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Economic challenges of intellectual property in the digital era: legal, economic and social aspects

Retos económicos de la propiedad intelectual en la era digital: aspectos jurídicos, económicos y sociales

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Valentyna Zhukovska
Professor, D. Sc. (Economics), Associate Professor, Department of Management, Faculty of Economics, Management and Psychology, State University of Trade and Economics, Kyiv, Ukraine
https://orcid.org/0000-0001-5033-711X, valentyna2015@ukr.net

Vasyl Goi
Candidate of Economic Sciences (Ph. D.), Doctoral Candidate, Department of Economics and Marketing, O. M. Beketov National University of Urban Economy in Kharkiv, Kharkiv, Ukraine
https://orcid.org/0000-0003-1822-4478 , vasssgoi@gmail.com

Viktoriia Cherednychenko
PhD in Economics, Senior Lecturer, Department of Management and State Service, Educational-Scientific Institute of Economics and Law, Bohdan Khmelnytsky National University of Cherkasy, Cherkasy, Ukraine
https://orcid.org/0000-0002-8276-3014 , ch_vicktoria@ukr.net

Olena Zabolotna
PhD, Associate Professor, Department of Economic Theory and Financial and Economic Security, Faculty of Economics, Business and Control, Odesa National University of Technology, Odesa, Ukraine
https://orcid.org/0000-0003-2107-233X , zabolotnaolenas@gmail.com

Viktoriia Shyshliuk
PhD, Associate Professor, Department of Economic Theory and Financial and Economic Security, Faculty of Economics, Business and Control, Odesa National University of Technology, Odesa, Ukraine
https://orcid.org/0000-0002-8163-5512 , shyshliuk.viktoria@gmail.com

Resumen

En la era digital contemporánea, las naciones están involucradas en una competencia activa, no solo en el ámbito de la economía, sino también en el dominio de la tecnología, estableciendo así un nuevo paradigma de dinámica de poder global. En este marco, los obstáculos económicos, legales y sociales asociados a la salvaguarda de la propiedad intelectual (en adelante, PI) han experimentado un aumento significativo. Este artículo tiene como objetivo examinar los desafíos económicos que plantea la propiedad intelectual en la era digital, considerando el telón de fondo de la competencia global intensificada y el imperativo de mantener la competitividad nacional en las dimensiones legal, económica y social. El artículo emplea una metodología de análisis estadístico, utilizando datos de propiedad intelectual obtenidos de la base de datos estadísticos de la Organización Mundial de la Propiedad Intelectual (OMPI), específicamente del Centro de datos estadísticos de PI de la OMPI. Los autores examinan los pagos e ingresos transfronterizos asociados con la explotación de la propiedad intelectual en diversas naciones. Además, el estudio investiga la composición y la dinámica de la propiedad intelectual en varios tipos (como patentes, diseños industriales, marcas registradas y modelos de utilidad) y regiones, lo que facilita una evaluación del panorama competitivo y los esfuerzos cooperativos entre los países líderes del mundo en el ámbito de la propiedad intelectual. Los desafíos económicos atribuidos a la propiedad intelectual se analizan en el contexto del comercio, la inversión, la cooperación tecnológica y la dinámica competitiva que involucra a Estados Unidos, China y la Unión Europea. Los hallazgos revelan un aumento notable en los pagos transfronterizos y los ingresos por propiedad intelectual, lo que refleja un grado relativamente limitado de cooperación entre las regiones más importantes del mundo. Esto indica una ventaja competitiva considerable que disfrutan los Estados Unidos, la Unión Europea y China. A pesar de la hegemonía y el liderazgo de los EE. UU. en el dominio de la propiedad intelectual, subrayada por una política proteccionista destinada a salvaguardar los derechos de propiedad intelectual, principalmente a través del control que ejercen las empresas estadounidenses, China está realizando progresivamente su potencial tecnológico. Esto se evidencia por las crecientes actividades de patentes emprendidas por las empresas chinas. Si bien China, Japón, Estados Unidos y Corea ocuparon las posiciones más

destacadas en términos de la proporción de los principales solicitantes PCT en 2022, China está emergiendo gradualmente como líder en el ámbito de la propiedad intelectual. El liderazgo del país se puede atribuir al esfuerzo innovador de las empresas que operan en el sector de la innovación y la tecnología, con un énfasis notable en las tecnologías móviles. En los últimos años, China ha superado a Japón y Estados Unidos en cuanto al número de solicitudes presentadas por empresas que buscan obtener los derechos de propiedad de sus invenciones, desarrollos e innovaciones.

Palabras clave: propiedad intelectual, regímenes políticos, protección de la propiedad intelectual, derechos de propiedad intelectual, protección tecnológica.

Abstract

In the contemporary digital era, nations are engaged in active competition, not solely within the realms of economics, but also in the domain of technology, thus establishing a new paradigm of global power dynamics. Within this framework, the economic, legal, and social hurdles associated with safeguarding intellectual property (hereinafter IP) have witnessed a significant rise. This article aims to examine the economic challenges posed by intellectual property in the digital age, considering the backdrop of intensified global competition and the imperative to maintain national competitiveness across legal, economic, and social dimensions. The article employs a statistical analysis methodology, utilizing intellectual property data obtained from the World Intellectual Property Organization (WIPO) statistics database, specifically the WIPO IP Statistics Data Center. The authors examine cross-border payments and revenues associated with intellectual property exploitation in diverse nations. Furthermore, the study investigates the composition and dynamics of intellectual property across various types (such as patents, industrial designs, trademarks, and utility models) and regions, thereby facilitating an assessment of the competitive landscape and cooperative endeavors among the world's leading countries in the realm of intellectual property. The economic challenges attributed to intellectual property are scrutinized within the context of trade, investment, technological cooperation, and the competitive dynamics involving the United States, China, and the European Union. The findings reveal a notable increase in cross-border payments and intellectual property revenues, reflecting a relatively limited degree of cooperation among the world's prominent regions. This indicates a considerable competitive advantage enjoyed by the United States, European Union, and China. Notwithstanding the US hegemony and leadership within the intellectual property domain, underscored by a protectionist policy aimed at safeguarding IP rights, chiefly through the control exerted by American firms, China is progressively realizing its technological potential. This is evidenced by the escalating patent activities undertaken by Chinese companies. While China, Japan, the United States, and Korea held the foremost positions in terms of the share of Top PCT Applicants in 2022, China is gradually emerging as a leader in the realm of intellectual property. The country's leadership can be attributed to the innovative endeavors pursued by companies operating within the innovation and

technology sector, with a notable emphasis on mobile technologies. Over recent years, China has surpassed Japan and the United States in terms of the number of applications filed by companies seeking to secure ownership rights for their inventions, developments, and innovations.

Keywords: intellectual property, political regimes, intellectual property protection, intellectual property rights, technology protection.

Introduction

Intellectual property (IP) assumes a pivotal role in the advancement of an innovative economy, thereby rendering its reliable protection and enforcement instrumental in fostering sustainable economic growth and securing competitive advantages on a global scale. Consequently, leading nations across the world are actively formulating legal frameworks and policy mechanisms to bolster IP protection and counter potential fraudulent activities of technology transfer and innovation exchange among countries. This issue carries significant weight, particularly among global technology hubs such as the United States, China, and the EU countries. Scientific discourse prominently highlights the economic, trade, and legal challenges entailed by countries' IP and technology protection policies, considering them as fundamental pillars for cultivating innovative economic progress. In light of the foregoing, this article aims to scrutinize the economic challenges arising from intellectual property in the digital era, within the context of global competition and the imperative to safeguard countries' competitiveness across legal, economic, and social dimensions.

Literature Review

Economic and legal challenges of intellectual property

The existing literature delves into the correlation between bolstering intellectual property rights (IPR) and the augmentation of innovation and economic growth. Notably, prior studies by Sweet and Maggio (2015), Fang, Lerner, and Wu (2017), and Neves et al. (2021) shed light on this relationship. Fang, Lerner, and Wu (2017) present empirical evidence revealing that innovation levels experience a surge after the privatization of state-owned enterprises, particularly in cities with robust IPR protection. This phenomenon amplifies firms' motivation to innovate and renders the private sector more responsive to the safeguarding of property rights compared to state-owned enterprises. In a broader context, Neves et al. (2021) discern a predominantly positive impact of IPRs on both innovation and growth, with a more pronounced manifestation observed in developed countries. This disparity can be attributed to divergent institutional factors and policy frameworks at play.

Legal challenges are examined within the context of the influence exerted by the reinforcement of patent regimes in both developed and developing nations, showcasing a positive impact on innovation that becomes more pronounced once a certain threshold of national income is attained. Arza et al. (2023), for instance, investigate the repercussions of regulatory modifications and the implementation of the Trade-Related Aspects of Intellectual Property Rights (TRIPS) agreement on the progress of innovation in Latin America. Notably, critical research endeavors focus on scrutinizing policy instruments and enforcement mechanisms that contribute to the enhancement of intellectual property rights (Suominen et al., 2023). Auriol, Biancini, and Paillacar (2023) undertake an empirical investigation encompassing panel data from 112 countries to analyze the determinants of intellectual property rights (IPR) adoption and its impact on manufacturing innovation. The findings of their study unveil a U-shaped relationship between IPR protection and a country's market size, as well as an inverse U-shaped association concerning the aggregate market size of its trading partners. The research demonstrates that heightened protection of intellectual property rights diminishes innovation at the borders and within developing nations, without necessarily fostering an increase in global-level innovation (Auriol, Biancini, & Paillacar, 2023). In light of globalization, enterprises navigate diverse legal frameworks governing the protection of intellectual property (IP) rights. This reality significantly influences their capacity to safeguard assets and rights, determine strategic geographical placements, and foster cross-border innovation (Papageorgiadis & McDonald, 2022). Notably, in the past quarter-century, there has been a discernible escalation in global efforts aimed at fortifying and aligning IPR systems through the inclusion of IP and trade-related provisions within trade agreements (TAs) (Campi & Dueñas, 2019). In the scholarly discourse, the legal and economic challenges of intellectual property (IP) are often explored within the framework of trade dynamics. Campi and Dueñas (2019) discover that the inclusion of IP chapters in trade agreements (TAs) influences bilateral trade flows among a balanced group of 110 countries during the period spanning from 1995 to 2013. Moreover, the impact on trade flows varies based on the presence or absence of intellectual property rights (IPR) chapters in Trans-Pacific Partnerships (TPPs), contingent upon the country's level of development and the intensity

of IPR regulations. Furthermore, scholarly investigations delve into the trade war between China and the United States, with specific attention directed toward the US-China Economic and Trade Agreement, commonly known as the "Phase I Agreement" (Shu Shang & Shen, 2021). The study specifically scrutinizes China's post-trade war dedication to upholding elevated standards of intellectual property rights, while also investigating the bilateral dynamics between the United States and China during and following the trade conflict. Additionally, it explores the repercussions of these dynamics on China's legal transformations from the perspective of transnational law (Shu Shang & Shen, 2021). The reinforcement of intellectual property rights regulations in the United States holds the potential to enhance trade and investment negotiations between the two nations (Shu Shang & Shen, 2021).

The political, legal, and economic challenges associated with intellectual property rights are intricately intertwined with social challenges, which encompass the safeguarding of human rights to intellectual property (Helfer, 2015).

Consequently, the economic and legal challenges associated with IP are intricately interconnected. Legal frameworks and enforcement policies exert an influence on the extent of innovation and trade, particularly within cross-border contexts, as well as on the expansion of the private sector and overall economic growth. Furthermore, economically advanced nations tend to possess more effective institutions for IP enforcement, with their practices being disseminated and adopted by developing countries.

Materials and Methods

The article adopts a methodological approach grounded in statistical analysis, utilizing intellectual property data from various authoritative sources including the World Trade Organization (WTO), United Nations Conference on Trade and Development, Trade in Commercial Services database, World Intellectual Property Organization (WIPO) statistics database, and WIPO IP Statistics Data Center. Employing this data, the authors examine cross-border payments and revenues derived from intellectual property utilization across different countries. Additionally, they delve into the structure and dynamics of intellectual property, categorizing it by type (patents, industrial design, trademarks, utility models) and region. Through this analysis, the study investigates the competitive and cooperative state of affairs among the leading countries in the realm of intellectual property. Moreover, a focused examination of the principal technological sectors characterized by a high number of patents is conducted across Asia, Europe, and North America. This endeavor enables the identification of significant disparities in the intellectual property landscape based on regional distinctions.

Result and discussion

In 2021, the cross-border payments related to the utilization of intellectual property witnessed a notable surge, reaching approximately USD 1 trillion, signifying a significant increase of 65% compared to 2010. This indicates a nearly 50-fold rise over the past four decades. Notably, the United States emerged as the primary beneficiary in terms of revenue, generating the largest sum in 2021, amounting to $124 billion. Germany and Japan also rank prominently among the leading nations in revenue from the sale of intellectual property rights, with $57 billion and $47 billion, respectively. When considering countries with a moderate level of revenue from IP sales, China attains $11 billion, while Brazil, Turkey, and Argentina also contribute significantly (refer to Table 1). Within sub-Saharan Africa, South Africa, Ghana, and Kenya stand out as leaders in terms of income generated from the sale of intellectual property (World Intellectual Property Organization, 2023).

Table 1 – Ranking of the world's leading IP exporters, in USD billion, 2021

Ranking	Economy	IP Exports in 2021 (Billion USD)	Ranking	Economy	IP Exports in 2021 (Billion USD)
1	United States of America	124,613	11	Republic of Korea	8,022
2	Germany	56,947	12	United Arab Emirates	3,267
3	Japan	47,860	13	Israel	1,668
4	Netherlands	38,302	14	Australia	1,228
5	Switzerland	29,916	15	India	870
6	United Kingdom	23,502	16	Brazil	705
7	Ireland	17,609	17	Cyprus	594
8	China	11,948	18	Türkiye	228
9	Singapore	11,648	19	Argentina	227
10	Canada	8,535	20	South Africa	135

Source: Authors' calculation based on World Intellectual Property Organization (2023), World Trade Organization (WTO), United Nations Conference on Trade and Development, Trade in Commercial Services database.

Based on the Global Innovation Index (GII) 2023, payments for intellectual property refer to the funds received by an entity in one country from another country for the utilization of IP. On the other hand, intellectual property revenues denote the payments received by participants in one country from counterparts in another country for the utilization of the former intellectual property. In 2021, payments for IP totaled $528 billion, while revenues amounted to $453 billion. Collectively, payments and revenues of IP usage accounted for 9% of the overall trade in commercial services, marking an increase from the 7% recorded in 2012. The observed upward trajectory in global "IP trade" signifies the restructuring of worldwide production in recent years, largely driven by technological advancements, particularly the proliferation of digital technologies. This phenomenon has facilitated a decline in trade costs associated with fragmented production activities on a global scale.

As production becomes increasingly globalized, the exchange of ideas across borders has intensified, primarily through intangible assets such as technological knowledge, software, and know-how. Consequently, companies are progressively acquiring

technology from external sources to acquire new knowledge, enhance skills, optimize business processes, and more.

The composition of intellectual property (IP) rights is characterized by the predominant presence of Industrial design, accounting for 6% of the total (experiencing a decline from 11% in 2012). Patents comprise 13% of IP rights, also demonstrating a downward trend from 21% in 2012. In contrast, Trademarks (class count) represent a substantial portion, constituting 70% in 2021. This category has witnessed a growing share from 2012 to 2021 (rising from 60% in 2012). Utility models account for 11% of the IP rights, displaying an increasing trend compared to the 7% recorded in 2012 (refer to Figure 1).

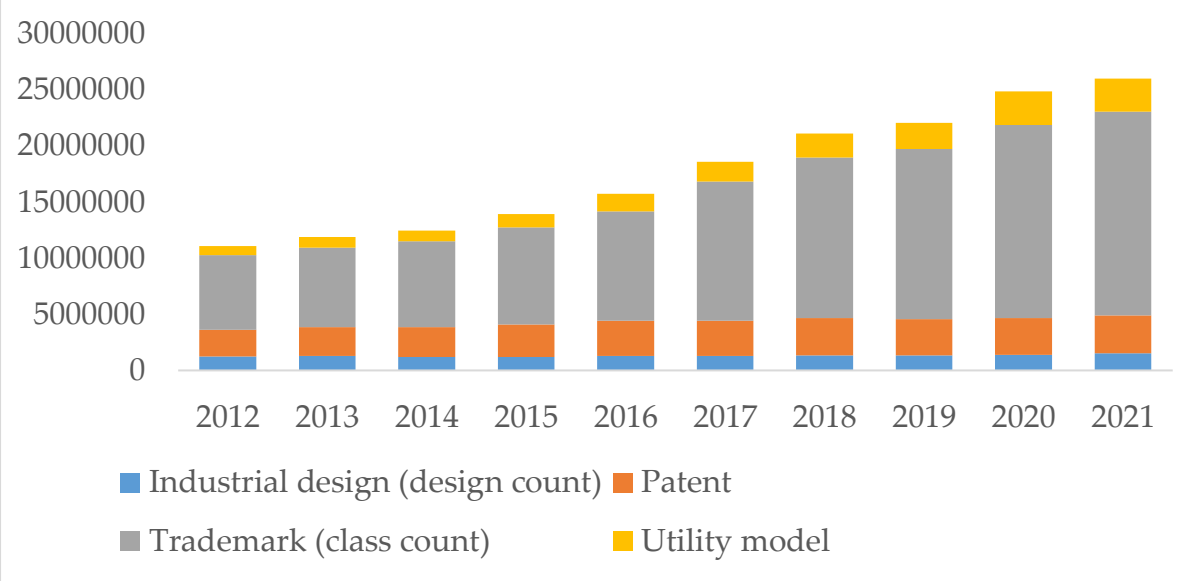

Figure 1 – Intellectual property right: Total applications in the world, 2012-2021
Source: WIPO statistics database (2023a).

It is noteworthy to highlight the notable increase in the number of intellectual property applications filed by type in Asia and Europe from 2012 to 2021, primarily driven by China, Japan, and South Korea (refer to Table 2). In terms of application composition, Asian countries contribute to 69% of industrial design filings, 68% of patent registrations, 70% of trademark registrations, and an overwhelming 98% of utility model registrations.

Table 2 – Intellectual property right: Applications by regions, thousand units, 2012-2021

Region, total	2012	2017	2018	2019	2020	2021	2021-2017
Industrial design (design count)							
Africa	16,2	20,2	17,4	17,5	15,5	15,5	-4,7
Asia	848,2	845,1	915,3	928,9	983,8	1049,7	204,6
Europe	329,9	334,9	331,9	331,3	306,3	353,7	18,8
LAC	15,8	15,4	15,4	15,6	15,1	17,7	2,3
North America	38,2	52,6	54	57,4	58,3	69	16,4
Oceania	10,3	9,1	9,7	10,2	8,8	9,6	0,5
Patent							
Africa	14,8	16,1	16,3	17	16,4	20,9	4,8
Asia	1321,2	2062,5	2229,2	2102,2	2188,7	2299,6	237,1
Europe	345,8	356	362,1	363,9	357,9	357,9	1,9
LAC	63,1	57,3	55,5	56	52,1	54,8	-2,5
North America	578,1	642	633,3	657,9	631,7	628,6	-13,4
Oceania	33,5	35,1	36,2	35,8	35,1	39,3	4,2
Trademark (class count)							
Africa	196,2	250	255	265	254,6	292,8	42,8
Asia	3177,1	8239,4	10029,5	10698	12341,8	12648	4408,6
Europe	1959,9	2195,1	2252,1	2340,5	2521,3	2850,3	655,2
LAC	604,9	711,1	744,4	783,5	849,9	1034	322,9
North America	568,3	797,6	827,8	847	1017,5	1075,7	278,1
Oceania	149,5	186,9	199,8	194,1	208,7	244,3	57,4
Utility model							
Africa	0,31	0,55	0,71	0,72	0,67	0,66	0,11
Asia	768,84	1710,9	2096,64	2293,54	2951,65	2877,66	1166,76
Europe	52,74	43,58	42,15	40,5	38,88	34,25	-9,33
LAC	4,45	4,56	4,36	4,5	4,49	4,08	-0,48
Oceania	1,86	1,82	2,26	1,86	4,41	7,84	6,02

Source: WIPO IP Statistics Data Center (2023).

Furthermore, it is noteworthy to examine the prominent nations in terms of the number of applications submitted under the Patent Cooperation Treaty (PCT). The PCT, established in 1970, serves as an international patent law treaty facilitating a streamlined procedure for filing patent applications. In 2022, China, Japan, the United States, and Korea emerge as global frontrunners concerning the proportion of Top PCT Applicants, characterized by applicants having more than 10 PCT applications. Notably, China holds a share of 26.57%, followed closely by Japan at 24.36%. The United States accounts for 20.19%, while Korea maintains a share of 7.80%. China's remarkable success can be attributed to

the innovative endeavors of companies operating within the innovation and technology sector, particularly those specializing in mobile technologies. Notably, a majority of patent applications in China originate from domestic entities. From 2019 to 2022, the following companies emerged as the top PCT applicants: Huawei Technologies Co. Ltd., Guangdong Oppo Mobile Telecommunications Corp. Ltd, BOE Technology Group Co., Ltd, Ping An Technology (Shenzhen) Co., Ltd, and ZTE Corporation. Regarding the primary technological domains that lead in terms of the number of IP applications filed in China, noteworthy sectors include computer technology (13.5%), measurement (7.2%), electrical machinery, apparatus, energy (6.1%), machine tools (5.0%), and digital communication (4.8%). In terms of foreign destinations for registration in China, the United States of America accounted for 41.3%, followed by the European Patent Office at 14.9%, Japan at 8.4%, China, Hong Kong SAR at 6.3%, and the Republic of Korea at 5.7% (WIPO Statistics Database, 2023b).

Table 3 – Top PCT Applicants (applicants with more than 10 PCT applications) in the world.

	Applicant's Name	Code	2018	2019	2020	2021	2022	2022-2018
1	Huawei Technologies Co., Ltd.	CN	5 405	4 411	5 464	6 952	7 689	2 284
2	Samsung Electronics Co., Ltd.	KR	1 997	2 334	3 093	3 041	4 387	2 390
3	Qualcomm Incorporated	US	2 405	2 127	2 173	3 931	3 855	1 450
4	Mitsubishi Electric Corporation	JP	2 812	2 661	2 810	2 673	2 320	-492
5	Telefonaktiebolaget Lm Ericsson (Publ)	SE	1 645	1 698	1 989	1 877	2 158	513
6	Guangdong Oppo Mobile Telecommunications Corp., Ltd	CN	1 042	1 927	1 801	2 208	1 963	921
7	Boe Technology Group Co., Ltd	CN	1 813	1 864	1 892	1 980	1 884	71
8	Nippon Telegraph And Telephone Corporation	JP	-	703	1 372	1 508	1 884	-
9	Lg Electronics Inc.	KR	1 697	1 646	2 759	2 885	1 793	96
10	Panasonic Intellectual Property Management Co., Ltd.	JP	1 465	1 567	1 611	1 741	1 776	311
11	Vivo Mobile Communication Co., Ltd.	CN	179	603	955	1 336	1 515	1 336
12	Sony Group Corporation	JP	1 342	1 566	1 793	1 789	1 513	171
13	Zte Corporation	CN	2 080	1 085	1 316	1 493	1 479	-601
14	Nec Corporation	JP	947	1 024	1 121	1 350	1 428	481
15	Robert Bosch Corporation	DE	1 525	1 687	1 375	1 213	1 290	-235
16	Microsoft Technology Licensing, Llc	US	1 476	1 370	1 529	1 303	1 271	-205
17	Lg Energy Solution, Ltd.	KR	-	-	-	548	1 186	-
18	Fujifilm Corporation	JP	962	1 158	1 128	1 095	1 181	219
19	Murata Manufacturing Co., Ltd.	JP	889	701	697	882	1 043	154
20	Sz Dji Technology Co., Ltd	CN	722	874	1 073	1 042	920	198

Source: compiled by the authors based on data from WIPO Statistics Database (2023a).

In the United States, the top PCT applicants from 2019 to 2022 included Qualcomm Incorporated, Hewlett-Packard Development Company, L.P., Microsoft Technology Licensing, Google Inc. LLC, and 3M Innovative Properties Company. Comparatively, the non-patent registration applications in the US were predominantly filed by the following technological sectors: computer technology (13.6%), medical technology (9.5%), digital communication (7.8%), pharmaceuticals (6.8%), and biotechnology (7.8%). Regarding foreign registration destinations in the United States, the primary locations were as follows: The European Patent Office (19.6%), China (17.8%), Japan (10.5%), Canada (7.1%), the Republic of Korea (6.5%), and others (38.5%) (WIPO Statistics Database, 2023c).

China has surpassed both Japan and the United States in terms of the number of applications filed by companies to register ownership of inventions, developments, and innovations between 2021 and 2022. Specifically, China's share increased from 23.65% in 2020 to 26.57% in 2022, while Japan's share decreased from 26.13% in 2020 to 24.36% in 2022. Furthermore, European Union (EU) countries are prominent among the top ten leaders in terms of the number of applications for innovations, inventions, and developments over the past five years. Notably, Germany accounted for 8.72% in 2018 and 6.56% in 2022, France accounted for 3.26% in 2018 and 2.64% in 2022, and Switzerland accounted for 1.78% in 2018 and 1.94% in 2022.

Other notable countries include Sweden, the Netherlands, and the United Kingdom. Collectively, the European countries' total share amounted to 15.52% in 2022, compared to 18.86% in 2018.

Table 4 – Countries - leaders in PCT Applicants (applicants with more than 10 PCT applications) in the world, units / %.

№	Year	2018		2019		2020		2021		2022	
	Total / share	150459	100	158362	100	172655	100	169494	100	175461	100
1	CN	29132	19,36	34722	21,93	40838	23,65	44704	26,37	46628	26,57
2	JP	41176	27,37	43143	27,24	45117	26,13	41511	24,49	42746	24,36
3	US	34809	23,14	33809	21,35	35946	20,82	35429	20,90	35434	20,19
4	KR	9134	6,07	10061	6,35	12085	7,00	12004	7,08	13685	7,80
5	DE	13125	8,72	13226	8,35	13673	7,92	11332	6,69	11515	6,56
6	FR	4906	3,26	4970	3,14	5043	2,92	4648	2,74	4624	2,64
7	CH	2675	1,78	2487	1,57	2841	1,65	3039	1,79	3397	1,94
8	SE	2754	1,83	2705	1,71	3057	1,77	2912	1,72	3060	1,74
9	NL	2981	1,98	2695	1,70	2696	1,56	2505	1,48	2458	1,40
10	GB	1935	1,29	1962	1,24	2268	1,31	2147	1,27	2173	1,24

Source: compiled by the authors based on data from WIPO Statistics Database (2023a).

In Asian countries, the largest share of Patent Cooperation Treaty (PCT) publications was observed in the following sectors: digital communication (9%), computer technology (8%), electrical machinery, apparatus, energy (8%), audio-visual technology (6%), medical technology (5%), and semiconductors (5%) during the period of 1995-2022 (Table 5).

Notably, there has been a noteworthy increase in the number of patents registered by these technology sectors, particularly between 2016 and 2022, where the numbers have doubled or even tripled compared to the period of 2011-2015. Additionally, significant growth in the number of patents has been observed in sectors such as measurement, telecommunications, and biotechnology.

Table 5 – Intellectual property right in Asia: PCT publications by technology, 1995 – 2022.

№	Field of technology	1995-2000	2001-2010	2011-2015	2016-2022	1995-2022
1	Digital communication	725	21000	38532	90698	150955
2	Computer technology	1603	20022	27589	86534	135748
3	Electrical machinery, apparatus, energy	2140	23061	36353	71900	133454
4	Audio-visual technology	2585	22913	19980	46973	92451
5	Medical technology	1264	13157	16392	42703	73516
6	Semiconductors	1167	15762	19525	36649	73103
7	Optics	1490	15378	17224	34802	68894
8	Measurement	1352	11897	13400	38459	65108
9	Telecommunications	1080	16308	14258	26148	57794
10	Transport	851	9270	14580	31732	56433
11	Pharmaceuticals	1960	14088	10178	23173	49399
12	Organic fine chemistry	3234	13471	8333	16310	41348
13	Biotechnology	1763	10473	6957	17545	36738
14	Other special machines	1136	7285	7965	18577	34963
15	Materials, metallurgy	1035	7538	8659	16971	34203

Source: World Intellectual Property Organization (2023).

In European countries, the largest share of Patent Cooperation Treaty publications was observed in the following sectors: electrical machinery, apparatus, energy (5%), transport (5%), medical technology (5%), measurement (4%), digital communication (4%), and pharmaceuticals (4%) from 1995 through 2022. Furthermore, patent activity in the EU countries showed gradual and stable growth from 2011 to 2022, with a peak in innovation activity occurring in 2000 across various sectors of technological activity. However, since 2011, there has been a slight decline. In comparison to Asian countries, Europe exhibits a lower level of innovation activity in various sectors.

Table 6 – Intellectual property right in Europe: PCT publications by technology, 1995 – 2022.

№	Field of technology	1995-2000	2001-2010	2011-2015	2016-2022	1995-2022
1	Electrical machinery, apparatus, energy	7111	24019	20050	28860	80040
2	Transport	6884	24905	17708	29384	78881
3	Medical technology	6764	25401	16328	28976	77469
4	Measurement	6360	22777	14089	21642	64868
5	Digital communication	4103	21720	14165	21313	61301
6	Pharmaceuticals	6513	25352	11551	17505	60921
7	Organic fine chemistry	8909	24708	10689	13468	57774
8	Computer technology	4001	21604	11464	18101	55170
9	Mechanical elements	5187	17521	12356	16750	51814
10	Engines, pumps, turbines	4552	16683	12747	15229	49211
11	Civil engineering	5519	16394	10512	14447	46872
12	Other special machines	5314	14919	9784	16742	46759
13	Handling	5534	15230	9397	14845	45006
14	Biotechnology	5580	17394	8731	13087	44792
15	Basic materials chemistry	5548	14204	8191	11448	39391

Source: World Intellectual Property Organization (2023).

In North America, the largest share of PCT publications was observed in the following sectors: computer technology (10%), medical technology (10%), pharmaceuticals (7%), digital communication (6%), biotechnology (5%), and measurement (4%). Unlike Europe and Asia, North America is characterized by its dominance in computer technology, medical technology, pharmaceuticals, biotechnology, and digital communications. This specialization in key sectors has positioned North America as the most competitive region in the digital age. Furthermore, patent innovation activities across various technological sectors of the economy are expected to intensify from 2016 to 2022. As noted by Schwartz (2019), the hegemony and leadership of the United States are partially attributed to its control over intellectual property held by American firms engaged in global production distribution. These firms have established commodity chains that allow them to capture a disproportionate share of global profits. This control contributes to maintaining the stability of the U.S. dollar as a national currency, despite persistent current account deficits and an increasing net international debt relative to the country's gross domestic product. Additionally, compliance with the trade-related aspects of intellectual property rights (TRIPS) and the dominant control of commodity chains within the United States further enhance the country's infrastructure power.

Table 7 – Intellectual property right in North America: PCT publications by technology, 1995–2022.

№	Field of technology	1995-2000	2001-2010	2011-2015	2016-2022	1995-2022
1	Computer technology	8493	43991	32015	49863	134362
2	Medical technology	13617	45395	26810	42518	128340
3	Pharmaceuticals	11331	33321	16340	28952	89944
4	Digital communication	4647	23691	17490	34219	80047
5	Biotechnology	11181	26027	11505	21065	69778
6	Measurement	6302	20072	11612	18055	56041
7	Electrical machinery, apparatus, energy	5923	19233	12713	16629	54498
8	Organic fine chemistry	8735	20550	8674	11949	49908
9	Basic materials chemistry	6328	14990	9396	10932	41646
10	Telecommunications	5380	17534	6241	9527	38682
11	Civil engineering	3229	11306	10708	13191	38434
12	Semiconductors	2826	14824	8992	11430	38072
13	Audio-visual technology	5292	13817	7336	10504	36949
14	IT methods for management	1413	12181	8769	11481	33844
15	Other special machines	4104	10403	6217	11668	32392

Source: World Intellectual Property Organization (2023).

It is worth highlighting that according to the latest data from the Organization for Economic Cooperation and Development, the percentage of foreign ownership of domestic inventions in 2017 was 18.3% (16.1% in 2020). Specifically, Japan accounted for 1.0% (0.8% in 2020), the United States accounted for 4.6% (4.5% in 2020), and the European Union accounted for 7.5% (data based on patent applications to the European Patent Office). Moreover, in 2017, the percentage of patents with domestic ownership of inventions made abroad was also 18.3%, with Japan accounting for 0.6%, the United States accounting for 4.1%, and the European Union accounting for 8.3% (data based on patent applications to the European Patent Office). These statistics indicate that in EU countries, foreign residents are more likely to own intellectual property invented by residents within the EU. The percentage of patents with foreign co-inventors in 2017 amounted to 8.3%, with Japan accounting for 0.5%, the United States accounting for 3.7%, and the European Union accounting for 5.3% (OECD, 2023, International cooperation in patents). This indicates a generally high level of competition among countries in the realm of intellectual property, which can potentially lead to trade and technological conflicts. In light of this, Malkin (2022) examines the trade and technology conflict between the United States and China, highlighting China's autonomy and influence in the global economy, which stems from its rapid economic growth. The author specifically identifies China's growing advantages in areas such as intellectual property protection and commercialization, the expansion of the global value chain, setting standards, and competition policies (Malkin, 2022). It is reasonable to agree with the conclusion regarding China's significant hidden productive capacity and its industrial and technological policies aimed at harnessing the country's structural potential.

The economic development processes in Asian countries, particularly China, naturally contribute to technological advancements and the establishment of institutions for intellectual property rights (IPR) protection. China's economic strength has fostered the emergence of technological advantages and a flourishing digital technology sector. From 1971 through 1980, China experienced an average annual GDP growth rate of 6.24%, followed by 9.35% in 1981-1990, 10.45% in 1991-2000, 10.57% in 2001-2010, and 6.95% in 2011-2021. In comparison, other countries and regions of the world exhibited lower

(around 3-3.5%) or moderate (4%-7%) economic growth rates. Europe, the Eurozone, and the EU, in particular, faced notably low growth rates since the early 2000s, prompting them to seek partner countries for stable economic growth and attract investments in high-tech sectors. China has emerged as a significant investor in the European economy, leading to the development of collaborations in the technology sector. It is noteworthy that Chinese venture capital (VC) investments have been directed toward European technology startups. In 2021, Chinese venture capital investment in Europe witnessed a remarkable increase, more than doubling to reach a record €1.2 billion. The primary focus of these investments was on the United Kingdom and Germany, with particular emphasis on sectors such as e-commerce, financial technology, gaming, artificial intelligence, and robotics. However, it is anticipated that China's foreign direct investment (FDI) in Europe will experience a decline in 2022 due to factors such as the government's stringent capital controls, reduced financial capital availability, and the ongoing impact of COVID-19-related restrictions (Rhodium Group and the Mercator Institute for China Studies, 2021).

Amidst China's robust economic growth, there has been a notable acceleration in its technological development. Over the past decade (2011-2021), the development of information and communication technology (ICT) has gained momentum globally, with China making significant strides in catching up with other countries in terms of ICT production and exports. From 2001 through 2010, the average share of ICT exports in China stood at 3.48%, while Central Europe and the Baltic States recorded 5.2%, Europe and Central Asia at 7.81%, the European Union at 8.59%, and the United States at 4.4%. However, in the subsequent period of 2011-2021, China closed the gap and surpassed other regions, with ICT exports reaching 11.61%. This signifies China's progress in outpacing the United States, as well as the countries of Central Europe and the Baltic States, in terms of ICT exports.

In revisiting the trade and technological conflict between the United States and China, it is noteworthy to highlight the significant competition that exists between the two nations in the realm of technology and intellectual property. This competition stems from their respective motivations to safeguard their domestic markets and assert influence in

political and economic spheres. However, it is important to acknowledge that strategic cooperation is also observed between the United States and China, which has fostered economic and cultural ties within China-US relations. This cooperative dynamic is particularly evident in their trade and investment interactions. China's accession to the WTO in 2001 has played a pivotal role in boosting bilateral trade between the two countries, surpassing a value of $120 billion (Moore & Button, 2020). In 2020, China emerged as the United States third-largest trading partner and the primary source of imports. Notably, the United States predominantly imported mobile phones, computers, and toys from China. Additionally, China continues to be the main contributor to the United States trade deficit. As of 2021, the total value of US trade in goods with China reached approximately USD 657 billion. This figure encompassed exports worth USD 151 billion and imports amounting to USD 506 billion, resulting in a trade deficit of roughly USD 355 billion for the United States (Statista, 2023a). Coca-Cola holds the distinction of being the first American company to enter the Chinese market in 1979. Subsequently, an increasing number of American businesses have integrated China into their commercial strategies. As of 2020, out of the 121 US companies listed on the Global Fortune 500, 94 were engaged in business activities in China (Statista, 2023a). In 2020, the United States recorded actual utilized foreign direct investment (FDI) worth USD 2.3 billion flowing into China. Conversely, China received approximately USD 6.02 billion of FDI from the United States (Statista, 2023a). Moving to 2021, China maintained its position as the third-largest trading partner of the United States concerning merchandise exports, amounting to $151.1 billion (Statista, 2023b). Furthermore, in terms of merchandise imports, China ranked as the largest trading partner for the United States, with imports totaling $506.4 billion (Statista, 2023c). In 2021, the United States maintained its position as the largest market for China's exports. China's exports to the United States reached a value of over 3.7 trillion yuan, representing a notable increase of approximately 19% compared to 2020 (Statista, 2023d). Conversely, the United States faced a trade deficit with China, with imports from China exceeding exports to China by approximately $355.3 billion in 2021. Additionally, Chinese direct investment in the United States amounted to around $7.2 billion in 2020, with a particular focus on the consumer goods and services sectors, which accounted for approximately $1.6 billion of Chinese direct investment (Statista, 2023e).

Despite the increase in trade volume between the United States and China, tensions have emerged due to divergent national policies aimed at safeguarding their respective interests, particularly in the areas of intellectual property (IP) rights protection and trade. The onset of the trade war in 2018 exacerbated these tensions. To protect US intellectual property, the Trump administration implemented protectionist trade measures. In May 2019, the administration imposed a ban on US companies collaborating with Huawei, a prominent Chinese multinational telecommunications and electronics firm, citing concerns over alleged espionage and IP theft (Damian, Nakashima & Lynch, 2019). In June 2019, restrictions were imposed on collaboration with five prominent computer companies: Chengdu Haiguang Integrated Circuit, Chengdu Haiguang Microelectronics Technology, Higon, Sugon, and Wuxi Jiangnan Institute of Computing Technology. These measures were implemented due to apprehensions that these companies were utilizing their technologies for military applications (Jenny & Donnan, 2019). Hence, the policy pursued by former President D. Trump aimed at imposing economic restrictions and curtailing the "advancement of Chinese high technology to Europe and the United States." Chen, Chen & Dondeti (2020) assert that "the trade war is not merely about trade but rather about technological supremacy, and both sides could potentially succumb to the 'Thucydides trap'—a scenario where a rising power challenges a dominant one." This argument finds support in the recently published US National Security Strategy, unveiled by the White House on October 21, 2022, which designates China as "the most significant geopolitical challenge," underscoring an intensified strategy to counter China by fortifying alliances with partner nations. In light of these developments, there has been a shift in the approach of the J. Biden administration's policy towards China in recent years. E. Blinken emphasized, "Even as President Putin's aggression persists, we will maintain our focus on the most significant long-term challenge to the international order, and that is the People's Republic of China. China is the sole nation with intentions to reshape the international order and possesses increasing economic, diplomatic, military, and technological capabilities to achieve that goal. Beijing's vision would diverge from the universal values that have underpinned much of the world's progress over the past 75 years" (Blinken, 2022). The United States acknowledges China's growing international

influence and its aspirations for leadership in the Asian region. However, the United States also recognizes the potential threat posed by China, particularly due to its close relationship with Russia. As highlighted by Ciuriak (2021), innovation and the protection of intangible assets generated through innovation have emerged as the primary focal points in the trade and technology conflict between the United States and China, which is increasingly drawing involvement from third countries.

Building upon the political trajectory set by the previous administration of D. Trump's confrontational stance towards China, the Biden administration initially embarked on a policy restructure that aimed to incorporate elements of "competition" and "cooperation" (the three Cs). However, in practice, the Biden administration has primarily emphasized competition, specifically "strategic competition." Consequently, bilateral cooperation between the United States and China has been scaled back, while global powers continue to vie for leadership on the global stage, particularly in the domains of technology and innovation.

Mr. Blinken's speech aligns with the ongoing US strategy for the forthcoming decade, emphasizing "investment, coordination, and competition." As articulated by A. J. Blinken (Blinken, 2022), "We will allocate resources to enhance the fundamental elements of our national strength - our competitive edge, our capacity for innovation, and the robustness of our democratic institutions. We will synchronize our endeavors with our network of allies and partners, working collectively towards shared objectives. Through the strategic deployment of these two crucial assets, we will engage in competition with China, safeguard our interests, and shape our envisioned future."

Conclusion

The expansion of cross-border payments and the generation of revenue through intellectual property utilization across different nations underscore the significant potential of technology sectors in the digital era, thereby influencing both competition and cooperation among global leaders. The composition and dynamics of intellectual property across various types and regions highlight the dominance of China and the United States in this realm, giving rise to numerous economic and legal complexities concerning technology transfer and protection in the digital age. On one hand, intellectual property facilitates the exchange of knowledge and technology while fostering trade growth.

On the other hand, it intensifies competition among global technology hubs and necessitates stronger safeguards for intellectual property rights. Economic challenges are inherently intertwined with legal challenges and subsequently amplify social tensions, prompting the need to fortify political frameworks for the protection of intellectual property rights. Based on the analysis of intellectual property dynamics, recent years have witnessed an upsurge in cross-border payments and revenues derived from intellectual property, albeit with limited levels of cooperation among prominent global regions.

This trend signifies the notable competitive advantage held by the United States, the European Union, and China. Despite the US hegemony and leadership in intellectual property, supported by protective policies and the control exerted by American firms, China is progressively realizing its technological potential through heightened patent activities within its business landscape. Although China, Japan, the United States, and Korea currently stand as frontrunners in terms of the share of Top PCT Applicants in 2022, China is gradually emerging as a leader in the field of intellectual property.

The leadership of a country is established through the innovative endeavors of companies operating in the innovation and technology sector, with a notable dominance of firms engaged in mobile technologies. In recent times, China has surpassed both Japan and the United States in terms of the number of applications submitted by companies seeking

to secure ownership rights over inventions, advancements, and innovations. Consequently, the United States acknowledges China as its primary geopolitical rival, specifically within the realm of innovation. As a result, these two nations persistently vie for global leadership, particularly in the technology and innovation sectors.

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