illustrate, the share of the EU15 exceeded the one of V-4 in 2013. Although, relatively to 2004, in 2013 the increase of HT share in total export of V-4 and the decrease of the EU15 can be observed.

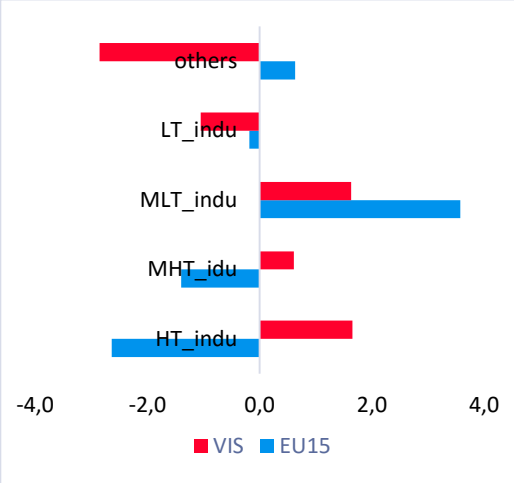
[4] In the figures and tables provided below LT stands for low-tech industries, MLT for middle-high-tech industries, MHT for middle-high-tech industries and HT for high-tech industries.

[5] See the detailed information on: http://ec.europa.eu/eurostat/cache/metadata/Annexes/htec_esms_an3.pdf.

Figure 1. Share of technology sectors in the exports of EU15 and V-4 in 2013, (in %)

Figure 2. Change in the shares of technology sectors in exports of EU15 and V-4 over 2004-2013, (in % points)





Source: own calculations based on the data from Eurostat, (HT, NACE Rev.2, 3-digit level).

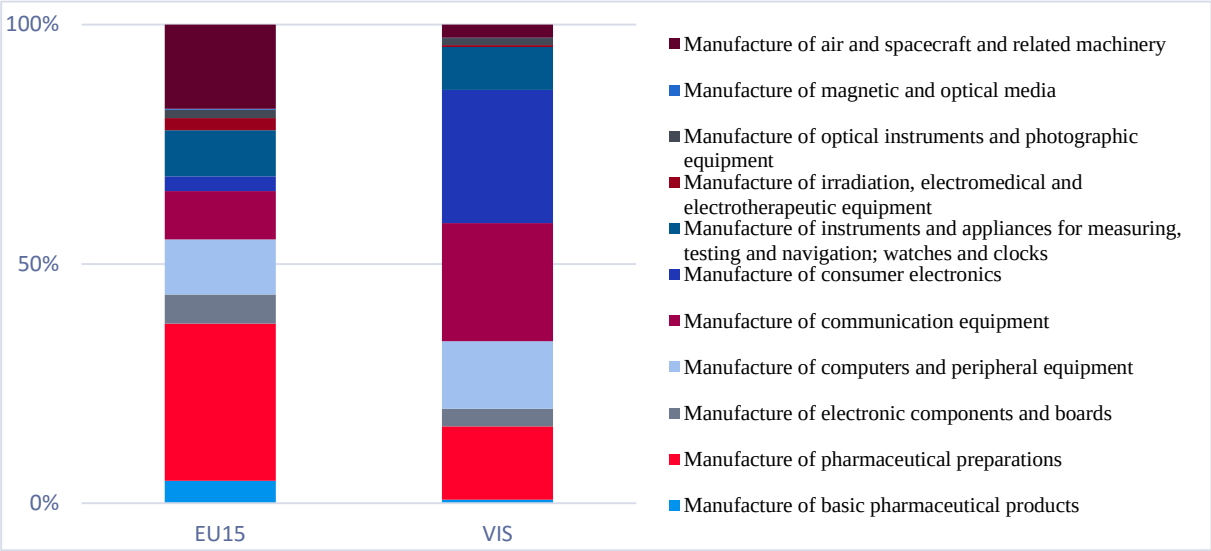
The disaggregated data of the high-tech exports by the product groups are reported in Table 1 and Figure 3. As the latter two illustrate, the EU15 mainly export pharmaceutical products (more about 37% of exports of HT comes on this product group). While exports of V-4 exhibit completely different structure. Namely, Visegrad countries mainly export consumer electronics and communication equipment.

Table 1. The percentage share of different product groups in HT exports of the EU15 and V-4 in 2013

Product groups	EU15	VIS
Manufacture of basic pharmaceutical products	4.7 %	0.8 %
Manufacture of pharmaceutical preparations	32.8 %	15.3 %
Manufacture of electronic components and boards	6.0 %	3.7 %
Manufacture of computers and peripheral equipment	11.5 %	14.1 %
Manufacture of communication equipment	10.1 %	24.7 %
Manufacture of consumer electronics	3.1 %	27.8 %
Manufacture of instruments and appliances for measuring, testing and navigation; watches and clocks	9.6 %	8.9 %
Manufacture of irradiation, electro-medical and electrotherapeutic equipment	2.6 %	0.4 %
Manufacture of optical instruments and photographic equipment	1.8 %	1.4 %
Manufacture of magnetic and optical media	0.2 %	0.1 %
Manufacture of air and spacecraft and related machinery	17.6 %	2.8 %

Source: own calculations based on the data from Eurostat, (HT, NACE Rev.2, 3-digit level).

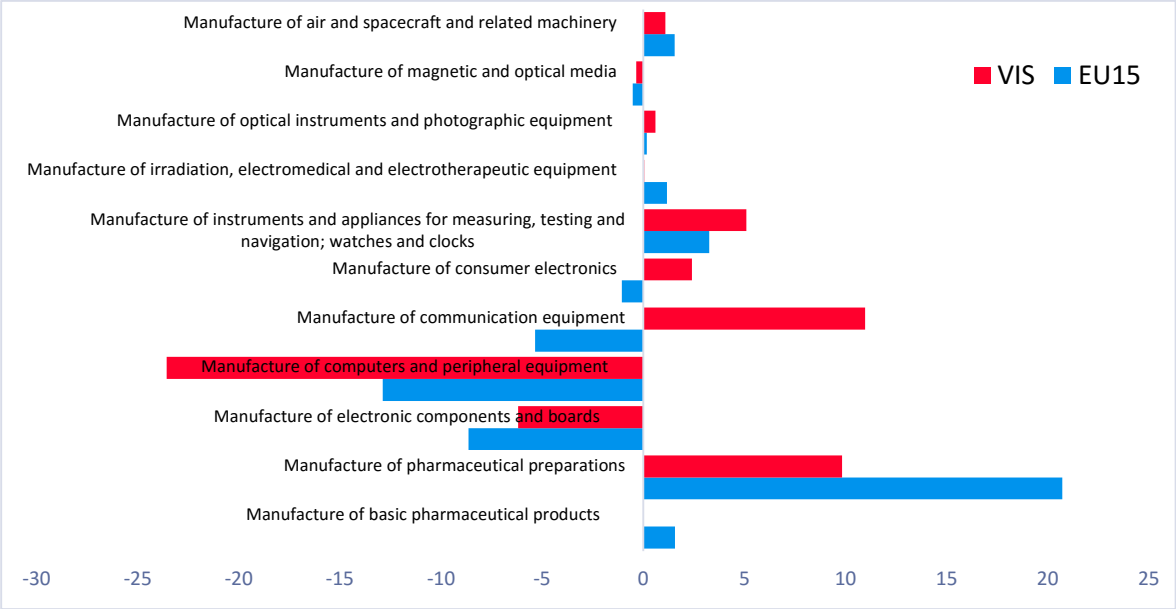
Figure 3. The structure of HT exports of the EU15 and V-4 in 2013



Source: own calculations based on the data from Eurostat, (HT, NACE Rev.2, 3-digit level).

Additionally, the dynamics of disaggregated high-tech exports indicate that in 2004-2013 the decrease in HT share in overall exports of the EU15 was due to the drop in the share of electronic components, boards, computers and peripheral equipment. As for the V-4 countries, the increase might be explained by the increased shares of communication equipment and pharmaceutical preparations in their HT exports.

Figure 4. The change in the shares of different product groups in HT exports of the EU15 and V-4 in 2013, (in % points)



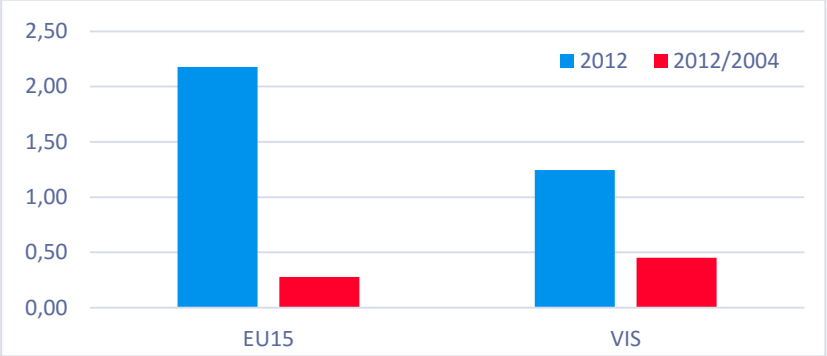
Source: own calculations based on the data from Eurostat, (HT, NACE Rev.2, 3-digit level).

So as Figure 4 indicates, V-4 countries further diversify their exports at the expense of the raised shares of pharmaceutical preparations, while EU15 mainly specialize on exporting the

latter and further decrease their exports in other product groups related to the electronic components.

To characterize the difference in specialization of the EU15 and V-4 the data of the R&D spending should also be reported. As Figure 4 demonstrates, in 2012 R&D spending in the EU 15 was twice as large as the one of V-4. However, the dynamics of R&D spending over the period 1999-2012 indicates that relatively to 2004, in 2012 the change in the R&D expenditure of V-4 is positive and twice as large as the change in the EU 15.

Figure 5. Share of R&D expenditures in GDP in 2012 (in %) and changes in the share over 2004-2012 (in % points)



Source: World Bank, World Development Indicators database.

Since R&D expenditures are crucially important for specializing in manufacturing of pharmaceutical products, it is not surprising that the R&D expenditures of the EU 15 exceed those of V-4. However, it is remarkable that, as the data reveal, after the EU accession V-4 are characterized by the increased R&D expenditures.

Intra-Industry Trade

IIT is defined as simultaneous exports and imports of similar goods produced in the same industries. It is an exchange of highly differentiated goods produced by manufacturing sectors that are well developed in industrialized countries. It is noteworthy that technological progress has accelerated differentiation (qualitatively or non-qualitatively) of the goods (final as well as intermediaries) and as a result the volume of IIT has been increased. Moreover, due to the digital revolution and the internet, services that were non-tradable in the past have become accessible for trade and further enlarged IIT.

We calculate IIT by the Grubel-Lloyd (*GL*) index as follows:

$$IIT_{R,P,j,t} = 1 - \frac{\sum_R \sum_P \sum_{i \in j} |X_{RPit} - M_{RPit}|}{\sum_R \sum_P \sum_{i \in j} (X_{RPit} + M_{RPit})} \cdot 100 \qquad (1)$$

where R stands for a reporter, P for a partner and i for a commodity. In other words, as presented by *GL* index, IIIT is a difference between total trade and inter-industry trade and ranges from 0 and 1. The higher the index, the more intensive is IIT[6].

In order to show more precisely the different features of trade flows and trade partners, IIT can be divided into two types of IIT: horizontal (HIIT) and vertical (VIIT). Horizontal intra-industry trade is an exchange of varieties of goods with similar qualities, while vertical intra-industry trade is an exchange of final goods with different qualities or an exchange of final goods and intermediate goods produced in the same industry. HIIT and VIIT with varieties of high quality are usually conducted by the industrialized countries whereas the less developed ones take sometimes part in VIIT exporting low-quality goods and importing those of relatively high quality.

For separate analysis of horizontal and vertical trade we used a method presented in Greenaway, Hine and Milner (1994, p. 95). The authors assume that differences in quality are reflected by differences in prices. Prices are further treated as proxies for unit values of analyzed goods (measured e.g. in €/kg). Consequently, it is assumed that the unit values as well as prices of homogeneous (or very similar) products exported to and imported from different countries are close to the average value/price. If a product is highly differentiated, then the unit values and prices of its varieties differ. This indicates that there are quality differences between different varieties of products exported to and imported from different countries).

Horizontal IIT occurs when the relative unit values of simultaneous exports and imports of similar products comprise a narrow partition. The narrower this partition is, the more rigorous the good's similarity conditions and the less intensive IIT are. Similarly to other authors (including Greenaway, Hine & Milner, 1994; and Abd-el Rahman, 1991), we propose to adopt of a 15% deviation of relative unit values of exports (UV^{Ex}_i/UV^{Im}_i) as a boundary of the partition of unit values of exports and imports and presenting horizontal intra-industry trade. Therefore, we have:

$$0.85 \le \frac{UV_i^{Ex}}{UV_i^{\mathrm{Im}}} \le 1.15 \tag{2}$$

If the unit value of exports is relatively high in comparison with the unit value of imports (meaning that exports are of higher quality than imports or that exports involve final goods, while imports involve intermediate goods from the same industry), then we have:

$$\frac{UV_i^{Ex}}{UV_i^{\mathrm{Im}}} > 1.15 \tag{3a}$$

On the other hand, if the unit value of exports is relatively low compared with the unit value of imports (meaning that exports involve products of lower quality than imports or that exports involve intermediate goods, while imports involve final goods from the same industry), then we have:

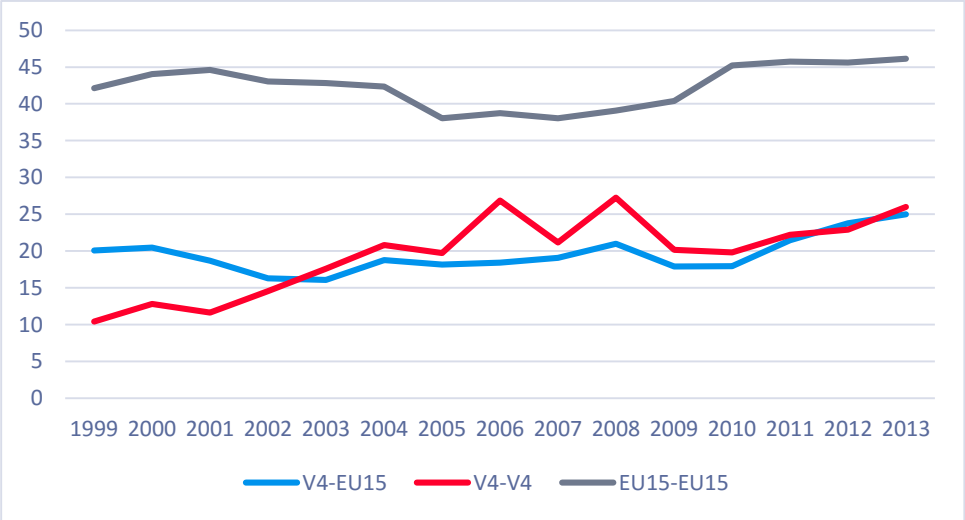
$$\frac{UV_i^{Ex}}{UV_i^{\mathrm{Im}}} < 0.85 \tag{3b}$$

[6] We have extreme cases when the index equals 1 or 0: the whole trade is IIT when $\sum_{i=1}^{n} X_i = \sum_{i=1}^{n} M_i \Rightarrow GL = 1$ or the whole trade is inter-industrial: $\sum_{i=1}^{n} X_i = 0$, or $\sum_{i=1}^{n} M_i = 0 \Rightarrow GL = 0$.

Inequalities given by 3(a) and 3(b) provide good indications to identify where the particular country is located in IIT. Namely, if the inequality (3a) holds, then the examined country participates in vertical intra-industry trade, exporting high quality products and importing low quality ones (VIIT high quality). However, if the inequality (3b) holds, then the examined country supplies low quality products, buying in return high quality goods (VIIT low quality).

Based on the methodology described above (equation 1), we calculated IIT for V-4 and EU15. As Figure 6 indicates, IIT in high-tech is the highest among the EU 15 and is the lowest among the EU 15 and V-4. Intra V-4 IIT was lower than IIT between V-4 and the EU 15 preceding the EU enlargement and higher following the EU enlargement with more or less similar trend over the recent years. Therefore Figure 6 highlights that IIT of V-4 in high-tech comes mainly on intra V-4 trade rather than the EU 15, especially after their accession to the EU.

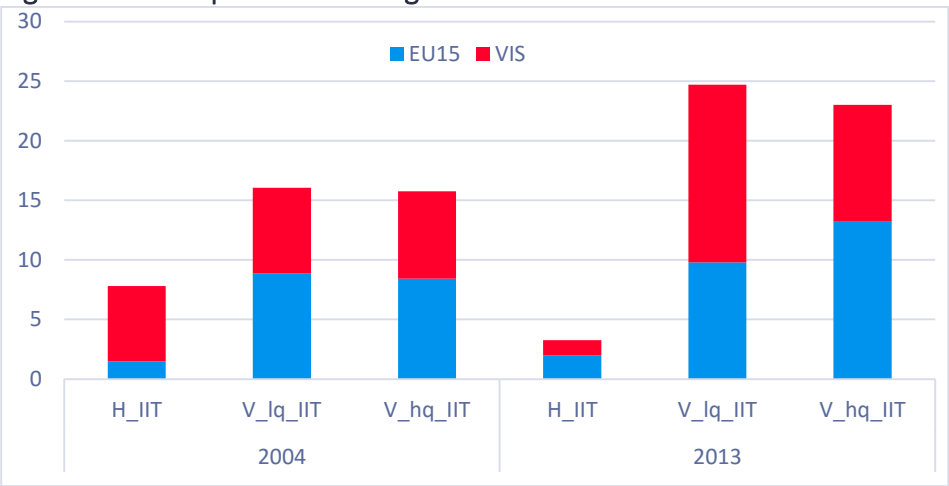
Figure 6. IIT in High-Tech Exports in %



Source: own calculations based on the data from Eurostat, (HT, NACE Rev.2, 3-digit level).

Moreover, we analyzed the composition of IIT. Namely, based on equations (2), 3(a) and 3(b) we calculated the horizontal (H_IIT), vertical low quality (V_lq_IIT) and vertical high quality (V_hq_IIT) intra-industry trade in high-tech. As Figure 7 indicates, in 2004, horizontal IIT was the highest among V-4 and the lowest between V-4 and the EU 15. Moreover, V-4 traded with the EU-15 mainly in vertical low quality products. In 2013, V-4 decreased horizontal IIT and increased vertical low quality IIT among one another. Furthermore, high quality IIT also raised with the EU 15.

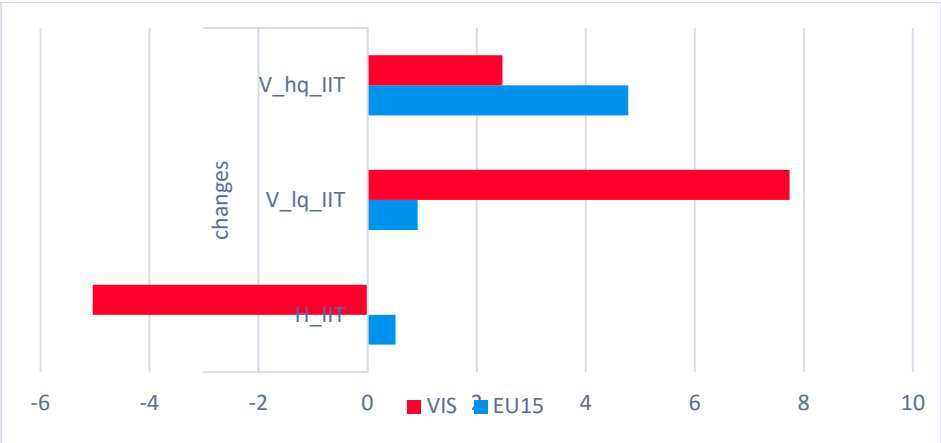
Figure 7. IIT composition of Visegrad countries in 2004 and in 2013 in %



Source: own calculations based on the data from Eurostat, (HT, NACE Rev.2, 3-digit level).

As Figure 8 demonstrates, the decrease in horizontal IIT among V-4 took a place at the expense of the considerable rise in vertical low quality products among V-4. The increase in high-quality IIT was also remarkable and mainly referred to the IIT of V-4 and the EU 15.

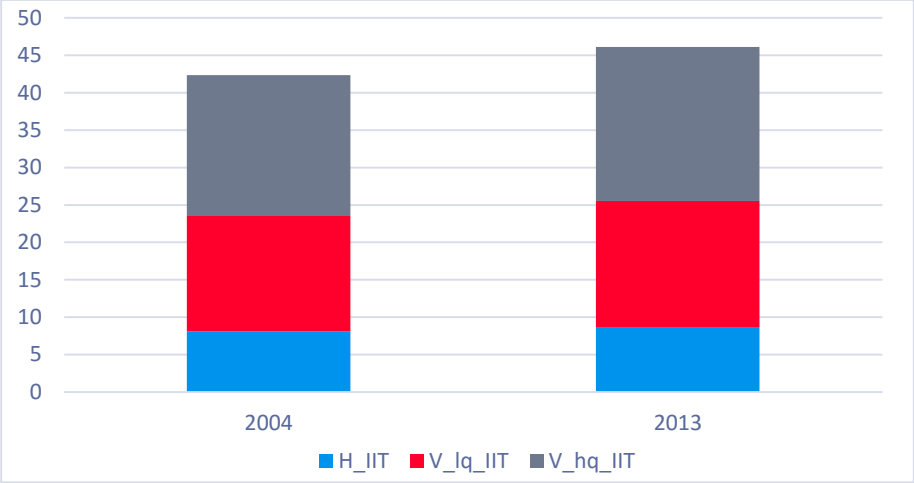
Figure 8. Change in IIT composition of Visegrad countries over 2004-2013 in % points



Source: own calculations based on the data from Eurostat, (HT, NACE Rev.2, 3-digit level).

For comparison, we also examined IIT of the EU 15. As Figure 9 shows, the intra EU 15 IIT mainly comes on vertical high quality IIT, while horizontal IIT has the lowest share.

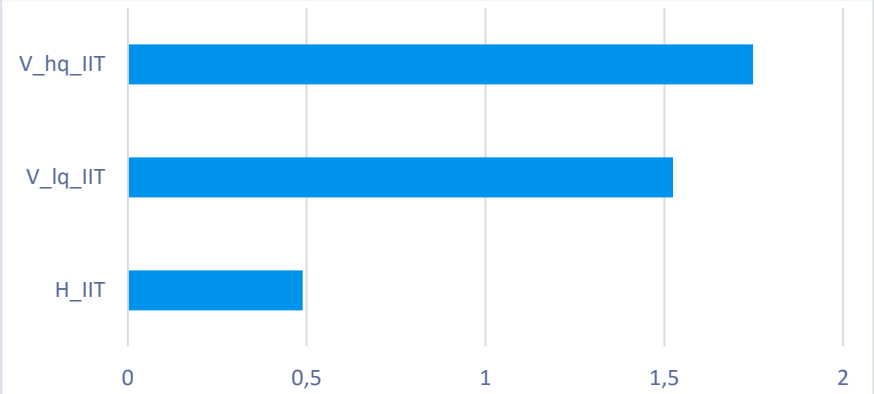
Figure 9. IIT composition of intra EU-15 in 2004 and 2013 in %



Source: own calculations based on the data from Eurostat, (HT, NACE Rev.2, 3-digit level).

As for the change after the EU enlargement, Figure 10 highlights that for all horizontal and vertical IIT the change was positive. However, the biggest increase comes on vertical high-quality IIT and the smallest on horizontal IIT.

Figure 10. Change in IIT composition of intra EU 15 over 2004-2013 in % points



Source: own calculations based on the data from Eurostat, (HT, NACE Rev.2, 3-digit level).

To conclude, preceding the EU accession IIT of V-4 mainly contained horizontally differentiated products while following the EU accession both vertical low and high quality IIT increased considerably. As for the case of the EU 15, our statistical analysis highlights that the EU enlargement was also positive on their specialization since the vertical high quality IIT has raised significantly. However, the trade pattern among V-4 still differs from the intra-EU 15 trade pattern: while the former exchange mainly vertically differentiated low quality products, the latter trades in vertically differentiated but high-quality products.

Conclusions

The paper aimed to provide some evidence for the trade pattern of V-4 relatively to the EU-15, based on the high-tech industry data. Our statistical analysis demonstrated that the share of high-tech in the overall exports of V-4 has been increasing over years since 2004, however it still falls behind the one of the EU 15. Furthermore, the structure of high-tech industry exports differ considerably. Namely, the EU15 mainly export pharmaceuticals, while

Visegrad countries mainly export consumer electronics and communication equipment. This finding may imply that V-4 mainly export communication equipment and consumer electronics to the less developed countries which cannot afford buying the better quality products from the more advanced producers which create innovations in high-technology. Therefore, further research should be dedicated to identify the directions of exports in high-tech industry from V-4, to derive more precise analysis by applying advanced econometric tools.

Furthermore, elaboration of IIT revealed that the EU accession has changed the IIT composition of V-4. More precisely, in the 2004-2013 period V-4 switched from trading in horizontally differentiated goods to vertically differentiated products. As for the EU 15, our statistical analysis highlighted that the EU enlargement was also positive on their specialization since the vertical high quality IIT has raised even further. However, the trade pattern among V-4 still differs from the intra-EU 15 trade pattern: while the latter trade in vertically differentiated high-quality products, the former exchange vertically differentiated but low quality products.

Overall, our statistical analysis demonstrates that V-4 gain the comparative advantage on exporting the products which are not human capital intensive and does not require high R&D spending. Therefore our analysis suggests that in order to catch up with the EU 15 in high-tech export performances, V-4 needs to increase investment in human capital and in R&D. This will ensure that in the long-run physical capital endowment of V-4 will be high enough to benefit from the trade with the advanced and innovative countries.

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Innovate or remain domestic? Innovation and internationalization nexus. Initial evidence for Poland from a large firm-level survey

Introduction

"Innovation distinguishes between a leader and a follower" is a famous quote from Steve Jobs. It seems that at least to some extent it also distinguishes between exporter and non-exporter status.

Several focal studies within the strand of new trade theory have found that innovation and exporting are inextricably linked at firm-level. Aw et al. (2011) conclude that the marginal benefit of simultaneous exporting and innovating increases with productivity, with self-selection effect typical for heterogeneous firms' literature driving a large part of the observed complementarity. Altomonte et al. (2013) shows that there is a positive, broad, strong and robust correlation between the extent of internationalization of firms and innovation activities in the panel of European manufacturing firms (EFIGE).

The literature on the innovation-internationalization nexus for Poland is scarce. The goal of this article is to present some initial results of a large survey of Polish exporting and non-exporting firms conducted by the Institute for Development within a research project "Analysis of international trade of Poland in the light of new trade theories. Implications for economic policy at the crisis era"[8].

As the access to officially gathered firm-level or micro-level data for Polish enterprises is restricted, we conducted a large survey on a sample of exporting and non-exporting enterprises merging it with financial data provided by InfoCredit (provider of data for Amadeus database). The following selection criteria were applied: an enterprise had to have a complete 5 year period of data availability in the InfoCredit records, total sales per enterprises should exceed 2 million PLN (roughly 500k EUR) each year, exports shall exceed 1 million PLN each year (or approx. 250k EUR). This gave a database of about 7000 relatively large and matured enterprises across Poland, from which randomly selected ones were surveyed (depicting spatial distribution of firms at NUTS-2 level) with direct contact - a pollster personally visited the enterprises and conducted in-depth interviews. Our sample consists of rather large firms (upper tail of distribution), predominantly from manufacturing industry, that have at least 5 year continuity of financial reports (and thus have been active for at least 5 years). Out of 709

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[8]Financed by National Science Centre (grant number: 2012/05/B/HS4/04209), carried out in the Institute for Development and chaired by Professor Gawlikowska-Hueckel. The questionnaire was prepared by S. Uminski, T. Jurkiewicz and T. Brodzicki.

effectively questioned enterprises, 498 were exporters (X) and the remaining where non-exporters (NX).

The questionnaire focused on several categories/groups of questions: competitiveness, barriers and obstacles of doing business, consequences of membership of Poland in the EU and of the global financial crisis, exports, imports, firms expectations for the future. As has been already stressed, in the present article we focus only on issues related to innovation performance and innovation behaviour at firm level. Other issues will be analysed in-depth in the forthcoming papers. The main hypothesis is that there is a significant and robust difference between exporters and non-exporters in their innovative activity.
The structure of the reminder of the article is as follows. In section 2 the literature on the nexus between export performance of companies and their innovativeness is shortly reviewed. In section 3 the results of the survey are presented and discussed. Finally, concluding section 4, discusses the limitations of our research as well as gives guidelines for future empirical studies.

Innovation and exports performance

As it has been already stressed several important studies have showed that innovation and exporting and other internationalization activities are inextricably linked at firm-level. For instance, Cassiman and Golovko (2011) show that product and, to a lesser extent process innovation, drive firm exports. Altomonte et al. (2013) show that there is a positive, broad, strong and robust correlation between the extent of internationalization of firms and innovation activities in a large panel of European manufacturing firms. They stress at the same time that trade promotion and innovation policies should be enhanced and closely coordinated to reap the benefits of the apparent synergies.

The results obtained by Cieślik et al. (2014) confirm the importance of firm characteristics for export performance in the CEE countries, including Poland. According to authors the financial support to R&D and innovation activities in transition economies should bring an improvement the export performance of firms.

In a recent study Cieślik et al. (2015) analyse in a probit model the relationship between various types of innovations and export performance of Polish firms over the period of 2008-2010. The authors tried to control for the stocks of human capital and physical capital, firm size (employment size groups), level of technological sophistication of the sector as well as the role of foreign capital participation. They did not control for the level of productivity though. The results indicate that the probability of exporting is positively related to both product and process innovations, firm size, the share of university graduates in productive employment (proxy for human capital) and foreign capital participation in the case of exporters.

It has to be stressed, however, that most of studies in the heterogeneous firms literature treat the notion of innovation in a very simplified manner. In most of the studies it has been proxied by R&D spending or in-house R&D activity (e.g. Cieślik et al. 2014). Innovation itself is a much broader term and innovation activities taken within and outside of an organisation are numerous (Tidd & Bessant 2009, Keeley et al. 2013). It is not only R&D that matters in firms internationalization. Sterlacchini (1999) in a study of small Italian firms in non-R&D-intensive industries belonging mainly to supplier dominated industries found that the probability of

becoming an exporter was affected positively by the size of a firm and negatively by its nature as a sub-contractor. At the same time innovative non-R&D activities, and in particular the amount of expenditure on design, engineering and pre-production developments, exerted a significant and positive impact on the share of exports in total sales.
Wakelin (1998) conducted an interesting study for a sample of UK firms analysing export behaviour of both innovating and non-innovating firms. Export behaviour was defined both as the probability of exporting and the propensity to export of the exporting firms. She found the determinants to vary between innovators and non-innovators. Surprisingly, non-innovative firms were found to be more likely to export than innovative firms controlling for their size. At the same time larger innovators were found to be more likely to enter foreign markets. Small innovators, on the other hand, with one or two innovations were less likely to export and more likely to service the domestic market alone than the equivalent non-innovators. It is likely that fixed costs of entering foreign markets could be too large for smaller innovative firms. Nevertheless, the number of past innovations had a positive impact on the probability of an innovative firm exporting. At the same time improved quality of sectoral innovation system was noticed to improve the probability of exporting of both innovative and non-innovative firms. The study showed that innovators with higher unit labour costs were more likely to export and had a higher propensity to export and average wages which could reflect either better utilization of more skilful labour (human capital) or higher overall productivity. Wakelin (1998) concluded that the capacity to innovate changed the behaviour of the firm relative to non-innovators.

Roper and Love (2002) analysed determinants of export performance of UK and German manufacturing plants finding significant differences. Non-innovators differed from innovators particularly in absorption of spillover effects. Product innovation had a strong and positive impact on the probability and propensity to export in both states. Innovation activity was higher in Germany. However, scale of innovation activity had a positive impact on export propensity in UK, while it was negative in Germany. Surprisingly, co-location of other innovative firms was found to discourage exporting (argument contra industrial clustering).

Basile (2001) analysed export behaviour of Italian manufacturing firms finding that innovation capabilities were among the most important competitive factors and to a large extent explained heterogeneity in export behaviour. The export intensity of innovating firms was systematically higher than that of non-innovators.

Nassimbeni (2001) conducted an empirical analysis on a sample of 165 small Italian manufacturing firms comparing exporters and non-exporters in in terms of technology, ability to innovate, and a number of other structural factors (such as size and age). The propensity of small firms to export was strictly linked to their ability to innovate the product and develop valid inter-organisational relations, while it was to a smaller extent related to a given firm's technological profile. Larger size increased propensity to export, although small firms were found not to be totally precluded from entering foreign markets. Age also proved to be the factor. Taking into account product and process innovations, it seems that product innovations are of greater importance for small exporters as ability to break into a foreign market and to successfully compete against the local offer is closely linked to a wider product range and to the availability of novel products. Nassimbeni stressed that exporters faced more

heterogeneous market demands and fiercer competition, whereby they were stimulated to improve their product innovation or customisation capability (reverse causality). Technology and process innovations were identified as not discriminant for exporters.

Guan and Ma (2003) analysed several aspects of innovation capabilities of Chinese firms and their export performance in a panel of 213 manufacturing industry firms. They identified that export growth was related to improvement of several considered innovation dimensions, except for the manufacturing capability. Domestic market share proved to be irrelevant, while the impact of productivity growth rate was robust and significant. At the same time larger firms demonstrated stronger export competitiveness. Guan and Ma (2003) stated that core innovation assets (R&D, manufacturing and marketing) could not alone lead to sustainable export growth. Supplementary assets are required in order to gain competitiveness in more demanding international markets.

DiPietro and Anoruo (2006) analysing export performance of Chinese firms show that interaction and harmonizing of various innovation assets available at firm level are primary factors in the improvement of international competitiveness. They reach the policy conclusion concerning next generation of export promotion policies that should include measures towards establishing a favourable environment for creativity. Internationalization and innovation potential seem to be closely linked. This is further stressed by Altomonte et al. (2013).

The results of studies presented above are interesting and very informative. On the other hand we would like to stress the small size of analysed panel which, to a large extent, biases the outcomes of empirical analysis and at least to some extent puts in question the obtained results.

Innovation activity and export performance of Polish firms

As it has been already explained, our sample consisted of 709 effectively questioned enterprises: 498 exporters (X) and the remaining where non-exporters (NX). The data was supplemented by financial data from InfoCredit. The questionnaire consisted out of 90 questions with some related to innovation capabilities and performance of firms. Our intention was to identify important differences between exporters and non-exporters.

In an interesting study on Korean firms Hobday et al. (2004) distinguished four different groups of firms according to innovation capability depending on their awareness of need to change and preparedness and ability to change in practice. Firms with low awareness and low ability to change are unaware and passive and thus constitute the non-innovator group. Firms having mediocre or high awareness and ability constitute the innovators group. As innovators introduce innovations from time to time and can be followers (they introduce it following the leaders) and thus have reactive strategies or can be the leaders themselves and thus behave in strategic manner assuming the role of a leader (and thus gaining first mover advantage). Highly innovation-aware firms, introduce innovations constantly and thus are referred to as creative.

Following Hobday et al. (2004) the authors of this study included the questions in our survey (see Tables 1- 3). Respondents in our sample, generally, are aware of the need of change – 75,4 per cent of them identified it as important or key. Looking at the structure of responses

of exporters and non-exporters it is clear that exporters are more aware of the need to change than non-exporters. The difference between the two analysed groups is statistically significant (as shown by the value of chi-square test).

At the same time, around 18,5 per cent of companies in the sample declared that they did not introduce change. They were thus innovatively passive. Passive firms represent 15,5 per cent of exporters and 25,6 per cent of non-exporters. 37,8 per cent of firms declare to introduce innovation from time to time (on ad hoc basis). Within the group of ad hoc innovators, non-exporters are more likely to be reactive (followers) and exporters are more likely to behave in a strategic manner thus taking overall the role of the leader in the relevant market. A high share of 43,7 per cent of firms declare to introduce change constantly, which is to a large extent surprising. In accordance, 48,6 per cent of exporters and 32,2 per cent of non-exporters can be referred to as creative. The difference between exporters and non-exporters is once again statistically significant (chi-square test) in favour of exporters.

However, the very high share of creative firms should be treated with caution. One of the questions in the questionnaire allowed us to verify it (*Has the company got on offer innovative products or services in the last three years?*). 57,5 per cent of enterprises disagreed. 23,3 per cent answered that they introduced new products or services which were innovative for the firm, and only 19,2 per cent introduced new products or services which were innovative for the market in which they operated. Despite of their declarations, around 60 per cent of firms ~~is~~ are therefore passive in reality

The firms have also indicated the share of innovative products and services in their total sales in the last three years. The share of innovative products is overall low, with small advantage for exporters over non-exporters which is clear from the histogram (see Figure 1). The distribution is clearly skewed to the right as could have been expected.

Most of firms (64,6 per cent) judge their ability to introduce innovations as high (4 or 5) and only 10 per cent as low (1 or 2). The ratio of responses by exporters to non-exporters once again points in favour of exporters. The difference between the two analysed groups is once again statistically significant (chi-square test).

Generally, as exporters are more aware of the need to change and have higher ability to introduce change in practice, they should be more innovative. ~~It~~ However, it highly depends on their market strategies.

In another question: *In the past three years has the company introduced new products or services?* 45 per cent of firms answered no (42,6 per cent of exporters and 50,7 per cent of non-exporters) and 55 per cent agreed (57,4 per cent of exporters and 49,3 per cent of non-exporters). We take the introduction of new products or services as a verification of the actual status of an innovator. If the firm declares to be creative (permanent innovator) or ad hoc innovator, but has not introduced a new product or service in the last three years, we treat it as a non-innovator (passive).

The modified results show that overall 60,5 per cent of firms in the sample are non-innovators – 55,8 and 71,6 per cent respectively for exporters and non-exporters. 29,1 per cent

of exporters and only 15,2 per cent of non-exporters are creative. Exporters are also more likely to be ad hoc innovators with the leader status in the market. The share of reactive ad hoc innovators is roughly the same in both analysed sub-groups.

A short review of empirical literature showed that type of innovation matters with particular importance of product innovations. Most of the companies in our sample introduced new products or services or technologically improved products or services (see Table 7). Exporters outperform non-exporters in all innovation-related activities in the last 3 years (as shown by X to NX ratio). The difference is particularly evident with entry into new markets (new market innovation), significant organizational changes, significant changes in ownership, modern production methods and technologically improved products or services. Among exporting firms the following changes are the most frequent (introduced during the last 3 years): product innovations (novel products or services – 57,4 per cent and technologically improved products or services – 44 per cent), process innovations (modern production methods – 35,1 per cent) and entry into new markets (31,3 per cent). However, the difference between the two groups is statistically significant only in the case of technologically improved products or services as well as expansion and acquisition of new markets for their products or services.

Table 8 presents average properties of firms in our sample dividing it into innovating and non-innovating exporters and non-exporters. Innovating firms are defined as ones that have introduced novel or technologically improved products in the last three years.
Innovators, both exporters and non-exporters, are larger by employment size than non-exporters. Innovating exporters are on average the largest. Exporters are larger than non-exporters in terms of total assets, total sales and value added. At the same time average value added in 2012 was clearly higher for non-innovators.

Innovators are on average younger than non-innovators. Simultaneously, innovating exporters have the highest total productivity and capital productivity with on average lower labour productivity. Exporters are more capital intensive. Innovating exporters have the highest return on assets however not far away from non-innovating exporters at the same time having the lowest current liquidity.

What needs to be stressed here is, that the new trade theory rejects the standard assumption of a representative firm and firms' homogeneity. Micro-level data clearly show that firms differ a lot between and within sectors. This new strand of literature highlights heterogeneity in productivity, size, and other characteristics even within narrowly defined industries (Melitz, Redding 2014). Furthermore, heterogeneity is systematically related to participation in foreign trade, with exporters being on average larger and more productive than non-exporters, prior to entering export markets. Only firms breaching a certain level of productivity threshold can enter and remain in the foreign markets and thus gain an exporter status. Firms with low-productivity are unable to penetrate foreign markets but can also be eliminated from the domestic market. Firms usually learn their actual productivity in comparison to competitors only after they have already entered the market.

In this research we have utilized the detailed financial data provided by InfoCredit to calculate different productivity indices in order to identify statistically significant differences

between exporters and non-exporters: including labour productivity, capital productivity, total productivity (TPROD) and last but not least the TFP.

The histogram of labour productivity in 2012 (see Figure 2) is clearly skewed to the right for both exporters and non-exporters, as could be expected. Very productive firms are rare, while firms with low productivity clearly dominate. The further decomposition into innovating and non-innovating firms in Figure 3 reveals no clear difference between the groups. There is no clear advantage in labour productivity of innovating exporters.

More elaborated statistical analysis showed that he differences between the two analysed groups was statistically significant with labour productivity generally higher for exporters (based on the comparison with V-Cramer and eta).

Concluding remarks

It could be generally argued that innovation plays a central role in economic prosperity. It simultaneously seems to play a significant role in export behaviour of firms and the internationalization-innovation nexus is evident. Analogously to Cieślik et al. (2015) it can be concluded that the probability of exporting seems to be positively related to both product and process innovations controlling for firm size.

Similarly to other country level studies important differences with respect to innovation activity for Polish exporters and non-exporters were identified. Exporters prove to be more focused on innovations, are more aware of the need to implement changes, and are better prepared to introduce them in reality. They are more probable to be creative (constantly introduce change) and are more likely to behave in more strategic manner (ad hoc innovators) assuming the position of a market leader. The propensity of firms to export is linked to their ability to innovate in particular along the product dimension.

Exporters outperform non-exporters in all innovation-related activities. The difference is particularly evident with entry into new markets (new market innovation), significant organizational changes, significant changes in ownership, modern production methods and technologically improved products or services. Among exporting firms product innovations, process innovations and entry into new markets are the most popular.

Product innovators, both exporters and non-exporters, are on average larger in terms of number of employees than non-exporters. At the same time innovating exporters are the largest. Exporters are larger than non-exporters in terms of total assets, total sales and value added. Innovators are on average younger than non-innovators. Innovating exporters have the highest total productivity and capital productivity with lower, on average, labour productivity. Innovating exporters have the highest return on assets however, at the same time, are not far away from non-innovating exporters with having the lowest current liquidity.
The results presented here are initial and require a more elaborated analysis in the second stage of our research project with the use of a logistic regression model where innovation – related variables alongside other factors will explain the export-status of firms, controlling for a number of conditioning aspects such as firm productivity, firm size, sector of operation, human and fixed capital endowment and the role of foreign capital.

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Table 1. Respondents' readiness to introduce changes

		How far is the firm prepared and able to change in practice?					
		1 - low	2	3	4	5 - high	Overall
How far firm is aware of the need to change?	1 – low (irrelevant)	41,9	20,0	4,4	0,4	0,5	4,4
	2	9,7	30,0	5,6	0,8	1,9	4,4
	3	38,7	17,5	35,6	8,2	4,2	15,8
	4	3,2	27,5	40,0	58,6	12,6	35,8
	5 – high (key)	6,5	5,0	14,4	32,0	80,8	39,6
	Overall	100,0	100,0	100,0	100,0	100,0	100,0

Source: Own elaboration, based on survey results.

Table 2. To what extent the Respondent is aware of the need to change? Exporters vs. non-exporters differences (percent of responses)

	Exporters (X)	Non-exporters (NX)	Overall (X+NX)	Ratio X/NX
1 – low (irrelevant)	3,4	6,6	4,4	0,51
2	3,2	7,1	4,4	0,45
3	14,3	19,4	15,8	0,73
4	34,9	37,9	35,8	0,92
5 – high (key)	44,2	28,9	39,6	1,53
Overall	100,0	100,0	100,0	1,00

Source: Own elaboration, based on survey results.

Table 3. To what extent is a respondent prepared and able to change in practice? (percent of responses)

	Exporters (X)	Non-exporters (NX)	Overall (X+NX)	Ratio X/NX
1 – low	3,41	6,64	4,37	0,51
2	5,02	7,11	5,64	0,71
3	22,29	32,70	25,39	0,68
4	35,94	30,81	34,41	1,17
5 – high	33,33	22,75	30,18	1,47
Overall	100,00	100,00	100,00	1,00

Source: Own elaboration, based on survey results.

Table 4. Market strategies followed by respondents (in per cent)

	Exporters (X)	Non-exporters (NX)	Overall (X+NX)	Ratio X/NX
Passive	15,5	25,6	18,5	0,60
Ad hoc - reactive	17,1	26,5	19,9	0,64
Ad hoc - strategic	18,9	15,6	17,9	1,21
Creative	48,6	32,2	43,7	1,51
Overall	100,0	100,0	100,0	-

Source: Own elaboration, based on survey results.

Table 5. Character of innovations (their novelty) introduced by Respondents

	Exporters (X)	Non-exporters (NX)	Overall (X+NX)	Ratio X/NX
no	53,6	66,8	57,5	0,80
new to firm	25,9	17,1	23,3	1,52
new to market	20,5	16,1	19,2	1,27
Total	100,0	100,0	100,0	1,00

Source: Own elaboration, based on survey results.

Table 6. Market strategies followed by respondents (in per cent), post-control

	Exporters (X)	Non-exporters (NX)	Overall (X+NX)	Ratio X/NX
Passive	55,8	71,6	60,5	0,78
Ad hoc - reactive	5,8	5,7	5,8	1,02
Ad hoc - strategic	9,2	7,6	8,7	1,22
Creative	29,1	15,2	25,0	1,92
Overall	100,0	100,0	100,0	

Source: Own elaboration, based on survey results.

Table 7. Type of innovation introduced in the last 3 years by Respondents

Change area		X	NX	Overall	X/NX ratio
new products or services	no	42,6	50,7	45,0	0,84
	yes	57,4	49,3	55,0	1,17
technologically improved products or services	no	56,0	66,8	59,2	0,84
	yes	44,0	33,2	40,8	1,33
modern production methods	no	64,9	73,9	67,6	0,88
	yes	35,1	26,1	32,4	1,35
significant organizational changes	no	73,5	81,5	75,9	0,90
	yes	26,5	18,5	24,1	1,43
significant changes in ownership	no	89,0	91,9	89,8	0,97
	yes	11,0	8,1	10,2	1,37
new cooperation with other firms or institutions (e.g. R&D)	no	85,7	87,2	86,2	0,98
	yes	14,3	12,8	13,8	1,11
entry into new markets	no	68,7	78,2	71,5	0,88
	yes	31,3	21,8	28,5	1,44

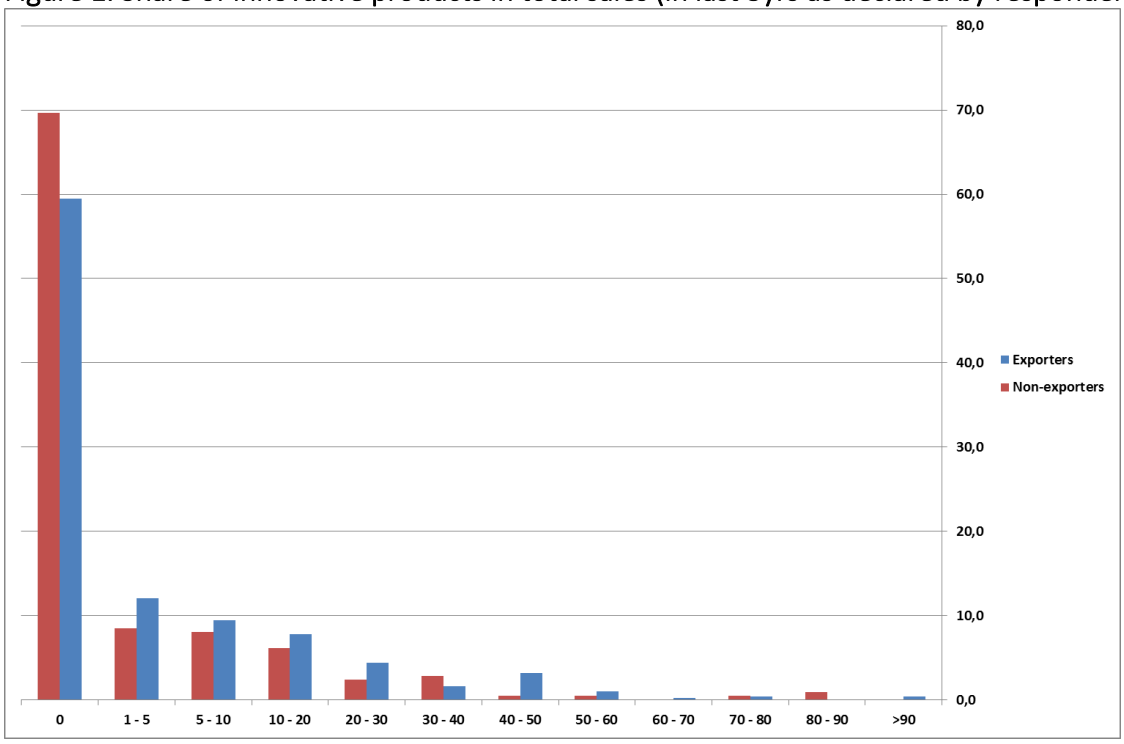
Source: Own elaboration, based on survey results.

Table 8. Average properties of companies in our sample

	Exporters (X)		Non-exporters (NX)	
	Non-innovators	Innovators	Non-innovators	Innovators
No of employees	110	161	42	134
Total assets (K)	16100	13335	2506	4055
Total sales	76858	64411	17103	18533
Value added	36140	25911	6581	7403
Value added per worker	939	412	1059	184
Unit labour costs	141	59	52	53
Average wage	115	48	43	45
K/L	585	125	80	67
Capital productivity	47	137	48	49
Labour productivity	2661	735	1351	485
Total productivity	75	78	43	45
Year established	1992	1994	1992	1996
ROA	0,06	0,07	0,04	-0,06
Current liquidity	9,8	3,5	4,3	4,1

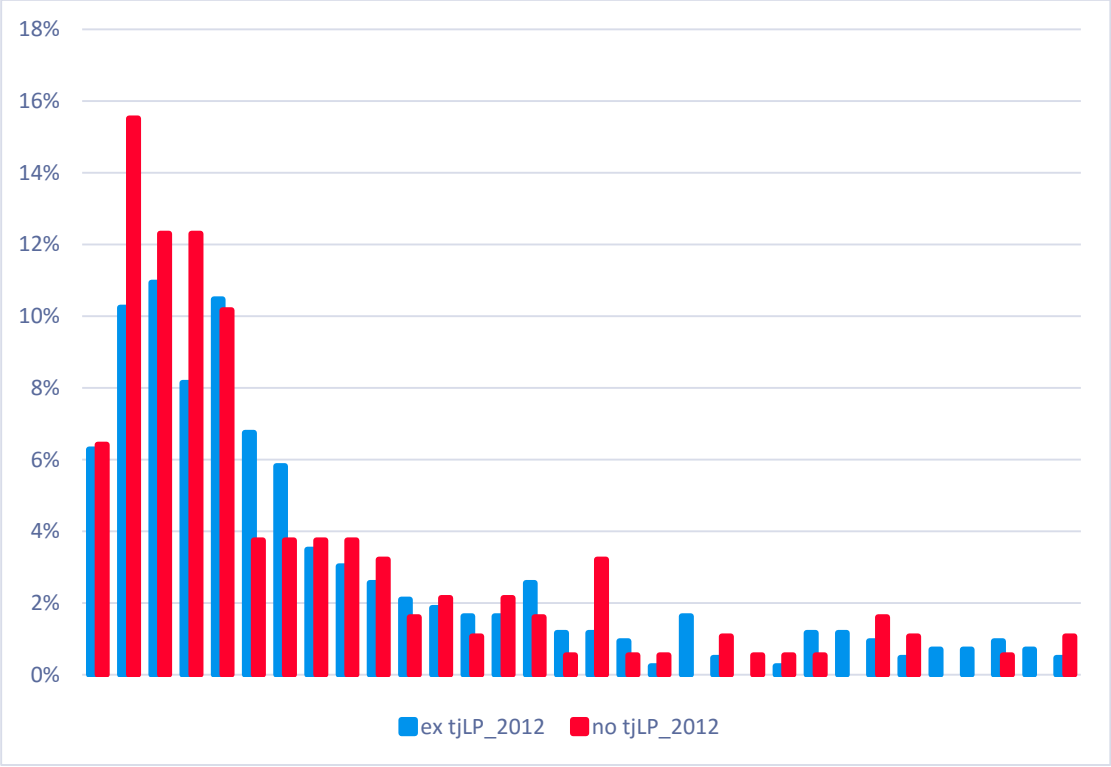
Source: Own elaboration, based on survey results.

Figure 1. Share of innovative products in total sales (in last 3yrs as declared by respondents)



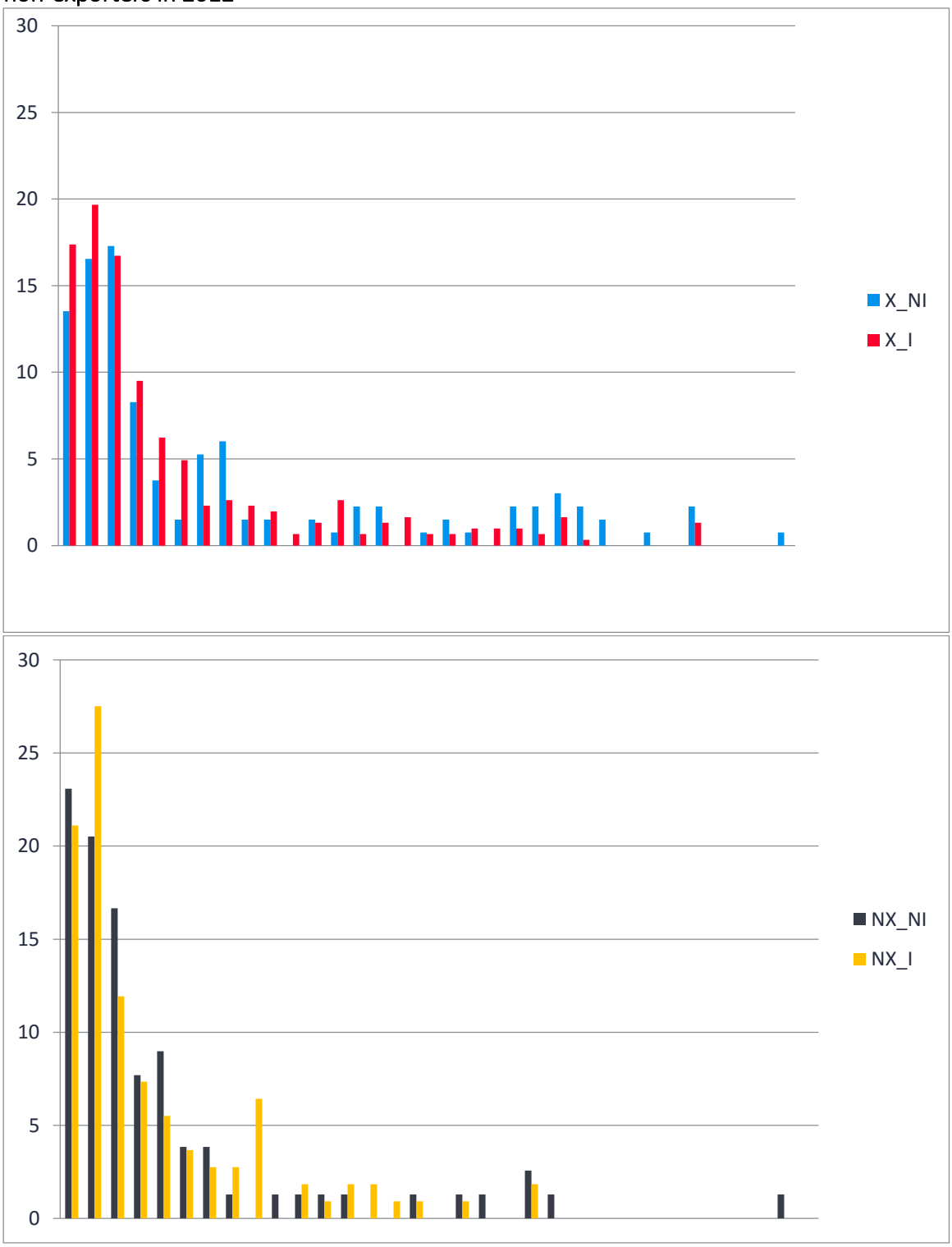
Source: Own elaboration, based on survey results.

Figure 2: Distribution of labour productivity (LP) – exporters vs. non-exporters in 2012



Source: Own elaboration, based on InfoCredit database.

Figure 3: Distribution of labour productivity (LP) for innovating and non-innovating exporters vs. non-exporters in 2012



Source: Own elaboration, based on data from InfoCredit for firms in the sample.

PROF. JERZY GOŁUCHOWSKI, DAWID SZARAŃSKI

Alignment of information and communication technologies to the level of maturity of the cluster

Introduction

Clusters are playing more and more crucial part in modern economy. Their main assumption is the sector cooperation of competing companies within precisely defined areas. Clusters have become a platform facilitating initiation and implementation of common actions of companies, R&D units and administration – actions that would not be possible single-handed. Each cluster has its own dynamics and is set in different market environment. However, this does not hinder the identification of development stages of the clusters, which can be reflected in the models of their maturity.

At different stages of maturity the processes of communication between members of the cluster are as different as different the processes of building trust are, sharing knowledge or creating innovations together. The aim of the present article is an attempt to answer the question concerning the way ICT can support the communication of clusters being in different stages of development. The authors by analyzing models of maturity of the clusters point out to examples of useful ICT tools which can be helpful for the management of the networks.

Cluster as a platform for network cooperation

Network approach, as a new concept of cooperation between economic entities, was created at the end of 1970s, as a result of technological changes taking place on the business market (Business-to-Business, B2B) and increased international competitiveness (Ratajczak-Mrozek 2009: 75). The influence of dynamic growth of information-communication technologies has also been significant. Access to a potential client, as well as information about them, have become easier.

The value of networked enterprises increases with the number of included enterprises, which increases the number of communications influencing the quality of the decisions made by the users of the network, the performances of the network and the cluster as a whole (Arsovski 2013: 107). The crucial issue in the network approach is the meaning of the contacts the companies have with the environment – hence creating wide and complex relations, as well as expanded network of connections (Ratajczak-Mrozek 2009: 75). The phenomenon of clusters is an example of such an approach, but also very characteristic.

Although there are disputes as to the terminology itself, a cluster is usually defined as a geographic concentrations of interconnected companies, specialized suppliers, service providers, firms in related industries, and associated institutions (for example universities,

standards agencies, and trade associations) in particular fields that compete but also co-operate)[9].

Clusters are created in various sectors, i.e. in the technologically advanced (e.g. ICT, biotechnology, aviation), the traditional industrial (e.g. motorization, construction) and the services (e.g. tourism) ones. An effectively functioning cluster increases the productivity of local companies, stimulates and supports their innovation as well as contributes to creating new workplaces, increasing the number of new companies (Brodzicki, Szultka 2002: 11). The participants, as competitors, fight for clients in their specialized fields of activity. Nevertheless, they are yet capable of exchanging experiences, having in mind the benefits coming out of that exchange. The cooperation creates the effect of "accelerated catching up" with the highest standards (Rosińska-Bukowska 2012: 59).

In the case of clusters an important role is played by the phenomenon of triple helix, meaning cooperation of partners from different sectors like business, science and administration. In practice, the cooperation involves also social partners (e.g. professional associations), financial institutions (e.g. investment funds), business support institutions (e.g. technological parks) or media creating the reputation of the cluster. The cooperation would not be possible without social capital. Social capital is understood roughly as the goodwill that is engendered by the fabric of social relations in which an individual is embedded, and which can be mobilized to facilitate action (Steinfield, Scupola, López-Nicolás 2010: 1157).

The essence of a cluster is the cooperation of entities with different potentials, size and sector origin (like business, R&D, administration, media). The key matter is acquiring a suitable formula for managing the network of cooperation, which influences the subsequent activity of the cluster. It is worth mentioning that there is no universal legal and structural form, as various models reflecting specific relationships appear.

Taking into consideration the reality clusters function in, the most frequent situation in Poland is that nonprofit organizations (e.g. associations, foundations) are established. Their aim is to coordinate actions of the network. Another legal form of organizing clusters is establishing commercial law capital companies (like a limited liability company or a joint-stock company). Other formula based on partner cooperation of companies are also followed (e.g. partnership, joint-venture, consortium). Such a contract does not create a separate legal body, but gives the sense of safety and community within the structure of internal bodies and all the partners have an objective influence (Koszarek 2011: 109). The forms of organization presented above influence the working organization of clusters, their communication and shaping the existing internal processes.

Actions initiated within the framework of clusters need to be characterized by the added value for their participants. The clustering of economic activity is a well-known phenomenon, usually explained by the benefits that proximity gives to the firms and consumers by reducing many different types of transaction costs (Steinfield, Scupola 2008: 320). The cooperation

[9] *A Practical Guide to Cluster Development,* A Report to the Department of Trade and Industry and the English RDAs by Ecotec Research & Consulting, London 2004, p.7

between the members of a cluster is usually concentrated around fields clearly defined and playing a key role for the participants. An issue worth mentioning is cooperation in respect to R&D, production, logistics, lobbing or marketing and sale. The fields of cooperation result from specific activity of a given cluster including its sector belonging, the situation on the market or needs diagnosed by the members of the cluster.

It should be added that any common action can be undertaken only when the participants of the cluster have trust in each other. The trust means belief of all the members that all the actions are based on good will and commonly respected social norms (that is legal and ethical; Góra 2008: 4). As far as clusters are concerned, trust is the bonder of the organization. It also makes the integration easier. It favors the increase of productivity, though does not guarantee it. On the other hand, an increase in productivity can increase the trust.

Processes and the flow of information, knowledge and communication in a cluster

The necessary condition for common implementation of processes (and for functioning of the cluster initiative) is the subjective sense of gaining tangible benefits from functioning in the cooperative structure and the trust of partners (Dobrzyński, Dziekoński, Jurczuk 2013: 78). It is the key element both in the stage of initiating the cluster and its further development. The process of clustering as a process of social capital management is also a learning process helping to develop organizational knowledge in a cluster. The aim of this process is to solve strategic problems related to shared goals (Stachowicz, Bojar 2007: 2). The feature of mature cluster initiatives are clearly defined by commonly implemented processes, which, through the synergy effect, determine the strength of the cluster resulting in increased pro-client orientation and productivity, better coordination of the participants' actions and more flexible reaction to market conditions (Dobrzyński, Dziekoński, Jurczuk 2013: 79). Business processes are understood here as orderly sets of productive or service actions performed in a defined period of time and as a result bringing benefits to the external or internal client (Kania 2012: 16). In the case of clusters having a defined organizational form and being in different stages of development, the implementation of the processes is slightly different. It should be stressed that the variety of business processes makes it possible to classify them according to various criteria – such as range, level of automation, adding value, the range of applied knowledge, level of formalization, ways of constructing and many others (Kania 2012: 19).

The key advantage for entities gathered in a cluster is, above all, the access to information, which would not be possible when acting outside the network of cooperation. Thanks to the fact a cluster is able to function as an effective system, coping well in the dynamically changing environment. As a result of the exchange of information between members of the cluster, knowledge is created. This knowledge becomes a strategic resource of the cluster, often having crucial influence on the entities acting in the cluster (like access to information concerning market trends or potential clients). The members of the cluster, sharing their individual knowledge, generate collective knowledge transforming the cluster into a learning and constantly developing organization. It derives both from the inner resources generated by members and from the outer ones, gathered from the environment of the cluster. It has a special significance within the context of the needs of the cluster as well as of the tasks performed by it. An indispensable factor is efficient management of the generated knowledge,

which is to strengthen the potentials of the cluster members and to build their market competitiveness. The process of creating and managing the knowledge is different in various development stages of clusters.

Supporting processes implemented in clusters using information-communication technologies

Information-communication technologies have become more and more crucial factor in achieving success in the processes carried out in organizations. The situation is similar in clusters. They can be treated as partially virtual organizations. This approach has been also discussed in the guide of the Polish Agency for Enterprise Development (Frankowska 2012: 159).

The possibility to use ICT in clusters would not be feasible if there was not better and easier access to Internet (both fixed-line and mobile). Internet technologies, especially those available in the cloud, made it much easier to connect the whole infrastructure and IT integration, which created new possibilities for development. Applying ICT in clusters brings many advantages, such as:

- Supporting innovative processes,
- Strengthening relations between companies operating within a cluster, as well as their outside partners (e.g. B2B technologies, Extranet),
- Creating new possibilities for companies acting within a cluster for networking with entities operating outside the cluster (e.g. B2B technologies),
- Breaking all boundaries for companies in respect to reaching the market (e.g. Internet websites)
- Managing relations with end-clients (Carbonara 2005: 214).

However, the choice of ICT is not a goal in itself. It complements the correctly designed management of the processes of the cluster. In case they are not ordered, even the best IT system will only be supporting incorrectly designed structure of the processes. According to Kania, in the process approach ICT, from being a set of tools associated with simple automation, becomes an integral part of the strategy of increasing the effectiveness (Kania 2012: 78).

IT solutions support all the areas, starting with documenting events and finishing with forecasting and strategic planning. The systems usually have a module structure and allow for adjustment to the requirements of the organization (Sasak, Kożuch 2011: 120). Among available tools highly influencing the abilities to aid business processes are fairly new suggestions, not used frequently, such as:

- New concepts for data management (MDM, ECMS),
- Systems for managing business processes,
- Technologies connected with process analysis (stores for process data, tools: Process Data Mining, business Intelligence 2.0),
- Web 2.0 technologies and social applications,
- Semantic applications (Kania 2012: 243).

Shortage in using IT tools supporting processes of an organization tends to have a negative influence on its further development. The effectiveness of the process decreases and as a result the competitiveness of the entity becomes limited.

Models of process maturity in an organization

The analysis of processes taking place in cluster organizations seems to be quite important from the point of view of its market competitiveness. The crucial / vital issue is knowing to what extent the given cluster controls the processes occurring inside it.

The main goal of actions undertaken with regards to managing the processes is to increase effectiveness of the cluster through standards for the actions being performed, observing them and subsequently improving. The models of process maturity are helpful in this respect. Generally, they allow for specifying the level of thinking and process acting of the organization and where it can arrive moving to a higher degree of its maturity. The fundamental idea of the maturity models is the ability to evaluate processes occurring in an organization, or its chosen area, on five subsequent levels of maturity (Brajer-Marczak 2012: 516). In the opinion of Grajewski, models can be divided into several levels with their specific features:

- Level 1: Initial chaos – unpredictability (temporary modifications of the processes), high dependence on individual abilities of employees.
- Level 2: Experienced repetition – practice and experimenting in order to search for abilities to repeat actions within the framework of the processes.
- Level 3: Standardization – designing within the framework of the processes is standardized, stable and repeatable.
- Level 4: Managing the processes – applying the measurements of the process effectiveness.
- Level 5: Constant improvement – constant improvement and optimization of the processes (Grajewski 2007: 120-121).

Organization wanting to perform individual evaluation of the maturity level process can use one of the already existing models (e.g. Capability Maturity Model CMM, Business Process Maturity Model BPMM). Another possibility is applying an authorial maturity model.

Model of alignment ICT to the level of maturity of the cluster

Both British experience as far as development of clusters is concerned[10] and the benchmark survey (Hołub 2012: 30) carried out in 2012 by the Polish Agency for Enterprise Development show some basic stages of the life of clusters, including the embryonal stage, stability, maturity and declining ones. Based on that, three main life stages of a cluster are most often mentioned:

- Stage I – embryonal, which is the beginning period of the functioning of a cluster. Some entities begin their cooperation in the basic sector, around which the cooperating links are organized, following mutual goals at the same time. At this stage the most important issue is to build the trust which enables the participants to be open and willing to share basic information with their competitors.

[10] *A Practical Guide to Cluster Development,* A Report to the Department of Trade and Industry and the English RDAs by Ecotec Research & Consulting, London 2004, p.11

- Stage II – growth/maturity, is a period with a lot of entities being members of the cluster and its connections with the environment are strong. Within the cluster new entities emerge (spin offs) and entities already functioning unite and transform. Members of the cluster trust each other and share knowledge (open and hidden) and carry out mutual projects.
- Stage III – decline/transformation, is the period when the entities become less interested in the functioning of the cluster, ties between the participants loosen up and the competitiveness decreases. This is mainly the effect of aging of the sector around which the cluster was organized (Hołub 2012: 30). The process of exchanging knowledge and information gradually disappears.

Taking into consideration those various stages, the models of activity of clusters, the forms of their organization and their unique features – reaching the highest level of maturity is difficult. This thesis is confirmed, among others, by surveys carried out by Dziekoński and Jurczuk in 90 companies gathered within the frameworks of *Podlaski Klaster Obróbki Metalu* (metalworking cluster) and *Klaster Piekarniczy* (bakers' cluster), using the maturity model Capability Maturity Model (CMM; Grela 2013: 171). The carried out audit process showed that 58% of the tested companies are inside the initial level connected with implementing the process approach. About 37% of the companies were facing the level of repetition of the processes, while the maturity process of 5% of the tested organizations was defined as "level 0" (Grela 2013: 171). What is worth noticing is that 77% of the tested companies were coming from the production sector. As a rule, it forces their participants to take better care of thought-out and quality management. In the case of clusters functioning in other sectors (e.g. creative industries) the percentage of entities applying the process approach will probably be considerably lower. However, an opposite situation can take place in highly technological sectors (ICT, pharmacy, airport services) which are characterized by pro-quality approach.

The analysis of processes can be carried out in groups being in various stages of growth or, in other words, various levels of the cluster's maturity. It seems that only during the stage of growth or maturity do clusters perform their actions in an orderly way, which leads to creating new products being the result of common initiatives. They also implement their own patents and innovations, successfully attract new investments to their region and operate on foreign markets (Piotrowski 2014: 5). The analysis of the processes in clusters may not lead to achieving the highest level of maturity, but can still be an effective method of improving their functioning.

In the view of implementing the maturity models, the key issue is a thought-of strategy for applying models supported by ICT. It should be stressed that the process approach ideas fell on fertile ground and appeared at the same time as the intense IT development, supported by the newly created Internet technologies (Kania 2012: 40).

When matching ICT with the needs of a cluster it is essential to take into consideration the level of maturity of the cluster, especially the maturity of processes in a cluster treated as a virtual organization. Companies operating on the market usually make use of authorial technological solutions and their integration within cluster can be impossible, therefore it is advised to use the commonly available and popular technologies presented below. A list of exemplary tools aligned to the level of maturity of the cluster is presented in Table 1.

Table 1. A list of IT tools to be used in a cluster, according to its phase of development

Stage of development of a cluster /level of maturity of the cluster	Exemplary area of implementing the technology	Selected tools improving the management
The embryo phase Level 1: initial chaos	Communication among participants	Skype, Hangouts, Facebook,
	Marketing of the cluster	Wordpress, Tumbr, YouTube, Facebook, Flickr
	Building relations and attracting new members	LinkedIn, Google Groups, Ning
The growth phase Level 2: repetition	Common decision taking	Loomio, Thumb,
	Managing common actions	Asana, Trello, Planio
	Virtual cooperation and integration of resources	Google docs, Dropbox, Evernote, Slack
	Obtaining, processing and sharing data	Zoho CRM, Microsoft Dynamics, QuickBase, Survey Monkey
The maturity phase Level 3: standardization	Managing processes of creating innovations	Intuit Brainstorm, Mindomo, Idea Scale
	Project management	Microsoft Project, Basecamp
	Advocacy	Piktochart, Slideshare, YouTube,
The decline phase Level 4: managing the processes	??	??

While choosing ICT for a cluster being on the lowest (first) level of development, the basic problem is communication carried out on a rather low level of trust. At this stage the cluster participants need tools which will support and enhance communication among them. The suggestion to use popular tools for tele-conferences (e.g. Skype) seems to be justified. Development of communication among members of the cooperating network can also be performed while using networking platforms (e.g. LinkedIn, Ning or Google Groups). Clusters being in the embryo phase of development also have defined promotional needs. That is why using blog platforms (e.g. Tumbr), tools for creating and administering websites (e.g. Wordpress) or improving communication with the environment is suggested.

On the second level of maturity the cluster undertakes specified actions, hence supporting effective communication between participants carrying out various ventures is essential. Making the cooperation easier through tools for working in a group (e.g. Asana, Trello) and virtual collaboration (e.g. Google Docs, Dropbox) seems to be indispensable. What can also be useful are the technologies facilitating obtaining, processing and sharing data (e.g.

Zoho CRM, Quickbase, Microsoft Dynamics, SurveyMonkey) as well as tools accelerating the decision making process (e.g. Loomio, Thumb).

On the next level of maturity the cluster implements projects and concentrates on creating innovative products. The need to design a communication process enabling effective work on advanced projects arises. In this context, additional tools enabling remote and collective work on new ideas (e.g. Intuit Brainstorm, Idea Scale) can be helpful for the cluster management. It is also suggested in order to implement more advanced technologies supporting the processes being carried out. Basecamp can facilitate managing large projects, while IBM Collaboration Solutions will improve the flow of information. Cluster which creates innovative products has to educate future clients and prepare the market for its offered innovations. The necessary promotion can be supported by tools like YouTube, Slideshare or systems for webinars and e-learning.

Challenging can be the attempt to suggest technologies supporting communication during the last phase of development of the clusters (the decline phase) when participants limit their activity in the network. Here the technologies should help them to keep in touch and delay the moment of ending the activity of the cluster.

Implementing technologies regardless of the development stage of the cluster should lead to technological integration of its members and automation of activities performed together. The subsequent step can be the integration of the outer processes followed by their analysis. In the case of a single company such a path of action seems to be rather obvious and comparatively easy to implement. However, taking into consideration complex structure of a cluster (large number of members, various IT solutions used) integration of technologies becomes a challenge. Therefore the starting point for any implementation is to obtain the consent of members of the cluster as far as the use of a given IT tool is concerned. Only after successful implementation it is possible to go on to the automation of common processes.

Conclusion

Information and communication technologies support management processes both in single companies and in a whole group of entities gathered in clusters, treated as virtual organizations. In the clusters the choice of technologies should result from their actual needs. It can be connected with maturity levels of the organizations. Their long-term theoretical and practical experience in creating maturity models can also be used. The stage of development of the cluster (its maturity) is of crucial importance as it defines areas where technology can be applied (e.g. virtual cooperation, communication, decision taking). Due to making use of the maturity models, the organization has the chance to increase its effectiveness through ordering and constant improving processes, including internal and external communication.

The presented concept of improving communication through adjusting IT technologies to the maturity of the cluster is an introductory concept and requires verification. In this article, illustrating adjusting ICT to the level of maturity specified IT tools have been used. However, generalization is also advisable – instead of specified tools, respective classes of tools can be referred to. The intention of the Authors is checking the suggested theoretical model in Polish clusters.

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Prospects for the Development of the Mobile Market: The Increasing Importance of Mobile Marketing

Introduction

The starting point for this paper was the concept of sustainability. What inspired me to reflect upon modern marketing was the work done by Irena Krystyna Hejduk and Wiesław Maria Grudzewski (2014), whose field of interest is the sustainable development of business. Sustainable enterprises keep developing and adapting to the market, hence enabling themselves to operate even under uncertain and difficult circumstances. Research carried out by the IBM Institute for Business Value suggests that a modern approach to marketing is one of the key features of sustainable enterprises (Grudzewski; Hejduk 2014: 12). As a senior marketing manager working in online advertising, I see firsthand the potential that mobile marketing offers.

Louis Gerstner, former chairman of IBM, said that "every now and then, a technology comes along that is so profound, so powerful, so universal, that its impact will change everything. It will transform every institution in the world. It will create winners and losers" (Doyle 2008: 325). According to Andrzej Sznajder, the development of the Internet was one of the most spectacular phenomena of the 1990s (Sznajder 2000: 9). Włodzimierz Szpringer, talking about the advent of the Internet era, mentions even a transition from the Old Economy to the New Economy, which implies the need for a new understanding of the market (Szpringer, 2008: 31). In 2014, 93% of Polish companies had access to the Internet and 65% had their own websites (GUS, 2014). Of course, the Internet offers opportunities not only for producers but also consumers. According to Barbara Dobiegała-Korona and Tymoteusz Doligalski (2004: 29) the Internet makes it easier to disseminate information about a brand. It offers interactivity and the ability to quickly and flexibly update information. It also enables consumers to compare products and conveniently purchase them, as well as personalization, cost savings, integration, trust, and entertainment.

As early as the 1980s, Alvin Toffler used the term "prosumer" in the context of social changes to describe a person who has the qualities of a producer and a consumer (Toffler 2006). Today, this idea is being further developed, for example by means of Value Based Marketing (Doyle 2008). The assumption is that a company not only creates a product in itself, but also specific values for the consumer. For instance, a value generated thanks to the Internet is the convenience of online shopping. My market research focuses on consumers and their perception of the usefulness of mobile technology in everyday life. With this article I invite representatives of science and the advertising industry to a broader discourse on the role of new technologies in modern marketing.

The global and Polish mobile advertising markets

According to eMarketer.com experts, 2016 will be a turning point for mobile ads – outlays on mobile advertising are expected to exceed 50% of the total expenditure on online advertising (eMarketer 2015). The experts believe that by 2019 the online piece of the advertising pie will surpass 70%. Calculations done by ZenithOptimedia reveal that in 2014 expenditure on mobile ads reached USD 27.4 billion globally, accounting for 22.1% of the total outlays on online advertising and 5% of advertising expenditure (ZenithOptimedia 2015). In Poland, an adEx report – prepared by IAB Poland in collaboration with PwC – showed that in 2014 mobile ads had a share of 5.4% and that during that year the dynamics of expenditure growth reached 122%, which is very close to the global average growth level (IAB Poland 2015).

Table 1. Mobile Internet Ad Spending Worldwide 2013 - 2019.

	2013	2014	2015	2016	2017	2018	2019
Mobile Internet ad spending (billions)	$19.2	$42.63	$68.69	$101.37	$133.74	$166.63	$195.55
% change	117.9%	122.1%	61.1%	47.6%	31.9%	24.6%	17.4%
% of digital ad spending	16%	29.4%	40.2%	51.15%	59.4%	65.9%	70.1%
% of total media ad spending	3.7%	7.8%	11.9%	16.5%	20.5%	24.1%	26.8%

Source: eMarketer.com, *Mobile Ad Spend to Top $100 Billion Worldwide in 2016, 51% of Digital Market,* April 2015<http://www.emarketer.com/Article/Mobile-Ad-Spend-Top-100-Billion-Worldwide-2016-51-of-Digital-Market/1012299> viewed 27 May 2015.

Table 2. Mobile Internet Ad Spending in Poland (PLN) 2012 - 2014.

	2012	2013	2014
Internet ad spending (billions)	2,2	2,432	2,6
Mobile Internet ad spending (billions)	0,0132	0,027	0,140
% of change in Mobile Internet ad spending (year/year)	+132%	+106%	+122%
% of shares in total digital ad spending	0,6%	1,1%	5,4%

Source: IAB Poland and PwC, *AdEx*, 2013-2015. <iabpoland.pl> viewed 27 May 2015.

The results recorded by the mobile ad industry suggest this market has big development potential, thanks to three key factors: high penetration of mobile telephony in the world, decreasing prices of mobile services and devices, and the development of new functionalities

and a highly intuitive interface of mobile devices. Last year in Poland, the number of active SIM cards increased by 1 million to reach a total of 57.6 million at the end of December 2014 (Central Statistical Office 2015). This means that the penetration of mobile telephony in a nation of 38.5 million people amounts to 149.6%.

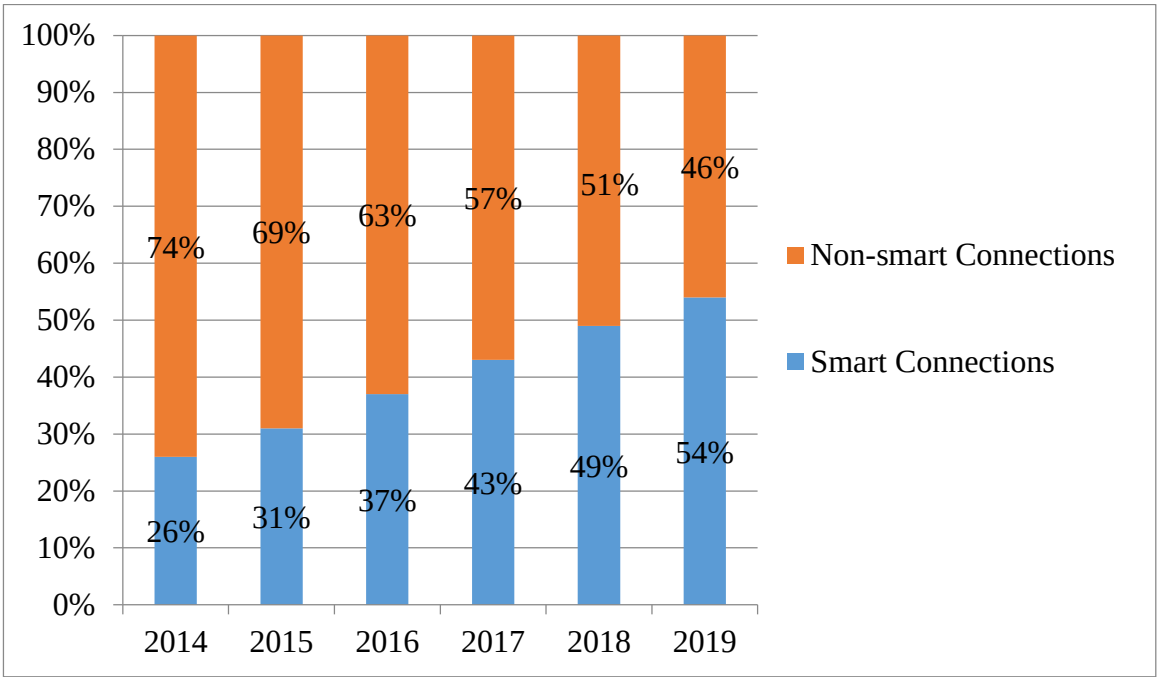
The "IAB Poland Mobile 2014" study revealed that 69% of Internet users already have a smartphone. The popularity of phablets—devices that bring together the functionality of a smartphone with a tablet with a 5.5 x 6.9 inch screen—is also growing. According to Jupiter Research analysts (2015), in 2018 phablets will represent a quarter of the smartphone market globally. Apple has great hopes for phablets and has launched its new model iPhone 6 Plus. The benefit for users of that and other mobile devices is the price of the mobile web connection. The Polish Office of Electronic Communications estimates that users pay on average between PLN 0.66 and 2.60 for 1GB of data in a package exceeding 30GB (Electronic Communications Office, 2014).

Globalization has helped bring down telecommunication barriers around the world. Mobile technologies are developing dynamically, which results in mobile products having a shorter life cycle. Globally, communication is growing cheaper, more efficient, and richer in new functionalities. The foundation for these developments is the Internet, and in particular the process of digitisation. According to the recent "We Are Social" report, there are 3.010 billion Internet users and 3.649 billion mobile users (penetration: 51%). Users browse the Web primarily on desktop PCs and laptops (62%), but 31% of the respondents surf using a phone and 7% a tablet. The study reveals that on average Poles spend daily 1 hour 49 minutes online connected via their mobile phones.

As the "IAB Poland Mobile 2014" study confirmed, the main advantage of mobile devices is the applications they offer. One respondent in three uses apps when connecting to the Web via a smartphone. The key functions for smartphone users involve navigation, music and email apps. In 2014, roughly 179 billion apps were downloaded. Social media apps also enjoy large popularity – the number of Facebook users logging in by means of mobile devices grew in 2014 from 296 million to 526 million. 745 million people use Facebook on their mobile devices every day (Facebook 2015).

In 2015, CISCO experts estimated that the share of mobile devices in overall Internet connections has been growing systematically. In 2019, the participation of mobile devices in online traffic should exceed 50%. As the Gemius Traffic report shows, in the second quarter of 2015 in Poland 14.8% of online traffic was generated by non-desktop devices, while in 2013 it was 8% (CISCO 2015).

Figure 1. Global Growth of Smart Mobile Connections



Source: CISCO, *Global Mobile Data Traffic Forecast Update 2014–2019*, February 2015 <http://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/white_paper_c11-520862.html> viewed 27 May 2015.

Characteristics of mobile marketing

Philip Kotler and Kevin Keller see the growing role of mobile marketing and perceive new technologies in a positive way (2012: 13). Referring to M. E. Porter's concept of five forces, A. Sznajder analyzed the impact of mobile technologies on the competitive position of a business. In his opinion, the power of buyers and consumers is growing, the notion of substitution is being extended, competition and cooperation have become more intense, and barriers to entry are going down (Sznajder, 2014 : 64). So mobile technology affects all of the five market forces. According to C. Krum (cited in Sznajder, 2014: 68), mobile marketing encompasses mobile advertising, SMS and MMS, location-based marketing, application-based marketing, WWW search engines on mobile devices, traditional marketing on TV, in the printed press, on the radio, and online promotion.

Table 3. Technologies commonly used for mobile marketing

SMS marketing
Mass dispatch of visual MMS messages and VMS (voicemailing)
QR codes and NFC technology
Geolocation and mobile navigation
Marketing based on mobile apps, creating mobile versions of websites (for instances in the RWD technology)
Wearable devices

Source: Based on Marketingmobilny.pl, <http://marketingmobilny.pl/co-to-jest/> viewed 14 May 2015 and the author's own analysis.

Mobile advertising comes in a number of forms: display ads, applications, mobile websites, rich media ads, native ads, video ads, mobile email-based marketing, mobile SEO/SEM, and advergaming. The code of good practices of mobile advertising, which was created by the Polish mobile operators, defines mobile ads as ones "that can be received by means of portable electronic devices such as a mobile phone, tablet, palmtop, navigation and other devices that have a wireless connection to the Internet." The Mobile Marketing Association, on the other hand, defines mobile marketing as a "(...) set of practices that enable organizations to communicate and engage with their audience in an interactive and relevant manner through and with any mobile device" (MMA 2009). Mobile advertising can be divided into *push* messages and *pull* messages. Push advertising pushes messages, via sms, mms or wap-push, without the user's involvement. Pull advertising requires the user's engagement – by either going on a product's website or installing an app.

A study carried out in 2013 by A. Stephen, Y. Bart and M. Sarvary (2013) proves that the efficiency of a mobile campaign depends on the category of product being advertised. The study involved 36,000 American consumers, to whom mobile ads for products from 13 categories were shown. The following categories, defined by the qualities of the products, were distinguished:

Table 4. Product categories with example products

High involvement	Sports car Designer clothing Jewellery	Life insurance Furniture Gym membership Brokerage service
Low involvement	Cup of coffee Movie ticket Candy Beer	Toothpaste Basic groceries Socks Smartphone case
	Hedonic	Utilitarian

Source: A. Stephen, Y. Bart, M. Sarvary, *Making Mobile Ads That Work*, HBR, December 2013, p. 32.

The results of the study unambiguously indicate that the influence of mobile advertising on the willingness to buy and on the positive attitude towards the product occurred only in the case of utilitarian and high involvement products. The ad increased the positive attitude by 4.5% and the willingness to buy by 6.7%. The results of a study I co-authored, *E-Consumers: Consumer Journey Online*, which was conducted by IAB Poland among 11,000 Internet users suggest, however, that consumer behaviour differs depending on the category to which the product belongs. The biggest conversion rate among Internet users was achieved in the software, motor and house appliance categories.

Mobile marketing means new opportunities for consumers and business. Table 5 shows some of the opportunities offered by mobile solutions in promotion.

Table 5. Benefits attributable to mobile marketing promotion

For individual buyers	For business
– Quick access to information about the product – Products and offers can be quickly compared – Products can be bought from any place at any time – Dedicated, active discount vouchers can be acquired – Access to information about the product's availability and current location – Access to offers in real time	– Practically constant access to the consumer – Constant communication with the consumer is possible – Innovative technologies making the message attractive and interactive – New offers can be quickly introduced – Personalized offers can be created based on analysis of the customer's preferences – Marketing communication can be diversified according to particular consumer groups – Introducing loyalty schemes whose results can be tracked in real time, so changes to offers can be made accordingly – Current monitoring of the results of advertising activities – Quick reaction to crisis situations – Support of other advertising media, taking into account relatively lower costs of mobile advertising – Using wearable devices

Source: The author's own analysis and A. Sznajder, *Technologie mobilne w marketing (mobile technology in marketing)*, 2014, p. 134.

To sum up, the advantages can be grouped in eight key categories, i.e.: time savings, interactivity, ease of control, automation, availability, personalization, cost optimization, and measurable results. When activities are assessed, the system responsible for displaying the ads delivers statistics in real time. Depending on the provider chosen by the company, it can be an online advertising network with an AdServer or solutions offered by automatic networks, such as Google. Statistics are collected based on tracking codes embedded in websites and applications.

Apps can involve creative solutions, as they often bring together informative utility and entertainment. Apps can directly or indirectly drive up sales: indirectly by creating an interest in the product or building a positive image of the brand, and directly by leading up to a purchase. Another solution with a high level of interactivity is augmented reality, which brings together elements of the real and the virtual worlds. For instance, the users of SnapShot Showroom can put virtual furniture into their apartment thanks to a connection with the

camera in their mobile phone. This solution can be useful for consumers who are planning to buy something new for their apartment – the app takes into account the real size of the furniture, so the consumer sees a visualization of the proposed arrangement.

Another solution which is used increasingly more often are photocodes or QR codes (Quick Response). The QR code is a two-dimensional matrix barcode created in 1994 by the Japanese company Denso Wave (Sznajder 2014). It can contain a unique business card, an http link, an email address, text or picture. QR code generators are free and available as apps or computer software.

A great advantage of mobile devices over desktop computers is the geolocation option, which can be used to track the changing location of users and to study their behaviour. According to R. McCourtney (cited in Sznajder 2014: 137), geolocation offers precise targeting that has a psychological impact, the opportunity to develop marketing relationships, a likelihood for strong buying impulse among consumers, efficient marketing activities, and a high return on investment. An example of geo-location is beacon technology, which assigns digital information to real-life objects. This technology was used by Nivea in a campaign addressed to mothers going sunbathing with their children. Brazilian magazines featured an ad with a beacon wristband for the child. Thanks to a dedicated app, the user could check where their child was playing and if they were still "on the radar" of the app.

Another item specific for mobile marketing is mobile vouchers, the advantages of which include minimising printing costs, personalization, efficiency measurement, and flexibility at the stage of preparation. For instance, McDonald's uses a free app to offer a voucher that within 20 minutes of activation entitles the user to selected special offers in a McDonald's restaurant.

My own market research

The purpose of a study I conducted in May 2015 was to find out if Internet users use a smartphone during the decision-making and shopping processes. The method used was a CAWI questionnaire. The invitation to participate in the survey was displayed on websites belonging to the Ad!Vice network in the form of a pop-up layer ad. The displayed invitations yielded 520 replies. After the final verification of the surveys, the total number was narrowed down to 494 respondents. The following research questions were asked:

- Do Internet users use a smartphone during the decision-making and shopping processes?
- What is the percentage of conscious smartphone users?
- What device is the most often used to connect to the Internet?
- What factors motivate the choice of app by a smartphone user?

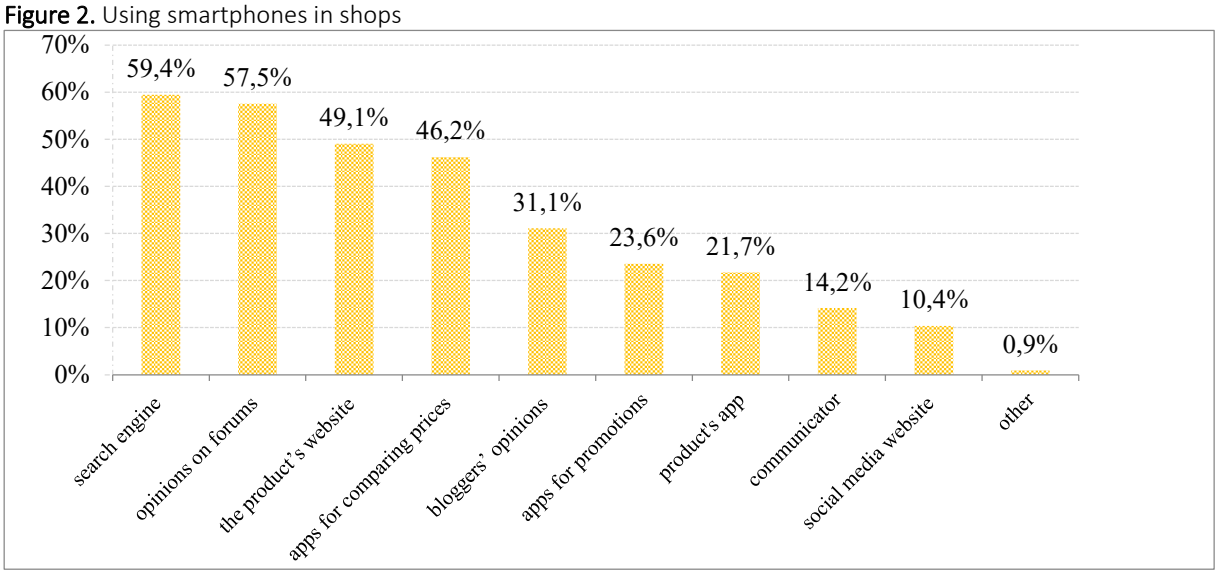
The following research hypothesis was proposed:
Internet users use smartphones to look for information on products.

Among smartphone users, 85% were conscious users, i.e. they were able to identify a smartphone's features. According to an IAB Poland study carried out in 2013, 64% of respondents were conscious users, while in 2014 the figure rose to 76%. The systematically growing number of informed users suggests that smartphones have grown in popularity in Poland and that the level of knowledge about such devices has increased.

When it comes to connecting to the Web, 44% of respondents use portable computer while 27% use desktop computers and 15.6% most often use smartphones.

42% of the surveyed group use apps on their smartphone. The decisive factor for installing an app is its utility (88%). Other important factors were easy to navigate (74.5%), whether it is informative (67.8%) and communication with friends (63%).

Figure 2. Using smartphones in shops



Source: M.Grodner, *Mobile Marketing*, CAWI, May 2015, n=494.

The results of the survey suggest that smartphones are used by Internet users in the decision-making process. 65% of those surveyed check if a product or service has a mobile app and 41% use a smartphone to look up product information when shopping. As figure 2 illustrates, shoppers most frequently enlist the help of: a search engine (59%), opinions on forums (57.5%), the product's website (49%), apps for comparing prices (46%), and bloggers' opinions (31%). Smartphones play the biggest part in the decision-making process in the following industries: household appliances (57%), entertainment (55%), clothing and shoes (47%).

Mobile devices are also used to make purchases: 49% of respondents indicated they had bought a product/service via a smartphone, tablet or phablet. One in three had bought a product or a service through a mobile device during the previous week. The ROPO effect (Research Online Purchase Offline) may also drive conversion higher. A study conducted in 2014 by Gemius S.A. also reveals the popularity of shopping via smartphone: 35% of those surveyed bought something using their smartphone. Those who were sceptical pointed out the following drawbacks to shopping by smartphone: inconvenient forms to fill in, ill-adapted mobile shop sites, too small font sizes, complex shopping process (Wygnański 2014: 46). Briefly, the barriers in smartphone shopping are usually technological. If mobile solutions are developed to make the navigation in a smartphone more user friendly, the number of prospective buyers using mobile devices could go up (see table 6).

Table 6. Factors motivating online purchases (data in percent).

- Availability 24/7 86
- Home delivery 81
- Easy comparison of offers 81
- Prices are more attractive than in brick-and-mortar shops 79
- No need to go to a shop 77
- Easy access to rare products 64
- Wider product range 63
- More information about products 47
- Speed 46
- Access to second-hand or collector's items 45
- Goods can be returned within 10 days without a reason 33
- Loyalty programmes 13

Source: GEMIUS S.A., *E-commerce in Poland 2014. Gemius for e-Commerce Poland,* 2014, < http://www.infomonitor.pl/download/e-commerce-w-polsce-2014.pdf> viewed 24 May 2015.

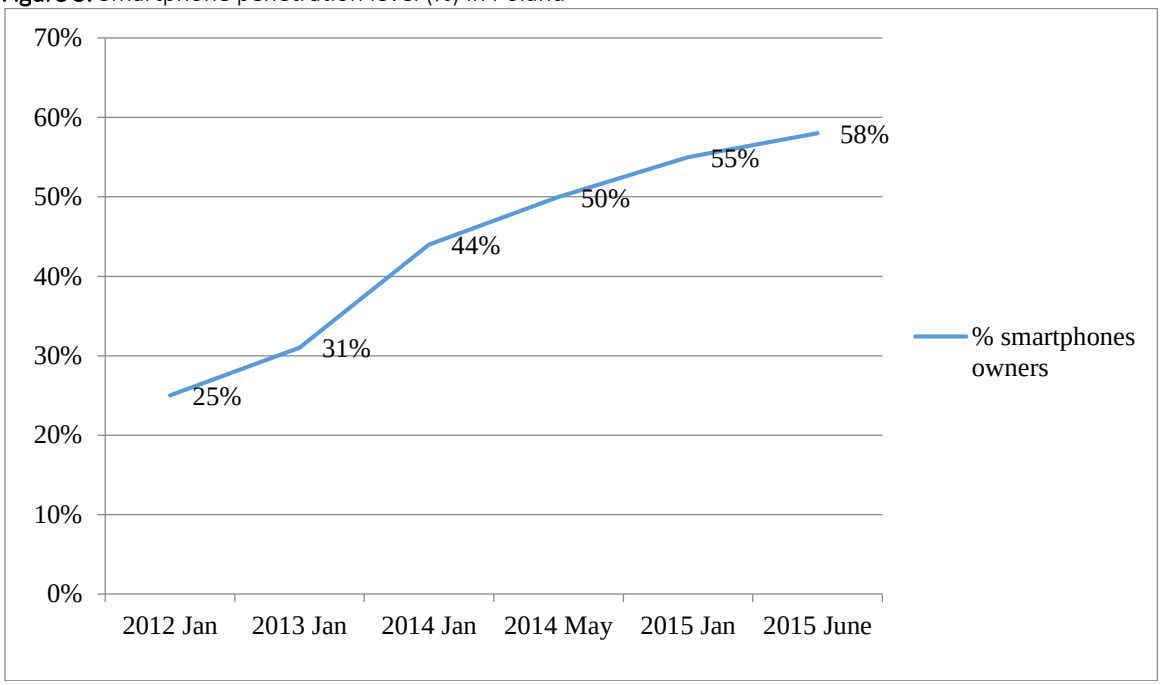
A study conducted in 2013 by Columbia Business School concerns smartphone-assisted shopping. Based on the replies from the participants and their shopping habits, five types of smartphone-assisted consumers were distinguished. The biggest group are the Experience-Seekers, who look for the best experience and are not motivated solely by price. An ad campaign addressed to this group should involve creative solutions, rich media or be focused on interaction. The study confirmed the high potential of mobile solutions in boosting the sales of products (Columbia Business School 2013).

Conclusion

Representatives of the players active on the Polish online advertising market have been asking for years: "Is this THE year for mobile ads?" If we look at the ongoing trend in the West, the expenditure on mobile advertising has been growing dynamically. The results of my study show that smartphones are involved in the consumers' decisions to buy particular products – they constitute a source of information about goods and they can be used to shop. The impact smartphones have on the shopping process was confirmed by the study conducted in 2013 by Columbia Business School[11] and by another study carried out in 2014 by Gemius S.A.

[11]http://www.aimia.com/content/dam/aimiawebsite/CaseStudiesWhitepapersResearch/english/Aimia_MobileAssistedShopper.pdf

Figure 3. Smartphone penetration level (%) in Poland



Source: Research by TNS Poland. May 2015, Mobile Life 2012, N=502; Mobile Life 2013, N=915, Omnibus – regular study carried out twice a month with N=1000, Connected Life 2014, N=979; sample: Poles

In the context of marketing strategy, experts more and more often talk about multiscreening—using many screens at the same time. In 2014, nearly 50% of Internet users said they surfed the Web using several devices at the same time[12]. Smartphones systematically take over the functionalities of desktop devices and people use them at the same time as they watch TV, listen to the radio, read articles online or use a computer. Contemporary marketing should take consumers' habits into account. An advertising campaign for mobile devices organised together with a campaign dedicated to desktop devices can boost efficiency – such solutions offer a better brand experience to the consumer. What is key is a well-thought-out, consistent strategy that takes into consideration the most important media for the target group.

The Mobile World Congress, which was held in 2015 in Barcelona and hosted 93,000 participants, showcased the promising trends on the mobile market: mobile payments, increased mobile device security, digitization, popularising cloud-based solutions, and the growing role of wearable devices and of the Internet of Things in mobile marketing. The table below presents some of the trends in the online advertising industry which are important for the development of the mobile market.

[12] (tvb + www) 4742 people, 2014.

Table 7. Forecasted changes on the mobile market

Description of the phenomenon	Year of the forecast	The forecast	Entity making the prediction
Expenditure on mobile advertising will rise. Mobile advertising will grow highly popular. The presence of brands in the mobile sphere will become a standard element of the marketing strategy.	2017	Global expenditure on mobile advertising will rise to $75 billion from $27.4 billion in 2014, which will account for 40.4% of expenditure on online advertising and 12.7% of the global expenditure on advertising.	ZenithOptimedia Group – a media house active on the global market of advertising services.
The number of smartphones used globally will increase. Thanks to their price, availability and functionalities, mobile devices will start to supplant desktop devices.	2019	A tenfold increase in the global traffic in mobile networks, up to 292 exabytes. 5.2 billion mobile device users (69% of the global population).	Cisco, Visual Networking Index (VNI) Mobile Forecast
Mobile banking will grow more popular.	2019	By 2019, the number of mobile banking users will grow to more than 1.75 billion, accounting for 32% of the global population.	Juniper Research
Wearable devices are becoming increasingly popular in different areas of life. For instance, the Embrace smartwatch can inform user that a person suffering from epilepsy is having a seizure.	2019	The global market of wearable devices is expected to grow up to 45.7 million units sold in 2015 and 126.1 million in 2019.	(IDC) Worldwide Quarterly Wearable Device Tracker
Mobile devices will keep growing more secure. Sample solutions: - Fingerprint sign-in - Iris scan sign-in - Voice-based biometrics	Unknown, near future	Innovative solutions planned for deployment in mobile banking will make it more popular.	Report: Polska.jest.mobi 2015, drawing from the opinions of electronic banking managers in Poland (RAIFFEISEN POLBANK, PKO BANK POLSKI, Eurobank, BGŻ BNP PARIBAS S.A, PKO BANK POLSKI, BANK PEKAO S.A., BZW BK, ING BANK ŚLĄSKI, GETIN NOBLE BANK)

Source: the author's own work based on the opinions of mobile market analysts.

Mobile devices can compete with desktop devices as far as the consumption of video is concerned. Experts from eMarketer.com estimate that the percentage share in the expenditure on video ads will increase (eMarketer 2015b).

Summing up the picture of the mobile market, the opportunities offered by mobile advertising and the study results, I see potential in the mobile market; mobile marketing can help businesses build competitive advantage.

Innovation introduced as new solutions in mobile devices, the potential of the smartphone market as well as the gadget and accessories market will drive the dynamic development of the mobile market, which will reveal new chances and opportunities both for business and end users. From the consumer's point of view, it will involve new experience and new ways of building a relationship with brands. For managers, expertise in mobile solutions might soon become an indispensable requirement skill.

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Towards a political economy of algorithms: high-frequency trading and the efficient market hypothesis.

Algorithms have become an object of research of growing importance in media and technology studies in recent years not only for a theoretical, but also a politically oriented analysis (see e.g. Berry 2011, Goffey, Fuller 2012, Bunz 2014, Pasquinelli 2014). With the rapid expansion of Web 2.0, new forms of internet search and advertisement, Facebook, Google's or Apple's politics of information (Jordan 2015), but also high frequency trading, which constitutes the proper object of this paper, algorithms of information and financial flows govern more and more aspects of our social world. The last book by Frank Pasqualle *The Black Box Society* presents numerous examples of this algorithmic governance and argues that without making these algorithmic mechanisms publicly known and regulated by law we will not avoid a growing instability and dissymmetry of power relations (Pasqualle 2014). Pasqualle's arguments for the "intelligible society" seem nevertheless too weak since what his perspective lacks is the point of view of political economy. This change of perspective from legal and political studies to the one of political economy of algorithms is the aim of this text. The outlines of a political economy of algorithms or a political economy of the Turing machine has been introduced by authors associated with the so-called post-operaism, most notably by Christian Marazzi (1994) and Matteo Pasquinelli (2011). With their innovative use of Marx's notion of "general intellect" (Virno 1992, Vercellone 2007) and the development of the theory of cognitive capitalism (Vercellone 2005, Fumagalli, Lucarelli 2010, Moulier-Boutang 2011), post-operaists were able to give a critical account of the digital revolution beyond the limits of the liberal theories of the "network society" or "knowledge economy". The added value of their theoretical work can be summarized in one argument: the technologically advanced capitalist societies are still permeated by the social struggles and conflicts that arise from the contradictions inherent to capitalism as a mode of production and a regime of accumulation.

The main theoretical problem with critical inquiries into the political economy of high-technology capitalism lies within the role the notions of knowledge and information have played in the development of the neoclassical theory after World War II (Mirowski 2002). Whereas the theory of cognitive capitalism arises from the diagnosis of a fundamental contradiction between the technological and social conditions of knowledge production and distribution on one side and capitalist valorization on the other, the neoclassical theory envisions the market as the best existing processor and distributor of information. With its roots in Hayek's idea of the "marketplace of ideas" (Mirowski 2009: 107), the neoclassical orthodoxy aimed at treating information as a sort of commodity that can be traded at a fair price. In regard to the problem of economics of knowledge, the neoclassical orthodoxy is more a philosophical hypothesis than a strict economic theory: if information can be translated into

exchange value than the market is the best existing processor of information – and capitalism is still the mode of production and a regime of accumulation best fir for the economy based on knowledge and information.

In this paper I would like to *test* one of the most important neoclassical theories describing the role of information in contemporary capitalism by applying it to the problem of the expanding algorithmic automation of capital and information flows. The theory in question is the efficient market hypothesis (EMH), put forward in 1965 by the American economist and Nobel laureate in Economics Eugene Fama. The form of algorithmic automation I intend to test the EMH against is high-frequency trading: a relatively new trend in finance that consists in an automated execution of financial operations in a fraction of a second by privately owned algorithms. My thesis is that this level of contemporary algorithmic automatization is, philosophically speaking, simultaneously a realization and a deconstruction of the theoretical efficiency of financial markets and thus it should be treated as an argument against the neoclassical claim that market (or capitalism in general) is the best existing processor of information – at least not in the context of contemporary technological possibilities of information computation.

The main theoretical core of the EMH was formulated probably best by Paul Krugman: "financial markets price assets precisely at their intrinsic worth given all publicly available information" (Krugman 2008). The hypothesis was put forward against the formerly prevalent schools of thought among investment professionals, that is "technical analysis" and "fundamentals analysis" (MacKenzie 2008: 75) according to which it was possible to determine the future stock prices analyzing either the past fluctuations of those prices or the structure of the company. The revolution in finance theory that took place in the American academia in the 50s and 60s and which led to the formulation of the EMH assumed that the movements of stock prices are random (the so-called "random walk theory") (MacKenzie 2008: 57–66) and that the proper price of the stock is determined by its risk level in relation to the stock market index (what is the basis of the Capital Asset Pricing Model, CAPM) (MacKenzie 2008: 51–54). The EMH was just a next logical step in the ongoing revolution in finance theory. It was no longer the condition of the company (or its past condition) that was supposed to determine the value of the stock (and hence – the company itself), but the market as a whole. Market distributes "efficiently" all the information about the company and hence the price of the stock represents all available information about the given company. In his paper from the year 1970 Fama distinguished three versions of the financial markets efficiency (Fama 1970): a weak, semi-strong and strong one, depending on what kind of information the market distributes – all past information (weak efficiency), past and new (public) information (semi-strong) and past, new and also private information (strong efficiency). Whether the strong efficiency is clearly a kind of a purely metaphysical hypothesis, the semi-strong efficiency is considered to describe the behavior of most developed financial markets. The theoretical conclusion from Fama's model is that there's no possibility to acquire important information about the future price of stocks outside of the market. Any new available information which is being "efficiently" distributed by the market finds its representation in stock prices.

Donald MacKenzie in his detailed history of the contemporary finance theory showed to what extent the theoretical financial models have changed the way financial markets function. Independently from the version of the hypothesis, its main goal was to show that it is impossible

to out-perform the market and that the possibility of arbitrage, i.e. taking advantage of price differences, will disappear shortly after the new information is introduced into the market. The gains from investment are not due some additional, inside knowledge, but from a calculated strategy of investment. The outcome of the theory was a gradual replacement of professional traders with executors of theoretical models, e.g. index funds of market portfolios (MacKenzie 2008: 84). Since the possible return on a given investment is the function of a risk inherent to this investment and the risk is calculable in reference to the overall market index, the efficiency of the market and the investment strategy can be represented by a mathematical model. An entirely new profession arose – market analysts called "Quants" that work mostly with mathematical models and calculate the risk of given investment strategy (Patterson 2011) instead of analyzing the structures of companies issuing stocks. MacKenzie points towards a "Barnesian performativity" of the new finance theory and the EMH in particular (MacKenzie 2008: 252–259) – the view of finance markets inherent to this theoretical work has slowly changed the markets themselves. The theory gave instructions how to build models to describe the behavior of the markets and the application of those models has changed this very behavior. The market efficiency is a self-fulfilling prophecy and the EMH is a theoretical cornerstone of the whole body of finance theory from CAPM to the Black-Scholes model of option pricing.

If information is what is being represented in the assets' price, the EMH poses information as something that can be measured and traded, that is as a commodity form. The problem of a notion of information was a crucial one in the post-war economic theory. Philip Mirowski has showed the importance of cybernetics and information theory for a neoclassical theory in economics after World War II which strived to develop Hayek's intuition that the market is the best possible information processor exceeding in this respect every human agent (Mirowski 2002). The neoclassical theory has developed three major notions of information:

	Shannon	Blackwell	Turing
Information is:	a thing	an inductive index	symbolic computation
Cognition is:	irrelevant	intuitive statistics and epistemic formal logic	symbol manipulation
Learning is:	purchase of a commodity	statistical inference	algorithm augmentation
Communication is:	same as exchange	signaling	information transmission

Table 1 Three Paradigms of Neoclassical "Information"
Source: Mirowski 2009, s. 116.

This prevalent role of the notion of information for the neoclassical theory found its full realization precisely in the EMH: "'Efficiency", a slippery term in the best of circumstances, had come increasingly to connote the proposition that the market could package and convey knowledge on a 'need to know' basis in a manner that could never be matched by any human planner" (Mirowski 2014: 268). The information (knowledge) is thus in this hypothesis

conceived as a form of an exchange value that can be measured and distributed by the market. The economic sphere of information processing is the sphere of circulation, especially the sphere of the circulation of capital in its most dynamic and unbound form, that is financial capital. The EMH was without a doubt a child of its time. On one hand it developed the fundamental intuition of postwar neoclassical economics that market processes are indeed information processes and, on the other hand, it fit perfectly, and in fact propelled the neoliberal counterrevolution of the late 70s and 80s, which was described by Chritian Marazzi in general terms as a shift from investment in the direct process of production towards the extraction of surplus value from sphere of circulation and reproduction (Marazzi 2011: 48).

Let us test this hypothesis. Since the opening of the first electronic stock exchange NASDAQ in 1971, the development of digital technologies in capitalism was strictly linked with the material transformations of financial markets and stock exchanges. The possibility to trade faster, to gain real time access to increasing amount of data, to have one's own electronic account on stock exchange etc. – each of these technological innovations changed the way the stock exchanges function. The latest of these innovations was the introduction of computer trading engines and high-frequency trading. Experts vary in estimating the amount of trades conducted by algorithmic engines, but according to reports from the years 2010 and 2012 they are responsible for around 80 per cent of US stock trades, one third of stock trades in UK and around 40 per cent of stock trades on European stock exchanges[13]. This process can be very profitable – although one transaction conducted by an algorithm looking for an arbitrage possibility can bring less than a cent, one company can sometimes achieve a few billions transactions in a week. The company Spread Networks "spent over $200 million to lay a cable between Chicago and New York-area exchanges, estimating that firms could make $20 billion in a year exploiting price discrepancies (lasting less than a second) between the two cities" (Pasqualle 2014: 131). In high-frequency trading speed is everything and the goal is always to "front run" human agents and other algorithms. An advantage of fraction of a second can sometimes make a huge difference. Another company, Hibernia Networks, announced in 2010 that it plans to join New York and London by a new transatlantic cable, called Project Express, that will save 5.2 milliseconds in communication between the two stock exchanges[14].

The role of algorithms in financial markets was probably best manifested by the recent crises caused by the algorithms of high-frequency trading, a completely new form of financial crises. The most famous was the so-called "flash crash" (Keller 2010). On the 6th May 2010 in less than 30 minutes the Dow Jones Industrial Average index fell by nearly 1000 points (the biggest intraday point of decline in its history), only to recover much of its value just few minutes later. The financial effect consisted of temporarily around 1 trillion dollars in market value disappearing. According to the findings of the Commodity Futures Trading Commission and the Securities and Exchange Commission, the crash was triggered by a sell order of one of the mutual-fund groups through an algorithmic trade, which, together with a general market instability as a result of the economic turmoil in Europe, caused a snowball or better a "hot

[13] Jack Clarck, *Rise of the Machines: How computers took over the stock market*, http://www.theregister.co.uk/2013/06/21/hft_financial_trading_rise_of_the_machines/

[14] Matthew Philips, *High-Speed Trading: My Laser Is Faster Than Your Laser*, http://www.bloomberg.com/bw/articles/2012-04-23/high-speed-trading-my-laser-is-faster-than-your-laser.

potato" effect[15]. With the increase of volume of trades the algorithms that reacted to the initial sales began trading faster, pushing the prices further down. The crunch expanded to equity markets where it also caused a reaction by automatic trade algorithms. The rest is history – although a very short one.

This explanation of the "flash crash" was met with strong criticism, initially expressed by David Leinweber (Leinweber 2011). Whatever other explanation was given to the incident, the role of financial algorithms was obvious – the flash crash was the first financial crisis caused, at least partially, by the high-frequency trade algorithms. And despite some initial security measures were introduced, like e.g. "circuit breakers", they did not help the Knight Capital Group, which used to be the largest trader in U.S. equities. On August 1, 2012 the high-frequency trade algorithm that was supposed to have been deactivated has gone berserk and started executing orders that cost the company 10 million dollars per minute. After 45 minutes and an intervention of a human agent neutralized the code of the algorithm[16]. The incident cost around 440 million dollars and resulted after few days in 75 percent of Knight's equity being erased.

How do high-frequency trading algorithms really work? We could distinguish three kinds of algorithmic operations:

1. The first one consists of algorithms searching for an even minimal arbitrage possibility. If, for example, a stock is listed on two stock exchanges, a program may find a discrepancy in stock prices between those two exchanges and perform an automatic buy and sell operation that would last a moment. The speed is everything in this case – an arbitrage possibility exists only till the first operation.
2. The second kind of operations is based on information search. Algorithms are programmed to search for key words in the net, like e.g. "[company name]", "litigation", "scandal" or "breakthrough innovation" and perform automatically trade operations based on the found information (Pasqualle 2014: 129). Also in this case the winner (the fastest subject of operation) takes it all – after the information is being distributed ("efficiently") in the market it stops being a key factor in price determination.
3. A third kind of operation, and the one that seems unethical even to some advocates of high-frequency trading and without a doubt undermining smaller, independent traders, consists in algorithms trying to spot an order of a transaction and conduct financial operations before this transaction is realized (Pasqualle 2014: 129–130). For example, an algorithm spots that you are planning to buy few thousands of stocks for one dollar. Because buying the stocks increases their value, the algorithm buys the same stock seconds or even milliseconds before you. It makes you not only buy the stocks for more than a dollar now, but also increases the value of the stocks acquired by the algorithm. Because in most cases one algorithm tries to front run another algorithm, the differences of milliseconds in communication can be – again – of a tremendous importance.

The question is: do the high-frequency trade algorithms make the financial markets more or less efficient? By posing this question we touch upon the general problem with the EMH, often

[15] http://www.economist.com/node/17202255

[16] Nick Baumann, *Too Fast to Fail: Is High-Speed Trading the Next Wall Street Disaster?*, http://www.motherjones.com/politics/2013/02/high-frequency-trading-danger-risk-wall-street

raised by its critics – the theory cannot be empirically refuted. It is more of a philosophical conception about the nature of information and the function of markets. Therefore, it should not be surprising that although high-frequency trading has led to several giant and many more smaller crises and has made the financial markets even more opaque that they were before, the advocates of the efficient market hypothesis will claim that the functioning of trade algorithms not only confirms the efficient character of financial markets, but even enhances it.

The speed of algorithmic operations on financial markets reduce the possibility of arbitrage close to zero. A price discrepancy is automatically spotted by a program and reduces by instantaneous buy and sell orders. In an efficient market, prices need to reflect the available information fast and trade algorithms allow for that. In this sense the high-frequency trading is the next step after telegram, telephone and e-mail that allows for better information distribution. It this sense high-frequency trading is supposed to increase liquidity and reduce the volatility of the market (Rijper, Sprenkeler, Kip 2011: 7). Algorithms should also reduce the transaction costs making it possible for more people to get involved in financial markets and reduce the costs of information distribution, therefore providing a better trading environment[17].

But what kind of efficiency is meant here? What kind of trading environment is really created? And most important, what's the logic of information distribution in the markets dominated by high-frequency trading?

First of all, we have to remember about the distinction between the "informational efficiency" and "allocative efficiency" (Mirowski 2014: 266). Even if we agreed that high-frequency trading enhances the distribution of information about price discrepancies on the markets, does it really lead to a better allocation of resources, given that the companies using trade algorithms earn literally billions of dollars?

Second of all, we have to take into consideration the dissymmetry of (computational) power: the efficient market hypothesis was created on the eve of informational revolution and although the economic actor was conceived in it as a smaller processor of information (with the market being the greatest information processor), it did not envision the computational power of computers today. Therefore high-frequency trading introduced the dissymmetry of power between the computational powers of a human brain and trade algorithms. Frank Pasqualle argues for a more public control and transparency in high-frequency trades, but the question is whether a human agent will ever be able to front-run an algorithm. If market is not efficient, the dissymmetry of power consists in the dissymmetry of knowledge and even if it is efficient, the high-frequency trading introduces new dissymmetry of power: only those actors who have enough money to hide their operations or construct their own algorithms are able to even the odds in the new algorithmic trade environment.

And lastly: high-frequency trading exposes the self-referential character of financial markets (Marazzi 2008, 35) that is, their detachment from the so-called "real economy". A French economist from the regulation school, André Olrean, analyzed the 2000 crisis as a result of a "convention" that regulated the financial markets in the 90s (Orlean 2012). The technology bubble and the crash of NASDAQ were caused, according to Orlean, by a convention guiding

[17] Burton Malkiel, *High-frequency trading is a natural part of market evolution*, http://www.ft.com/cms/s/0/1513400e-e8cf-11de-a756-00144feab49a.html#axzz3eFoSJDD4

the behavior of financial markets that the value of high-tech firms and start-ups is going to rise indefinitely. Algorithmic financial operations and high-frequency trading in specific introduce a new level of financial capital self-referentiality – the new conventions are now not so much the cultural conventions (based on natural language), but algorithms executing their programs (based on codified software language) (Pasquinelli 2011: 20).

These effects of high-frequency trading exposes, in my opinion, the contradictions inherent to the contemporary high-tech, digital form of capitalism. High-frequency trading realizes and radicalizes the assumptions of efficient market hypothesis – it is probably the most "efficient" form of (economic) information distribution *if* (economic) information is thought to be represented by the stock price; what is more, the programs executing algorithmically automated financial operations are the perfect participants of efficient markets since their only function is information processing. And the same time high-frequency trading and the new form of financial crises caused by high-frequency trading algorithms expose the inefficiency of market regulated by algorithmic financial operations. Thus, philosophically speaking, we can speak of a simultaneous fulfillment and a deconstruction of the efficient market hypothesis. Financial markets have never been efficient and the digital technology makes this state of affairs only more evident by reducing their "efficiency" to mere information distribution, introducing even greater power dissymmetry and deepening their self-referential character. High-frequency trading simply makes utterly visible what was known before – that market is not the best processor of information. The task of the new political economy is to think of a theory of information distribution outside and beyond the market.

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