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Navigating leadership challenges with technology: Uncovering the potential of ChatGPT, virtual reality, human capital management systems, robotic process automation, and social media

Pawel Korzynski, Andrzej Krzysztof Kozminski, Anna Baczynska

ABSTRACT

Objective: The article aims to examine the use of technology in leadership, and whether it can bring real advantages to leadership effectiveness.

Research Design & Methods: In this article, we provide a preliminary analysis of empirical research conducted among managers working in the USA, Japan, India, and France on technology use. The analysis was conducted on a country level.

Findings: We found that technology is an important issue, but the application of too many technological solutions is not effective for leaders. Analysis of non-technological solutions to overcome a constraint is necessary, especially in the long term.

Implications & Recommendations: The study was devoted to the use of new technologies by leaders in different countries. We examined technologies that have influenced present-day leadership and contemporary business in recent years. Without any doubt, new technologies such as ChatGPT will have an impact on the current leadership.

Contribution & Value Added: The article's added value consists of the updated and synthetic presentation of the application of different technologies in leadership activities.

Article type: literature review and research article

Keywords: digital technologies; chatGPT; virtual reality; robotic process automation; social media; human capital management systems

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INTRODUCTION

As the swift advancement of technology in recent times revolutionized how businesses and organizations are operated (Rymarczyk, 2020), many leaders in organizations assumed an entrepreneurial mindset and approach, acting like entrepreneurs to drive innovation and growth within their companies (Aránega, Montesinos, & del Val Núñez, 2023). As a result, current leaders have increasingly embraced various emerging technologies to maintain competitiveness and enhance productivity (Montenero & Cazorzi, 2022; Sieja & Wach, 2019). Generative AI such as ChatGPT refers to artificial intelligence systems that can create content or predict outcomes based on the data provided (Wach *et al.*, 2023). The importance of generative AI for leaders lies in its ability to automate complex data analysis and decision-making processes, leading to more accurate and efficient outcomes, and ultimately, better-informed

strategic decisions (Korzynski & Mazurek *et al.*, 2023). Virtual reality (VR) is a technology that allows users to immerse themselves in a computer-generated environment, enabling them to interact with the environment and its elements. For leaders, VR is important as it offers innovative ways to train employees, design products, and market services, reducing costs and enhancing customer experiences (Smutny, 2022). Blockchain is a decentralized digital ledger that enables secure, transparent, and tamper-proof recording of transactions across a distributed network (Wu & Zhang, 2022). The significance of blockchain for leaders is its potential to improve trust, reduce fraud, and streamline operations, particularly in industries like finance, supply chain management, and healthcare. Human capital management systems (HCMS) are software applications that facilitate the management of employee data and organizational processes, streamlining human resources functions. Leaders benefit from HCMS by gaining better insights into their workforce, improving employee engagement, and fostering a more efficient and productive organization (Silic, Marzi, Caputo, & Bal, 2020). Robotic process automation (RPA) involves the use of software robots to perform repetitive tasks, thus increasing efficiency and reducing human errors. The adoption of RPA is crucial for leaders as it allows them to optimize their operations, reduce costs, and enhance overall productivity (Plattfaut & Borghoff, 2022). Finally, social media encompasses various online platforms that facilitate communication, collaboration, and information sharing among users. The importance of social media for leaders is twofold. Firstly, it serves as a valuable tool for brand building, marketing, and employee engagement (Korzynski, Mazurek, & Haenlein, 2020). Secondly, it enables leaders to stay informed about industry trends, gather feedback, and maintain a strong presence in the digital space (Korzynski, Paniagua, & Mazurek, 2023).

The article aims to examine how different technologies influence leadership effectiveness. To determine factors influencing leaders' effectiveness, we considered a new leadership concept, termed bounded leadership (Kozminski, Baczynska, Skoczeń, & Korzynski, 2022). This concept assumes that leaders are constrained by different issues such as office politics, cultural norms, employee motivation, or emotional attitudes, and coping with these constraints helps leaders be more effective in fulfilling their roles (Kozminski, 2015).

Previous studies focused primarily on the individual impacts of technology and leadership activities on organizational outcomes. However, there is a lack of research examining the combined effects of technology usage and leadership activities on leadership effectiveness. The study described in this article sought to address the existing knowledge gap by investigating the interrelationship between technology usage and leadership activities (*i.e.*, coping with different constraints), and its influence on leadership effectiveness. By examining this complex interplay, the study attempted to provide valuable insights that can contribute to a better understanding of how leaders can leverage technology to enhance their decision-making, problem-solving, and overall leadership performance.

This article is structured as follows. Firstly, we will discuss the concept of leadership constraints and analyse how these constraints might be minimized thanks to technology. Secondly, we will propose hypotheses concerning the relationship between the use of technology, overcoming constraints, and leadership effectiveness. Thirdly, we will present the data collection and results. Finally, we will discuss the results, implications, and limitations of this study.

LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

Bounded Leadership Theory

Industry professionals argue that conventional management theories provide solutions that result in effective processes and foreseeable outcomes during times of stability. However, these theories often fall short when confronted with the demands of an ever-changing, complex, and uncertain environment. Similarly, leadership theories are frequently limited in scope. In contrast, the bounded leadership theory proposes a holistic and versatile perspective, transcending the focus on a leader's characteristics or responsibilities, and taking into account numerous constraints linked to actions at various levels, including individual, team, organizational, and stakeholder dimensions (Kozminski, 2015). This alternative perspective on leadership is evocative of Herbert Simon's concept of bounded rationality, which asserts that individual actions are shaped by emotions and irrationality, as their innate ability to process information

and tackle problems is restricted (Cristofaro, 2017). In recent times, this theory of bounded rationality has found application in leadership studies, as demonstrated by a Polish investigation involving top-level executives (Kozminski, 2015). The study endorsed the idea that the efficacy of leaders is impeded by a myriad of factors, including power dynamics, organizational culture, ethical challenges, emotional components, workforce motivation, procedural protocols, and information accessibility.

Coping with Constraints and Leadership Effectiveness

Leadership effectiveness is often influenced by various constraints that leaders must overcome to achieve success in their organizations (Kozminski *et al.*, 2022). Understanding and addressing these constraints can significantly impact a leader's ability to guide their team and organization effectively. Cultural constraints pertain to deeply ingrained values and norms that are difficult to change, even if they prove to be counterproductive (Sørensen, 2002). By navigating these challenges and fostering a positive organizational culture that supports growth and development, leaders can enhance their effectiveness in driving organizational change and promoting innovation (Meng & Berger, 2019). Emotional constraints are typically associated with strong negative emotions that can prevent leaders from behaving rationally and making sound decisions (Llamas-Díaz, Cabello, Megías-Robles, & Fernández-Berrocal, 2022). Developing emotional intelligence can help leaders manage their emotions, improving their decision-making abilities and ultimately enhancing their leadership effectiveness (Dasborough *et al.*, 2022). Entitlement constraints arise from organizational formalization, which outlines responsibilities and hierarchical structures (Monteiro & Adler, 2022). Balancing the need for formalization with flexibility allows leaders to adapt to changing circumstances and maintain effectiveness. By doing so, they can create a more agile organization, better equipped to respond to dynamic market conditions (Newman, Mintrom, & O'Neill, 2022). Ethical constraints involve leaders facing ethical dilemmas and navigating morally complex situations (Al Halbusi, Tang, Williams, & Ramayah, 2022). By practising ethical leadership, leaders maintain trust and foster a positive organizational environment, thus increasing their effectiveness, especially in the long term (Dey, Bhattacharjee, Mahmood, Uddin, & Biswas, 2022). Informational constraints reflect the challenges leaders face in collecting, processing, and acting upon information. Developing strategies to manage these constraints, such as leveraging technology and cultivating networks to access relevant information, can enhance a leader's decision-making capabilities and improve their overall effectiveness (Delanoy & Kasztelnik, 2020). Motivational constraints relate to the diminished motivation of a leader or their followers. By employing various motivational techniques, leaders can maintain high levels of engagement and productivity within their teams, ultimately boosting their effectiveness in achieving organizational goals (Tang, Chen, van Knippenberg, & Yu, 2020). Political constraints stem from power dynamics and office politics that can hinder leadership effectiveness. Navigating these challenges by building alliances, managing conflicts, and fostering a positive political environment can enhance a leader's ability to influence and create strategic alignment within the organization (Borah, Iqbal, & Akhtar, 2022). These arguments lead to the following hypothesis:

H1: Coping with constraints is positively associated with leaders' effectiveness.

Technology and Leadership Effectiveness

Generative AI technologies, such as ChatGPT, are revolutionizing the way leaders manage information and make decisions in various industries (Kellogg, Sendak, & Balu, 2022). One of the primary challenges leaders face is dealing with informational constraints because of vast amounts of data and the limited possibility to extract valuable insights from them. Generative AI models can address this issue by rapidly processing and analysing large datasets, enabling leaders to access data-driven recommendations or alternative perspectives based on historical data, trends, and patterns (Lund & Wang, 2023). This capability can help leaders refine their strategies, set priorities, and make more effective decisions. Moreover, generative AI technologies can also help leaders overcome motivational constraints among employees, business partners, or clients. These tools can assist leaders in crafting clear, concise, and persuasive messages tailored to different audiences, which can improve communication and engagement (van Dis, Bollen, Zuidema, van Rooij, & Bockting, 2023).

Blockchain technology, originally developed for cryptocurrency transactions, has evolved into a versatile tool with applications beyond finance, including the facilitation of leadership functions. By providing a secure, decentralized, and transparent platform for various types of transactions, blockchain-related technologies enable leaders to bypass centralized authorities, thus addressing entitlement constraints (Sharif & Ghodoosi, 2022). One of the key benefits of blockchain technology is its ability to create a single source of truth (Hartelius, 2023), which can help leaders overcome informational constraints. By ensuring that all parties involved in a project or business operation have access to the same data, blockchain can facilitate smoother communication and decision-making processes (Çolak, 2022). Additionally, Blockchain's decentralized nature also allows for greater collaboration and resource sharing among organizations, which can contribute to overcoming entitlement constraints, where leaders need to rely on centralized authority that approves various business operations.

Virtual reality (VR) technology has emerged as a powerful tool for leadership training, particularly in addressing emotional constraints (Maslova, Gasimov, & Konovalova, 2022). Virtual reality can create immersive and realistic simulations of emotionally challenging situations, allowing leaders to practice their responses and develop the necessary skills to handle such interactions more effectively. One notable aspect of VR training is the concept of body transfer, which enables leaders to observe a trained leader's body movements (*e.g.*, side glances, eye rolls, and dismissive hand gestures) on an avatar during emotionally charged discussions with employees (Bailenson, 2018). By observing and mimicking these nonverbal cues, leaders can gain a better understanding of how their body language affects their interactions with others and learn to communicate more effectively in emotionally charged situations and this way influence positively their effectiveness.

Human capital management systems play a vital role in helping leaders address various leadership constraints, such as cultural, informational, and motivational constraints, ultimately leading to improved leadership effectiveness. Cultural constraints refer to the limitations leaders face in aligning their organization's values, norms, and practices with the diverse backgrounds and perspectives of employees and stakeholders (Kozminski *et al.*, 2022). Human capital management systems facilitate a range of processes related to human capital, including recruitment and selection, onboarding, performance assessment, and talent management. These systems enable leaders to identify candidates who exhibit cultural fit and promote desired social behaviours within the organization, thus minimizing cultural constraints (Dastmalchian *et al.*, 2020). In terms of addressing motivational constraints, HCM systems can facilitate leader-follower interactions at suitable times and improve communication within the organization. Leaders began treating employees as customers, focusing on improving their experiences and satisfaction levels (Nikolova, Schaufeli, & Notelaers, 2019). This shift in approach resulted in increased motivation and productivity among employees. Moreover, HCM systems can provide leaders with tools to track employee performance and identify areas for improvement, helping them to address performance-related motivational constraints. By offering personalized feedback and development plans, leaders can empower employees to take charge of their professional growth, resulting in a more engaged and motivated workforce (Ehrnrooth, Barner-Rasmussen, Koveshnikov, & Törnroos, 2021).

Social media platforms, particularly professional ones such as LinkedIn, play a crucial role in helping leaders overcome various leadership constraints, including motivational, cultural, and political constraints. By leveraging social media, leaders can enhance communication, collaboration, and networking within and beyond their organizations, leading to better overall performance (Borah *et al.*, 2022). Social media platforms enable leaders to share their vision, goals, and achievements with a wider audience, fostering motivation and buy-in from employees and other stakeholders (Cortellazzo, Bruni, & Zampieri, 2019). Additionally, social media platforms facilitate the sharing of best practices, success stories, and industry news, which can inspire employees and help them stay informed and engaged in their work (Korzynski *et al.*, 2020). Social media platforms provide also an opportunity for leaders to celebrate diversity, promote inclusive organizational culture, and share initiatives that support underrepresented groups (Sun, 2020). By leveraging social media, leaders can foster a sense of belonging and unity within their organizations, ultimately leading to a more inclusive and high-performing workforce. Social media platforms offer leaders a space to overcome political constraints that refer to the challenges leaders face in navigating the complex web of relationships, power dynamics, and interests

within their organizations and the broader business environment. On social media, leaders can build their personal brand, establish credibility, and develop strategic relationships with key stakeholders, influencers, and decision-makers (Yue, Thelen, Robinson, & Men, 2019).

Based on the above discussion, the following hypothesis was established:

H2: The use of technologies in organizations such as generative AI, virtual reality, blockchain, human capital management systems, robotic process automation, or social media is positively associated with leadership effectiveness.

RESEARCH METHODOLOGY

We hired a professional survey agency to conduct a study among experienced managers in four countries: the US (203), India (n=201), Japan (211), and France (216). To analyse how the use of different technologies such as AI (internal chatbots), VR, human capital management systems, social media platforms, robotic process automation, and blockchain-related technologies and coping with constraints facilitate leaders in fulfilling their roles more effectively, we collected the following data: leaders’ technology use, participants’ application of each technology in their work; leaders’ coping with constraints, replies to statements on coping with specific constraints, *i.e.* political, entitlement, motivational, informational, cultural, emotional, and ethical in a 1-7 scale, in which 1 meant totally different behaviour and 7 meant very similar behaviour; and leaders’ effectiveness, *i.e.*, responses to questions about effectiveness on individual, team, organizational, and stakeholder level on a 1-7 scale (Kozminski *et al.*, 2022).

We applied variance-based structural equation modelling (SEM), *i.e.*, partial least-squares SEM, due to the presence of formatively measured constructs (Wong, 2013). Moreover, we decided to calculate and compare the average values of the above-mentioned variables on a country level.

RESULTS AND DISCUSSION

Figure 1 demonstrates the percentage of leaders using specific technologies. From an overall perspective, HCMS emerged as the most popular technology across all four countries, with adoption rates ranging from 44% to 56%. Social media also demonstrated significant popularity as the second most adopted technology, with adoption rates ranging from 32% to 43%. On the other hand, V, with adoption rates between 9% and 24%, and blockchain, with adoption rates between 11% and 22%, generally had lower adoption rates, making them the least popular technologies among the listed options.

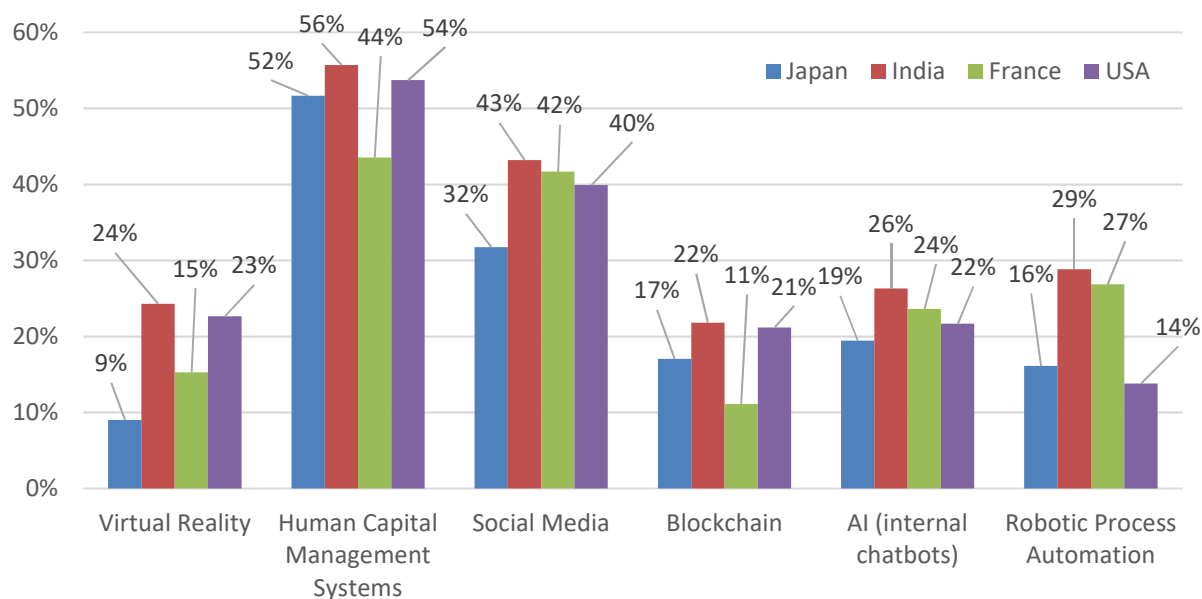


Figure 1. Percentage of leaders taking advantage of specific technologies
 Source: own elaboration of the survey (n = 831).

Comparing the countries, India demonstrated the highest adoption rates for all technologies among the four countries, with the most popular technologies being HCMS (56%) and social media (43%). The USA and France showed similar adoption rates for the most popular technologies, with HCMS respectively at 54% and 44%, and social media at 40% and 42%, respectively. Japan has the lowest adoption rates for most technologies, with the most popular being HCMS (52%) and social media (32%). A possible factor contributing to Japan having lower adoption rates for most technologies could be the characteristics of Japanese managers who participated in the survey. Japanese managers might be less open or more reserved when providing information about their organization's use of technology. Cultural norms and practices, such as a higher emphasis on privacy or a tendency to be more cautious and discreet about sharing information, could have influenced their responses. This could potentially lead to an underreporting of technology adoption rates in Japan, which might make the results appear biased. To account for this possibility, it is essential to consider cultural differences and their potential impact on survey responses when comparing countries.

Figure 2 presents average results on coping with the constraints in four countries. In Japan, leaders reported an average rating of 4.66, suggesting a moderate level of similarity in their coping behaviours with the constraints. India had a slightly higher average rating of 4.79, indicating a somewhat similar approach to coping with constraints as Japan. France and the USA showed higher average ratings, with 5.18 and 5.06, respectively, suggesting that leaders in these countries have more similar coping behaviours when dealing with constraints compared to Japan and India.

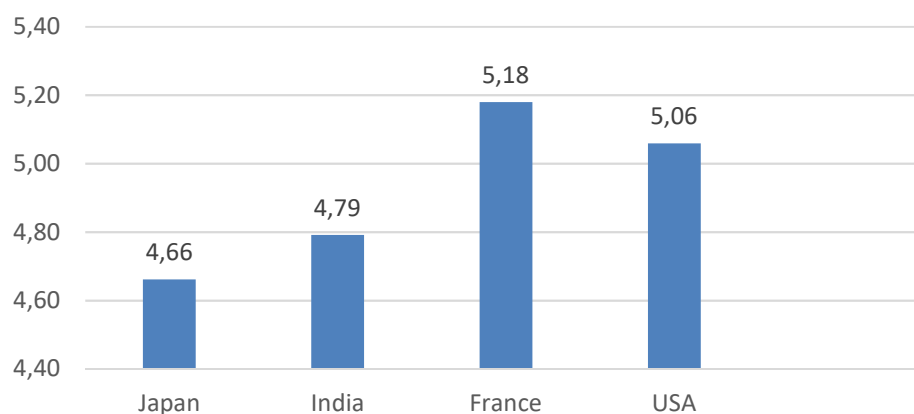


Figure 2. Coping with the constraints across countries

Source: own elaboration of the survey (n = 831).

To test hypothesis 1 and hypothesis 2, we used the resampling method for significance testing and bootstrapping of 5000 resamples and 100 cases per sample. The results (Table 1) confirmed the relationship between coping with constraints and leaders' effectiveness (p-value less than 0.045). Thus, we can confirm hypothesis 1. However, we cannot confirm the relationship between technology and leaders' effectiveness, and thus, hypothesis 2.

Table 1. Path coefficients and p-values

Path	Parameter Estimate	p-value
H1: Coping with constraints → Leaders' effectiveness	0.081	0.045
H2: Use of technology → Leaders' effectiveness	0.103	0.375
Managerial experience → Leaders' effectiveness	0.012	0.790
Tenure → Leaders' effectiveness	0.003	0.962
Country → Leaders' effectiveness	0.048	0.286
Gender → Leaders' effectiveness	0.074	0.181

Source: own elaboration of the survey (n = 831).

In addition to the SmartPLS analysis, we decided to compare the average values of our main variables at the country level (Figure 3). This approach allowed us to gain a better understanding of the differences

between countries in terms of leadership effectiveness, coping with constraints, and technology use. By doing so, we could identify patterns and insights that might not be apparent through the SmartPLS analysis alone, and further our understanding of the interplay between these factors in various national contexts. We discovered that both coping with constraints and the use of technology might play a significant role. Intriguingly, French leaders demonstrated a high ability to cope with constraints (average 5.18) but a lower adoption of technology (average 0.27) compared to their counterparts in the US and India. Conversely, Indian leaders, on average, exhibited the highest utilization of technology (average 0.33) but a relatively lower proficiency in coping with constraints (average 4.79). Consequently, neither French nor Indian leaders achieved the highest effectiveness scores (France: 5.34, India: 5.22). Thus, we cannot fully confirm hypotheses 1 and 2. This implies that in today’s technology-driven era, leaders require a variety of tools to enhance their effectiveness. However, an overemphasis on technology could potentially diminish the human touch and reduce the ability to address various constraints effectively.

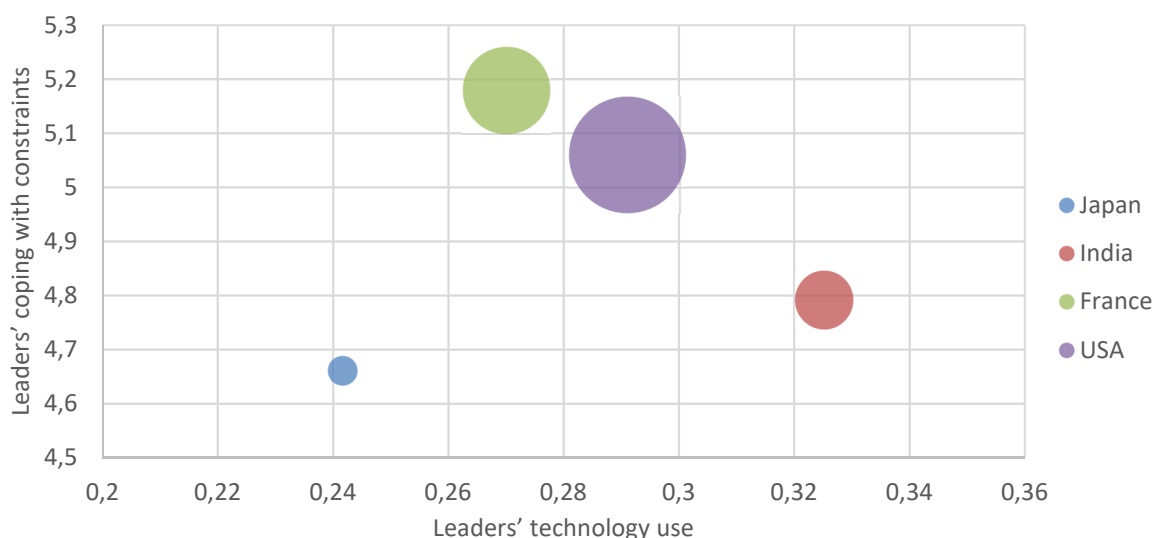


Figure 3. Leaders’ effectiveness (bubble size), coping with constraints, and technology use

Source: own elaboration of the survey (n = 831).

CONCLUSIONS

While the statistical analysis conducted in SmartPLS did not confirm a direct relationship between technology use and leaders’ effectiveness, examining the data at a country level revealed that a certain level of technology use can be supportive for leaders. Various technologies can help leaders address different constraints and enhance their effectiveness.

Generative AI models, such as ChatGPT, can tackle informational constraints by quickly processing and analysing large datasets, providing data-driven recommendations or alternative perspectives. For instance, Bain & Company integrated OpenAI’s technologies into its management systems (Bain & Company, 2023).

Blockchain technologies can help overcome entitlement constraints by reducing reliance on centralized authorities for business operations approval and address informational constraints by granting leaders access to specific data. Home Depot, a US-based home improvement retailer, employed blockchain technology to swiftly resolve transaction disputes within its supply chain (King, 2021).

Virtual reality (VR) can assist leaders in managing emotional constraints, as demonstrated by T-Mobile, which used VR training to help its leaders lead change during the merger with Sprint (Mursion, 2020).

Human capital management systems can help minimize cultural constraints through targeted recruitment and onboarding practices. For example, Arvato Bertelsmann implemented candidate-matching software to identify candidates with suitable cultural DNA (Harver, 2020). Human capital management systems like the one used at Illycaffè can also provide leaders with valuable employee data and insights (Oracle, 2021).

Social media platforms, particularly professional ones such as LinkedIn, can be employed by leaders to address motivational, cultural, and political constraints. These platforms allow CEOs to engage with employees, promote company values, and create connections with various networks. Ramon Laguarta, the CEO of Pepsico, is an example of a leader who uses social media effectively (Jones, 2019). By regularly reacting to the content shared by Pepsico's employees on LinkedIn, he sends positive signals of recognition for their work, thereby addressing motivational constraints. Lynn Good, CEO of Duke Energy, an American electric power and natural gas holding company, leverages LinkedIn to promote specific values such as sustainability and respect for employees at all organizational levels (Gravier, 2019). In doing so, she addresses cultural constraints by fostering a shared set of values within the company. Rafał Brzoska, the founder and CEO of InPost, a logistics company that operates parcel lockers, frequently posts on LinkedIn about his company's achievements, innovations, and challenges (Forbes, 2021). By doing this, he breaks into various political, media, and business networks, overcoming political constraints that arise from industry cliques where members support one another. By implementing robotic process automation (RPA), leaders can delegate mundane tasks to machines, as exemplified by Uber's application of RPA in processing invoices, which helped address motivational challenges related to long working hours (UiPath, 2021).

While this study provides valuable insights into the role of technology in helping leaders overcome constraints, it is important to acknowledge its limitations. Firstly, the data collection was limited to four countries, which may not fully represent the global landscape of technology adoption and leadership practices. Expanding the research to include a more diverse range of countries could yield more comprehensive insights. Secondly, the cross-sectional nature of the data does not allow for the examination of causal relationships or the evolution of technology adoption over time. Longitudinal studies could provide a more nuanced understanding of how leaders adapt to and leverage technology over time. Finally, the self-reported nature of the survey data may be subject to social desirability bias, as respondents might be inclined to present a favourable image of their technology adoption and leadership practices. Future research could benefit from incorporating objective measures or triangulating data sources to validate the findings. Acknowledging these limitations not only helps provide a more balanced perspective but also offers opportunities for future research to build upon and extend the current study.

Drawing from our research insights, we developed a practical contribution in the form of a multi-step approach that leaders can implement to effectively leverage technology in their leadership endeavours. This framework aims to bridge the gap between technology adoption and leadership effectiveness, ultimately enhancing overall performance.

Frequently, leaders are not fully conscious of all the factors that limit their capabilities. They require a variety of perspectives, such as a helicopter view to grasp the broader context of their organization and industry, a movie director view to understand relationships among employees, social norms, and motivational issues, and a kind of MRI view to introspect on their emotions and ethical dilemmas.

Recognizing some constraints may be straightforward, while others can be more elusive. Addressing political constraints (stemming from power struggles and office politics) and entitlement constraints (arising from organizational formalization and hierarchical responsibilities) necessitates adopting a helicopter view. To tackle informational constraints (associated with difficulties in gathering and processing data), cultural constraints (related to detrimental social norms), and motivational constraints (linked to decreased motivation of team members), leaders need to adopt a movie director view. To identify emotional constraints (involving intense negative emotions inhibiting rational behaviour) and ethical constraints (pertaining to leaders' ethical quandaries), an MRI view is essential.

Applying weights to certain constraints by analysing how important the constraint is in the leader's functioning will help set priorities. We can imagine that there are a number of issues that each leader can identify as a constraint. The time horizon is worth considering. Some constraints will serve as single events while others will occur regularly.

Table 2 below shows some examples of how leaders can match constraints with technological solutions.

Table 2. Leadership constraints and possible technological solutions

Type of constraint	Possible technological solution
Political	Social media platforms
Entitlement	Blockchain
Motivational	Generative AI, robotic process automation, social media platforms
Cultural	HCMS, social media platforms
Informational	Generative AI, HCMS
Emotional	Virtual reality
Ethical	—

Source: own elaboration.

Our study shows that technology is an important issue but the application of too many technological solutions is not effective for leaders. Analysis of non-technological solutions to overcome a constraint is necessary, especially in the long term.

In conclusion, our research provided valuable insights into how leaders can effectively harness technology to overcome constraints and enhance their leadership effectiveness. By developing a practical, multi-step approach, we aimed to bridge the gap between technology adoption and leadership performance. This framework consists of several steps: identifying constraints, analysing the impact of these constraints, matching constraints with appropriate technological solutions, and considering non-technological alternatives in the long term.

By recognizing and understanding the various constraints that leaders face, they can prioritize their efforts and adopt suitable perspectives to address them effectively. Our study emphasized that while technology might play a role in overcoming leadership constraints, relying solely on technological solutions may not always yield optimal results. Hence, it is essential for leaders to strike a balance between technological and non-technological approaches in their pursuit of improved leadership effectiveness.

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Conflict of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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The shift of the foreign direct investments paradigm impacted by the Fourth Industrial Revolution

Jan Rymarczyk

ABSTRACT

Objective: The purpose of the article is to examine the impact of ground-breaking inventions collectively called the Fourth Industrial Revolution (4IR) or Industry 4.0 on foreign direct investments (FDIs). In particular, the impact of the inventions on offshoring and reshoring (backshoring, nearshoring, insourcing) was analysed in the context of other factors and their potential future course.

Research Design & Methods: The article is theoretical and empirical in nature and based on theoretical literature on the subject, secondary sources containing the results of empirical research, and desk research. Predictive analysis and logical reasoning methods played therefore a very important role, since the studied phenomena are in the process of evolution. The structure of the article consists of findings on the origins and the definitions of offshoring and reshoring and their theoretical foundations, an analysis of the motives, barriers and course of these processes follows, and the presentation of the research results and the final conclusions.

Findings: The implementation of 4IR inventions has the potential to fundamentally change the geography of FDIs and their importance in the world. It is likely to decrease the significance of labour costs as a factor of production location while increasing the role of human capital and technology. As a result, reshoring phenomena will intensify, and many global value chains will be liquidated or shortened. The ambivalent impact of 4IR on the geography of production will be probable, while the trend towards reshoring and spatial dispersion of the production of complete products in the long term may appear to be stronger.

Implications & Recommendations: To a significant degree, Industry 4.0 will probably change the criteria for the implementation of FDIs, their size, and the directions of capital flows. The consequences of this will vary depending on the type of industry and the production carried out within. In particular, the effects will differ when divided between highly developed and developing countries. If the former benefit from the change in business models and strengthen their competitive advantages, the latter may suffer significant losses related to the increase of unemployment and the collapse of their industrialization strategy based on the inflow of FDIs. Therefore, actions by governments and international organizations are necessary to prevent this 'dark' scenario from becoming a reality.

Contribution & Value Added: The article presents the theoretical foundations of offshoring and reshoring as well as the analysis and synthesis of their motives and barriers. Their course and recent determinants were characterized. The assessment of the impact of 4IR inventions on offshoring and reshoring and the identification of factors that will affect these two aspects of FDIs positively and negatively in the short, medium, and long term in the future have the greatest importance for the value of the study. Moreover, the study found that the reverse flow of FDIs implies the need to formulate their new paradigm. The former paradigm characterised them in a limited way as a unilateral flow of capital from the country of origin to the host country. The one proposed in the article takes into account also the return movement of capital as an immanent element of FDIs of increasing importance.

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INTRODUCTION

The basic forms of international business include international trade and foreign direct investments (FDIs). Historically, the former preceded the latter, considered its higher, developed form. The dynamic development of FDIs is related to the stimulating influence of political, economic, socio-psychological and, last but not least, technical and technological factors. Those mentioned as the last are even considered the most important, because they preceded and determined the others. Breakthrough changes in the sphere of general technique and technology of production have been included in four intervals referred to as industrial revolutions. The fourth one is a process that is currently taking place and ultimately its effects may differ from those expected. Nevertheless, based on the current progress in the implementation of its basic inventions and their effects, it is expected that it will radically change the nature of production processes with far-reaching consequences in all spheres of the functioning of societies. Despite its application also in service activity, the complex of those manufacturing processes is also called Industry 4.0. (Rymarczyk, 2020; 2021). This may be influenced by the disappearance of differences between a product and a service as a result of widespread digitization. Although the Fourth Industrial Revolution constitutes a consequence and continuation of previous scientific, research and technical achievements, its turning point has been conventionally accepted to have taken place in 2010.

There are grounds to believe that overcoming technical and economic barriers related to the industrial implementation of its inventions will affect the size of the structure and the geography of FDIs. The previous FDI paradigm defined it as the complete or partial takeover of the ownership of an entity abroad or the establishment of a new one to conduct business activity (Rymarczyk, 2017). It, therefore, limited FDIs to one option, namely the flow of capital from its country of origin to the host country. However, under the influence of geopolitical, economic, and technical and technological changes that are taking place in the global economy, it should include reshoring in addition to the offshoring option. The proposed new paradigm of FDI could be as follows: 'FDI is the movement of capital consisting of taking over the ownership of an entity or establishing a new one abroad to conduct business activity, as well as its relocation to the country of origin of the investment, a neighbouring or a third country.'

RESEARCH METHODOLOGY

The current article is based on available literature and online sources. This is a theory development article, which relies on literature review and desk research (Rymarczyk, 2020; 2021).

This conceptual article derives research propositions from literature review and desk research of current business press papers, professional reports, company web pages, and blogs because this subject is relatively new in the theory of economics and international business. This article should be considered as a conceptual paper, in which literature review and desk research lead to the development of theoretical propositions. As for the scientific approach, this article uses a qualitative design of research, the method of indirect observation, cause-effect analysis, and predictive synthesis, modelling, induction, and description.

LITERATURE REVIEW AND THEORY DEVELOPMENT

The Origin and the Notions of Offshoring and Reshoring

Political, economic, socio-psychological and, above all, technical and technological changes occurring in the world economy, gradually intensified from the mid-1960s, and resulted in an extraordinary increase, albeit to a varying degree, in the internationalization of national economies. The main authors of these processes – which we call globalization – have been business entities commencing their activities in various countries of the world. For a long time, their deepening internationalization was treated as a linear process, following a sequential or stepwise manner. The intensification of establishing business activity abroad, *i.e.* offshoring, became one of the most widespread strategies used by companies to increase their competitive advantage since the early 1990s (Di Mauro *et al.*, 2018). The basic form

of offshoring involved foreign direct investments, consisting in the creation (greenfield) or acquisition (brownfield) of existing enterprises in various foreign locations. The outsourcing of individual production phases to specialized, local and independent companies abroad was of lesser significance. In this way, global supply and value chains of transnational corporations (TCNs) were created. The literature dealing with these phenomena abounds. It would be impossible to cite even the most representative examples of the literature, here. Therefore, only items containing literature reviews on FDIs, mainly from the last few years, have been listed (Le, 2021; Letsou & Pantelidis, 2020; Otieno & Aduda, 2022; Paul & Feliciano-Castero, 2021; Riker & Wickramarachi, 2020; Trąpczyński, 2013; Wan, 2010; World Bank, 2020). However, with increasing frequency since the beginning of the twenty-first century, the phenomenon opposite to offshoring has been observed, involving the transfer of production either back to the country hosting the corporation's headquarters, referred to as 'reshoring,' 'backshoring' or 'insourcing,' or its neighbouring country, *i.e.* 'nearshoring.' In the literature on the subject, various forms of reshoring are distinguished, namely (Gray *et al.*, 2013; Tate & Bals, 2018):

- in-house reshoring, meaning the transfer of activities carried out by the corporation's own foreign branch to its own branch in the country of its registered office;
- reshoring for outsourcing, meaning the transfer of activities performed by the corporation's own foreign branch to other companies in the country of the corporation's registered office;
- reshoring for insourcing, meaning the transfer of activities performed by foreign suppliers to the corporation's own branch in the country of its registered office;
- outsourced reshoring, meaning the transfer of activities performed by the corporation's foreign suppliers to suppliers in the country of its registered office.

It should be noted that the optimal combination of offshoring and reshoring from the point of view of efficiency is referred to as rightshoring.

Theoretical Foundations of Offshoring and Reshoring

The offshoring and reshoring phenomena can be treated as elements of a company's internationalization process influenced by the dynamics of competition on a global scale, the environment of the country of investment origin, its location, and the specificity of the company itself (Arik, 2013). From the theoretical point of view, they can be explained primarily by the theory of transaction costs and Dunning's OLI-eclectic paradigm. According to the first theory, lower transaction costs in a foreign location are a factor stimulating offshoring, and their over-proportional increase in relation to the benefits achieved affects reshoring decisions (Rao, 2003). Dunning's paradigm consists of three theories (Dunning & Lundan, 2008). The first is the theory of monopolistic advantage (ownership theory). It states that a company invests abroad, because it can benefit from the advantages over local companies related to technology, finance, marketing, production, etc. However, if these advantages can be used more effectively in the country of the company's origin or in the neighbouring country, as a result of a change in the situation on the foreign market and its surroundings or within the company, it will be inclined to change its location to the one closer to its head office.

The second theory, *i.e.* the internationalization theory, assumes that if a company has monopolistic advantages, it will use them internally, *i.e.* in the form of foreign direct investments (offshoring) in its subsidiaries in foreign countries, and not in the form of internationalization that would result in its acquisition by competitors, *e.g.* by selling licenses. In this case, reshoring may be justified by the greater security of maintaining these advantages and better management of those advantages in the country of origin of the company than in the host country. In developed countries, the quality of the law protecting intellectual property is usually higher than in developing countries. Moreover, production in this location gives the benefits of products made at home.

The third element of the paradigm is the location theory, pointing to the specific benefits of locating investments in a given country. First of all, these include lower costs of labour, as well as materials, raw materials, energy and environmental protection. The implementation of a number of modern technologies related to 4IR, discussed later in the article, significantly reduces the benefits of arbitration in this area. This results in the fact that the share of the listed elements that make up

the final product is significantly reduced in relation to the participation of the capital. Production in the highly developed, home country of the company becomes labour- and material-efficient, with the increase of labour productivity, quality and modernity of products; relations with consumers are closer and the negative impact of the production on the natural environment is reduced, which creates impulses to relocate the previously offshore production.

The stimulants to the interpretation of the phenomenon of reshoring can also be found in a number of other theories in the field of business and international enterprise management, such as the internationalization theory, resource-based theory, dynamic capabilities theory, contingency theory, factor market rivalry theory, Ahroni's behavioural theory and others. So far, however, there has not appeared a separate theory of reshoring (Di Stefano & Fratocchi, 2019; Ellram *et al.*, 2013; Wiesmann *et al.*, 2017).

Motives and Barriers of Offshoring

The comparison of the motives and barriers of offshoring and reshoring, as well as their development, carried out here with the application of the theoretical and empirical method, allows for the identification of factors determining the processes of globalization and de-globalization of enterprises and their course in the period of 4IR. In particular, it provides an answer to the question of whether the decision to invest abroad was already based on reasons for the need to make reshoring decisions in the future. Such a case may be, for example, when the decision on offshoring was erroneous, *i.e.* the company's management incorrectly assessed the proportions of potential profits and benefits to costs and risks. If this is not the case, an alternative cause of reshoring is likely to be an unforeseen change in conditions in the host country market, the domestic market, conditions within the company, and the global economy in general. It should be noted that reshoring does not necessarily mean de-internationalization of the company, because production can be moved not only to the country of the company's headquarters, but also to another country. If it is a neighbouring country, the already mentioned nearshoring is taking place. In addition, the development of production in the company's home country with the use of modern technology can lead to an increase in the international competitiveness of its products and an increase in exports, which is also treated as a form of its internationalization.

Generally, the motives for offshoring can be divided into (Ashby, 2016; Di Mauro *et al.*, 2018; Rymarczyk, 2017):

- cost-related;
- market-related;
- supplies-related;
- political;
- strategic.

Cost-related motives and the expected benefits related to them are considered the most important ones. Not only labour costs – which are much lower in developing countries – but also lower costs of materials, energy, and environmental protection are put forward. Access to new, large, and absorptive markets with a low level of competition is mentioned in the second place. Supply-related motives concern access to raw materials, qualified workforce as well as know-how and modern technology, which can be ensured by investments in high-tech clusters, located mainly in highly developed countries. The political determinants of offshoring are related to the policy towards FDIs applied by the countries of origin and host countries, as well as the political risk in the latter ones. With many financial, fiscal, and other tools, both the countries of origin and the host countries support companies in their international operations. Factors encouraging investments in a given country, sometimes even *sine qua non*, include its political, economic, and social stability. The strategic motives include the maintenance or increase of the company's international competitiveness or the weakening of the competitive influence of other companies. This may take place through a takeover of some or all of the assets of other companies, creating new companies, entering into strategic alliances, or creating joint ventures. The strategic motive may also include dispersing the risk of the business activity throughout a number of countries.

Offshoring, however, results in the creation of some negative phenomena for the company. These include the geographical distance related to an increase in costs regarding trade, border procedures

and customs, and transport and cargo insurance, higher risk of the loss or damage to cargo, the likelihood of failing to meet delivery deadlines and production downtime taking place. The supply chain gets more complex and less transparent and controllable, and the costs of inventories and logistics increase. Communication barriers, cultural differences, lower qualifications of employees, lower standards of control and management, no tradition of well-organized large-scale production, lack of direct contact with the company's R&D centres, and lower quality of local materials and raw materials mean that intermediate and final products manufactured in foreign locations are of lower quality. Moving production abroad is associated with a decrease in employment in the company's home country and the country's budget revenues. There is also a political risk involved. Changes in governments and the transition from a policy favouring FDIs to a restrictive one can significantly hamper the activities of foreign companies, increase their costs and deprive them of planned profits. In an extreme case, foreign companies may be expropriated or forced to 'domestication,' *i.e.* the obligation to enter into a joint venture with a local partner. Dependence on production abroad can reduce a country's economic, social, and security-related stability. In the event of conflicts and emergencies, supply chains are likely to be disrupted. The Covid-19 epidemic has shown the excessive dependence of European countries on the production of medical equipment and pharmaceutical raw materials and microprocessors in China. Leading European politicians state that globalization has gone too far and call for bringing the production of certain sectors back to Europe, for greater diversification of supply chains and for replication of production. It is stated that excessive de-industrialisation, relocation of production, and lengthening of delivery chains to their extremes annihilate production capacities and know-how in highly developed countries and lead to the limitation of their sovereignty. The impulse to intensify reshoring may also result from the common policy of the European Union (*Koronawirus*, 2020).

Development of FDIs and Their Determinants

The development of globalization processes, including FDIs, has a sinusoidal character. After a period of strong growth, their progress weakens or even decreases, exemplified mainly by a decrease in the dynamics and volume of trade and international capital flows. The years 1980-2007 are referred to as the golden age of globalization or hyper globalization. It was interrupted by the outbreak of the global financial crisis of 2007-2009. After overcoming this crisis, there was a slight and short-term increase in the global inflow of FDIs, and then their stagnation until 2014 at the level of approximately USD 1500 billion, followed by a strong increase lasting two years. After reaching a value of about USD 2000 billion, they fell and accelerated intensively in 2020 due to the Covid-19 pandemic. At that time, the investments fell by 35% compared to the previous year – from USD 1500 billion to USD 1000 billion (Figure 1).

This was the largest decrease in FDIs since 2001 when the Internet bubble burst and it was 10 times greater than the decline in global GDP and five times greater than global trade (Kalotay & Sass, 2021). In the following year, *i.e.* 2021, there was a significant increase in FDIs, by as much as 64%, exceeding the level of the first full year of the Covid-19 pandemic, and they amounted to USD 1582 billion. This was influenced by the dynamically developing market of mergers and acquisitions and the rapid increase in the implementation of project finance as a result of liberal financing conditions, significant state financial aid packages stimulating the development of infrastructure sectors and the reduction of the impact of the 'pandemic shock' (UNCTAD, 2022). In 2022, however, as indicated by the data from the first quarter of this year, a significant weakening of the FDIs inflow was expected.

While the world continued to feel the effects of Covid-19, a new threat emerged in the form of war in Ukraine, with its effects going far beyond its borders. The immediate effects include a dramatic decrease in FDIs inflows to Russia following the imposition of sanctions by many countries, and also a decrease in FDIs inflows to Ukraine due to high political risk. However, the indirect effects on FDIs are much greater. There has been a significant reduction in the supply of energy raw materials from Russia, as well as food, mainly cereals from Ukraine, resulting in a sharp increase in their prices. In many countries, including Poland, there has been a double-digit inflation and forecasts of its further increase, rendering real planning of investments, impossible both domestically and abroad, may lead to social unrest and political destabilization. In order to suppress the inflation, in general, interest rates have been raised

significantly. This has not reduced inflation, although it may have limited its growth rate. Certainly, however, high interest rates on loans and their possible further increase may contribute to a slowdown in global investment processes. According to common predictions, the emergence of risk in the fuel, food, and finance markets will result in a global recession, which will have a negative impact on FDI. In addition, the world is still feeling the effects of the pandemic. In China, the largest recipient of FDIs after the US, the 'zero Covid-19' policy has been implemented with lockdown re-introduced in certain regions that play an important role in global supply chains, which has reduced investment in related industries.

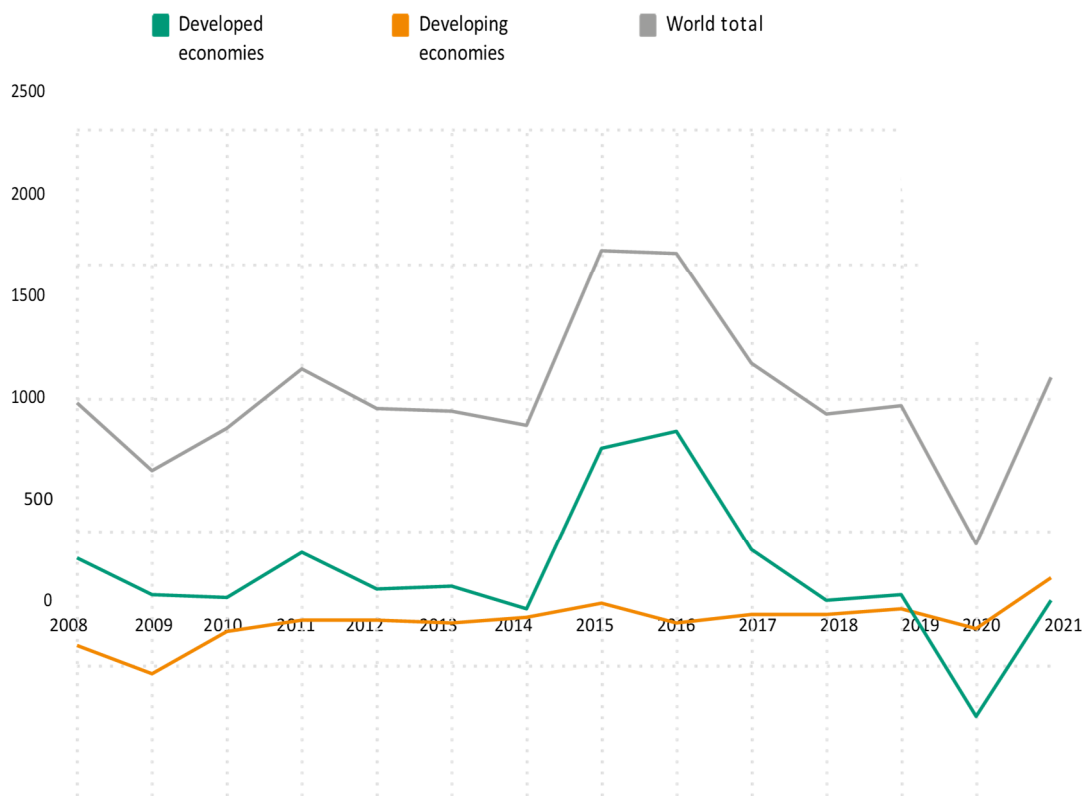


Figure 1. FDI Inflows, Global and by Economic Grouping 2008-2021 (billions of USD)

Source: UNCTAD, 2022.

Noteworthy, the amplitude of fluctuations in the inflow of FDIs to developed countries almost exactly corresponded to that of global FDIs, while the inflow to developing countries was highly stable after the global financial crisis and their collapse in 2020 was smaller than in the developed countries (Kalotay & Sass, 2021).

However, in the analysed FDIs trend in the years 2008-2022, it is impossible to see the impact of 4IR, due to the high level of data aggregation and the previously identified their potential, ambivalent impact on supply chains, *i.e.* both on their development and their limitation. Undoubtedly, however, the increase in risk and uncertainty resulting from the complexity, turbulence, volatility, and ambiguity of economic, political, social, and natural processes in the world will result in the desire to reduce them, where, in the long term, the use of inventions of the current industrial revolution may be of great help.

Motives and Barriers of Reshoring

As already mentioned, the significance of factors stimulating reshoring depends not only on macroeconomic factors existing on the side of the host country and the country of origin of the investment but also on specific factors related to the type of enterprise and industry sector. Since FDIs are carried out mainly by large companies from industries in which the input of human labour plays an important role, it is a logical conclusion that reshoring will mainly concern those companies.

There is extensive literature on the motives, barriers and effects of reshoring. Apart from the theoretical and speculative considerations, the authors have referred to case studies based on various number of companies – from one to several hundred. They have also presented their various classifications and number of motives (Albertoni *et al.*, 2015; Ancarani *et al.*, 2019; Benstead *et al.*, 2017; Dachs *et al.*, 2017; Di Mauro *et al.*, 2018; Eltetö, 2019; Foerstl *et al.*, 2016; Johansson & Olhager, 2018; Kramer, 2017; Nassimbeni *et al.*, 2019; Wiesmann *et al.*, 2017; Young, 2016). In this article, the motives have been divided into related to:

- the host country;
- the company's country of origin;
- the company's specific characteristics;
- the global supply chains.

The first group of motives includes such factors as:

- increase in wages, prices of raw materials, materials, energy, and general costs of doing business in the host country, changing the planned benefits of offshoring;
- economic, political, and social instability;
- large exchange rate fluctuations;
- high and growing inflation;
- increase in taxation and strict control over the use of transaction prices and other methods of tax optimisation;
- government interference in company operations;
- lack of suitably qualified workforce;
- lack of material infrastructure;
- limited availability of appropriate quality raw materials;
- low quality of manufactured products;
- lack of development and innovation of products and manufacturing processes due to the location of R&D centres mainly in the country of origin of the company or in highly developed countries;
- drainage of know-how from the company and lack of adequate protection of intellectual property;
- psychological and cultural distance;
- bureaucracy and corruption;
- general costs of foreign ownership.

The following motives for reshoring are related to the company's country of origin:

- decrease in labour costs due to the use of new technologies and production techniques;
- increase in the efficiency of manufacturing processes;
- shortening of the time of manufacture and delivery to customers;
- higher quality and innovativeness of production;
- increasing operational flexibility;
- effects of the national technological cluster and spillover;
- increasing customer satisfaction and satisfying their preferences to purchase domestically produced products (made in effect);
- reducing the distance to customers and greater possibility of product customization;
- reduction of unemployment;
- social and environmental responsibility of business;
- pressure from trade unions and the government;
- government subsidies for relocation;
- emotional elements (patriotism, loyalty);
- untapped production potential in the country.

Motives specifically related to the company include:

- correction of previous wrong decisions on investing abroad (*e.g.* overestimation of benefits and underestimation of costs);

- change of the company's business strategy;
- termination of contracts with suppliers;
- global reorganization of the company;
- changing the company's business model;
- imitation of competitors.

The last group of motives is related to global supply chains including:

- liquidation or shortening of supply chains;
- reduction of logistics costs;
- reducing the size and cost of inventories;
- elimination of customs, border, and trade costs;
- elimination of minimum delivery requirements;
- elimination of the risk of inadequate quality, size, and delivery times;
- elimination of the risk of supply chain disruption;
- elimination of the risk of damage or loss of chains (*e.g.* due to random events, terrorism, and piracy).

The negative aspects of reshoring primarily include the costs of liquidation of operations abroad and their transfer to the country of origin. The next stage involves launching production based on costly, new, labour-saving technology in this country. There emerges a need to employ highly qualified and therefore highly paid specialists, whose deficit is already noted, also in industrial countries. Not all raw materials and components may be available on the local market. Thus, it remains indispensable to maintain global supply chains to a limited extent. If the global value creation chains formed final products sold in the countries of the FDI location, their liquidation will require their export from the home countries of the transnational corporations with all the consequences related to logistics, costs and other consequences related to them, or launching their comprehensive production on site. Similarly to the overestimation of the positive effects of offshoring, an error in the assessment of the benefits of reshoring can also occur, causing a deterioration of the company's situation.

Trends in the Development of Reshoring

Data on reshoring are poor, fragmentary, estimated, and they sometimes differ from each other. For example, according to data from the Ministry of Trade, Industry and Energy of South Korea, in 2014-2018, on average, 482.2 companies worldwide reshored each year, while 10.4 companies returned to this country annually (Chang-Gyun, 2020). In the same period, Nassimbeni *et al.* (2019) counted 253 cases of reshoring and nearshoring to Europe and the number of jobs resulting from this relocation was 12 840. In turn, Reshoring Initiative, the industrial organization reported that since 2010, as a result of reshoring, 1.6 million jobs were reappointed in the USA, and in 2022 a record number of new jobs related to reshoring, *i.e.* 350 000, was to appear, because 1800 companies planned to completely or partially move their production from abroad (Ouellette, 2022).

In general, empirical evidence indicates that reshoring processes of companies originating from the European Union, the United States and Japan have intensified in the last 10 years, especially from China, with the greatest extent related to large and medium-sized high-tech industries (Consultancy.eu, 2022; Pla-Barber, Villar, & Narula, 2021). A number of studies conducted in numerous corporate populations (1700, 1300, 840) in the US and Europe found a positive and significant relationship between 4IR and reshoring (Kamp & Gibaja, 2021; Raza *et al.*, 2021; Tilley, 2017). In such industries as machinery, electrical, electronics, and means of transport, reshoring was influenced primarily by economic factors, including automation, increased flexibility, and shortening of delivery times that are generally related to 4IR inventions. On the other hand, in the industries of semiconductors, medical products, pharmaceuticals and chemicals, political factors played a greater role, *i.e.* security of supply chains weakened by Covid-19, regional competitiveness, and protectionism. The war in Ukraine and the possibility of an armed conflict between China and Taiwan also seem to have had an impact on the management of transnational corporations increasing their positive attitude to reshoring. According to the Kearney reshoring index, 92% of the surveyed CEOs in the US presented such an attitude towards reshoring, and 79% of those related to manufacturing in China have already moved part of their operations to the US or planned to

do so in the near future as part of the implementation of the China plus investment strategy. A significant part (70%) of the respondents were in the process of executing or planned nearshoring, *i.e.* relocation of a part of delivery chains to Mexico, Canada, or Middle America (Stone, 2022).

In turn, research conducted by BCI Global among CEOs of 125 companies, including 70 from Europe, 40 from the USA, and 15 from Asia from the pharmaceutical, machinery, automotive, and consumer packaged goods industries showed that 60% of them planned moving part of the production from its current location in Asia (BCI Global, 2022).

Reshoring also takes place in Asia. Due to rising labour costs there and the desire to diversify suppliers, Japanese companies, in particular, are moving their production from China to Thailand, Indonesia, Vietnam, and the Philippines (Enderwick & Buckley, 2020). However, substituting China, which is the 'factory of the world,' is not an easy task. It accounts for 60% of global exports of consumer goods and 41% of global exports of the TMT industry: technology, media, telecommunications (WEF, 2020). For example, 75% of blood thinners imported by Italy, 60% of components for the production of antibiotics imported by Japan and 40% by Germany, Italy, and France come from China. Several dozen per cent of imports of various other medical supplies to the G7 countries (bandages, dressings, plasters, antibiotics, etc.) come from China (Javorcik, 2020).

It should be noted that the policy of highly developed countries that supports such activities of companies has a large impact on reshoring. It is conducted intensively in the USA, which was mainly related to President Trump's America First policy, as well as in France, the United Kingdom, Germany, Japan, Taiwan, and Australia. It involves governments providing subsidies, tax reductions and tax holidays, consulting support, removing bureaucratic obstacles, and implementing regional, individualized support programs (Elia *et al.*, 2021).

However, the scale of reshoring and its impact on the economy and employment in the home countries of multinational corporations has been small so far. The main and growing role is played by FDIs' returns from China and other Asian countries, and in the case of Europe, also intra-EU flows and outflows from Russia, in connection with the sanctions imposed on it, to the countries of Central and Eastern Europe, *i.e.* Poland, the Czech Republic and Hungary, as well as to Turkey.

DISCUSSION

The Fourth Industrial Revolution means a transition to the implementation of a business model based on the development strategy and implementation of innovative and ground-breaking technologies for the production of goods and services. Predictive analysis of their potential impact on offshoring leads to the conclusion that artificial intelligence, the Internet of Things, big data, cloud computing, blockchain, and autonomous vehicles will have the most important positive impact on it (Korzynski *et al.*, 2023, Wach *et al.*, 2023).

The use of these devices will optimize global supply chains (WEF, 2017). First of all, the delivery time will be significantly shortened. Advanced methods of forecasting such as predictive and prescriptive information analysis will allow much more accurate predictions of changes in trends in consumer demand. Planning will be conducted and continued in real time of the delivery cycle. It will be shortened and will enable a dynamic response to changes in demand and supply. The growing flexibility of the delivery process will allow customers to change their orders in terms of type, size and destination shortly before the agreed delivery date of the products. Modern means of transport, such as drones, will allow the delivery to be made on the day of placing and accepting the order. This will be particularly important for just-in-time emergency deliveries and perishable products. The storage of products will be minimized, and the entire process will be automated, which will significantly reduce its costs.

The complexity of supply chains will be reduced, they will become more transparent and much better monitored (Capgemini Consulting, 2017; De Beule & Nauwelaerts, 2018; Schrauf & Bettram, 2016; Strange & Zucchella, 2017; WEF, 2017). This will be related to their effective and constant control and the exchange of information between their stakeholders. Business networks and cloud-based platforms will enable them to use the same database. This database integration across the entire supply

chain and its real-time availability will increase its agility. Collaboration between companies and customers will become easier, closer, and more efficient. All participants of the network will have full information on stocks, demand, transport, logistic and production capacities, etc. They will receive information about bottlenecks and ways to remove them in real time. The use of advanced, digital (intelligent), and automated management systems and cost optimization models will mean that supply chain goals can be set and implemented automatically. These systems will be able to recognize risks and emerging threats in supplies and change their parameters in order to remove potential failures.

In turn, decisions to relocate investments to the home countries of TNCs or their neighbouring countries will be particularly favourably influenced by the use of such inventions as advanced robotics, 3D printing, nanotechnology, augmented reality, and digital production simulation.

Advanced robotics includes devices that can function autonomously and communicate with each other and with people. They are equipped with artificial intelligence, which enables them to learn from experience, *i.e.* perform recursive manufacturing processes. Their configuration can be easily changed, which allows for a flexible and quick response to changes in projects. Reprogramming of production, as a result of *e.g.* a change in demand, which in a normal factory requires human intervention and stopping machines can be done autonomously in a 'smart' factory. This is of particular importance in single and low-volume production. Basing production on cyber-physical devices will mean, first of all, a far-reaching reduction in the employment of not only manual workers, but also technical personnel, which is the most important element of production costs in highly developed countries. Thus, this invention can be considered the most important in stimulating reshoring (Gronau, 2015; Habib, 2020; Toorajipour *et al.*, 2021).

Moreover, 3D printing or additive manufacturing consists in manufacturing products in accordance with their programmed digital pattern or drawing by applying successive layers of the appropriate material. In this way, a uniform product with a very complex shape can be created. Laborious and time-consuming preparation of models or dies is eliminated, labour, material, and energy costs are reduced (Abeliansky *et al.*, 2015; Chetan, 2022; Dilberoglu *et al.*, 2017; Laplume *et al.*, 2016; Rayna & Striukowa, 2015).

Direct contact between producers and consumers will enable quick adaptation of production to their changing tastes, *i.e.* customization of products with a further impact on the increase in demand and sales. This will mean the shortening or liquidation of many global supply chains. Intermediate stages of production located in different countries and flows of intermediate goods will be eliminated. It seems that 3D printing can be classified as the second most significant thing for reshoring.

Nanotechnology is the manipulation of atoms and extremely small particles to create materials with high efficiency, negligible weight, great strength, adaptability, and recyclability. The materials can be used to produce intelligent products, *e.g.* with the memory of the previous shape and reacting to changes in external conditions. This technology will be used with an increasing range in the smart factories and 3D production, mainly related to the location in highly developed countries, home countries of TNCs, and thus, they will favour reshoring.

A similar positive impact on reshoring and production in the above-mentioned location will be exerted by augmented reality and digital production simulation. The first device is also referred to as digital prototyping, because it is helpful in the design of machines and devices. It is used in a digital simulation of production, based on the use of special computer software to plan the implementation and testing of the production process and to create its new model. These technologies are developed in R&D centres of transnational corporations and, combined with 3D printing, increase the efficiency and reduce the cost of TNCs production in the countries where their headquarters are located, which has a positive effect on reshoring.

It should be noted that a strict separation of 4IR inventions into those that support offshoring and those that positively affect reshoring is not possible, because, for example, artificial intelligence, the Internet of Things, big data, and cloud computing can be used to support both options. The division presented here means that some of them stimulate the first option more strongly than others.

In general, the impact of 4IR on FDIs will be individualized, *i.e.* it will depend primarily on the degree of advancement of the implementation of its inventions in individual TNCs. This has been taking place with varying intensity, with companies from the United States, China, Germany, Japan, South Korea, and

the United Kingdom being at the forefront (Rymarczyk, 2022). The leaders in these processes are digital platforms such as Facebook, Amazon, Apple, Google, Netflix, Instagram, LinkedIn, Yahoo, Alibaba, and transnational industrial corporations, including General Motors, General Electric, Microsoft, Toyota, IBM, Panasonic, Lenovo, Siemens, Volkswagen, Toshiba, Huawei, Oracle, Sony, Samsung, Mitsubishi, ABB, BMW, Tesla, Bosch, and many others. In general, it is estimated that in recent years, *i.e.* more or less since 2016, the industry has slowed down in the implementation of new technologies and almost 70% of companies in the world are stuck in the pilot stages of their development (*90 Manufacturing*, 2021). However, there are reasons to accept the thesis that in the near future there will be a trend reversal, *i.e.* acceleration of the implementation of 4IR inventions, especially those supporting reshoring.

In general, it should be expected that factors stimulating and inhibiting it will affect it with different time horizons. They will include:

- offshoring stimulated by the improvement of supply chains as a result of the use of 4IR inventions (positive, long-term impact);
- reshoring stimulated by the use of 4IR inventions (negative, long-term impact);
- regionalization, *i.e.* a transition from global investments determined by the pursuit of regional efficiency, looking for outlets and from investments in vertical segments of supply chains to investments at the level of the industrial base and clusters. There will be a shortening of supply chains and nearshoring (negative, long-term impact);
- abandoning single sourcing and geographical diversification of supply sources (positive short and mid-term impact);
- replication (geo-redundancy) of supply sources, *i.e.* several suppliers of the same component (positive, short-term impact);
- economic protectionism and nationalism (negative, long-term impact);
- the growing importance of the imperative of sustainable development (negative, long-term impact);
- Covid-19 (negative, short-term or medium-term impact);
- war in Ukraine (negative, medium-term impact);
- changing the inventories management strategy, instead of just in time just in case, *i.e.* adjusting the size of inventories in the warehouse to the expected demand. This enables *e.g.* replacement of air transport with cheaper rail or sea transport (negative, short-term impact);
- reduction of irreversible DFIs (negative, long-term impact);
- concluding more flexible investment agreements instead of formal, relational ones (negative, long-term impact);
- cooperation in supply chains with other participants in the form of strategic alliances, joint ventures, mergers and acquisitions (positive, long-term impact).

It can be assumed that in the short and medium term, the size of FDIs will be subject to strong fluctuation, *i.e.* they will decrease or increase depending on changes in the external environment of TNCs. However, in the long term, the large-scale application of 4IR inventions will result in both an increase in new investments in the home countries of TNCs or in neighbouring countries and their return from distant foreign locations. However, a radical and permanent decline in FDIs should not be expected. The world economy is highly related to them. About 12% of GDP formation depends on them, and in the case of Germany, it is even 17%. (Flach *et al.*, 2020). Due to the efficiency and pressure of competition, TNCs will continue to choose to use arbitrage and comparative advantages of labour-intensive production in low-wage countries. Moreover, access to raw materials not found in the home countries of TNCs, close access to their sale markets, and lower environmental protection costs will have a positive impact on FDIs.

CONCLUSIONS

For a long time, FDIs were treated as a one-way flow of capital from the country of origin to the host country. The issue of disinvestment, *i.e.* a situation where, for various reasons, an investor was forced to resign from further business activity in a foreign country, was discussed marginally. Most often, these

were issues related to political risk. Relatively recently, however, the phenomenon of transferring foreign investments to the home country, *i.e.* reshoring or the neighbouring country, *i.e.* nearshoring, has been observed. Its size, in relation to offshoring, is relatively small. However, the emergence of breakthrough inventions in the sphere of communication, transport, production, and distribution and their gradual implementation in highly developed countries give rise to grounds for withdrawing from offshoring. Their complex has been called the Fourth Industrial Revolution or Industry 4.0. Probably, the application of its breakthrough inventions on a wider scale than at present will result in a paradigm shift in foreign direct investment. So far, the most important motive for investing in developing countries and emerging markets, *i.e.* cheap labour, will significantly lose its importance. On the other hand, the most important factor in production and services will be modern technology and human capital. Large resources of highly qualified employees and scientists related to new production methods and business models will determine the location of investments. As high technology clusters are located mainly in highly developed countries, they will concentrate on the manufacturing of modern products with high added value. Furthermore, the production of traditional industries such as clothing, textile, leather, and metal, which has so far been carried out in low-wage locations as part of offshoring, may be relocated to home countries, because automation, robotization, and 3D printing will reduce the share of human labour to a minimum, almost completely eliminating unskilled workforce.

Generally, 4IR may mean a weakening of the tendency to globalization or its slowdown (slowbalization). Let us note that the scenario of the development of the situation in the field of foreign direct investment presented in the article is futurological in nature and is based both on the views presented in the literature on the subject and on the author's predictive analysis. Few studies on the impact of 4IR on foreign direct investment have appeared so far. They generally focus on studying the motives behind offshoring and backshoring from the theoretical and limited practical side, *i.e.* based on the case study method of single or more cases, usually in the context of a specific country. This is probably due to the fact that the 4IR industry and its most important devices for FDIs are *in statu nascendi*, so it is difficult to study the impact of something that will take place to a greater extent only in the future. Nevertheless, the discussed phenomena require constant, thorough observation and analysis as well as actions on the part of national governments and intergovernmental organizations, because their effects can be very serious in the economic and social spheres. In particular, the industrialization strategy in developing countries may fail, thus leading to mass unemployment and increased emigration.

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The role and antecedents of contextual intelligence in complex decision-making environments: The case of the pharmaceutical/biotech sector

Richard Evans, Piotr Trąpczyński

ABSTRACT

Objective: The objective of this article is to explore the concept of contextual intelligence (CI) as an important individual trait in complex decision-making environments and to understand its antecedents.

Research Design & Methods: We surveyed 52 professionals from the pharmaceutical/biotech sector to explore the antecedents of CI behaviours by using Spearman's rho correlation analysis, Student's t-tests, and a two-stage cluster analysis.

Findings: Gender does not appear to differentiate the level of CI, while age is only negatively correlated with future-minded behaviour. Respondents with doctorate education were characterised by a higher level of communitarian behaviours than those with lower education qualification attainment.

Implications & Recommendations: In roles which are subject to VUCA (volatility, uncertainty, complexity, and ambiguity) conditions, the integration of linguistics, cultural awareness, and analytical abilities are important besides interpersonal skills, especially in face-to-face or virtual interactions.

Contribution & Value Added: Our study provides a novel empirical contribution to the concept of CI through an exploratory study of medical affairs professionals and their self-reported CI behaviour profiles, including several individual-level characteristics.

Article type: research article

Keywords: Contextual intelligence; decision-making; VUCA; complex environments; decision-maker characteristics

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INTRODUCTION

Scholars have long called for increased attention to the context of decision-making (Elbanna & Child, 2007; Elbanna *et al.*, 2020; Hough & White, 2003; Shepherd & Rudd, 2014). In particular for strategic decisions which can be regarded as 'ill-structured, nonroutine, uncertain and pervasive' (Shepherd & Rudd, 2014, p. 340), the context which needs to be taken into account pertains to the top management team (TMT), strategic decision-specific characteristics, the external environment, or the characteristics of the firm itself. While scholars have long urged to pay more attention to the context in different areas, such as strategy, management or entrepreneurship, the relevance of considering contextual variables in international entrepreneurship (IE) and international business (IB) studies has surfaced relatively recently (Child, 2009; Child *et al.*, 2022; Elbanna *et al.*, 2020; Reuber *et al.*, 2017; Teagarden *et al.*, 2018). In the field of IB, this context is particularly complex, as decision-makers are confronted with several diverse and interrelated economic, cultural, institutional, political, social, and technological as well as other environments across national and organisational borders (Child *et al.*, 2022).

Shapiro, Von Glinow and Xiao (Shapiro *et al.*, 2007) coined the term ‘polycontextuality,’ which refers to multiple and qualitatively different contexts embedded within one another, which contribute to individuals’ – and thus organisations’ – enactment of their situation.

With regard to the aforesaid external context, firms have to operate in a complex environment which may be described as a VUCA, *i.e.* characterised by volatility, uncertainty, complexity, and ambiguity (Breen, 2017; Sarkar, 2016). It is in turbulent environments where Kutz and Bamford-Wade (2013) argue that the relevance of monitoring and responding proactively to the behaviour of other people with appropriate adaptation matters in particular, since the notion of context pertains to the interactions and interdependencies among and between individuals within an organisation and beyond it. Thus, an important characteristic of decision makers can be referred to as contextual intelligence (CI), which ‘is the awareness of the interactions between and movement among these agents which, ultimately informs behaviour in a socially complex environment’ (Kutz & Bamford-Wade, 2013, p. 67).

Meanwhile, a lot of research acknowledging the relevance of the ‘micro-foundations of strategy within international entrepreneurship or international business focuses on the demographic characteristics of decision-makers, such as gender, age, educational background, language skills, or cognitive styles (Elbanna, Child, & Hsieh, 2020; Kiss, Williams, & Houghton, 2013; Maitland & Sammartino, 2015; Shepherd & Rudd, 2014). Some studies investigated the effects of managers’ psychological characteristics on decision processes, including the locus of control, need for achievement, risk-taking propensity, proactiveness or global mindset (Elbanna *et al.*, 2020). However, contextual intelligence (CI) has not been examined for its relevance to international entrepreneurship or international business, although its relevance has been prominently acknowledged (Khanna, 2014; Khanna, 2015). In the meantime, it has been reported as an important leadership skill which can be conducive to ‘identifying external and internal influences that are not immediately obvious’ (Kutz & Stiltner, 2022, p. 2). Kutz and Stiltner (2022) investigated the CI behaviours of athletic trainers practising in the United States of America, with particular attention to differences related to respondent characteristics of the CI behaviours. They found that the most notable difference was athletic trainers with less experience and/or less education reported practising several CI behaviours less than more educated or more experienced respondents. However, there were no differences between males and females. Kutz *et al.* (2017) studied healthcare managers and found, among other things, that female healthcare managers with bachelor’s degrees reported practice of four CI behaviours more frequently than those with some college/technical training, and in three cases those with masters’ degrees more frequently than those with some college/technical training. However, the results with regard to age and education differed for specific dimensions, with no consistent patterns which could be generalised.

Given the aforesaid paucity of research considering decision-maker characteristics of particular relevance, especially in the VUCA environment, in the current exploratory article, we aim to:

- delineate the practice frequency of CI by medical affairs (MA) professionals operating in a complex and dynamic contextual environment;
- describe differences according to respondent characteristics to explore the antecedents to CI behaviours.

We address these objectives in the empirical context of MA professionals from the pharmaceutical/biotech industry whose role is to co-operate and communicate with healthcare professionals (HCP). The definition of ‘health’ that we use is a social construct described by the World Health Organisation (WHO) as ‘a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity’ (WHO, 1946). This is clearly a complex and contextual definition given that we are all unique due to the genetic heterogeneity of the human race, which while being an ally in the ongoing and omnipresent struggle against pathogens, makes medical or clinical decision-making more complex. In this context, the predominantly positivist approach of scientific realism may be challenged in conditions of making healthcare decisions requiring extrapolation of study data for example due to study design which may lead to ambiguity or uncertainty. An interpretivist approach may be more conceptually suited to dealing with data interpretation and discussive communications around

further understanding and application in healthcare decision-making and the development of perspectives required for the extrapolation of study results to inform individual healthcare decisions. Thus, in reality, it is important to emphasise interpersonal and communication skills which could further enhance MA communications with HCPs regarding the translation of scientific research aimed at explaining, discussing, and understanding how this may apply to healthcare decisions and bring relevant feedback on insights from HCPs which companies may act on.

The paper is structured as follows. We will first present the concept of CI and discuss its different applications. Subsequently, we will elaborate on the methodology of our exploratory study and on Kutz's (2017) operationalisation of CI. We will then present our empirical findings and finally, we will discuss their relevance for international business and entrepreneurship.

LITERATURE REVIEW

Contextual intelligence was described by Sternberg (1985) under the concept of practical intelligence, where context-competent individuals showed abilities to easily fit into new surroundings, adapt to the surroundings and be able to manage the surroundings as appropriate which he classified as a contextual sub-theory of intelligence (Sternberg, 1985, p. 45). This concept was further distilled by Terenzini (1993). Given the advances in IT, the growing pace of internationalisation, and the pursuit of increased decision-making effectiveness, Terenzini (1993) implies that there are three forms of personal competence required besides organisational understanding:

- Tier 1 – Technical/Analytical Intelligence;
- Tier 2 – Issues Intelligence;
- Tier 3 – Contextual Intelligence (CI).

Tier 1 appears to be related to a cognitive construct, given that it relates to factual knowledge/information and analytical and methodological competencies and skills for modelling, which may be taken to represent the intelligence quotient (IQ). Tier 2 relates to generic and generalisable organisational and interpersonal skills which are necessary to function effectively which, for modelling, may be aligned with emotional intelligence (EQ). The author proposes that Tier 1 intelligence precedes Tier 2 intelligence.

Tier 3, or, the 'crowning form,' represents the experiential knowledge or wisdom attributes with the other foundational Tiers to facilitate real people taking actual decisions by individuals who earn themselves legitimacy, trust, and respect based on their profiles.

This aspect of decision-making or formulation and implementation of an action plan is further described by Motamedi (2018) as 'contextual competence' which he describes as comprising the hybridisation of CI and development of an action plan.

Khanna (Khanna, 2014; Khanna, 2015) described CI as the ability to understand the limits of our knowledge and to adapt that knowledge to a context different from the one in which it was developed, which may be interpreted as a feature of being able to deal with complexity by applying a concept which appears to be an experiential or tacit knowledge or a feature of an individual showing an ability somewhat similar to experiential innervation. In his publication in 2014 (Khanna, 2014), he also stresses the need for managers to develop experience or knowledge of local context from their own perspective rather than relying on conventional market research.

Khanna (Khanna, 2014) published his perspective on the relationship between theory learned in business schools and practice, noting that many people then overestimate the role of such theory when looking to succeed in international business and entrepreneurship due to differing conditions which exist and are difficult to codify. He further cites the lack of CI as being a contributor to high failure rates regarding cross-border businesses whereas having knowledge of success in a country may not be a significant factor to predict business success in other countries.

It is clear that in some aspects of life, knowing facts and deciding in certain scenarios or areas of life is very easy but in the field of international business and entrepreneurship or discussions around health the context is complex, and we need to understand the limits of our knowledge. With this in

mind, being able to call on and apply CI is a universally important skill when dealing with VUCA conditions and this includes situations when there may be several ‘right answers,’ but CI will seek to identify and focus on the best answer or option to implement (Kutz, 2017, p. 14).

Kutz and Bamford-Wade (2013) reported that CI is a model which facilitates leadership and improvement of performance in complex, transforming environments which according to Knight *et al.* (1997) represents a better predictor than IQ in real-life scenarios. Noteworthy, CI is differentiated from emotional intelligence (EQ) through the application of good judgement and intuitive insights especially in the environment of non-linear relationships (Kutz & Bamford-Wade, 2013; Nye, 2008).

While the concept of CI was previously published, Kutz identified specific behaviours related to it (Kutz, 2017; Kutz & Bamford-Wade, 2013). The contextual intelligence framework is a circumplex based on 12 behaviours organised around three time-orientations (*i.e.* Hindsight, Insight, and Foresight), called 3D thinking, which in turn are grouped according to three meta-skills (Complexity Thinking, Synchronicity, and Tacit Awareness) (Kutz, 2017; Kutz & Bamford-Wade, 2013). This operationalisation of CI will be used in our exploratory study described in the ensuing sections.

With regard to medical education, there is a major challenge to academic constructs related to the clinical practice of systems thinking at the level of an individual patient which may lead to challenges when working with complex scenarios where benefit may be achieved through deviation from mechanistic guidelines (Paes, 2019). These mechanistic guidelines do of course have validity in certain non-complex scenarios but there is also a need to be able to act in a non-linear fashion when appropriate. Overall, this interface between theory and practice does raise questions about the level or balance of educational attainment required for particular roles versus experience. Especially, when these may not be major actors in the final decision-making. This is of course a major area of differentiation between medicine and IB given that even after discussion of certain treatments with a physician the patient may still decline treatment, whereas in business the actions are more controlled and implemented based on the decisions taken.

Despite recent evidence supporting females attaining higher grades in school subjects, we still see evidence of under-representation for females in STEM subjects (Science, Technology, Engineering, and Mathematics) which the authors report as being multifactorial (Verdugo-Castro *et al.*, 2022). Given this scenario, a vital research question arises as to the profiles of CI in females compared to males in light of the hybridisation required to effectively implement praxis in the fields of complex decision-making requirements. Thus far, only Kutz *et al.* (2017) investigated differences in CI of females with different levels of education, while Kutz and Stiltner (2022) looked into differences between education level, experience level, and the number of credentials. We followed these research efforts in the context of the pharmaceutical/biotech sector to address the research questions of how CI behaviours differ between:

RQ1: gender;

RQ2: age;

RQ3: education level;

RQ4: area of study (*related to the context, i.e. medical and healthcare, or unrelated*).

RESEARCH METHODOLOGY

Empirical Setting and Data Collection

One response to engage and support healthcare decision-making by HCPs in healthcare industries from the pharmaceutical, biotech, and medical device sectors has been to develop and implement a medical affairs (MA) function which has a major role in communicating scientific or medical information to and from HCPs in a fair, balanced, and scientifically accurate framework. Core requirements for roles in MA are usually to hold an advanced degree and have the ability to show strong interpersonal skills and be able to communicate scientific and technical data effectively (Theron *et al.*, 2021). Typical qualifications for these roles include physicians, pharmacists, and MSc- or PhD-level scientists; other profiles supplementary to medicine may also be considered.

Training for these roles is usually delivered by the employing company and covers disease area and therapeutics, compliance including pharmacovigilance, company product training, and any additional legal/regulatory or company standard operating procedures required to perform the defined role they are employed to do. There is currently no additional required certification for roles in MA apart from those covered under typical qualifications.

The MA function is a hybrid department which includes both face-to-face functional roles (usually field-based as medical science liaisons (MSL), or hybrid including head office/field-based roles) or non-HCP facing roles which includes the Medical Information (MI) service.

The challenges of engaging with HCPs in order to communicate scientific or medical data dictate that soft/human skills would also play a very important part, especially when engaging in face-to-face or virtual encounters with HCPs. These skills may also improve opportunities for further career development in a corporate and/or internationally mobile profession within MA function and life.

A non-experimental descriptive survey of MA professionals' self-reported behaviours was conducted utilising a cohort based on a sample of LinkedIn networked professionals from the pharmaceutical and biotech sectors. The survey was targeted mainly at MA professionals. However, some responses were collected from medical, commercial, global marketing, or medical communications functions depending on the respondents' description of responsibilities which may differ across organisations. The data collection took place in October 2021 and resulted in an effective sample size of N=51. The objective of the convenience sampling was to account for the role of such respondent characteristics as gender, age, and the level and field of education. The distribution of these characteristics is provided in Table 1.

Table 1. Characteristics of the respondents

Characteristics	N (%)
Gender (N=51)	
Female	22 (43)
Male	29 (57)
Age range (yrs)	
25-34	8 (16)
35-44	9 (18)
45-54	22 (43)
55-64	12 (24)
Highest level of academic qualification obtained	
Bachelor's degree	1 (2)
Master's degree	20 (39)
Doctorate	30 (59)
Field of highest educational attainment	
Business	1 (2)
Healthcare	13 (25)
Medicine	13 (25)
Pharmacy	5 (10)
Science	19 (37)
Current role function	
Commercial	1 (2)
Medical	11 (22)
Medical Affairs	37 (73)
Other	
Global Marketing	1 (2)
Medical Communications	1 (2)

Source: own elaboration of the survey data.

Data Operationalisation

The Contextual Intelligence Profile (CIP™) tool used had content validity established in a previous publication (Kutz *et al.*, 2017) and was developed by Matthew Kutz, who represents his framework for CI as a circumplex representing three meta-skills described as complexity thinking, synchronicity, and tacit awareness related to time-oriented descriptors of foresight (the ability to articulate a realistic plan for an ideal future), hindsight (the ability to use past experiences to their full advantage), and insight (the ability to understand what influences the present moment) which he further describes as 3D thinking and these are further defined through 12 CI behaviours aligning four behaviours per 3D thinking descriptor (Kutz, 2017). Kutz originally identified the 12 CI behaviours following a series of research projects which focused on identifying important leadership behaviours regardless of industry, job, or rank in an organization (Kutz, 2017). He describes CI as ‘the ability to demonstrate the skill to discern, transition between, and respond to many different contexts’ (Kutz, 2017, p. 31).

Moreover, the 12 behaviours comprise CI when they are practised en-masse as it is the sum of these parts and not individual behaviours which demonstrate CI in practice (Kutz, 2017, p. 37–50). The details of the measurement instrument are provided in Table 2.

Table 2. CI behaviours’ conceptual framework

3D thinking dimension	CI behaviour	CI description
Foresight	Diagnoses context	Awareness and understanding of the environment related to people and surroundings related to how they may influence each other.
	Change agent	Ability to ask or raise difficult or challenging questions to introduce or do things differently through readily supporting with full confidence, highlighting the danger of not changing and also having an open mind for further continuous improvements.
	Future-minded	Ability and self-awareness as to when they can see and communicate a clear plan aimed at overcoming obstacles and/or contradictions which may of course change as well as when to consult others to help fill any gaps in the plan(s).
	Intentional leadership	A keen self-awareness of leadership style and personal preferences in order to learn and adopt additional appropriate leadership styles in advance of being required.
Hindsight	Constructive use of influence	Accurate interpretation based on previous experience of which power (legitimate, expert, referent, coercive, reward) is likely to be most effective with certain individuals and/or situations.
	Critical thinker	A high degree of self-awareness to recognise limitations and bias in their perspectives but readily embrace complexity and new ideas through critical analysis of the past and the ability to innervate experiences.
	Influencer	Differentiated from ‘constructive use of influence’ focusing on the use of interpersonal skills, previous success and empathy to communicate your perspective and building rapport to enable/inform awareness of whether the message is received.
	Consensus builder	Aligning people with different perspectives and/or competing values around a collaborative solution through the appropriate use of questions and harmonising the different perspectives into a good-faith effort.
Insight	Communitarian	A personal trait which is focused on active support for a community and the connection or interactions between self and the community with which you may identify with based on deeply-held beliefs.
	Mission minded	Alignment with corporate equity and reputation with a heightened awareness of how the performance and actions of self and/or others may affect perceptions of the employing organisation.
	Appreciates diverse ideas	Demonstrating courage to listen to alternative or additional ideas of people who may have different perspectives to yours in a sincere way which builds respect even in an environment of disagreement, conflicting, or different ideas.
	Multicultural leadership	A leadership trait which demonstrates empathy to try to understand differences in cultures, gender and ethnicity in a demonstration of authenticity, humility and appreciation that context matters.

Source: own elaboration based on Kutz (2017).

To address the research objectives formulated at the outset, we conducted statistical analyses using the IBM SPSS Statistics version 25 package. Using this tool, Spearman's rho correlation analysis and Student's t-tests as well as a two-stage cluster analysis were performed. The classic threshold $\alpha = 0.05$ was adopted as the level of statistical significance. Prior to conducting all analyses, the data set was analysed for missing values, revealing that they were random. Thus, stochastic regression imputation (simple imputation) was used.

To prepare the data for analysis, first, the distributions of all variables were verified. Basic descriptive statistics were calculated together with the Shapiro-Wilk test. Due to the presence of outliers exceeding the third standard deviation, they were removed and replaced with the next closest values in the set. The results of the analysis are presented in Table 3 for the main dimensions of the CI tool and the specific behaviours, respectively.

Table 3. Descriptive statistics with the Shapiro-Wilk test

Variables	<i>M</i>	<i>Me</i>	<i>SD</i>	<i>Sk.</i>	<i>Kurt.</i>	<i>Min.</i>	<i>Max.</i>	<i>W</i>	<i>p</i>
Hindsight	65.82	68.00	11.44	-0.47	0.47	31.00	88.00	0.98	0.514
Foresight	65.67	67.00	11.77	-0.27	-0.50	39.00	90.00	0.98	0.551
Insight	64.04	66.00	11.79	-0.98	1.08	29.00	83.00	0.94	0.010
Communitarian	13.59	14.00	4.35	-0.49	-0.86	4.00	20.00	0.94	0.008
Diagnoses Context	16.94	18.00	3.46	-0.65	-0.23	8.00	22.00	0.94	0.018
Consensus Builder	15.94	16.00	3.23	-0.55	0.48	7.00	23.00	0.97	0.146
Mission Minded	14.77	15.00	4.11	-0.59	-0.19	5.00	22.00	0.96	0.066
Embraces Diverse Ideas	17.37	17.00	3.61	-0.27	-0.66	9.00	24.00	0.97	0.181
Influencer	16.86	18.00	3.27	-0.17	-0.31	10.00	24.00	0.97	0.319
Critical Thinker	16.94	17.00	3.02	-0.38	0.48	9.00	23.00	0.97	0.251
Multicultural Leadership	18.47	19.00	3.19	-0.52	-0.08	10.00	24.00	0.96	0.125
Future Minded	16.82	17.00	3.29	-0.25	-0.71	10.00	23.00	0.97	0.144
Change Agent	15.90	16.00	3.76	-0.27	-0.33	7.00	24.00	0.97	0.265
Intentional Leadership	16.00	16.00	3.92	-0.53	0.42	4.00	23.00	0.97	0.208
Constructive Influence	16.24	17.00	3.43	-0.45	0.06	6.00	22.00	0.96	0.082

Source: own elaboration of the survey data.

The distribution normality tests showed that the distributions of most variables were close to the Gaussian curve. Only the Communitarian and Diagnoses Context indicators of CI were distant from the normal distribution ($p < 0.05$). However, the skews did not exceed the absolute value of 1. This indicates a distribution with a slight level of asymmetry. Therefore, the ensuing analyses were based on parametric tests.

RESULTS AND DISCUSSION

Relationships Between Contextual Intelligence and Sociodemographic Variables

To explore how sociodemographic variables are related to CI, both a series of Student's t-tests for independent samples and an analysis of Spearman's rho correlation were performed, whereby gender differences were tested first. The conducted Student's t-test for independent samples revealed no statistically significant effects. This means that gender did not appear to differentiate the level of CI, neither for the main dimensions nor for specific behaviours (Table 4).

Subsequently, the analyses of Spearman's rho correlation between age and indicators of CI were performed. Table 5 presents the results of this analysis. The analysis showed that age was only related to the contextual intelligence behaviour of Future Minded. The relationship was negative and moderate. It follows that the older the respondents were, the lower the intensity of this CI behaviour among them. The other correlations were statistically insignificant.

In the next step, it was verified whether the level of education differentiates the intensity of behaviour related to contextual intelligence. Bachelor's education ($n = 1$) and graduate education ($n = 20$) were combined for the analyses. Student's t-tests were performed again for independent samples (Table 6).

Table 4. Gender differences in CI

Variables	Male (<i>n</i> = 29)		Female (<i>n</i> = 22)		<i>t</i>	<i>p</i>	95% <i>CI</i>		Cohen's <i>d</i>
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>			<i>LL</i>	<i>UL</i>	
Hindsight	65.03	12.85	66.86	9.46	-0.56	0.577	-8.38	4.72	0.16
Foresight	65.65	12.50	65.68	11.03	-0.01	0.993	-6.78	6.73	0.00
Insight	63.45	13.68	64.82	8.97	-0.41	0.686	-8.12	5.39	0.12
Communitarian	13.24	4.83	14.05	3.68	-0.67	0.503	-3.20	1.59	0.18
Diagnoses Context	16.76	3.65	17.18	3.25	-0.43	0.668	-2.40	1.56	0.12
Consensus Builder	15.86	3.46	16.09	2.83	-0.25	0.802	-2.05	1.59	0.07
Mission Minded	15.00	4.04	14.45	4.26	0.47	0.643	-1.81	2.90	0.13
Embraces Diverse Ideas	17.45	3.94	17.27	3.21	0.17	0.865	-1.90	2.25	0.05
Influencer	16.72	3.56	17.05	2.90	-0.34	0.732	-2.19	1.55	0.10
Critical Thinker	16.90	3.45	17.00	2.43	-0.13	0.901	-1.76	1.55	0.03
Multicultural Leadership	18.03	3.52	19.05	2.66	-1.12	0.267	-2.82	0.80	0.32
Future Minded	17.07	3.52	16.50	3.00	0.61	0.546	-1.31	2.45	0.17
Change Agent	16.34	3.83	15.32	3.68	0.96	0.340	-1.11	3.17	0.27
Intentional Leadership	15.48	4.32	16.68	3.29	-1.08	0.284	-3.42	1.02	0.31
Constructive Influence	15.79	3.58	16.82	3.20	-1.06	0.295	-2.97	0.92	0.30

Source: own elaboration of the survey data.

Table 5. Age differences in CI

Variables	Statistics	Age
Hindsight	Spearman's <i>rho</i>	-0.14
	significance	0.317
Foresight	Spearman's <i>rho</i>	-0.17
	significance	0.244
Insight	Spearman's <i>rho</i>	-0.12
	significance	0.412
Communitarian	Spearman's <i>rho</i>	-0.05
	significance	0.703
Diagnoses Context	Spearman's <i>rho</i>	-0.08
	significance	0.570
Consensus Builder	Spearman's <i>rho</i>	-0.10
	significance	0.469
Mission Minded	Spearman's <i>rho</i>	-0.19
	significance	0.192
Embraces Diverse Ideas	Spearman's <i>rho</i>	-0.11
	significance	0.428
Influencer	Spearman's <i>rho</i>	-0.12
	significance	0.391
Critical Thinker	Spearman's <i>rho</i>	-0.11
	significance	0.457
Multicultural Leadership	Spearman's <i>rho</i>	-0.06
	significance	0.676
Future Minded	Spearman's <i>rho</i>	-0.30
	significance	0.031
Change Agent	Spearman's <i>rho</i>	-0.01
	significance	0.951
Intentional Leadership	Spearman's <i>rho</i>	-0.13
	significance	0.358
Constructive Influence	Spearman's <i>rho</i>	-0.10
	significance	0.488

Source: own elaboration of the survey data.

Table 6. Differences in CI dimensions depending on the level of education

Variables	Bachelor's & master Degree (n = 21)		Doctorate (n = 30)		t	p	95% CI		Cohen's d
	M	SD	M	SD			LL	UL	
Hindsight	67.38	10.32	64.73	12.22	0.81	0.422	-3.92	9.21	0.23
Foresight	66.19	10.95	65.30	12.49	0.26	0.793	-5.90	7.69	0.08
Insight	62.67	8.21	66.27	11.14	-1.26	0.214	-9.35	2.14	0.36
Communitarian	11.33	3.92	15.17	3.97	-3.41	0.001	-6.09	-1.57	0.97
Diagnoses Context	16.57	3.30	17.20	3.60	-0.63	0.529	-2.62	1.36	0.18
Consensus Builder	16.38	2.82	15.63	3.50	0.81	0.421	-1.10	2.60	0.23
Mission Minded	14.57	4.25	14.90	4.07	-0.28	0.781	-2.70	2.04	0.08
Embraces Diverse Ideas	17.43	3.44	17.33	3.78	0.09	0.927	-1.99	2.18	0.03
Influencer	17.57	3.38	16.37	3.15	1.30	0.198	-0.65	3.06	0.37
Critical Thinker	16.33	3.14	17.37	2.92	-1.21	0.233	-2.75	0.69	0.34
Multicultural Leadership	18.10	3.13	18.73	3.26	-0.70	0.488	-2.47	1.20	0.20
Future Minded	16.90	3.42	16.77	3.26	0.15	0.884	-1.76	2.04	0.04
Change Agent	16.24	3.75	15.67	3.82	0.53	0.599	-1.60	2.74	0.15
Intentional Leadership	16.48	2.79	15.67	4.57	0.78	0.437	-1.26	2.88	0.21
Constructive Influence	17.10	3.03	15.63	3.61	1.52	0.135	-0.47	3.40	0.43

Source: own elaboration of the survey data.

Only the communitarian index showed clear differences. The recorded effect was very powerful. Comparing the means, respondents with doctorate education were characterised by a higher level of Communitarian behaviours than those with lower educational attainment. The remaining indicators of CI were not differentiated by the education of the respondents.

Finally, we verified whether there were differences in the behaviour of CI depending on the field in which the respondents completed their education. For our analyses, the fields of medicine (n = 13) and health care (n = 13) were combined into one group and compared with the fields of science or other fields: economics (n = 1), pharmacy (n = 5), and science (n = 19). The results of the Student's t-tests for independent samples turned out to be statistically insignificant for each variable. This means that medical subjects did not differ from research subjects in terms of CI (Table 7).

Table 7. Differences in CI dimensions depending on the scientific area

Variables	Medicine & healthcare (n = 26)		Science & other (n = 25)		t	p	95% CI		Cohen's d
	M	SD	M	SD			LL	UL	
Hindsight	64.96	11.92	66.72	11.09	-0.54	0.588	-8.25	4.73	0.15
Foresight	66.15	12.38	65.16	11.34	0.30	0.766	-5.69	7.68	0.08
Insight	62.92	13.54	65.20	9.80	-0.69	0.496	-8.95	4.40	0.19
Communitarian	13.54	4.82	13.64	3.90	-0.08	0.935	-2.58	2.37	0.02
Diagnoses Context	16.88	3.23	17.00	3.74	-0.12	0.908	-2.08	1.85	0.03
Consensus Builder	16.00	3.73	15.88	2.68	0.13	0.896	-1.71	1.95	0.04
Mission Minded	14.73	3.83	14.80	4.45	-0.06	0.954	-2.40	2.27	0.02
Embraces Diverse Ideas	16.65	3.84	18.12	3.27	-1.47	0.149	-3.48	0.54	0.41
Influencer	16.65	2.78	17.08	3.75	-0.46	0.648	-2.30	1.44	0.13
Critical Thinker	17.04	3.03	16.84	3.08	0.23	0.817	-1.52	1.92	0.07
Multicultural Leadership	18.31	3.39	18.64	3.03	-0.37	0.714	-2.14	1.48	0.10
Future Minded	16.69	3.22	16.96	3.42	-0.29	0.775	-2.14	1.60	0.08
Change Agent	16.42	3.47	15.36	4.05	1.01	0.318	-1.06	3.18	0.28
Intentional Leadership	16.15	4.46	15.84	3.35	0.28	0.778	-1.91	2.54	0.08
Constructive Influence	15.58	3.25	16.92	3.53	-1.41	0.164	-3.25	0.57	0.40

Source: own elaboration of the survey data.

Cluster Analysis of CI

To classify the groups from the studied sample in terms of their sociodemographic variables and the behaviour of CI, a two-stage cluster analysis was performed. The analyses included gender, education, and all indicators of CI. The analysis was set up to distinguish three clusters. The Silhouette measure was 0.3, which indicates the correctness of group separation. The three cluster groups were evenly distributed: $n = 17$, 33.3%. Figure 1 shows the distribution of these clusters.

In the first cluster, people with a relatively low level of CI behaviours were identified. Most of them were men with doctoral degrees. The second group included people with a high level of CI. They were also men who completed their education with a doctoral degree. The third cluster included people with a relatively moderate level of CI. They were mainly women with bachelor's or master's degree. Table 8 provides detailed information on the prediction coefficients and the percentages of the factors.

Table 8. Cluster characteristics extracted from the analysis in the studied sample

Predictors	Predictor relevance	Cluster 1 ($n = 17$; 33.3%)	Cluster 2 ($n = 17$; 33.3%)	Cluster 3 ($n = 17$; 33.3%)
Intentional Leadership	1.00	11.94	19.29	16.76
Constructive Influence	0.90	12.71	18.82	17.18
Education	0.79	Doctorate (88.2%)	Doctorate (88.2%)	Bachelor & Master Degree (100%)
Influencer	0.78	13.65	19.18	17.76
Diagnoses Context	0.65	14.17	19.88	16.76
Consensus Builder	0.52	13.35	18.24	16.24
Mission Minded	0.51	11.59	17.76	14.94
Critical Thinker	0.49	15.00	19.41	16.41
Future Minded	0.46	14.41	19.18	16.88
Change Agent	0.33	13.47	18.24	16.00
Embraces Diverse Ideas	0.24	15.42	19.12	17.76
Multicultural Leadership	0.23	16.82	20.24	18.35
Communitarian	0.21	13.29	16.00	11.47
Sex	0.07	Male (70.6%)	Male (58.8%)	Female (58.8%)

Source: own elaboration of the survey data.

To summarise, our study provides a novel empirical contribution to the concept of CI through an exploratory study of MA professionals and their CI behaviour while taking into account several individual-level characteristics. It is interesting to observe the similarity observed between this group and female hospital managers (Kutz *et al.*, 2017) where 'communitarian' is reported as the lowest mean behaviour for both groups as well as showing statistically significant differences based on educational attainment comparing bachelor's/master's degrees versus doctorates ($p = 0.001$). This may require further research, especially when looked at from the perspective of Maslow's sixth tier of self-transcendence (Venter, 2017) in which Maslow describes this person as being someone who is freed from a 'dichotomous way of thinking' (Maslow, 1968, p. 180) with potential to have global impact in which they are able to identify and understand different perspectives and not become infatuated with self (Venter, 2017).

The insights from this study can be summarised by regarding the reported frequencies of behaviours in comparison with the *a priori* ranges used in Kutz *et al.* (2017) (Table 9).

Our findings indicate that around 83.3% (10/12) of the CI behaviours were reported to be practised with very high or high frequency with only mission-minded and communitarian being reported as moderate or low respectively, which is where both of these behaviours were reported among US female hospital managers (Kutz *et al.*, 2017).

Table 9. Ranked CI behaviour frequencies (Frequency ranges determined a priori as in Kutz et al., 2017)

Dimension	Mean value	Very High (≥ 16.75)	High (15.50-16.74)	Moderate (14.41-15.49)	Low (≤ 14.40)
Communitarian	13.59				X
Diagnoses Context	16.94	X			
Consensus Builder	15.94		X		
Mission Minded	14.77			X	
Embraces Diverse Ideas	17.37	X			
Influencer	16.86	X			
Critical Thinker	16.94	X			
Multicultural Leadership	18.47	X			
Future Minded	16.82	X			
Change Agent	15.90		X		
Intentional Leadership	16.00		X		
Constructive Influence	16.24		X		

Source: own elaboration of the survey data.

CONCLUSIONS

This peculiar empirical context with its complexity and the relevance of managerial skills pertaining to an understanding, interpretation, and appropriate reaction to the context can be regarded as a proxy for the broader notion of doing business in VUCA environments. Besides interpersonal skills, in roles which are subject to VUCA conditions, the integration of linguistics, cultural awareness, and analytical abilities are important, especially in face-to-face or virtual interactions. Noteworthy, as a concept, CI is very important in complex scenarios for individuals working in organisations as it enables them to appreciate and understand the specific aspects of the organisational culture and dynamics and thus improves the possibility to make better context-based decisions.

Furthermore, CI is important for decisions in the area of international entrepreneurship and business, because it may improve decision-makers' understanding and ability to respond to the unique opportunities and challenges presented by the different scenarios which are likely to be unique with more than one correct answer or option available. Indeed, the international activities of the firm are influenced by the external context, both of the foreign countries where the firm is operating and its home economy, as well as the internal context provided by the characteristics of the organisation itself and its members (Child *et al.*, 2022).

This leads to the realisation that since firm internationalisation is a highly uncertain process and as decision-makers cope differently with the related uncertainty, the issues of cognitive limits, tolerance of risk and uncertainty, and experience are crucial factors determining strategic decisions (Maitland & Sammartino, 2015; Niittymies & Pajunen, 2020). Extant research provides some evidence that these skills are crucial especially if the actors in the decision process have diverse cultural and educational backgrounds and experiences (Kiss *et al.*, 2013). However, while the vital importance of CI as a skill in an international environment has been already underlined (Khanna, 2014; Khanna, 2015), its use as an important individual characteristic of decision-makers which goes beyond the conventionally studied variables, such as age, education, or international experience is yet to take place.

Thus, talent management professionals within pharmaceutical/biotech and medical device and other industries should consider CI as an area which can help to identify and equip people who are more likely to develop as international leaders given the skills required for navigating a VUCA environment in order to make improved or informed career development and/or internationalisation decisions.

This descriptive, exploratory small sample size dataset of MA professionals currently working in the pharmaceutical/biotech environment carries a high risk of bias because of the Likert scale, self-rating perception method, sample selection criteria, and generalisation of results; both in healthcare as well as

other complex environments such as international business. Future studies should consider the alignment of CI and leadership profiles aligned with positivist/interpretivist phenotypes in areas which explore the confirmation of CI as a key skill for complex decision-making in VUCA environments such as healthcare, internationalisation, or portfolio management. Scholars should also consider proposing a model which looks at the hypothetical relationship between IQ, EQ, and CI for personnel development.

In addition to these avenues of exploration, it would be useful to further explore the 3D profiles given the potential importance of hindsight given that many entering roles in MA are likely to be recently qualified and as such, they may hypothetically have clear development requirements in order to communicate more effectively with senior, very experienced healthcare key opinion leaders; the same criteria need to be assessed and applied for people making IB and internationalisation/portfolio decisions. The rationale also supports experience which may illustrate previous success (with the caveat that each decision is likely to be unique) and the potential to implement what we describe as 'experiential innervation' which is the connecting of dots from your experience in different areas/conditions to hybridise a solution, which may also include nonlinear thinking.

To sum up, this exploratory investigational study sought to raise awareness of contextual intelligence and suggest future questions and hypotheses to be explored in future research. It also reported that amongst MA professionals, CI behaviours are reported to be practised with high frequency – further research will be necessary to align and validate these behaviours in relation to role performance and positive outcomes in VUCA decision-making environments such as healthcare and international business.

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Study-related determinants of university graduates' entrepreneurship

Mariusz Trojak, Paulina Hojda, Sylwia Roszkowska

ABSTRACT

Objective: The study undertook an assessment – unique in Polish conditions – of the factors related to higher education differentiating the group of graduates of the Jagiellonian University (JU) in terms of their professional activity in the context of taking up employment or starting self-employment.

Research Design & Methods: Lazear's theory was applied to find study-related entrepreneurship determinants. The study attempted to determine the factors influencing the employment of Jagiellonian University graduates or their self-employment. The following explanatory variables were used during the study: scientific discipline and students' faculty, professional activity or possibly running a business by the student, mode of study (full-time versus part-time), and scientific and non-scientific activities such as volunteering, undertaking studies abroad, and internships. The analyzes were based on data collected during the alumni career paths research of more than 6000 graduates who completed their studies between 2015 and 2019.

Findings: The Mann-Whitney test and parametric t-Student tests showed that graduates of the JU who started a business, as opposed to those who work as employed persons, already set up a business during their studies and then continued it or started other types of business activity. Regarding the two analysed groups of students, there were significant differences in the completed faculty, study mode (full-time versus part-time), student internships, studies, internships abroad, and volunteering.

Implications & Recommendations: The results of the analyses can be used by several groups of beneficiaries. Firstly, they can be useful for high school graduates intending to start higher education, as they indicate such disciplines and fields of study, after which the chances of professional success are the highest. The second group interested in the results of this work might be university students, who, based on its results, may undertake additional academic and non-academic activities that could increase their chances of professional success. Thirdly, the management of universities can use the results of research when preparing an educational offer that would be best suited to the needs of the labour market.

Contribution & Value Added: The subject of factors differentiating the professional attitudes of university graduates, especially in countries undergoing systemic transformation, is insufficiently explored. Deficiencies in quantitative research based on large sets of data are particularly visible. This article fills this gap by pointing to the factors that significantly affect self-employment or hired work by graduates of the oldest and one of the most renowned universities in Poland.

Article type: research article

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INTRODUCTION

One of the most important life decisions that young people make is to start their professional career as an employed person or as an entrepreneur. Often, these decisions are related to the decision to start university studies. It is worth paying attention to the global trend which is the systematic increase

in the percentage of people undertaking higher education. Today, tertiary education is, on average, the most common attainment level among 25-34-year-olds in OECD countries and constitutes 45%; in Poland, it is 43% (OECD, 2022). According to the EU policy, universities should support entrepreneurial activities and hence positively influence economic and social progress (European Commission, 2006). As we know, almost half of the population between 25 and 34 years old take up tertiary education, hence, entrepreneurial support at universities becomes important. The study attempted to analyse the factors related to studies that differentiate graduates of Jagiellonian University (the oldest and one of the most respected universities in Poland) in terms of the type of professional activity after graduation. The study was based on data from the Careers Service of the Centre for Academic Support JU. The research contributes to the entrepreneurship literature by empirically testing Lazear's hypothesis using a sample of JU graduates in the period 2014-2019 and narrowing the determinants to those related to students' academic activities. According to Sułkowski (2016), one of the basic conditions for the development of entrepreneurship is an appropriate educational process, carried out at all levels of education, including higher education. For this reason, this study attempted to identify significant studies-related determinants that affect the decision made by graduates of Jagiellonian University to take up employment or start their own businesses.

Many researchers focus on the issues of motivation and factors determining the decision of university graduates to start a business. A popular psychological approach is a theory of planned behaviour (TPB) developed by Ajzen (1991). It assumes that intentions are a significant determinant of human social behaviour. In his model, Ajzen indicates that the intended results from the expectations of a given person regarding the benefits of a given behaviour – attitude, the perception of the correctness of this behaviour from the point of view of social norms – subjective norms, and additionally from the assessment of the difficulty of a given behaviour: perceived behavioural control (Wasilczuk, 2021; Wach & Bilan, 2021). Concerning this theory, a person can have the feeling of having control over life and taking up self-employment can be a manifestation of this ability to control.

Such an approach, however, seems to be insufficient to fully explain entrepreneurial attitudes based on social psychology. The alternative entrepreneurial intention model is called Shapero's entrepreneurial event (SEE). Initially, it was developed by Shapero (1975), then developed by Sokol (1982), and finally, Kruger contributed to it with important findings (1993). According to the SEE model, individuals' intentions are guided by inertia until something disturbs or displaces them (Krueger & Brazeal, 1994). Such displacement is an initial factor that causes a change in human behaviour (Shapero & Sokol, 1982). Such a change can push an individual into risky behaviour connected with starting up a business. According to Ayob, Yap, Sapuan, and Rashid (2013), displacement can be negative like the lack of job satisfaction, or positive such as rewards. Noteworthy, the SEE model stresses that desirability, feasibility, and a propensity to act are the major factors that control an individual's intention to create a new venture (Ahuja, Akhtar, & Wali, 2019). Perceived desirability refers to a situation in which an individual starts a company, and perceived feasibility is the recognition by an individual that he or she can establish such a company, while the perception of attractiveness is influenced by personal attitudes, values, and feelings that result from the individual's social environment, such as family, friends, and colleagues. Factors such as knowledge and human and financial resources influence the perceived feasibility (Shapero & Sokol, 1982). It is worth mentioning that entrepreneurial activities are risky, and risk is the central part of entrepreneurial intention (Zhang, Wang, & Owen, 2015). Many researchers proved that a positive attitude towards risk or a willingness to bear uncertain results is associated with entrepreneurial intention (Douglas & Shephard, 2002). Wach indicates that the environment and experience of the family business has a positive effect on entrepreneurial intentions, making students with family entrepreneurship background more entrepreneurial than those that do not have such experience (Wach, 2015).

The intention to become an entrepreneur is not a sufficient condition to start a business. According to Piróg (2014), there are external and internal determinants that create four groups of factors interacting with each other. These are individual/personal characteristics of an individual, social capital/social conditions, potential/competence, qualification capital (education and experience), and external condi-

tions (macroeconomic context). This approach is coherent with Lazear's 'jack-of-all-trades' theory, according to which the choice between self-employment and paid employment shows that having a background in many different roles increases the probability of becoming an entrepreneur (Lazear, 2002). University education and university-related additional activities deliver a lot of various competencies to the students. In turn, it may influence the choice of an individual graduate to become self-employed or paid employed. In this research, Lazear's model was applied to identify study-related determinates which have an impact on JU graduates to search for paid employment or start their own businesses.

The rest of the paper is organized as follows. Section 2 briefly reviews the evolution of university graduates' entrepreneurship and develops our hypotheses. In Section 3, we describe our sample and research design. Next section provides the results of the distributions' comparison of hired and self-employed graduates. Finally, the last section concludes and gives some insights on policy implications of the study.

LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

Lazear's 'jack-of-all-trades' theory was verified by many researchers. A big sample data set of 29 transitional post-communist countries was meant to verify the hypothesis of the negative impact of university education on the probability of being self-employed. To create a set of entrepreneurship determinates Lazear's model was applied and empirical analysis was conducted. It was proved that a university education does not support entrepreneurship. However, the research proved that individuals with some experience and a more balanced portfolio of human and social capital can lead to taking up a decision to set up a business, which supports the 'jack-of-all-trades' theory (Habibov *et al.*, 2016). Lazear's hypothesis was also supported by Schutzer, who proved that a balanced skill set is important for making progress in venture creation. This set of skills comes from the innate entrepreneurial talent of an individual and prior managerial and entrepreneurial experience, early interest in an entrepreneurial career, and further investments in entrepreneurial education (Stuetzer *et al.*, 2013a). However, Silva tested Lazear's hypothesis using two different methods for the Italian working population. When cross-sectional techniques were used the theory seemed to be valid. However, when the panel technique was used, the results showed that a spread of knowledge across different fields does not increase the probability of becoming an entrepreneur (Silva, 2007). In the German case, a large representative sample of the German population was used to evaluate the validity of the balanced skills concept and its influence on choosing own business rather than paid employment. In this study, nascent entrepreneurs were compared to people who decided to continue their paid work. The article leads to the conclusion that Lazear's theory is backed by German data (Wagner, 2006). Another German study conducted on innovative (technology-oriented or knowledge-based) new firms showed that the traditional human capital indicators individually have little or no influence on entrepreneurial skills. However, consistent with Lazear's theory those entrepreneurs who have got a varied set of work experience have higher entrepreneurial skills relevant to starting and growing a firm (Stuetzer *et al.*, 2013b). Using a data set of Canadian entrepreneurs and individuals who were paid/employed, Åstebro and Thompson (2011) tried to find the set of characteristic skills and triggers that pushes people towards risky occupations which are connoted with setting up a business. The article tested the jacks-of-all-trade and the so-called 'test for variety' hypothesis. These two theorems are not mutually exclusive, but they imply distinctive interpretations of the cause and effects of occupational variety. In this research, it was proven that the 'test for variety' dominates the effects of Lazear's theory. However, both theorems seem to be true (Åstebro & Thompson, 2011). Similar conclusions come from the work of Chung and Parker, who proved that the 'test for variety' is a key driver of entrepreneurship decisions of college graduates (Chung & Parker, 2020).

In the Polish case, Lazear's hypothesis was tested too. The research of Kurczewska and Mackiewicz positively verified Lazear's concept proving that in Polish conditions, individuals with a broader educational and professional background are more likely to start a business. Additionally, the level of education has a negative influence on the chances of survival as an entrepreneur, but at the same time, the number of fields studied has a strong impact on success (Kurczewska & Mackiewicz, 2020). The same authors did another piece of research focusing on the determinates

which increase the probability of business survival. They found out that the breadth of education impacts the propensity to start a business, but it also increases the chances of business survival. The breadth of professional experience turned out to have a significant impact on business survival, but this result did not hold for extensive managerial experience (Kurczewska & Mackiewicz, 2020). According to the work of Gano and Łuczka (2020), Polish students have insufficient knowledge in the field of running their own business, therefore providing them with appropriate qualifications in this regard should increase entrepreneurial intentions. Hence, not directly, Lazear's concept is supported, because a proper skill set is a stimulant of nascent entrepreneurship.

RESEARCH METHODOLOGY

Higher Education Institution (HEI) Data

In Poland, two methods are used to monitor the professional careers of graduates of universities and other higher education institutions. One of the tools is the nationwide system for monitoring the economic fate of university graduates (the so-called ELA), which has been run in a centralized manner since 2014. In this study, particular importance was given to employment and wages as economic outcomes of higher education. The data contained in the ELA come from two sources: the POL-on system, developed and implemented by the Ministry of Education and Science and the Social Insurance Institution.

The second method of examining the professional career of graduates is research conducted individually and separately by universities. An example of such a study are the activities undertaken by JU since 2008. The JU intends to systematically collect data on the entire population of graduates. Accordingly, graduates are invited to participate in this study at different time intervals (0.5 years, 3 years, and 5 years after graduation). The effectiveness of this study is astonishingly high and averages between 55% and 65% of returns. In the current study, the results of the JU's studies were used, because they are much more accurate and include non-economic parameters that are missing in the ELA study.

Sample Characteristics

This study used data from surveys conducted among graduates of master's studies from 2015, 2016, 2017, 2018, and 2019. Due to the high convergence of survey questions conducted in individual years, it was possible to build a uniform database based on which it was possible to conduct research of a quantitative nature.

We used a graduates' survey to compare hired and self-employed workers. The comparative analysis was built based on data obtained in the last four editions of the survey, *i.e.* for 2015, 2016, 2017, 2018, and 2019 vintages. In the end, 7675 observations were included in the database. The following Table shows the number of records (survey responses) by year.

Table 1. Sample size in the JU graduates survey

Academic year	No. of responses	Share of the whole sample
2014/2015	1935	25.21%
2015/2016	1651	21.51%
2016/2017	1391	18.21%
2017/2018	1070	13.94%
2018/2019	1628	21.21%

Source: own study.

The table below presents the distribution of graduates by present-day (up to six months after graduation). It turns out that more than half of JU graduates were not continuing their studies but working. A quarter of JU graduates combined work and study and 15% did not work.

The proportion of graduates taking up paid jobs and those studying has been relatively stable over time. On average, every year between 2015 and 2019 around 6% of all working graduates were self-employed.

Table 2. Distribution of JU graduates by post-graduation status, 2015-2019 vintages

Post-graduation status	Number	Share
I am working and not continuing my education	4256	55.45
I am working and pursuing my studies	1927	25.11
I am not working, but continuing my education	688	8.96
I am not working and I am not continuing my education	542	7.06
No answer	262	3.41
Total	7675	100.00

Source: own study.

Table 3. Distribution of working graduates by employment and activity, 2015-2019 vintages

Year	Category	Numbers	Percentage
2015	hired	1423	93.25
	own business	103	6.75
2016	hired	1229	95.05
	own business	64	4.95
2017	hired	1058	95.23
	own business	53	4.77
2018	hired	791	93.5
	own business	55	6.5
2019	hired	1314	93.39
	own business	93	6.61
Total 2015-2019	hired	5815	94.5
	own business	368	5.95

Source: own study.

Study-related Variables

In the following analysis, we wanted to determine whether the fact that graduates start their own businesses or take up employment depended on certain characteristics related to the period of study. Furthermore, we tested the set of hypotheses if the distributions of those two groups differ due to these characteristics. Among the variables were mainly those related to the faculty completed, the scientific discipline, and the type of study divided into the full-time and part-time programs.

Self-employment and running own business were the most popular among graduates from the Faculty of Management and Social Communication (31% of them started running a business), the Faculty of Law and Administration (17.7%), and the Faculty of Philosophy (approximately 10%). On the other hand, the least popular faculties (from each faculty less than 10 graduates started a business in the analyzed period) were the Faculty of Biochemistry, Biophysics and Biotechnology (three people), Faculty of Chemistry (five people), and the Faculty of Polish Studies (nine people). The structure of those self-employed and hired by faculty translates into the structure of these groups by discipline. The social sciences discipline was dominant (61-62% of graduates in both groups can be assigned to this discipline), while the interdisciplinary sciences discipline was the least popular. The sciences and natural sciences, on the other hand, were marginally more popular among the business group than among the salaried employees.

A feature that differentiates the two groups is the mode of study. In the case of salaried employees, the vast majority have completed full-time studies (around 82%), while among those who were self-employed, only 7% declared having completed full-time studies.

Table 4. Distribution of working graduates by faculty, discipline, and programme completed, 2015-2019 vintages

Category	Hired		Self-employed	
	#	%	#	%
By faculties				
Faculty of Biochemistry, Biophysics and Biotechnology	133	2.29	3	0.82
Faculty of Biology, Faculty of Biology and Earth Sciences, Faculty of Geography and Geology	339	5.83	17	4.62
Faculty of Chemistry	198	3.4	5	1.36
Faculty of History	261	4.49	16	4.35
Faculty of International and Political Studies	442	7.6	21	5.71
Faculty of Law and Administration	1043	17.94	65	17.66
Faculty of Management and Social Communication	1582	27.21	114	30.98
Faculty of Mathematics and Computer Science	240	4.13	21	5.71
Faculty of Philology	543	9.34	29	7.88
Faculty of Philosophy	586	10.08	38	10.33
Faculty of Physics, Astronomy and Applied Computer Science	127	2.18	29	7.88
Faculty of Polish Studies	308	5.3	9	2.45
Inter-faculty interdisciplinary studies	13	0.22	1	0.27
By disciplines				
Humanities	1220	20.98	65	17.66
Interdisciplinary studies	13	0.22	1	0.27
Science and natural sciences	1018	17.51	75	20.38
Social sciences	3564	61.29	227	61.68
By programme type				
Full-time programme	4818	82.85	26	7.07
Part-time programme	951	16.35	238	64.67

Source: own study.

Variables Related to Non-study Activity

The structure of hired and self-employed graduates is different when considering activities during their studies. Looking at the activities related to the field of study, one can note that graduate entrepreneurs already started their own businesses during their studies (almost 22% of them), while in the group of graduates who are employees, this amounts only to 1%. Differences of several percentage points between the two groups can also be noticed in the case of work placements at home and abroad. In the case of non-degree-related activities, a difference in structure is also apparent, in particular the significant prevalence of self-employment among graduate entrepreneurs and the dominance of casual work among employed graduates.

Table 5. Distribution of working graduates by activity undertaken during their studies, 2015-2019

Activity	Activities matched to the studies				Activities unmatched to the studies			
	Hired		Self-employed		Hired		Self-employed	
	#	%	#	%	#	%	#	%
Full-time employment	1412	24.28	104	28.26	1398	24.04	71	19.29
Own business	57	0.98	81	22.01	124	2.13	101	27.45
Occasional work	908	15.61	67	18.21	2353	40.46	105	28.53
Volunteering	1511	25.98	77	20.92	874	15.03	52	14.13
Internship in the country	3279	56.39	157	42.66	296	5.09	17	4.62
Internship abroad	2594	44.61	122	33.15	250	4.30	17	4.62
Studying abroad	760	13.07	29	7.88	–	–	–	–

Note: % refers to the entire group of hired and self-employed.

Source: own study.

It is also worth considering the number of activities broken down by those related and unrelated to the study process and by graduate entrepreneurs and those in paid employment.

Among activities unrelated to the field of study, it can be seen that generally, the majority undertook no more than one activity. Two activities were undertaken by several per cent of respondents in both groups. Three or more activities involved only a few per cent of graduates. The distribution of the number of activities consistent with the completed field of study was similar in both groups of graduates with a slight difference for two activities, which also predominated among graduates taking up paid employment. Among graduate entrepreneurs, on the other hand, the lack of activities related to the field of study was predominant (about 27 declared cases).

Looking at total activities, the distribution was very similar among the employed and self-employed. Between two and four activities were undertaken by around 85-87% of respondents in both groups.

Table 6. Distribution of working graduates by the number of activities undertaken during their studies, 2015-2019

No. of activities	Hired graduates	Percentage	No. of activities	Self-employed graduates	Percentage
Activities unmatched to the completed field of study					
0	2299	39.54	0	154	41.85
1	2241	38.54	1	128	34.78
2	917	15.77	2	48	13.04
3	237	4.08	3	23	6.25
4	97	1.67	4	8	2.17
5	23	0.4	5	4	1.09
6	1	0.02	6	3	0.82
Activities matched to the completed field of study					
0	1431	24.61	0	100	27.17
1	1216	20.91	1	84	22.83
2	1543	26.53	2	80	21.74
3	1133	19.48	3	65	17.66
4	404	6.95	4	27	7.34
5	84	1.44	5	11	2.99
6	4	0.07	6	1	0.27
Total activities					
0	263	4.52	0	9	2.45
1	1249	21.48	1	92	25
2	1237	21.27	2	79	21.47
3	1442	24.8	3	82	22.28
4	1136	19.54	4	63	17.12
5	465	8	5	35	9.51
6	23	0.4	6	8	2.17

Source: own study.

RESULTS AND DISCUSSION

Comparison of the Distributions of Hired and Self-employed Graduates

To compare the distribution of employed and self-employed graduates, many statistical tests were carried out. The null hypothesis states that two independent samples are drawn from a population with the same distribution using the Wilcoxon rank sum test, also known as the Mann-Whitney two-sample statistic (Wilcoxon, 1945; Mann & Whitney, 1947). To compare the structure of the two groups, many parametric tests were also carried out (the table below shows the results of the Student's t-test, but the tests were carried out with modifications such as rejecting the assumption of the equality of variance in the two groups or the Welch test).

Using 5% as a cut-off significance level, it should be concluded that the distributions of graduates who were hired and self-employed differ due to several characteristics. Firstly, differences were evident in the faculty completed and the full-time or part-time programme (Dolton & Silles, 2001; Jasiński *et al.*, 2017).

Looking at activities during the studies in line with the field of study, we found that the distributions of entrepreneurial graduates and employed graduates differ in terms of work internships, studies

abroad, and volunteering. Moreover, own a business, irrespective of its matching with the field of study, is an element of differentiation between the two groups; self-employed graduates already start their own business during their studies and then continue it or enter into new types of these activities. Further differentiating factors were occasional work or full employment during studies unmatched in the field of study. In this case, graduates in paid employment were more likely to be interested in these activities (Pinto & Pereira, 2019; Odlin *et al.*, 2022). Interestingly, the distribution of graduates by the number of activities undertaken during the studies was statically the same.

Table 7. Results of the non-parametric Mann-Whitney test and the parametric Student's t-test (assuming different variances) for equality of the distributions of hired and self-employed

Variables	Mann-Whitney test		Student's t-test	
	Test statistics	p-value	Test statistics	p-value
Faculty	-2.695	0.007	-2.7729	0.0058
Discipline	-0.591	0.5544	-1.1521	0.2499
Programme (full or part-time)	-3.159	0.0016	-1.9146	0.0563
Study abroad	2.893	0.0038	3.5199	0.0005
Number of activities unmatched to the studies	0.016	0.9876	-1.2147	0.2252
Number of activities matched to the studies	0.804	0.4212	0.3505	0.7261
Total number of activities	-0.202	0.8402	-0.6429	0.5207
Employment during studies matched to the field of study	-1.72	0.0853	-1.6464	0.1005
Activities during studies matched to the field of study	-26.484	0	-9.7068	0
Occasional work matched to the field of study	-1.323	0.1859	-1.2521	0.2112
Volunteering matched to the field of study	2.155	0.0312	2.3005	0.0219
Internships matched to the field of study	5.139	0	5.1554	0
Foreign inter matched to the field of study	4.294	0	4.5063	0
Employment during studies unmatched to the field of study	2.075	0.038	2.2241	0.0267
Activities during studies unmatched to the field of study	-25.146	0	-10.8313	0
Occasional work unmatched to the field of study	4.535	0	4.8831	0
Volunteering unmatched to the field of study	0.469	0.6391	0.4791	0.6321
Internships unmatched to the field of study	0.399	0.6896	0.4155	0.678
Foreign intern abroad matched to the field of study	-0.293	0.7694	-0.2841	0.7765

Source: own study.

CONCLUSIONS

This article provided empirical evidence that two analysed groups of working university graduates, *i.e.* those hired and entrepreneurs differed in terms of some characteristics. These were degree-related variables (faculty and full-time vs. part-time studies) and variables defining activities during studies (such as internships, volunteering, internships abroad and studying abroad, employment, occasional work, and own business taken during studies).

The results of the Mann-Whitney statistics met partially the assumptions of Lazear's theory, which refers to entrepreneurs' pre-experience in a variety of areas. Undertaking many different activities during studies is an example of such preparation. In this way, individuals acquire sufficient skills and knowledge to run their businesses. The null hypothesis can be rejected as stated that there is no difference between medians of the above-mentioned variables. The distributions in the two groups of working graduates differed significantly.

The main limitation of the analysis presented in this article is that connected with the variables' availability, the collected data relates only to some aspects of the Jagiellonian University graduates' entrepreneurship or activities. As regards other research limitations, one should bear in mind that analysed data were collected from one specific Polish University.

Firstly, it implies that the results should be interpreted only in the context of Poland and secondly, in the context of a region with a specific labour market such as Malopolskie voivodship. At the same

time, this limitation suggests an important future research question: Are there any specific characteristics of the labour market in this region which encourage or discourage young people to undertake own businesses? This question can also be confronted with a discrepancy between students' plans and the real proportion of graduates running their businesses. Surveys carried out among students demonstrate that this career path is often declared. Over two-thirds of Polish students (73.2%) perceived themselves as entrepreneurial persons. Almost half of the students (42.3%) had an innovative idea for the business and 26.9% declared to choose this career path after studies (Kunasz, 2008). However, there is a lack of data that verifies the level of putting these declarations into practice. Generally, in Poland, the percentage of fresh alumni starting their own business after graduation is calculated at around 2-10% and is varied depending on the type of HEIs.

Furthermore, the article was based on data collected before the Covid-19 pandemic, when the labour market was completely different, particularly for individuals running their businesses. Finally, we cannot forget that data in the vast majority related to young entrepreneurs, who are the most vulnerable to various crises. For this reason, the presented analysis should be revised after the pandemic.

The direction of future research may consist in including the differences between various HEIs. It might be applied by using and comparing data from Polish Graduates Tracking System. Another area for developing future research is including some macro-level variables (such as the unemployment rate or this directly connected with entrepreneurship 'climate,' *i.e.* Doing Business Indicators). The third new research field is a trial to confront country data with some international students' or graduates' surveys (*e.g.* Eurostudent) in terms of entrepreneurship.

The most practical implication is that the analysis results can be used when preparing the University's educational offer to provide students with some entrepreneurial skills. The differences between faculties should be considered. Additionally, University careers advisors are provided with knowledge of entrepreneurship's determinants.

However, in interpreting the data and results presented in this article, it is important to remember that there are many determinants of choosing an entrepreneur's career. The role of the HEI diploma has not been proven to be the most important in this process (Greene & Saridakis, 2008).

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Non-fungible tokens as an area of entrepreneurial activity: Global perspective and potential directions of change

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ABSTRACT

Objective: The objective of the article is to identify the intensity of the interest in non-fungible tokens (NFTs) in a spatial and temporal frame of reference (regions of the world in the period January 2021 – May 2022) and the project changes based on Internet users' queries for the keyword 'NFT.'

Research Design & Methods: The basic research material under consideration consisted of spatial-time series generated from Google Trends. The data generated were subjected to relational and ratio analysis relying on clusters, correlation, and regression. The analytical tools used allowed for a cross-regional comparative analysis in a dynamic frame and a simplified prediction of the interest in NFTs on a global scale.

Findings: The biggest interest in NFTs is found in 'the heart of today's fastest-growing economy in the world' consisting of Hong Kong, China, and Singapore. The dynamic growth of NFT collection and transactions in 2021 translated into the culmination of the interest in NFTs in January 2022. However, this interest was short-lived and significantly dropped in the next few months. Regardless of the region of the world, the trends of exchange in this field coincide. The NFT market will probably develop, but the dynamic growth that took place in 2021 will no longer occur.

Implications & Recommendations: The results of the study have practical implications for creators, investors, institutions and governments, as well as those interested in understanding the growing NFT branch as a part of the new global digital economy and the dynamically growing market of digital assets. In particular, it is necessary to take into account the currently discussed vision of introducing digital currencies and abandoning cash. From the theoretical perspective, the article complements the NFT analyses and the research instruments used.

Contribution & Value Added: The conducted study is pioneering in terms of the cognitive plane, i.e. analysis of the interest in NFTs on a global scale. The analytical process based on data generated from Google Trends, together with the research instruments used, is not reflected in the current scientific output. As assets that are objects of trade, NFTs fit into the new and rapidly evolving phenomenon. It is a cognitive area embedded in a very modest scientific output. The article enriches theoretical and cognitive research in the field of artificial intelligence.

Article type: research article

Keywords: artificial intelligence; cryptocurrencies; entrepreneurship; Google Trends; NFT; non-fungible token

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INTRODUCTION

The evolution of the Internet gradually moves areas of human activity, including entrepreneurship, to the global network. The COVID-19 pandemic caused a very rapid movement of the education and science sector to the virtual space, alongside communication and information. At the same time, another area of the Internet that is dynamically expanding is the one directly related to the broadly understood

financial market. In this context, attention should be drawn to the cryptocurrency market and non-fungible tokens (NFTs) created based on the market's technological concept. They are a new asset category, different from cryptocurrencies (Dowling, 2022b), which combines IT technologies and human creativity (so-called creative economy) (Mazieri *et al.*, 2022).

Living in an AI-powered era fosters creativity inherent in entrepreneurial attitudes. At the same time, problems long forgotten by many, such as pandemics, conventional wars, and high inflation, are coming back. Irrespective of these disruptions, it is common to strive for prosperity. In this context, it is necessary to consider the new investment areas created by, among other things, NFTs (Carayannis *et al.*, 2022). Anyone can make a non-fungible token, even using a free platform. Regardless of the risk and vague rules, currently, new digital products appear to be equally attractive to investors looking for a safe haven, investors interested in a big and quick profit, creators of these new virtual solutions, as well as intermediaries seeking profit from the activity of all stakeholders of the new market, including fraudsters. It is a very receptive market absorbing entrepreneurial initiatives rooted in artificial intelligence and, at the same time, based on classic business models. Given the global nature of NFTs and the lack of public registers, it is currently impossible to determine where in the world there are the most creators, intermediaries and, finally, investors.

In 2021, NFTs gained global popularity. However, researchers suggest that no region is a clear leader in the NFT market (Grauer *et al.*, 2022). In this context, the research problem took the form of the need to specify in which regions of the world the interest in NFTs is the greatest and how this interest changed over time in the period January 2021 – May 2022. The analysis was based on data obtained from Google Trends which were subjected to relational and ratio analysis relying on the analysis of clusters, correlation, and regression.

The article is of theoretical and cognitive nature and contributes to the academic literature on NFTs as regards the interest in this type of asset from a spatial and temporal perspective. The analytical material obtained and reviewed, along with the statistical tools used, is an innovative approach and meets the criterion of an empirical scientific experiment. The practical implications include the increasingly frequent discussions about the vision of abandoning cash in favour of digital currencies and the development of business activity carried out in virtual space that spans national borders and is ahead of legislative processes.

The article is divided into sections. It begins with an introduction to the topic of non-fungible token. Then, the latest literature was reviewed. The next part of the article explains the research methodology. The main part of the article are the results of empirical research. The last section will contain the main conclusions and limitations of this research and directions for future studies.

LITERATURE REVIEW

A non-fungible token is a special type of cryptographic token that represents the originality of a digital asset, which is a declaration that a given file exists only in a single copy. This solution makes it possible to create digital intellectual property, so NFTs are digital assets in the form of multimedia. These include images, videos, music, texts, games, game footage, avatars, virtual creations, virtual sports cards, virtual real estate, or even virtual body parts of famous people available primarily on the Ethereum blockchain. The two main sources of NFTs are digital games and artworks (Vasan *et al.*, 2022). Currently, NFT is one of the most significant public successes of blockchain technology (Dowling, 2022a) which has dominated modern programming techniques (Jain *et al.*, 2022). The NFT transactions are based on a mechanism of exchanging the ownership of a digital file and are subject to copyright. Just like artwork, they can be sold or just shared. The blockchain itself stores the entire traffic and transaction history (Leonard & Ariawan, 2021). Non-fungible tokens are revolutionising the crypto landscape, becoming popular among investors and the general public (Umar *et al.*, 2022).

The use of NFT was pioneered by creative industry entrepreneurs who tried to generate new streams of revenue and ways of engaging stakeholders. Subsequently, NFTs took advantage of the cultural need for new content, new experiences, new entertainment and new conversation topics, especially at a time when activity was restricted due to the pandemic (Agrawal & Sandhu, 2022). Despite the rapid increase

in popularity, there were concerns related to the legal ownership of NFT assets and the prevalence of speculation and fraud connected to the NFT trade (Chalmers *et al.*, 2022). Cryptocurrencies and NFTs are associated with a separate culture, philosophy, and a world with faithful followers. The credibility of this financial instrument relies, for example, on advertisements featuring celebrities, *e.g.* Hollywood stars and the world's leading athletes. This mechanism is not new. It is also a part of dangerous assets such as pyramid schemes (Leonard & Ariawan, 2021). The investment creativity of Bernard Madoff based on this criminal scheme was also endorsed by many people from the world of business, politics, and culture. It seems that economic education cannot keep up with the real problems of the modern financial market. In this context, the importance of conducting general research and analyses of NFTs seems to be very high, regardless of the risk and potential failure inherent in entrepreneurship.

Cryptocurrencies and NFTs attract more and more attention from entities such as investors, neobrokers, decision-makers, regulatory bodies and portfolio managers (Maouchi *et al.*, 2021). Among all the stakeholders of these new digital projects, there are many entrepreneurial units representing all the above-mentioned professional groups and creators. While the scientific output on cryptocurrencies is rather rich, although certainly not exhaustive, the literature on NFTs is in the early stages of development (Umar *et al.*, 2022). Today, NFTs are one of the most exciting, fastest-growing areas of the cryptocurrency world and have become especially popular among retail investors (Grauer *et al.*, 2022).

Investing in times of uncertainty and global unrest, which undoubtedly describes the world of the COVID-19 pandemic, Russia's military aggression against Ukraine and two-digit inflation is very difficult and involves high risk. In view of this, many analysts point to the potential of blockchain markets, in particular of NFTs and DeFi tokens (connected with decentralised finance), which are evolving rapidly (Maouchi *et al.*, 2021). Since the introduction of revolutionary technology in 2008, the phenomenal growth of blockchain markets has led the future digital markets. Analysts also point to NFTs as a remarkable public success of blockchain technology (Dowling, 2022a) with its unique mechanism of transferring rights via digital resources. The dynamic growth of NFTs left investors with a dilemma: is this a boom on new assets or maybe a speculative bubble (Maouchi *et al.*, 2021)?

The literature review provides evidence that there is a demand for diverse studies concerning NFTs, including empirical research on their continuous evolution (Pinto-Gutiérrez *et al.*, 2022). Taking into account the issues addressed, along with the research instruments used, the presented results should be regarded as pioneering on a global scale. Of course, the area selected for the analysis is but a small part of the complex topic that is NFT.

Non-fungible Tokens as a New Asset on the Financial Market and Research Hypotheses

In the past, people invested in real estate, foreign currencies, stocks, bonds, bank deposits, and gold, among other things. Today, many people are investing in digital products including cryptocurrencies and NFTs. While digital currencies are a fairly well-recognised product, the term NFT has only recently become popular. The trend of looking for new opportunities to invest funds and earn money based on the scenario inherent in the traditional stock market is not revelatory. The new investment area connected with the potential benefits of NFT creators and users can be modelled in conjunction with the cryptocurrency market, which in practice is a source of funding for digital images. Over the past five years, the global financial industry has witnessed a revolution in digital assets in terms of market trends and the use of visual features (Nadini *et al.*, 2021).

The role of cryptocurrencies in the global financial system is growing every year. Data from December 2021 shows that the market capitalisation of cryptocurrencies exceeded USD 2.25 trillion. For years, the most popular cryptocurrency has invariably been Bitcoin. However, its dominance has been steadily declining largely in favour of Ethereum-based tokens such as NFTs and decentralised finance assets (DeFi) (Yousaf & Yarovaya, 2021; Chowdhury *et al.*, 2022).

Enthusiasm in the NFT market led to huge growth in the industry in 2021. The very high growth of NFT collections (Grauer *et al.*, 2022) increased the recognition of the crypto-art market. Analysts associate 2021 with a bull market (Arslanian, 2022; Maouchi *et al.*, 2021). This situation was caused by a very large increase in the prices of major cryptocurrencies between 2020 and 2021 (Pinto-Gutiérrez *et al.*, 2022; Przyłuska-Schmitt *et al.*, 2022) and an extreme increase in NFT trading volumes (Ante, 2021b).

However, while cryptocurrencies significantly affect the pricing of NFT transactions, the opposite relationship does not hold (Dowling, 2022a). At the same time, NFT pricing is inefficient due to market immaturity (Dowling, 2022b; Ante, 2021a). The turnover of the NFT market reached USD 17.7 billion and in Q1 2022 the value of NFT turnover was close to USD 7.9 billion (NonFungible, 2022). The global market capitalisation of NFTs in 2021 was USD 7 billion. Sales of digital tokens oscillate around USD 2 billion per month. In 2021, users sent cryptocurrencies worth more than USD 44.2 billion to ERC-721 and ERC-1155 contracts, two types of Ethereum smart contracts linked to NFT markets and collections (Grauer *et al.*, 2022). However, unregulated NFT transactions and the investment euphoria surrounding them can lead to high demand volatility (Agrawal & Sandhu, 2022). The vast majority of NFT transactions take place at the retail level, meaning cryptocurrency worth less than USD 10 000. The NFT market is much more retail-oriented than the traditional market. At the same time, it should be noted that the number of intergovernmental transactions has increased in the recent period (Grauer *et al.*, 2022).

The development of NFTs is a global project. Interest in this new product is determined by the level of socio-economic development of a given region, including the prevalence of cashless payment systems. In this context, the diverse level of technological development in different areas of the world creates an area for new entrepreneurial activity that brings together investors, creators, and business intermediaries. However, each party has different intentions and expectations when it comes to participating in the creation, investment, and service of NFTs. The anonymity of activity in the global network makes it difficult to accurately determine in which regions of the world NFT is developing in these three areas. However, there is a possibility of identifying the level of interest in NFT in a spatial system based on Internet users' queries.

The research process consisted in the verification of three hypotheses:

- H1:** Most of the NFT-related activity takes place in regions that are technologically advanced and where cryptocurrencies and blockchain are very popular.
- H2:** Changes in the interest in NFTs happen on a global scale.
- H3:** Interest in NFTs stays at a relatively constant level with a tendency to decrease slightly over time.

Noteworthy, with technological advances including the emergence of new financial products, such as NFTs, there arise new potential criminal acts that pose a real operational threat (Leonard & Ariawan, 2021). Digital space and digital assets can facilitate criminal behaviour in the current regulatory environment. The conversion from physical to virtual space obscures criminal activity, so facilitating the anonymity of perpetrators and creating new challenges for the legal and regulatory environment (Dupuis *et al.*, 2021). Therefore, regardless of the potential valuable artistic and financial opportunities for creative entrepreneurs, NFTs should be approached with caution (Chalmers *et al.*, 2022). This concerns not only criminal activities, but also security gaps, lack of regulatory solutions, and the global nature of NFTs.

As NFTs began to rapidly gain popularity in 2020-2021, it is currently impossible to predict what the future will look like. The exceptionally positive results of NFT transactions seem to indicate the beginning of a new crypto bubble. Therefore, researchers and policymakers should continue to analyse the behaviour of this market segment (Agrawal & Sandhu, 2022). Projection is very difficult in this case due to limited information resources, notwithstanding the fact that since the global financial crisis, advances in blockchain technology and the associated broad spectrum of digital assets have been gaining momentum in global financial markets (Umar *et al.*, 2022).

RESEARCH METHODOLOGY

The use of artificial intelligence to create NFTs is part of the solutions of the future, the practical application of which is becoming increasingly common. Artificial intelligence is also big data, which is where Google Trends fits in. It is a free online tool developed by Google LLC in 2008 that allows users from anywhere in the world to analyse big data. This application is constantly evolving, and the scope of its use is expanding very rapidly as it is used in business and scientific analyses (Jun *et al.*, 2018). The useful-

ness of this tool has been confirmed by numerous studies, including those with a socio-financial dimension (Jegorow, 2018). The use of data from Google Trends is becoming increasingly common, including its application in the case of cryptocurrencies and NFTs (Maouchi *et al.*, 2021). Furthermore, the choice of the research tool was dictated by the fact that most of the Bitcoin price analyses, in mid-2010, have reported a significant relationship between the Bitcoin price and the factors (*e.g.* search volume and media exposure) extracted from the social network service-based statistics (Lee & Rhee, 2022).

Google Trends interprets the information and normalises the data to be between 0 and 100. The numbers represent the search interest relative to the highest point based on the location and time of the query. A value of 100 represents the highest popularity of a keyword. Analysing large datasets using Google Trends provides information that goes beyond public as well as commercial datasets. The application enables the geographical mapping of searches for specific information (Wang *et al.*, 2022).

Two main datasets covering weekly quotes from 1 January 2021 to 31 May 2022 were extracted from Google Trends. However, the adopted starting point was shifted to February 2021 in part of the analyses, because the number of searches for the keyword NFT before this period was so small compared to the other results recorded in the adopted time frame that it did not exceed a value of 1 in the vast majority of regions. The first dataset shows the global interest in NFTs by region (static frame) and the second includes all regions with the search index for the keyword NFT of at least 25 (dynamic frame).

The classification of regions was based on cluster analysis. The comparison of individual time series values was based on a correlation analysis in which the Pearson correlation coefficient was used. The research problem related to the projection of interest in NFTs was included in a regression analysis of the truncated time series of global search indices for the keyword NFT. The time series covering the period from mid-January 2022 to the end of May 2022 included the change in the trend from upward to downward. The estimation of the curve was based on eight analytical models to determine the theoretical value of the dependent variable NFT_t , in which t is the independent time variable (week):

$$NFT_t = \alpha_0 + \alpha_1 t \quad (1)$$

$$NFT_t = \alpha_0 + \alpha_1 \ln t \quad (2)$$

$$NFT_t = \alpha_0 + \frac{\alpha_1}{t} \quad (3)$$

$$NFT_t = \alpha_0 + \alpha_1 t + \alpha_2 t^2 \quad (4)$$

$$NFT_t = \alpha_0 + \alpha_1 t + \alpha_2 t^2 + \alpha_3 t^3 \quad (5)$$

$$NFT_t = \alpha_0 t^{\alpha_1} \quad (6)$$

$$NFT_t = \exp\left(\alpha_0 + \frac{\alpha_1}{t}\right) \quad (7)$$

$$NFT_t = \alpha_0 \exp(\alpha_1 t) \quad (8)$$

where:

- (1) – Linear; (2) – Logarithmic; (3) – Inverse; (4) – Quadratic; (5) – Cubic;
(6) – Power; (7) – Power; (8) – Exponential.

RESULTS AND DISCUSSION

The global distribution of searches for the keyword NFT showed a clear dominance of Asia and North America. The highest search rates for the keyword NFT between January 2021 and May 2022 were recorded in: Hong Kong (100), China (97), Singapore (94), and Taiwan (59). These regions form a distinct cluster. Another cluster was formed by 10 countries, of which the three highest ranked are in Asia: the Philippines (52), South Korea (50), United Arab Emirates (50), Canada (50), Nigeria (49), Australia (48), New Zealand (48), Lebanon (47), Venezuela (45), and the United States (44). This means that the greatest interest in NFTs, which is not the same as a homogeneous geographical distribution, was in Asia. The above-mentioned countries were followed by Australia, New Zealand, North America, Europe, and South America (Figure 1).

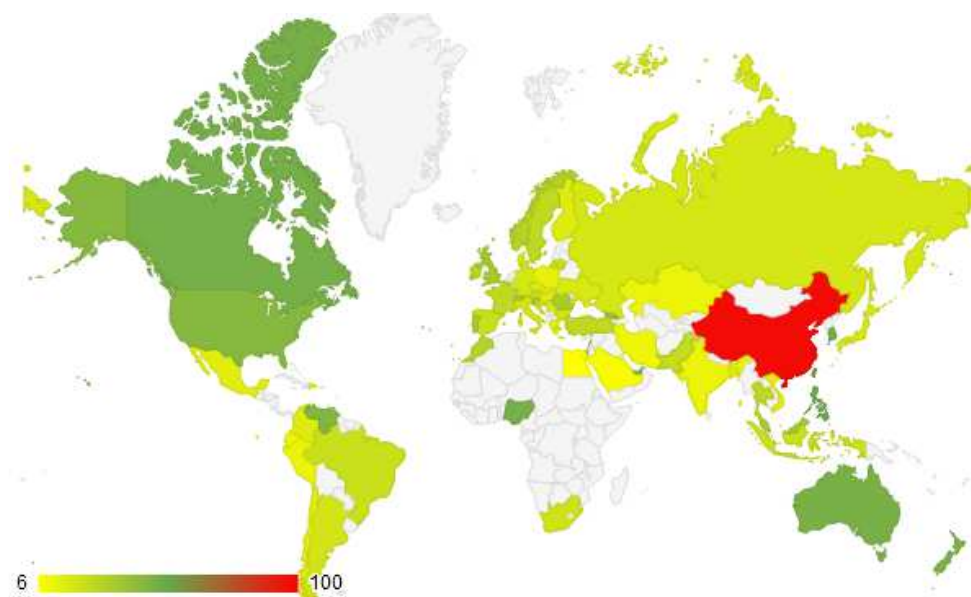


Figure 1. NFT keyword search index according to Google Trends data (January 2021 – May 2022)

Source: own elaboration.

The distribution of the index values for the keyword NFT by region shows a clear right-skewed asymmetry (most regions of the globe are below average) and a clear clustering of results around the mean ($\bar{X} = 29$; $Q_2 = 24$; $SKE = 1.95$; $K = 4.56$). At the same time, it is important to note the large dispersion ($CV = 66.62\%$) caused by the high gap between the two clusters of the highest-ranked regions of the globe. Among the regions with the highest search rates for the 'NFT' keyword, technologically advanced countries dominate. This result allows for positive verification of H1. Nigeria and Venezuela did not meet this criterion. Taking into account the state of their economies, social development and cultural heritage, the interest in NFTs in both of these countries should be linked to other determinants. In Nigeria, these are investment issues and artistic activity. In turn, in Venezuela, it is mainly due to very high inflation and the search for alternative savings and investment systems.

The convergence of the searches of the keyword NFT between different regions of the globe was confirmed by the results of the correlation analysis (Table 1). The obtained results confirmed H2. In the frame of reference formed based on the two aforementioned clusters of regions with the highest value of the index analysed, the values of Pearson's correlation coefficients indicated the existence of a clear and very clear relationship in most of the pairs compared. The only country that did not follow this pattern was Venezuela, where the correlation was not confirmed when juxtaposed with Taiwan and Nigeria. In the remaining pairs, the relationship was average.

In the vast majority of regions, the culmination of the interest in NFT was in January 2022. The highest values for the NFT search index were first recorded in August/September 2021 in Turkey and Venezuela, and in Thailand in late November 2021 (Figure 2). Following the global culmination of the interest in NFT in January 2022, the next highest values of the index analysed were recorded successively in Turkey, South Korea, and Nigeria in early April 2022.

The highest value of the NFT keyword search index at the end of May 2022 was recorded in China and amounted to 50 points. This was followed by Georgia with a score of 45 points and South Korea – 38 points. Thus, the dominance of Asia was clear at the time.

Regression analysis indicated a high level of fit for all models (independent variable: time) (Table 2, 3). The cubic model (cubic polynomial) showed the highest goodness-of-fit to empirical data. The large declines in NFT keyword searches recorded in January and February 2022 entered a phase of stabilisation in the following two months only to go back to a downward trend in May 2022, although not as strong as it was at the beginning of the year.

Table 1. Event study estimates for monetary policy responses to the Covid-19 crisis – Czechia

Pearson Correlation	World	Hong Kong	China	Singapore	Taiwan	Philippines	South Korea	United Arab Emirates	Canada	Nigeria	Australia	New Zealand	Lebanon	Venezuela	USA
Hong Kong	0.941**														
China	0.824**	0.872**													
Singapore	0.977**	0.932**	0.809**												
Taiwan	0.871**	0.919**	0.772**	0.854**											
Philippines	0.767**	0.735**	0.736**	0.792**	0.658**										
South Korea	0.786**	0.769**	0.833**	0.759**	0.759**	0.615**									
U.A. Emirates	0.978**	0.945**	0.858**	0.957**	0.869**	0.792**	0.787**								
Canada	0.966**	0.851**	0.680**	0.940**	0.793**	0.706**	0.698**	0.911**							
Nigeria	0.595**	0.669**	0.751**	0.557**	0.598**	0.498**	0.608**	0.658**	0.459**						
Australia	0.980**	0.894**	0.775**	0.975**	0.818**	0.770**	0.739**	0.947**	0.971**	0.533**					
New Zealand	0.957**	0.875**	0.752**	0.966**	0.760**	0.764**	0.694**	0.927**	0.943**	0.493**	0.969**				
Lebanon	0.948**	0.948**	0.833**	0.935**	0.884**	0.714**	0.738**	0.961**	0.870**	0.641**	0.904**	0.891**			
Venezuela	0.404**	0.326**	0.383**	0.494**	0.0217	0.571**	0.282*	0.391**	0.417**	0.097	0.494**	0.502**	0.295*		
United States	0.947**	0.806**	0.653**	0.907**	0.754**	0.685**	0.708**	0.888**	0.989**	0.435**	0.952**	0.921**	0.831**	0.402**	
Georgia	0.770**	0.853**	0.877**	0.725**	0.803**	0.567**	0.773**	0.823**	0.611**	0.742**	0.681**	0.657**	0.839**	0.066	0.576**
Israel	0.915**	0.858**	0.835**	0.877**	0.799**	0.694**	0.878**	0.908**	0.848**	0.583**	0.870**	0.846**	0.878**	0.341**	0.856**
Switzerland	0.987**	0.939**	0.816**	0.959**	0.885**	0.755**	0.787**	0.960**	0.955**	0.572**	0.968**	0.928**	0.928**	0.406**	0.938**
Netherlands	0.978**	0.936**	0.768**	0.960**	0.889**	0.718**	0.742**	0.950**	0.960**	0.538**	0.957**	0.923**	0.942**	0.382**	0.930**
Great Britain	0.986**	0.908**	0.765**	0.962**	0.823**	0.744**	0.732**	0.953**	0.982**	0.547**	0.982**	0.956**	0.917**	0.421**	0.965**
Malaysia	0.954**	0.942**	0.836**	0.964**	0.893**	0.779**	0.789**	0.949**	0.885**	0.603**	0.931**	0.915**	0.939**	0.383**	0.847**
Romania	0.967**	0.916**	0.822**	0.932**	0.829**	0.700**	0.780**	0.959**	0.914**	0.591**	0.931**	0.921**	0.953**	0.290*	0.901**
Portugal	0.978**	0.916**	0.790**	0.954**	0.827**	0.733**	0.754**	0.961**	0.938**	0.553**	0.953**	0.951**	0.945**	0.399**	0.924**
Slovenia	0.933**	0.870**	0.725**	0.904**	0.775**	0.723**	0.676**	0.916**	0.927**	0.506**	0.921**	0.894**	0.880**	0.432**	0.911**
Norway	0.979**	0.924**	0.792**	0.957**	0.852**	0.739**	0.757**	0.961**	0.951**	0.583**	0.962**	0.947**	0.939**	0.380**	0.930**
Morocco	0.946**	0.909**	0.791**	0.922**	0.858**	0.743**	0.766**	0.949**	0.887**	0.565**	0.910**	0.897**	0.932**	0.310**	0.874**
Belgium	0.989**	0.946**	0.815**	0.964**	0.874**	0.742**	0.783**	0.964**	0.953**	0.599**	0.963**	0.934**	0.952**	0.365**	0.933**
Ireland	0.957**	0.873**	0.697**	0.925**	0.806**	0.681**	0.663**	0.920**	0.965**	0.503**	0.949**	0.927**	0.900**	0.342**	0.950**
Thailand	0.867**	0.807**	0.860**	0.873**	0.757**	0.852**	0.799**	0.868**	0.793**	0.592**	0.860**	0.834**	0.813**	0.545**	0.792**
Sweden	0.982**	0.923**	0.764**	0.952**	0.858**	0.735**	0.751**	0.949**	0.969**	0.557**	0.962**	0.938**	0.921**	0.374**	0.953**
Turkey	0.736**	0.718**	0.796**	0.720**	0.615**	0.615**	0.727**	0.754**	0.671**	0.673**	0.728**	0.692**	0.671**	0.504**	0.659**
France	0.967**	0.928**	0.841**	0.937**	0.836**	0.730**	0.797**	0.972**	0.896**	0.628**	0.930**	0.922**	0.950**	0.353**	0.882**
Austria	0.951**	0.906**	0.799**	0.913**	0.819**	0.690**	0.761**	0.945**	0.900**	0.591**	0.920**	0.895**	0.941**	0.300*	0.882**

Notes: ** Correlation is significant at the 0.01 level (two-tailed). * Correlation is significant at the 0.05 level (two-tailed).

Source: own elaboration in SPSS.

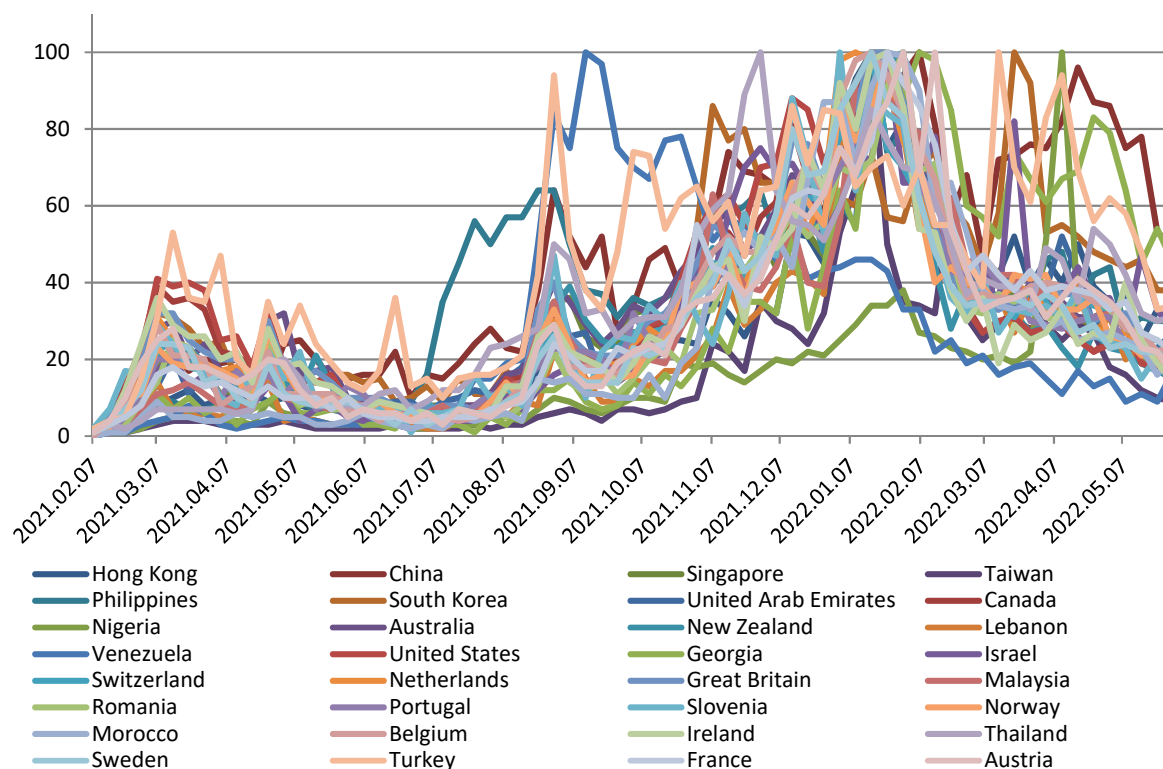


Figure 2. The search index of the 'NFT' keyword according to Google Trends data (February 2021 – May 2022)

Note: Data from January 2021 were excluded from the analysis, because the 'NFT' keyword search index was less than 1 in most regions. The list includes regions with a total search index of 25+.

Source: own elaboration.

Table 2. Regression results: Model summary

Equation	Model fit		Analysis of variance			
	R Square	Std. Error	F	df1	df2	Sig.*
Linear	0.746	12.133	52.750	1	18	<0.001
Logarithmic	0.925	6.599	221.159	1	18	<0.001
Inverse	0.766	11.626	59.016	1	18	<0.001
Quadratic	0.906	7.596	81.751	2	17	<0.001
Cubic	0.972	4.285	183.732	3	16	<0.001
Power	0.912	0.133	185.985	1	18	<0.001
S	0.659	0.261	34.740	1	18	<0.001
Exponential	0.850	0.173	101.980	1	18	<0.001

Note: * Acceptable level: Sig. <0.05.

Source: own elaboration in SPSS.

The strong downward trend in the value of the NFT keyword search index with respect to the maximum value recorded in early 2022 is reflected in the theoretical model based on a linear function. However, this model has the lowest fit to empirical values, while having the largest estimation error. The inverse model has a similar low level of fit between the theoretical model and the actual data. In this case, however, the prediction should be based on the assumption of an invariant value of the NFT keyword search index, both in the short and long term.

The projection of a downward trend in the value of the NFT keyword search index was not confirmed only by the quadratic model. Other estimates indicated a downward trend of decreasing magnitude over time. This means that the interest in NFT reached a relatively sustainable level with a slight downward trend (Figure 3). The above results (graphic illustration and regression analysis) confirmed H2.

Table 3. Regression results: Parameter estimates

Equation	α_0	α_1	t	Sig.*	α_2	t	Sig.*	α_3	t	Sig.*
Linear	82.632	-3.417	-7.263	<0.001						
Logarithmic	105.393	-27.704	-14.871	<0.001						
Inverse	30.253	91.709	7.682	<0.001						
Quadratic	106.373	-9.892	7.981	<0.001	0.308	5.378	<0.001			
Cubic	127.338	-20.590	-10.932	<0.001	1.551	7.540	<0.001	-0.039	-6.117	<0.001
Power	124.968	-0.511	-13.638	<0.001						
S	3.463	1.579	5.894	<0.001						
Exponential	86.331	-0.068	-10.099	<0.001						

Note: * Acceptable level: Sig. <0.05.

Source: own elaboration in SPSS.

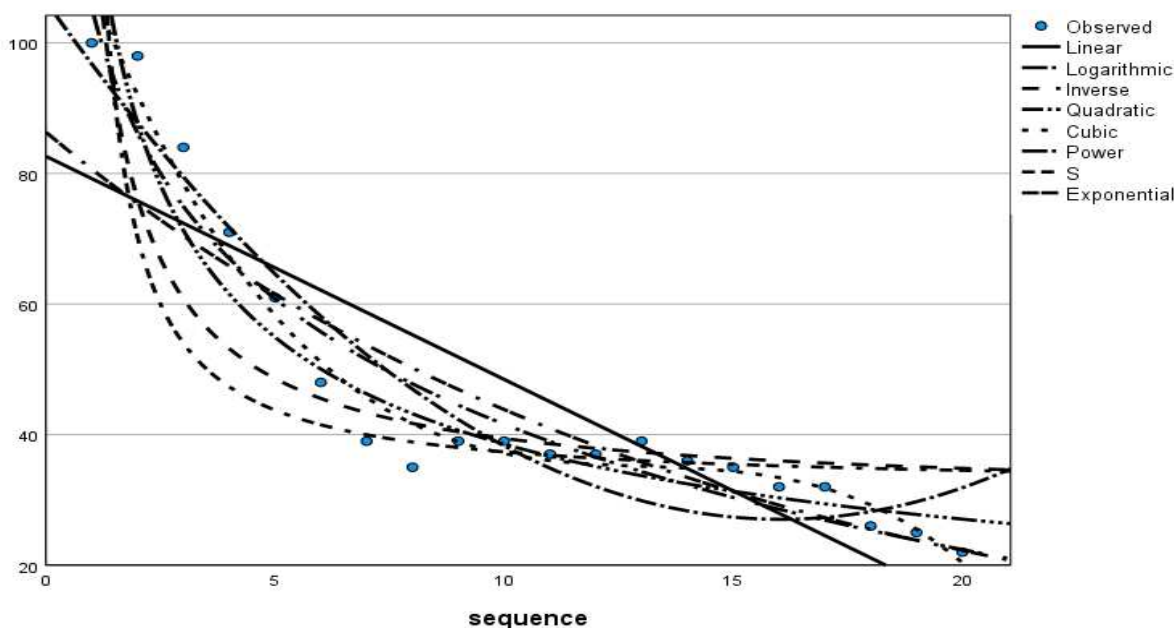


Figure 3. Global interest in NFT: Curve estimation (January – May 2022)

Source: own elaboration.

In general, NFT sales rose sharply in 2021, although there were signs of a slowdown by the end of the year. In contrast, the pronounced interest in NFT observed in late 2021/2022 began to fade rather quickly. The increased interest in NFT was due to its real presence among financial assets and potential earning opportunities mainly from the perspective of creators, investors, and intermediaries. This raises the questions of whether NFTs can regain the widespread public interest they reached in 2021, whether there will be increased transaction activity in the future, and whether the price of popular NFT collections will increase (Grauer *et al.*, 2022).

The May 2022 declines in digital currency quotes, currently described as historic, will certainly have an impact on the developing NFT market. Regardless of attempts to mitigate the reaction of disappointed investors by pointing to the high risk associated with the young cryptocurrency market, the financial losses are real. At the same time, an investment in digital currencies allowed many investors to multiply their funds invested many times over. The COVID-19 pandemic crisis proved to be a short-lived trigger for the collapse of rapidly rising unit prices. As a result, despite pronounced price fluctuations, it is cryptocurrencies that have proven to be a far more efficient capital investment than gold in 2019-2021 (Przyłuska-Schmitt *et al.*, 2022). In contrast, the attractiveness of NFT transactions during the COVID-19-induced market collapse can be attributed to a short-term effect due to asymmetric information, market frictions, differences in investors' risk appetite/aversion to certain asset classes,

etc. (Umar *et al.*, 2022). Noteworthy, NFT transactions can bring diversification benefits in turbulent times, as seen during the COVID-19 crisis and especially around the big market drop in March 2020 (Aharon & Demir, 2021). In the context of these potential benefits of this new digital asset, it is extremely important to conduct multifaceted theoretical and empirical research so that the opportunity does not turn into a loss of life savings and, in extreme cases, loss of possessions combined with debt. The economics of imaginary entities cannot replace the economics of real values and assets.

CONCLUSIONS

Artificial intelligence is a potential area for entrepreneurial development in the creation of completely novel innovative application solutions, including financial instruments and research tools. The originality and novelty of these solutions made the testing phase transfer to business and research practice. This phenomenon falls under the NFT market, both from the perspective of creators, intermediaries or investors and researchers with limited access to primary information. An analogous approach should be taken with regard to data obtained from Google Trends.

The financial market is opening up to an increasing number of services carried out with cryptocurrencies, while more and more attention is being paid to investments in more categories of electronic assets, such as NFTs. Cryptocurrency exchanges, neo-brokers, crypto developers, and NFT trading platforms have experienced a spectacular boom over the past two years. At the same time, the huge drops in cryptocurrency prices in 2022 associated with the bear market should be highlighted. Such drops, although not as significant, were also observed in the NFT market. In both cases, there was no shortage of products that showed an upward trend regardless of the clear drop in the overall market.

The obtained results indicate that the biggest interest in NFTs is found in 'the heart of today's fastest-growing economy in the world' consisting of Hong Kong, China and Singapore. The credibility of the obtained results is high while being limited by research constraints. The main ones are the lack of official databases, data dispersion, and the possibility of data manipulation in computer systems.

The dynamic growth of collections and transactions in the NFT market in 2021 certainly translated into a culmination of interest in NFT in January 2022. However, this interest was short-lived and significantly dropped within several months. Regardless of the region of the world, the trends of changes in this field coincide, as confirmed by correlation analysis. Analysts agree that the NFT market will continue to grow but the dynamic growth observed in 2021 will no longer occur. The waning interest in the NFT market may result in a smaller influx of developers and investors in the future, which does not imply a potential reduction in the market but rather its saturation.

The NFT technology has rapidly conquered the art market and is finding more and more business applications, for example among luxury goods brands. The results of the completed study have practical implications for developers, investors, institutions, and governments interested in understanding the growing NFT industry as part of the new global digital economy, the booming market for digital assets and, in particular, the discussed vision of widespread introduction of digital currencies and abandonment of cash. From the theoretical perspective, the article complements the NFT analyses along with the research instruments used.

Research on this new asset is extremely important due to the limited access to official databases and its high potential combined with very high investment uncertainty. Future research, in addition to quantitative studies that assess the NFT market in terms of the participation of stakeholders and finances, should focus on a qualitative context, including but not limited to the impact of buying and selling decisions of NFTs (market psychology), the impact of NFT valuation in various markets, technological and legal security of NFTs, the role of financial institutions (exchanges) in the NFT market, and the impact of NFTs on culture and art.

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Financial risk in the activity of voivodships in Poland: Synthetic measure as an element of risk assessment in the activities of local government units in the years 2010-2020

Andrzej Pawlik, Paweł Dziekański

ABSTRACT

Objective: The article aims to analyse the spatial diversity of financial risk in the activity of voivodships in Poland and to use a synthetic measure to present selected factors that have a direct impact on the risk assessment.

Research Design & Methods: The authors used literature and statistical analysis for the research. The technique for order preference by similarity to ideal solution (TOPSIS) was used to create synthetic measures. Empirical data were collected by voivodships in Poland for the years 2010-2020.

Findings: The synthetic rate of financial risk in 2020 ranged from 0.40 (Lubelskie) to 0.77 (Mazowieckie), and in 2010 from 0.37 (Opolskie) to 0.61 (Śląskie). Comparing 2020 to 2010, the voivodships Śląskie, Podlaskie, Warmińsko-Mazurskie, and Lubelskie showed a decrease in the value of the synthetic measure. The measure of financial risk was correlated, among others, with own revenues, operating surplus, income from participation in taxes constituting state budget revenues, level of current transfers, liabilities, number of entities and natural persons conducting business activity, and number of employees.

Implications & Recommendations: The detected correlations in the area of financial risk of the voivodships show that the local authorities in their actions should take into account the risk assessment system. The voivodships should define probabilities and impacts in terms of risks, criteria for assessment, and risk analysis in the organization. Finance and economy are interlinked. The actions taken in this aspect must be based on analyses that facilitate comparisons and on current information necessary for effective ac.

Contribution & Value Added: The value of the article is the indicated set of variables allowing us to assess the financial risk of the voivodships, the years of the presented analysis 2010-2020, and the synthetic measure as a basis for the assessment of financial risk.

Article type: research article

Keywords: risk; financial risk; voivodship; synthetic measure; sustainable finance

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INTRODUCTION

The activity of a local government unit (LGU) is a continuous process of making short-, medium-, and long-term decisions regarding various aspects of functioning. Their decisions can be divided into operational and financial. The operational decisions are related to the functioning of the entity, which occur in the sphere of current activities and generate operational and investment risk that result in tangible assets combined with investment risk. The financial decisions refer to the source of financing and financial risk. Risk is a potential threat to which we are all constantly exposed (Akintoye, & MacLeod, 1997). It is an objective category that always occurs independently of human

consciousness. It becomes a key decision criterion in each area of operation and the measured risk is managed (Almeida, Teixeira, da Silva, & Faroleiro, 2019).

Risk, fulfilling itself, results in dysfunctionality of the individual. The areas of activity of LGUs are characterized by the risk of occurrence of events that may hinder the implementation of the set objectives and tasks. Effective risk management involves assessing and analysing risks in individual areas of activity (Jastrzębska, 2014). Economic risk is a risk occurring in the economy that is examined in the context of specific goals and opportunities to achieve them (Rampini, Sufi, & Viswanathan, 2014).

Financial risk is mainly identified with the possibility of obtaining income different (lower) than assumed. In addition, when the risk of obtaining lower budget revenues is burdened with the probability of implementing higher expenditures, the risk of liquidity loss may be generated (Poniatowicz, 2010).

The aim of the study is to analyse the spatial diversity of financial risk in the activities of voivodships and the use of a synthetic measure in its assessment. This allowed to rank and group the surveyed units from the point of view of the main criterion and to present selected factors directly affecting the risk assessment. When addressing the issue of risk, the following research questions were formulated: How do financial variables shape current and investment activities? What is the role of risk in current and investment activities? What is the regional variation in the level of risk in individual voivodships?

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LITERATURE REVIEW

The voivodeship – as the analysis subject of analysis – is a regional self-government community (total population) created to perform the tasks of public administration. It performs public tasks of a provincial nature, not reserved by law for government administration bodies. In order for the voivodship self-government to be able to perform its tasks independently and to exercise its rights, it was equipped with financial resources and legal personality. The basic tasks of the voivodship self-government include shaping and maintaining spatial order, stimulating economic activity, preserving cultural and natural heritage, and maintaining and developing technical and social infrastructure of voivodship importance.

The modern economy operates in conditions of risk, which is an ambiguous and complex concept, so it is difficult to determine its essence in an unambiguous and precise way (Wang, Liang, Li, & Yang, 2016). The risk is a hazard or an opportunity. The risk is understood as the probability of damage to the property or the image of the individual, which will hinder the achievement of the objectives set (Allegrini, D'Onza, Paape, Melville, & Sarens, 2006). Bernstein (1998) describes risk as a variation of the rate of return. Damodaran (2002), on the other hand, indicates standard deviation as a measure of risk. He defines risk as the distribution of rates of return around the expected value, which describes the uncertainty associated with the possibility of achieving a certain level of income.

Jajuga and Jajuga (1998) describe the risk as the possibility of the occurrence of an effect inconsistent with expectations, and the deviation from the assumed result may be both negative and positive. According to Marshall (2001), risk is the possibility of events or adverse trends causing future losses or fluctuations in the future level of income. The risk should be determined in relation to possible outcomes and volatility, as well as expected results in the course of operations (Merna, & Al-Thani, 2008).

The activity of voivodships is a continuous process of making decisions that concern various aspects of functioning with a different horizon (short-, medium- and long-term). Their decisions can be divided into investment (related to investment activities, the effect of which is tangible assets, combines investment risk with them), financial (the effect of which is the nature, structure and type of liabilities, the risk associated with them is financial risk) and operational risks occur in the sphere of current activities and generate operational risk (Ahmeti, & Vladi, 2017).

Risk assessment in the public sector allows for the identification, analysis, assessment of operation and communication of risk in a way that allows an individual to minimize losses and maximize opportunities. As a process, the assessment should take into account the specificity of the voivodship and be an integral part of general management and permeate all processes. It should also allow for the identification of the most critical processes and services carried out in the entity, the threats to those processes and services and the assessment of their impact on the business. The final stage of the analysis should be to build resistance to these risks.

Risk analysis in the activities of voivodships serves to improve the quality of the decision-making process in the field of service provision, change management, innovation, provide better use of resources and taking into account the priorities for action. It allows for an efficient flow of information, making the right decisions, and coordinated cooperation, which will contribute to the rational management of public funds in the area of revenue collection and expenditure. This should ensure greater effectiveness in the implementation of tasks at a higher quality level, defining an attitude in relation to risk, counteracting risk by creating and implementing specific action plans, withdrawing from activities with too-high a risk and transferring risk to other entities (Poniatowicz, 2010).

RESEARCH METHODOLOGY

The research aimed to analyse the spatial diversity of financial risk in the activities of voivodships and the use of a synthetic measure in its assessment. This allowed us to rank and group the surveyed units from the point of view of the main criterion and to present selected factors directly affecting the risk assessment.

The empirical data used in the study describing the financial situation in spatial terms of Poland's 16 provinces are described for the years 2010 and 2020. Their selection was determined by the availability of data collected from the Central Statistical Office (CSO). The voivodeship is a local government unit, a regional self-government community (total population) created to perform public administration (this is NUTS 2 – regions (voivodships or parts thereof) – 16 units).

At the first stage of the implemented research, diagnostic variables were selected to describe the phenomenon under study (financial risk of voivodeships). The quality of statistical data is determined by three characteristics, namely the usefulness of data, timeliness, and accuracy. The study distinguished financial situation variables describing the income and expenditure aspects (which may pose risks), which are presented in Table 1.

In the next stage of the research, the authors tried to eliminate quasi-constant variables from the set of diagnostic variables. To evaluate the variables, the following were used the coefficient of variation and correlation coefficient. The selection of variables was also made based on factor analysis performed in the Statistica programme (Malina, 2006).

Variables describing objects in linear ordering should be characterized by high variability, be poorly correlated with each other, and be strongly correlated with rejected variables. As a result of the analysis, the variables X1, X4, X7, X17, X19, X20, X21 were rejected and further studies included X2, X3, X6, X8, X9, X10, X11, X12, X13, X14, X15, X16, X18. The selection of simple variables and their verification allowed us to determine the observation matrix, consisting of objects and features. It was saved in the form of X_{ij} :

$$X_{ij} = \begin{bmatrix} X_{11} & X_{12} & \dots & X_{1m} \\ X_{21} & X_{22} & \dots & X_{2m} \\ \dots & \dots & \dots & \dots \\ X_{n1} & X_{n2} & \dots & X_{nm} \end{bmatrix} \quad (1)$$

where:

- X_{ij} - the values of the j -th variable for the i -th object, the object data matrix;
- i - the object number ($i = 1, 2, \dots, n$);
- j - the variable number ($j = 1, 2, \dots, m$).

Table 1. Financial situation variables describing the income and expenditure aspect

	Variables	unit
X1	Share of current income in total income	%
X2	Share of own revenues in total revenues	%
X3	Share of operating surplus * in total income	%
X4	Share of property expenditure in total expenditure	%
X5	Charge of current expenses to wages and salaries	%
X6	Share of operating surplus and income from the sale of assets in total income	%
X7	Self-financing rate/ Share of operating surplus and property income in property expenses	%
X8	Current transfers (subsidies + grants) per capita	PLN
X9	Operating surplus per capita	PLN
X10	Total liabilities per capita	PLN
X11	Share of total liabilities in total income	%
X12	Charge of total income to debt servicing expenses	%
X13	Debt service charge on own income	%
X14	Share in taxes constituting state budget revenue **/total income (fiscal wealth per capita index)	%
X15	Debt service expenditure/own revenue (debt service ratio)	%
X16	Expenditures on education and upbringing / number of inhabitants	PLN
X17	Expenditures on housing / population	PLN
X18	Healthcare expenditure / population	PLN
X19	Public administration expenditure / number of inhabitants	PLN
X20	Expenditure on agriculture and hunting / population	PLN
X21	Expenditures on transport and communication / population	PLN

Note: S – stimulant, D – destimulant; * operating surplus = total income – property income – current expenditure;

** Municipalities have a share in the personal income tax (PIT) and corporate income tax (CIT).

Source: own elaboration of data from the Local Data Bank of Statistics Poland (LDB).

In the set of diagnostic variables, the final list of which is presented in Table 1, selected for the construction of the synthetic measure, the following are distinguished:

$$S \text{ (stimulant)} = \{X2, X3, X6, X9, X14, X16, X18\} \quad (2)$$

$$D \text{ (destimulant)} = \{X8, X10, X11, X12, X13, X15\} \quad (3)$$

Diagnostic variables typically have different titles and varying ranges of variation, which prevents them from being directly compared and added (Rogowski, & Krysiak, 1997). The selected variables were subjected to the procedure of zero unitarisation using the following Hellwig's formula:

$$Z_{ij} = \frac{x_{ij} - \min_i x_{ij}}{\max_i x_{ij} - \min_i x_{ij}}, \text{ when } x_i \in S \quad (4)$$

$$Z_{ij} = \frac{\max_i x_{ij} - x_{ij}}{\max_i x_{ij} - \min_i x_{ij}}, \text{ when } x_i \in D \quad (5)$$

where:

S - stimulant, $i=1.2...n$; $j=1.2...m$;

D - destimulant, $i=1.2...n$; $j=1.2...m$;

$\max x_{ij}$ - the maximum value of the j -th variable;

$\min x_{ij}$ - the minimum value of the j -th variable;

x_{ij} - means the value of the j -th variable for i of this object.

Z_{ij} normalized value j of this variable for i of this object (Wysocki, & Lira, 2005; Kukuła, 1999; Dziekański, Pawlik, Wrońska, & Karpińska, 2020; Dziekański, & Prus, 2020).

The obtained values Z_{ij} belonged to the range $[0;1]$. All variables were unified due to the range of variability as well as their location in the observation space. As a result of unitarization, we obtained a matrix of values of the Z_{ij} following features:

$$Z_{ij} = \begin{bmatrix} z_{11} & z_{12} & \dots & z_{1m} \\ z_{21} & z_{22} & \dots & z_{2m} \\ \dots & \dots & \dots & \dots \\ z_{n1} & z_{n2} & \dots & z_{nm} \end{bmatrix} \quad (6)$$

where:

Z_{ij} - is the unified value of the j -th variable for the i -th object.

The synthetic measure was used to assess the variation of provincial financial risk in Poland. It was built based on the TOPSIS method (Behzadian, Khanmohammadi, Otaghsara, Yazdani, & Ignatius, 2012).

The synthetic measure for individual objects was determined based on the formula:

$$q_i = \frac{d_i^-}{d_i^- + d_i^+}, \text{ in which } 0 \leq q_i \leq 1, i = 1, 2, \dots, n \quad (7)$$

where:

$q_i \in [0; 1]$ - the value of the synthetic measure;

d_i^- - the distance of the object from the anti-pattern (from 0);

d_i^+ - the distance of the object from the pattern (from 1).

A higher value of measure indicates a better situation of the individual in the studied area (Jahanshahloo, Lotfi, & Izadikhah, 2006; Velasquez, & Hester, 2013).

In the last stage of research, the division into typological groups was used to interpret the obtained measures. The size of the synthetic measure in the first group means a better unit, in subsequent groups – the weaker units. A linear regression and autocorrelation analysis were also presented (Zeliaś, & Malina, 1997).

The correlation coefficient (Pearson) was assessed, expressed by the formula:

$$r_{xy} = \frac{\sum_{i=1}^n (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^n (x_i - \bar{x})^2 \sum_{i=1}^n (y_i - \bar{y})^2}} \quad (8)$$

where:

r_{xy} - Pearson's linear correlation coefficient;

x and y - are measurable statistical features $x = (1, 2, \dots, n)$, $y = (1, 2, \dots, n)$, and are arithmetic means of features x and y . The necessary calculations were carried out using the Statistica software.

Regression analysis (performed in Gretl) is an analytical technique used to calculate the estimated relationship between a dependent variable and one or more describing variables (Gigerenzer, 2004; Schmidt, 2020).

Spatial autocorrelation is the correlation between the values of the same variable at different points in space (Griffith, 2003; Getis, 2007). The global and local spatial correlation coefficient of Moran's I. The global Moran's I (Anselin, 1995; Upton, & Fingleton, 1985; De Siano, & D'Uva, 2012):

$$I = \frac{\sum_{i=1}^n \sum_{j=1}^n w_{ij} (x_i - \bar{x})(x_j - \bar{x})}{S_0 \sigma^2} \quad (9)$$

The local form of the I Moran coefficient for observation i , determine the similarity of a spatial unit to its neighbours and the statistical significance of this relationship and is determined by the formula:

$$I = \frac{(x_i - \bar{x}) \sum_{j=1}^n w_{ij} (x_j - \bar{x})}{\sigma^2} \quad (10)$$

where:

n - number of spatial objects (number of points or polygons),

x_i, x_j - the value of the variable for the compared objects;

\bar{x} - the average value of the variable for all objects;

w_{ij} - elements of the spatial weight matrix (weight matrix standardized in rows to one);

x_{ij} - means the value of the j -th variable for i of this object.

$S_0 = \sum_{i=1}^n \sum_{j=1}^n w_{ij}$, $\sigma^2 = \frac{\sum_{j=1}^n (x_i - \bar{x})^2}{n}$ - variance (Anselin, & Bera, 1998; Getis, & Ord, 1992).

To illustrate the spatial relationship of the financial risk distribution of voivodships in Poland, Moran's I statistics were calculated, using the Queen matrix standardized in rows to one. The calculations were made in the PQStat programme.

RESULTS AND DISCUSSION

Figure 1 presents the results of the classification of voivodships obtained on the basis of the synthetic measure TOPSIS. Four groups were distinguished, consisting of five, three, four, and four voivodships in 2020, and six, three, three, and four voivodships in 2010. The synthetic measure of q_i financial risk in 2020 ranged from 0.40 (Lubelskie) to 0.77 (Mazowieckie), and in 2010 from 0.37 (Opolskie) to 0.61 (Śląskie). Comparing 2020 to 2010, the following voivodships Śląskie, Podlaskie, Warmińsko-Mazurskie, Lubelskie present a decrease in the value of the synthetic measure. The first group includes voivodships with the lowest financial risk: Mazowieckie, Wielkopolskie, Dolnośląskie, Kujawsko-Pomorskie and Pomorskie, and the fourth group – with the highest financial risk: Lubuskie, Podlaskie, Warmińsko-Mazurskie and Lubelskie.

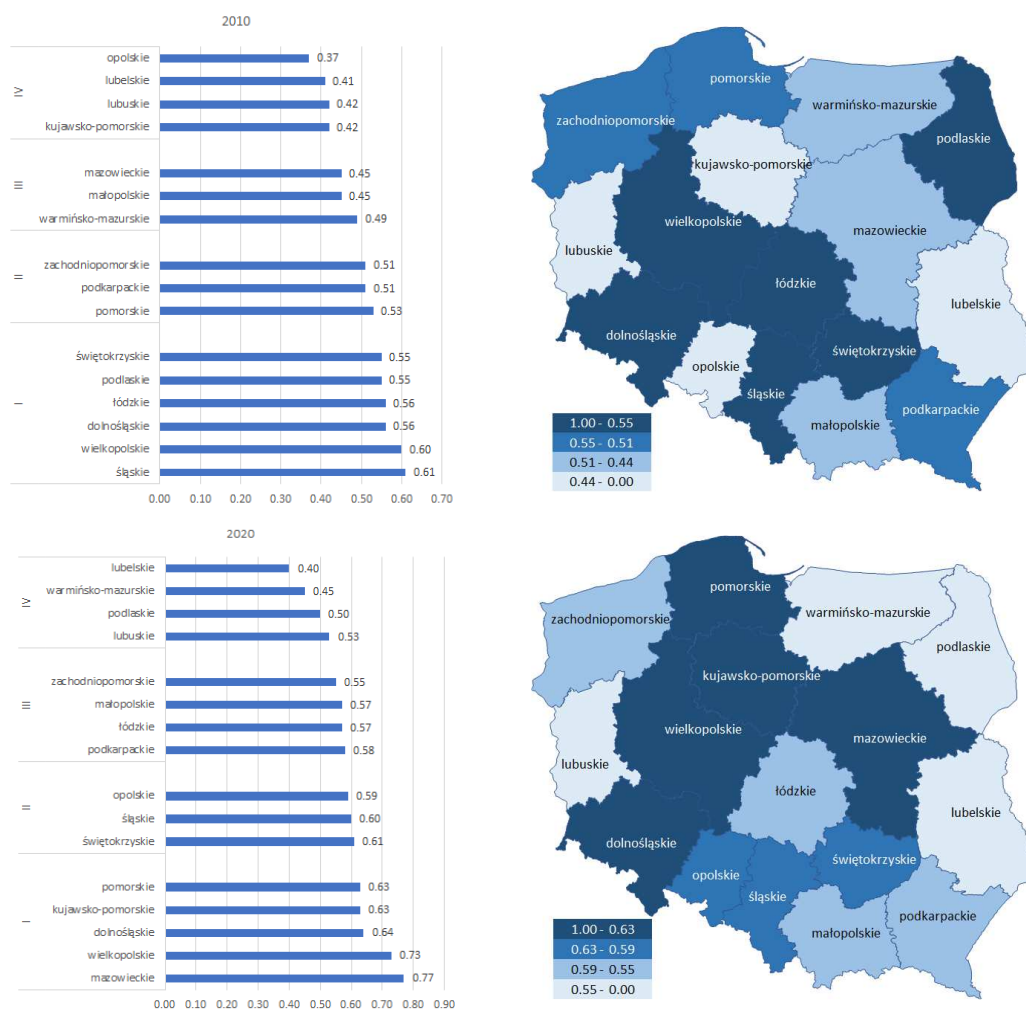


Figure 1. Spatial differentiation of the synthetic measure financial risk of voivodships in 2010 and 2020

Source: own elaboration of data from the Local Data Bank of Statistics Poland.

The financial risk measure was correlated with the share of own income in total income (0.5438), the operating surplus in total income (0.6808), surplus income from the sale of property in total income (0.6758), operating surplus per capita (0.6209), the share of taxes constituting state budget income in total income (0.5428), and health care expenditure per capita (0.4343). The value of the financial risk measure

was negatively correlated with the level of current transfers (sum of subsidies and subsidies) per capita (0.388), total liabilities per capita (-0.5434), the share of total liabilities in total income (-0.5554), encumbrance of own income with debt service expenditure (-0.6904), or the ratio of debt service expenditure to own income (-0.5902). The high value of the correlation of the synthetic measure of financial risk with the share in taxes constituting state budget revenues – personal income tax (0.5719), corporate income tax (0.5686) – indicates the dependence of voivodships on income from the state budget.

Negative values of global Moran's I statistics mean the occurrence of a different level of the studied phenomenon in units distant in relation to neighbouring ones. In the considered period, there was a slight negative autocorrelation and a decrease in value (comparing 2020 to 2010) for the synthetic measure of financial risk, see Table 3. The decreasing value of the considered statistics means a decreasing spatial dependence.

Table 3. Values of global Moran's I statistic for the synthetic measure of financial risk of voivodships in 2010 and 2020

Statistics	2010	2020
Moran's I	-0.379643	-0.150688
Expected I	-0.066667	-0.066667
Assuming normal		
Variance I	0.022125	0.022125
Z-Statistics	-2.104116	-0.56487
p-value	0.035368	0.572162
Assuming randomness		
Variance I	0.02354	0.021183
Z-Statistics	-2.039909	-0.577291
p-value	0.041359	0.563743

Source: own elaboration of data from the Local Data Bank of Statistics Poland in the Statistica programme.

The obtained values of local Moran's I statistics are presented in Figure 2. High positive values of local Moran's I statistics in 2010 were obtained in the case of the following voivodships: Zachodniopomorskie, Pomorskie, Mazowieckie, and negative for Małopolskie, Lubuskie, Opolskie. In 2020, positive statistics were obtained for Podlaskie, Kujawsko-Pomorskie, Dolnośląskie, and negative for Lubelskie, Warmińsko-Mazurskie, Mazowieckie. At the same time, the decreasing trend in the value of the considered statistics (Lubelskie, Łódzkie Mazowieckie, Pomorskie, Warmińsko-Mazurskie, and Zachodniopomorskie) in the period under consideration means a decreasing spatial dependence (Figure 2).

To assess the impact of socioeconomic variables of voivodships on the diversity of financial risk, the regression model was estimated, see Table 4. The fit of the model was measured by means of the following indicators: determination factor R-squared 0.734180 and adjusted R-squared 0.714610, which confirmed that the model allows explaining 73.41% of the variance of variables. Statistics F (12, 163) 37.51636 is statistically significant as well as (P value) was statistically significant, which means that the construction of the linear model was correct.

The voivodship authorities should be able to predict the risk of action. Determining the risk facilitates making rational decisions and actions enabling the implementation of tasks and objectives that are important from the point of view of meeting the needs of the voivodship community.

The implemented tasks of voivodships cannot be carried out effectively as a result of the impact of various factors on finances. The identification of these factors (internal or external) in terms of realised income and expenditure, changes in legal regulations, and the economic situation require constant analysis by the authorities. They should provide up-to-date, ongoing information necessary for the decision-making process. The multi-factor analysis method and the synthetic measures of financial (investment or operational) risk created on this basis prove to be supportive in this process (Kata, 2012). The financial risk associated with innovative processes financed, among others, by credit instruments

determines the financial situation. The risk occurs in the investment activity undertaken by the voivodship and is reflected in the levels of non-implementation of budgets in part of investment expenditure (included in the budget in the asset part) (Filipiak, 2017).

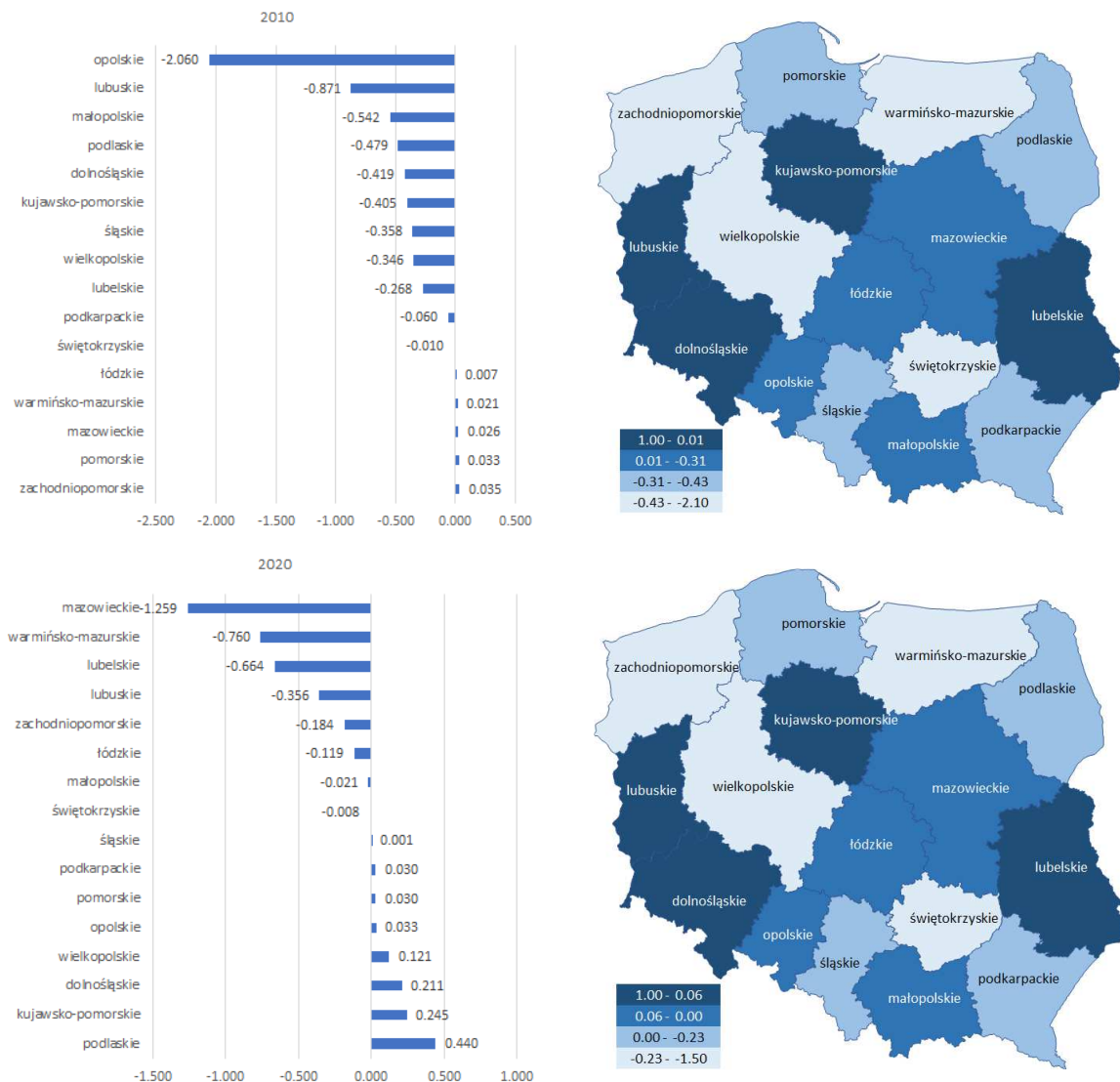


Figure 2. Spatial differentiation of the synthetic measure of financial risk in voivodships in 2010 and 2020

Source: own elaboration of data from the Local Data Bank of Statistics Poland.

The synthetic measure presented in the study allows to include in one number many features that have a significant impact on the analysed risk phenomena. Such measures may be particularly useful in comparative analyses, as well as in the assessment of changes in the studied phenomenon. This risk is determined by their activity (including investment), sources and structure of expenditure financing and income potential determining financial independence. The main threats affecting the financial situation undoubtedly include the issues of safe debt and its servicing, which examined Filipiak (2013). To the mentioned areas, we should also add the management of financial liquidity or income and current expenditure, the difference of which is an operating surplus/deficit. The risk of over-indebtedness is greater as local authorities benefit more from EU subsidies and receive less from the state budget. Poor financial situation causes threats to the safe functioning of units, and reckless decisions of managers, even with a favourable initial situation, may cause significant problems later, including debt (Trussel, & Patrick, 2009).

Table 4. The results of the regression analysis between the measure of financial risk and socioeconomic variables of voivodships in 2010-2020

Name of the socio-economic variable	Coefficient	Standard error	t-Student's	p-value
Constant	-0.525137	0.122615	-4.283	<0.0001
Total expenditure by budget classification headings Section 851 – Health care PLN	0.000380319	0.000203829	1.866	0.0639
Electricity in households by location of the consumer Electricity consumption per capita in the countryside kWh	0.000113518	4.20174e-05	2.702	0.0076
Share of legally protected areas in the total area %	0.00258366	0.000376034	6.871	<0.0001
% area of active landfills where municipal waste is disposed of – as of 31 December	-522.978	189.792	-2.756	0.0065
Waste collected selectively in relation to total waste %	-0.00155004	0.000513057	-3.021	0.0029
Registered entities per 1000 population	-0.0105334	0.00119941	-8.782	<0.0001
Natural persons conducting economic activity per 1000 population	0.0158281	0.00156914	10.09	<0.0001
Employed persons by section groups and gender in poviats (per person) 1000 inhabitants	0.00108448	0.000223066	4.862	<0.0001
Corporate income tax (PLN) pc	0.000950006	0.000166120	5.719	<0.0001
Industrial areas %	0.187455	0.0362337	5.173	<0.0001
Wastewater treated per year discharged in total dam3 per 100 km2	-0.000198709	5.06931e-05	-3.920	0.0001
Population using sewage treatment plant in % of total population in %	0.00549375	0.000770746	7.128	<0.0001
Arithmetic mean of the dependent variable	0.495511	Standard deviation of the dependent variable	0.087170	
Sum of residual squares	0.353476	Residual standard error	0.046568	
Determining coefficient R- square	0.734180	Corrected R-square	0.714610	
F (12, 163)	37.51636	P-value for the F test	9.94e-41	
Logarithm of credibility	296.7842	Information criteria Akaike	-567.5685	
Bayesian information criterion	-526.3522	Crit. Hannana-Quinna	-550.8513	

Note: least squares method estimation, observations used 1-176; Dependent variable (Y): the measure of financial risk.

Source: own elaboration of data from the Local Data Bank of Statistics Poland in the Statistica programme.

CONCLUSIONS

The decrease or increase in the financial risk of voivodships results from the fact of functioning in changing conditions, the impact of which may lead to increasing financial problems.

The synthetic rate of financial risk in 2020 ranged from 0.40 to 0.77 and in 2010 from 0.37 to 0.61. Comparing 2020 to 2010, voivodships Śląskie, Podlaskie, Warmińsko-Mazurskie, and Lubelskie presented a decrease in the value of the synthetic measure. The measure of financial risk was correlated, among others, with own revenues, operating surplus, income from participation in taxes constituting state budget revenues, level of current transfers, liabilities, number of entities and natural persons conducting business activity and number of employees.

An entity must agree on a risk assessment system that includes definitions for different levels of risk probability and impact, risk assessment, and analysis criteria in a uniform manner across the organisation. This allows for risk identification, unambiguous assessment of the impact on the entire organization, indication of the risk that has the greatest impact on the organization's ability to achieve its objectives, reduction of subjectivity, and increased transparency of risk assessment.

Effective risk analysis requires the use of a uniform method for individual areas of functioning and development. The investigated risk should be adequately described in the documentation and ranked according to the order and speed of response to it in individual areas of activity.

The results of the study allow for comparisons to be made between the units studied and new areas of analysis to be identified. In terms of new directions of research, future research should compare the results of ordering on the basis of a larger number of variables describing the main criterion, comparing the results of linear ordering with another method, or analysing outliers and determining their impact on the studied area.

Problems encountered in the process of analysis were the availability of data, comparability of data, and changes in legislation, especially in the area of local government tasks, finances, and financial reporting.

The value of the article is the indicated set of variables allowing to assess the financial risk of the voivodships, the years of the presented analysis 2010-2020, and the synthetic measure, as a basis for the assessment of financial risk.

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Conflict of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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The domestication of value chains through local content requirements: Can interconnected economies benefit from the Chinese experience?

Tomasz Geodecki, Marcin Zawicki

ABSTRACT

Objective: The objective of the article is to reflect on the effectiveness and conditions of economic policy based on local content requirements (LCRs) by testing the hypothesis that the application of LCRs in China between 2004 and 2014 was instrumental in increasing the volume of value added created in its economy.

Research Design & Methods: By using inter-country input-output tables, we attempt to assess the effectiveness of LCRs in increasing the volume of value added induced in a country where, as is the case in China, they are used to enhance domestic technological capabilities. Our analysis focused on high-tech and medium-high-tech (HT&MHT) sectors. In order to test the hypothesis, data from 2004 and 2014 were analysed for Austria, China, Germany, and the Visegrád countries (V4). This approach makes it possible to compare the effects of the domestication of value chains in China with the processes that accompanied the internationalisation of value chains in the group of four emerging economies.

Findings: The findings of our study justify the conclusion that the application of LCRs in China's HT&MHT industries in 2004-2014 effectively increased the volume of value added created in its domestic economy. The negative consequences of LCRs predicted by the theory indeed occurred in China's HT&MHT industries. The prices of intermediate inputs increased more than proportionally relative to the prices of outputs; likewise, the value added of suppliers to these industries increased more than proportionally. The gross value-added coefficient in HT&MHT industries decreased. Nevertheless, the induced value added by HT&MHT industries in the Chinese economy significantly outweighed the value-added loss resulting from the reduction in the direct gross value added coefficient in these industries. The reduction in margins resulted from the imposition of LCRs, which forced final producers to scale up sourcing from local suppliers. Local content requirements in China may have contributed to a rapid increase in technological capabilities. Technological catching up by Chinese HT&MHT producers and their suppliers accelerated in the context of increasing scale of production achieved by intensifying participation in world trade and by increasing the purchasing power of local consumers.

Implications & Recommendations: Although some elements of technological self-reliance present in the Chinese model may serve as an inspiration for the Visegrád countries to reflect on the international division of labour that emerged in the 1990s in Europe, the space for its renegotiation seems to be constrained not only by their population size but also by their limited ability to mobilise innovative inputs.

Contribution & Value Added: The novelty of our approach consists in estimating the positive and negative effects of LCRs as predicted by theory, expressing them in monetary terms, and comparing them with the effects achieved by economies where value chains are internationalized.

Article type: research article

Keywords: economic policy; global value chains; industrial upgrading; interconnected economies; local content requirements

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INTRODUCTION

Catching-up mechanisms are a central issue in research on developing economies. In this area, numerous analysts consider high technology sectors to be the most promising, since it is where developing countries have the greatest potential to boost productivity through knowledge development (Stehrer & Wörz, 2001; Fagerberg & Godinho, 2004). However, in order to upgrade, business actors in developing countries need to gain access to leading technologies and markets in developed countries to achieve an appropriate scale of production as well as the ability to meet their demand for state-of-the-art products (Hobday, 1995; Amsden, 2001). In the globalisation era, such an opportunity is provided by the insertion of selected segments of the national economy in international value chains, where industrial upgrading is achieved through cooperation with global leaders (Baldwin & Lopez-Gonzalez, 2015).

However, firms in the Global South are faced with the dilemma of how to promote cooperation with foreign lead firms within the latter's global value chains and, at the same time, to maintain their capacity to capture value added given the fact that, in the long run, they want to avoid getting stuck in low value added activities without viable prospects for functional upgrading. An alternative is to create their local value chains (Lee *et al.*, 2018) by, among other things, inducing lead international firms to scale up cooperation with local business actors and to transfer knowledge to them. One of the instruments used for this purpose is local content requirements (LCRs), *i.e.* administrative requirements to purchase a certain proportion of intermediate inputs from local suppliers.

There are good reasons to believe that LCRs provided an important tool for implementing China's industrial policy after its accession to the WTO in 2001. Efforts to promote technological self-sufficiency and domestication of value chains were further strengthened by the Made in China 2025 strategy (MIC, 2025) which seeks to modernize China into an advanced manufacturing leader. At the other extreme of internationalisation are medium-sized and small open economies of the four Visegrád countries (the V4), *i.e.* the Czech Republic, Hungary, Poland, and Slovakia, whose industries constitute part of global value chains organised mainly by TNCs headquartered in Western European countries. As they actively strive to chart their paths of economic development, it is reasonable to inquire whether China can indeed provide an appropriate model in this respect.

This article aims to reflect on the effectiveness and conditions of LCR-based economic policy by testing the hypothesis that the application of LCRs in China between 2004 and 2014 was instrumental in increasing the volume of value added created in its economy.

The relevance of this study is supported by two arguments. Firstly, by using inter-country input-output tables the authors attempted to assess the effectiveness of LCRs in increasing the volume of value added created in a country where, as is the case in China, they were used to enhance domestic technological capabilities.

The novelty of our approach consists in estimating the positive and negative effects of LCRs as predicted by theory, expressing them in monetary terms, and comparing them with the effects achieved by economies where value chains are internationalized. Moreover, we examined whether the effectiveness conditions for LCRs as identified in the literature have been met, namely whether the coordination problem was overcome and production was rapidly scaled up in industries with a high potential for learning by doing (Tomsik & Kubicek, 2006; Veloso, 2001; 2006). If so, the rapid value-added growth in China's high-tech and medium-high-tech industries may indeed have resulted from the application of LCRs.

The rest of the paper is organised as follows: after Introduction in Section 2. we review the literature regarding goals of LCRs, implementing it as an instrument of innovation policy and barriers to its use. At the end of this section we formulate hypotheses. Section 3 presents research methodology. Section 4 provides results of the research on the consequences of LCRs implementation in the Chinese economy, compare and discuss the accompanying effects in the fields of overcoming coordination problem, indigenizing R&D and the role of domestic demand. Section 5 concludes.

LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

The Origin and Goals of LCRs

Local content requirements are policies enacted by governments that require foreign firms to use domestically manufactured goods or domestically supplied services to operate in a given host economy. They take a variety of forms. They may focus on input markets and trade or be related to discriminatory government procurement and localisation requirements associated with data protection and security (OECD, 2016). Moreover, LCRs are defined as a specific type of localization barriers to trade that seek to force foreign companies to manufacture locally what they would otherwise produce outside a nation's borders and export to a recipient economy.

Countries define 'local content' in a variety of ways, such as the percentage of local components used in the assembly of a final product; the share of locally developed intellectual property embodied in the development of a product or service; or the share of locally produced or local content in the broadcasting and audio/visual sectors. Local content requirements impact both private and public sector procurement.

According to estimates, since the financial crisis of 2008 until 2016, more than 140 new local content measures were put in place by governments largely to improve domestic employment and industrial performance. Local content requirements were introduced by dozens of countries, including Argentina, Brazil, Canada, China, India, Indonesia, Malaysia, Mexico, Nigeria, Russia, Turkey, and Vietnam. Brazil even 'made LCRs a centrepiece of its industrial policy' (Ezell *et al.*, 2013).

Nonetheless, LCRs tend to cause welfare losses. The benefits gained by upstream producers may not offset the negative effects of making goods manufactured by final producers more expensive, such as reduced consumer surplus and loss of competitiveness of downstream producers vis-à-vis their foreign rivals (Stone *et al.*, 2015; Grossman, 1981). Davidson *et al.* (1985) conclude that LCRs increase domestic producers' rents and reduce consumer welfare. Richardson (1991) adds that domestic producers of final goods also pay for this by losing their market shares to less expensive foreign producers, whereas domestic welfare depends on whether the suppliers' gain compensates for the producers' loss. The effect on domestic welfare as a whole is contingent on the magnitude of these changes, but when combined with the negative effect on foreign producers, both global production and global welfare are reduced. Stone *et al.* (2015) note that this research current focuses on the effects of LCRs dependent on the market power of upstream producers. If this power is substantial, LCRs amplify inefficiencies in a given sector (Belderbos & Sleuwaegen, 1997), but if it is small, LCRs may increase them, which is desirable when a monopolistic foreign subsidiary forces low prices on numerous domestic suppliers (Moran, 1992). Even so, the rationales behind introducing LCRs may involve more complex factors than just the desire to affect respective market powers or domestic prices.

In their formal analysis of the mechanisms of LCRs' impacts, Tomsik and Kubicek (2006) highlight that they are not as clear as they would appear from the competitive equilibrium model. Indeed, the invalidation of the assumption of constant returns to scale is insufficient to justify the use of LCRs in developing countries, as they increase the benefits of suppliers at the expense of profits of final producers, raising the GNP rather than the GDP. The coordination problem, *i.e.* a situation where a final good cannot be manufactured in the absence of a domestically produced intermediate good is an argument in favour of LCRs. This problem arises in the context of a certain minimum level of transport costs and specificity of an intermediate good, otherwise, it would be easy to acquire inexpensively abroad. Again, these conditions may not be sufficient, as the natural comparative advantage may favour the production of some goods in a developed country. Only when the coordination problem is aggravated by the inadequate scale of production does it lead to the conclusion that too small a demand for a particular good may limit manufacturers' profits and thus prevent them from setting up production in a developing country. Local content requirements may be more effective if a given industry in the host country is characterised by a large technology gap but has a large learning potential. The rapid increase in the scale of production accelerates learning by doing and, when combined with low labour costs, the host economy may become more competitive in manufacturing this good than

the developed one despite its less efficient technology. In this way, LCRs enable the developing country to overcome the initial technological backwardness in a given industry (Tomsik & Kubicek, 2006). Therefore, LCRs are often imposed on industries where higher value-added stages can be located in the local developing economy. This instrument was also used by developed countries in the past (Stone *et al.*, 2015; Chang, 2007), although restrictions on their application have been agreed upon by World Trade Organisation's (WTO) members. However, they can still be put forward as a precondition for receiving public support (Tomsik & Kubicek, 2006).

Veloso (2001, 2006) concludes that this policy instrument is intended to enhance technological capability, especially in developing countries. By attracting foreign investment, domestic producers have a unique opportunity to improve their competences, but on condition that the foreign manufacturer is willing to cooperate and transfer the requisite knowledge to domestic producers. Moreover, the learning-by-doing effect associated with the increased scale of operations of domestic suppliers and the rapidly falling learning curve in the high-tech and medium-high-tech (HT&MHT) sectors mean that LCRs should be considered as an instrument of innovation policy as well (Veloso, 2001). Thus, in countries characterised by a large technology gap, the positive effect of industrial upgrading resulting from inducing producers to cooperate with local suppliers can significantly outweigh the increase in costs of intermediate inputs and raise welfare (Tomsik & Kubicek, 2006; Veloso, 2006). This rarely occurs in advanced economies (Veloso, 2001) due to the already high level of technology and the lower relative benefit of raising it still further.

The subsidies that accompany LCRs can also be more than offset by an increase in value added thus freed up – which is critical is the ability of local producers to achieve economies of scale. In an analysis conducted for the Brazilian automotive market, increasing production from 35 000 to 200 000 units boosted optimal local content from 45% to 90% (Veloso, 2006). At low production levels, however, virtually all the benefits associated with LCR-based policies disappear. This observation may confirm the effect of scale on increasing factor productivity noted by Verdoorn (1949), which is likely because the Keynesian increase in aggregate demand is important for inducing investment in new technologies (the so-called Kaldor-Verdoorn effect; see Kaldor, 1966).

To sum up, there are two research currents on LCR effects: the older one focuses on changes in the market power of firms (*e.g.*, Grossman, 1981; Davidson *et al.*, 1985; Richardson, 1991), whereas the more recent one expands the analysis to include technological aspects (Tomsik & Kubicek, 2006; Veloso, 2001; 2006). Below, they shall be called 'market power' and 'innovation' currents, respectively.

LCRs in China's Technological Self-reliance Strategy

Albeit unofficially and covertly, LCRs are at the heart of China's contemporary economic policy. The catalyst for the current wave of industrialization in China was its accession to the WTO in 2001, which marked a period when the country's manufacturing industry marched into the international market. 'Foreign investments flooded into China to capitalize on opening the Chinese market to foreign competitors. Year by year, China becomes the production outsourcing base of the international manufacturing industry' (Huimin *et al.*, 2018). At the same time, China kept accumulating a trade surplus. These developments led to increasing China's share of HT&MHT exports (Figure 1), which were originally identified as priority areas.¹

The objectives of China's current economic policy resemble those pursued in the 1990s by the four dragons of East Asia (South Korea, Taiwan, Hong Kong, and Singapore) in electronics. To overcome market barriers to entry and then to assimilate process and product technologies, those firms engaged in subcontracting which consisted in supplying Western companies with semi-finished and finished products under their brand – thus enabling East Asian producers to enter markets previously controlled by Western ones (Hobday, 1995). By adopting similar objectives, contrary to WTO rules, China did not abandon its policy of preferences for local producers. The opening of China's automotive market to foreign

¹ Specifically, these strategic sectors include: information technology, numerical control machinery and robotics, aerospace and aviation equipment, maritime engineering equipment and high tech maritime vessel manufacturing, advanced rail equipment, energy-saving and new energy vehicles, electrical equipment, new materials, biomedicine and medical devices and agricultural machinery and equipment (Chamber, 2017).

investment in the early 1990s constitutes an instructive case in point (see *e.g.*, Tabata, 2014). Accession to the WTO raised concerns among domestic producers that TNCs with economies of scale and extensive supply networks would drive local producers out of the market (Ali *et al.*, 2004). However, the state urged investors to co-opt domestic players by requiring them to enter into joint ventures and offset programs as a precondition for access to its emerging huge automotive market (Gallagher, 2003; Thun, 2004).

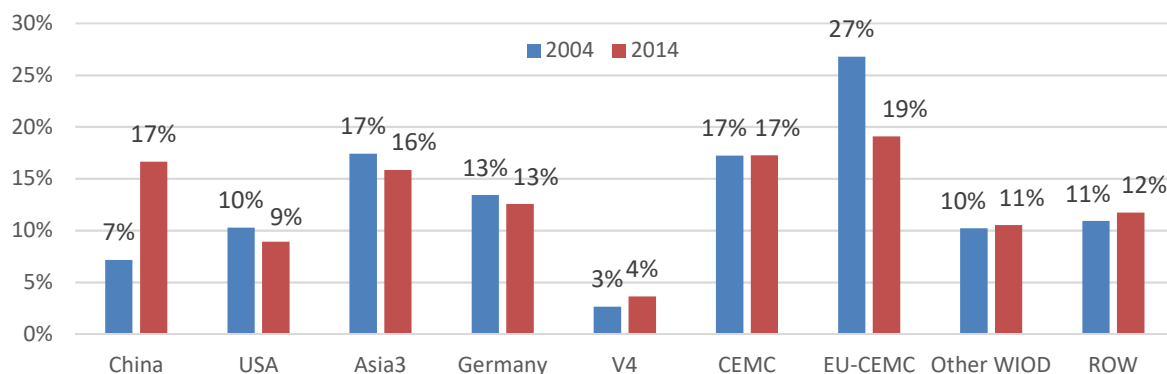


Figure 1. Share of HT&MHT products in world trade

Source: own elaboration based on WIOD.

Preferences for local manufacturers also existed in other areas, such as nuclear and renewable energy equipment. For example, in 2010, Clean Development Mechanism funds were made available only to Chinese majority-owned entities (Stone *et al.*, 2015). The success story of the country's wind power sector is also well documented (Qiu & Anadon, 2012; Liu *et al.*, 2015). The government's development programme for this sector, localization rate, R&D, and intellectual property support successfully promoted domestic technology development and international technology transfer. The increasing scale of production subsequently reduced costs by more than 4% with each doubling of capacity (Qiu & Anadon, 2012), ultimately enabling China to become a leader in wind energy production in 2010 and a major exporter. It is worth noting that, apart from market access, China's authorities were able to defend their policy of supporting domestic producers by citing the examples of other countries using LCRs to a much greater extent (Stone *et al.*, 2015; Deringer *et al.*, 2018).

Industrial upgrading, technological progress, and an unprecedented rise to global prominence in the first dozen years or so since joining the WTO emboldened the Chinese authorities to take even bolder steps towards technological independence. In May 2015, Prime Minister Li Keqiang launched the initiative Made in China 2025 (MIC 2025) which sets out to turn China into an advanced manufacturing leader. This 10-year comprehensive strategy focuses heavily on intelligent manufacturing in 10 strategic sectors and 'has the aim of securing China's position as a global powerhouse in high-tech industries which constitutes nearly 40 per cent of China's entire industrial value-added manufacturing' (ISDP, 2018; Chamber, 2017).

Policies implemented under MIC 2025 are designed to achieve three main objectives (Chamber, 2017, p. 13):

1. localize and indigenize;
2. substitute;
3. capture global market share.

Local content requirements provide a common ground for achieving each of the MIC 2025 objectives, as its success is critically determined by the scale and scope of LCR implementation in the sectors of interest as stipulated by the strategy.

As a result, more and more analysts are expressing reservations about China's economic policy. Chinese government subsidies skew markets, and undercut the American and other foreign manufacturers, leading to overcapacity and the dumping of cheap products on the global market. There are also widespread concerns about China's goal of achieving 70% self-sufficiency in core components and

critical materials by 2025. According to analysts, China applies implicit detailed quotas on the use of local resources for domestic companies in violation of WTO rules. In response to the emerging Chinese ‘techno-nationalism’ (Wübbecke *et al.*, 2016), technologically leading countries have begun to take measures to restrict Chinese exports and investment. China’s ability to build its production on the rapidly growing demand of the world’s largest population is becoming an important resource in this regard. Therefore, in view of the expected retreat from globalisation, in recent years, Chinese authorities have taken measures to strengthen internal circulation (Blanchette & Polk, 2020).

Domestication vs Internationalization of Value Chains

China’s retreat from increasing economic openness, noted since the mid-2000s, has not been experienced by developed countries so far. In the era of production fragmentation, production sharing and offshoring became a way for leading global firms to reduce manufacturing costs and increase profits as they morphed into transnational corporations (TNCs). Advances in long-distance communication and the removal of barriers to investment and trade enabled them to exploit international wage differentials (Baldwin, 2012). Thus, reduced manufacturing costs are an important factor in sustaining the export competitiveness of certain segments of Western economies (Milberg & Winkler, 2013; Grodzicki & Skrzypek, 2020).

The ‘trade-in tasks’ brought about a second unbundling, *i.e.* the separation of factories from offices (Baldwin, 2006) leading to a ‘functional specialization’ of economies within global value chains (Stöllinger, 2021). The so-called factory economies specialise in manufacturing stages that yield relatively less value added per unit of output than the headquarter economies (Baldwin & Lopez Gonzalez, 2015; Stöllinger, 2021). From the perspective of developing countries, unlikely to become technological leaders, foreign investment provides an opportunity for at least ‘spot’ industrialisation and the development of technological competence in individual production stages.

The so-called Factory Europe has become one of the most important centres where low-cost economies cooperate with technological leaders. Thanks to their insertion into global value chains, the Visegrád countries became important producers and exporters of complex manufacturing goods (Bruszt & Greskovits, 2009). The still significant role of the manufacturing sector in these economies appears to be associated with production for leading firms from the global core countries, especially Germany. Due to the strong cooperation ties in industry, economists (*e.g.*, Augustyniak *et al.*, 2013) often use such shorthand terms as the German-Central European Supply Chain (GCESC) or the Central European Manufacturing Core (CEMC), which includes Austria (Stehrer & Stöllinger, 2015). Interdependence may be the source of growth for this cluster’s export-oriented industry (Augustyniak *et al.*, 2013) thus maintaining the cost competitiveness of the German economy (Simonazzi *et al.*, 2013; Grodzicki & Skrzypek, 2020) thanks to which producers from the V4 countries gain access to global markets. However, Nölke and Vliegenthart (2009) warn that the dependent nature of V4 economies may hinder development opportunities owing to the dominant role of TNCs in industry (Table 1). For the most part, foreign corporations neither contribute to the development of local research systems nor show much interest in training the workforce of their affiliates. Instead, they prefer to import new technologies from their parent companies (Nölke & Vliegenthart, 2009; Bruszt & Greskovits, 2009). Although some elements of technological self-reliance present in the Chinese model may serve as an inspiration for the Visegrád countries to reflect on the international division of labour that emerged in the 1990s in Europe, the space for its renegotiation seems to be constrained not only by their population size (64 million), but also by their limited ability to mobilise innovative inputs.

The size of the Chinese economy and its associated capabilities are too large to be confined to the standards set by competitors from developed countries. Admittedly, in 2004–2014 Chinese companies in general were not global lead firms not least because of a lack of access to technology and markets. However, practice reveals that China’s decision to join the WTO should be considered not so much as a token of recognition of free trade rules but as an attempt to build domestic firms capable of competing not only on costs. Hence its acquisition of the capacity to manufacture technologically advanced goods led to a natural consequence, namely an attempt to become technologically independent.

Table 1. Investment positions of China vs CEMC

Country / Country group	Inward FDI stock (% of GDP)		Outward FDI stock (% of GDP)	
	2004	2014	2004	2014
CHN	12.6	10.4	2.3	8.5
CZE	48.0	58.5	3.2	8.8
HUN	59.2	71.4	7.6	28.9
POL	33.0	38.8	0.3	5.1
SVK	65.4	49.2	2.5	2.7
V4	44.3	48.4	2.6	8.8
AUT	23.5	39.8	23.2	49.3
DEU	25.9	22.1	28.3	36.0
CEMC	28.3	28.4	24.3	32.1
World	24.3	33.1	25.2	33.5

Source: own elaboration based on UNCTAD database.

The trajectory of China's policy of domestication of value chains – and its dissimilarity from the common experience of growing interconnectedness in the age of globalization (OECD, 2013) – can be portrayed by comparing a sample value chain in the HT&MHT sectors in China with its counterparts in the Central European Manufacturing Core. This sample (Figure 2; for details, see Grodzicki and Geodecki, 2016) illustrates China's growing control over its global supply by analysing the extent to which backward and forward linkages are controlled by domestic business actors and the extent to which a given sector of the economy studied relies on final demand driven by domestic consumers.

China's policy of domestication of value chains through LCRs can be viewed as an attempt to build technological capabilities by overcoming the coordination problem, *i.e.* strengthening incentives for firms to invest in technological development. By combining cost advantages with building technological capabilities of suppliers to HT&MHT industries, Chinese authorities were trying to build comparative advantages in this sector. However, this meant that before rising wages could act as a comparative disadvantage, they needed to significantly strengthen domestic demand to achieve economies of scale. These elements distinguish it from the policies pursued by developed countries, such as Germany, which generated comparative advantages in HT&MHT exports much earlier, but were too expensive to rely solely on local intermediates (Figure 2.A.) and not large enough to rely on domestic final demand (Figure 2.D).

Unlike other developing economies, including the V4, China tried to overcome the constraints inherent in the dependent nature of its economy by making itself independent of headquarter economies in technology imports. This was particularly important in HT&MHT, which increasingly relied on local content (Figure 2.A). Likewise, the huge market size made it possible to treat domestic consumers as the main buyers of HT&MHT products and the main source of value added created (Figure 2.D). As the world's largest population is still far from meeting its aspirations, this market has strong growth prospects and makes China resilient to possible restrictions on access to other markets.

Hypotheses Development

Based on the goals of LCRs raised in the literature review, the practice of developing countries, the expected effects of LCR raised by representatives of 'market power' and 'innovation' currents, and the goals and activities for localization of value chains in China, we aimed to test the following hypothesis:

H: The application of LCRs in China in 2004-2014 effectively increased the volume of value added created in its economy.

Additionally, based on the data on Chinese HT&MHT sectors, in which LCRs were actively applied between 2004 and 2014, three auxiliary hypotheses were formulated:

H1: The consequences of LCRs predicted by theory occur in China's HT&MHT sectors.

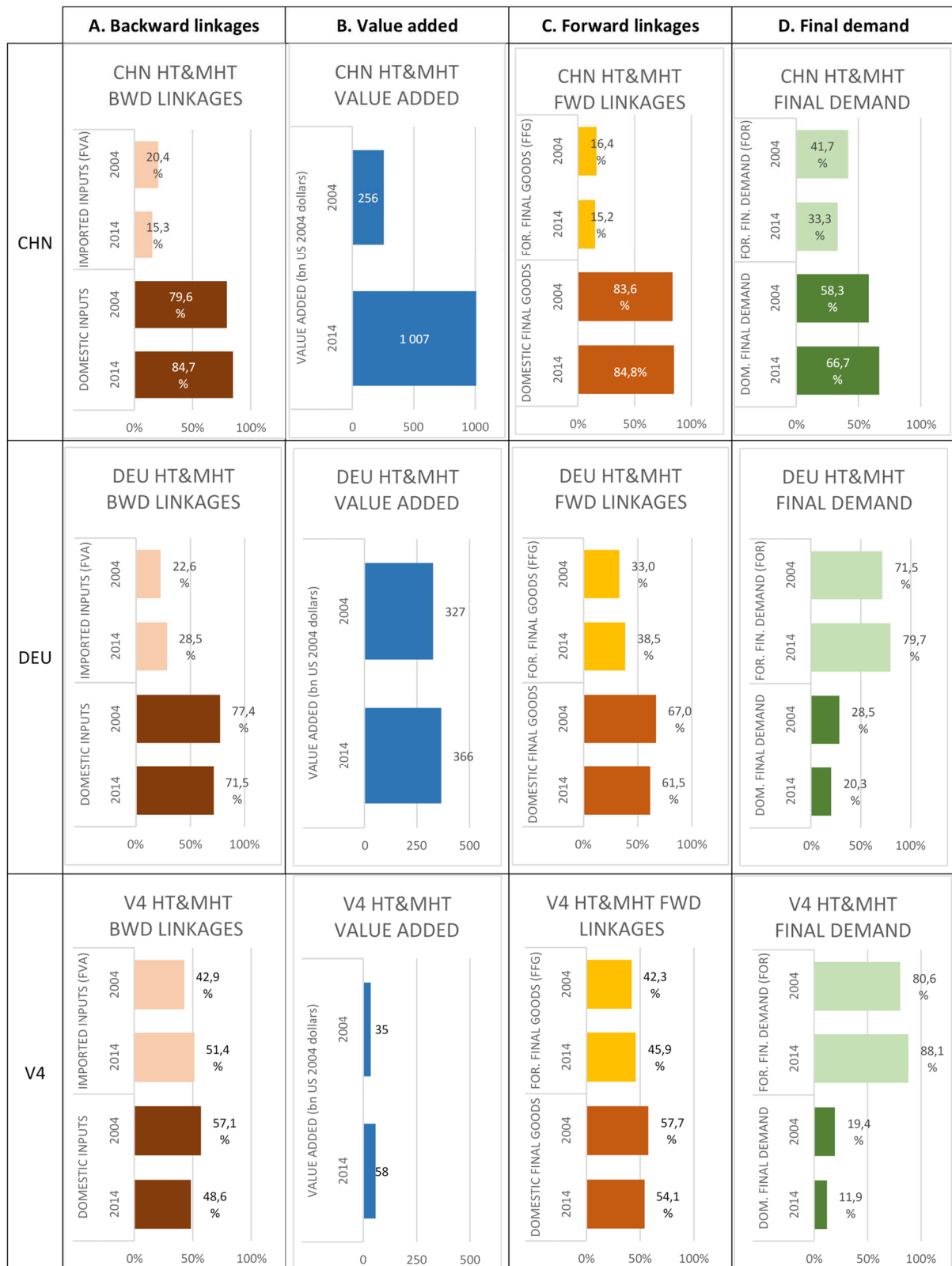


Figure 2. Position of HT&MHT sectors of the analysed economies in global value chains in 2004 and 2014
 Source: own elaboration based on WIOD.

H2: The induced value added in the Chinese economy by its HT&MHT sectors outweigh the expected decline in the value-added ratio in these industries.

H3: The impact of LCRs on technological capabilities and value creation occurs as anticipated by the representatives of the innovation current.

It would be the case if the following three processes were observed:

1. The non-market methods of coordinating economic processes that favour the suppliers of the HT&MHT sector increased.
2. Technical change in the economy clearly accelerated.
3. The scale of production in sectors subject to LCR increased above average.

We shall therefore rely on circumstantial inferencing. We assume that LCRs in the Chinese economy were quite likely effective provided that two conditions were met:

- the application of LCRs brought about a positive net effect in the form of increased value added in the domestic economy, which would be consistent with the theory and findings of the representatives of the market power current;
- a range of mechanisms emerged to increase the volume of value added in the sector affected by the instrument, as predicted by the representatives of the innovation current.

RESEARCH METHODOLOGY

The Object of Study and Research Technique

To test the hypothesis, data from 2004 and 2014 were analysed for Austria, China, Czech Republic, Germany, Hungary, Poland, Slovakia, the Visegrád countries (V4), and the Central European Manufacturing Core (CEMC), which includes the V4 as well as Austria and Germany. The period studied covers the decade before the announcement of the Made in China 2025 strategy (MIC 2025), during which China consolidated its position as a modern and globally significant producer of high-tech goods. It also marks a ten-year period since the Visegrád countries joined the European Union during which the CEMC emerged. This approach makes it possible to compare the effects of the domestication of value chains in China with the processes that accompanied the internationalisation of value chains in the group of four emerging economies and, at the same time, to weigh the rationale of the industrial policy of a catching-up country against the conditions existing in developed countries – technology providers to the CEMC (Stehrer & Stöllinger, 2015).

Our analysis focuses on the HT&MHT sectors. By comparing Eurostat's high-tech classification of manufacturing industries with the strategic sectors listed in MIC 2025, we shall explore the changes in value added in the following seven two-digit divisions of NACE Rev. 2:

- C20 Manufacture of chemicals and chemical products;
- C21 Manufacture of basic pharmaceutical products and pharmaceutical preparations;
- C26 Manufacture of computer, electronic and optical products;
- C27 Manufacture of electrical equipment;
- C28 Manufacture of machinery and equipment n.e.c.;
- C29 Manufacture of motor vehicles, trailers and semi-trailers;
- C30 Manufacture of other transport equipment.

As business actors in these industries have a disproportionately high share of R&D inputs in their turnover, we assumed that technological knowledge constitutes a significant proportion of intermediate inputs acquired by them.

Using a catalogue of HT&MHT broken down by sector, we relied on input-output tables (Timmer *et al.*, 2015) to demonstrate how the value-added processes that policymakers, including the authors of MIC 2025, strive to affect using industrial policy tools, proceed in individual countries and sectors. We referred to the WIOD database (Timmer *et al.*, 2015), the latest edition of which (November 2016) covers the years 2000-2014 and 56 industries in 44 countries worldwide.

RESEARCH STAGES

Direct Input and Direct Value-Added Ratios

Verifying the main hypothesis and, subsequently, auxiliary hypotheses H1-H3 required estimating direct material intensity and direct value-added content using the national input-output table (NIOT) taken from the WIOT (Timmer *et al.*, 2015), in which the global output (X) of each j th sector (number of sectors $S = 56$) consists of intermediate inputs purchased by industry j from 56 domestic suppliers (x), imported input costs (imp), and value added (VA) according to formula 1 below.

$$X_j = \sum_{i=1}^n x_{ij} + imp_j + VA_j \quad (1)$$

Analysing the subsequent components of global output, we obtained the following coefficients for sector j :

– domestic input (DI):

$$DI_j = \sum_{i=1}^n x_{ij} / X_j \quad (2)$$

– imported input (II):

$$II_j = imp_j / X_j \quad (3)$$

– and gross value added (GVA):

$$GVA_j = VA_j / X_j \quad (4)$$

Inverse Matrix Coefficients

Next, we estimated the well-known Leontief inverse matrix, which analyses the direct and indirect effects of certain final demands in one industrial sector on other industrial sectors. Inverse matrix coefficient tables are compiled to estimate how much production is ultimately being induced in all sectors of the economy by a final demand increase of one unit in a specific sector. In this way, we can estimate the full – direct and indirect – influence of an increase in final demand on the product of a particular sector.

By performing appropriate transformations on the input-output matrix, we obtained the Leontief inverse matrix L^{-1} :

$$L^{-1} = (I - A)^{-1} \quad (5)$$

in which I is the unit matrix and A is the material intensity matrix in which the individual elements $a_{ij}=x_{ij}/X_j$. The elements of matrix L^{-1} , L^{-1}_{ij} represent full material intensity coefficients. They show how many units of output in sector i have been used, both directly and indirectly, to increase the final demand of sector j by one unit, while leaving the final demand of the other sectors unchanged.

Using the technical coefficients table, which presents the relationship between national inputs from sector i and the value of the global output of sector j (e.g., Ministry, 2016; Alvares, & Bravo, 2012), we estimated domestic inputs, imported inputs, and gross value-added inducement coefficients:

– domestic input inducement coefficients (DII) – reflect the value of domestic materials from individual sectors consumed directly and indirectly in the whole economy when final demand in a given sector (and thus intended only for final purposes, *i.e.* consumption, investment or export) increases by a unit value:

$$DII = DI * L^{-1} \quad (6)$$

For a given sector j , this coefficient is an element of dii_j row vector DII :

– imported inputs inducement coefficients (III) – report the value of foreign-sourced materials consumed directly and indirectly throughout the whole economy to achieve an increase in final demand in a given sector by a unit value:

$$III = II * L^{-1} \quad (7)$$

For a given sector j , this coefficient is element iii_j of row vector III :

- gross value-added inducement coefficients (GVAI) – report the gross value added generated directly and indirectly in the whole economy by increasing final demand in a given sector by a unit value:

$$GVAI = GVA * L^{-1} \quad (8)$$

For a given sector j , this coefficient is $gvai_j$ row vector GVAI.

RESULTS AND DISCUSSION

In an attempt to verify H1, we referred to the effects of performance requirements identified in the literature to determine whether any of the following effects predicted by market power analysts actually occurred:

- prices of intermediate inputs purchased by producers from the Chinese HT&MHT sectors increased;
- market power (as measured by the increase in value added) increased to a greater extent in sectors which supplied more intermediate inputs to Chinese HT&MHT sectors than in those which supplied less to these sectors;
- the profit margin of final producers decreased.

As expected by theorists (Grossman, 1981; Davidson *et al.*, 1985; Richardson, 1991), import substitution strengthened upstream suppliers. Chinese HT&MHT sectors saw a stronger rise in the prices of intermediate inputs relative to the increase in the price of gross outputs (Table 2, col. a) than the other countries studied. Local content requirements introduced in a specific sector clearly favoured domestic suppliers. In China, the association between the increased share of HT&MHT as recipients of the manufacturing sector's intermediate inputs and the increase in the sector's value added between 2004 and 2014 was stronger than in other countries, which implies that local content policies may indeed have enhanced the market power of intermediate goods suppliers (Table 2, col. b).

Table 2. Growth of input and output prices in HT&MHT (a) and value-added growth of HT&MHT suppliers in relation to growth in the share of HT&MHT sectors in their sales of intermediate inputs in 2004-2014 (b)

Country / Country group	Input prices minus output prices (a)	Correlation coefficients between the growth of the share of supplies for HT&MHT and value added growth (b)
CHN	14.1	0.59***
CZE	7.6	0.25
HUN	-4.2	-0.13
POL	0	0.26
SVK	5.1	0.48*
V4	2.3	-
AUT	3.8	0.34
DEU	-0.6	0.1
CEMC	0.2	-

Note: (a) Differences in price level growth rates of intermediate inputs and gross output of HT&MHT industries between 2004 and 2014 (in percentage points). Weighted averages reflect the share of individual sectors and countries in gross output. (b) Linear correlation coefficients of the change in the share of HT&MHT sectors as recipients of intermediate inputs of manufacturing sectors (percentage points) and the growth rate of value added percentage points in these sectors between 2004 and 2014; significant at the level ***<0.01; **<0.05; *<0.1; N=19; NCHN=18 (n/a for C33).

Source: own elaboration based on WIOD and SEA WIOD (Timmer *et al.*, 2015).

Neither cost increases in HT&MHT nor the correlation between increased profitability and being a supplier to HT&MHT were necessarily due to the enactment of LCRs. After all, in the CEMC countries, which did not apply LCRs, increased co-operation with the HT&MHT sectors was also generally accompanied by a faster increase in value added, moreover, input prices seemed to be proportional to supplier profitability. Therefore, there must have been other factors besides LCRs that affected the profitability of scaling up co-operation with high-tech sectors. Nevertheless, the fact that once the LCR policy was applied in China, its domestic suppliers to HT&MHT imposed higher prices and increased profits to a

greater extent in proportion to their degree of co-operation with HT&MHT, is consistent with the models proposed by Grossman (1981), Davidson *et al.* (1985), and Richardson (1991), which emphasise the correlation between LCRs and supplier market power. The key question posed in this approach is whether, once LCRs have been applied, the gains to input producers outweigh the losses to final producers (Richardson, 1991). To estimate the net effect on domestic welfare, we assumed that the above-mentioned changes in the Chinese economy occurred as a result of LCRs and that it was the LCR that acted to reduce the profitability rate of final producers as a result of strengthening their suppliers. On the other hand, we assumed that none of the CEMC countries pursued an LCR policy. This assumption simplifies the interpretation of the observation (Figure 3) that between 2004 and 2014, the Chinese economy became more independent from the global economy, whereas the CEMC economies grew more interdependent. Contrary to global integration trends, China reduced the values of import intensity coefficients in the HT&MHT sectors from 0.13 to 0.07 (see Figure 3, coefficient of imported inputs – II). This means that in 2014, a one yuan increase in output increased the demand for intermediate inputs from abroad by seven fen as compared to 13 fen in 2004. This was achieved amidst an increase in the share of local content: domestic direct material intensity (DI) coefficients increased from 0.63 to 0.74. Since domestic intermediate goods may not have been perfect substitutes for foreign goods, direct value-added (GVA) coefficients decreased from 23 to 18 fen per one yuan of global output.²

As regards H1, there are reasons to believe that the negative consequences of LCRs predicted by the theory indeed occurred in China's HT&MHT industries. The prices of intermediate inputs increased more than proportionally relative to the prices of outputs. Likewise, the value added of suppliers to these industries increased more than proportionally.

Conversely, the CEMC countries became even more interconnected, as evidenced by their increased mutual trade flows. In Germany, direct import intensity (II) increased from 0.17 to 0.23, in Austria from 0.34 to 0.38, and in the V4 countries from 0.36 to 0.44. While in Germany and Austria, this was accompanied by increased value-added content (GVA) – by ca. 0.33–0.36 in relation to output – cooperation with Western economies kept it at a lower level in the V4 countries (0.23–0.24, though still lower values were noted in Slovakia).

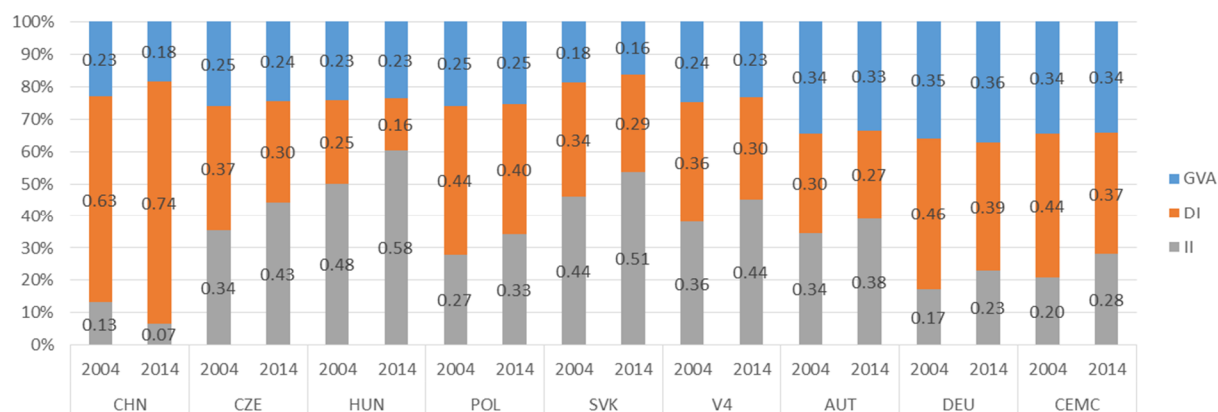


Figure 3. Direct material intensity and value-added content coefficients

Source: own elaboration based on WIOD. For V4 and CEMC, the estimated values are the weighted average shares of individual countries in the global output of HT&MHT sectors.

In verifying H2, we wanted to assess whether the potential negative consequences of LCRs were compensated for by increases in value added across the Chinese economy and in welfare. To this end, we examined whether the induced value added in the Chinese economy by Chinese HT&MHT actually outweighed the expected decline in the value-added ratio in these sectors.

² Note that this reduction is relative as it expresses the ratio of value added to global output. Yet even though the global output in Chinese HT&MHT sectors increased fivefold in monetary terms, the slower-growing value added still increased fourfold.

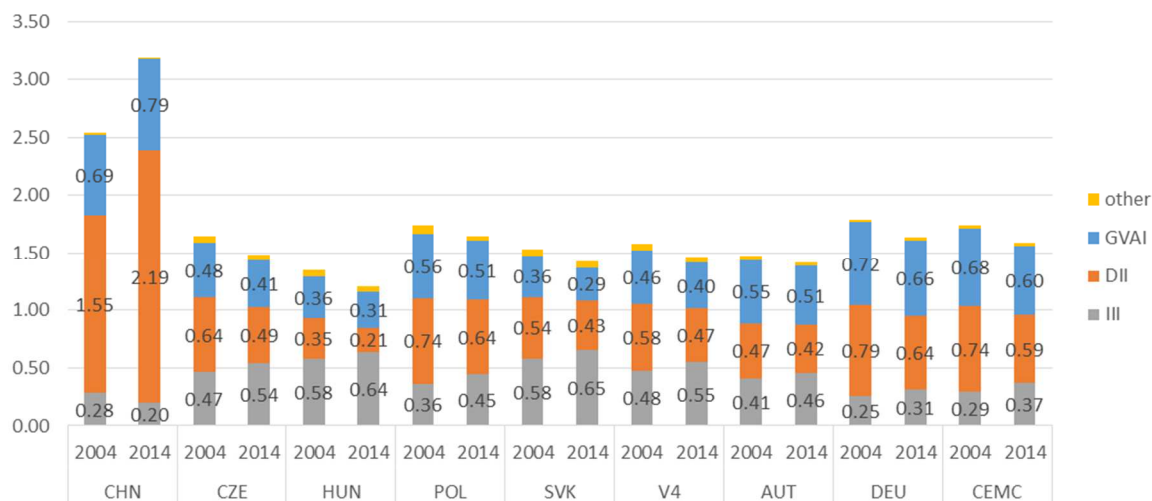


Figure 4. Coefficients of induced gross value added, domestic and imported input use in HT&MHT sectors
 Source: own elaboration based on WIOD. Weighted averages of shares of individual sectors and countries in final demand.

To estimate the effects of a decade of domestication of value chains in China and their internationalization in the CEMC, we referred to the model of offshoring effects proposed by Milberg and Winkler (2013, p. 153) to estimate the impact on the labour market. Firms based in headquarter economies engage in offshoring to reduce their costs by moving production to lower-wage countries. The model in question identifies four effects of the latter: (1) a reduction in product prices boosts sales (scale effect); 2. the mark-up effect includes an increase in margins of offshoring companies; (3) the investments made and lead to higher productivity; at the same time, however, (4) a substitution effect occurs, which means that domestic production factors are replaced by foreign ones. Part of the value added is thus produced abroad instead of domestically as before, but this is a precondition for increasing the proportion of value added created by investors. In the case of the domestication of value chains, the substitution effect is reversed: foreign suppliers are replaced, and more value added is created domestically. However, final goods producers face increased costs in the form of higher prices of intermediate goods, which reduces demand, the scale of production, and profit margins.

To estimate the consequences of the analysed changes for domestic welfare, we looked at a counterfactual scenario (CS) in which the values of the direct and induced coefficients remained at 2004 levels (*e.g.*, we assumed that for China these coefficients in 2014 were identical to those in 2004, or 0.23 instead of 0.18 for GVA and 0.69 instead of 0.79 for GVAI; see Table 3). Thus, we were able to determine whether the reduction in the direct gross value added ratio (GVA) of China’s HT&MHT sectors that occurred until 2014 was compensated for by an increase in the value added induced by these sectors throughout the national economic system (GVAI) in the period studied, or in both these sectors and cooperating industries.

To estimate the magnitude of these effects and compare the results across countries, we converted the changes in GVA and GVAI into monetary units. The estimation revealed that changes in these values between 2004 and 2014 were dramatically different for China and the CEMC countries, as suggested by Figures 3 and 4.

China’s HT&MHT sectors experienced a several-fold increase in GVA – from USD 256 bn. to USD 1007 bn. (an increase of USD 751 bn.; see Table 3, col. 1), but at the cost of reducing GVA from 0.23 to 0.18, which, compared to the counterfactual scenario, meant a reduction of potential GVA in HT&MHT by USD 240 bn. in 2014 (see Table 3, col. 2a). This means that increasing global output in 2004–2014 while keeping the GVA coefficient at 0.23 would have added USD 240 bn. more value to HT&MHT in 2014 alone. To be able to compare this figure with the effect of a change in GVAI, which allows us to estimate the effect of increasing final demand on the national economy as a whole, we need to translate the effect of a change in global output into the effect of a change in final demand. By dividing final

demand by global output,³ we can obtain an approximate answer to the question of how much lower was the monetary value of GVA in HT&MHT in 2014 due to the reduction in GVA from 0.23 to 0.18 relative to final demand. This allows us to compare col. 2b with col. 3 showing the change in GVAI. This means that the change of -240 bn. dollars is approx. -86 bn. dollars if the reduction in question is taken to refer to the effect of the change in final demand alone.

The substitution effect for the whole economy (GVAI) was positive and amounted to an additional USD 186 bn. (Table 3, col. 3.). This was due to increased final demand in HT&MHT and the diversion of a significant proportion of it to domestic suppliers. In other words, the reduction in the percentage share of value added in the global output of these sectors resulting from the supply of domestic instead of foreign intermediate goods was overcompensated by an increase in value added in the whole economy (+186 bn. dollars in 2014 alone). If the increase in local content results, among other things, from LCRs, it must be concluded that the latter contributed to the domestication of value chains and effectively raised welfare in China. The total GVAI in the entire Chinese economy expressed as the effect of boosting final demand in China's HT&MHT sectors increased by USD 1.2 trillion compared to 2004.

In contrast, in the CEMC countries where value chains are internationalised, the increase in GVA was not so spectacular, but still distinct (USD 66 bn., see Table 3, col. 1) given the dynamics of industrial production in other EU countries. The GVA of HT&MHT increased by an extra USD 16 bn. compared to the counterfactual scenario (see col. 2), which was due to increased global output of the HT&MHT sectors and a slight increase in the share of value added, especially in Germany (Table 3, col. 2a). This was accompanied by a reduction in the scale of co-operation with domestic suppliers. The combined effect, including the gains of the HT&MHT sectors and the losses to domestic suppliers from the diversion of HT&MHT's final demand to foreign suppliers in 2014, was -68 bn. dollars (Table 3, col. 3). This is how much higher the gains to the CEMC economies would have been if the increase in final demand had not been swallowed up by a reduction in the value of induced GVA, well below the 2004 level. However, in the case of the CEMC, the reduction in GVAI shown in the table (Table 3, col. 3) is due to the unrealised potential of cooperation with domestic entities, which would not necessarily have materialised.

On the one hand, the German and Austrian economies have to deal with the substitution effect by offshoring production to low-cost locations. On the other hand, however, according to the aforementioned model by Milberg and Winkler (2013), offshoring in Western countries is accompanied by cost reductions and increased competitiveness, sustained demand for HT&MHT products, a mark-up effect increasing investment and productivity, and a resultant scale effect. Indeed, both the GVA of the HT&MHT sectors and their impact in the form of GVAI increased between 2004 and 2014 (by USD 50 bn. or 10% in Germany and USD 5 bn. or 17% in Austria, respectively). The precondition for such expansion was the considerable increase in the scale of co-operation with foreign players largely located in the low-cost V4 economies. Likewise, in the latter, the substitution of local sourcing of intermediates measured by the loss of GVAI did not entail a reduction in GVAI in real terms. On the contrary, it increased from USD 55 bn. to USD 88 bn., *i.e.* by USD 33 bn. (Table 3, col. 4) or 56%, which is significant. Cooperation in the CEMC is mutually beneficial in terms of increased productivity and scale of production. This additional effect in Germany translated into a significant increase in added value and profits in HT&MHT (the mark-up effect), whereas in the V4 it led to a substantially expanded scale of production and added value created (Table 3, col. 1 and 4) thanks to access to Western European and non-European markets offered by cooperation in the CEMC.

Our findings show that in China, between 2004 and 2014, *i.e.* immediately after WTO accession, when the utility and feasibility of using LCRs were being tested, the negative as well as positive effects of LCRs predicted in the literature occurred and the latter probably prevailed. As regards H2, the induced value added by HT&MHT industries in the Chinese economy significantly outweighed the value-added loss resulting from the reduction in the direct gross value added coefficient in these industries. If this was the outcome of LCRs, then their cost-benefit balance in HT was positive. In the following

³ The assumption that the effect of the change in final output is proportional to the change in global output may not be met, but for the purpose of the discussion we only need a rough comparison of changes in GVA and GVAI in monetary units. The figures in col. 2b should therefore be treated as approximations.

section, we will discuss these findings by referring to the LCR effectiveness conditions as identified by Tomsik and Kubicek (2006), and Veloso (2001, 2006), among others, which serves verifying H3.

Table 3. Value added in HT&MHT sectors in 2014 compared to 2004 and to the counterfactual scenario (CS) in which the direct and induced gross value-added ratios remain at 2004 levels (US 2004 million dollars)

Country / Country group	1. GVA change (GVA2014-GVA2004)	2. Actual GVA 2014 minus CS as the effect of		3. Actual GVAI 2014 minus CS as the effect of final demand change	4. GVAI change (GVAI2014-GVAI2004) as the effect of final demand change
		2a. global output change*	2b. final demand change		
CHN	751.254	-239.385	-85.615	185.905	1 205.384
CZE	8.010	-571	-513	-4.896	11.440
HUN	2.550	324	317	-2.576	2.736
POL	9.521	529	428	-3.375	13.532
SVK	3.300	-615	-544	-2.145	5.125
V4	23.382	-333	-712	-12.992	32.832
AUT	3.970	-13	-12	-2.954	5.030
DEU	39.546	16.248	13.549	-52.179	49.739
CEMC	66.898	15.902	13.480	-68.125	87.601

Note: *Actual CHN GVA2014 = 1 007 356 = 0.18 * 5 494 236, counterfactual scenario (CS) = 1 246 740; = 0.23 * 5 494 236; Actual CHN GVA2014 – CS as the effect of global output change = -239 384.

Source: own elaboration based on WIOD and SEA WIOD (Timmer *et al.*, 2015).

Overcoming the Coordination Problem

The difference in the coordination mechanisms applied seems to be clear. In a planned economy such as China's, authorities force the HT&MHT sectors to redirect their demand for intermediate inputs to domestic players. The gains for the cooperating sectors together with the gains for Chinese HT&MHT producers compensated for the loss of value added due to the substitution effect of the domestication of value chains (see Table 3). This happened even though increases in the prices of intermediate inputs and decreases in GVA confirmed the predictions of theorists as to the negative-effects of LCRs (Tomsik & Kubicek, 2006; Stone, 2015; Grossman, 1981; Richardson, 1991). These and other administrative instruments seem to be effective where there is a high potential for technological catching up and at the same time a high potential for scaling up (Veloso, 2001; 2006). In technology frontier countries, redirecting demand to domestic sectors does not have much potential for productivity gains from technology learning.

In neoclassical economics, there is no need for ex-ante coordination, because participants hold small shares of the market, cannot influence prices, and there is no room for economies of scale given the decreasing marginal productivity of technology (Chang, 2003). On the other hand, state coordination permits reduced consumption of scarce resources, which cannot be achieved under market competition. Especially in technologically backward economies which invest in specific knowledge-based resources, the loss of investment effects (*e.g.*, in research and technological capabilities) due to lack of coordination can be extremely costly as shown by transaction cost economics (*e.g.*, Williamson, 1985). In the absence or imperfect protection of intellectual property, a steadily growing supply of technological knowledge can suspend the law of diminishing returns to scale, as improved technologies rapidly diffuse throughout the economic system (*e.g.*, Romer, 1990). This process is driven by the public factor, since positive externalities resulting from increasing technological capabilities are not usually factored in by entrepreneurs in their calculations. It would therefore appear that in developing countries, sometimes the market copes with the coordination problem less successfully than in the presence of a public agent implementing central planning or industrial policy measures (Chang, 2003; Auerbach & Sotiropoulos 2012).

Indeed, it seems unlikely that under market conditions, final goods producers in the HT&MHT sectors would voluntarily agree to lower their profit margins and thereby enable suppliers to increase their benefits and promote the technological advancement of the entire economy, as was the case in China (see Table 3, col. 2b and 3). Without LCRs, Chinese HT&MHT producers and foreign investors in these sectors might not have chosen to scale up sourcing from Chinese suppliers, as the latter, at least initially, offered less efficient technological solutions at a higher price (Table 2). On the other hand, in

the CEMC, cost-cutting measures through offshoring were observed, which fits in with the logic of the market mechanism (see Figure 3 and Table 3, col. 2b and 3).

However, the coordination problem occurs only if the following two conditions are met: (1) the good in question is sufficiently specific, and (2) transport costs are sufficiently high (Tomsik & Kubicek, 2006). Since technological knowledge ‘turns out not to be ‘information’ that is generally applicable and easily reproducible, but specific to firms and applications’ (Pavitt, 1984, p. 343), whereas goods supplied in the R&D stage rank among the most specific and tacit assets (Winter, 1987; Dosi, 1988). Likewise, transport costs are important for technological industries; higher technological intensity implies a higher propensity of TNCs to move production to foreign subsidiaries due to the high cost of technology transfer (Keller & Yeaple, 2013). Moreover, technology as an intermediate input in high-tech industries can be particularly expensive due to the monopolistic nature of any new business solution further reinforced by the use of the patent system, as was originally observed by Schumpeter (1934). The importance of the R&D indigenization policy can be interpreted in the light of an analysis conducted by Linden *et al.* (2009) which focuses on value flows within global value chains and points to the low share of value added by the Chinese iPod manufacturer. Less than half of the retail price (USD 144 out of USD 299) was accounted for by inputs of which the 10 most expensive ones were produced by high-tech suppliers from the Asian tigers and the U.S., which received a total of USD 125 (or 85% of the cost of all inputs). The value of locally produced inputs was limited to the remaining USD 19, which underscores the crucial importance of technology ownership for the capacity to create high value added.

Thus, despite official assertions by Chinese policymakers that China does not pursue a local content policy, practice suggests otherwise (Wübbecke *et al.*, 2016). In April 2018, President Xi Jinping reiterated the importance of indigenous innovation, saying that ‘the core technologies are the pillars of a great power’ and ‘the core technologies can only come from self-reliance’ (Liu, 2018). Therefore, the cooperation of Chinese business actors with outside investors should be seen as a way of building their technological capabilities, whereas increasing the scale of sourcing of domestic intermediate inputs in the decade of 2004-2014 was intended to help indigenous suppliers to master core technologies.

Indigenizing R&D and Escaping the Middle-Income Trap

The positive effects of innovation policies thus understood are highlighted by studies on spillovers from foreign investment in Chinese manufacturing industries (Abraham *et al.*, 2010; Lu *et al.*, 2017), including high-tech manufacturing (Liefner *et al.*, 2006; Fu & Gong, 2011). However, the findings of research on high-tech sectors suggest that the most important source of technological knowledge is China’s R&D effort (in the ICT sector: Wang *et al.*, 2010) and that FDI is of limited importance for productivity growth (Hale & Long, 2011). Table 4 presents data on R&D spending and its effects such as patents. They illustrate the varying capacities of individual economies to independently develop technology and set trends in this area. Particularly noteworthy in this respect is the Chinese economy, in which research efforts multiplied between 2004 and 2014 (with a fourfold nominal increase in GDP, business R&D expenditure in relation to GDP increased by a factor of 2, thus the total business R&D spending increased by a factor of 8), resulting in an unprecedented increase in intellectual property stocks.

Coordination failure alone may not provide a sufficient incentive to locate production in a particular country. Even if inputs are specific and trade costs are sufficient, it may still be less profitable to carry out certain activities in developed countries (Tomsik & Kubicek, 2006; Veloso, 2006). This happens, among other things, in the absence of an appropriate scale of production in a developing country due to its small population or low purchasing power. This was the reason behind the failure of import-substituting industrialization in Latin America and the pursuit of export-oriented industrialization by Southeast Asian countries (Low & Tijaja, 2013). China, too, largely focused on strengthening its export capacity immediately after WTO accession, especially in HT&MHT products.

It is important to note that the above-mentioned complementarities between scale and efficiency gains arise not only from technological progress but also from learning-by-doing, thereby illustrating growing experience with each additional unit of a good produced. This effect can be obtained through the application of LCRs if a technological gap exists and the good in question is locally produced. In such a situation, LCRs artificially accelerate learning. With increased productivity and lower labour

costs, the manufacturing of a given intermediate good can become more competitive than in a developed country. However, to shorten the period during which the application of LCRs forces manufacturers to use less efficient local technology, the sectors subject to intervention must have a high learning potential (Veloso, 2005; Tomsik & Kubicek, 2006). In high-tech industries, latecomers may create high value added per unit thanks not only to access to monopoly profits but also to the great potential for market growth (Stehrer & Wörz, 2001; Fageberg & Godinho, 2004).

Table 4. Technological input (R&D expenditure as a percentage of GDP) and output (number of patent applications and patents granted) in 2004 and 2014

Country / Country group	R&D (% of GDP)				Patents (number)			
	GERD		BERD		Patent applications filed under PCT		Triadic Patent families	
	2004	2014	2004	2014	2004	2014	2004	2014
CHN	1.22	2.02	0.81	1.56	1.783	24.036	296	2.431
CZE	1.14	1.96	0.71	1.10	118	191	22	22
HUN	0.86	1.35	0.35	0.96	156	134	49	14
POL	0.55	0.94	0.16	0.44	98	345	21	41
SVK	0.50	0.88	0.25	0.32	26	35	1	6
V4	0.74	1.21	0.33	0.64	398	704	93	84
AUT	2.17	3.08	1.47	2.2	896	1.386	272	332
DEU	2.44	2.88	1.70	1.95	15.480	17.527	6.376	4.260
CEMC	2.13	2.57	1.45	1.72	16.774	19.617	6.742	4.676

Source: own elaboration based on OECD (2021a) and OECD (2021b).

An early discussion of localization policy (Richardson, 1991) suggests that it may lead to the loss of markets to less expensive foreign competitors. Understandably, Chinese buyers had no alternative, since their domestic market was protected by tariffs. However, given the rising labour cost (Table 5), it is difficult to explain why foreign buyers were sourcing ever more expensive Chinese products citing exclusively market power arguments (Grossman, 1981; Richardson, 1991; Stone *et al.*, 2015). Despite the symptoms of local content policies, Chinese HT&MHT exports in the decade studied increased spectacularly from 7% to almost 17% of world exports (see Figure 1) and did so much faster than the share of total goods exports. Even though OECD research (2016) shows the generally negative impact of LCRs on trade volumes, it confirms that among the countries that have applied this particular policy instrument, China experienced hardly any negative consequences. The Kaldor paradox (1978) appears to have been at work in this case. The paradox is that contrary to intuition, in countries experiencing rapid technological development, an increase in unit labour cost (Table 5) is accompanied by an increase in export competitiveness as measured by the share in world exports. These findings were confirmed by Fagerberg (1996), who pointed to the role of R&D in increasing the competitive capacity of East Asian tigers in the 1980s and the complementarity of technological efforts with economies of scale in some high-tech industries. Avoiding the so-called middle-income trap means finding an answer to the question of how to permit wages to rise without losing markets and compete on quality and unique solutions rather than on costs. Doubts as to whether the Chinese economy could manage such a transition were expressed by Gill and Kharas (2007) who coined the term ‘middle-income trap.’ A decade later, Wei *et al.*, (2017) were quite certain that data on Chinese patents appeared encouraging enough that there was no room for doubt any longer.

Thus, the Chinese initiatives mentioned in the literature review aimed at increasing scale and gaining competitive advantages in HT&MHT industries were intended to increase technological capabilities, which is not only the *raison d'être* for applying LCRs but also a precondition for their effectiveness. Indeed, the initial reduction in the technological gap made it possible to induce producers to co-operate with indigenous suppliers without excessively reducing economic efficiency (Veloso, 2006).

The Role of Domestic Demand

The fast-growing domestic demand driven by high wage dynamics (Table 5) may also have been a factor in China's industrial production dynamics. Recalling the observations made by Verdoorn (1949), the aforementioned Kaldor (1966) argued that productivity growth is not only due to increases in scientific and technological knowledge, but that factor productivity increases with an increase in the scale of production. In his reasoning, Kaldor indicated that in different markets dominated by the same American investors, despite having access to the same knowledge and know-how, business actors increased labour productivity faster in larger markets. Particularly important for the capital goods sector was the increase in workers' wages generating demand for industrial goods (Kaldor, 1966) and thus stimulating entrepreneurs' interest in wage increases. In accordance with Myrdal's cumulative causation principle, increasing demand, in turn, accelerates production, leads to productivity increases, and a further reduction in prices, which again stimulates demand, but this time it also enhances the cost competitiveness of a given economy. If it occurs in technologically advanced industries, non-price competitiveness also increases due to innovations driven by learning by doing (Amable, 1992). This Verdoorn-Kaldor effect has a clear Keynesian angle and may explain how, despite increasing unit labour costs, the potential for learning by doing and the competitiveness of Chinese HT&MHT producers continued to increase.

Analysts note that in transforming its hitherto low-wage economy, 'China's economic planning apparatus through its economic transition utilised aspects of Kaleckian and Keynesian aggregate demand economic theory' (Kenderdine, 2017), the objective being to limit overexposure to global markets by unleashing the potential of a domestic market composed of 1.3 billion consumers (Valverde, 2020). With a shrinking working-age population and wages rising due to the achieved technological level, the previous model of low-cost exports could not be maintained, especially in the context of a general retreat from globalisation among Western democracies. The dual circulation strategy and measures taken by the Chinese authorities to strengthen internal circulation should be seen as a strategy to move away from an export-led development model on their terms (Blanchette & Polk, 2020). The strengthening internal circulation may also result from a natural confrontation between latecomers and incumbent leaders. Examining the development trajectories of Brazilian, Korean and Chinese industries, Lee *et al.* (2018) noticed a process called by them in-out-in-again, which means that after joining GVCs and gaining initial competence in the production of technologically advanced goods, further self-development efforts require a temporary reduction in dependence on foreign contractors to return as global market actors having built their brands. In these circumstances, having a large domestic market may present a considerable advantage.

This process is illustrated by the data on labour productivity, wages and labour compensation, and their relationship to value added presented in Table 6. In the decade preceding MIC 2025, China already saw a significant increase in wages: fourfold in the whole economy and almost threefold in the comparatively better-paid HT&MHT sectors. Apart from the rapid growth in value added, an extra wage growth driver was the increase in their share of value added to 55% in the economy as a whole and 48% in HT&MHT sectors subject to greater international competition. These readings are similar to those of developed countries (AUT and DEU) rather than to the catching-up ones (V4).

For China, the negative consequences of LCRs predicted by theory were not particularly severe. The reduction in consumer surplus due to the increase in the cost of final goods, even if it did occur, was overcompensated by wage increases. On the other hand, the reduced cost competitiveness of domestic enterprises vis-à-vis foreign ones hardly affected Chinese producers as they were becoming increasingly focused on the domestic market (as much as 67% of final demand; cf. Figure 2D) protected by high trade barriers.⁴ Growing consumer demand was therefore being met by domestic producers, which promoted value-added retention and contributes to productivity growth through economies of scale as well as a rapidly falling learning curve. At the same time, the comparison of labour productivity and wages explains why high-tech sectors were becoming an area that catching-up countries were

⁴ In 2013, China had one of the highest explicit barriers to trade and investment indicators (OECD Entrepreneurship at a Glance 2015, p. 109).

keen to enter – it is not so much the pace as the gap between labour productivity and wages that is highest there.⁵ Focusing on them not only increases the potential to shift from competing on the cost to competing on product quality and technological sophistication (Kaldor, 1978; Fagerberg, 1996; Lee *et al.*, 2018) – which, as was pointed out above, Chinese high-tech manufacturers have largely succeeded in doing – but is also simply the most profitable solution (Stehrer & Wörz, 2001).

Table 5. Labour productivity, labour compensation, and labour share in the economies studied in 2004 and 2014

Country / Country group	Productivity (global output thousand USD2004) / employee)			Wages (labour compensation thousand USD2004 / employee)			Labour compensation / value added		
	Whole economy								
	2004	2014	Change	2004	2014	Change	2004	2014	Change (p.p.)
CHN	7.2	28.6	298%	1.2	5.1	325%	48%	55%	+7
CZE	55.4	72.9	32%	11.5	14.5	26%	51%	51%	0
HUN	47.2	50.3	7%	12.2	11.5	-6%	57%	54%	-3
POL	35.6	53.7	51%	8.2	12.0	46%	50%	50%	0
SVK	45.0	77.8	73%	8.7	15.5	78%	47%	49%	+2
V4	43.7	60.3	38%	10.6	12.7	20%	52%	51%	-1
AUT	135	144	7%	41.2	43.1	5%	59%	61%	+2
DEU	125.6	125.9	0%	40.2	39.5	-2%	62%	62%	0
CEMC	113.2	113.6	0%	23.3	23.7	2%	60%	60%	0
HT&MHT									
CHN	34.3	91.8	168%	3.0	8.0	167%	39%	48%	+9
CZE	97.8	149.3	53%	12.2	16.0	31%	48%	44%	-4
HUN	111.9	147.9	32%	11.4	13.0	14%	42%	37%	-5
POL	64.1	105.1	64%	8.3	12.3	48%	50%	46%	-4
SVK	97.9	218.3	123%	8.9	17.9	101%	49%	51%	+2
V4	90.6	144.0	59%	9.7	14.0	44%	47%	44%	-3
AUT	296	341	16%	54.8	59.7	9%	54%	52%	-2
DEU	276.3	286.7	4%	61.7	63.9	4%	62%	60%	-2
CEMC	253.9	262.6	3%	28.9	38.6	34%	60%	57%	-3

Source: own elaboration based on WIOD and WIOD's Socio-Economic Accounts.

CONCLUSIONS

The findings of our study justify the conclusion that the application of local content requirements in China's HT&MHT industries in 2004-2014 effectively increased the volume of value added created in its domestic economy.

As regards H1, there are reasons to believe that the negative consequences of LCRs predicted by the theory indeed occurred in China's HT&MHT industries. The prices of intermediate inputs increased more than proportionally relative to the prices of outputs; likewise, the value added of suppliers to these industries increased more than proportionally. Moreover, the gross value-added coefficient in HT&MHT industries decreased. These phenomena occurred with greater intensity in China than in benchmark countries where LCRs were not applied.

As regards H2, the induced value added by HT&MHT industries in the Chinese economy significantly outweighed the value-added loss resulting from the reduction in the direct gross value added coefficient in these industries. If this was the outcome of LCRs, then their cost-benefit balance in HT was positive. Another argument in support of the research hypothesis was the occurrence of mediating mechanisms, which are identified in the literature as motivations for the use of LCRs (Tomsik & Kubicek, 2006; Veloso, 2006).

⁵ Although labour costs are higher in HT&MHT than in the economy as a whole, the former's much higher productivity provides entrepreneurs with a more favourable difference between output and compensation per worker.

The reduction in margins in China's HT&MHT sectors appears to have resulted from the imposition of LCRs, which forced final producers to scale up sourcing from local suppliers. By definition, they are less productive in a developing country, hence LCRs are applied to increase their productivity. This contrasts with the absence of such instruments in the CEMC countries, where market logic dictates that leading players in headquarter economies should cooperate with low-cost suppliers from abroad.

As regards H3, LCRs in China may have contributed to a rapid increase in technological capabilities expressed in terms of R&D intensity and the number of patents. As such, LCRs underpinned considerable investment in the development of local technological capabilities. Although rising wages reduced export competitiveness, technical progress overcompensated for this effect. In consequence, non-price competitiveness (exemplified by the growing share of Chinese sectors in the global HT&MHT products market) and productivity increased, which resulted in a fourfold increase in value added in these sectors over the period in question. In technological frontier countries, there is no potential for such an artificial acceleration of technology transfer, learning, and increasing technological capabilities by increasing the scale of production.

Technological catching up by Chinese HT&MHT producers and their suppliers accelerated precisely in the context of significantly increasing scale of production achieved by intensifying participation in world trade and by increasing the purchasing power of local consumers. Developed countries have no extra potential for such scaling up, whereas, in developing countries, the domestication of value chains would entail a temporary loss of major markets. Moreover, in the latter, the vast majority of final customers are foreign ones accessed thanks to collaboration with headquarter economies. In such a situation, domestication efforts would be counterproductive in terms of increasing the scale of production. This suggests that catching-up countries have limited room for manoeuvre as regards the application of LCRs in pursuit of technological development, unless they have the demographic potential to exploit domestic demand should their foreign partners decide to retaliate.

Therefore, we relied on circumstantial inferencing: we did not seek unequivocal evidence of impacts, *i.e.* whether and to what extent LCRs were actually instrumental in the occurrence of these phenomena. However, since the application of this policy instrument brought about positive net effects in the form of increased value added in the domestic economy, and a range of mechanisms emerged to increase the volume of value added in the sector affected by it, we have sufficient evidence to conclude that China's application of LCRs in 2004–2014 indeed induced technical progress and increased the volume of value added in its economy. However, it appears that other developing countries are unlikely to benefit from this experience. China's policy proved to be successful thanks to the existence of a technological gap, the prospects for economies of scale resulting from the size of its internal market, which significantly strengthened the effects of export expansion, and a sufficiently strong state capable of resisting not only the pressure from final goods manufacturers but also from previous global incumbents on technologically advanced products markets. The experience gained by China in the period immediately following its accession to the WTO (until 2014) provided a good starting point for the announcement in 2015 of the Made in China 2025 strategy, which seems to emphasise the country's desire to substitute foreign technologies with its own.

Having said that, our research approach has some limitations. Firstly, we assumed that China applied LCRs, whereas no such measures were adopted by the EU member states. However, in reality, various other more or less hidden barriers protect the European market against competition from outside (tariffs) and from technologically catching-up economies (*e.g.*, product standards). The already high level of technological sophistication of the German and Austrian economies may be the effect of institutions created decades ago to strengthen internal economic circulation. This implies that certain negative effects of such hidden LCRs should also be visible in the developed CEMC countries. We did not address the potential industrial policy impacts such as the loss of cost competitiveness and the struggle to regain it through offshoring. Secondly, our findings may lead to the conclusion that subjecting economic actors to an industrial policy regime requires a strong political control of economic life. China officially denied violating WTO rules, which was met with widespread disbelief (cf. Wübbecke *et al.*, 2016), but analyses of LCRs applied by other countries suggest that other large economies, such as the United States, Brazil, and India, use similar instruments to an even greater extent than China (Stone

et al., 2015; OECD, 2016; Deringer *et al.*, 2018). This strongly implies that behind the façade of free trade, powerful players pursue protectionist policies anyway (Chang, 2003; Wallerstein, 2004), whereas China was put on the spot, because its very size threatens the incumbent leaders. In this situation, more useful lessons for developing countries may be drawn from case studies of medium-sized countries and sectoral policies. The consequences of the Made in China 2025 Strategy also promise to be an informative object of study, as they may already manifest themselves in the subsequent editions of international input-output tables.

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Conflict of Interest

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