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The impact of digital platforms on industrial enterprises: An empirical analysis in the context of external sanction pressure

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Abstract

The rapid technological revolution, the shortening of the life cycle of many products, the spread of the principles of 'universal connectivity' in industry are forcing manufacturers to develop new business models that reduce the time to market products, increase productivity, and create new principles for delivering value to consumers and interacting with partners. Platform business models are the answer to these challenges. At the same time, industrial companies are increasingly not only platform participants but also platform registrants themselves. Based on the identified strategies for the implementation of different types of business models by industrial companies, the article discusses the potential impact of their implementation. The research presented provides a new perspective on the relationship between the chosen combined models of platform solutions and the performance of industrial companies in the context of sanctioned restrictions on access to financial capital. The empirical analysis allowed us to draw conclusions about the greatest impact on the financial results of the choice of the 'leader', 'diversifier' and 'advanced e-commerce' models when these companies operate on international platforms. To diversify and enter new markets — the 'leader' and 'diversifier' models and the choice of the 'extended e-commerce' model prevent the creation of new markets. The choice of a particular model for implementing platform solutions is influenced (with the highest degree of significance) by the availability and access to the financial capital of industrial companies.

Keywords: industrial enterprises, digital platforms, competitiveness, effects, access to foreign markets, strategy, ecosystem.

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数字平台对工业企业的效应：外部制裁压力下的实证分析

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摘要
技术革命、许多产品生命周期的缩短以及“通用连接”原则在工业中的普及，迫使制造商形成新的商业模式。它们有助于缩短产品上市时间，提高生产率，为向客户提供物资和与合作伙伴互动创造新的原则。应对这些挑战的办法就是建立数字平台商业模式。与此同时，越来越多的工业企业不仅是平台成员，而且注册自己的平台。本文研究了平台采用的潜在效应。它们以工业企业实施不同类型商业模式的某些战略为基础。本研究从一个新的角度探讨了在限制获得金融资本的制裁背景下所选择的平台解决模式（模式组合）与工业企业绩效之间的关系。通过实证分析作者得出结论：当企业在国际平台上运营时，选择“领导者”、“多样化者”和“扩展电子商务”模式对财务业绩的影响最大。“领导者”和“多样化者”模式对多样化和进入新市场的影响最大，同时选择“扩展电子商务”模式阻碍了新市场的创建。工业企业金融资本的可用性和获取途径对平台解决实施模式的选择产生了（最大程度的）影响。
关键词：工业企业、数字平台、竞争力、效应、进入外国市场、战略、生态系统。

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Introduction

The technological revolution, the shortening of the life cycle of many products, and the spread of the principles of ‘universal connectivity’ in industry are forcing manufacturers to create new business models that help reduce time to market, increase productivity, and formulate new principles for delivering value to consumers and interacting with partners. The answer to these challenges is the creation of platform business models. Over the past decade, the landscape of platform business models for industrial companies has changed significantly and become more heterogeneous. This is evidenced by the increasing complexity of the organisational structures of industrial companies with the use of digital business models, the increase in the number and variety of digital technologies used, the emergence of new digital platforms and entrepreneurial initiatives aimed at further transforming the traditional business models of industrial companies.

According to many analysts and top managers, the use of platform business models, including digital platform tools, helps organisations improve their brand reputation, customer service quality and customer retention rates [Ehret et al., 2013; Gatignon et al., 2017; Chakravorti, Chaturvedi, 2018].

The use of digital platform tools for industrial companies is based on:

- emerging virtual markets characterised by strong interconnectedness and focused on the convenience of transactions. In such markets, information plays a special role, being transmitted to a larger number of people in a very short time and at a much lower cost than in traditional markets [Yang et al., 2017; Dabbs et al., 2018];
- recombinating the value chain. The model proposed by M. Porter in 1985 is significantly modified in virtual markets, where value creation is the result of a new combination of information, physical products and real services, a new configuration of transactions and a reconfiguration of resources, capabilities and relationships between suppliers, partners and buyers [Keen, Qureshi, 2006; Sharma, Mehrotra, 2007; Rust, 2020];
- creating a flow of innovation and entrepreneurship (according to J. Schumpeter) [Teece, 2010; Schneider, Spieth, 2013];

- using the resource theory of the firm. Information resources enhance a firm's capabilities and have a much higher level of mobility than others, making them more important for the platform economy and value creation [Velu, 2016; Chakravorti et al., 2017].

In its 2020 research, PricewaterhouseCoopers describes digital platforms as fundamentally new operating technologies that enable a company to gain a competitive advantage by improving service to customers and optimising business relationships with partners. It is emphasised that internet technologies are one of the key aspects of the platform economy, but not the only one.

Thus, platform business models differ significantly from traditional ones in the value chain.

For example, virtual value chains play a strategic role in collecting, organising, selecting, synthesising and disseminating information [Flavián et al., 2019]. Virtual markets are highly diverse and interconnected [Foss, Saebi, 2017; Robertson, 2017], focusing on operations, information, products and networks. Both electronic and mobile wireless business models, which use open standards to support networks, have the potential to break down traditional boundaries between firms in the value chain. New forms of relationships between buyers and sellers in existing markets create value and are highly efficient by reducing transaction costs. Virtual markets are also characterised by high coverage and completeness of the information presented [Evans et al., 2017; Leischnig et al., 2017].

The purpose of this article is to assess the impact of implementing one or the other of the platform business models on the availability of financial capital for industrial companies.

The article attempts to answer the following research questions:

- Which type of platform business model or tool is most effective for industrial enterprises in the context of sanctions pressure and limited access to financial capital?
- How do sanctions and restrictions on access to financial capital affect the choice of platform business models and firm performance?

1. Theoretical review

The main difference between platform business models is the development of a value creation model based on facilitating the exchange of resources, information, etc. between several interdependent groups [Nenonen, Storbacka, 2010; Arora,

Table 1
Classification of platform business models by end-user groups

	Government	Business	Consumer	Collective users
Government	G2G (coordination and interaction)	G2B (information; public services portal)	G2C (information; public services portal)	G2E (information model to improve the quality of government services for users)
Business	B2G (government procurements)	B2B (various forms of e-business)	B2C (various forms of e-business)	B2E (internal company system to ensure the participation of geographically remote employees in business processes)
Consumer	C2G (enquiries and interaction; public services portal)	C2B (searching and analysing information, interaction)	C2C (personal interaction)	C2E (systems for the participation of individual users)
Collective users	E2G (monitoring the quality of the receiving online consultations, information from different users)	E2B (systems for the monitoring of enterprise systems to ensure the participation of geographically remote employees in business processes)	E2C (online platforms for individual users)	E2E (a model for integrating online exchanges so that trading participants can access many exchanges simultaneously from a single point)

Source: compiled by the authors.

2019]. Examples of such groups include producers and consumers of goods and services, consumers of information contained in government information systems, etc.

In our view, the criteria for the existence of a platform business model could be.

- the ease with which new participants can join the platform;
- the ability to attract the necessary number of participants to create a critical mass of users and customers;
- the creation of conditions for exchange and value creation by platform participants.

At the same time, the key success factors for the use of digital platform tools for industrial companies are [Foss, Saebi, 2017; Gatignon et al., 2017; Ronte et al., 2018; Flavián et al., 2019]:

- the ability to create and maintain the company's competitive advantages;
- maintaining the company's strategic positioning;
- the ability to track market changes in consumer preferences, personalise customer needs and meet those needs;
- short time to market;
- cost reduction and more effective control of cost drivers;
- the ability to better train employees and implement effective human resource management systems;
- the ability to monitor competitors' behaviour, market pricing and market shares;
- high quality of service, logistics (as opposed to traditional markets);
- creating new supply chains and improving delivery services;
- high quality website design that meets or exceeds customer expectations;
- the ability to discover the company's virtual consumer market faster.

There are currently many classifications of platform business models, for example segmentation by end-user groups (Table 1).

Next, we will look at the platform business models used by industrial companies.

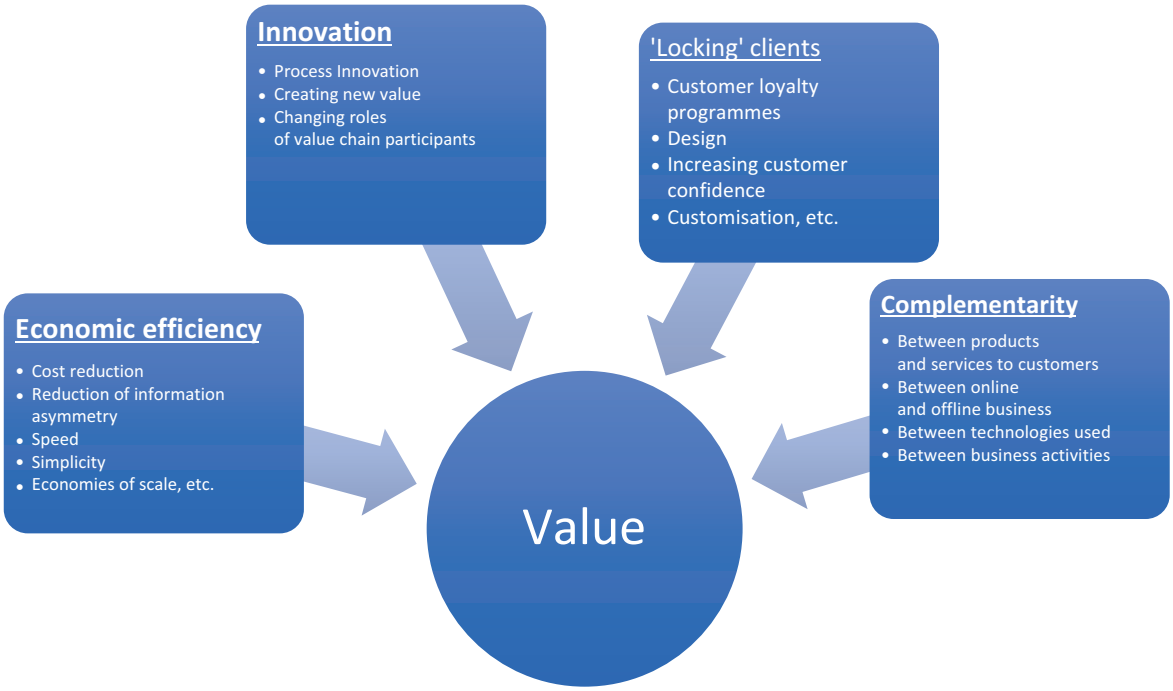
B2C (business-to-consumer) platform business models. On these platforms, businesses interact directly with consumers, usually in the retail sale of goods. The main value that businesses offer to consumers is the simplification

Table 2
Classification of business segments of B2C platform business models for industrial enterprises

Business model	Examples	Description	Revenue model
Internet Portal	Mail.ru Yandex	The resource provides content and the ability to search for content on the site. Services: mail, music, news, video, etc. Positioned by the user's home page	Advertising, subscription, affiliate, sale of goods
Content provider	WSJ.com Vedomosti.ru ESPN.com	Provides users with information, entertainment content, online broadcasts, etc.	Advertising, subscription, affiliate
Brokerage model	Booking.com Kayak.com Hotels.com	Allows users to optimise their search for options based on various parameters	Transactional
New market creation model	Ebay.com Avito.ru Airbnb.com	Companies that use Internet technology to connect potential buyers and sellers	Transactional
Services	Umi.com Renins.ru	Providing various services to users	Selling services
Social media	Vk.com Facebook.com "Odnoklassniki"	Online communities that help users to group together around interests and interact with each other.	Advertising, subscription, affiliate

Source: compiled by the authors.

Fig. 1. Sources of value creation in platform business models



Источник: составлено авторами по [Amit, Zott, 2012].

and acceleration of the purchasing process. The platform allows a company to quickly monitor demand and save on premises and staff. According to experts, the B2C sector is currently the most popular platform business model among industrial companies.

Table 2 shows the segments of industrial companies' platform business models in B2C markets.

Platform e-government models (G2B - Government to Business, between the State and businesses; G2C - Government to Citizen, between the State and citizens; G2E - Government to Employee, between the State and civil servants; G2G - Government to Government, between government agencies). Interaction between government and industry can be mediated through the capabilities of platform business models. Such interaction is commonly referred to as e-government, which is understood as the transformation of the internal and external relationships of government organisations based on the use of platform capabilities to optimise the services provided, increase public participation in public administration issues and improve internal business processes.

The exchange-to-exchange (E2E) platform business model is a model for integrating online exchanges so that trading participants can access many exchanges simultaneously from a single point. E2E companies focus on the interests of the end user: they use modern software to bring together people who want to buy or sell different services. The model focuses on the interests of the individual customer, making quality a key element of the overall equation. The growth of E2E companies is due to the proliferation of smartphones.

Another factor driving the growth of the E2E sector is the fact that consumer sentiment moves at lightning speed. Online media and social networks provide companies with instant feedback. E2E companies have great potential to create value for customers, employees and shareholders by focusing on quality of service.

The B2E (Business-to-Employee) platform business model is an internal corporate system for ensuring the participation of geographically dispersed employees in business processes, based on the creation of various networks. Many industrial companies use such automation networks to provide products and/or services to their employees. Typically, companies use B2E networks to automate corporate HR processes. Examples of B2E applications include online management of insurance policies, distribution of company announcements, online submission of applications to other employees, etc.

Thus, platform business models encompass the following interrelated market segments:

1) the sale of goods and services using ICT (e-commerce);
2) e-procurement;
3) electronic distribution;
4) automation of internal business processes
5) remote customer service;
6) e-mail marketing;
7) creation of a communication environment and information brokerage;

8) providing information and communication infrastructure and electronic interaction.

The sources of value creation for all platform business models are shown in Fig. 1.

The first source is increased efficiency, which occurs primarily by reducing transaction costs, reducing information asymmetry, increasing the speed of transactions, etc. [Lindgren et al., 2010; Kushwaha, Shankar, 2013; King et al., 2020].

The second source is complementarity: the interdependence between products and services for customers (both vertically and horizontally), between types of online and offline businesses, between technologies used and strategies of entrepreneurial activity [Lindgren et al., 2010; Kemp, 2019].

The third source is the so-called locking of customers. It suggests that in the context of the spread of digital platforms, the level of competition between companies increases, and then strategies for 'locking' customers are needed, i.e. the creation of various loyalty programmes for customers, deepening customisation, creating 'happiness' of the customer as a sales driver [Kushwaha, Shankar, 2013; Klimanov, Tretyak, 2014; Klimanov, Tretyak, 2019].

The fourth source is innovativeness. It suggests that achieving leadership in digital platforms requires constant (daily) innovation: in services offered, content, etc. [Lindgren et al., 2010; Palo, Tähtinen, 2013; Hynes, Elwell, 2016].

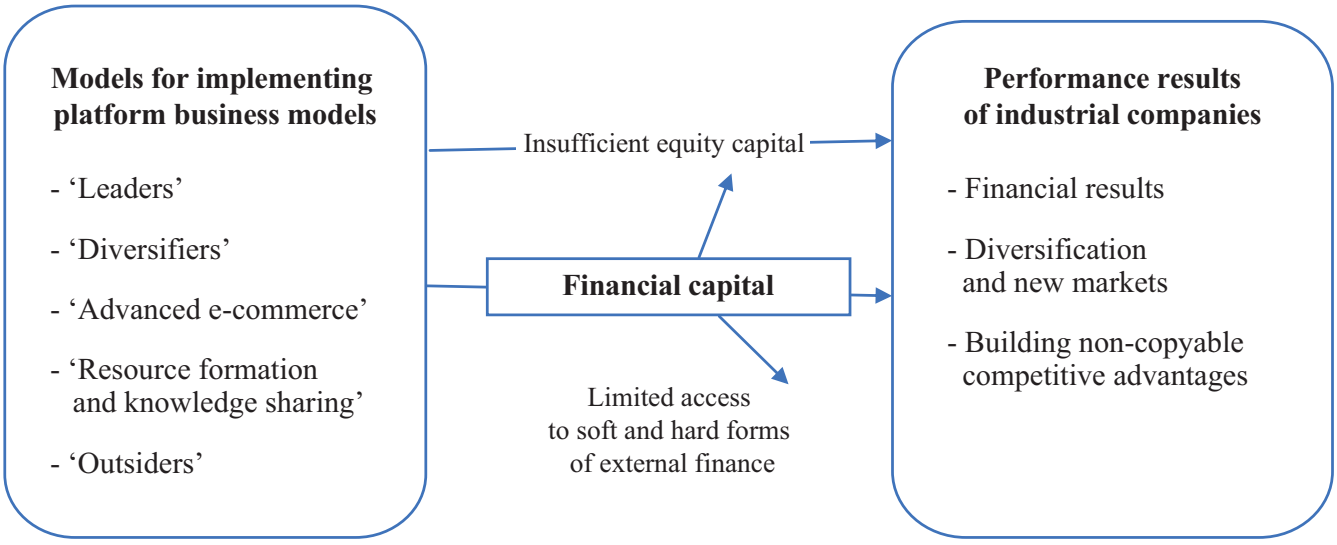
The article examines the implications for industrial companies of implementing different types of platform business models.

2. Research methodology

In the applied research paper 'The Use of Digital Platforms and Digital Financial Assets by Russian Industrial Enterprises under Sanctions Restrictions',[1] the authors identified clusters of industrial enterprises using platform business models and tools as 'leaders', 'diversifiers' and 'extended e-commerce', 'resource formation and knowledge exchange', 'atypical', 'outsiders'. Thus, we include the elements of a business model as signs of cluster identification: strategic, economic, operational and a model for building interaction. At the same time, as shown in the first part of the study, companies can implement several platform models - aimed both at generating income and at developing new competences, open or closed. Since the strategy that generates the highest revenues for companies is when the implementation of platform business models is spun off as a separate business (a new line of business), such strategies are capital intensive. We can therefore assume that access to financial capital is important when developing a specific strategy for using platform business models or their tools.

The developed research model is based on the methodology described in [Trachuk, Linder, 2021] and is tested on 2023 data collected during the period of sanctions imposed on the Russian economy and restrictions on access to resources, including financial capital. The empirical analysis was conducted on a sample of data from 276 industrial enterprises.

Fig. 2. Theoretical model of the study



Source: compiled by the authors.

[1] The use of digital platforms and digital financial assets by Russian industrial enterprises in the context of sanctions restrictions: a report on Research. M., Financial University, 2023.

Table 3
Results of reliability and dependability of measurement models

Measurement models	Cronbach's alpha	Reliability statistics
First-order models		
Performance results of industrial enterprises	from 0.714 to 0.795***	χ^2/df = 1.996; GFI = 0.627; CFI = 0.912; AGFI = 0.669; TLI = 0.749; RMSEA = 0.025
Availability and access to financial capital	0.769–0.812***	
Second-order models		
'Leaders'	from 0.726 to 0.811***	χ^2/df = 1.994; GFI = 0.822; CFI = 0.901; AGFI = 0.879; TLI = 0.934; RMSEA = 0.041
Cost of registering and running your own platform	from 0.711 to 0.876***	
Revenue share from new markets	from 0.735 to 0.884***	
Interaction costs with partners	from 0.749 to 0.825***	
Improving the quality of service	from 0.722 to 0.939***	
'Diversifiers'	from 0.709 to 0.983***	χ^2/df = 1.873; GFI = 0.808; CFI = 0.829; AGFI = 0.849; TLI = 0.962; RMSEA = 0.039
Availability of goods	from 0.731 to 0.873***	
Cost of registering and operating the exchange	from 0.818 to 0.902***	
Cost of developing and launching new products	from 0.779 to 0.895***	
Cost of staff training	from 0.717 to 0.839***	
'Advanced e-commerce'	from 0.714 to 0.944***	χ^2/df = 1.833; GFI = 0.819; CFI = 0.805; AGFI = 0.822; TLI = 0.911; RMSEA = 0.036
Marketing innovation costs	from 0.743 to 0.885***	
Cost of developing and launching new products	from 0.774 to 0.886***	
Number of new products/services launched	from 0.716 to 0.908***	
'Training of resources and skills'	from 0.854 to 0.983***	χ^2/df = 1.917; GFI = 0.842; CFI = 0.854; AGFI = 0.866; TLI = 0.906; RMSEA = 0.042
Cost of staff training	from 0.809 to 0.916***	
Availability of patents	from 0.761 to 0.829***	
Cost of basic research	from 0.779 to 0.889***	
Cost of applied research	from 0.902 to 0.955***	
Cost of developing and launching new products	from 0.889 to 0.942***	
Share of products new to the world	from 0.819 to 0.908***	
'The outsiders'	from 0.828 to 0.915***	χ^2/df = 1.995; GFI = 0.831; CFI = 0.878; AGFI = 0.819; TLI = 0.947; RMSEA = 0.038
Cost of interacting with partners	from 0.889 to 0.926***	
Cost of doing business on platforms	from 0.877 to 0.907***	
Cost of running creative simulations	from 0.819 to 0.948***	

Note. *** – $p < 0.001$.
Source: compiled by the authors.

Table 4
Analysis of reliability and dependability of the variables used in the model

Variable	Cronbach's alpha	Composite reliability	Average variance explained	1	2	3	4	5	6	7
'Leaders'	0.772	0.903	0.64	**0.64**						
'Diversifiers'	0.751	0.759	0.76	0.11	**0.76**					
'Advanced e-commerce'	0.829	0.803	0.78	0.23	0.294	**0.78**				
'Creating resources and sharing knowledge'	0.911	0.937	0.61	0.17	0.019	0.029	**0.61**			
'The outsiders'	0.849	0.884	9.59	0.09	0.008	0.017	0.059	**0.59**		
Financial capital	0.629	0.617	0.63	0.31	0.308	0.207	0.113	0.169	0.63	
Performance results	0.819	0.684	0.74	0.34	0.054	0.048	0.079	0.134	0.109	**0.74**

Source: compiled by the authors.

2.1. The influence of financial capital on the implementation of platform business models in the activities of industrial companies

Financial capital is the most important resource for implementing development strategies and therefore for choosing a strategy for implementing platform business models. The availability of and access to financial capital allows you to diversify your business and open up new areas of development using platform models. For example, for 'leaders', this strategy allows them to register their own marketplaces (usually industry-specific ones for B2B markets) and generate income not only from selling their products, but also from owning the marketplace assets. For 'diversifiers', the availability of and access to financial capital provides the opportunity to introduce digital platforms for the development of many non-core activities. Owners of exchange-traded commodities have the opportunity to develop their own exchange platforms.

According to the results of the survey, industrial companies expect the following effects from the implementation of platform business models:

- the opportunity to build and maintain the company's competitive advantage (87% of respondents);
- maintaining the company's strategic positioning (34%);
- the opportunity to track market changes in consumer preferences, personalise customer needs and meet those needs (54%);
- reduced time to market (23%);
- cost reduction and more effective control of cost drivers (47%);
- the opportunity to better train employees and implement effective human resource management systems (91%);
- the opportunity to monitor competitors' behaviour, market pricing and market shares (44%);
- high quality of service and logistics (as opposed to traditional markets) (67%);
- creating new supply chains and improving delivery services (62%);
- high quality website design that meets or exceeds customer expectations (28%);
- the opportunity to discover the company's virtual consumer market more quickly (14%).

We therefore group the expected impact of digital platform adoption into three areas:

- improving financial performance;
- business diversification and entry into new markets;
- the creation of non-copyable competitive advantages (knowledge and skills).

Therefore, the following hypotheses can be made.

Hypothesis 1: The financial performance of industrial companies depends on the model of platform business model implementation, while the use of a combination of platform implementation models help achieve the highest possible performance results.

Table 5
Descriptive statistics and correlation matrix

Variables	Average	Standard deviation	Minimum value	Maximum value	1	2	3	4	5	6	7	8	9
Performance results	6.28	1.03	1	7	1								
Access to financial capital	6.54	1.09	4.23	6.95	0.639	1							
Company size	5.09	1.22	1.49	6.3	0.74	0.187	1						
Company age	6.79	1.26	1.23	10.2	–0.044	0.105	0.148	1					
‘Leaders’ (L)	5.74	1.11	1.03	7.47	0.036	0.139	0.084	0.039	1				
‘Diversifiers’ (D)	4.98	1.32	0.01	4.78	0.407	0.438	0.217	0.439	0.509	1			
‘Advanced e-commerce’	4.54	1.35	1.02	7.05	0.502	0.519	0.377	0.156	0.472	0.442	1		
‘Resource Formation and Knowledge Exchange’	2.37	1.28	1.04	6.99	0.278	0.212	0.274	0.103	0.513	0.567	0.372	1	
‘Outsiders’ (O)	3.29	1.74	1.03	7.12	0.179	0.198	0.182	0.116	0.438	0.471	0.589	0.43	1

Note. $n = 648$; ** – $p < 0{,}05$.
Source: compiled by the authors.

Hypothesis 2: Financial capital has a significant positive effect on the diversification of the core business and the entry into new markets, which ensures higher financial performance.

As described in the methodology [Trachuk, Linder, 2021], we will consider two types of restrictions on access to financial capital: in a soft form, when the rate of return from the company’s activities is lower than the interest rate on loans, and in a hard form, which assumes that the company does not have access to the credit market.

The theoretical research model developed is presented in Fig. 2.

2.2. Research variables

Three groups of indicators were used as dependent variables, each scored on a 7-point scale where 1 - the indicator has significantly decreased, 4 - the indicator has not changed, 7 - the indicator has significantly increased:

- indicators of financial performance: turnover, profitability of sales;
- indicators of the creation of non-copyable competitive advantages: revenue from sales of new products, presence of investment in research and development, presence of patents;
- indicators of diversification and entry into new markets: market share, number of new markets/ segments, increase in customer value.

Subjective indicators of performance are often used in management research because objective results vary widely across industries, while subjective indicators reflect the dynamics of change from the perspective of management. Furthermore, the correlation between subjective and objective assessments has been confirmed. The use of

Table 6
Relationship between financial capital, the application pattern of the platform business model and performance results on a general sample of industrial enterprises. Results of the analysis

Research variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Control variables						
Costs of creating and operating platform business models	0.0059*** (0.0022)	0.0089*** (0.0027)	0.0069*** (0.0017)	0.0079*** (0.0033)	0.0073*** (0.0021)	0.0088*** (0.0013)
Costs of transforming business processes	0.0066*** (0.0024)	0.0067*** (0.0038)	0.0095*** (0.0026)	0.0069*** (0.0019)	0.0097*** (0.0026)	0.0079*** (0.0021)
Costs for cloud services and data centers	0.0058*** (0.0013)	0.0074** (0.0029)	0.0099*** (0.0035)	0.0088*** (0.0019)	0.0052*** (0.0018)	0.0116*** (0.0014)
Costs of technological innovation	0.0083*** (0.0018)	0.0065*** (0.0017)	0.0072*** (0.0021)	0.0084*** (0.0032)	0.0093*** (0.0018)	0.0059*** (0.0033)
Education	0.0031*** (0.0017)	0.0054*** (0.0018)	0.0049*** (0.0026)	0.0052*** (0.0015)	0.0073*** (0.0019)	0.0046*** (0.0028)
Marketing innovation expenses	0.0054*** (0.0016)	0.0068** (0.0022)	0.0027*** (0.0027)	0.0042** (0.0037)	0.0053 (0.0014)	0.0079*** (0.0019)
Company size	0.0028*** (0.0011)	0.0034*** (0.0009)	0.0029*** (0.0015)	0.0037*** (0.0016)	0.0041 (0.0023)	0.0016*** (0.0014)
Company age	–0.0124** (0.0051)	–0.0153*** (0.0069)	–0.0125** (0.0075)	–0.0167*** (0.0063)	–0.0183*** (0.0082)	–0.0195** (0.0091)
Financial capital	0.0297*** (0.0032)	0.0213*** (0.0052)	0.0199*** (0.0037)	0.0187*** (0.0028)	0.0171*** (0.0035)	0.0224*** (0.0041)
Revenue from export activities	0.0153*** (0.0028)	0.0149*** (0.0037)	0.0191*** (0.0044)	0.0176*** (0.0045)	0.0173*** (0.0048)	0.0184** (0.0014)
Economic sectors	Incl	Incl	Incl	Incl	Incl	Incl
Key Variables						
'Leaders' (L)		0.0129*** (0.0047)	0.0148*** (0.0061)	0.0139*** (0.0052)	0.0146*** (0.0057)	0.0169*** (0.0046)
'Diversifiers' (D)		–0.0008*** (0.0048)	–0.0026*** (0.0044)	–0.0081*** (0.0052)	–0.0069*** (0.0065)	–0.0038*** (0.0075)
'Advanced e-commerce'		0.0158*** (0.0024)	0.0136*** (0.0021)	0.0178*** (0.0032)	0.0151** (0.0039)	0.0191*** (0.0057)
‘Formation of resources and exchange of knowledge’		–0.0024*** (0.0022)	–0.0059*** (0.0031)	–0.0093*** (0.0042)	–0.0086*** (0.0037)	–0.0046*** (0.0016)
'Outsiders' (O)		0.1067*** (0.0026)	0.0182*** (0.0035)	0.0174** (0.0028)	0.0198*** (0.0026)	0.0106** (0.0044)
Double cross variable						
L × D			–0.0217*** (0.055)			–0.0012*** (0.0033)
D × 'Advanced e-commerce'				–0.0162*** (0.0029)		–0.0071*** (0.034)
L × 'Advanced e-commerce'					–0.0179*** (0.0082)	–0.0167*** (0.0059)
Triple cross variable						
L × D × 'Advanced e-commerce'						–0.0068*** (0.0037)
Constant	1.442*** (0.351)	2.589** (0.475)	2.981*** (0.644)	3.058 *** (0.392)	2.533*** (0.489)	3.062*** (0.358)
F-statistics	42.12***	38.17***	29.87***	34.83***	35.28***	31.56***
R^2 corrected	0.18	0.15	0.16	0.15	0.18	0.17

Note. $n = 648$; Standard errors are given in brackets; *** – $p < 0{,}001$; ** – $p < 0{,}05$; * – $p < 0{,}10$.
Source: compiled by the authors.

subjective indicators is therefore justified and can be considered reliable.

Independent variables: assignment of industrial companies to a particular cluster according to the type of platform solutions implementation model.

Based on the results of the study[2], industrial companies were classified into five clusters: 'leaders', 'diversifiers', 'advanced e-commerce', 'resource formation and knowledge sharing', 'outsiders'.

Control variables: The performance of industrial companies varies significantly according to industry, company size and age, and these parameters are used as control variables. The industry variable is treated as a binary variable, equal to 1 if the enterprise belongs to this industry and 0 otherwise[3]. The age of an enterprise is measured by the number of years it has been in existence and its size by the number of average employees. All variables are transformed using the natural logarithm, which allows the assumptions of normal distribution to be met.

2.3. Empirical research results

As described in the methodology [Trachuk, Linder, 2021], the data must first be analysed for reliability and validity using the method of confirmatory factor analysis (CFA). The results of this analysis are presented in Table 3.

The significance of the variables used is confirmed by Cronbach's alpha, whose threshold must be at least 0.7. In our case, all the variables have values between 0.709 and 0.983, which confirms the reliability of the measurements. As shown in [Trachuk, Linder, 2021], it is also necessary to assess the consistency of the second-order component variables using the average variance explained (AVE)[4], the threshold value of which must exceed 0.5. For all variables, the value was higher than the normative value. The results are presented in Table 4.

It is also necessary to use the Harman test to analyse the data, since the variables were obtained using the subjective opinions of the same respondents. The results of the test showed the presence of seven principal components with values greater than 1, none of which accounted for more than 50% of the variance. Therefore, it can be said that there is no general assessment of bias. The values of all variables were calculated as the arithmetic mean of the responses to the question. For the clusters based on the platform business model application model, the averages for each dimension were calculated first, and then the average for the constituent elements. The results are shown in Table 5.

Correlation analysis revealed a fairly high correlation between the models of innovative behaviour: 'leaders' and 'diversifiers'; 'diversifiers' and 'advanced e-commerce', 'advanced e-commerce' and 'outsiders'. There is no correlation between other models of innovative behaviour. Therefore, to reduce the problem of multicollinearity, double and triple crossover variables were included in the model.

In the second stage, linear regression was used to analyse the relationships between patterns of platform business model adoption, restrictions on access to capital and firm performance. The empirical study involved a step-by-step analysis:

- in the first stage (Model 1): the analysis of the basic model and the control variables;
- in the second stage (Model 2): the analysis of the basic model and the direct effects of the choice of model for the use of platform business models ('leaders', 'diversifiers', 'advanced e-commerce', 'resource and competence formation', 'outsiders');
- in the third stage (Models 3-5): the analysis of double cross effect ('leaders' and 'diversifiers' (Model 3), 'diversifiers' and 'extended e-commerce' (Model 4), 'leaders' and 'advanced e-commerce' (model 5);
- in the fourth stage (Model 6): the analysis of the triple cross effect ('leaders', 'diversifiers' and 'extended e-commerce').

In order to ensure the absence of multicollinearity in the models constructed, we used the variance inflation factors (VIFs) according to the specified methodology; in all cases their value did not exceed 6.8 (with a standard of 10), therefore there is no multicollinearity in the models studied. The results of the analysis are presented in Table. 6.

As the results of the analysis show, the best results are achieved by companies that choose the 'leaders' ($b = 0.0129$, $p < 0.05$), 'diversifiers' ($b = 0.0158$, $p < 0.05$), 'extended e-commerce' ($b = 0.0167$, $p < 0.05$). At the same time, 'advanced e-commerce' achieves the greatest results when the platform operates in international markets and companies have revenues from export activities, i.e. they operate on an international platform. The increasing cost of marketing innovation is encouraging companies to choose more profitable models for building platform business models – 'leaders' and 'diversifiers'. Investments in new technologies and equipment (data centres) stimulate the introduction of new platform solutions and have a greater impact on companies' diversification and entry into new markets. The choice of the 'advanced e-commerce' model has a negative impact on diversification and entry into new markets, but a stronger positive relationship with the financial performance of industrial enterprises. Industry specifics have an impact on the choice of platform business model only for 'leaders' and 'diversifiers'. The result of testing Models 3-5 indicates a negative relationship between the combination of platform solution models and performance results ($L \times D$: $b = –0{,}0217$, $p < 0{,}10$; $D \times$ 'advanced e-commerce': $b= –0{,}0162$, $p<0{,}05$; $L \times$ 'advanced e-commerce': $b = –0{,}0179$, $p < 0{,}10$). The effects of the triple combination of models for adopting platform business models do not affect the performance of

[2] The use of digital platforms and digital financial assets... 2023.

[3] Classification of industries: food production, including beverages, and tobacco; textile and clothing production; leather, leather products and footwear production; wood processing and production of wood products; pulp and paper production; publishing and printing activities; chemical production; production of rubber and plastic products; production of other non-metallic minerals products; metallurgical production and production of finished metal products; production of machinery and equipment; manufacture of electrical, electronic and optical equipment; manufacture of vehicles and equipment; production and distribution of electricity, gas and water; exploration and mining.

[4] Calculated using the formula: sum of squares of standardized loads / (sum of squares of standardized loads + sum of measurement errors).

industrial enterprises (when analysing the whole sample - Model 6). Accordingly, focusing a company on one or two types of implementation of platform solutions gives more significant results than following mixed strategies.

This confirms our first hypothesis. The chosen type of platform solution implementation model does influence the performance of industrial companies.

The second hypothesis - about the influence of financial capital - is also confirmed, and its presence has a statically significant positive effect with the maximum level of significance ($b = 0.0297$, $p < 0.05$).

3. Conclusions and future research

The study shows that access to financial capital is a strategically important resource that influences the implementation of platform business models and the performance of industrial firms. The research presented provides a new perspective on the relationship between the chosen model/combination of platform solution models and the performance of industrial firms in the context of sanctions-related restrictions on access to financial capital.

The empirical analysis carried out allowed us to draw the following conclusions. The choice of 'leaders', 'diversifiers' and 'extended e-commerce' models has the greatest impact on financial performance when these companies operate on international platforms. The choice of the 'leaders' and 'diversifiers' models also has the greatest impact on diversification and entry into new markets, while the choice of the 'advanced e-commerce' model prevents the creation of new markets. The choice of one or the other model for implementing platform solutions is influenced (with the highest level of significance) by the availability and access to financial capital of industrial companies.

The results obtained are of practical value for managers of industrial companies, business owners and entrepreneurs and indicate the need to allocate resources to the implementation of platform business models, even in conditions of limited access to financial capital.

A limitation of this study is the subjective nature of the respondents' assessments. In the future, it would be possible to use objective data in studies and compare the results obtained. In addition, this study was conducted on a sample of industrial companies; the analysis could be extended to other industries in the future.

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