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A significant undertaking in the realm of central bank currency exchange is the mBridge project (stakeholder: PRC), which attained the minimum viable product (MVP) stage in 2023. In Russia, even at the stage when there was a threat of the Russian Federation being disconnected from SWIFT, the creation of an alternative payment system based on a new technological platform was discussed at a high political level. This article analyzes the potential for Russia to develop its own initiative, with a particular emphasis on technological and digital sovereignty. It also assesses the viability of options for the advancement of the Chinese mBridge initiative. Furthermore, an expert assessment is provided of the potential conceptual impact of the integration of such projects on the existing global financial infrastructure. This includes an analysis of attempts to abandon the established international monetary system and significantly rebalance the political influence associated with it.

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Digital education has gradually become a strategic topic in current cooperation in international education. In this paper, after analyzing the international digital education landscape, we highlight the fact that cooperation in digital education helps to improve the educational welfare of BRICS countries and elaborate on the content of such cooperation. Based on this, it is proposed that BRICS digital education cooperation should focus on top-level design at the governmental level, with schools at all levels playing a key role, think tanks and research institutions providing scientific support, enterprises promoting the construction of digital infrastructure, and BRICS countries strengthening their digital education resource assistance.

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The article systematizes six decades of the development of semiconductor technologies, with an emphasis on the global dominance by the United States. The report presents an overview of the current state of this segment of the global economy in its most competitive domain, namely the value chain for the chips utilized in artificial intelligence and mobile devices. This study places particular emphasis on the competition between the US and China in the production of microchips for artificial intelligence in the context of their geopolitical confrontation, growing expectations for AI, and inflated market capitalizations. The analysis provides a consistent examination of the development strategies of the semiconductor industry in four key jurisdictions: the US, China, Taiwan, and the European Union. The article concludes with an analysis of the mounting competition and efforts by the major global actors to establish a presence in the world's most promising market.

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Inequality in the European Union in the First Quarter of the 21st Century: Nontrivial Tendencies

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Abstract

The article demonstrates the disparity of economic growth in the European Union from 2000 to 2023. Countries within the European Union are divided into three geographical and historical groups: the North, the South, and the East. The post-socialist East has considerably narrowed the gap in GDP per capita at PPP (in constant 2021 prices) with the South, thereby generating an overall convergence in per capita GDP levels across the EU. At the same time, the noticeable growth in the East group countries has been accompanied by a decline in population. The gap between the North and the rest remained, as did significant variation in country levels, although it narrowed compared to the period of large-scale EU

expansion. Concurrently, all groups exhibited a decline in performance relative to the US benchmark during the period under review.

The article also researches changes in the income levels of social groups within countries. This phenomenon suggests a consolidation of the economic dominance of the wealthiest (10 decile) of the population. In this case, disparities among country groups in the scale of tax redistribution of income exert a substantial influence on this phenomenon. Moreover, differences between country groups in the scale of tax redistribution of income have a significant impact on this: it is greatest in the developed North, less in the South, and even less in the East. The specific nature of redistribution, in conjunction with disparities in pre-existing conditions, has resulted in a discernible convergence of income levels among the affluent 10th decile in Eastern countries and its corresponding group in Southern countries. Upon initial observation, the parameters of convergence among EU countries appear to defy expectations. It is evident that the convergence process is more pronounced among the affluent segments of society compared to the overall population or the nations as a whole.

Introduction

More than 20 years have passed since the large-scale expansion of the European Union.[1] During this period, the development of the EU in the 21st century has been focused on addressing significant strategic objectives, including the consolidation and integration of a growing number of countries, as post-soviet states joined the EU.[2] This expansion resulted in a notable increase in inter-country income inequality, as the level of economic development among the fundamental EU members significantly surpassed that of the new member countries. The present study focuses on the economic growth of EU countries and the convergence of their levels of development. The investigation encompasses the analysis of the economic growth of EU countries from 2000 to 2023, as reflected in the income dynamics of various social groups. The countries are divided into three historical and geographical groups: the North (comprising the highly developed economies of Europe), the South (consisting of Mediterranean countries), and the East (comprising the post-socialist developing economies of European countries). The primary objective of the present study is to undertake a comprehensive analysis of income inequality, employing the GDP per capita in PPP terms (in 2021 prices) as the primary metric.

The initial section delineates the prevailing contemporary theories and approaches employed in the study of inter-country inequality and the issues associated with catching-up development. The works of T. Piketty and R. Solow are of particular value to us. The

[1] In 2004, Hungary, Cyprus, Latvia, Lithuania, Malta, Poland, Slovakia, Slovenia, the Czech Republic, and Estonia (the "Eastern Bloc" countries are highlighted) joined the EU. Bulgaria and Romania joined in 2007, followed by Croatia in 2013.

[2] 15 countries: Austria, Belgium, United Kingdom (until 2020), Germany, Greece, Denmark, Ireland, Spain, Italy, Luxembourg, the Netherlands, Portugal, Finland, France, Sweden.

article discusses, among other things, the concept of sigma convergence of income based on Solow's theorem, as well as the effects of tax redistribution noted in Piketty's book *Capital in the Twenty-First Century*. The second section delineates the methodology employed in the present study, while the third and fourth sections analyze the dynamics of inter-country (average income) and intra-country (share of income before and after taxation) inequality in the 21st century according to the authors' calculations for three historical time periods: 2000–2008, 2009–2019, and 2020–2023. The initial period, despite concluding with the global financial crisis of 2008–2010, was unmistakably a period of "success" accompanied by intense economic growth in the EU. The subsequent years were marked by the complication of global regulation, a slowdown in growth, and low inflation. In the 2020–2023 period, the global economy, and to a significant extent the European Union, encountered substantial macroeconomic turbulence, precipitated by the repercussions of the ongoing pandemic and a precipitous deterioration in the global geopolitical landscape. The present study analyzes the EU's relative lag in development compared to the US by breaking it down into the three country groups mentioned above. Additionally, it considers the issue of convergence between EU countries in terms of their level of development.

In the final section, we recommend analyzing the income dynamics of the wealthiest 10th decile of the population. This is significant for two reasons. Firstly, it is essential for evaluating inequality itself. Secondly, it is crucial for comprehending the role and position of social inequality in the development and performance of the European Union over the past two decades.

1. Intercountry inequality: Contemporary approaches

We propose a comprehensive examination of contemporary theories that explore the underlying causes and dynamics of international and income inequality. This examination will utilize the European Union as a case study, focusing on its development in the current century. We will not undertake a comprehensive examination of the foundational works of the Industrial Revolution of the 18th–19th centuries, which were authored by D. Ricardo, K. Marx, F. Engels, M. Weber, and other prominent scholars in the field. In the post-war period, American scientist S. Kuznets summarized empirical data on economic growth and inequality and put forward a hypothesis about the growth of inequality in countries in the early stages of economic development and its decline as income grows further (Kuznets curve) [Kuznets 1955]. A multitude of issues pertaining to growth are thoroughly discussed in the work of M. Doroshenko [2013]. The evolution of theoretical ideas about inequality is outlined in our 2022 publications: on inter-country inequality in Chapter 1 [Grigoryev, Pavlyushina 2022a] and on social inequality in Chapter 14 [Grigoryev, Pavlyushina 2022b]. In the recent past, these issues were revisited in a study on the specifics of economic growth [Grigoryev, Maykhrovich 2023]. Additionally, we will draw on recent research [Grigoryev, Lyakhova 2025] that explores the factors contributing to the European Union's lag behind the United States.

Conventional economic theory utilizes empirical analysis of long-term economic growth through structural changes occurring in the economy, accounting for variations

in the profitability of different areas of activity (low- and high-productivity sectors of the economy) [Kuznets 1955]. In response to the limitations of the Harrod–Domar model (1939, 1946) [Solow 1956], Solow proposed a neoclassical growth model. Solow conceptualizes economic growth as contingent upon capital intensity, population growth rates, and technological progress. The conclusion from the model that countries with the highest economic growth rates are far from equilibrium, according to Solow (points of stationarity at which capital intensity is constant), is useful for our purposes [Solow 1956]. This finding suggests that developing countries may experience higher economic growth rates compared to developed countries. Consequently, the conclusions derived from Solow's theorem served as the foundation for the assumption of income convergence in both developed and developing countries. Contemporary economists have proposed two types of such convergence: As posited by Paprotny (2021), the phenomenon of "sigma and beta convergence" merits consideration. The first scenario suggests a gradual equalization over time (i.e., a reduction) of the dispersion of income logarithms between developing and developed countries, while the second scenario pertains to the problem of catching up: poor countries with higher economic growth rates catch up with developed countries, reducing income gaps [Maykhrovich 2025 (in press)]. Despite employing Barro's methodology, which incorporates the smoothing of intra-cycle growth fluctuations, the analysis reveals the presence of "beta effects" that are modest in strength for 147 countries during the period from 1992 to 2022 [Maykhrovich 2023]. The Solow theorem, in its own right, as well as the concepts of convergence derived from it, are valid and can be applied within a large regional association. It is important to acknowledge the significant impact of institutional factors on development inequality, in addition to capital and technology [Grigoryev, Lyakhova 2025].

F. Bourguignon and K. Morrison conducted an analysis of the dynamics of intra-country and inter-country inequality for 33 groups of countries aggregated into six regions from 1820 to 1992. Their findings demonstrated that historical and geographical differences between countries influence income distribution [Bourguignon and Morrison 2002]. They demonstrated that since the onset of the 19th century, global inequality has been predominantly influenced by disparities among nations, a consequence of prolonged imbalances between geographical regions (recall the phenomenon of European colonialism). Building upon the contributions of Bourguignon and Morrison, Milanovic initiated an examination of the global inequality structure across income groups. In doing so, they presented the scientific community with the "The Elephant Curve" a graph depicting income growth by global percentiles [Lakner and Milanovic 2013]. It is imperative to acknowledge that the pivotal element in Milanovic's Curve paradigm pertains to the "Asian phenomenon," particularly China. A more thorough examination of the "Chinese phenomenon" can be found in our other articles [Grigoryev, Zharonkina 2024; Zharonkina 2025 (in press)].

Piketty's primary focus is on the growth of inequality within countries during the late 20th century and early 21st century, which contradicts Kuznets' hypothesis of a reduction in inequality with income growth [Piketty 2014]. Piketty expounded on the proliferation of income inequality within nations, attributing this phenomenon to higher returns on capital relative to economic growth rates. This dynamic, he posited, culminates in

the accumulation of wealth by the affluent segments of society. Piketty's approach to addressing inequality involves the redistribution of income from high-income groups to low-income groups by the state, facilitated by a progressive tax scale. Subsequently, it will be demonstrated that taxation exerts a substantial influence on income redistribution within the European Union.

One impediment to the alleviation of social inequality is the limited mobility of the population between social classes. A discernible distinction emerges among the various groupings of countries. Anglo-Saxon countries are distinguished by pronounced vertical social mobility, while Europe is marked by a more rigid social stratification. According to the observations of the American economist A. Krueger, social inequality will be more stable in countries with a stricter social hierarchy than in countries with free movement between social classes [Krueger 2012]. This notion is corroborated by calculations based on The Great Gatsby curve, which illustrates the relationship between inequality and intergenerational social mobility [Corac 2013].

It is evident that the scientific community has persistently endeavored to ascertain empirical evidence substantiating the efficacy of theorems in mitigating inequality. Given their status as established principles, these theorems are presumed to be true. The actual situation is more intricate. Sophisticated econometric methods occasionally enable the identification of effects that mitigate the disparity between countries. However, these effects are challenging to observe in practice and in conditions of macroeconomic instability. Goal 10 of the United Nations Sustainable Development Goals, entitled "Reduce inequality within and among countries," is notable for its lack of specific metrics or target indicators. In principle, the theories formulated in the mid-1950s should have demonstrated their efficacy with relative clarity over the past seven decades. However, the stylized facts reveal no such evidence [Grigoryev 2025].

To conclude this brief review of the literature, we note a relatively new work [Blanchet et al. 2022]. This is an extensive statistical study of inequality in the European Union (EU) compared to the United States (US) for the period 1980–2017, covering many types of redistributed income (pensions, unemployment insurance, etc.). Notably, the authors employ country groupings within the European Union that are analogous to those utilized in this study. Their calculations extend from 1980 onwards, yet there is a conspicuous absence of any reference to the transformation associated with the transition to a market economy in Eastern Europe. However, the turning point in the graphs around 1990 is evident in the literal sense of the word.

2. Grouping of countries within the EU

The scientific community has developed a multitude of approaches for the classification of EU countries. For instance, a conditional division into the "fundamental" and "new" EU [Grigoryev, Golyashev, Pavlyushina 2017] or a geographical division into the North, the South, and the East [Grigoryev, Popovets 2023], etc. Quantitative methods can exhibit significant variability; however, they are predominantly rooted in cluster analysis, which involves the classification of EU countries into convergence clubs [Suárez-Arbesú, Apergis, and Delgado 2023], the implementation of clustering based on per capita GDP,

with the objective of maximizing the distances between cluster centers for the base year [Grigoryev and Pavlyushina 2022a], and other approaches. In addition to per capita income, the studies utilize groups of indicators, including the openness of the economy, the share of the service sector, financial market development indicators, labor market indicators, demographic indicators, and the quality of human capital. The correlation between these indicators and income inequality, including in EU countries, has been substantiated in prior studies [Perugini and Martino 2008; Roine et al. 2009; Huber and Stephens 2014, etc.].

The absence of ideal classifications in the field necessitates an examination of the behavior of economies with divergent historical backgrounds, levels of development, and quality of socio-economic institutions during the period under review. The objective of this study is to examine the dynamics in modern conditions, specifically in the 21st century. It is important to note that the year 2000 was selected as the starting point, as the European Union was significantly less "populated" at that time compared to the present. The present study utilizes arithmetic means, which are influenced by individual countries with elevated or diminished parameters. However, this does not substantially alter the conclusions' intrinsic nature.

The present study focuses on comparing three groups of countries within the European Union (EU): the North, the South, and the East (see Table 1 on p. 11 and Appendix A). As a tool for analyzing economic inequality between groups and countries, we use GDP per capita in PPP terms at constant 2021 prices (international dollars per capita), calculated by the World Bank in May 2024 [World Development Indicator Database 2024]. Hereinafter, we use this parameter to refer to per capita income. The efficiency of this instrument has been previously documented in the research, which examined the global landscape of price inequality in 2017 [Grigoryev, Pavlyushina 2022a]. Given the limited sample size and heterogeneity of the EU (n = 27), we aggregated the per capita incomes of the groups. The following three periods of the 21st century are presented: the pre-crisis period of 2000–2008, the EU debt crisis and subsequent economic recovery of 2009–2019, and the era of four macroeconomic shocks [Grigoryev 2023] to the global economy in 2020–2023. The results obtained graphically are shown in Figure 1 (p. 13).

Table1. Economic indicators of country groups within the EU, 2000–2023

Group	Average annual GDP (PPP, 2021 prices) growth rate, %			Government expenditures on education and healthcare, % of GDP				Average GDP (PPP, 2021 prices), thousand international dollars per capita			
	2000–2008	2009–2019	2020 – 2023	2000	2008	2019	2023	2000	2008	2019	2023
The North	1.3	1.5	1.6	10.9	12.9	12.2	12.4	51.2	57.8	64.7	6.3
The South	1.0	0.6	3.2	10.6	11.7	10.7	11.5	43.8	47.8	48.5	50.1
The East	4.7	3.1	3.2	10.0	10.8	10.2	10.7	18.8	28.4	38.3	42.2

Source: compiled by the authors based on data from the World Bank and Eurostat. Country parameters are provided in Appendix A.

The Northern region constitutes the pre-World War I industrial core of Europe. The following countries were selected for further analysis: Austria, Belgium, Germany, Denmark, Finland, Ireland, Luxembourg, the Netherlands, and Sweden. The per capita GDP in 2000 (rounded) for these countries ranged from $48,000 to $57,000 PPP/capita, with an average of $51,200. The northern group is predominantly composed of mature economies, characterized by lower average growth rates compared to the other two groups. However, these economies exhibit greater stability in their GDP, the highest share of government spending on human capital, and a progressive tax scale, with the average marginal income tax rate being the highest among the groups. It is noteworthy that the proportion of R&D expenditures to GDP in the North exceeds the EU average [Grigoryev, Lyakhova 2025]. The northern countries constitute the economic and demographic core of the EU, with Germany, the EU's largest industrial economy, playing a pivotal role (22% of EU GDP in 2023). Prior to the United Kingdom's exit from the European Union in 2020, Germany and the United Kingdom collectively accounted for over one-third of the bloc's GDP and population, thereby concentrating the Union's economic potential.

From 2000 to 2023, the North demonstrated a marked enhancement in its economic performance, attaining an average GDP per capita of $66,000 in PPP terms. However, it is imperative to note that this calculation encompasses the exceptional performance of Ireland and Luxembourg (see Appendix A). In fact, this most developed group of countries managed to maintain its position, although it lagged behind the US in terms of growth rates (see Appendix A).

The Mediterranean group, also referred to as the South, encompasses eight nations: Greece, France, Spain, Italy, Portugal, Croatia, Malta, and Cyprus have a GDP in 2000 ranging from $21,000 to $51,000 per capita, with an average of $44,000. Within the southern group, France, Italy, and Spain are the most economically significant countries. The economies of the Southern countries were at the epicenter of the 2010 European debt crisis. Consequently, a decline in average annual GDP growth rates for the group was observed even prior to the advent of the pandemic. This dynamic resulted in a state of stagnation in the southern region with respect to the population's overall well-being. This group has a higher share of services (e.g., tourism), which led to a deeper crisis during the pandemic in 2020 [Grigoryev et al. 2021].

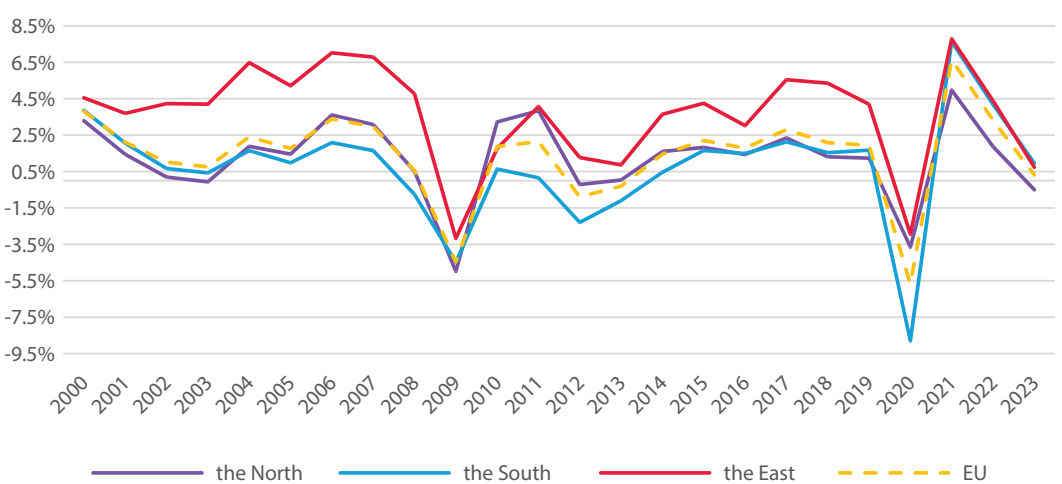
A rigorous examination of the circumstances reveals that the situation in the South group is of a dramatic nature. The region experienced a significant impact from the global financial crisis of 2008–2010, which originated in the European Union and subsequently spread to southern countries. This was followed by the global COVID-19 pandemic and the subsequent economic crisis of 2022. This phenomenon can be attributed, in large part, to the prevailing economic vulnerabilities of the nations within this group. These vulnerabilities encompass a range of issues, including the presence of negative current accounts, significant losses in income from Mediterranean tourism, mounting pressures from external migration, and the escalating burden of public debt. The average GDP per capita exhibited a modest growth of $44,000 to $50,000 PPP during the period under review. Concurrently, the economic disparity with the donor North region increased. Indeed, the slow growth of this group of countries (which account for 45% of the EU

population) with greater weight hindered the European Union during this period.

The Eastern European countries, otherwise known as the East, represent the third group of EU countries. These countries have a rich historical tapestry, having been part of the Eastern European empire, the socialist camp, and even the USSR. The countries in this group include Hungary, Poland, the Czech Republic, Slovakia, Slovenia, Romania, Latvia, Lithuania, and Estonia. In 2000, the average income in this region ranged from $20,000 to $31,000 PPP, with an average of $19,000. Following the implementation of an eastward expansion policy in the early 21st century, countries with transitional economies became members of the European Union. Presently, this demographic constitutes approximately one-fifth of the total population of the European Union.

The 21st century has been a noteworthy era for Eastern countries, characterized by their progress in the post-socialist transformation. Eastern countries have largely preserved their human capital as part of their planned economy legacy and have made a relatively smooth transition to a market economy with the help of the EU. This assertion is substantiated by the dynamics of per capita income, which is exhibiting the most rapid growth in comparison to the other two EU groups. Prior to the 2008 economic crisis and even preceding the European Union's accession in 2004, income exhibited particularly rapid growth.

Figure 1. GDP per capita income growth rates by country group, based on GDP per capita (PPP, constant 2021 prices), as a percentage of the previous year, 2000–2023



Source: compiled by the authors based on World Bank data.

Their growth trajectory commenced from a modest initial level and, by the year 2023, had attained an average of $43,000 per capita in PPP terms. However, this economic development did not fully counterbalance the impact of the South's persistent underperformance. The scientific community attributes this growth to Eastern European countries' ability to capitalize on economic and political integration with the

EU. The successful integration of the Baltic states (Latvia, Lithuania, and Estonia) has been documented [Dabrowski 2022]. In countries such as Poland, the Czech Republic, and Slovenia, the extent of inherited structural distortions in the planned economy was comparatively less pronounced compared to other post-socialist nations. This advantageous condition facilitated the implementation of rapid and consistent reforms with greater efficacy [Dabrowski 2024]. The challenges associated with market transformation in other Eastern European countries are examined in the works of Dabrowski et al. (2025) and Dabrowski (2023). Specifically, the failed attempts to establish stable and democratic institutions in Moldova, Georgia, Azerbaijan, and other regions are highlighted.

The alteration in the weights and roles of the three groups within the bloc is both a question of the growth of the bloc as a whole and of the distributional effects of integration—whether there is convergence between the members of the union. A comparative analysis of EU economic growth in relation to that of the US will be conducted, with particular attention to the dynamics exhibited by the three aforementioned groups. This approach is instrumental in elucidating the distinctive characteristics of transatlantic competition, a subject that is further explored in [Grigoryev, Lyakhova 2025]. In the present analysis, the focus is directed toward the countries that contribute most significantly to the EU's GDP and population: Germany (the North), Italy, France (the South), Poland, the Czech Republic (the East).

3. Intercountry inequality in the EU—dynamics by period

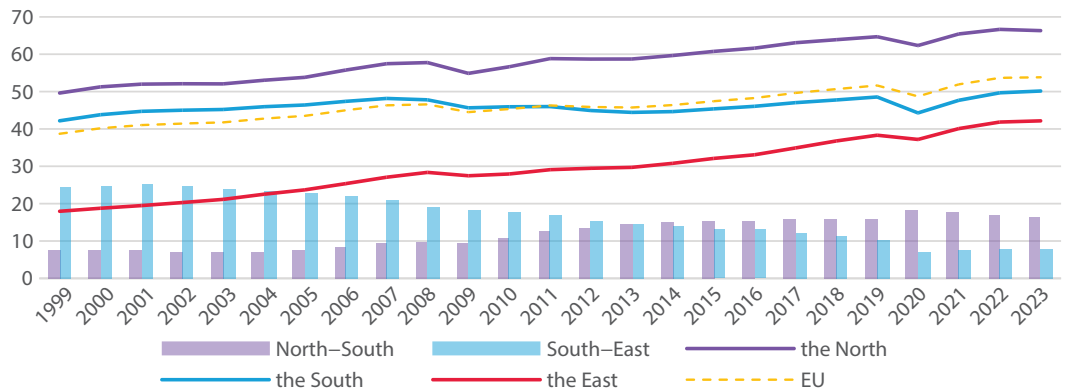
The dynamics of intercountry inequality reflect both the collective and individual successes of countries in their development and, concomitantly, indicate trends toward convergence or the absence thereof. At the beginning of the 21st century, the North and South began from relatively equal levels of per capita income (2000: the South lagged behind the North by $7,400 PPP). The disparity in income between the East and the old EU countries has reached unprecedented levels in the 21st century (in 2000, the gap was $25,000 PPP per capita). Prior to the global financial crisis of 2008, all three regions experienced income growth. However, the South lagged behind the North due to the higher base in the North, while the East rapidly caught up, exhibiting a significant increase in income (by 2008, the income gap between the North and the South was $10,000 per capita; between the South and the East, it was $19,400 per capita).

During the global crisis of 2008, the North experienced a steeper decline than the other groups (see Figure 2 on p. 15). However, the economies of the Southern states were adversely affected by the 2010 debt crisis and did not fully recover before the advent of the pandemic caused by the COVID-19 pandemic (See Table 1 on page 11). In contrast, the Northern and Eastern regions demonstrated a robust recovery from the repercussions of the crises, as evidenced by their swift return to pre-crisis levels in 2014. The divergent behaviors exhibited by the North and South groups at this stage confirm the rationale behind the division of the "old" EU and underscore the heterogeneity of the bloc.

In the future, per capita incomes in the East and the South converged even more. Since 2013, per capita income in the East has surpassed that of Croatia, Greece, and Portugal, with the gap widening since 2015 and 2020, respectively. By 2019, the Czech Republic's

per capita income had surpassed that of Spain, and it was now converging with that of France. The hypothesis that there is a trend between the North and the South is invalid; the data show that none of the southern countries (with the exception of the island of Malta) exceeds the income of a northern country (see Appendix A).

Figure 2. GDP per capita (PPP, 2021 constant prices), thousand international dollars, by EU country group, 2000–2023



Source: compiled by the authors based on World Bank data.

The robust economic foundation of the North was established in part during the 20th century, as evidenced by the data presented in Table 2 on p. 16. To that end, the present study has examined historical data on GDP per capita in PPP terms in 2011 prices [Madisson Project Database 2023]. It is evident that the Northern region exhibited higher mean incomes during the 20th century, with the distribution maintaining its integrity throughout the century. While in 1900 the disparity in per capita income between the North and the South was 36% of the North's income, by 1980 the difference had narrowed to 33%. In the 21st century, however, a different dynamic emerged. This outcome is noteworthy, as it suggests that, despite the numerous challenges faced during the 20th century, the Southern region possessed the capacity to achieve economic convergence with the Northern regions. However, the debt crisis of 2010, which had the most significant impact on Southern countries, led to a deviation from this trend. The crisis resulted in either a stagnation or a perpetuation of the economic disparity between the Southern and Northern regions. In the 20th century, there was a notable convergence between the East and the South. As illustrated in Table 2, the ratio of the income disparity between the groups to the income of the South remained at 20% throughout the 20th century. The 1990s witnessed a transformational crisis in the countries of the East, accompanied by a marked increase in the gap. However, by 2023, the data indicates a reversion to previous values. This development signifies a substantial accomplishment for Eastern European countries, which have capitalized on the human capital accumulated during the socialist era and the benefits of a sizable regional market characterized by comparatively lower initial wages.

Table 2. GPD per capita (PPP) in European countries in the 20th century (in 2011 prices) and in the 21st century (in 2021 prices), thousand international dollars/capita

Country	GDP per capita (PPP, 2011 prices)				GDP per capita (PPP, 2021 prices)	
	1900	1938	1950	1980	2000	2023
Germany	4.8	8.0	6.2	22.5	50.3	63.6
United Kingdom	7.6	10.0	11.1	20.6	44.9	54.5
Spain	2.7	2.6	3.5	14.0	27.0	34.1
France	4.6	7.1	8.3	23.5	33.4	39.1
Italy	3.3	5.0	5.6	21.0	32.7	36.2
Czech Republic	-	-	-	12.3	17.1	32.2
Poland	2.7	3.5	3.9	9.1	12.7	32.5
The North	**4.5**	**7.2**	**8.6**	**22.0**	**51.2**	**66.3**
The South	**2.9**	**4.4**	**4.0**	**14.8**	**43.8**	**50.1**
The East	**2.3**	**2.9**	**3.1**	**12.3**	**18.8**	**42.2**
Δ1 (Δthe North – the South)	1.6	2.8	4.6	7.2	7.4	16.2
Δ2 (Δthe South – the East)	0.6	1.5	0.9	2.5	25.0	8.0
Δ1/the North	36%	39%	53%	33%	14%	24%
Δ2/the South	21%	34%	23%	17%	57%	16%

Source: compiled by the authors based on data from the University of Groningen (20th century) and the World Bank (21st century).

The occurrence of sigma convergence within each group and across the entire European Union (EU) can be ascertained through the evaluation of income dispersion within these groups. By 2019, the coefficient of variation within the North had fallen to a threshold level of 33.3%, yet this does not permit the designation of the North as homogeneous. The group remains characterized by a considerable degree of data dispersion in comparison to the rest. During the period of the ongoing global pandemic and the energy crisis that began in 2022, the group lost its momentum toward convergence (see Appendix A). It is only in 2018 and 2019 that the North group can be considered to be statistically homogeneous; therefore, it can be assumed that sigma convergence is absent in the North group. This phenomenon can be attributed to the remarkably high per capita incomes observed in Luxembourg and Ireland, which serve to amplify the variability within the data set.

The South exhibits distinct characteristics from the North, manifesting in its low and declining variation coefficients. The indicator demonstrated a decline from 25.0% in 2000 to 16.1% in 2023. It has been observed that per capita incomes in the South are converging, which suggests that the group is becoming moderately homogeneous. Convergence is observed due to the levelling of indicators in the lagging countries of Croatia, Malta, and Portugal, accompanied by a slowdown in the growth rates of the leading countries in terms of per capita income—Italy, France, and Spain.

The most significant fluctuations in the dynamics were observed in the eastern region, where the variation decreased from 31% in 2000 to 11% in 2023. A discernible convergence has emerged among European countries that emerged from the Russian and Austro-Hungarian empires. The sigma convergence of per capita income by 2023 is attributable to a slowdown in income growth in the leading Czech Republic and its convergence with Slovenia, Lithuania, and Poland, which are demonstrating catch-up growth. In this group, the most important trend is catching up—approaching the countries of the South while maintaining distance from the group of the North. Recent developments indicate that Eastern countries are beginning to demonstrate comparable levels of progress with Southern countries on an individual level, particularly in the case of Slovenia, Lithuania, and the Czech Republic.

A notable decline in the coefficient of variation, from 56% in 2000 to 40% in 2023, signifies sigma convergence within the EU-27. While we do confirm the persistent heterogeneity, it would be premature to assume otherwise. Difficulties in achieving income convergence within the EU compared to the US remain [Grigoryev, Lyakhova 2025]. Following the accession of the Eastern EU member states, the coefficient of variation increased by 2008. However, by the second major crisis of the 21st century, it had stabilized at a minimum of 40% by 2019.

Despite the declining coefficient of variation, it is premature to conclude that inter-country inequality in the EU-27 has decreased over the past 23 years. A salient division of the EU into a "rich" North and a converging South and East can be noted. In order to illustrate the impact of EU enlargement on the convergence of member states in terms of per capita income, a calculation of the variation in per capita GDP was conducted for the EU-15: 15 countries in the North (excluding the UK) and the South (excluding Croatia and Cyprus, which joined later). The economic development of the "old" EU—the central bloc of developed countries—was fairly stable during the period under review. Average GDP per capita grew from $47,400 to $57,300 in PPP terms between 2000 and 2023. The coefficient of variation for the "fifteen" remained stable at 38% over two decades, with the exception of the post-crisis year of 2021. This finding suggests that the overall proportions within the original core of the EU have remained constant within the expanded bloc (see Appendix A).

Given the recent salience of the issue of the widening economic gap between the EU and the US, the key points in this saga of transatlantic competition for prosperity will be highlighted. It is evident that key European Union countries have experienced a substantial decline in their performance relative to the United States, particularly during the period following the global financial crisis that transpired from 2008 to 2010. Consequently, the North, South, and the EU as a whole have also experienced a decline (see Appendix A). The countries of the East, with their former affiliation to empires before World War I and the socialist experiment in the period after World War II, made a leap forward before joining the EU, until 2008 and even until 2019 (before the COVID-19 pandemic). However, in the 2020s, this momentum experienced a slight decline, although several countries continued to make progress in catching up with their neighbors. The disparities among the three aforementioned groups within the EU and the US increased during the period under review.

In the context of studying inter-country convergence during market development, it can be posited that in 21st-century Europe, we are witnessing a large-scale experiment in Solow convergence. The European Union project, a successful endeavor in its own right, has been further enriched by the incorporation of ten countries with disparate histories and levels of development, primarily for political reasons. These countries, depending on their human capital and EU markets, the institutional conditions of a large union, and some financial assistance, were able to capitalize on these factors to make significant progress in their development. The EU, as a whole, encountered numerous external shocks while exhibiting heterogeneity in its national levels of development and institutional systems. Consequently, it is not unexpected that the EU, in its entirety, and the three groupings of countries, each in their own manner, have been disadvantaged in the transatlantic competition with the more homogeneous Anglo-Saxon nation, the United States.

4. Intra-country inequality in the European Union and tax redistribution

The impact of internal inequality on socio-political processes is significant [Piketty 2014]. The convergence of countries' levels of development can be regarded as a desirable benefit, particularly within a unified political bloc such as the EU. Nevertheless, social inequality within nations persists as an intractable problem, irrespective of whether it is regarded as a catalyst for development or a social threat. Therefore, it would be a mistake to consider trends in economic inequality in isolation from the broader context of inequality within countries. First, it should be noted that intra-country inequality has developed historically in the countries of the North and South for a very long time, and in the countries of the East relatively recently. Contemporary trends in internal inequality are determined by processes occurring within the market economy, such as privatization, and within the system of institutions, including the high income taxation factor previously discussed.

In order to analyze the actual stratification, the national income of EU countries is to be broken down into three components: the share of the poorest 50% of the population, or deciles 1–5 (hereinafter referred to as the poor); the share of the middle 40%, deciles 6–9 (hereinafter referred to as the middle class); and the share of the richest 10%, or decile 10 (hereinafter referred to as the rich). This breakdown is also employed by the World Inequality Lab (established in 2017 under the direction of Piketty) [World Inequality Database 2023]. The arithmetic mean shares for each social group in the North, South, and East were calculated, and a comparison will be made between them and over time. The World Inequality Lab has information on income shares before and after taxes, which allows for the observation of the extent to which income is redistributed (cf. Piketty's basis for the promotion of equality: progressive taxes on capital, inheritance, and property) [Piketty 2014].

Table 3 (p. 19) presents the income structure by social class and EU country group in two states—before and after taxes—in key years of the 21st century. It is noteworthy that the shares of income by social stratum have stabilized, particularly the high shares

of the 10th decile. After taxes are factored in, these shares remain relatively constant and do not undergo significant changes during the period under review. Consequently, the present study will prioritize an examination of the nature and scale of income redistribution before and after taxes, as opposed to a focus on the dynamics of these processes.

The findings indicate that the middle class, constituting 40% of the population, receives approximately 44% of the income across all country groups, both prior to and following redistribution through the tax system. The lowest-income 50% of families receive approximately 26–28% of the income after the implementation of redistribution policies in the South and East regions, and 31% in the North. It is noteworthy that 5 percentage points of income are subject to redistribution in the East, 8 percentage points in the South, and 9 percentage points in the North. In other words, an increase in total per capita income is accompanied by a significant redistribution of income, constituting an established European tradition. The result is a surprising picture in which the wealthiest 10% of the population in less developed countries receive 30% of income, 27% in the South, and 26% in the North. Indeed, a multifaceted system of regional disparities in inequality exists, influenced by both the level of development and the extent of redistribution. The parameters for the key countries in all three groups—Germany, the UKain, France, Italy, Poland, and the Czech Republic (see Figure 3 on p. 20)—are provided in Appendix B. This approach provides a more concrete picture of inequality that is not diluted by averages.

Table 3. Shares of pre-tax and post-tax national income by deciles in the EU-27, 2000–2022

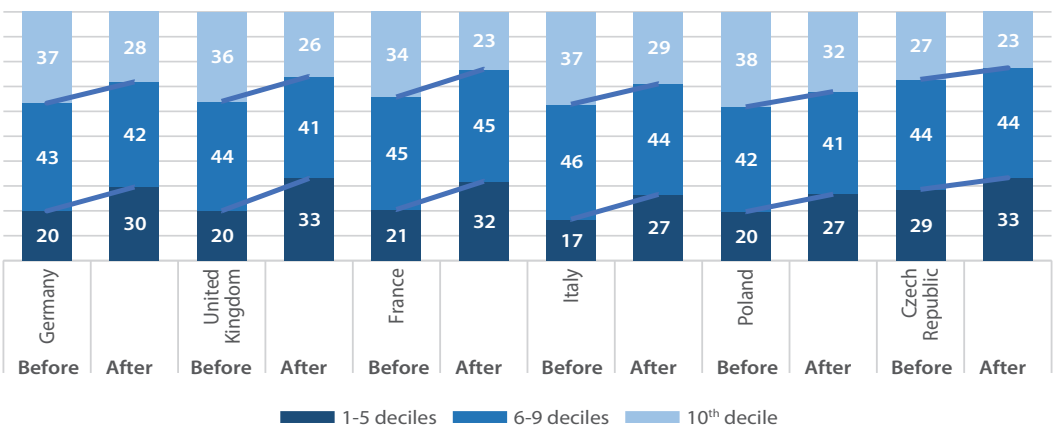
	Before	After	Before	After	Before	After	Before	After
	2000		2008		2019		2022	
The North								
Top 10% (10th decile)	0.33	0.25	0.33	0.25	0.33	0.25	0.33	0.26
average 40% (6th – 9th deciles)	0.44	0.43	0.44	0.43	0.45	0.43	0.45	0.43
lower 50% (1st – 5th deciles)	0.23	0.32	0.23	0.32	0.22	0.32	0.22	0.31
The South								
Top 10% (10th decile)	0.35	0.28	0.34	0.27	0.34	0.27	0.34	0.27
average 40% (6th – 9th deciles)	0.46	0.45	0.46	0.45	0.45	0.45	0.46	0.45
lower 50% (1st – 5th deciles)	0.19	0.27	0.20	0.28	0.21	0.28	0.20	0.28
The East								
Top 10% (10th decile)	0.33	0.29	0.35	0.31	0.34	0.31	0.34	0.30
average 40% (6th – 9th deciles)	0.46	0.45	0.44	0.44	0.45	0.44	0.45	0.44
lower 50% (1st – 5th deciles)	0.21	0.26	0.21	0.25	0.21	0.25	0.21	0.26

Source: compiled by the authors based on the World Inequality Database (WID).

The data presented in Table 3 generally indicates the rigidity of inequality within the statistical database under consideration. The aforementioned study [Blanchet

et al. 2022] obtained more pessimistic results, but on a more complex and detailed statistical basis, namely the growth of social inequality in the EU by 2017. In the six leading countries, the share of the 10th decile (after taxes) is marginally lower than the group averages, the share of the middle 40% of the population is stable at 45% of gross income, and the share of the bottom 50% of the population is relatively "high" at 29–30% (with the exception of Italy and Poland). France exhibits the most pronounced disparity in after-tax income shares, with a 22-percentage-point gap between the poor and the middle class, and an 11-percentage-point discrepancy between the middle class and the wealthy. This assertion is substantiated by the highest marginal income tax rate in the South group (in 2022, the marginal tax rate in France will be 55.2% [OECD 2024]). The most pronounced disparities in income inequality are observed among the sample countries of Italy and Poland, where the wealthiest segments of the population exhibit the highest levels of income accumulation.

Figure 3. Shares of pre-tax and post-tax national income in the selected EU countries, %, 2022



Source: compiled by the authors based on the World Inequality Database (WID).

It is imperative to understand not only the immediate consequences of tax redistribution, but also the underlying mechanisms that underpin it. The utilization of taxation as a means of addressing internal social inequality has become a prevalent practice in the 21st century. As of 2024, 23 out of 27 EU countries have implemented a progressive taxation system [Hammer, Christl, and De Poli 2021], and there is a growing body of evidence supporting the efficacy of this tool in European countries compared to countries in other parts of the world [Inchauste and Karver 2017].

According to the findings presented in Table 4 on p. 21, a concise overview of the key differences between EU groups in terms of tax systems is provided. The format of this article precludes an exhaustive examination of each nation's tax system. Consequently, we offer statistics concerning the number of countries implementing progressive and proportional income tax scales, in addition to the average marginal income tax rate,

for the purpose of comparison. A comparison of the tax policies of the "new" and "old" (North and South) EU reveals significant discrepancies. In the northern countries, a significant redistribution of income has occurred over the period under review. This redistribution has had a positive impact on reducing social inequality, though it has not yet overcome it, through fiscal instruments as an integral part of social policy. In the southern countries, the progressive tax scale demonstrates less significant results, accompanied by larger budget deficits. In Eastern countries, the redistribution effect is less pronounced than in the other two groups, and there are specific reasons for this. For the purposes of further analysis, it is important to note that certain countries within the group have maintained a fixed tax rate. These countries include Bulgaria, Hungary, Romania, and Estonia. It is noteworthy that other countries, including Slovakia (until 2013), Latvia (2018), and Lithuania (2020), have also implemented a proportional scale [Barrios et al. 2020; Hammer, Christl, and De Poli 2021]. Consequently, affluent groups in Eastern countries are less encumbered by transfers to the economically disadvantaged than their counterparts in the Global North and South.

Table 4. Comparative characteristics of tax systems, 2024

Parameter	The North	The South	The East
Number of countries with a progressive income tax scale, units	9	8	6
Number of countries with a fixed income tax scale, units	-	-	4
Average marginal income tax rate, 2024, %	51	43.7	25.2

Source: compiled by the authors based on OECD and PWC data.

5. Income dynamics of the 10th decile after taxes

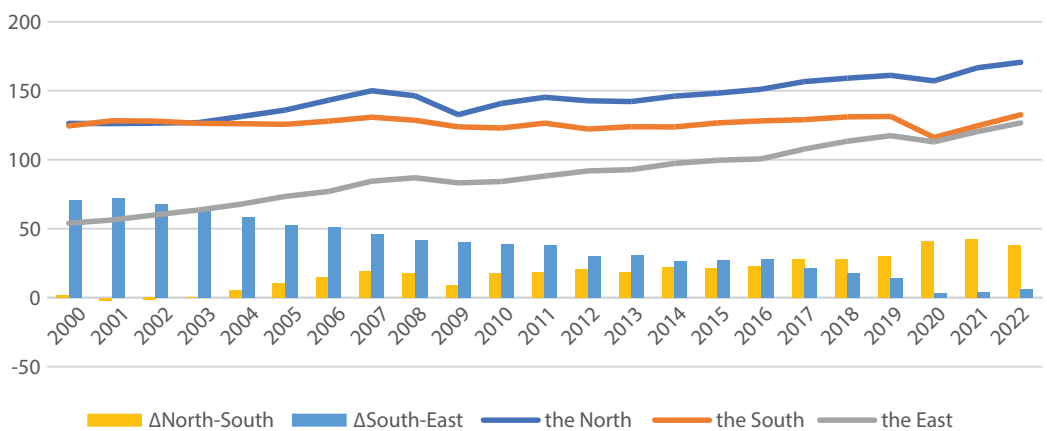
The persistence of elevated social inequality against the backdrop of economic growth engenders substantial gains for the high-income 10th decile, which predominantly comprises high-paying jobs in business and government, as well as inheritance, business profits, income from securities, and so forth. This is an inertial process that the market economy sustains on an ongoing basis.

We have previously addressed the issue of intraregional inequality in terms of income groups (quintiles, deciles) in our other works, particularly highlighting the distinctive impact of crises on a significant reduction in the income of the 10th decile compared to the total national income [Grigoryev, Pavlyushina 2018; Grigoryev, Pavlyushina 2022b]. In this paper, we seek to underscore the potential of this approach to illuminate hitherto unexplored trends in inequality. We propose a methodology for calculating the after-tax income of the 10th decile for each country and for each group separately in absolute terms. This calculation will be based on two indicators from the statistical databases of the World Bank and the World Inequality Lab. To obtain the income of the 10th decile of country j in period t, we multiply the per capita GDP of

country j in period t by the share of the 10th decile income after taxation of country j in period t and multiply the resulting number by 10^3 (see Appendix B).

We will demonstrate these indicators in Figure 4 (p. 22). It shows a surprising picture in which, after income redistribution, the 10th decile of the East converges with the 10th decile of the South. At the beginning of the 21st century, the rich South and North had relatively equal incomes, but by the end of the period under review, the rich South had lost their position and were caught up by the new rich from the East. Thus, the integration of the rich fits into the history of EU integration with overall growth in inequality in the EU.

Figure 4. Weighted average of imputed post-tax GDP per capita (PPP, 2021 constant prices) of the 10th decile, thousand international dollars, 2000–2022



Source: compiled by the authors based on data from the World Bank, the World Inequality Lab (see Appendix B).

Conclusion

The picture of the EU's development in the 21st century points to certain successes in bringing countries closer together. The observed convergence of the eastern region toward the southern direction is particularly pronounced. The human capital accumulated during the period of the planned economy may play a certain role in this. It is evident that the trend toward convergence was observed until the global crisis of 2008–2010. Subsequent to this period, the Southern states have exhibited a persistent underperformance in comparison to other demographic groups, a circumstance that has contributed to the escalating disparity between the European Union and the United States.

The limitations inherent in the scope of this work preclude the possibility of supplementing the initial tier of analysis with broader coverage in two or three

[3] The income of the 10th decile of each country in absolute terms is equal to

$$\frac{National\ GDP \times 10^{th}\ decile\ income\ share}{0.1 \times Population} = GDP\ per\ capita\ of\ the\ country \times 10^{th}\ decile\ income\ share \times 10$$

directions. Initially, the work cited in the article [Blanchet et al. 2022] suggests the presence of underlying social inequality in the EU, as evidenced by a more thorough examination of income. Secondly, the institutional disparities (diverse tax systems, etc.) delineated in Grigoryev and Lyakhova (2025) imply specific challenges in the integration process and impose constraints, including on the convergence of the overall level of development of EU countries. Thirdly, there is a room for a more thorough delineation of each of the three regional groups, encompassing their economic, demographic, and other characteristics. An expansion of the aforementioned analysis would facilitate the identification of potential correlations between internal economic characteristics (e.g., unemployment, labor market specifics, population structure, etc.) and the observed trends in income inequality dynamics. Such an expansion would also allow for the refinement of arguments concerning the etiology of income disparities and the degree of convergence among groups of countries.

A notable consequence of the interplay between income inequality and the extent of its redistribution is a discernible convergence in the post-tax income levels of the affluent elites in the Southern and Eastern regions. In essence, had Karl Marx conducted a thorough review of the statistical data presented, it is plausible that he might have conceptualized the notion of a "10th decile international," a category that has exhibited a marked divergence from the middle and lower strata of European society, despite the implementation of substantial tax redistribution measures in favor of low-income groups.

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Appendix A: Economic indicators of the EU-27, the US, and the UK, 2000–2023

	Population, million (right: share of EU-27, %)				GDP (PPP, 2021 constant prices), billion international dollars (right: share of EU-27, %)				GDP per capita PPP (2021 constant prices), thousand international dollars (EU-27)						
	2000		2023		2000		2023		2000	2008	2019	2020	2021	2022	2023
North															
Austria	8	2	9.1	2	429	2	588	2	53.6	61.2	64.7	60.3	63.0	65.7	64.4
Belgium	10.3	2	11.8	3	517	3	742	3	50.5	56.8	60.5	57.4	60.7	62.7	62.9
Germany	82.2	19	83.3	19	4 109	24	5 260	22	50.0	55.5	63.0	60.3	62.5	62.9	63.2
Denmark	5.3	1	5.9	1	307	2	425	2	57.4	62.5	66.6	65.2	69.7	70.2	71.5
Finland	5.2	1	5.6	1	243	1	316	1	46.9	57.5	56.9	55.4	56.8	57.5	56.5
Ireland	3.8	1	5.3	1	205	1	613	3	53.7	62.4	97.2	103.1	118.7	125.6	115.5
Luxembourg	0.4	0	0.7	0	50	0	87	0	113.5	135.1	131.7	128.4	135.5	134.6	130.5
Netherlands	15.9	4	17.9	4	892	5	1263	5	56.0	63.7	67.8	64.9	68.6	71.3	70.7
Sweden	8.9	2	10.5	2	425	2	661	3	47.9	55.8	61.2	59.6	62.7	63.2	62.7
Total	140	33	150.1	33	7 176	42	9 954	41							
Average[1]									**51.2**	**57.8**	**64.7**	**62.3**	**65.4**	**66.6**	**66.3**
Coefficient of variation[2]***, %***									35.4	37.5	32.9	34.9	36.9	36.8	34.1
South															
Spain	40.6	9	48.3	11	1 621	9	2 289	9	39.9	44.9	46.9	41.5	44.3	46.7	47.3
France	60.9	14	68.3	15	2 798	16	3 689	15	45.9	50.1	53.4	49.3	52.5	53.7	54.0
Greece	10.8	3	10.4	2	339	2	383	2	31.4	41.7	33.5	30.5	33.5	35.9	36.9
Italy	56.9	13	59	13	2 867	17	3 105	13	50.4	52.1	49.7	45.5	49.8	52.3	52.6
Malta	0.4	0	0.6	0	12	0	33	0	31.0	36.2	53.3	50.3	56.7	57.7	59.6
Portugal	10.3	2	10.6	2	361	2	439	2	35.1	37.3	40.2	36.9	38.7	41.1	41.5
Croatia	4.5	1	3.9	1	95	1	159	1	21.3	31.1	35.1	32.5	36.9	39.9	41.1
Cyprus	0.9	0	1.3	0	25	0	48	0	36.1	44.3	46.2	44.2	48.8	51.7	52.2
Total	185.3	43	202.4	45	8 118	47	10 146	42							
Average									**43.8**	**47.8**	**48.5**	**44.3**	**47.7**	**49.7**	**50.1**
Coefficient of variation, %									25.0	16.9	17.3	18.0	18.1	16.3	16.1

	Population, million (right: share of EU-27, %)				GDP (PPP, 2021 constant prices), billion international dollars (right: share of EU-27, %)				GDP per capita PPP (2021 constant prices), thousand international dollars (EU-27)						
	2000		2023		2000		2023		2000	2008	2019	2020	2021	2022	2023
East															
Bulgaria	8.2	2	6.4	1	103	1	214	1	12.6	21.8	27.7	27.0	29.3	31.6	33.1
Czech Republic	10.3	2	10.9	2	302	2	516	2	29.4	40.3	47.8	45.1	47.8	48.4	47.5
Estonia	1.4	0	1.4	0	29	0	57	0	20.7	34.6	42.7	41.3	44.3	43.7	41.7
Hungary	10.2	2	9.6	2	226	1	386	2	22.1	29.5	37.2	35.6	38.3	40.4	40.2
Lithuania	3.5	1	2.9	1	55	0	133	1	15.8	30.4	43.3	43.3	46.0	46.7	46.2
Latvia	2.4	1	1.9	0	34	0	72	0	14.6	28.7	35.2	34.2	36.9	37.7	38.4
Romania	22.4	5	19.1	4	333	2	768	3	14.9	27.0	36.6	35.5	37.7	39.4	40.3
Slovakia	5.4	1	5.4	1	99	1	213	1	18.3	29.5	37.2	36.2	38.4	38.6	39.2
Slovenia	2	0	2.1	0	60	0	102	0	30.1	41.3	44.6	42.5	45.9	47.1	47.9
Poland	38.3	9	36.7	8	710	4	1 600	7	18.6	25.6	38.2	37.5	41.1	43.4	43.6
Total	104	24	96.3	21	1 951	11	4 060	17							
Average									**18.8**	**28.4**	**38.3**	**37.2**	**40.1**	**41.8**	**42.2**
Coefficient of variation, %									30.7	20.0	14.7	14.2	13.8	12.4	11.0
EU-27	429.3		448.8		17 245		24 160		**40.2**	**46.6**	**51.6**	**48.7**	**51.9**	**53.7**	**53.8**
Coefficient of variation, %									56.2	47.2	41.1	43.5	43.9	43.0	40.0
EU-15[3] ("old" EU)	378.5		415		17 709		23 454		46.8	51.8	55.2	51.4	54.8	56.5	56.5
Coefficient of variation, %									36.0	38.1	37.9	41.7	42.8	41.9	38.9
United Kingdom	58.9		68.4		2 547		3 594		43.2	49.0	52.5	46.9	51.0	52.8	52.6
Δ North–South									7.4	10.0	16.1	18.0	17.8	17.0	16.2
Δ South–East									25.0	19.4	10.2	7.1	7.6	7.8	8.0
EU-15 (excluding UK)[4]	320		347.2		15 174		19 893		47.4	52.3	55.7	52.2	55.5	57.2	57.3
Coefficient of variation, %									37.9	39.7	37.9	41.3	42.3	41.5	38.3
United States	282.2		334.9		15 530		24 977		**55.0**	**60.8**	**69.5**	**67.4**	**71.3**	**72.8**	**74.6**
Δ North–US									3.8	3.0	4.8	5.0	5.9	6.2	8.3
Δ South–US									11.2	13.0	21.0	23.1	23.7	23.2	24.4
Δ East–US									36.3	32.4	31.2	30.2	31.2	31.0	32.4

Source: compiled by the authors based on data from the World Bank (World Development Indicators).

Notes to Appendix A:

GDP and GDP per capita are given in PPP terms at constant 2021 prices.

1 — Average per capita income for a group of countries (in thousands of PPP dollars) is calculated using the formula: the ratio of the total GDP of the group (in PPP dollars) to the total population of the group (in persons).

2 — Coefficient of variation — a relative measure of data dispersion, calculated as the ratio of the standard deviation to the arithmetic mean (%). For a sample to be considered homogeneous, the coefficient of variation must not exceed the threshold value of 33.3%.

3 — Indicators are calculated for the **EU-15** group: **fundamental countries of the EU**. Austria, Belgium, Germany, Denmark, Finland, Ireland, Luxembourg, the Netherlands, Sweden, the United Kingdom, France, Italy, Portugal, Greece, and Spain. The following are given: the total population of the group of countries, the total GDP of the group of countries, the average per capita income of the group of countries, calculated using a formula similar to that in paragraph 1.

4 — Indicators are calculated for the **EU-15** group: **the North group + the South group excluding Croatia and Cyprus**. The total population of the group of countries, the total GDP of the group of countries, and the average per capita income of the group of countries, calculated using a formula similar to that in paragraph 1, are given.

Appendix B: Distribution of the 10th decile post-tax national income in the EU-27, PPP in constant 2021 prices

	Share in national GDP[1]		Per capita GDP, thousand international dollars per capita[2]					
	2000	2022	2000	2008	2019	2020	2021	2022
North								
Austria	0.28	0.28	148	173	170	167	174	183
Belgium	0.25	0.24	126	135	148	137	147	153
Germany	0.25	0.28	125	158	180	168	176	177
Denmark	0.19	0.21	107	118	130	132	143	147
Finland	0.23	0.25	108	137	136	136	140	143
Ireland	0.27	0.28	147	151	265	276	323	346
Luxembourg	0.33	0.30	373	472	385	381	408	407
Netherlands	0.22	0.23	123	144	158	149	160	167
Sweden	0.20	0.23	97	128	133	137	146	146
Average aggregate[3]			126	146	161	157	167	171
Arithmetic mean[4]	0.25	0.26	**151**	**180**	**189**	**187**	**202**	**208**
Arithmetic mean excluding Luxembourg			**123**	**143**	**165**	**163**	**176**	**183**
Coefficient of variation, %			56.7	61.8	44.5	45.7	47.6	47.1
South								
Spain	0	0.27	113	125	128	109	118	126
France	0.25	0.23	116	129	124	111	123	124
Greece	0.34	0.30	105	116	90	81	92	106
Italy	0.29	0.29	146	140	146	129	143	151
Malta	0.26	0.29	81	98	157	141	162	167
Portugal	0.30	0.27	105	110	112	100	101	110
Croatia	0.27	0.28	57	88	100	90	104	113
Cyprus	0.28	0.21	103	99	111	102	98	107
Average aggregate			124	129	131	116	124	133
Arithmetic mean	0.28	0.27	**103**	**113**	**121**	**108**	**118**	**126**
Coefficient of variation, %			25.2	15.7	18.6	18.2	20.7	17.7

	Share in national GDP[1]		Per capita GDP, thousand international dollars per capita[2]					
	2000	2022	2000	2008	2019	2020	2021	2022
East								
Bulgaria*	0.30	0.39	38	68	115	110	112	122
Czech Republic	0.24	0.23	71	102	111	102	107	109
Estonia*	0.36	0.32	75	113	133	129	140	139
Hungary*	0.24	0.29	53	81	110	102	110	117
Lithuania	0.33	0.34	52	109	150	147	156	159
Latvia	0.33	0.32	47	95	112	108	115	122
Romania*	0.33	0.37	49	105	133	130	139	145
Slovakia	0.22	0.21	40	74	82	80	80	79
Slovenia	0.25	0.25	74	103	109	104	112	115
Poland	0.28	0.32	51	81	121	119	130	139
Average aggregate			54	87	117	113	120	127
Arithmetic mean	0.29	0.30	**55**	**93**	**118**	**113**	**120**	**125**
Coefficient of variation, %			24.7	17.2	15.5	16.6	17.8	17.8
EU-27, coefficient of variation, %			64	58	42	45	47	45
EU-15, coefficient of variation, %[5]			51	58	44	48	49	48

Source: compiled by the authors based on data from the World Inequality Database (World Inequality Lab) and the World Bank.

Notes to Appendix B:

GDP per capita is given in PPP terms at constant 2021 prices (World Bank database).

1 — Shares of the 10th decile in national GDP after taxation are taken from the World Inequality Database (World Inequality Lab).

Share of national income after taxes attributable to the 10th decile. The unit of observation is an adult aged 20 years and older. Income is divided equally between spouses [post-tax national income top 10% (share, adults, equal split)].

2 — The income of the 10th decile of each country in absolute terms is calculated using the formula: *GDP per capita of the country × share of income of the 10th decile after tax × 10*.

3 — We have named this parameter "average aggregate"; it is calculated using the following formula: *average GDP per capita of the group (from Appendix A) × arithmetic mean of the share of income of the 10th decile after tax of the group × 10*.

4 — Classic arithmetic mean parameters.

5 — Indicators are calculated for the EU-15 group: the North group + the South group excluding Croatia and Cyprus.

* — Countries with a fixed income tax rate are indicated.

Prospects for Further Development of the mBridge Project: Rebalancing Political Leadership

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Abstract

Until recently, due to the liquidity and stability of the US dollar, most international settlements were conducted in this currency, thereby strengthening the US economy and its political weight. However, the advent of digital technologies has begun to delineate the contours of a novel architecture for the global financial system. Various options for employing digital currencies in cross-border

settlements are currently being tested around the world. A significant undertaking in the realm of central bank currency exchange is the mBridge project (stakeholder: PRC), which attained the minimum viable product (MVP) stage in 2023. In Russia, even at the stage when there was a threat of the Russian Federation being disconnected from SWIFT, the creation of an alternative payment system based on a new technological platform was discussed at a high political level. This article analyzes the potential for Russia to develop its own initiative, with a particular emphasis on technological and digital sovereignty. It also assesses the viability of options for the advancement of the Chinese mBridge initiative. Furthermore, an expert assessment is provided of the potential conceptual impact of the integration of such projects on the existing global financial infrastructure. This includes an analysis of attempts to abandon the established international monetary system and significantly rebalance the political influence associated with it.

1. Introduction

Digital technologies have *become decisive in shaping the emergence of a new financial infrastructure for the global economic system* and international relations. Gradually, based on the development of central bank digital currencies (CBDCs) and blockchain technology, new models of cross-border payments are emerging, significantly changing the landscape of the international currency market and cross-border payment systems before our very eyes. Just like the new business model generated by technological innovations, digital currency can pose problems for traditional financial systems and financial security. Chinese experts believe that the transition of digital currency supervision from national to global regulation is an inevitable trend [Wang Junsheng 2025]. This assertion is debatable, including from the perspective of national security and state control in this area by central banks. However, certain trends toward hybrid distribution of functions at different levels can be observed and may depend, among other things, on the economic power and political independence of a particular state.

Currently, more than 130 countries, representing 98% of the global economy, are exploring the use of digital currencies to adapt to technological changes.[1] According to the Bank for International Settlements (BIS), there are currently four retail CBDCs in operation—in the Bahamas, the Eastern Caribbean, Nigeria, and Jamaica. These countries are primarily focused on developing domestic instant retail payments, which can be compared to the fast payment system project in Russia. Retail CBDC pilot projects are currently being implemented in 24 jurisdictions, and 23 jurisdictions have wholesale CBDC pilot projects.[2] Since 2016, major central banks around the world have begun

[1] Rejection of the "digital dollar" gives the EU and China a chance to introduce their own CBDC standards. *Frank Media*. 2025. Jan. 28. Available at: https://frankmedia.ru/191067 (in Russian) (accessed 6 March 2025).

[2] Rise of the central bank digital currencies: drivers, approaches and technologies. *BIS*. 2020. Aug. 24 (Update – March 2024). Available at: https://www.bis.org/publ/work880.htm (accessed 6 March 2025).

to explore projects involving the interconnection of several legal digital currencies, and CBDCs have become an important topic of research. Currently, the world's largest projects in the field of CBDC use are Japer-Ubin, mBridge, Dunbar, Nexus [Wang Junsheng 2025], and others. In March 2025, European Central Bank President Christine Lagarde announced plans for the European Union to launch its own digital euro by October of this year.[3]

In 2023, the mBridge project became one of the most important projects of central banks to explore the use of digital currencies for cross-border settlements, despite the fact that none of its key participants (Thailand, the UAE, China, Hong Kong, and Saudi Arabia) had fully launched their own CBDCs.

When the project was mentioned at the 16th BRICS summit in Kazan in 2024, search results for "mBridge" widely covered the BIS discussion on closing the project. Experts note that mBridge has already reached the minimum viable product stage, and participants can choose directions for its continuation without support from the BIS.[4] The implementation of the mBridge project could have a profound impact on global economic integration and the international monetary system [Danilova, Maslov 2024 (1)], so it is interesting to take a closer look at the project. China itself notes that the project aims to achieve the key objectives of the G20, namely to enable faster, cheaper, and safer cross-border payments and settlements through the use of new technologies [People's Bank of China 2022]. According to mBridge product owners, the project is highly scalable and efficient, involving developing countries in international trade that have been poorly integrated into global settlements since the 2008 crisis and are experiencing difficulties with them.

Until recently, due to the liquidity and stability of the US dollar, most international settlements were conducted in this currency, which strengthened the US economy and political influence. However, there are now noticeable signs of a shift in the balance of currencies in international settlements and the growing role of the Chinese yuan, which is strengthening China's status in the global financial arena. mBridge is causing concern in the West. Previously, this conclusion was based on indirect evidence, but Bloomberg now directly points to Russia and China seeking alternatives to the US dollar.[5]

The purpose of this article is to provide an expert assessment of the potential impact of the mBridge project on the redistribution of global influence among individual centers of power. In the next section, we describe the history and current status of the mBridge project, demonstrate China's role in the project, and identify the key differences between mBridge and SWIFT and CIPS. In the third section, we

[3] ICYMI: ECB President Lagarde said that EU is looking to launch the digital Euro CBDC by October this year. 2025. March 9. Available at: https://x.com/Cointelegraph/status/1898958241645629664 (accessed 10 March 2025).

[4] BIS considers ending Mbridge project due to links with BRICS, but is it too late? *Bitcoin. comNews*. 2024. Oct. 30. Available at: https://news.bitcoin.com/ru/bis-rassmatrivaet-vozmozhnost-prekrashcheniya-proekta-mbridge-iz-za-svyazey-s-briks-no-ne-slishkom-li-pozdno/ (in Russian) (accessed 30 October 2024).

[5] BIS Debates Ending Project Eyed by Putin to Undermine Dollar. *Bloomberg*. 2024. Oct. 28. Available at: https://www.bloomberg.com/news/articles/2024-10-28/bis-debates-ending-project-eyed-by-putin-to-undermine-dollar (accessed 30 October 2024).

analyze the prospects and scenarios for Russia's involvement in projects using CBDCs (connection to an existing project, interconnection). In the fourth section, we identify the potential impact of the mBridge project on the redistribution of global influence among individual centers of power. The main conclusions are summarized in the conclusion.

2. About the mBridge project and China's participation

China was among the first countries to initiate the development and testing of a national digital currency, the digital yuan. Concurrently, in collaboration with the United Arab Emirates (UAE) and Thailand, it launched the pilot phase of the mBridge cross-border project, which utilizes national digital currencies in international settlements. The acronym "mBridge" signifies "Multilateral Central Bank Digital Currency Bridge." In 2023, the mBridge project emerged as a pivotal undertaking for central banks, aiming to investigate the potential of national digital currencies for facilitating cross-border financial transactions [Danilova, Maslov 2024 (2)]. The creators of the project have asserted that the implementation of mBridge addresses the existing gap in the international payment system by providing a high-quality platform based on the CSDB [International Monetary Institute IMI 2024].

The Digital Currency Bridge project was originally a bilateral pilot project that was jointly implemented in 2017 by the Bank of Thailand and the Hong Kong Monetary Authority (first phase). In the subsequent phase of the project (at this phase the project was designated as Inthanon-LionRock) in 2019, the focus shifted to the examination of issues pertaining to cross-border trade and the potential applications of business initiatives for the purpose of simplifying settlements and enhancing capital market operations. In the third phase of the project, which occurred in 2020, the Central Bank of China and the Central Bank of the United Arab Emirates participated. The Hong Kong Centre at the BIS Innovation Hub also provided support. The nomenclature was officially modified to "Multilateral Cross-Border Digital Currency Bridge" (m-CBDC Bridge), and was subsequently shortened to mBridge. In 2021, the parties published a phased report on the multilateral project and presented 15 potential scenarios for its application, testing its use in international trade settlements, cross-border e-commerce, supply chain finance, and other areas [RUC FinTech Institute 2022]. Prior to the initiation of the pilot project, the project team engaged in active collaboration with representatives of the private sector. This collaboration was undertaken with the objective of identifying potential business applications for the platform.[6]

mBridge implements payments and clearing settlements through decentralized point-to-point transactions, i.e., through direct interaction without intermediaries. This happens in real time—quickly and efficiently—and the project's reliance on blockchain technology protects transactions from being altered, ensuring greater transparency and security. The absence of intermediaries gives the technology a unique advantage over

[6] Maslov, A.V., 2022. mBridge. A new step in the use of CBDC for international settlements. *PLUS Journal*, No 10 (296). Available at: https://plusworld.ru/journal/2022/plus-10-2022/mbridge-novyy-shag-v-ispolzovanii-tsvtsb-dlya-mezhdunarodnykh-raschetov/ (in Russian) (accessed 5 October 2023).

traditional systems and increases the efficiency of payments [International Monetary Institute IMI 2024]. The project takes into account the regulatory requirements of each jurisdiction.

mBridge is fundamentally different from SWIFT and CIPS. SWIFT is a financial messaging system that only transmits information and currently connects the largest number of users worldwide. CIPS is the main channel for cross-border remittances in yuan. If successful, mBridge could offer a new payment channel. According to Guan Shuxuan, director of the Digital Currency Department of the Bank of China, CIPS and mBridge have different characteristics and can jointly improve the efficiency of cross-border payments, as well as clearing and settlement in renminbi in various directions. Compared to SWIFT and CIPS, mBridge has several significant differences: first, it uses central bank digital currency for clearing and does not require an agent bank clearing account; second, mBridge emphasizes full equality for all participating countries/regions in terms of governance; third, the currencies and banks covered by mBridge correspond to the countries/regions participating in the currency bridge project, i.e., for each additional country/region, a new currency and local participating banks will be added [International Monetary Institute IMI 2024].

The mBridge project does not have its own website. The most comprehensive official information about the mBridge project is available on the Bank for International Settlements website at.[7] After the BIS suggested in October 2024 that participants choose the direction of the project's continuation without support from the BIS, it became much more difficult to work with new and verified information.

The authors reviewed

- the website of the People's Bank of China (PBC — the central bank of the People's Republic of China) and found no publications regarding mBridge after June 2024;[8]
- the website of the Hong Kong Monetary Authority (HKMA) and found no publications regarding mBridge after June 2024;[9]
- the website of the Bank of Thailand (BOT) and, with the exception of press releases, found only one main document describing the mBridge project, authored by the Bank for International Settlements in 2022;[10]
- the website of the Central Bank of the United Arab Emirates (The Central Bank of the UAE) and found a section dedicated to mBridge, which was last updated in 2022;[11]

[7] Project mBridge reached minimum viable product stage. *BIS*. (Updated 11November 2024). Available at: https://www.bis.org/about/bisih/topics/cbdc/mcbdc_bridge.htm (accessed 6 March 2025).

[8] Project mBridge Reaches MVP Stage. *The People's Bank of China*. 2024. Jun. 6. Available at: http://www.pbc.gov.cn/en/3688241/3688636/3688642/5374885/index.html (accessed 6 March 2025).

[9] Project mBridge reaches MVP stage. *The Hong Kong Monetary Authority*. 2024. June 5. Available at: https://www.hkma.gov.hk/eng/news-and-media/press-releases/2024/06/20240605-4/ (accessed 6 March 2025).

[10] Findings from the Multiple Central Bank Digital Currency Bridge (mBridge) Pilot and Next Steps. *The Bank of Thailand*. 2022. Oct. 26. Available at: https://www.bot.or.th/en/news-and-media/news/news-20221026.html (accessed 6 March 2025).

[11] M-bridge. *The Central Bank of the UAE*. 2022. Oct. 28. Available at: https://www.centralbank.ae/en/our-operations/fintech-digital-transformation/mbridge/ (accessed 6 March 2025).

- the website of the Saudi Central Bank (SAMA) and found only joint press releases from June 2024.[12]

The Bank for International Settlements was the project office and methodological center for the mBridge project. It was the participation and support of the Bank for International Settlements that gave the project its supranational status. We can only wait for official statements from the participating countries on the form and timing of the mBridge project's development without BIS support: will it be a private project of several countries, and will one of the countries, for example China, take the lead in promoting the project?

At the same time, discourse regarding mBridge continues to develop within China. The 2025 financial report of Tsinghua University contains information that, "in developing the mBridge project strategy, the Project Steering Committee envisages the gradual transformation of mBridge into an influential international cross-border payment infrastructure, whose most striking features are universality and inclusiveness, which, in the Committee's view, will lead to the inevitable expansion of mBridge [Wang Junsheng 2025]. China's International Monetary Institute (IMI) is looking at how SWIFT, CIPS, and mBridge can coexist to help traditional clearing systems and mBridge develop in a coordinated way across different technologies and currencies to make cross-border payments, clearing, and settlement in renminbi more efficient [International Monetary Institute IMI 2024]. The Tsinghua Financial Review is devoted to the study of financial infrastructure and the construction of a digital currency management system based on a multilateral central bank digital currency bridge [Wang Junsheng 2025]. To summarize various Chinese sources on the project, Chinese representatives are speculatively testing various scenarios: integration into existing financial technologies or interfacing with them; the possibility of independently implementing the mBridge project in a separate inter-country region and gradually and naturally increasing its production capacity while identifying additional areas for improvement in the process, with a view to facilitating trade procedures in the region.

3. Russia and international settlements in CBDCs

Let us consider separately the prospects for Russia's participation in international settlements in CBDCs. Our country does not yet have its own cross-border project related to CBDCs and is currently piloting a national digital currency. Ensuring the direct exchange of digital currencies of Russian and foreign central banks and the execution of cross-border payments in these currencies can be achieved by creating our own project or by joining an existing one. Let us consider both options.

[12] SAMA Joins mBridge Project. *The Saudi Central Bank*. 2024. Jun. 5. Available at: https://spa.gov.sa/en/N2117066 (accessed on 6 March 2025).

Scenario 1: Creating Russia's own project for using the CBDC for international settlements

Back in the fall of 2019, due to threats of Russia being cut off from the SWIFT international payment system, information emerged that Russia, China, and India were working on creating an alternative to SWIFT to simplify trade with countries subject to US sanctions. In early 2021, Russian Deputy Foreign Minister Alexander Pankin did not rule out the creation of an alternative payment system in Russia based on new technology [Kochetkov 2022].

At present, there are no public statements about the development of projects to use the digital ruble for international settlements. A pilot project on the digital ruble is ongoing. The first stage of the project is primarily aimed at ensuring the circulation of the digital ruble in the domestic market, and its full implementation, according to the Financial Market Development Strategy, should take place by 2030. As for the domestic circulation of the digital ruble, the exact date is still uncertain: the initial forecast assumed widespread use of the digital ruble for domestic settlements no earlier than 2025.[13] As of the beginning of the year, many banks participating in the pilot project indicated the need to postpone the widespread launch of the digital ruble until after 2026, while others said they were ready to launch in July 2025, as planned by the Bank of Russia. Fifteen banks and about 30 companies are participating in the pilot project. In February 2025, the Bank of Russia confirmed that the mass introduction of the digital ruble would take place later, noting that the regulator was receiving questions from the industry about the scope of necessary improvements and requests to postpone the widespread introduction of the digital ruble.[14, 15]

Assuming that the development of a project involving the use of the digital ruble for international settlements is initiated in the near future, it will only be possible to implement it in a few years, according to global experience. In particular, according to estimates by the consulting agency KPMG, it will take at least 10 years of preparation and development of the platform to achieve success, which is also related to the different levels of development of CBDCs in each country [RUC FinTech Institute 2022]. We believe that as such technologies spread around the world, the time required to develop new initiatives will be significantly reduced compared to current estimates by consultants. Nevertheless, such a solution is relevant in the medium term, but does not solve current problems.

When developing your own project, it is important to pay attention to the following political and political-economic aspects.

[13] The Russian Ministry of Finance and the Bank of Russia presented the Financial Market Development Strategy until 2030 for public discussion. *Central Bank of the Russian Federation* (official website). 2021. Sept. 13. Available at: https://www.cbr.ru/press/event/?id=12197 (in Russian) (accessed 19 November 2023).

[14] The Central Bank has postponed the mass introduction of the digital ruble. *RBC*. 2025. Feb. 27. Available at: https://www.rbc.ru/finances/27/02/2025/67c016ec9a7947d63247bd9f (in Russian) (accessed 09 March 2025).

[15] Banks assess readiness for launch of digital ruble in 2025. *RBC*. 2025. Jan. 8. Available at: https://www.rbc.ru/finances/08/01/2025/676c0d0b9a79470966c2baf6 (in Russian) (accessed 09 March 2025).

The development and integration of such a project into the global system requires implementation in partnership with other countries due to the high volatility of the ruble. The composition of the states will largely determine the scale of the project. For example, it seems possible to create such a project for the EAEU member states due to the existing mechanism of economic cooperation: the Customs Union and the practice of developing the "four freedoms" (free movement of goods, services, capital, and human resources). For the EAEU, this project could be a breakthrough for the development of an independent payment system in the region. However, none of the EAEU member states, except Russia, is a global power and has the political weight to promote the spread of such a pro-Russian project in the world. This must be taken into account when assessing the economic and political profitability of the project in this configuration.

The project could be made more profitable by the participation of countries that would link it to a basket of low-volatility currencies, such as the dirham or the yuan. It is possible to develop such a project with China within the framework of the Agreement on Trade and Economic Cooperation between the EAEU and its member states, on the one hand, and the People's Republic of China, on the other hand, of May 17, 2018,[16] with the aim of deepening comprehensive cooperation and an ad hoc project to align the development plans of the EAEU and the Belt and Road Initiative (the "point of alignment" [Danilova 2024]). The agreement is non-preferential and allows for the initiation of ad hoc projects.

The external economic environment is favorable for the development of such initiatives in view of the restructuring of China's trade: as China's trade with the US declines, its trade with the EAEU member states increases: currently, trade in this direction exceeds half of China's trade with the US. The geographical proximity of our countries increases the profitability of such projects.

Table 1. Trade turnover of selected countries in 2021 and 2024, billion US dollars[17]

Countries	2021	2024
Russia — China	146.8	245 Russian exports 115.5 Russian imports 129
China – Belarus	5	8
China – Kazakhstan	1	4
China – Kyrgyzstan	1	2
China – Armenia	1	2
China – United States	620	564
Russia – United States	3	3

[16] Agreement on Trade and Economic Cooperation between the Eurasian Economic Union and its Member States, on the one hand, and the People's Republic of China, on the other hand. *Eurasian Economic Commission: official website*. 2018. May 17. Available at: https://eec.eaeunion.org/upload/medialibrary/21b/Tekst-russkiy-_EAEU-alternate_-final.pdf (in Russian) (accessed on 19 February 2024).

[17] Compiled by the authors based on an analysis of news reports: initial data found in Google searches using queries such as "20... year trade turnover 'country 1' 'country 2'."

Another way to increase stability and solve the problem of high volatility of the ruble is to create a synthetic ruble. A synthetic ruble is a ruble with a stable exchange rate relative to a number of leading currencies, detached from the ruble exchange rate used for domestic settlements. A similar example in global practice is China's creation of the so-called offshore yuan (CNH), jointly developed by the Hong Kong Monetary Authority and the People's Bank of China [Aliev, Yu Xiao, Ryazanova 2024].

The BRICS countries have the necessary political weight. According to the Financial Times (FT), BRICS Bridge was one of the main items on the agenda of the summit in Kazan, which took place on October 22–24, 2024. This system is positioned as an alternative to SWIFT, independent of the "dollar system," the publication wrote. However, the Russian president noted at the summit that the BRICS countries are not creating an "alternative to SWIFT" within the alliance, as the existing tools are sufficient. At the same time, the Russian president notes that the issue of alternatives is very important today.[18]

The development, testing, and integration of the project require cooperation and expert support from global financial institutions such as the Bank for International Settlements, based in Switzerland. The competencies of individual countries and the expertise at their disposal are insufficient to implement such a project. The possibility of attracting expertise from international institutions also has a political dimension: despite the international status of the Bank for International Settlements, the organization is in fact pro-Western, and in the current political configuration, it is difficult to engage its expertise. However, the situation should be kept under review and, if circumstances change, this option should be revisited. Alternatively, targeted diplomatic efforts could be made to push events in this direction.

Scenario 2: Connect to an existing CBDC project: mBridge, BIS Project Mariana

China emphasizes ensuring the confidentiality of each country when connecting to and using the mBridge platform. This issue has not been studied in Russia, and the authors believe that it would be useful for practitioners to study the technical side of the issue in detail, thereby providing relevant conclusions for more comprehensive political conclusions. Currently, there is no information on how to connect to the project: is it supposed to be a peer-to-peer connection or a multi-level integration, i.e., new participants can use the project infrastructure for international settlements but may have limited access to setting the rules of interaction?

At the same time, even without a domestic technical assessment of the project, the issues of technological and digital sovereignty cannot be ignored. The main content of the first concept is the development of digital technologies and the creation of digital infrastructure using freely distributed software, server devices, and encryption technologies, both collectively and individually; digital sovereignty implies the right of nation states to independently manage their digital resources, supervise and control the activities of their own digital platforms, as well as the ability of the state to block

[18] Putin denies creation of SWIFT alternative in BRICS. *RBC*. 2024. Oct. 24. Available at: https://www.rbc.ru/finances/24/10/2024/671a68a79a794736c04b1b8c (in Russian) (accessed 30 October 2024).

information posted on them by relevant authorities and organizations if it does not meet the national interests of the country [Kochetkov, Maslov 2022].

The 2021 National Security Strategy of the Russian Federation notes that "the rapid development of information and communication technologies is accompanied by an increased likelihood of threats to the security of citizens, society, and the state." Consequently, the scenario of connecting to a project under foreign control cannot be assessed unequivocally. The implementation of digital sovereignty directly depends on the level of development of information technologies and the availability of a sufficient number of highly qualified IT personnel. The sphere of any international rights is regulated primarily by the goodwill of external actors and the potential of domestic ones.

The BIS Project Mariana [BIS 2023] deserves special mention. The project was carried out as part of a joint effort between the BIS Innovation Hub and banks in France, Singapore, and Switzerland. The aim of the project was to test the concept of using various CBDCs for cross-border payments and exchange transactions. The project started in November 2022 and ended on September 23, 2023. The results of the project demonstrated the fundamental feasibility of the proposed approach. In the context of the project, a number of countries with hypothetical CBDCs (wholesale CBDCs)—representing various currencies such as the euro, the Singapore dollar, and the Swiss franc—have engaged in transactions by leveraging special bridges. These bridges facilitate the transfer of tokens between platforms and automated market makers through the utilization of a public blockchain, thereby enabling transactions to occur without the involvement of intermediaries.

On the one hand, the pilot was successful and showed that direct exchange of CBDCs can speed up and reduce the cost of international settlements. On the other hand, the project clearly highlighted serious cyber risks and privacy issues that cannot be resolved automatically and require significant research and investment in operating mechanisms and infrastructure. In addition, it is obviously very difficult to ensure cooperation between countries, develop standards, and secure the necessary investments, including significant liquidity pools for the operation of automatic market makers.

4. International settlements in CBDCs and the balance of political forces

Another important aspect of the transition to international settlements using CBDCs relates to the *balance of power* and the restructuring of the world. The implementation of a project in this area, which could become in demand worldwide, will influence the geopolitical situation: the political weight of the state that launches its platform on a global scale will increase due to the greater integration of national technologies and financial instruments into the economies of other states. Scientists note that trends such as the widespread introduction of digital cryptocurrencies and the abolition of cash; the robotization of labor; and the widespread introduction of 5G systems for tracking information flows, primarily related to the movement of cryptocurrencies, imply a rejection of the current Bretton Woods system of institutions. According to globalists, a networked power structure may emerge in the digital society of the future. In the medium

term, the transnational digital elite is unlikely to establish global dominance, as nation states such as the US, China, and Russia will remain leading actors on the world stage for some time to come [Kochetkov 2024; Kochetkov 2022]. Thanks to the mBridge project, China is claiming the role of digital elite. China, which is historically characterized by implicit actions, a lack of concrete form, and "millennial" thinking (long strategic horizons), has managed to transform a unified digital space in the financial sector into a minimum viable product (MVP), which could be part of the program for the restructuring of Central Asia and Europe, as well as the modern world as a whole.

Of course, unexpected alternative scenarios cannot be ruled out. For example, US President Donald Trump has essentially announced the suspension of activities to introduce CBDCs in the US.[19] At the same time, he signed an executive order on the creation of a US cryptocurrency reserve.[20] To a certain extent, these two consecutive steps do not rule out potential strategic intentions to use cryptocurrencies to solve international settlement problems in the future. This assumption raises many doubts and questions but does not seem completely unrealistic in several scenarios. For example, the US could create state-backed stablecoins that could potentially be used for international settlements. Alternatively, the US could enter into agreements with certain countries to conduct trade settlements using cryptocurrency assets, which could potentially reduce payment costs and pilot an alternative cross-border settlement mechanism. The political aspect is also important here, as such an approach would strengthen the US's role in shaping global standards and help it become a key rule-maker. Of course, this path is extremely difficult, if only because it will require the US to ensure compliance with sanctions, AML (anti-money laundering) and KYC (customer identification) requirements in the use of cryptocurrencies, which has so far been met with limited success.

5. Conclusion

Against the backdrop of digitalization, we are seeing conceptual changes in the principles of interaction within human societies, and digital financial infrastructure is coming to the fore in terms of the integration of states into the system of international relations. The basket of cryptocurrencies, previously represented only by independent (decentralized) digital assets, is being replenished with national (sovereign) digital currencies. A number of countries and intergovernmental associations have already offered the world technologies for the direct exchange of CBDCs.

Russia is currently testing its own digital ruble, the prospects for which are currently limited to the domestic market. The question of using the digital ruble in international settlements remains open.

[19] Strengthening American Leadership in Digital Financial Technology Executive Order. *The White House*. 2025. Jan. 23. Available at: https://www.whitehouse.gov/presidential-actions/2025/01/strengthening-american-leadership-in-digital-financial-technology/ (accessed 7 March 2025).

[20] Fact Sheet: President Donald J. Trump Establishes the Strategic Bitcoin Reserve and US Digital Asset Stockpile. *The White House*. 2025. March 6. Available at: https://www.whitehouse.gov/fact-sheets/2025/03/fact-sheet-president-donald-j-trump-establishes-the-strategic-bitcoin-reserve-and-u-s-digital-asset-stockpile/ (accessed 07 March 2025).

The mBridge project is an important step in the development of international settlements without the use of the US dollar and could lead to a restructuring of the international financial system. The creation of a similar project in Russia could protect it from sanctions pressure in the future. Consequently, there is a clear case for developing such a project and, at the same time, for the Russian diplomatic service to be closely involved in promoting it. This would be a response to global demand for the introduction and use of more convenient, secure, and privacy-friendly digital currencies [Wang Junsheng 2025].

An important political signal indicating the project's prospects is the question raised by the BIS about withdrawing from it.[21] A project with no prospects for development would not have sparked debate in the authoritative US media. Given the political tensions between China and the US, as well as the ban on the CBDC signed by Trump, the BIS's withdrawal may be aimed at eliminating the potential for restructuring the existing global financial infrastructure inherent in the mBridge project. The open and vocal opposition to the project underscores that it poses a threat to the existing international payment architecture.

Given the conservatism of banks in using payment systems and the US-backed dominance of SWIFT and the US dollar in settlements, it is to be expected that the existing CIPS infrastructure will grow rapidly in terms of yuan settlements. This will be met with resistance from the US, leading to the separation and isolation of a number of banks that will only operate through CIPS, but not through SWIFT. Only large countries will be able to afford this, as smaller countries will fear sanctions due to the fact that these flows are not transparent to the US and undermine the role of the US dollar as a reserve currency. The FATF (Financial Action Task Force on Money Laundering), as an intergovernmental body, can apply a wide range of administrative measures against such countries.

Contradictory conclusions can be drawn about the changing role of SWIFT in the international architecture of cross-border payments. On the one hand, SWIFT technologies are not used in the mBridge project. On the other hand, the mBridge project is based on the ISO 20022 standard developed by SWIFT, which incorporates many years of experience in international financial transactions. Thus, SWIFT continues to serve as the foundation of the global financial market.

The most important open issue in the integration of CBDC exchange platforms remains the capacious political sphere—ensuring data confidentiality, national information security, and guarantees of compliance with the agreements reached. The resolution of these technical issues is closely linked to national sovereignty, and the integration of viable products may be artificially slowed down by government administrators in order to control the associated risks.

[21] Rejection of the "digital dollar" gives the EU and China a chance to introduce their own CBDC standards. *Frank Media*. 2025. Jan. 28. Available at: https://frankmedia.ru/191067 (in Russian) (accessed on 6 March 2025).

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Dynamics of Carbon Markets in Russia and Southeast Asia: Nature-based Climate Projects

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Abstract

Russia and Southeast Asia are pursuing strategies to enhance economic growth and industrial capacity, while taking into account environmental and climate-related limitations. In pursuit of carbon neutrality, both regions are prioritizing the implementation of natural and climate projects through a globally prevalent market mechanism: carbon markets. These markets are interpreted differently in diverse ways, ranging from the concept of absolute "freedom" in market dynamics to models characterized by substantial government and institutional involvement, facilitated by administrative and methodological regulations.

The present article has two objectives. The initial objective is to compare approaches to using natural capacity to achieve carbon neutrality in Russia and Southeast Asia. The second approach involves contextualizing these comparative characteristics within the broader framework of conceptual discourses

concerning the economic efficiency of natural and climate solutions, as well as the prospects for carbon markets in the context of the global climate change initiative.

The comparative analysis of the formation and dynamics of carbon markets in Russia and Southeast Asia reveals similarities in the formation of supply and demand for natural offsets. The experience of both regions demonstrates that the trading of carbon units is highly politically and ideologically determined, depends on the level of economic modernization, and is not a totally market-driven phenomenon. The current volume of issued carbon units remains minimal, precluding the discussion of a reduction in total greenhouse gas emissions and a substantial mitigation of climate change. However, despite the limited effectiveness of non-market measures, carbon markets are an important factor in stabilizing the climate in countries with significant state involvement in economic development, and it refers to both Russia and many Asian countries.

Introduction

Carbon markets are a globally widespread economic mechanism for combating climate change. According to the World Bank, mandatory and voluntary carbon markets cover about 20% and 10% of annual anthropogenic greenhouse gas (GHG) emissions, respectively,[1] and with countries and companies striving for carbon neutrality, the volume of carbon markets could increase to 80% of annual anthropogenic greenhouse gas emissions by 2030 [Ecosystem Marketplace 2023]. At the same time, nature-based climate projects remain one of the world's most popular tools for issuing certified carbon credits (CCUs).[2] Recent initiatives by major global greenhouse gas emitters—the US,[3] the EU, and China—are promoting greater integration of voluntary and mandatory markets to build a new generation of carbon markets capable of overcoming their main shortcomings: the unreliability of verifying the effects of natural climate projects, double counting and reselling of EUs, and the low quality and prices of carbon offsets.[4]

[1] The volumes of mandatory and voluntary carbon markets cannot, strictly speaking, be directly compared, as they have different metrics. The scale of mandatory markets is determined by the total GHG emissions of companies subject to carbon regulation legislation. The scale of voluntary markets is measured by the initial sales of carbon credits, which only record the balance of reduced or absorbed GHG emissions, not the total emissions of the crediting entity.

[2] A carbon unit is an asset in the form of prevention (e.g., renewable energy projects), reduction (e.g., energy efficiency projects), or increased absorption (e.g., reforestation) of 1 ton of CO_2 -eq, which one counterparty can purchase from another through exchange (e.g., Mosbirzha) and over-the-counter (e.g., bilateral direct agreements) trading.

[3] In the US, on May 28, 2024, a government decision was adopted defining the key principles for the functioning of highly integrated and high-quality voluntary carbon markets. See: https://www.whitehouse.gov/briefing-room/statements-releases/2024/05/28/fact-sheet-biden-harris-administration-announces-new-principles-for-high-integrity-voluntary-carbon-markets/ (accessed 11 July 2024).

[4] In this article, the terms *"carbon credit"* and *"carbon offset"* are used interchangeably; in reality, they should be distinguished, since carbon credits can be used for purposes other than offsetting a company's greenhouse gas emissions covered by scopes 1, 2, and 3 (e.g., for investment, to achieve other sustainable development goals), while carbon offsets can be implemented not only through the trading of carbon units.

Russia and Southeast Asia (SEA) have recently initiated the implementation of a carbon trading mechanism, recognizing the significant potential of nature-based solutions. A comprehensive analysis entails not only a comparison of the functioning of carbon markets in market economies as a whole, with the objective of achieving a balance between high rates of industrial and economic growth and reliance on natural and climate capacity to achieve carbon neutrality, but also taking into account the experience of Russia and Southeast Asia within the broader discourse on the merits and limitations of natural offsets and carbon markets.

A comparative analysis of Russia and the SEA has been carried out within a political economy approach, focusing on the driving forces behind the formation of demand and supply for natural offsets and the motivations of large reference groups (international organizations, NGOs, states, private businesses) within the strategic perspective. The analysis of carbon regulations in these two regions is conducted through the lens of subject-object relations, including various agents, structures, and institutions with their own interests, hierarchies, and motivations. The empirical basis of the study has been structured on the data from international programs (the Clean Development Mechanism (CDM), Joint Implementation (JI)), foreign and national registries (GS, VSC, etc.), a review of scientific literature and specialized analytical reports (Ecosystem Marketplace, Voluntary Carbon Markets Integrity Initiative, etc.). Moreover, a total of 29 sociological interviews were conducted in Russia during 2022–2023. These interviews were conducted as part of the implementation of the federal initiative of the Ministry of Education and Science of the Russian Federation concerning carbon supersites (polygons).

1. Common climate challenges for Russia and Southeast Asia

Russia and SEA have similar characteristics in terms of the development of their industrial and energy sectors, which makes them comparable in terms of their trajectories toward carbon neutrality. According to the UNIDO classification, both economic entities are classified as *middle industrial countries*, although in one case this mainly refers to raw materials and primary processing, and in the other to metallurgy, the chemical industry, and the beginnings of high-tech industries (see Table 1 on p. 46).

Table 1. Comparative characteristics of Russia and Southeast Asia

Indicators	Russia	Southeast Asia
Population (thousand people)	146,150	671,681
GDP per capita (in current prices, US dollars)	13,817	5,392
Greenhouse gas emissions from production, million tons CO_2 equivalent	1,712	1,805
Greenhouse gas emissions from consumption, million tons CO_2 equivalent	1,360	1,851
Net exports (+)/imports (-) of emissions, million tons CO_2 equivalent	3	-46
Energy Sector		
Length of main gas pipelines, km	113,073	17,665
Oil and gas production, million barrels per year	6,573	1,144

Liquefied natural gas storage terminal capacity, million tons per year	31.1	110.7
Energy intensity (kg of standard fuel per dollar of GDP at PPP)	134	144.8
Installed power of power plants, GW	275	310
Annual electricity generation (GWh)	1,115,093	1,164,276
Share of coal-fired power generation in electricity production, %	14.8	43.6
Share of renewable energy sources (excluding large hydropower plants) in electricity generation, %	0.36	10.04
Manufacturing Sector		
Share of industrial value added in GDP, %	15.1	21.8
Share of high-tech products, % of industrial value added	21.2	59.2
Share of employment in industry, %	14.2	14.5
Carbon intensity of manufacturing, kg CO_2 per $1 of added value in industry	1.27	0.58
Top 5 traded industrial goods, share in exports, %	1. Fuel (31) 2. Metals (29.3) 3. Chemical industry products (12.4) 4. Food products (7.7) 5. Wood products (3.7)	1. ICT (24.2) 2. Chemical industry products (11.0) 3. Food products (8.9) 4. Metals (6.9) 5. Machinery and equipment (5.7)

Source: compiled by the author based on the following databases: 1) key macroeconomic indicators from EMISS and ASEANStatistics 2) energy indicators from https://www.iea.org/data-and-statistics 3) industry indicators from UNIDO, Industrial Analysis Platform https://iap.unido.org/data/country?p=RUS 4) greenhouse gas emissions from https://globalcarbonatlas.org/emissions/carbon-emissions/

Firstly, energy is the primary source of anthropogenic greenhouse gas emissions, with hydrocarbons predominating in both regions in the medium term. A comparative analysis of the regions reveals that they are comparable in terms of electricity generation. While coal-fired power generation constitutes a mere 14.8% of the nation's total electricity generation, in certain megaregions, such as Siberia, this figure reaches 35.7%, a proportion comparable to the SEA, where coal-fired power plants generate 43.6% of electricity and heat. The intensive use of hydrocarbons is supported by comparable plans for the development of new oil and gas infrastructure. At present, 21,346 km and 9,936 km of pipelines are under construction in Russia and the SEA, respectively. The construction of liquefied natural gas storage terminals is also planned to increase. The capacity is expected to increase from the current 31.1 to 195.2 million tons per year in Russia and from 110.7 to 174 million tons per year in the SEA. The utilization of carbon-free energy sources, encompassing both nuclear and renewable energy, is constrained. Nuclear energy is not a viable option in the SEA, while renewable energy is underdeveloped in Russia, contributing a mere 0.36% to electricity and heat generation, in comparison to 10.04% in the SEA. This reliance on hydrocarbons, in conjunction with elevated energy intensity (134.0 kilograms of fuel equivalent per dollar of GDP at PPP in Russia and 144.8 kilograms in the SEA, in comparison to the global average of 104.2 kilograms), impedes decarbonization processes within the energy sector and prompts regions to explore alternative approaches to achieving carbon neutrality [IEA 2024].

Secondly, Russia and the SEA are medium-developed industrial economies (among the top 30 countries in the UNIDO Competitive Industrial Performance (CIP)), where the same proportion (approximately 14%) of the workforce is employed in sectors that are challenging to decarbonize. The carbon intensity of Russian industry is twice that of Southeast Asian industries. Concurrently, the latter's exports of industrial goods are increasingly contingent on the US, where progressively stringent requirements for the carbon footprint of products are being implemented [Volgina 2023]. The necessity to achieve and sustain elevated economic growth rates, predicated on both conventional and alternative energy sources, renders it challenging for both Russia and the Southeast Asian region to operate within the prevailing paradigm and disregard market-based approaches to carbon regulation.

Thirdly, the Russian Federation and the countries of the Southeastern European region, with their unique ecosystems, are facing the consequences of climate change and environmental degradation. Their extensive coastlines render them among the most vulnerable territories globally, as indicated by the 2050 Climate Change Index. Russia is particularly susceptible to the effects of global warming. Between 1976 and 2021, the country experienced an average temperature increase of 0.49°C per decade. In contrast, the global average temperature increased by 0.18°C during the same period.[5] The contemporary era is marked by an escalating frequency of natural disasters, with fires[6] and floods[7] becoming increasingly prevalent, particularly in the Siberian region. This phenomenon is accompanied by the thawing of permafrost, the drying up of swamps, the outbreak of peat fires, and the extinction of certain species of flora and fauna.[8] According to the Mekong Institute, 5,216 natural disasters were documented in Southeast Asia between 1980 and 2022, 41% of which were floods, resulting in annual damage to 80 million people. Concurrently, nature serves as a formidable instrument in the struggle against climate change. According to recent data, forests comprise 49.8% of Russia's total area. The pristine forests of Siberia are among the top five most valuable "megaforests" on the planet.[9] In the Far East, forests encompass 38.9% of the territory. In the early 2000s, the region functioned as a net absorber of greenhouse gases. However, as the population

[5] Eighth National Communication of the Russian Federation submitted in accordance with Articles 4 and 12 of the United Nations Framework Convention on Climate Change and Article 7 of the Kyoto Protocol. Ministry of Natural Resources and Environment of the Russian Federation and Roshydromet of the Russian Federation, Moscow, 2022.

[6] Over the past 20 years, the area of fires in Siberia has increased 200 times: if in 1997, 31.3 thousand hectares were engulfed in wildfires, then in 2018 it was already 8.5 million hectares.

[7] In the Siberia megaregion, where 90% of the country's water resources are concentrated, floods are becoming large-scale and destructive. For example, due to the flood in the city of Tulun in 2019, 10 thousand houses were destroyed, 40 thousand people were left homeless, and the costs of restoration amounted to 40 billion rubles (0.3% of the mega-region's GDP).

[8] In addition to weather anomalies, the nature of Siberia suffers from man-made disasters: the damage from the spill of 21 thousand tons of diesel fuel in Norilsk in 2020 was estimated at 146.2 billion rubles, and another 174 million rubles (about 250 thousand rubles per person) were paid to indigenous peoples due to restrictions on reindeer herding and fishing as the main types of economic activity of the small peoples of Taimyr.

[9] Four other "megaforests" are located in the United States (Alaska), Brazil (Amazon), Congo, and New Guinea.

grew and urbanization reached 64% by 2022 (75% in Russia), an increasing number of forest areas have been converted into agricultural land.

In this context, natural climate projects in Russia and the SEA are being considered not only for the production of natural offsets to achieve carbon neutrality, but also as important tools for nature-based solutions (NbS) to adapt to negative weather anomalies [Battle for Climate 2021; OECD 2024].

2. Theoretical understanding of the role of natural offsets and carbon markets in achieving carbon neutrality

Natural offsets are tools for combating climate change that are effective in theory [Stepanov, Galimova 2021] but controversial in practice [Miron, Soares 2021]. The importance of nature-based climate projects for the issuance of carbon credits is dictated by two circumstances. *First,* despite the anthropogenic cause of the current climate crisis, natural flows account for 95% of the annual carbon cycle, on which the desired stability of temperature fluctuations within acceptable limits depends. With minimal intervention in nature, it is possible to achieve large-scale effects. *Second,* nature has a huge carbon reserve (38,000 billion tons in the ocean and 2,300 billion tons in the biosphere), and in certain areas, its release due to, for example, fires or the melting of permafrost can quickly exceed the "heat effect" of annual anthropogenic emissions (which amount to 11.9 billion tons worldwide).

Natural offsets are usually complementary to carbon markets. There are different classifications of carbon markets depending on the type of supply and demand, as well as the mechanisms for trading carbon units. In this article, we adhere to the internationally accepted division into so-called **mandatory** and **voluntary** carbon markets, which differ from each other in the nature *of the intentions* of GHG emitters to participate in the carbon unit (CU) trading system.

Where governments set emission quotas that companies are required to meet, trading in emission permits with the corresponding potential use of carbon credits can be classified as *mandatory* carbon markets. Under another classification, these are referred to as "carbon *permit* markets" [Patnaik 2023]. Market advocates naturally also consider a carbon tax[10] as a market-based solution to global warming, although there are theoretical grounds for doubting its market nature (by analogy with the introduction of property rights)— relevant discussions are taking place in the context of the debate on ways to overcome the "tragedy of the commons" [Murphy et al. 2015]. *Mandatory carbon markets* cover about 20% of annual GHG emissions, and as more countries introduce carbon taxes and emissions trading systems, the size of these markets will also grow, according to some estimates, to 47% by 2030.

In the case of *voluntary* markets, demand is driven by the companies themselves. In another classification, such markets are referred to as "carbon *credit* markets" [Broekhoff et al. 2019]. *Voluntary markets* are not directly regulated by the state but are organized

[10] The system of state regulation using a carbon tax in some jurisdictions (e.g., Scandinavian countries) involves the use of *market* instruments such as carbon credits, which allow for a reduction in the tax base, so the carbon tax generally correlates with the functioning of *mandatory* carbon *markets*.

by international institutions (e.g. REDD+ under the auspices of the UNFCCC), non-governmental organizations (Gold Standard, Plan Vivo, etc.), which develop their own methodologies for assessing climate projects and programs and maintain registers of carbon credits issued and offset. Voluntary regulation of carbon markets is made possible by the existence of socially responsible companies that comply with norms and standards developed, for example, by the IOSCO and CFTC commissions for the California program in the US or the non-profit organization ICVCM's Core Carbon Principles in the UK, among others. As more private companies adopt *corporate strategies* of "net zero emissions" or "carbon neutrality," the volume of voluntary markets is expected to grow to 23–28% of annual GHG emissions, and its capitalization could exceed $3 trillion by 2030 [Forest Trends' Ecosystem Marketplace 2024].

Mandatory and voluntary carbon markets are interlinked, there are no strict demarcations between them, and they may overlap [IETA 2023]. Thus, voluntary carbon markets do not exclude government participation (see section II.1 of Table 2) and regulation by different entities. For example, carbon credits (CERs) were issued after a comprehensive analysis led by the UNFCCC, and if they received regulatory approval, these credits (known as secondary CERs) could be traded alongside emission allowances (EUAs) in the European ETS system; without UNFCCC approval (so-called primary CERs), they were sold at a significant discount (see, for example, the Bluenext trading platform).

Currently, natural offsets are mainly traded on voluntary carbon markets, although they are also used in several national or regional emissions trading systems (the US (California), South Korea, Singapore, etc.).

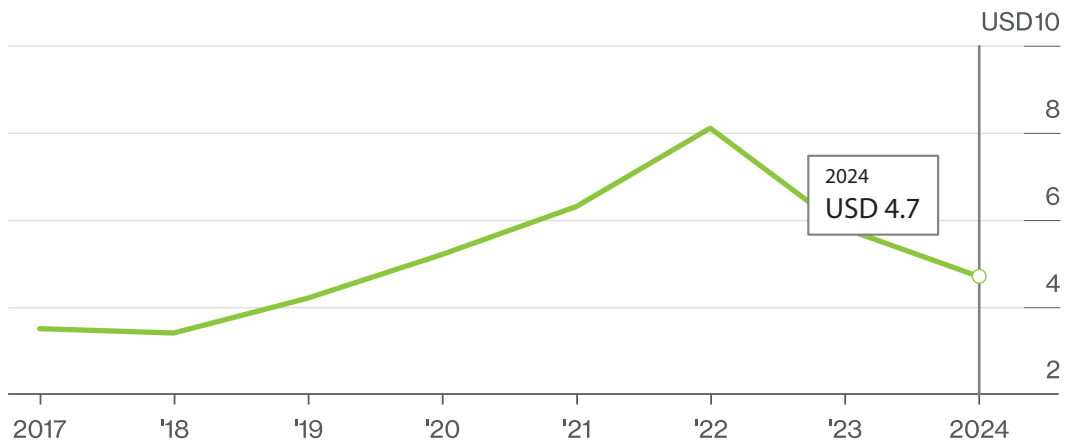
In theory, in both cases, natural offsets in both mandatory and voluntary markets allow issuers to offset part of their GHG emissions, but for different purposes: to meet government-mandated quotas or to voluntarily offset the carbon footprint of their products or services. In practice, however, modern carbon markets and natural offsets have a number of significant shortcomings that raise questions about their effectiveness.

1. In many jurisdictions, *the low cost* of carbon credits and emission allowances does not create adequate costs for emitters and expected benefits for climate project initiators, and lags significantly behind the social value of carbon[11] $80) (see Figure 1 on p. 51).

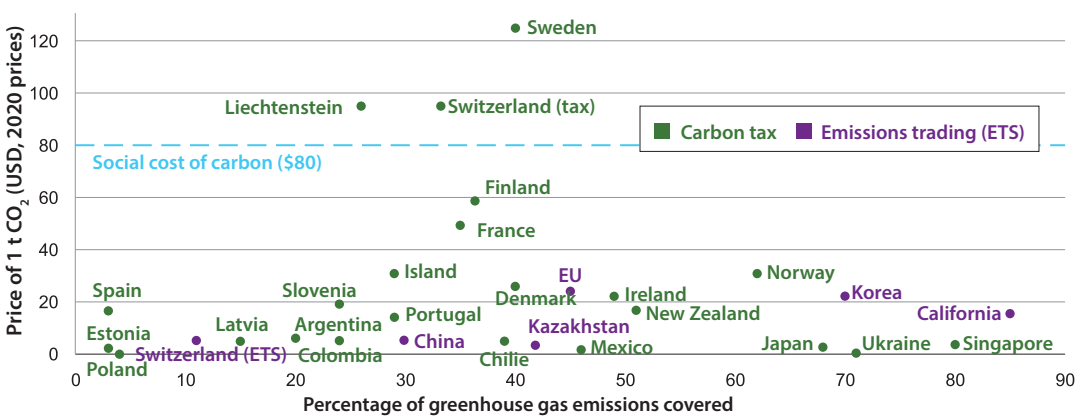
2. In some carbon markets where monitoring and verification systems are underdeveloped, various types of *opportunistic behavior* are observed. Major climate initiatives have increasingly failed. In 2023, the Cariba megaproject by US verifier Verra was discredited, which could lead to the write-off of "low-quality carbon credits" and the withdrawal of up to 38–51% of the verifier's insurance coverage. In 2024, the leader in marine biosecquestration, startup Running Tide (Maine, US), closed its microalgae aquafarm because it failed to achieve verified absorption levels.

[11] Social Carbon Cost (SCC) is an estimate of the likely socio-economic damage resulting from the emission of one ton of CO2 equivalent. Unlike market-based carbon pricing mechanisms such as carbon allowances, credits, offsets, and taxes, the social cost of carbon is a calculated indicator used purely for analytical purposes. Estimates vary significantly depending on the models used and are constantly being revised. We use an estimate based on the GIVE model (2021) with a discount rate of 3%: SCC 1 t CO_2 is estimated at $80, 1 t CH_4 at $1,316, and 1 t N_2O at $26,791.

Figure 1. Carbon price in voluntary (A) and mandatory (B) carbon markets, USD



A)



B)

Source: compiled by the author based on: A) weighted average price of carbon credits according to MSCI Carbon Markets, B) cost of allowances and carbon tax according to the World Bank Carbon Pricing Dashboard.

3. Carbon markets are seen as a tool of eco-capitalism [Rathi 2024] and create conditions for "greenwashing,"[12] helping big consulting firms thrive, which, according to [Mazzukato, Collington 2023. P. 211], earn good money from the obsession of businesses and governments with ESG metrics and carbon reporting. Critics of carbon markets suggest that reducing GHG emissions is the only way to save the climate [Coyle 2021] or even insist that "green economic growth" is an illusion [Schröder, Storm 2020]. Against

[12] "Greenwashing" originated from the English idiom "money washing" and is associated with fictitious carbon reporting, MRV procedures, etc.

this backdrop, non-market alternatives are being proposed, such as the concept of degrowth [Aronoff 2021] or the establishment of maximum permissible GHG emissions, geoengineering [Grubb et al. 2023], shifting the focus from regulating production to creating incentives to limit consumption [Makarov, Alataş 2024], or, instead of decarbonizing the economy, it is recommended to concentrate efforts and finances on adapting to the inevitable negative consequences [Porfiriev, Katsov 2011].

This criticism is accompanied by a lack of uniform understanding of the directions for reducing GHG emissions, as this process is interpreted by several concepts:

1) *Low-carbon development* emphasizes the gradual reduction of anthropogenic GHG emissions;
2) *Deep decarbonization* implies faster rates of emission reduction not only in the energy sector, but across all industries;
3) *Carbon neutrality* implies covering the annual volume of unavoidable CO_2 equivalent emissions through the use of any type of carbon credits;
4) *"Net zero"* requires achieving a state of "no impact on the climate" when the total volume of residual emissions (i.e., those that are difficult to reduce due to technological and financial constraints) is offset by reliable removal from the atmosphere and long-term storage of CO_2;
5) *"Zero carbon" development* is achieved through economic activity without any anthropogenic GHG emissions.

In Russian discourse, the first four approaches are understood as largely identical, which distorts the understanding of alternatives for decarbonizing the economy and narrows the range of solutions [Gorbacheva 2023].

These conceptual differences manifest themselves differently in Russia and Southeast Asia, which are united more by empirical reality than by ideological conviction in the effectiveness of carbon markets and natural offsets (see Table 2 on p. 52).

Table 2. Voluntary and mandatory carbon markets in Russia and Southeast Asia

Countries	Russia	Cambodia	Laos	Malaysia	Myanmar	Thailand	Vietnam	Singapore	Indonesia	Philippines	Brunei	Timor
Total emissions, 2021 (million tons CO_2 equivalent)	1800	75	43	368	247	451	458	64	1475	227	12	6
Emissions forecast, 2030 (million tons of CO_2 equivalent)	2170	155	104	-	842	927	927	60	1950	325	23.6	-
Emissions per capita (tons of CO_2 equivalent per person per year)	12.5	4.4	5.9	11.3	4.5	6.4	4.7	11.3	5.4	2.0	27.9	4.5
Carbon intensity (g CO_2 -eq/GDP)	1209	2892	2284	1091	3124	903	1334	186	1394	628	1018	3161
Target year for achieving carbon neutrality	2060	2050	2050	2050	-	2050	2050	2050	2060	-	-	-
I. Mandatory (compliance) carbon markets												
Year	2021							2019	2023			
Status	++			+		+	++	+++	+++		+	

Countries	Russia	Cambodia	Laos	Malaysia	Myanmar	Thailand	Vietnam	Singapore	Indonesia	Philippines	Brunei	Timor
Type (1-ETS; 2-carbon tax)	1			1		1	1	2	1+2		n/a	
Price per 1 ton of CO_2 , USD								18.5	0.61			
% of GHG emissions covered by the initiative								80	26			
II. Voluntary carbon markets												
II.1 Governmental Crediting mechanisms												
Year	2022	2012	2012			2014	2012		2012			
Status	+++	+++	+++			+++	+++		+++			
Scale (R-regional; N-national)	N	R	R			N, R	R		N, R			
Price per 1 ton of CO_2 (US$)	9–10					0.64–9.46			0.61			
Market volume since the start of implementation (Mt CO_2 e)	1.5	0.1	0.2			13.9	4.4		56.2			
II.2 Foreign NGOs (Gold Standard, Verified Carbon Standard, Plan Vivo)												
NGO	GS, VSC	GS, VSC	GS, VSC	VSC	GS, VSC	GS, VSC	GS, VSC	VSC	GS, VSC, PV	GS, VSC		
Year	2003	2003	2003	2005	2003	2003	2003	2005	2003	2003		
Market volume since the start of implementation (Mt CO_2 e)	0.8	51.3	1.27	0.52	0.51	15.1	9.93	1.28	91.1	0.69		
II.3 International program (Clean Development Mechanism, Joint Implementation)												
Year	2008	2005	2005	2005	2005	2005	2005	2005	2005	2005		
Market volume since the start of implementation (Mt CO_2 e)	266	9.7	4.5	13.9	7.0	16.7	32.7	0.56	49.3	5.1		
III. International transfer of carbon units (ITMO) under Article 6 of the Paris Agreement												
Year	-	2022				2022	2022	2023	2023			
Role (1-buyer; 2-seller)	-	2				2	2	1	2			
Number of contracts	-	1				1	2	13	1			
Counterparty	-	Singapore				Switzerland	Singapore, S. Korea	N	Norway			
Market volume since introduction (kt CO_2 e)	-	50				50	100	650	50			

Note: Status is indicated by + pending, ++ under development, +++ implemented.

Source: compiled by the author based on Gold Standard,[13] Verified Carbon Standard,[14] Plan Vivo,[15] Clean Development Mechanism,[16] Joint Mechanism,[17] World Bank,[18] Climate Watch.[19]

13 Gold Standard. https://registry.goldstandard.org/credit-blocks?q=russia&page=1

14 Verified Carbon Standard. https://registry.verra.org/app/search/VCS/All%20Projects

15 Plan Vivo. Access mode: https://mer.markit.com/br-reg/public/

16 Clean Development Mechanism. https://cdm.unfccc.int/Registry/vc_attest/index.html

17 Joint Mechanism. https://ji.unfccc.int/index.html

18 World Bank Carbon Pricing Dashboard. https://carbonpricingdashboard.worldbank.org/

19 ClimateWatch. Режим доступа: https://www.climatewatchdata.org/

3. Carbon market development practices in Southeast Asia

SEA is one of the world leaders in the development of voluntary carbon markets, with more than 311 million certified credits issued in the region, 68% of which are from forestry projects (see Figures 3 and 4 on p. 54).

Figure 3. Structure of carbon credit issuance in voluntary carbon markets in regions of the world, 1996–2023

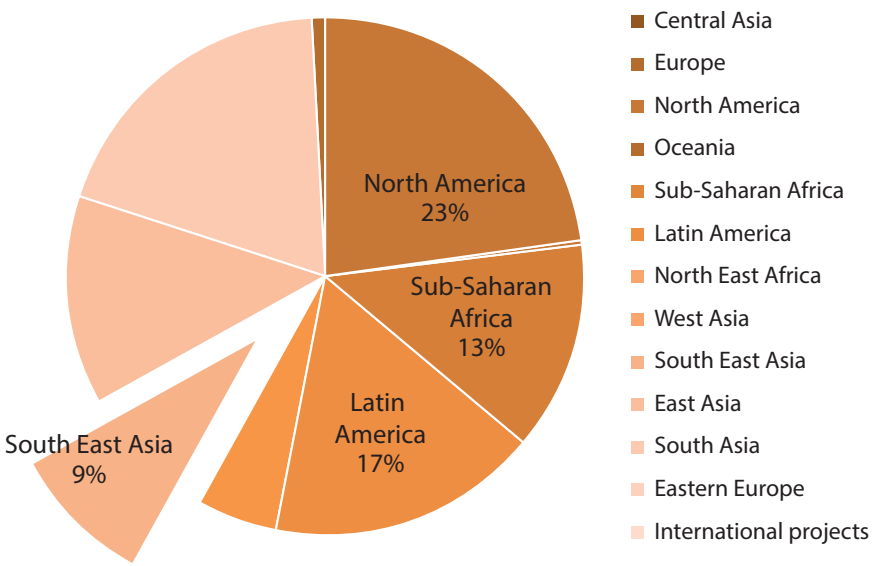
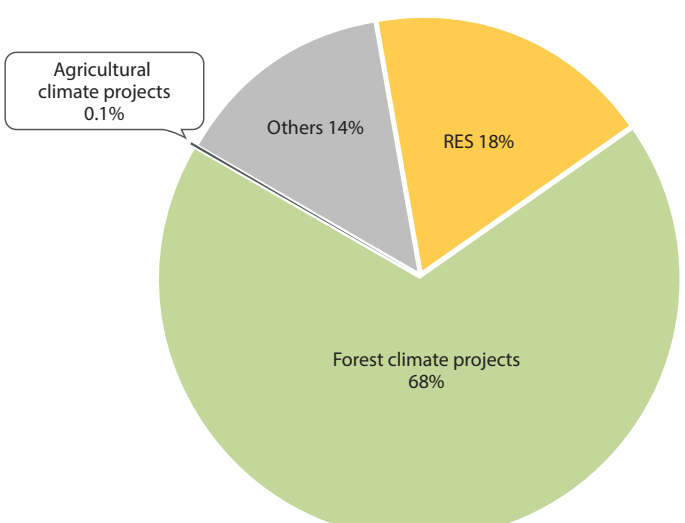


Figure 4. Structure of carbon credit issuance in Southeast Asia, 1996–2023



Demand formation

For carbon markets to function, demand for carbon credits must be created, which cannot be achieved without government programs or the involvement of foreign buyers. The voluntary carbon market in SEA began to take shape in 2003 with the introduction of the Clean Development Mechanism (CDM) under the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol, primarily for buyers from the European Union. Initially, the SEA was regarded as a provider of inexpensive CU, and Western countries, which had historically been responsible for accumulated anthropogenic emissions, utilized this market mechanism as an opportunity to employ the least costly options for offsetting the carbon footprint of their products [Rabe 2018]. In 2012, Japan initiated a voluntary carbon crediting system (Joint Crediting Mechanism, JCM) with the goal of reducing itſ international emissions. Under the JCM, Southeast Asian countries receive Japanese technology, technical support, and consulting from Japanese firms, and Japan utilizes their carbon credits to meet its international emission reduction commitments.

Domestic demand for carbon credits in the SEA region has been created by the introduction of national mandatory carbon regulation systems since 2019. SEA countries have adopted national carbon neutrality strategies, which they aim to achieve by 2050 (Indonesia by 2060, and Thailand by 2065, with plans to achieve "net zero" by 2065). Large-scale trading is only carried out in Indonesia in a hybrid format called the Carbon NEK Trading Scheme, where 146 large coal-fired power plants are benchmarked at 1.3 t CO2 -eq/MWh, and if the quotas are not met, the company will pay a carbon tax, which will be introduced in 2025 at the weighted average price of carbon on the domestic market. Natural offsets are not accepted, but other types of carbon credits are used, in particular renewable energy projects registered in the national registry. In 2023, 8,515 carbon credits were issued under the Indonesia Carbon Exchange (IDXCarbon) through large renewable energy projects in Indonesia: the PT Pertamina Geothermal Energy geothermal power plant (84.4% of carbon credit issuance), PT UPC Sidrap Bayu Energi wind farm (11.5%), and PT PJB UP Muara Karang solar power plant (1.1%).

Supply formation

A critical volume of certified CU issuance is required to maintain the liquidity of carbon markets. The establishment of bio-plantations in Southeast Asia can be traced back to the 1980s and 1990s, a period during which Japan actively relocated polluting industries, including petrochemicals and cement production, and initiated the cultivation of biomass for the purposes of wood processing and paper production. The implementation of artificial bio-plantations has been observed to cause a disruption to the water balance, as these bio-plantations require the extraction of water from much deeper than normal forest land. The absence of long-term oversight regarding bio-plantations has resulted in illegal logging, inciting protests in densely populated regions of Thailand and Indonesia [Dauvergne 1997; Laely, Davies, Alam 2020].

The implementation of CDMs in Southeast Asia was meticulously designed to enhance the quality of forestry projects and the culture of decision-making through the application of scientifically sound methodologies, consulting services provided by foreign NGOs, and the establishment of rigorous standards for assessing additionality effects. This positive experience has enabled the implementation of more than a hundred projects, primarily in Indonesia, and laid the groundwork for offering natural offsets. Government agencies in Southeast Asian countries exhibited minimal involvement, though in certain instances, they endeavored to regulate the situation by imposing additional charges (in Thailand and Vietnam) on international initiators for the privilege of implementing projects [Mehling et al. 2012]. The needs and rights of local residents were largely ignored due to the region's dependence on donor assistance and international consulting [Balboa 2018; UNEP 2023]. For instance, as part of a large-scale initiative known as The Southern Cardamom REDD+, implemented by the Cambodian Ministry of Environment and the international organization Wildlife Alliance [Chávez 2024], more than a hundred local banana farmers were forcibly resettled without the equitable distribution of benefits. According to a study [Parsons 2023], Southeast Asian countries have faced "carbon colonialism," in which natural resources continue to be exploited, exported, and profited from far from the places and people they belong to. In many ways, this is an old story, but what is new is the hidden costs of natural resource use, i.e., the "carbon bill" that is linked to resource feasting. The considerable distance between extraction centers and "dirty" industries, on the one hand, and the places where products are directly consumed, on the other hand, complicates direct environmental control. This, in turn, makes it difficult to account for the enormous volumes of greenhouse gas emissions that actually occur in the production of seemingly "clean" products. As an example, [Parsons 2023] cites English textile factories in Cambodia, which use large amounts of biomass from illegal logging to produce electricity and steam new, "zero-carbon" cotton shirts in the UK. Concurrently, Cambodia confronts considerable risks associated with global warming, which is adversely impacting the "profitable" land use and forestry sector.

As these countries have developed their own scientific expertise, five SEA countries—Indonesia, Thailand, Vietnam, Laos, and Cambodia—have initiated national voluntary CU programs since 2014, relying on domestic verification and validation organizations. The accelerated economic growth experienced by the Southeast Asian (SEA) region during the 2010s resulted in numerous countries' transition from the status of "least developed countries" and "lowest income countries." This transition, in turn, precipitated a decline in funding from international development institutions and financial entities. The emergence of carbon markets was perceived as a novel source of financing to compensate for lost government revenues. However, domestic demand for CU was found to be low, primarily due to the substantial subsidies received by the primary emitters, namely energy companies. These companies exhibited a lack of interest in acquiring carbon offsets to compensate for their high-emission activities. The services of foreign registries and verifiers remained inaccessible, leading to the resale of natural offsets at higher prices on Western secondary markets. The cost of natural offsets in Asia remains one of the lowest in the world: an average of $5.55, which is four times cheaper than in Europe, where they sold for $24.57 in 2023 [Forest Trends' Ecosystem Marketplace 2024].

Market formation

The success of carbon markets depends largely on the development of intermediary and consulting institutions (marketplaces, brokers, rating agencies, etc.) for the seamless integration of CU supply and demand. With declining donor support and external financing, SEA countries are strengthening state regulation of carbon markets, while facing challenges, primarily in data *collection and exchange* [The agenda for decarbonizing ASEAN... 2021]. The variability of natural ecosystem absorption makes these projects susceptible to "baseline" justification when determining "additionality" effects. Data exchange is difficult because various government agencies, international organizations, and independent NGOs are involved in carbon regulation, none of which are willing to share the data they have collected or require payment for its use. Many targets are set based on closed, unreviewed forecast models, and CO_2 sequestration estimates are based on fragmented, singular sources that are not representative of the diversity of SEA's ecosystems [Arimura, Sugino 2024]. For example, to justify the "additionality" of biomass utilization projects, data is collected from only 1/5 of a sample of nearly 500 sites in Vietnam.[20] Although climate policy in SEA is generally overseen by the Ministry of Natural Resources at the national level, there is bureaucratic competition for influence and funding sources. A telling example is Vietnam, where the Ministry of Natural Resources, as part of its 2011 national climate strategy (Climate Change Strategy 2011), is responsible for developing a mandatory emissions trading system based on its own scenario calculations, while the Ministry of Planning and Investment presented its own Green Growth Strategy in 2012, which establishes a voluntary mechanism for trading CU, taking into account greenhouse gas emission reduction targets that differ from those of the Ministry of Natural Resources [Asian Development Bank 2017]. Such divergent actions against the backdrop of fragmented carbon markets in Southeast Asia limit domestic demand for CU and increase dependence on foreign intermediaries.

Another problem is the lack *of in-house expertise* to assess the quality of climate projects. The reduction in the activities of international organizations has led to a shortage of highly qualified specialists who not only have the "fieldwork" skills to validate the results of climate projects but also possess the comprehensive knowledge to negotiate and consult with clients. The lack of research and development skills in Southeast Asia is linked to the overall low level of innovation in the regions where most forest climate projects are implemented. For example, research and development expenditure in Indonesia accounts for 0.28% of GDP, in Vietnam 0.43%, in Thailand 1.21% and in Malaysia 0.95%.

Nevertheless, over time, international experiments have created the conditions in Southeast Asia for the formation of an expert community that defends regional interests in the field of forestry. Consequently, under the direction of the ASEAN Secretariat, the Regional Knowledge Network on Forest Law Enforcement and Governance and the Regional Knowledge Network on Forest and Climate Change were established in

[20] What is needed to update and maintain a Safeguards Information System? Lessons from Viet Nam. UN-REDD Programme. Available at: https://www.un-redd.org/post/what-needed-update-and-maintain-safeguards-information-system-lessons-viet-nam (accessed 11 July 2024).

2007, unifying experts from prominent research institutes within the region. In order to coordinate reforestation efforts, the ASEAN Clearinghouse Mechanism (CHM) was established in 2004 to collect information on the current state of forest areas in the SEA. This platform is a "soft" environmental monitoring instrument intended for the establishment of an autonomous advisory environment and expert community that is not subject to external influence. Independent expertise, derived from meticulous research, has become a sought-after commodity among executive and supervisory bodies. This expertise is instrumental in the organization of cross-border monitoring of criminal activity and fire conditions in the region. The establishment of interregional ASEAN centers has played a role in the legitimization of public management of natural capital in the SEA, despite the unresolved issue of transparency of these structures [Urpelainen 2022].

Attempts to integrate mandatory and voluntary markets in SEA are being made through various platforms and network programs for the development of MRV procedures and blockchain data exchange technologies, such as the International Carbon Action Partnership (ICAP), the International Emission Trading Association (IETA), the Asia-Pacific Roundtable, and the World Bank's Partnership for Market Readiness (PMR) initiative to develop carbon markets. The carbon markets of China and South Korea, which accept natural offsets, are also considered promising in terms of international carbon transfer. However, these efforts remain sporadic, often dependent on bilateral agreements, and an important direction for the development of carbon markets in the SEA region is seen in strengthening the role of domestic expertise and interregional cooperation regimes for the issuance of high-quality natural offsets. In this context, Singapore, with its modest capacity to issue carbon credits, is an important trading platform for their secondary circulation. Established in 2023 by the Singapore government with the support of the World Bank, the Asian Carbon Hub[21] integrates the main carbon credit registries and trading exchanges (Climate Impact X, AirCarbon, etc.), and attracts more than 100 service companies for monitoring, verification, and insurance of carbon credits.

4. Russia's experience

Demand formation

In Russia, the use of carbon credits dates back to 2005, when the Kyoto Protocol came into force, although the first carbon credits were issued in 2003 under the Swiss Gold Standard registry. Moreover, at the beginning of the journey, before the emergence of voluntary markets, Russian environmental projects received international support,[22] but unlike donor support in the EU, here support was provided in the form of loans to Russian enterprises for the implementation of commercially viable projects (the internal rate of return reached, according to estimates [Safonov 2002], 70%) for reducing harmful

[21] International Emissions Trading Association Singapore Limited.

[22] Russian program for the organization of investments in environmental protection, established in accordance with the Agreement between the Russian Federation and the IBRD in 1995.

emissions, including GHG emissions. Overall, during the period 2003–2022, 268 million CUs were issued in voluntary programs led by the FCCC (Joint Implementation Projects) and foreign NGOs (GS, VCS) in Russia. Unlike in SEA, these were mainly implemented as part of energy projects to reduce[23] or prevent[24] greenhouse gas emissions for the needs of Russian energy companies, chemical and metallurgical enterprises. Natural offsets were practically not used. Only two projects are registered in foreign registries: project VCS1544 to reduce the impact of logging by the company "Terneyles" in Primorsky Krai and project GS3660 for reforestation by the non-profit organization Center for Environmental Innovation in Altai Krai. However, information about their validation is not reflected in the registries.

The state system of mandatory and voluntary carbon regulation began to be established after the adoption in 2021 of the Low Carbon Development Strategy[25] and the Federal Law "On the Limitation of Greenhouse Gas Emissions." Both the Strategy and the Climate Doctrine updated in 2023,[26] it is stated that Russia gives priority to the implementation of natural and climatic measures and plans to increase greenhouse gas absorption from 535 to 1,200 million tons of CO_2 by 2050 in order to achieve carbon neutrality by 2060. To stimulate domestic demand, mandatory carbon reporting has been introduced, which Russian companies emitting more than 150,000 tons of CO_2 e, submitted for the first time in their history in 2023, and after 2024, reporting will become mandatory for enterprises with emissions of more than 50,000 tons of CO_2. A system of fines and administrative sanctions will be introduced for providing incomplete or inaccurate data in reports.[27] The Russian Federation's constituent entities have initiated the Sakhalin experiment on quota trading.[28] In September 2022, the Moscow Exchange held its first commodity auction for the sale of 20 CUs for a total of 20,000 rubles, and in November 2023, 2,735 CUs were sold for 1,914,500 rubles.[29] In 2024, the St. Petersburg International Commodity and Raw Materials Exchange launched its first trading in carbon units in the amount of 100 tons of CO_2 equivalents at an initial price of 1,000 rubles per carbon unit. To date, 50 climate projects have been registered in the Russian registry and almost 20,000 carbon units have been credited toward reducing the carbon footprint.

[23] For example, under the Joint Implementation Projects program, projects were implemented to reduce fugitive emissions at oil and gas pipeline facilities in the Kostroma, Tula and Perm regions, among others.

[24] For example, the Swiss GS verified the issuance of 500,000 CUs from a biogas plant at the Kronostar factory; the American VSC registry registered 788,000 CUs for a biomass-based energy production project at the Arkhangelsk Pulp and Paper Mill.

[25] Decree of the Government of the Russian Federation No 3052-r of 29 October 2021.

[26] Decree of the President of the Russian Federation No 812 of 26 October 2023.

[27] Draft law No 265466-8 "On Amendments to the Code of the Russian Federation on Administrative Offenses". State Duma of the Russian Federation. Available at: https://sozd.duma.gov.ru/bill/265466-8

[28] Federal Law "On Conducting an Experiment to Limit Greenhouse Gas Emissions in Certain Subjects of the Russian Federation" of 6 March 2022 No 34. ConsultantPlus. Available at: http://www.consultant.ru/document/cons_doc_LAW_411051/ (accessed 11 July 2024).

[29] Information on the total number of contracts and the total value of contracts concluded at commodity auctions by National Mercantile Exchange (NAMEX). September 2022, October 2023. Available at: https://www.namex.org/ru/commodityauctions/realtimeCA/monthCA (accessed 11 July 2024).

In this context, natural and climate projects have become popular with Russian companies not as a way to offset direct emissions, but as a natural extra source of income. *"Business understands the law of economics, and every business has 'profit' written in its charter, so the 'carrot' method is very important in itself,' a respondent emphasizes. Another respondent agrees: "We have a lot of forests, a lot of land, a lot of territory. Why can't we make money from it?"* In the long term, this strategy by Russian businesspeople may prove to be misguided if the concept of "net zero emissions" begins to prevail globally, which would affect the principles of international non-financial reporting.[30]

Supply formation

Large Russian companies are not only demanding carbon credits but are also the main initiators of climate projects because, as one respondent noted, *"this is still a promising and business-oriented topic for us. Large corporations are currently heavily involved in this, especially those that depend on share prices."* In 2022, the Russian CU registry recorded the implementation of the first climate project by DalEnergoInvest, which involved preventing the emission of 1,800 tons of CO_2 as a result of electricity generation by a solar power plant on the Kuril Islands in the Sakhalin Region.[31] Natural and climate projects generate a multiple of the volume of CUs. For example, one of the first forest climate projects registered in Russia was the Poronaisky Forestry Project in the Sakhalin Region, which is expected to generate 1.5 million CUs by 2102.[32] However, the prolonged nature and ambiguity of the estimates of the effects give rise to justified doubts about their validity. *"To date, all estimates of absorption are theoretical, i.e., they do not have a solid evidence base. There is no need to prove that vegetation absorbs carbon. The question is: how much?"* This is the question asked by one of the respondents.[33]

To fill this gap, the Russian Ministry of Education and Science launched a carbon sink program in 2021. As a result, a network of diverse "carbon farms" *(forest-agriculture-aquaculture farms)* was created to produce natural and technological offsets in Russian regions. Large Russian companies have become industrial partners of these testing grounds [Gulev, Durmanov, Shashkin 2022]. The "farms" are designed to promote the use of the absorption and accumulation capacities of natural ecosystems, whose carbon potential on voluntary markets is likely to increase in value given their long-term nature and valuable indirect effects in terms of biodiversity protection, income diversification, job creation, etc. However, according to a survey of carbon sink operators, there remains "uncertainty regarding the verification of the data obtained

[30] It is no coincidence, for example, that in 2023, Google announced that it would stop purchasing cheap carbon offsets for "carbon neutrality" and intends to achieve "net zero emissions" by 2030 through CDR projects.

[31] Carbon Unit Registry of the Russian Federation. Registry publications. Available at: https://carbonreg.ru/ru/projects/ (accessed 11 July 2024).

[32] Validation report of the Carbon Polygon Research Center of Novosibirsk State University. Available at: https://carbonreg.ru/ru/projects/8/ (accessed 11 July 2024).

[33] Order of the Ministry of Education and Science of the Russian Federation No 74 of 5 February 2021.

(in particular, uncertified instruments may be used in current studies)" [Center for Strategic Research 2022. P. 13].

In parallel with this, a large-scale federal initiative, Major Innovative State Project "Unified National System for Monitoring Climate-Active Substances,"[34] is being implemented under the supervision of the Russian Ministry of Economic Development for scientific expertise on climate initiatives (including forest climate initiatives). However, these are assessed differently by experts. For example, some experts claim that the net absorption of GHGs by Russian forests "allows for the compensation of about 10% of GHG emissions in Russia" [Ptichnikov, Shvarts, Kuznetsova 2021], while others argue that "doubling the net sink in the LULUCF seems doubtful ... and achieving carbon neutrality in Russia's economy by 2060 is unlikely" [Klimenko et al. 2023]. According to other estimates, "Russia will achieve carbon neutrality 10 years earlier, by 2040, and subsequently become a net absorber of greenhouse gases" [Dmitriev 2022], "Russia will have the opportunity to sell its CO_2 assimilation services to countries with low CO_2 absorption capacity" [Fedorov, Moiseev, Sinyak 2011], because, according to estimates by the organizers of the "forest farm" at the Voronezh State University of Forestry a nd Technologies named after G.F. Morozov (VSUFT), income from the sale of natural offsets amounts to 595,000 rubles per hectare at the current price of CUs on the Moscow Exchange [Concept... 2023]. Against this backdrop, a respondent representing a large chemical company notes that *"many speculators have appeared in this area. We have been looking for contractors to inventory GHGs for four months now. There are a lot of speculative elements, and there are no independent experts who could help assess the capabilities of contractors. From this point of view, everything is very complicated. There are very few companies that can guarantee high-quality work."*

Market formation

To assist climate project developers in Russia, special calculators have been prepared for investors in "forest climate units" [Kuznetsov, Stetsenko, Nikishova 2022]; maps of Russian regions with an economic assessment of the potential for implementing forest climate projects have been published,[35] methodologies have been developed based on the system of approaches and methodological support for the implementation of climate projects adopted in the Russian Federation [Sorokina, Ptichnikov, Romanovskaya 2023]; various methodologies for their assessment have been developed,[36] which have undergone public discussion.

Validation and verification centers (see Table 3 on p. 62) registered with Rosaccreditation have already validated 50 climate projects.

[34] Order of the Government of the Russian Federation No 3240-r of 29 October 2022.

[35] Interactive map of climate projects in Russia. ESG Alliance. Available at: https://maps.esg-a.ru/climate-projects-map (accessed 11 July 2024).

[36] Carbon Unit Registry of the Russian Federation. Climate Project Methodologies. Available at: https://carbonreg.ru/ru/methodology/accepted_methodologies/ (accessed 11 January 2024).

Table 3. Register of accredited organizations for greenhouse gas validation and verification in Russia, 2022–2023

Organization	Region	2022	2023	Область аккредитации
Saint Petersburg Forestry Research Institute	Saint Petersburg	+	+	Verification. Forestry activities
Rusatom Infrastructure Solutions	Moscow	+	+	Validation. Energy
Federal Center for Analysis and Assessment of Technogenic Impact	Moscow	+	+	Verification. Energy
Atomenergoproekt	Moscow	+	+	Verification. Animal husbandry
NES Profekspert	Tatarstan	+	+	Verification. Energy
Nanocertifica	Moscow	+	—	Verification. Industry
PROMMASH TEST Ekologiya	Saint Petersburg	+	—	Verification. Industry
Yu. A. Izrael Institute of Global Climate and Ecology (IGCE)	Moscow	+	—	Verification. Plant and animal husbandry
Bauman Moscow State Technical University	Moscow	+	+	Verification. Agriculture
Innopolis University	Tatarstan	+	+	Validation. Energy
Center for Laboratory Analysis and Technical Measurements for the Siberian Federal District	Novosibirsk	+	+	Verification. Plant and animal husbandry
RUDN University	Moscow	+	+	Verification. Metallurgy
VNIIGAZ-Certificate	Moscow region	+	+	Validation. Energy
Ufa State Petroleum Technological University	Republic of Bashkortostan	—	+	Validation and verification
National Center for Validation and Verification of Environmental Information of the Institute of Global Climate and Ecology	Moscow	—	+	Validation and verification
Russian Energy Agency (REA) by the Ministry of Energy of the Russian Federation	Moscow	—	+	Validation and verification
SOYUZEXPERTIZA CCI RF (SOEX)	Moscow	—	+	Validation and verification (oil and associated gas production)
Russian University of Transport (MIIT)	Moscow	—	+	Validation and verification (railway transport activities)
Novosibirsk State University	Novosibirsk	—	+	Validation (agriculture, forestry, logging)
Coordinating Informational Center of CIS Member States on approximation of regulatory practices	Moscow	—	+	Validation and verification (production of organic and inorganic chemicals)
Union for the Protection of Environmental Rights of the Population of the Moscow Region	Moscow region	—	+	Validation and verification

Note: + indicates active status, — indicates termination of the organization's activities.
Source: National Accreditation System, Register of Accredited Entities, 2023.

As in Southeast Asia, assessment methodologies and standards in Russia are high-level in nature, similar in content to the Swiss GS and US Verra methodologies and based on a traditional approach that assumes an average additional absorption

over *100 years*. According to the Russian methodology, additionality effects must be demonstrated "through a reliable assessment showing that the activity would not have been carried out *in the absence* of project *incentives, taking into account all* relevant national regulations and legislation" [Guidlines No 001 2023]. For project initiators, for example in reforestation, *guarantees* must be provided that *"the project results will be maintained for 100 years"* to minimize the risks of permanence [Methodology ... No 0010 2023], otherwise a discount of 3–15% of the volume of "issued" CUs is proposed. To reduce the risk of double counting and resales, a *certification* is introduced stating that the project results "will not be transferred to third parties and will not be encumbered by third-party rights *during the implementation period* of the climate project".[37] Such utopian horizons and comprehensive and "soft" legal formulations cast doubt on the authenticity of the effects and create risks of unscrupulous behavior [Agafonov 2024].

Coordination among participants in the carbon market in Russia is complicated by a lack of consensus and the existence of different methodologies from different federal agencies and private services. For example, two methodologies are proposed for calculating direct emissions (scope 1): one by the Ministry of Natural Resources[38] and one by the Ministry of Economic Development,[39] which in some cases give discrepancies of 20–30% in the assessment of a company's greenhouse gas emissions. As in the EU, one of the main problems is the formation of an up-to-date information database. For example, auditors from the Accounts Chamber of the Russian Federation noted that "ambitious targets have been set for the coming decades to increase the capacity of forests to absorb greenhouse gases, but these have not been linked to forestry measures that would stimulate such capacity. The targets for forest absorption capacity in strategic planning documents are not consistent with each other" [Accounting Chamber of the Russian Federation 2022]. Data collection and exchange is difficult not only between carbon sink programs and state projects supervised by different ministries, but also within the research community itself. As one respondent noted, *"We have encountered the problem of processing large amounts of data. Our farmers are drowning in information, accumulating large amounts of data and acquiring digital skills to process it, but they do not understand the processes taking place in the soil and the causal relationships that exist today. These can only be understood on the basis of many years of observation."*

Moreover, there is a conceptual diversity of project types in official discourse: "adaptation",[40] "green,"[41] "climate," "sustainable development,"[42] and "ESG projects,"

[37] Draft resolution of the Government of the Russian Federation on the rules for creating and maintaining a carbon unit registry. Date: 20 October 2023. https://regulation.gov.ru/projects#npa=142902

[38] Order of the Ministry of Natural Resources of Russia No 371 "On the approval of methods for the quantitative determination of greenhouse gas emissions and greenhouse gas removals" of 27 May 2022.

[39] GIS Energy Efficiency, https://co2.gisee.ru/calculator

[40] Order of the Government of the Russian Federation No 1912-r of 14 July 2021.

[41] Decree of the Russian Federation No 1587 of 21 September 2021.

[42] Information letter of the Bank of Russia No IN-06-28/96 of 19 December 2021.

which are poorly correlated with each other. *"Right now, gather ten entrepreneurs, ask them about carbon credits and the ESG agenda, and four of them will say something intelligible, while the rest will have no idea what you are talking about,"* notes one respondent.

This departmental diversity explains the wait-and-see strategy of Russian businesses, which point out that *"we lack a call center that could consolidate all the information and all the companies on the climate agenda. We need to develop common approaches and methodologies in this area because the climate agenda in Russia is very fragmented."*

Indeed, at the regional level, the climate agenda is usually overseen by several ministries, blurring responsibility and the quality of decision-making, which affects, for example, the preparation of annual adaptation plans, the implementation of which, according to the Russian Ministry of Economic Development, remains low. As one respondent emphasizes, *"the whole system of quotas and carbon credits would be better formed at the regional level. This is not yet working very well at the national level." Another respondent disagrees, arguing that "it is preferable to focus on the federal level. At the local level, there will again be disagreements about who is responsible for what. I would like to see some uniformity."*

To consolidate research and strengthen management decisions, a *Siberian climate hub*[43] is being created for three regions with similar natural, climatic, and economic characteristics: the Novosibirsk Region, the Kemerovo Region, and the Altai Krai. The main goal is to carry out research work in two areas: first, how the economy of the regions affects the climate, i.e., how the economic activity of the three regions affects changes in greenhouse gas emissions; second, how climate change affects the regional economy, i.e., how certain weather phenomena (increases in average annual temperatures and precipitation levels, etc.) affect the socio-economic condition of the three regions (crop yields, public health, etc.). These studies enable ministries in neighboring regions to take scientifically sound action to combat climate change and its consequences (fires, floods, droughts, etc.) and to use cost-effective decarbonization options.

International transfer of EU is being developed along the EAEU vector, primarily with Kazakhstan, which in 2021 relaunched its mandatory quota trading system with the acceptance of natural offsets. The creation of "mirror" carbon supersites (polygons) in the BRICS countries in 2024 is intended to strengthen international cooperation on CU issues under Article 6 of the Paris Agreement [ICLRC 2023]. Some business respondents are skeptical about building equal international relations. *"The Chinese came to us for consultation. They knew we had free land, were ready to take tens of thousands of hectares from us on a long-term lease, and offered: 'We will bring our Chinese workers and equipment, sow the crops we need, take the harvest back to China, and we will only pay you rent.' That's a mutually beneficial relationship,"* notes a respondent from Altai.

[43] This research initiative was supported by the heads of three regions, and the Legislative Assembly of the Novosibirsk Region approved the Law on the Creation and Functioning of the Hub in its second reading (11 July 2024). See: https://zsnso.ru/proekt-povestki-47-sessii-zakonodatelnogo-sobraniya-novosibirskoy-oblasti-7-sozyva

Conclusion

A comparative analysis of the development and current net worth in carbon markets in Russia and Southeast Asia shows many similarities between them in the formation of supply and demand for natural offsets.

1. In both regions, large-scale experience in voluntary carbon crediting began in the early 2000s with the emergence of international programs under the auspices of the UNFCCC (JI in Russia and CDM in the SEA) and foreign NGOs (VSC, GS, etc.). Since then, a comparable number of credits have been issued, 268 million and 311 million CUs, respectively. However, in Russia, energy projects have mainly been implemented by Russian oil&gas and manufacturing companies, while in SEA, forest carbon projects have been implemented by European and Japanese manufacturers.

2. Domestic demand for CUs is still insignificant and began to form with the introduction of state programs. Although these processes began 10 years earlier in Southeast Asia, in 2012, and at present two countries—Indonesia and Singapore—have fully-fledged markets, unlike Russia, where quota trading is still operating on a pilot basis in one region—the Sakhalin region. In this context, natural offsets are seen not so much as a way to offset companies' direct emissions, but as a source of additional income for the initiators of natural climate projects. The expected return in both regions is limited by the volatility of domestic and external prices, as well as the lack of high-quality carbon units.

3. The integration of carbon markets in both regions is complicated by weak coordination between participants (government agencies, verifiers, consultants) and difficulties in collecting and processing data, which lead to inconsistent management regimes and dependence on external consulting and international expertise. The creation of national intermediary and assessment institutions (trading hubs, brokers, ratings agencies, insurance companies) could improve the situation, but this is difficult to achieve without a high level of expertise, on which the improvement of assessment methodologies for climate initiatives for the new generation of carbon markets largely depends. This is seen as a promising form of cooperation between Russia and SEA, which are equally focused on selling natural offsets while overcoming their dependence on international consulting. Moreover, this is of national and international importance. Both regions are interested in selling natural offsets to counterparties in other jurisdictions under Article 6 of the Paris Agreement. According to the guidelines of the UN Framework Convention, in order to avoid double counting, national commitments to reduce greenhouse gases[44] of "host countries" are increased by the amount of international carbon credit transfers. Incorrect methodologies and overestimation of carbon offsets may lead to overestimating of national commitments and underestimation of "additionality" effects in the national greenhouse gas inventory.

The experience of Russia and SEA shows that the trading of carbon units is highly politically and value determined, depends on the level of economic modernization, and is not a totally market-driven phenomenon, as its launch and establishment require

[44] The Russian Federation's nationally determined contribution to the implementation of the Paris Agreement (NDC).

some degree of state involvement. The prices and volumes of carbon units are still low, which does not allow us to talk about a reduction in total greenhouse gas emissions or a significant mitigation of climate change. Nevertheless, the effectiveness of non-market instruments is very limited, carbon markets are an important factor in achieving carbon neutrality in countries with significant state involvement in economic development, which is well suited for both Russia and many Asian countries.

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Cooperation in BRICS Digital Education: Background, Content, and Approaches

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Abstract

Digital education has gradually become a strategic topic in current cooperation in international education. In this paper, after analyzing the international digital education landscape, we highlight the fact that cooperation in digital education helps to improve the educational welfare of BRICS countries and elaborate on the content of such cooperation. Based on this, it is proposed that BRICS digital education cooperation should focus on top-level design at the governmental level, with schools at all levels playing a key role, think tanks and research institutions providing scientific support, enterprises promoting the construction of digital infrastructure, and BRICS countries strengthening their digital education resource assistance.

Introduction

Currently, the new wave of technological revolution and industrial transformation is accelerating, with generative artificial intelligence developing rapidly, and digital technologies profoundly reshaping human production and lifestyles. Peace, development, cooperation, and mutual benefit remain the common aspirations of the international community. International educational cooperation plays a stabilizing and accelerating

role in promoting both national economic and social development as well as fostering good international relations.

In August 2023, during the 15th BRICS Leaders' Summit, Chinese President Xi Jinping proposed that BRICS countries "broaden cooperation in the field of education, effectively utilize the Vocational Education Alliance, and explore the establishment of a digital education cooperation mechanism." This proposal was widely supported by member countries and was included in the 15th BRICS Summit Johannesburg II Declaration. Over the past year, countries have made stronger efforts to advance digital education initiatives, and the exploration of global education digital transformation has become more active. On June 11, 2024, the 11th BRICS Education Ministers' Meetings were held in Kazan, Russia, where "support for the establishment of a BRICS digital education cooperation mechanism" was included in the key outcomes of the meetings, the Kazan Declaration of the 11th Meeting of the BRICS Ministers of Education. This marked a significant step forward in digital education cooperation among the BRICS countries.

1. Digital education cooperation enhances educational welfare for BRICS countries

In January 2024, Saudi Arabia, Egypt, the United Arab Emirates, Iran, and Ethiopia officially became BRICS members, increasing the number of BRICS countries to 10. BRICS nations now cover over 26% of the world's total land area, with a combined population of around 3.5 billion, accounting for 45% of the global population, and contributing 35.7% to the world's GDP. As the world's most dynamic and promising emerging markets, BRICS countries have close bilateral and multilateral relationships, with extensive cooperation in political, economic, and cultural aspects. In terms of multilateral relations, BRICS countries regularly hold high-level meetings through mechanisms such as the BRICS Summit, promoting policy coordination and pragmatic cooperation. The prosperity and stability of BRICS will make significant contributions to the development of all humanity.

Since the establishment of the BRICS multilateral cooperation organization in 2009, the scope of cooperation has gradually expanded from focusing on economic and financial issues to encompassing political, security, and cultural exchanges, covering topics such as health, science, technological innovation, culture, counter-terrorism, cybersecurity, and energy security. As of 2020, BRICS cooperation extends to over 30 areas [Ding Xiaojiong, Zhang Minxuan 2022]. Education plays a crucial role in improving the quality of the workforce, developing human resources, enhancing labor productivity, and promoting technological progress. This has long been a common understanding among BRICS countries. Over a decade, BRICS countries have continuously expanded their cooperation in the field of education, with growing momentum. As early as the third BRICS Leaders' Meeting held in Sanya, China in 2011, member states proposed the establishment of a "BRICS-UNESCO Working Group" to develop joint strategies under this framework, prioritizing education at the national level.[1] The aim was to carry

[1] Ministry of Foreign Affairs of the People's Republic of China. Sanya Declaration of the Third BRICS Summit (Full Text). 2011. April 14. Available at: https://www.mfa.gov.cn/web/gjhdq_676201/gjhdqzz_681964/jzgj_682158/zywj_682170/201104/t20110414_9383526.shtml (in Chinese) (accessed 16 March 2025).

out practical and effective cooperation at various levels and systems of "South-South cooperation" and global collaboration, using education to strive for the eradication of poverty and to promote sustainable economic and social development. In November 2013, the first UNESCO-BRICS Education Ministers' Meetings were held in Paris, officially launching BRICS cooperation in education. Since then, initiatives such as the BRICS Network University, BRICS University League, BRICS Summer Program, and BRICS TVET Cooperation Alliance have been successively initiated, leading to substantive measures and building up a wealth of experience in educational cooperation.

Currently, the BRICS Network University encompasses 76 member universities and offers joint master's programs in six priority fields, including energy and computer science. In 2023, the number of students registered for transnational learning reached 5,200. There are plans to expand the number of participating universities in each country to 20, with a focus on joint digital education programs and research to promote cross-border learning [Roscongress 2024]. The international version of China's *National Smart Education Public Service Platform* has been launched in nine languages, including English and Russian, covering 2.7 million users in BRICS countries and providing 18,000 MOOC resources [Ministry of Education of the People's Republic of China 2024]. India's DIKSHA digital education platform provides resources in 23 local languages, with an average daily visit count exceeding 5 million. It has also shared basic education digital solutions with South Africa. Brazil's *Aluno Conectado* program has equipped public schools with 610,000 digital devices, and its remote teaching system has opened interfaces for Portuguese-speaking African countries. Russia's *Modern Digital Educational Environment* project has established a unified national digital education platform, integrating 46,000 virtual laboratory resources, with 870,000 visits from BRICS countries in 2023. At the 11th BRICS Education Ministers' Meeting in June 2024, topics such as digitalization, mutual recognition of academic qualifications, and university ranking systems were discussed. The meeting approved the Declaration of the 11th BRICS Education Ministers' Meeting and the protocol for new members to join, further expanding areas of cooperation [TV BRICS 2024].

With the acceleration of the new technological revolution and industrial transformation, alongside the rapid development of artificial intelligence, digital technology has increasingly transformed human production, life, and learning methods, opening up broad prospects for the development of education. On one hand, the fundamental goal of education is to cultivate individuals who meet the needs of the era, and digital technology has shaped the framework for talent development in the digital age. Since Paul Gilster first introduced the concept of "digital literacy" in 1997 [Gilster 1997], the question of how to cultivate digital literacy and reshape civic values has quickly become a global concern. Eshet-Alkalai pointed out that digital literacy, as the core competency and key skill required of citizens in the digital era, encompasses six aspects: reproduction literacy, photo-visual literacy, branching literacy, information literacy, socio-emotional literacy, and real-time literacy [Eshet-Alkalai 2012]. The United Nations has included digital literacy in the thematic indicators of the 2030 Sustainable Development Goals (SDGs), encouraging the development of digital literacy and skills to promote growth in education and career opportunities. On the other hand, education, as a key area of social life, must confront the integration of digital technologies and their

transformation and turn it into an important opportunity for its own development. Many scholars believe that digital technology has surpassed its original role as a tool and evolved into a living environment, opening vast opportunities for new educational models such as ubiquitous learning and lifelong learning [Selwyn, Facer 2014; Bilyalova et al. 2019]. Haleem et al. [Haleem et al. 2022] identified 34 applications of digital technology in education, including the development of online libraries, promotion of distance learning, enhancement of special education, creation of virtual classrooms, building of knowledge and understanding skills, access to the latest teaching resources, real-time student assessment, and the shift toward blended teaching and learning. They argue that digital technology will be further integrated into classrooms in the future. The deep integration of digital technology and education has given rise to digital education, and the digital transformation of education has become a significant trend of the era.

Cooperation in the field of digital education is increasingly becoming a key area of international educational collaboration. It is widely recognized that digital education offers new possibilities for promoting equitable, inclusive, and high-quality education. The Organisation for Economic Co-operation and Development (OECD) stated in its latest report that digital education contributes in three dimensions: improving the quality of teaching and the student learning experience, promoting equity, accessibility, and inclusiveness through personalized learning tools and assistive technologies, and increasing efficiency by reducing costs and enhancing the productivity of educators [OECD 2023]. In November 2023, the 42nd session of the UNESCO General Conference adopted "The Recommendation on Education for Peace and Human Rights, International Understanding, Cooperation, Fundamental Freedoms, Global Citizenship and Sustainable Development." This important document, which underscores the role of education in promoting sustainable development and human wellbeing, recognizes the digitalization of education as an essential means to achieve shared educational goals globally. The term "digital" appeared 21 times in the text of the recommendation, covering a wide range of aspects related to educational transformation, including educational goals, digital literacy, educational resources, learning environments, teaching methods, assessment strategies, teacher competencies, and learning modes. As a result, digitalization has emerged as a transformative force in educational reform, leading the direction of global education changes. In addressing the topic of "international digital education cooperation," the recommendation offers the following suggestions: "Encourage the sharing of open educational resources; establish physical and/or digital resource centers to provide materials and guidance that help implement the objectives of this recommendation throughout the education and lifelong learning process, including human resources or training." It also states, "Member States should leverage new digital opportunities and follow research-based evidence to mitigate risks. Digital open learning environments, digital resources and tools, and equipping learners with the necessary skills to use these resources and tools will enable learners to engage in responsible digital learning and help bridge the digital divide" [UNESCO 2023]. Recently, UNESCO has further emphasized that "digital technology has become a societal necessity to ensure that education is a fundamental human right, especially in a world where crises and conflicts are becoming more frequent. Digital education provides significant support

in achieving sustainable development goals and building a shared future for education" [UNESCO 2024].

In this context, the importance of international cooperation in digital education has been increasingly recognized by more governments, international organizations, and educational institutions worldwide, and has translated into concrete actions. Many countries and international organizations are actively promoting digital education as a key focus and breakthrough in regional and global educational cooperation frameworks. They are exploring effective forms of international cooperation in digital education to enhance the flow and optimization of high-quality educational resources, meet the educational needs of different groups, innovate teaching and learning models, improve teaching and learning experiences, enhance the digital literacy of teachers and students, and bridge the digital divide between regions and ethnic groups. The goal is to ensure that the benefits of educational development reach all learners, thereby achieving educational equity and high-quality development.

Given the ongoing expansion of BRICS educational cooperation and the strengthening of cooperation between BRICS countries and UNESCO, BRICS countries are well-positioned to take the lead in cooperation in digital education. This could involve early-stage explorations in building digital education platforms, sharing digital educational resources, and bridging the digital education gap.

2. The rich connotations of digital education cooperation among BRICS countries

Digital education represents a new form of education in the digital age. Currently, there are three predominant ways in which digital education is understood within the international educational community: it is seen as an alternative to traditional education [Ţiţan et al. 2014; Allcoat et al. 2021], a new stage in the integration of technology and education [Sharma 2019; Qureshi et al. 2021], and an ideal form of education [Selwyn, Facer 2014; Bozkurt, Sharma 2020]. The China National Academy of Educational Sciences, in its annual series of reports, the China Smart Education Development Report, points out that digital education is a new form of education in the digital age, qualitatively different from the education forms of the industrial age [China National Academy of Educational Sciences 2023]. It presents new features in terms of core concepts, system structure, educational content, teaching models, and educational governance [China National Academy of Educational Sciences 2024]:

Update educational concepts. Digital education is the profound integration of the ancient ideal of "teaching according to individual needs" and the modern notion of "student-centered education." By fully empowering education through digital technologies such as artificial intelligence, big data, cloud computing, and blockchain, it breaks the time and space boundaries of teaching and learning. It not only provides fair learning opportunities for all learners, but also respects individual developmental patterns and differences. This shift moves education from "mass standardized education" to "mass personalized learning," establishing an educational philosophy that emphasizes equity, inclusiveness, sustainability, and lifelong learning.

Reshape the educational system. Unlike the school-centered educational system of the industrial age, digital education transcends the boundaries of schools, turning families and society into important learning environments. This facilitates the coordinated development of education by schools, families, and society. It also promotes the design of more flexible and personalized educational systems, in line with students' growth and cognitive patterns. Furthermore, the integration of the education chain, technology chain, and innovation chain has become a common trend, with industry-education and science-education convergence becoming widespread. A high-quality, personalized lifelong learning system, where "everyone learns, learning is available everywhere, and learning can happen at any time," is now being established.

Transforming educational models. Unlike the traditional education model, which emphasizes concentration, synchronization, and standardization, digital education can integrate physical, social, and digital spaces to create new learner-centered educational scenarios. It fosters learning communities that transcend class, grade, subject, and time-space boundaries, forming a new teaching paradigm centered on data-driven large-scale personalized instruction. In addition, digital education can collect multi-source, multi-modal data in an accompanying, imperceptible, ethical, and secure manner. By deeply analyzing this data, it facilitates data-driven precision teaching, achieving an organic combination of mass education and personalized learning.

Introducing innovative educational content. In the digital age, people face trillions of knowledge points and pieces of information. The ability to acquire, discern, integrate, and utilize knowledge has become a necessary skill for modern citizens. Digital education prioritizes cultivating learners' higher-order thinking, comprehensive innovation abilities, and lifelong learning capacities, with a particular focus on digital literacy and skill development. By establishing digital knowledge maps, designing cross-disciplinary learning themes, and diversifying the presentation of curriculum content, digital education shifts the focus from knowledge-centered to literacy-centered education.

Optimizing educational governance. Digital education aims to clarify the relationships between the government, society, family, and schools. It seeks to streamline traditional physical space-based operational processes, abstractly establish comprehensive data processes for educational operations, and coordinate the handling, flow, and storage of educational data. By utilizing data governance, digital education simplifies educational workflows, enabling a redesign of educational business processes. This contributes to improved management precision, more accurate service provision, and more scientifically informed decision-making. Ultimately, this results in a systematic leap from educational management to educational governance.

In summary, digital transformation is a key driver of global educational reform, and digital education holds tremendous potential to promote both educational reform and societal development.

For BRICS countries, digital education cooperation is particularly rich in its connotations. Such cooperation refers to a series of multilateral efforts among BRICS member countries to accelerate the digital transformation of education and advance international educational development. These efforts span the realms of digital education policies, practices, and research. By establishing a framework and international exchange

platform for digital education cooperation, BRICS countries engage in policy dialogues, system interactions, project collaborations, resource sharing, joint talent cultivation, facility co-construction, and data sharing. Through open cooperation and mutual learning, these nations jointly explore strategic consensus and theoretical methodologies for digital education, innovate practical models for integrating digital technology with teaching and learning, and promote deep, systemic reforms in educational philosophy, systems, models, content, and governance. These efforts aim to advance educational equity and high-quality development, cultivate more high-quality talents suited to the future labor market, improve the intellectual abilities of the population, and enhance the comprehensive national strength (the totality of a country's economic, military and political power in a given period), thereby contributing to the modernization process. Specifically, the content of BRICS countries' cooperation in the field of digital education includes the following points:

Joint discussions of the governance of digital education. Digital education governance is the fundamental guarantee for addressing the many challenges posed to education by the new technological revolution to education, realizing the positive interaction between technological innovation and high-quality educational development, and ensuring that the digitalization of education begins smoothly and shapes new advantages for development. BRICS countries can explore the following: establishing a joint annual education dialogue platform to provide opportunities for education policymakers, experts, scholars, and industry representatives from member countries to exchange ideas, share experiences, and seek cooperation; joint discussions and formulation of digital education development strategies to better serve the socioeconomic development and national strategic needs of each member country; working together to build a digital education standard system, stimulating the synergy of policies, mechanisms, and standards in education digitalization; developing and publishing AI governance guidelines to further clarify the applicability of generative artificial intelligence and other cutting-edge technologies in education, and establishing a new digital education order that aligns with the common interests of humanity; joint development of a Networked Digital Space Governance Framework to strengthen security in education, improve algorithm and data governance, give priority to cybersecurity supervision, prevent the misuse and abuse of technology, avoid endangering public safety, and facilitate the organized integration of new technologies into education; joint publishing of Digital Education Application Guidelines and Management Standards to place "people-centered" principles as the basic measure of the digitalization of education, incorporating the application of digital technology into a system of ethics and regulations, respecting the dignity and privacy of teachers and students, and protecting their right to information and choice.

Sharing quality digital resources. Countries around the world are increasingly recognizing the importance of pooling high-quality resources and prioritizing fairness in boosting the digitalization of education. These are key issues for empowering education with high-quality development through digital technology. BRICS countries can explore the following: strengthening the digital foundation for education and promoting the interconnection of new infrastructure in education; collaborating with high-tech

enterprises of member countries to encourage universities, vocational institutions, and related organizations to open access to high-quality digital education resources, increasing the openness and inclusivity of data; leveraging existing internationally influential digital education platforms, such as China's National Smart Education Public Service Platform (International Edition), by integrating technology and resources to provide member countries with diverse, high-quality MOOCs and personalized learning services, promoting the sharing of high-quality education resources on a larger scale; continuously introducing new models for globally co-building and sharing quality education resources, jointly developing digital education resources, enriching resource types, and innovating resource supply; strengthening intellectual property protection and promoting the sharing of digital education dividends among people in member countries.

Introducing the application of digital platforms. Application is the most fundamental and powerful driving force behind the digitalization of education, and the key to the success of integrating digital technology with education and teaching. BRICS countries can explore the following: providing digital education development assistance to countries in need, strengthening the construction of technical infrastructure, and improving mobile network coverage; by leveraging large models and powerful computing capabilities, they can collaborate on developing intelligent educational tools. These tools can be used to aggregate and integrate educational data, uncover data insights, accurately detect learning needs, precisely allocate teaching resources, facilitate personalized teaching and learning, and create digital profiles for teachers and students. This would enhance the professionalism and personalization of educational evaluations, promote innovative assessment methods, and improve remote access to various platforms. The aim is to strengthen technological innovation applications, deepen boundary-free learning, and build BRICS learning communities and international cultural exchange projects. Together, they would create an open, shared, and collaborative digital education ecosystem, providing comprehensive and multi-tiered digital education public services to member countries.

Co-establish educational cooperation organizations. The deeper the digitalization of education goes, the greater the need for organizational collaboration to gather strong forces to advance digital education reform. BRICS countries can look into establishing a BRICS Digital Education Alliance. This would serve as a bridge and link for member countries to exchange ideas, share resources, and collaborate on innovation; innovate educational organizational forms and explore educational forms such as digital universities, cloud-based schools, future learning centers, and education metaverses that integrate intelligence with virtual and physical elements to provide smart educational services to member countries; jointly construct specializations and courses in mutually agreed priority areas, carry out joint education programs, promote mutual recognition of courses, and facilitate the exchange and visits of teachers and students; and promote learning certification system innovations by improving qualification framework designs and exploring the use of intelligent technology in credit banks. This would help construct a digital learning certification system, enabling broader recognition and conversion of learning outcomes, thus forming a lifelong "learning passport, and establish a "talent

cultivation service platform" to bring together cooperative consensus to assist member countries in training more digitally skilled talent to meet future societal demands.

Enhance teachers' digital literacy. Digital literacy is a fundamental competency for citizens in the digital era. Improving teachers' digital literacy and skills is an inherent requirement for developing digital education. BRICS countries can explore the following: building a BRICS teacher capacity building network and collaborating on teacher development and training programs; and guiding teachers to utilize digital technologies for accessing, processing, using, managing, and evaluating digital information resources. They could also explore personalized, immersive, and intelligent teaching methods using technologies like knowledge graphs, learning analytics, and digital profiling to fully optimize teaching processes and innovate teaching approaches; explore digital collaborative teaching and "human-machine co-teaching." Through the establishment of virtual teaching platforms, BRICS countries could organize regular online seminars, workshops, and case studies. This would encourage teachers to share teaching experiences and tackle teaching challenges, using intelligent teaching systems to assist in teaching, achieving personalized instruction and targeted tutoring. Ultimately, this would enhance teachers' digital literacy and competence.

Promote digital education research. Educational research is the "guiding light" for educational development. Collaborative research in digital education can not only reveal the inherent rules and future trends of the development of digital education, but also provide theoretical foundations and methodological guidance for governments in BRICS countries to formulate education policies. BRICS countries can do the following: establish comprehensive research cooperation mechanisms and platforms, regularly host international seminars, workshops, and academic exchange events on digital education, and set up a database for research cooperation projects and an information-sharing platform, allowing researchers from different countries to access project information and match their collaboration needs. This would help to optimize the allocation and efficient utilization of scientific research resources; create research and innovation project funds and encourage interdisciplinary and cross-sector research, providing financial support for researchers from member countries to explore cutting-edge theories and practices in digital education; and foster deep cooperation among researchers and promote collaborative research in areas such as digital education theory systems, policy measures, practical approaches, and technological tools.

3. Multilateral collaboration to advance BRICS cooperation in digital education

The BRICS countries differ in geographic environments, stages of development, population sizes, and resource endowments. They also have unique languages, cultures, histories, religions, and customs. The 15th BRICS Leaders' Summit in August 2023 and the 11th BRICS Education Ministers' Meeting in June 2024 both emphasized the need to establish a BRICS digital education cooperation mechanism. This mechanism would aim to integrate digital tools into education, address challenges such as the digital divide, and promote lifelong learning, aligning with the goals of UNESCO and the OECD. In this

regard, cooperation in digital education among BRICS countries should fully consider these differences, adhere to the principles of mutual benefit and win-win outcomes, and respect the cooperation intentions and value choices of member countries. By optimizing approaches, cooperation and exchanges can be promoted. Based on the aforementioned aspects, cooperation in digital education among the BRICS countries can be advanced in the following ways:

(I) Top-level design for BRICS digital education cooperation. Firstly, BRICS countries should clarify their philosophy on cooperation, achieve a common vision for reshaping global digital education governance, and adhere to a global governance perspective that emphasizes joint consultation, construction, and sharing [Zhu Xu, Zhang Xinning 2024]. This would promote an international framework for digital education cooperation that fosters mutual understanding, tolerance, and affinity among diverse stakeholders, while striving to establish a more just and equitable global digital education governance system. **Secondly,** at the national level, efforts should be made to enhance top-level design and strengthen execution capability. The BRICS Leaders' Summits and Education Ministers' Meetings can play a strategic guiding role in coordinating positions and developing plans. Member countries should also strengthen communication and coordination in daily affairs, promptly identifying and overcoming institutional and systemic barriers to cooperation. Currently, cooperation among the BRICS countries operates in a relatively flexible manner, with a low degree of formalization. It is based on the subjective consensus of member states and relies on communication through leaders' summits, ministers' meetings, and other channels. However, willingness to cooperate and the resulting consensus lack legally binding enforcement. In the future, BRICS could consider establishing a secretariat or creating institutional mechanisms similar to the New Development Bank and the BRICS Partnership on New Industrial Revolution's Innovation Center. This would help institutionalize, professionalize, and improve the efficiency of cooperation in digital education, thereby strengthening the implementation capacity of the BRICS cooperation mechanism [Lu Jing 2024]. **Thirdly,** education authorities in each country should engage in ongoing consultations to deepen reforms. By focusing on international trends in digital education, they should introduce timely policies and measures, and continuously summarize and promote best practices. **Fourthly,** governments should leverage regional advantages to take the lead in exploring and promoting the participation of local enterprises, schools, and relevant organizations in BRICS digital education cooperation, encouraging companies and universities from member states to "go global together." Early exploration should be undertaken in areas such as digital education cooperation projects and digital talent exchanges, expanding cooperation between nations and cities in new fields such as the digital economy and green economy, jointly building demonstration zones for economic and trade innovation and development, and advancing cooperation in the digital education sector through regional industrial collaboration.

(II) Schools at all levels and types should play a key role in cooperation in BRICS digital education. Due to different historical and cultural development paths and national development needs, BRICS countries have differences in educational traditions, education evaluation, and teaching methods. The development of digital education

presents an opportunity for educational cooperation among the BRICS countries, with schools serving as the primary platform for advancing collaboration in digital education. **Firstly,** countries could diversify the paths of inter-school cooperation. In the early stages, initiatives like the BRICS TVET Cooperation Alliance, BRICS University League, and BRICS Network University have been launched, significantly contributing to the collaboration and exchange in teaching and research among BRICS countries, improving education standards and policy recommendations, and strengthening cultural exchanges. Local schools should build on this foundation, leveraging digital technologies to promote international cooperation and exchange in areas such as language learning, cultural exchange, talent cultivation, and scientific research, continuously enriching the content and expanding forms of cooperation, promoting the sharing of high-quality course resources, and facilitating mutual recognition of degrees, diplomas, and credits. **Secondly,** universities should innovate collaboratively by jointly building a global classroom platform, co-developing high-quality online teaching resources, exploring innovations in blended teaching models, and establishing cooperative innovation mechanisms to ensure the teaching quality of global classrooms. **Thirdly,** countries could emphasize brand leadership by creating internationally influential BRICS digital education brands in higher education, vocational education, and basic education, utilizing these brands to guide and elevate the openness and level of BRICS digital education. This includes enhancing the capacity to develop educational exchange brands, ensuring sustainable development, and increasing global influence, thus providing leadership and support for the high-quality development of digital education initiatives. **Fourthly,** countries could initiate the establishment of a BRICS teacher capacity-building network to improve teachers' digital literacy and competence. This includes formulating more specific and practical teacher training plans and evaluation systems, strengthening the exchange of teacher experiences between alliances, and ensuring that teachers can truly master and apply digital technologies to enhance teaching effectiveness and the learning experience of students.

(III) Think tanks and research institutions should provide reliable scientific research support for the development of digital education, propose suggestions on priority areas for cooperation in digital education, and assist in improving the macro-level institutional framework for digital education cooperation. **Firstly,** BRICS think tanks and research institutions at all levels can actively conduct international comparative analyses, focusing on the latest developments in education technology policies and practices worldwide, tracking digital education actions in various countries, and sharing the results of the development of digital education. Transnational expert teams may be organized to strengthen international cooperation in the development of standards to establish international standards and regulatory systems related to digital education, thereby enhancing the influence of the BRICS alliance in setting international digital education standards. **Secondly,** at present, BRICS countries generally face the challenge of weak research platforms, with limited development in digital teaching, personalized learning, and internationalized education. Therefore, in the future, according to different regional development needs and application requirements, they could promote collaborative research among BRICS educational and research institutions

on the theoretical systems, technological tools, application models, evaluation systems, and teacher-student literacy related to digital education. This collaboration would aim to achieve technological complementarity and better empower the development of digital education in BRICS countries. **Thirdly,** countries could establish a BRICS Educational Research Cooperation Center, drawing on the expertise of outstanding educational researchers from member countries to set up specialized departments. These departments would regularly monitor and evaluate digital education within the alliance, scientifically guiding the development direction of digital education cooperation and avoiding potential risks in the digital education field. **Fourthly,** countries could boost research on digital education by conducting interviews, surveys, and on-site observations to enhance researchers' understanding of the educational conditions and public opinions within BRICS. This would help address major strategic needs and enable a deeper understanding of the digital education needs and trends in each country, providing scientific evidence for the precise allocation of digital education resources.

(IV) Enterprises play a crucial role in developing new quality productive forces and participating in international cooperation in digital education. The development of education requires infrastructure support, as well as the integration of data and content resources. The construction of digital infrastructure is fundamental to advancing international cooperation in digital education, and is particularly vital for the digital transformation of education in developing countries. **Firstly,** BRICS digital education cooperation presents significant business opportunities for enterprises. Local businesses can actively participate in BRICS digital education cooperation by developing innovative technologies and applications in talent cultivation, human-computer interaction, infrastructure, and data resource development. This includes expanding mobile network coverage, opening access to remote education platforms, enhancing technological innovation application, and supporting the construction of digital infrastructure and educational environments within schools, thus providing strong backing for the digital transformation of education in these countries. **Secondly,** cooperation among BRICS enterprises in network infrastructure construction, the digital economy, and cybersecurity could be strengthened. This joint effort would advance the construction of new types of infrastructure, such as education training centers, international education support bases, and teaching equipment. **Thirdly,** countries could establish and improve unified standards for developing digital education resources. They could encourage digital education resource companies to provide diverse resource services in accordance with these standards and regulations, avoiding redundant low-level construction. They could also strengthen cooperation between enterprises, universities, and educational research institutions in order to provide the institutional conditions necessary for the balanced development of digital education across all countries.

(V) Strengthen digital education resource assistance among BRICS countries. Amid the intensifying strategic competition among major powers, the close cooperation and strong development of BRICS countries have triggered a heightened sense of crisis among Western powers. In response, various measures have been introduced to create technological barriers and constrain the digitalization process of developing countries. At this critical juncture, BRICS countries must stand together, build a digital

education community, complement and learn from each other, and jointly navigate these challenges. **On one hand,** under the premise of mutual benefit and win-win cooperation, BRICS countries can promote educational infrastructure assistance between member countries. Based on the concept of a digital education community, they can explore and implement new models of educational aid, breaking through the current bottleneck of fragmented aid. Following the principles of equality and mutual benefit, they may closely align with the individual needs and expressed interests of the recipient countries, enriching and refining aid strategies, improving the quality of educational assistance, providing students with a better learning environment, and fostering mutually beneficial cooperation. This would also lay a solid foundation for exchange and collaboration in digital education [Diao Junfeng 2024]. **On the other hand,** BRICS countries could build a free digital learning platform resource library accessible to all learners in the group. This would aim to reduce disparities in digital resources and teaching capabilities caused by uneven economic development among member states. During the production of digital education content, considerations such as gender equality, girls' education, and regional characteristics should be taken into account, while also providing differentiated learning resources, including those for people with disabilities. By leveraging digitalization, the educational gap can be narrowed, regional differences are minimized, and learners can be better equipped to understand the concepts of educational equity and equal opportunities. This ensures the quality of digital education assistance.

In summary, digital empowerment in education will significantly enhance "educational productivity" and bring revolutionary changes to the development of education globally. International cooperation in digital education is rich in content, offering a multidimensional and comprehensive blueprint for collaborative development. The BRICS countries have favorable opportunities and vast potential for international cooperation in digital education, with practical and viable options available. In line with the visions of international educational organizations such as UNESCO and the OECD regarding cooperation in digital education, BRICS member states can take the lead by leveraging their own strengths and addressing their specific needs. By moving toward each other, exchanging information, and sharing the achievements of digital education, these countries can jointly tackle the risks and challenges that digitalization may pose to education. Ultimately, the vision of "harmony in diversity, unity in the global community" in the international cooperation of digital education can be realized.

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Economic Results of Interstate Integration for Regions of the Russian-Belarusian Border Area

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Abstract

This article examines the theoretical underpinnings of interstate integration and the practical impact of this process on the economic characteristics of border regions. The predominant perspectives of economists on the subject of international economic integration are subsequently examined. In the empirical section, within the framework of the research objective, which is to assess the results of the integration process between the Republic of Belarus and the Russian Federation for the economy of border regions, the dynamics of gross regional product per capita, living standards, and population size are analyzed. A prevailing finding in the relevant literature is that border regions have not shown comparable progress in their economic indicators as observed in the national context. The factor of interstate integration has not enabled the border regions of the Russian-Belarusian border area to overcome their economic peripherality. Problems that are frequently encountered in border regions are associated with demographic processes, underdeveloped income levels, and low growth rates of gross regional product (GRP). In order to address this delay, a proposal has been put forth to establish a transnational strategy for the advancement of border

regions. This strategy would entail the coordination of industrial, economic, cultural, scientific, and educational initiatives within the Vitebsk, Mogilev, Gomel, Pskov, Smolensk, and Bryansk regions.

Introduction

The third decade of the 21st century has been a turning point in the agenda of interstate integration. What the global economic community has been striving for over decades is now, if not disappearing, then definitely undergoing a transformation. This is indicated by both contemporary publications by researchers[1] and politicians.[2] It is important to acknowledge that the concept of globalism has not been rendered obsolete; rather, it has undergone a process of fragmentation. Despite the ongoing pursuit of economic integration among nations, there remains a concomitant emphasis on safeguarding and advancing political interests. This phenomenon, known as "island globalization," has the potential to create a two-tiered global economic and political landscape. The "fourth industrial revolution" is contributing to this process by creating conditions for the reindustrialization of developed countries and reducing the economic feasibility of the international division of labor.

International economic integration is altering the institutional environment of states.[3] In order to survive and thrive in the face of shifting economic conditions, economic actors must demonstrate a capacity for adaptation. This adaptation involves the realization of emerging opportunities for foreign economic interaction, as well as the mitigation of the threat posed by external competition. Analogous changes are occurring in society. Consequently, the economic and social structures of one state are subject to the influence of another, a phenomenon that is particularly evident in border regions. The integration of Russia and Belarus into the Union State, as stipulated in the 1996 Treaty on the Creation of the Community of Belarus and Russia, has been in effect for nearly three decades. Consequently, a significant scientific undertaking at this juncture entails the identification and characterization of the transformations that have transpired in the economic and social domains of the Russian-Belarusian border regions during the period of the Union State's formation, influenced by the integration accords adopted by Russia and Belarus. The Union State functions as a site for the examination of interstate interaction within the post-Soviet space. Successful solutions and agreements are being adopted for implementation within the structure of the Eurasian Economic Union, as well as in bilateral interstate relations of the Russian Federation. Given the considerable

[1] Smagulova, S. M., 2024. Deglobalization of the world economy: causes and consequences. *Bulletin of the Altai Academy of Economics and Law*, No. 6-1. P. 160–166 (in Russian); Sautkin, A. P., Soloviev, S. A., Shaurina, O. S., 2024. De-globalization as a strategic vector for the development of the world economy. *Dnevnik Nauki*, No 2(86) (in Russian).

[2] https://iz.ru/1865521/2025-04-04/overchuk-zaiavil-ob-okonchanii-epokhi-globalizatcii-v-mire

[3] Kudryashov, V.S., 2019. International economic integration: theoretical aspects and world practice. *Scientific Notes of the Tambov Branch of the Russian Society of Military Experts*, No. 14. P. 79, 82. Available at: https://cyberleninka.ru/article/n/mezhdunarodnaya-ekonomicheskaya-integratsiya-teoreticheskie-aspekty-i-mirovaya-praktika (in Russian) (accessed 01 July 2025).

length of the border and the presence of shared development challenges, the findings of the study on the impact of integration in the regions of the Russian-Belarusian border area can serve as a basis for enhancing the effectiveness of interstate cooperation at the regional level with friendly neighboring countries.

Literature review

Since the inception of the field, a distinguishing feature of the theoretical foundations of international economic integration has been the divergence in researchers' perspectives not only on the mechanisms and characteristics of this phenomenon, but also on its essence as a whole [Ushkalova, Golovnin 2011. P. 4]. The following is a concise historical exposition of the theory of interstate integration, delineating the preeminent scholars in the scientific community who have examined this subject and their respective perspectives (refer to Table 1 on p. 87).

Table 1. Foreign views on interstate economic integration

Period	Researchers	Views
1940–1960s	James Meade [Meade 1953; Meade 1955], Wilhelm Roepke [Roepke 1959], Tibor Scitovsky [Scitovsky 1958], Bela Balassa [Balassa 1961]	**Neoliberalism** Integration is a state of affairs in which trade relations between different national economies are as free and advantageous as those within a national economy [Roepke 1959. P. 223]. For later neoliberals, integration, viewed as a process, means measures designed to eliminate discrimination between economic units belonging to different states... Viewed as a state, it can be represented as the absence of various forms of discrimination between national economies.
1950–1980s	Seymour E. Harris [Harris 1957], Paul Streeten [Streeten 1964], Jan Tinbergen	**From neo-Keynesianism to dirigisme** They argued for the need to coordinate the economic policies of states and advocated the formation of supranational authorities in integration associations of states. In their view, integration has four main goals: economic growth, the principle of equality (in economic activity), a more even distribution of income, and greater freedom of choice. They distinguished between "positive" and "negative integration." According to Tinbergen, "the problem of integration is part of the more general problem of devising optimal policy," and such a policy "expresses the optimum of centralization" [Tinbergen 1954]. The European model of state unification was built on the ideas of dirigistes about harmonizing economic, social, and other spheres in integrating countries.
1950s–1970s	Gunnar Myrdal, André Marchal	**Structuralism** They believed that integration could lead to deeper income inequality, imbalances in development, and uneven distribution of production. Therefore, they considered the complete liberalization of market processes in the integration space to be wrong. They argued for the need to regulate integration processes. "Modern integration is the integration of national economies, not the integration of markets, which is only pseudo-integration" [Marchal 1965. P. 34]. G. Myrdal defined integration as the realization of "equality of opportunity... an essential element of which is the mitigation of social rigidity that prevents individuals from freely choosing their working and living conditions," and that it is only possible if a "basis for international solidarity" is created [Myrdal 1956].
1980s	Sidney Rolfe	**Corporatism** Transnational corporations are the initiators and driving force behind interstate integration. As a result of these processes, the cost of labor, the cost of capital, the level of technological development, and other economic factors are equalized.

A variety of scientific perspectives on integration processes can also be found in the works of Russian scholars. The theoretical framework of economic integration

exhibits a multidisciplinary nature. The subject matter encompasses economics, political science, sociology, and other scientific disciplines. The genesis of Russian scientific research can be traced back to the examination of European integration experiences. The advent of a comprehensive study of the Western integration model by domestic scholars in the 1970s was precipitated by a confluence of political and ideological factors that were intricately intertwined with the historical context of the Cold War. Conversely, Soviet scholars exhibited a predominantly skeptical stance regarding the prospects for integration processes between capitalist countries. As Yu.V. Shishkov asserts, the Soviet leadership directed its attention toward Western European integration alliances, which were regarded as a maneuver by "American imperialism" to fortify its geostrategic position or, at best, as defensive measures by historically doomed capitalism in the face of the triumphant advance of "world socialism." This ideological framework subsequently influenced all research on integration in the Soviet Union, including that conducted at the newly established IMEMO RAS [Shishkov 2006. P. 54].

In the early 1970s, a domestic school of regional integration theory emerged, in which, according to V.V. Obukhovsky [Obukhovsky 2007. P. 38], the primary contributions were made by M.M. Maksimova [Maksimova 1969] and Shishkov. Additionally, he considers Yu.S. Borko, L.I. Glukharev, V.S. Pankov, and subsequently O.V. Butorina, I.D. Ivanov, and V.G. Shemyatenkov to be representative of the domestic school of international economic integration. A considerable number of scholars, including N.V. Bautina, Y.F. Kormnov, M.N. Os'mova, Yu.S. Shiryayev, and N.P. Shmelev, have dedicated their efforts to the exploration of issues pertaining to socialist integration.

The third decade of the 21st century was characterized by a reversal of the ongoing process of globalization. This phenomenon was not primarily driven by economic factors but rather by political considerations. The restrictions imposed by Western countries on one of the world's largest economies could not fail to trigger a process of global redistribution of spheres of influence. The formation of distinct groups, or "blocs," serves to fortify the integration processes within these respective entities. This assertion is corroborated, among other evidence, by the resurgence of Russia and Belarus' interest in the Union State's collaborative framework during the 2020s.

It appears that a three-factor model can be postulated to explain the motivating factors underlying interstate integration processes: political, economic, and commercial. The political integration process is aimed at extending the political influence of a more economically developed and militarily powerful state to other regions of the world. The objective of economic integration is to obtain preferential treatment for domestic economic entities and citizens of the state by reducing the cost of imported goods, services, and resources, as well as the cost of exporting goods and services to other regions of the world. The term "commercial" refers to the establishment of institutional frameworks that facilitate the extraction of benefits for commercial entities, whether they be individual or institutional, by the state. This process often involves the development of conditions conducive to the emergence of transnational corporations, which are entities that operate across national borders. Motives function as a driving force for integration, though they can also impede it.

These factors can undergo changes over time, resulting in a decline in the efficiency of integration processes.

The primary subject of analysis in this article is the integration process between the Republic of Belarus and the Russian Federation. A substantial corpus of economic and political studies has been dedicated to the issue of the Union State, including those prepared in different years by scientists from the Institute of Economics of the Russian Academy of Sciences, L. Vardomskiy, A group of researchers, including Yu. Godin, M. Golovnin, L. Kosikova, E. Lenchuk, A. Pylin, D. Ushkalova, B. Frumkin, E. Furman, B. Shmelev, and A. Shurubovich, contributed to the study.

In establishing the Union State, Belarus and Russia were guided by a combination of common interests and their own national objectives. A commonality of interest has been identified, namely the aspiration to ensure security and revitalize post-Soviet integration processes. The leadership of both states experienced a sense of discomfort regarding their role in the dissolution of the USSR. Belarus and Russia are similar in terms of their state identity, which is based on a civic foundation [Vardomskiy 2024. P. 77]. In its ethnocultural understanding, Belarus considers itself part of the Russian world and is oriented toward the values traditional for Russian civilization [Aleinikova 2017. P. 124–163]. However, it is imperative to acknowledge that this perspective is not universally shared among the citizenry.

The Russian-Belarusian border region is distinguished by the underutilization of its advantageous geographical location, which is often mitigated by concurrent socioeconomic challenges. Furthermore, as articulated in the works of A.N. Mikhailenko and I.I. Arsentyeva [Mikhailenko, Arsentyeva 2014. P. 124–163], subsequent to the establishment of the Single Economic Space and the Customs Union, the benefits previously available to border regions were diminished, thereby exerting a substantial negative influence on the quantity and nature of cross-border interactions within these areas. This phenomenon can be comprehended through the lens of economic integration, which has been demonstrated to profoundly alter the conditions of trade between participating nations. The concept of local border preferences, which was previously applicable to specific regions within these countries, has now evolved to encompass the entire territory of these nations.

A significant body of research has been dedicated to the analysis of the transformation of the institutional environment of the Russian-Belarusian border regions in the works of K.A. Morachevskaya. She examines the key consequences of state integration processes for the economic development of the Russian-Belarusian border region and also concludes that these processes had both positive and negative aspects [Morachevskaya 2017. P. 267–274]. The free movement of goods across the Russian-Belarusian border has had a significant impact on the Smolensk food market, resulting in heightened competition and the displacement of Smolensk products by more affordable Belarusian goods.

A.P. Katrovskii and G.V. Ridevskii were the first to conclude that the border regions of Russia and Belarus are developing more slowly than the economies of their respective countries [Katrovskyii, Ridevskii 2013. P. 128–136]. The hypothesis that the inter-capital location reduces the economic potential of the Smolensk, Vitebsk, and Mogilev regions due to the outflow of human and financial resources is put forward.

In the scientific community, the term "peripherality" is most frequently defined through a geographical (or geometric) lens. The concept of "periphery" is employed as the fundamental characteristic, that is, its physical distance from the center.[4] According to this assertion, the theory of spatial development posits that the periphery constitutes a territory characterized by limited transport accessibility and underdeveloped transport infrastructure. However, this is not particularly suitable for the Russian-Belarusian border region, which is located in the European part of Russia and has an extensive network of motorways. It is the position of the present author and corroborated by the findings of other researchers[5] that the "peripherality" of border regions is the result of their socio-economic indicators lagging behind the national average. Consequently, central regions exhibit the highest degrees of economic potential and development, attracting substantial labor and financial resources. In the Russian-Belarusian border region, the capital cities are located in the central part, while the border region is peripheral.

The challenges associated with cooperative endeavors among border regions have been examined in the scholarly works of P.G. Nikitenko and T.S. Vertinskaya, researchers at the Institute of Economics of the National Academy of Sciences of Belarus. A comprehensive analysis has been conducted on the repercussions of the Union State's establishment on Russia and Belarus' international trade [Nikitenko, Vertinskaya 2006. P. 86–99]. In her scholarly work, Vertinskaya examined the nature of cross-border relations in the Russian-Belarusian border region. According to [Vertinskaya 2019. P. 17–20], the formation of ties between economic entities can be attributed to two primary factors: historical establishment or spontaneous emergence under the influence of market forces. Furthermore, Vertinskaya acknowledges the absence of a comprehensive analysis of the EAEU's Single Economic Space at the regional level, highlighting the need for further research in this area [Vertinskaya 2018].

The objective of this study is to provide a comprehensive analysis of the economic changes that have occurred in the Russian-Belarusian border region within the context of interstate integration.

Research methodology

The present study examines the impact of interstate integration on the socio-economic situation of the Russian-Belarusian border regions. This investigation is conducted through the analysis of statistical and sociological data obtained from open sources and collected as part of a survey of border residents conducted by the authors.

The sociological study was conducted in the first half of 2024 using quota sampling. The data collection method employed was the "snowball" method. The survey was

[4] Kaibicheva, E. I., 2018. Evolution of theoretical approaches to the study of peripheral territories. *Regional Economy: Theory and Practice*, No 1 (448). P. 6. Available at: https://cyberleninka.ru/article/n/evolyutsiya-teoreticheskih-podhodov-k-issledovaniyu-periferiynyh-territoriy (in Russian) (accessed 01 July 2025).

[5] Morachevskaya, K. A., 2022. The phenomenon of borderland: approaches to interpretation and the role of center-periphery gradients. *Regional Research*, No 3 (77). P. 49 (in Russian).

administered to a total of 1,800 respondents aged 18 to 65. The group included representatives from various professions and social strata of the population. The survey revealed that between 50 and 60% of respondents (depending on the location of the survey) reside in regional centers, with the remainder inhabiting other settlements. An exposition of the characteristics of respondents residing in the three Russian and three Belarusian regions who participated in the survey is provided in Table 2 on p. 91.

Table 2. Characteristics of respondents who participated in the study conducted in 2024

Country	Russian Federation			Republic of Belarus		
Region	Bryansk Region	Pskov Region	Smolensk Region	Vitebsk Region	Gomel Region	Mogilev Region
Number of respondents	300	300	300	300	300	300
Number of men, %	30	40	38	34	58	48
Predominant level of education of respondents and its share	Higher education, 44%	Incomplete higher, 26%	Higher, 41%	Incomplete higher education, 37%	Higher, 34%	Secondary specialized, 29%
Average age, years	32	28	34	26	36	33
Minimum and maximum age, years / years	18/75	18/74	18/73	18/56	18/77	18/76
Predominant social status among respondents	Undergraduate, student, industrial worker, specialist in the manufacturing or commercial sector	Undergraduate, student, social specialist	Undergraduate, student, industrial worker, specialist in the manufacturing or commercial sector	Undergraduate, student, industrial worker, specialist in the manufacturing or commercial sector	Industrial worker, specialist in the manufacturing or commercial sector	Undergraduate, student, industrial worker, specialist in the manufacturing or commercial sector
Most families spend a percentage of their monthly income on food, %	20–40	20–40	20–40	20–40	20–40	20–40

Research results

The Russian-Belarusian border region includes three regions of the Russian Federation (Pskov, Smolensk, and Bryansk) and three regions of the Republic of Belarus (Vitebsk, Mogilev, and Gomel) (see Table 3 on p. 92).

The area of this region is almost 249,400 square kilometers, and the population at the beginning of 2024 was almost 6 million people. Over the past years of integration between Russia and Belarus, the demographic situation in the border region has remained depressed, with the population declining by an average of 23.3% between 1992 and 2024.

Table 3. Some indicators for the Russian-Belarusian border region

Regions	Area of regions, km²	Population, thousand people (beginning of 1992)	Population, thousand people (beginning of 2024)	GRP per capita in 2022 (US dollars)
Bryansk Region	34,857	1456.0	1142.4	6937.0
Smolensk Region	49,779	1152.1	864.0	8035.2
Pskov Region	55,300	837.7	581.2	6366.6
Vitebsk Region	40,051	1429.6	1081.9	5956.4
Gomel Region	40,372	1594.6	1338.6	6391.7
Mogilev Region	29,068	1254.8	981.2	5909.9

The population dynamics (see Table 4 on p. 92) for the regions under review are negative. The population decline in the Vitebsk region from 1990 to 2024 was 23.3%, in the Mogilev region—23.1%, and in the Smolensk region—25.4% (in Belarus, the population declined by 10.1% during this period, and in Russia—by 1.3%).

Table 4. Population dynamics, persons (at the beginning of the year)

Territory of the Republic of Belarus	1990	1992	1995	2000	2005	2010	2015	2020	2023	2024
Republic of Belarus	10,188,942	10,198,346	10,210,403	10,002,535	9,697,475	9,495,608	9,453,058	9,410,259	9,200,617	9,155,978
Brest Region	1,460,497	1,481,327	1,497,387	1,481,937	1,439,361	1,397,730	1,372,589	1,347,240	1,315,405	1,308,569
Vitebsk Region	1,415,763	1,429,613	1,426,433	1,366,363	1,289,464	1,227,031	1,183,028	1,133,625	1,091,948	1,081,911
Gomel Region	1,663,215	1,594,556	1,571,663	1,538,838	1,484,195	1,438,103	1,415,179	1,386,824	1,347,469	1,338,617
Grodno Region	1,172,287	1,193,337	1,208,623	1,178,176	1,122,058	1,071,681	1,046,049	1,025,680	998,600	992,556
Minsk	1,623,334	1,653,804	1,665,580	1,683,135	1,744,598	1,840,996	1,948,281	2,020,133	1,995,471	1,992,862
Minsk Region	1,578,686	1,590,946	1,596,096	1,547,447	1,470,493	1,424,993	1,431,088	1,473,247	1,462,021	1,460,289
Mogilev Region	1,275,160	1,254,763	1,244,621	1,206,639	1,147,306	1,095,074	1,056,844	1,023,510	989,703	981,174

Sources: Federal State Statistics Service (hereinafter referred to as Rosstat), National Statistical Committee of the Republic of Belarus (hereinafter referred to as Belstat).

This phenomenon is characteristic of most regions of Russia and Belarus, with the exception of the capital cities. The primary factor contributing to this decline is the observed decrease in the birth rate. The region is also marked by a decline in population due to migration, predominantly of an interregional nature.

A portion of the Belarusian population engages in internal migration to Russia, including the Smolensk region. The population decline in the regions under review has also been affected by factors such as rising unemployment, especially hidden

unemployment, and a decline in living standards, which is causing people to migrate to more prosperous regions of the country. During the 1990s, there was also migration of certain ethnic groups to other countries (e.g., Jews to Israel).

Contrary to Western European countries, where low birth rates are counterbalanced by migration, Belarus cannot rely on this strategy due to the economic challenges that adversely impact the country's overall demographic dynamics. The efficacy of incentives designed to promote an increase in the birth rate has been rendered moot.

With respect to demographic indicators, the Smolensk region has exhibited a more pronounced regression compared to the Vitebsk and Mogilev regions. The region's indicators demonstrate a substantial lag behind other regions of Russia. According to the RIA Rating Agency's 2022 Regional Demographic Ranking, it ranks 83rd[6].

It can be assumed that the demographic indicators in the region are influenced by the income of its residents. Let us consider the dynamics of average wages in the region (see Table 5 on p. 93).

Table 5. Average nominal salary in the Russian-Belarusian border regions, US dollars

Years	Vitebsk Region	Mogilev Region	Belarus	Smolensk Region	Russian Federation
1992	9.33	10.32	9.38	–	–
1995	60.13	62.14	65.66	67.04	103.63
1998	60.61	61.64	67.38	79.10	107.31
2001	172.74	168.91	189.92	81.71	111.05
2004	148.08	143.44	162.05	173.98	189.36
2007	292.23	299.78	326.27	373.83	563.78
2010	366.00	366.00	408.75	477.77	689.74
2013	507.82	511.01	575.67	642.02	935.44
2014	522.51	586.09	596.42	579.85	845.75
2015	365.93	365.02	423.35	385.00	558.25
2016	308.47	306.41	363.05	413.74	605.19
2017	355.78	357.39	421.69	450.18	671.21
2018	398.31	394.24	470.09	468.54	692.98
2019	435.98	426.32	522.57	483.18	733.47
2020	425.71	414.10	514.39	459.12	707.73
2021	465.25	451.98	568.67	495.95	767.69
2022	513.50	496.73	621.22	608.66	936.57
2023	529.68	519.77	636.72	576.61	864.12

Sources: Rosstat, Belstat.

[6] https://riarating.ru/infografika/20220404/630220607.html

As indicated by the findings presented in Table 5, there is a marginal discrepancy in wages between the Vitebsk and Mogilev regions, with the latter exhibiting a notable disparity compared to the mean wage in Belarus. Furthermore, this disparity has been increasing over time. In 1995, the difference in wages between the Mogilev and Vitebsk regions and the national average was approximately 9%. By 2010, this disparity had increased to 11.7%, and by 2023, it had reached 16.8%. In Minsk, the average wage in 2018 was $645, which is 64% higher than in the Dnieper-Dvina region of Belarus. As of 2023, the proportion remains unchanged, standing at 61% for the Vitebsk region and 64% for the Mogilev region. It is an inevitable consequence that the population of these regions will migrate to the capital region.

The available data on wages in Russia for 1992 are unreliable due to the presence of hyperinflation during that period, which led to an average wage increase of 11-fold in 1992. In terms of remuneration, the Smolensk region has been observed to exhibit higher than average wages when expressed in US dollars. However, the observed figures lag behind the Russian average by 45–50%. Consequently, wage disparities among the population are considerably more pronounced in Russia than in Belarus.

In the Vitebsk and Mogilev regions, real incomes underwent a comparable decline between 2014 and 2016, subsequently exhibiting an upturn in 2017. This phenomenon can be attributed to the economic downturn experienced by Belarus during the 2015–2016 period, marked by a decline in production and a deceleration in GDP growth.

The Russian-Belarusian border regions are distinguished by low birth rates, high mortality rates, and migration outflows, particularly from Belarusian regions. This phenomenon has resulted in a substantial decline in the population of these regions, amounting to more than 16% between 1992 and 2019. This indicator is considerably lower than the national average.

The regions under study are not conducive to attracting migrants due to their prevailing socio-economic conditions. Programs designed to stimulate the birth rate have not yielded the expected positive results, leading to an unfavorable outlook for the socio-economic development of the Russian-Belarusian border region.

The study involved a comparison of statistical and sociological data. The sociological study was conducted in the first half of 2024 using quota sampling. The data collection method employed was the “snowball” method. The survey was administered to a total of 1,800 respondents aged 18 to 65. The group comprised representatives from a variety of professions and social strata. The survey revealed that between 50% and 60% of respondents (depending on the location of the survey) reside in regional centers, with the remainder inhabiting other settlements.

The sociological survey, which was conducted as a component of the study, when compared with statistical data, generally indicates a slightly higher level of well-being among citizens residing in the Russian border region compared to Belarus (see Table 6 on p. 95). A significant proportion of the Belarusian budget is allocated to food expenditures. However, the proportion of the population living below the poverty line is higher in the Russian border region.

Table 6. Standard of living in the Belarusian-Russian border region in 2024

Respondents' answers	Smolensk Region	Bryansk Region	Pskov Region	Vitebsk Region	Mogilev Region	Gomel Region
My family spends up to 20% of its monthly income on food	20%	16%	14%	12%	11%	9%
My family spends between 20% and 40% of its monthly income on food	44%	54%	51%	54%	45%	47%
My family spends between 40% and 60% of its monthly income on food	28%	24%	30%	31%	35%	32%
My family spends more than 60% of its monthly income on food	9%	5%	5%	3%	9%	12%
Statistics	**Smolensk Region**	**Bryansk Region**	**Pskov Region**	**Vitebsk Region**	**Mogilev Region**	**Gomel Region**
Share of food products in the structure of household consumer spending (2022)	47%	43%	40%	40%	41%	39%
Share of population with income below poverty line / subsistence minimum (2022)	13%	12%	14%	5%	6%	6%

The dynamics of the sectoral structure and the growth rates of GRP are important for assessing the economic situation in the Russian-Belarusian border region. However, to get a more complete picture, it is important to compare the border regions with other regions of Central Russia and the Republic of Belarus in terms of GRP per capita. To compare the regions, GRP per capita indicators were calculated (see Table 7 on p. 95) for 2008–2023.

Table 7. Dynamics of GRP per capita in the regions of Belarus and Russia, US dollars

Region	2008	2010	2011	2012	2015	2017	2020	2022	2023
Brest Region	4,137	4,182	3,876	4,160	3,661	3,868	4,390	6,430	6,281
Vitebsk Region	4,286	3,996	4,182	5,030	3,787	3,501	4,260	5,849	5,966
Gomel Region	4,903	4,373	4,554	5,072	4,032	3,929	4,483	6,303	6,128
Grodno Region	4,475	4,122	4,236	4,676	4,104	4,284	4,925	7,704	7,859
Minsk	7,785	7,156	8,637	8,403	7,448	7,648	8,359	11,433	11,184
Minsk Region	6,198	5,365	6,188	6,481	5,903	5,768	6,322	9,520	9,452
Mogilev Region	4,251	3,974	3,877	4,299	3,626	3,651	4,008	5,806	5,627
Moscow	29,643	23,892	29,144	28,654	17,894	21,560	21,654	30,976	28,881
Pskov Region	4,270	4,272	5,126	5,228	3,416	4,088	4,591	6,302	5,792
Smolensk Region	4,845	5,180	6,270	6,661	4,368	5,088	5,568	8,013	7,512
Bryansk Region	3,882	3,796	4,689	5,322	3,618	4,357	4,846	6,898	6,406

Region	2008	2010	2011	2012	2015	2017	2020	2022	2023
Kaluga Region	5,939	6,153	7,923	9,125	5,489	7,067	7,385	9,359	8,684
Moscow Region	9,596	8,491	10,287	10,762	7,092	8,692	8,911	13,241	12,571

Source: Regions of Russia. Socio-economic indicators – 2018. Available at: https://www.gks.ru/bgd/regl/b18_14p/Main.htm (accessed 19 September 2024). Regions of the Republic of Belarus. 2018. Vol. 1. Available at: http://www.belstat.gov.by/ofitsialnaya-statistika/publications/izdania/public_compilation/index_10915 (accessed 19 September 2024).

From 2008 to 2023, the Grodno region of Belarus demonstrated the most substantial increase in GRP per capita in US dollars among all Belarusian regions, with an increase of 75.6%. The border regions exhibited the most pronounced decline in growth, with Gomel experiencing a 25% decrease, Mogilev a 32.4% decrease, and Vitebsk a 39.2% decrease. The Minsk region demonstrated a particularly notable increase, with a growth rate of 52.5%, closely followed by Minsk with 43.7%. A notable exception to this trend is observed in the Russian border regions, where a distinct pattern emerges. The Bryansk and Smolensk regions demonstrated notable growth, with increases of 65% and 55.1%, respectively. Concurrently, Moscow's GRP exhibited a 2.6% contraction. However, this trend did not result in an enhancement of the well-being of border residents in comparison to the Moscow region. The measure did not result in an enhancement of budget revenues. Organizations registered in the capital region engage in production activities within the region, yet they contribute to the capital's budget through tax payments. This dynamic gives rise to an imbalance between the growth rates of the GRP and the budget revenues of the capital.

In 2008, when the global economy entered another crisis, a significant differentiation emerged in GRP per capita in Central Russia and the Republic of Belarus. The leader, Moscow, exhibited an almost threefold increase in GDP compared to the Moscow region, a 3.8-fold increase compared to the capital of the Republic of Belarus, and a 6.1-fold increase compared to the Smolensk region, which ranked second among the six regions of the Russian-Belarusian border area. The Bryansk region, in particular, exhibited the lowest per capita GRP among the regions of the Russian-Belarusian border area, with a figure 7.6 times lower than that of Moscow in terms of per capita GRP in Central Russia. The economic downturn precipitated a decline in all regions of Central Russia by 15–30% in terms of this indicator in 2009. The Russian capital experienced the most precipitous decline, with a 32.9% contraction in its economy. The Smolensk region experienced a 18.6% decrease. The magnitude of the decline in the Republic of Belarus was comparatively less pronounced than that observed in the regions of Central Russia. In Minsk, the decline was recorded at 18.4%, while in the Vitebsk region, it was 15.5%. The Vitebsk and Mogilev regions, along with the majority of other regions within Belarus, failed to regain pre-crisis levels until 2012. The economy of Minsk demonstrated a faster recovery from the crisis compared to other regions. As early as 2011, the 2008 level had already been exceeded by 10.9%. In the Central Federal District of Russia, the economy demonstrated a more rapid recovery in comparison to Belarus, a phenomenon attributable to the

presence of market institutions within its economic structure. This stands in contrast to the Belarusian economic model, wherein the state sector exerts a more pronounced influence. In 2010, more than half of the regions examined exhibited levels that surpassed those recorded in 2008. Among the Russian regions bordering the Republic of Belarus, the Smolensk region demonstrated the most success in overcoming the crisis, with per capita production in dollar terms exceeding the 2008 level by 10.7% in 2010. Within the Central Federal District, the Smolensk region occupied the ninth position in terms of per capita GRDP in 2010, the eleventh position in 2011, and the tenth position in 2013. The 2014 crisis had a limited impact, affecting only Russian regions. Of the 18 regions that comprise the Central Federal District, 16 experienced a decline in per capita GRP, including the Smolensk region, where the decline was 13.8%.

In 2015, the crisis spread to all regions of Belarus. The decline in per capita indicators persisted in 2016. The Russian-Belarusian border region experienced a resurgence in growth in 2017, following a period of decline that saw all regions of the region affected. The service sector and agriculture were identified as the primary drivers of this economic upturn. In 2017, the Vitebsk and Mogilev regions exhibited underperformance in comparison to both Belarus and the broader Russian-Belarusian border region. The Smolensk region demonstrated a marginal improvement in its lag behind Moscow. In the context of Belarus, empirical evidence reveals a notable increase in inequality in per capita GRP between 2008 and 2023. In 2017, the Mogilev and Vitebsk regions were already more than twice as far behind Minsk. This trend persisted until 2023.

Conclusion

The findings, derived from statistical and sociological research, suggest that the border regions of Russia and Belarus exhibit a lower level of economic development compared to the capital and other regions of the Union State. Interstate integration has not resulted in an influx of population to the border areas, which have continued to decline, in some periods at a rate that exceeds the national average. The GRP per capita in border regions did not accelerate during the adoption and implementation of new interstate agreements on the simplification of trade and movement of citizens. As was the case at the inception of the integration process, citizens' incomes continued to lag behind the national average.

Conducted research[7] indicates increased competition in Russia's border regions due to Belarusian organizations entering the market with cheaper but high-quality products. This has resulted in a decline in the performance of local companies in the construction, transport, agriculture, and food sectors of the economy. The integration of these systems simplifies the movement of goods, eliminating the need for border-region partnerships and the registration of legal entities. Goods can be sold directly into the country, circumventing the involvement of intermediaries. This phenomenon also serves to diminish the benefits typically associated with a region's border location. The strategic positioning of the Russian-Belarusian border regions, where the distance between the

[7] Kuzavko, A. S., Kirillova, E. A., 2020. *Evolution of the Business Environment in the Dnieper-Dvina Region*. Smolensk: Smolensk State University (in Russian).

capitals is less than 800 km, fosters the migration of enterprising and active human resources, thereby creating a phenomenon known as the capital shadow.

In order to address the challenges that are characteristic of the Russian and Belarusian border regions, a unified supranational strategy for regional development is required. The establishment of an institutional framework within the Union State is imperative to ensure that the six border regions do not engage in competition with one another. Instead, these regions should be guided toward achieving distinct specializations within the Union State's economic structure. The coordination of industrial policy, tourism programs and routes, the education system, employment policy, and preferential regimes is imperative. These measures should be implemented not with the intention of fostering interstate competition between Belarus and Russia, but rather to counteract the outflow of capital, personnel, and resources to the capital regions.

Consequently, the study does not substantiate the hypothesis that border regions are the primary beneficiaries of interstate integration. While there are evident advantages for specific sectors of the economy and consumers, there are also domains necessitating state regulation.

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Semiconductors as the Main Technology of Today: Moore's Law and the Struggle for Technological Dominance

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Abstract

The article systematizes six decades of the development of semiconductor technologies, with an emphasis on the global dominance by the United States. The report presents an overview of the current state of this segment of the global economy in its most competitive domain, namely the value chain for the chips utilized in artificial intelligence and mobile devices. This study places particular emphasis on the competition between the US and China in the production of microchips for artificial intelligence in the context of their geopolitical confrontation, growing expectations for AI, and inflated market capitalizations. The analysis provides a consistent examination of the development strategies of the semiconductor industry in four key jurisdictions: the US, China, Taiwan, and the European Union. The article concludes with an analysis of the mounting competition and efforts by the major global actors to establish a presence in the world's most promising market.

1. Introduction

The specific model of digital giants makes the economic, social, and geopolitical role of digital companies so different from their old economy peers. The current "victory" of digital giants in the global economy is evident, in particular, in the fact that *the market capitalization of Big Data companies has eclipsed the rest of the manufacturing economy. By the 2020s, it became clear that the American digital giants had also defeated their competitors in Western Europe* thanks to a more effective economic and financial model.

There is no guarantee that the unprecedented stock market capitalizations we are seeing will remain at their current heights. One can recall the dot-com bubble burst of 2000–2001, when Cisco Systems' market capitalization reached half a trillion dollars for the first time in history and then fell fivefold, and even after 25 years, it has not returned to its former heights. Or the series of bankruptcies in the technology sector in 2001–2004. Donald Trump's second term as president could be just as marred as his first, only this time not by the biggest pandemic in a century, but by the biggest financial crisis in a century caused by a new bubble bursting. But the giants of digitalization are not threatened by bankruptcy or loss of leadership in the economic and political paradigm in which they operate today, under any scenario.

Digital "laws"—Moore's Law[1] and Metcalfe's Law[2]—work in favor of the "stock market bubble" of capitalizations, for the benefit of its beneficiaries—network and semiconductor giants.

The aim of this paper is to provide a topical assessment of the value chain of the microprocessor industry during a period of rapid reorientation towards artificial intelligence (AI), to describe the key players, their strategies, and the consequences of the current configuration of the industry in terms of the global economic, financial, and political dominance of the US and China. Going beyond a technological description of the industry allows us to characterize negative trends and mechanisms that are "built-in by definition" mechanisms involved in ensuring monopolistic technological dominance, inflated market capitalizations, and superprofits in the most marginal and strategically important market segments, primarily for players under direct or indirect US control. It is also important to analyze the political implications of the technological race between China and the US over Taiwan.

The article consists of nine sections. The introduction is followed by a description of the history of this crucial technology. The third section provides an overview of the industry's major players. The fourth section presents the reasons for the rapid

[1] Moore's Law states that the number of transistors on an integrated circuit doubles every 24 months. Moore's Law summarizes the exponential nature of scientific and technological progress in computing power and, more broadly, in the digital economy as a whole.

[2] Metcalfe's Law states that the usefulness to participants, value, and, as a result, market value of any network is proportional to the square of the number of devices or participants connected to that network, while the cost of building it depends linearly on the number of participants. This pattern applies to all networks, whether telephone, computer, social, or "non-obvious" ones such as Bitcoin, search engines, or platform software. It is Metcalfe's law that has ensured the dominance of American network giants (Microsoft, Meta (recognized as an extremist organization in Russia and banned), Apple, Google, Amazon) since the 2000s.

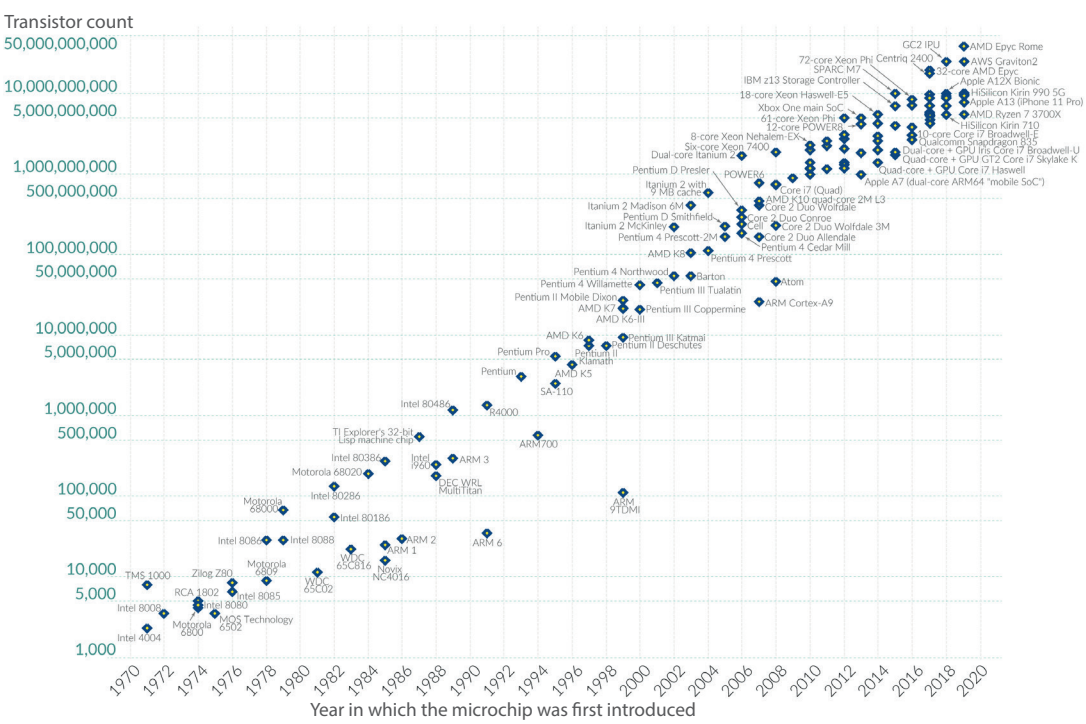
growth in the market capitalization of the largest semiconductor companies. Sections 5–8 describe the current market position and strategies of the four key jurisdictions for the semiconductor industry: the US, China, Taiwan, and the EU. The main conclusions are presented in the conclusion.

2. A brief history of semiconductor technology

A computer processor (integrated circuit) is a set of electronic circuits on a single small flat piece (or "chip") of semiconductor material, usually silicon, produced from special grade sand. A large number of tiny transistors are embedded in the small chip.

In 1965, in a short article, Gordon Moore, one of the founders of Intel, predicted that the number of transistors on a silicon wafer would double every year [Moore 1965]. This statement became known as Moore's Law. In reality, from 1971 to 2001, the number of transistors on a chip doubled every 1.96 years. Moore made the appropriate corrections in another article in the mid-1970s [Moore 1975]. Technology continued to develop at the same pace—Moore's prediction was surprisingly accurate and is expected to remain relevant for another decade, until the size of individual transistors drops to a few atoms (see Figure 1 on p. 102).

Figure 1. Moore's Law: Number of transistors in 1970–2020



Source: Roser, M., Ritchie, H. https://ourworldindata.org/uploads/2020/11/Transistor-Count-over-time.png, CC BY 4.0; https://commons.wikimedia.org/w/index.php?curid=98219918 (accessed 10 March 2025).

A modern chip can contain many billions of transistors in an area the size of a human fingernail. This allows modern computer chips to be millions of times more powerful and thousands of times faster than computer chips from the early 1970s. High performance is achieved because the components of the microcircuit switch quickly and consume relatively little energy due to their small size and proximity to each other.

The size of the transistors on the chip, measured in nanometers (nm), is inversely proportional to their number. The latest "tech process" at the end of 2024 is 3 nm, and in April 2025, a "tech process" of 2 nm was announced [Vicinanza 2025]. However, this is a marketing term that refers to a new generation of manufacturing and miniaturization *processes*, rather than the actual size of the transistor on the chip.

Today, a single chip can cost from less than a cent (the simplest chips for RFID tags or sensors) to several hundred or thousand dollars (for complex and low-volume products). For the latest generations of iPhones, the estimated price of the central processor is around $120 [Mohammadi 2024].

The main disadvantage of microchips is the high cost of designing and manufacturing the necessary photomasks. This means that microchips are only commercially viable if high production volumes of the same type of microchip are expected.

Processors are manufactured using photolithography. A laser shines through a template called a mask, and the processor is literally burned onto a silicon substrate coated with a special emulsion. This is very similar to developing a photograph. For a long time, lasers used a wavelength corresponding to deep ultraviolet, or DUV (Deep Ultra Violet), but about five years ago, it transitioned to extreme ultraviolet lithography (EUV, Extreme Ultra Violet).

By 2024, the terms DUV and EUV have become synonymous with the watershed between two generations of semiconductor technology. It is around EUV that the main restrictions imposed by the US on China are currently focused, although it cannot be ruled out that these restrictions may soon become total and extend to DUV technology.

In 1977, the first year for which the Semiconductor Industry Association published complete data, global semiconductor sales totaled just $3.8 billion. By 1984, the chip manufacturing business had grown sixfold to $24 billion annually, with US companies accounting for 50 to 60% of this amount. In the third quarter of 2024 alone, global microchip sales totaled $166 billion, and in September 2024, they broke the monthly record of $55 billion. In 2024, sales exceeded $600 billion by a wide margin [EP&T 2024].

Moore's Law (and the benefits it offers to the winner of the technological race) has almost magical status in the minds of the American public and political elite. It is a kind of fetish of modern American technological achievement, a symbol and the alleged root cause of the victory in the Cold War, an analogy to the moon landing in the 1960s.

The history of competition in the semiconductor industry (or, more precisely, the American view of it) is the subject of Chris Miller's book *Chip War: The Fight for the World's Most Critical Technology* (2022).[3] The author compares microchips to "the new oil" and begins his narrative with the greatly exaggerated role of this technology in the

[3] Miller, Ch., 2022. *Chip War: The Fight for the World's Most Critical Technology*. Scribner.

United States' military superiority over the USSR in the 1980s and the subsequent US victory in the Cold War.

In popular culture, this rivalry was reflected in one of the James Bond films, A View to a Kill (1985), where the events unfold against the backdrop of the technological race between the US and the USSR. The Terminator films[4] foreshadowed later discussions about the role of digital technology, in which the artificial intelligence of the Skynet company spirals out of control and destroys humanity. Thus, the microchips of the Cold War era turned against their creators.

The Cold War ended, and the topic of microchips temporarily ceased to be relevant to the general public. But after almost forty years, the race in the field of semiconductors has once again come to the forefront of the world politics. It has become, in essence, a central element in the confrontation between the US and China, and indirectly, an important element in the tensions surrounding Taiwan.

3. The semiconductor value chain and key players

Figure 2 (p. 105) shows the global ranking of the semiconductor industry. The companies listed are at various stages of the value chain. There are three stages:

1. Chip designers—they are often the largest consumers of their own designs for the end product or service.
2. Manufacturers (integrators) of equipment for the production of microchips.
3. Manufacturers of "physical" microchips (owners of fabs (or foundries)—factories that produce processors, in the jargon of this industry).

The first group includes Apple and Huawei, among others. However, these two companies are not shown in Figure 2 because chip design is only an intermediate stage in the creation of value, which is realized in the finished product. Nvidia is on the list because its product is packaged microchips that are then integrated into the final product by other players.

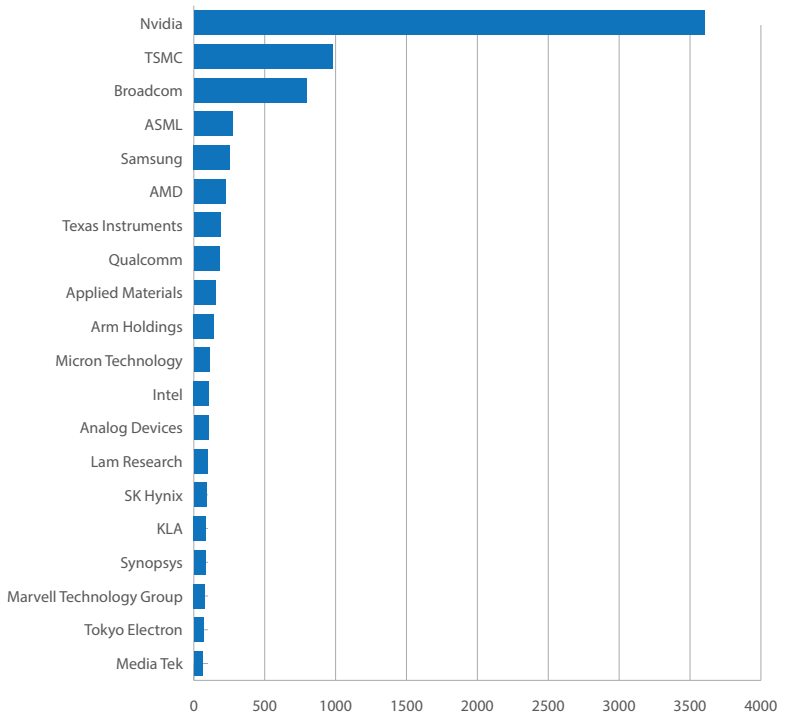
The main manufacturers of chip manufacturing equipment are the Dutch company ASML and the Japanese companies Nikon and Canon, which are still in the race but lagging significantly behind. These two companies produce equipment that is generally similar to ASML's, but operate mainly in the much less profitable digital camera market. The transition to the latest generation of chip technology proved too costly for them due to the rapid rise in research and development costs.

American companies produce many key components for this equipment, which are used in the final assembly, among dozens of suppliers from around the world. The software for developing microchips is also predominantly American. The final hardware complex is formally supplied by ASML, but the degree of US control over the technological process is sufficient for the US to completely control the Dutch company from a manufacturing point of view.

At the third stage of the chain, the production of physical microchips, the most prominent player is Taiwanese TSMC, the largest manufacturer of state-of-the-art logic processors, followed closely by South Korean Samsung for memory chips.

[4] The Terminator (1984), Terminator 2: Judgment Day (1991), Terminator 3: Rise of the Machines (2003), Terminator: Salvation (2009), etc.

Figure 2. Market capitalization of the largest companies in the semiconductor industry, billion US dollars



Source: Statista (accessed 10 December 2024).

Intel occupies a prominent place in the global hierarchy of players in this industry. This stems from the company's origins back in the 1950s, when Fairchild, the progenitor of the whole microprocessor industry, was still at the helm of this industry. Intel has retained the characteristics of the companies from that generation. They combined the first and third stages of the value chain, i.e., they designed chips and owned fabs for their mass production, which they were very proud of and considered an important competitive advantage. However, by the end of 2024, Intel had fallen seriously behind its competitors in terms of technology and product topology. By the end of 2024, the company had experienced a deep crisis, the dismissal of its long-time CEO Pat Gelsinger, who had failed to save the company, and a twofold decline in its market capitalization.

Only at the first stage of the value chain are players from the US completely dominant, including Apple in consumer electronics and Nvidia in specialized chips that are optimal for AI, cryptocurrency mining, and video signal processing (which is where the company started).[5]

Nvidia Corporation, an American technology company headquartered in Santa Clara, California, was founded in 1993 by three engineers, one of whom still heads the

[5] To keep things simple, we will leave out another important part of the semiconductor market—memory chips, which are dominated by South Korean companies. We will also skip over Chinese companies for now.

company. It specializes in the development of software, graphics processing units (GPUs), application programming interfaces (APIs) for data processing and high-performance computing, as well as system-on-chip (SOC) solutions for mobile computing and the automotive market. Nvidia is also a leading provider of hardware and software for AI. Nvidia's professional line of graphics processors is used for cloud computing, as well as in supercomputers and workstations for applications in fields such as architecture, engineering and construction, media and entertainment, automotive, scientific research, and manufacturing design. The GeForce line of graphics processors is aimed at the consumer market and is used in applications such as video editing, 3D-rendering, and computer games. With a market share of 92% (as of the first quarter of 2025[6]), Nvidia is the clear leader in the market for discrete graphics processors for desktop computers. The company has expanded its presence in the gaming industry and crypto mining (which it has acknowledged as "useless to society" [Hern 2023]).

In addition to developing graphics processors, Nvidia enables the creation of massive parallel programs that utilize graphics processors. These are used in supercomputing facilities around the world. In the first quarter of 2025, Nvidia's revenue from sales to data centers amounted to $39 billion.[7] This is almost three times the $14.51 billion the company earned in this segment in the third quarter of fiscal year 2023, and almost tenfold increase over two and a half years. The unprecedented massive purchases of Nvidia chips are driven by the race to implement AI, which has been joined by three giants of the data processing business—Amazon, Microsoft, and Google.[8]

Nvidia's technologies are being implemented for accelerated computing and the creation of artificial intelligence applications, particularly ChatGPT. Nvidia's solutions are used to train and run various large language models, including by OpenAI. The ChatGPT program, which generates human-like responses to user queries in a matter of seconds, was trained using tens of thousands of Nvidia graphics processors combined into an AI-powered supercomputer owned by Microsoft.

If we take a corporation's market capitalization as a measure of success, then the visual ratio between the three key companies in this microchip supply chain (Nvidia, TSMC, ASML) looks like a "matryoshka" doll: $3.9 trillion, $1.2 trillion, and $316 billion[9] (see Figure 3 on p. 107). Nvidia could be replaced by Apple, which has a similar market capitalization. For comparison, a circle equal to the combined market capitalization of the entire European automotive industry (Mercedes-Benz, BMW, Volkswagen, Peugeot, Citroën, FIAT, and Renault, operating on all continents) would be slightly smaller than ASML.

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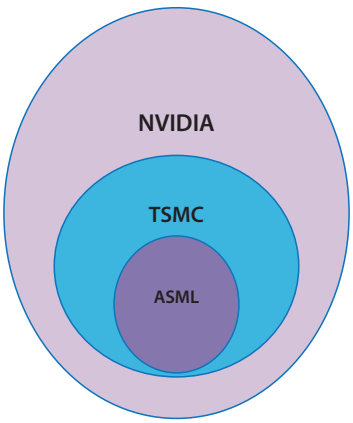
[6] YahooFinance. Available at: https://finance.yahoo.com/news/nvidia-secures-92-gpu-market-150444612.html?guccounter=1&guce_referrer=aHR0cHM6Ly93d3cuZ29vZ2xlLmNvbS8&guce_referrer_sig=AQAAANhbFhXrMzjpsROIqd8AfCLkUKkrCIYiqXbp-PteTQvoDmsd9nmJ2QPZ4riIkv4ptzBg6lFrPqJQnR5jZBWgT9Cxcbb9ljL0uNKSR3b-DtV88KU8hTpKSQAnC0g8lmpl95aqOhsOvFjm-_vsw6QD_fIKK8rJh33QsHtDjjdllK_-

[7] TrendSpider. Available at: https://trendspider.com/blog/nvidia-q1-2025-earnings/#:~:text=NVIDIA%20Q1%202025%20Financial%20Highlights,B%2C%20up%2042%25%20YoY.

[8] YahooFinance. NVIDIA Corporation (NVDA). Available at:: https://finance.yahoo.com/quote/NVDA/

[9] Data as of July 2, 2025. Source: Yahoo! Finance

Figure 3. Ratio of leading market capitalizations of companies at three stages of the semiconductor value chain



4. Technological transition and stock market bubble

Many people rightly consider the US stock market to be unprecedentedly overheated, with technology companies' share prices inflated, and see the reason for this in the pumping of the stock market with credit money. Perhaps this concept was best articulated by French economist Jacques Rueff (1896–1978): "Inflation consists of subsidizing expenditures that give no returns with money that does not exist."[10] In December 2024, influential Financial Times columnist Ruchir Sharma (and he was not alone) predicted the inevitable "bursting of the bubble" in the US stock market [Sharma 2024].

It should be noted that the leading companies themselves are unlikely to suffer significantly from the bursting of the bubble from an operational point of view or even in terms of their place in the global hierarchy—they are almost guaranteed to retain their top positions.

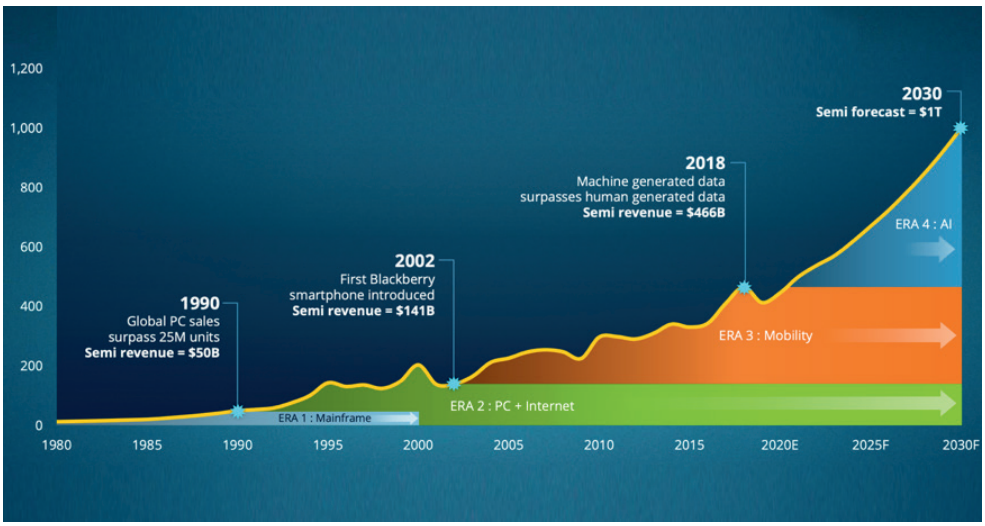
The presence of excess money supply and indebtedness at all levels is one of the reasons for the bubble in the stock market. However, this alone does not explain the concentration of the bubble in companies that have benefited from advances in microprocessors (Moore's Law rentiers) and network companies (Metcalfe's Law rentiers).

The starting point for their "premiumization" process, accompanied by simultaneous growth in microchip production volumes and margins, was the early 2020s, when the microchip market began to rapidly transform into solutions for artificial intelligence. The forecasts made at the beginning of the decade about explosive growth in the production of AI-specific devices have proven to be true.

Let us cite just one of the forecasts that has proven accurate to date—the forecast made in 2021 by the semiconductor company Applied Materials. AI chips will double the market to $1 trillion by 2030, while chips for mobile devices and traditional uses in PCs and servers will stagnate (see Figure 4 on p. 108).

[10] Quote from: Lehrman, L.E., 1996. Jacques Rueff, the Age of Inflation, and the True Gold Standard (Address). Parliament of France. Nov. 7. Available at: https://www.academia.edu/1108885/Jacques_Rueff_the_Age_of_Inflation_and_the_True_Gold_Standard

Figure 4. Semiconductor market volume forecast from 2021, in billions of US dollars



Source: Applied Materials Investor Day 2021. Available at: https://www.webull.com/news/40900415 (accessed 17 March 2025).

The obvious reason for the market's exaggerated growth and capitalization is the inflated expectations for artificial intelligence. But this alone does not explain the high profits of only a small group of companies in the microchip manufacturing industry, while others are rapidly losing their capitalization (as is the case with Intel).

The primary reason lies in the privileged pricing of the leaders' products, some of the most sought-after and productive microchips, and higher up the chain, the machines used to manufacture them.

The first reason for this privileged position is monopoly: ASML has a quasi-monopoly on the production of the most advanced lithographic equipment, TSMC on the production of the most advanced chips, Nvidia in the design of the most productive chips for AI, and Apple in the production of end devices that dominate Western markets in the highest price segment.

However, in addition to the monopoly factor, Moore's Law, thanks to the rapid change of chip generations, creates unique opportunities for "premium pricing" for the most advanced generation of products. The market is structurally formed in such a way that almost all premium demand (Rueff's "non-existent" crazy money) is concentrated around either mass-produced, but state-of-the-art chips ("$120 for an iPhone central processing unit" or "chips for artificial intelligence") or low-volume but costly-to-produce microchips for specialized tasks (the specialization of companies such as Texas Instruments or Broadcom).

Therefore, the upper segment of the market, which is relatively small in absolute terms, as a direct consequence of the rapid change of generations and topologies, concentrates such overblown market capitalization and market share. In the lower part of the market, excess production capacity has been accumulating for decades due to the fact that previous generations of equipment are not being phased out and the cost of producing large series of simple chips on them is approaching zero.

A certain analogy to premium pricing in IT can be found in the luxury goods market, where people pay many times more for items than for their complete and often indistinguishable copies. People buy expensive things because they can afford them, either with their own money or with borrowed money. The availability of huge amounts of free liquidity (a consequence of the monetary policy of the last decade and a half in the West) is a necessary condition and a direct analogue of the technology bubble, where available money (especially among the wealthiest consumers in Western countries) ensures massive demand for the latest and most expensive products in the AI segment.

But a product becomes a luxury item if it has a "history" (for example, it was consumed by the European bourgeoisie or aristocracy during their era of global dominance); it is considered to be of higher quality or was created by a well-known designer (clothing); it can be resold without loss, or even at a higher price than the original purchase (Swiss watches); its supply is limited, there is constant rotation and "modernization" of the product range (women's handbags), and only exclusive channels with highly involved and motivated staff ("boutiques") are used for sales.

If you look closely at how trade in microchips and related devices is organized, you can see the emergence of exclusivity (if not artificial scarcity) and a race for the latest and greatest through exclusive channels with motivated sellers. This system resembles the pricing system in the luxury goods market, with constant references to tradition, to "creators—scientists—great businessmen" and to "the first, legendary consumers."

There is no objective pricing for the latest generation of microchips and the end devices made from them. The price is determined by money-backed demand, and purchases at inflated prices are possible thanks to the pumping of money into the market, created in part by the issuance of US dollars due to the chronic US foreign trade deficit.

This results in a huge price gap between the cheapest and most expensive microchips and a capitalization gap between the top three to five companies with the most advanced products and the rest of the market, which is left with segments with already outdated and mass-produced products sold at a large discount.

5. US control over the microprocessor market

The US retains direct control over the most profitable segments of the semiconductor industry's value creation, the "distribution of the end-products," and some intermediate technologies, primarily the "bottlenecks" of the value chain— EUV lithography and TSMC's customers' technological designs.

Although both Dutch and Taiwanese companies (a significant portion of their shareholders are also US funds and individuals) have created enormous value for their shareholders and their home countries, together they account for only one-third of Nvidia's market capitalization, which at the end of 2024 showed the highest share price growth over the last 20, 15, 10, and 5 years among all stocks worldwide. Let's not forget Apple, with a market capitalization of $3.7 trillion at the turn of 2024–2025, which is also the world's largest developer and consumer of microchips.

Why does the US continue to control all stages of value creation in this market without exception, imposing all kinds of restrictions on Russia (where all exports of equipment

for the production of microchips and the microchips themselves are prohibited) and China (where only the previous generation of equipment and obsolete or stripped-down microchips can be exported)?

The officially stated reasons are, of course, in the case of Russia, the military-political conflict over Ukraine, and in the case of China, the need to create obstacles for Chinese law enforcement agencies and defense manufacturers, and the objective of "protecting democracy."

In reality, much of this boils down to the need to protect American companies in the critical phase of transition from simpler and more straightforward work with big data, where Amazon, Alphabet, and Microsoft already control two-thirds of the global market, to the next, more risky and complex stage of technological development. Namely, artificial intelligence, which is fueled by the same big data and relies on the power of huge data centers, supercomputers, and colossal investments.

Big data and cloud technologies are trillion-dollar markets, but they are already traditional. There are well-established terms and scenarios for data storage and processing, with successful business cases that no longer need to be proven. In the case of artificial intelligence, successful business practices are still being developed, and it is not yet clear how convincing they will be compared to the huge investments required.

China has demonstrated its ability to build a platform economy independent of the US and has created its own network giants. The only one of these to occupy an important niche outside China, TikTok, is also under constant pressure from the US because it threatens the unchallenged dominance of American digital giants. Unrestricted in its actions, China is capable of bringing unnecessary competition to the US in the artificial intelligence market, as it has done with communications equipment, personal electronics, electric vehicles, and many other goods.

Tech giants invested more than $200 billion in AI in 2024, and company executives expect this investment surge to continue next year and possibly even accelerate. These corporate spending programs, reminiscent in scale of the Apollo space program and the moon landings half a century ago, are themselves contributing to the growth of the US economy [Bergen, Doan 2024]. Such investments, while still in a high-risk phase (the current economic impact of AI is not that sizeable, while the investments are huge), require additional protection, especially from the countries outside the US sphere of influence. American politicians and tech company lobbyists believe that without the latest generation of microchips, Chinese and Russian AI developers will lag hopelessly behind American leaders in developing and providing access to large language models. Europeans may not have enough money for AI, at least on an American scale, as Cedric O, former French Minister for Digital Affairs and Chairman of the Board of Mistral, Europe's largest AI company, explicitly states in his speech.[11]

Another reason for pressure on China in the semiconductor sector is fierce competition in the market for the latest smartphones, tablets, and laptops between Apple and Huawei, also expecting the imminent transition to devices with "built-in" artificial intelligence. AI was promised by Apple in the new generation of iPhones from the end

[11] Global AI Leaders Series 2. AI Pioneers: How Europe Is Driving Innovation&Regulation. Available at: https://www.youtube.com/watch?v= m4wUHAjjgLI

of 2024. Judging by the hype that arose in 2024 after the "discovery" of microchips with almost "the very latest" topology in the devices of a Chinese competitor [Rozanova 2024], the topic of "competition for the chip design" is very painful for Apple too. Having the most advanced processor is a very strong marketing advantage that sells new generations of iPhones well and generates huge profits.

Meanwhile, according to many analysts, Apple's artificial intelligence will lag behind its competitors by the end of 2024, and sales of new generations of devices will have to be stimulated by marketing claims about increasingly sophisticated but as yet unproven chip topologies and promises of the imminent introduction of AI.

The market capitalization of just the two largest wholly American companies at the end of 2024, at $3.5 trillion and $3.7 trillion, is enough for the US government to resort to administrative and prohibitive measures in addition to market and competitive mechanisms. This motivation is more important than the use of chips in the arms race, although the latter is also important. Obviously, it is better to equip the latest combat aircraft with the most modern electronics based on the latest processors (and at the same time not give them away to potential adversaries), but due to the long service life of aircraft, the novelty factor of the processor is not so critical. Perhaps for the first time in history, the civilian market demands greater innovation and greater protection than the military market.

The main tools used by the US to neutralize the threat from Chinese companies are direct bans by the executive and legislative authorities, control over several key technologies used in the production of processors, dominance in the main markets for the latest and most marginal products (through "platforms" and their network effect, dumping, preventive capacity expansion), as well as control over companies' capital and their boards of directors. This is in addition to threats of criminal prosecution (as was the case with the daughter of Huawei's founder, who was detained in Canada[12]).

Export bans on advanced chips to China began under the Biden administration, on the grounds that Beijing's access to the world's most advanced chips poses a threat to US national security. US officials also claim that China could use advanced chips to develop new weapons systems, carry out disinformation attacks, and spy on its citizens.

In 2023, restrictions were imposed on the sale of Nvidia H800 and A800 computing accelerators to China, dealing a blow to Chinese developments in the field of HBM memory. HBM is a special type of fast memory used in modern high-performance devices such as video cards, AI accelerators, and data processing units (DPUs), which are special processors for data processing. Because HBM memory is located on the same chip as the GPU (graphics processing unit), it provides extremely high data transfer speeds. This architecture, with its memory integrated into the GPU, is ideal for high-performance devices such as powerful graphics cards, AI accelerators, and supercomputers that require enormous computing power [Denisenko 2024].

Reuters has noted that Chinese companies are preparing to launch HBM2E (the third standard in the HBM product family) on their own [Yang, Potkin, Freifeld 2024]. Although Chinese manufacturers have purchased the necessary equipment in advance, no progress has been observed in this area yet.

[12] See, for example: The Meng Wanzhou Huawei saga: A timeline. CBS News, 2021, Sept. 25.

Currently, there is also a ban in the US on the export to China of any equipment using EUV technology, which is required to produce the latest generation of chips. The US House of Representatives Special Committee on Strategic Competition between the United States and the Chinese Communist Party, which is pursuing numerous American companies for their ties to China, sent letters to several semiconductor equipment manufacturers in late 2024 expressing concern about technology sales to China and requesting detailed information on the companies' sales volumes and their leading customers [Swanson 2024].

These bans sparked debate among lawmakers, administration officials, and company executives about how far the US should go to restrain its own industry. For example, executives from US technology companies KLA, Applied Materials, and Lam Research argued to lawmakers and Biden administration officials that stricter rules for US companies than for their Dutch or Japanese competitors would hinder US technological leadership and at the same time be ineffective in restraining China in the long term [Swanson 2024]. Nevertheless, before leaving office, the Biden administration imposed export restrictions on another 200 Chinese chip companies. Under the new rules, most US suppliers will be prohibited from trading with companies on this list.

The Trump administration continued its policy of imposing restrictions on the Chinese semiconductor industry, while at the same time setting a goal of attracting manufacturing capacity in this industry to the US.

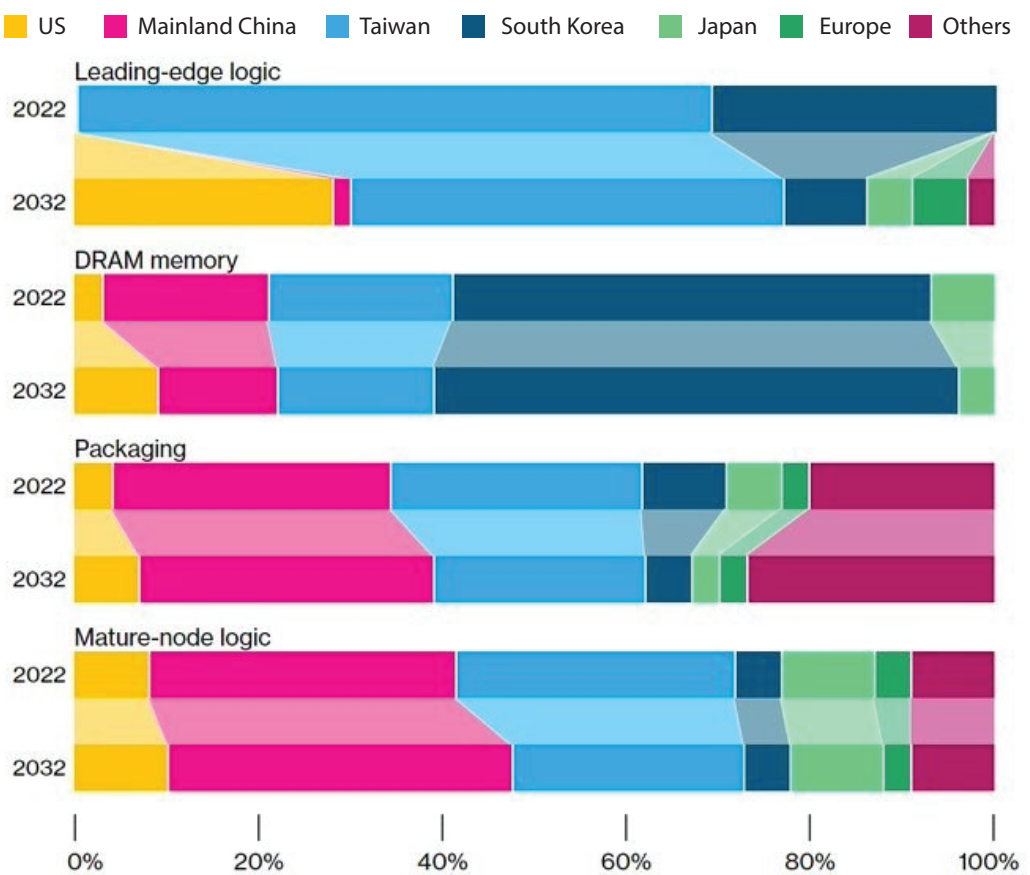
In 2022, the total share of US companies in the main segment of the semiconductor market was about 10% (see Figure 5 on p. 113).[13] American companies did not produce the most advanced chips at all. Thanks to the Biden administration's CHIPS and Science Act, the US is expected to return to the market for the most advanced microprocessors by 2030, with the US share of the global market growing to 14%, up from a more likely 8% without such measures.

The CHIPS and Science Act, or the Creating Helpful Incentives to Produce Semiconductors for America Act, was passed by Congress and signed by Joe Biden on August 9, 2022 [US Congress 2022]. It provides subsidies and tax breaks totaling $52.7 billion to microchip manufacturers operating in the United States. The Department of Commerce has been given the authority to allocate funds based on companies' willingness to support research, build facilities, and train new workers. At the same time, companies are prohibited from supplying advanced chips to China and Russia if they receive subsidies under the law.

As a result, six companies responded to the incentives provided by the law, announcing plans to build 20 fabs, some of which cost up to $20 billion. These companies include TSMC, Samsung, Intel, and others. In other words, the $52 billion allocated in the CHIPS Act is only the government's share of the expenditure, with the rest coming from investors. TSMC alone announced more than $100 billion in additional investments in the US by March 2025, already under the Trump administration [Shepardson, Holland 2025].

[13] See, for example, the post by Erik Brynjolfsson, an authoritative expert in the field: x.com/erikbryn/status/1823428609304047624 (accessed 11 June 2025).

Figure 5. US share of semiconductor production



Source: Bloomberg, based on the Semiconductor Industry Association and Boston Consulting Group data.

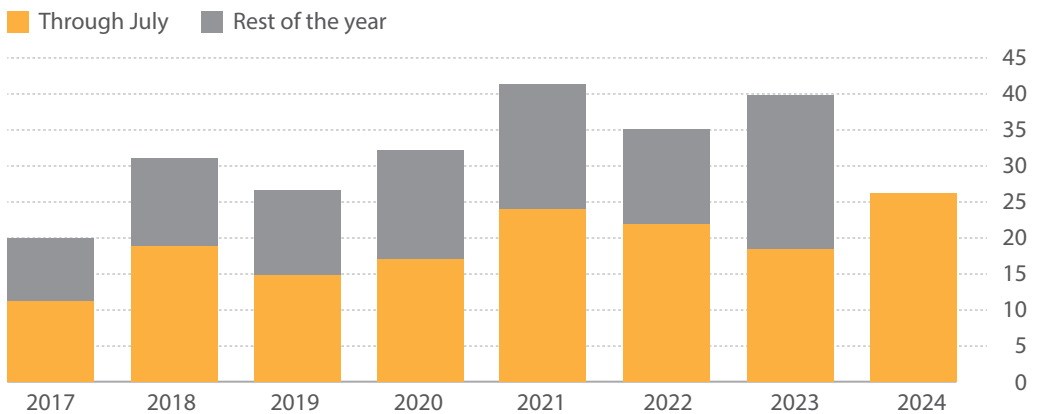
6. China's response to US actions

China's response to the restrictive measures taken by the US is a complex, multi-stage strategy that involves several parallel and complementary approaches. Almost all elements of traditional Chinese strategic thinking are evident here.[14]

First, buy time. While this window of opportunity remains open, China is actively buying up equipment for microchip production (see Figure 6 on p. 114) and luring Taiwanese workers to mainland China. The West reacted with some panic to a slight slowdown in orders for equipment for the PRC at the very end of 2024 and the negative forecast of a number of analysts for 2025: has China "had its fill," or has it developed its own photolithography technology? [Pan, Goh 2025].

[14] See, for example, the film Inside China's Accelerating Bid for Chip Supremacy. The film provides a detailed account of the US perspective on the development of the semiconductor industry in China. Available at: https://youtu.be/SUfjtKtkS2U?feature=shared

Figure 6. Chinese imports of semiconductor technology, billion dollars



Source: Bloomberg. Available at: https://www.bloomberg.com/news/articles/2024-08-22/chinese-imports-of-chip-gear-hit-record-26-billion-this-year (accessed 12 December 2024).

Second, China seeks to maintain large, profitable areas of cooperation where possible thanks to its strong position—in particular where China acts as a huge market for US companies, or where it has special, irreplaceable expertise or production scale. An example is China's cooperation with Elon Musk in the production of Tesla cars, with sales in China aiming for an annual volume of one million units. There are some things that no one else can make except China, and if they stop coming from China, it would be a huge blow to the US. For example, the assembly of iPhones and other tech products at Foxconn factories in China. Apple has spread out its gadget production chain across different countries as much as possible, but China is still the only place that can make the most complicated equipment and do the final assembly. The relocation of production already begun by the company, for example to India, means new risks for quality. In the face of fierce competition from Chinese and Korean manufacturers, Apple is unlikely to fully accept such a risk to the quality of its products in the short term.

Thirdly, China is seeking to "drive a wedge" into the enemy camp by singling out weaker or more dependent links. The PRC has managed (albeit to a very limited extent) to use the rather modest lobbying resources of microchip equipment manufacturers to delay the inevitable—a complete ban on imports.

Fourth, it has to "dodge blows" by seeking palliative solutions. For example, many American companies have removed some of their products from the scope of anti-China sanctions by creating special "non-sanctioned" product lines for China or by manufacturing certain goods for China outside the US.

Fifth, there is an opportunity to strike painful blows where the PRC can afford it, with the aim of creating room for negotiation. At the end of 2024, China imposed restrictions on exports of a number of rare earth metals to the US. And in December 2024, China launched an antitrust investigation against Nvidia for violating a

commitment made as part of its acquisition of an Israeli company to supply certain technology to China.

Sixth, and most importantly, China is trying to build its own technology ecosystem independent of the US in order to completely eliminate risks and build within China the same mechanisms for generating superprofits that have worked for the American Big Data companies. In essence, it is repeating the success of its own "platform economy" in microchip technology, but with the same risks, the main one being a focus on the domestic market. Or, more convincingly, it is repeating the success story of electric vehicle production, which was originally aimed at the international market.

Back in 2020, the Chinese government allocated a budget of $155 billion to support the semiconductor industry over the next ten years. China appears to be working simultaneously on creating its own equivalent of the Dutch ASML and on developing technologies that will enable EUV results to be achieved on DUV equipment. The Chinese company SMIC has achieved great success in microchip production. Its share of the global market in dollar terms is small, at only 6% (see Table 1 on p. 116), but it should be understood that TSMC's share is "inflated" due to the high cost of its latest products. Chinese AI microchip developer Cambricon Tech is often compared to Nvidia. In early 2025, Huawei achieved great success in the performance of its microchips for artificial intelligence, literally "stepping on the heels" of Nvidia. In terms of share price growth, it has even outperformed its American competitor over the past year. Shanghai Micro Electronics Equipment (SMEE) recently filed a patent application covering an EUV lithography machine [Shilov 2024].

Seventh, China is using "verbal interventions." For example, Chinese Foreign Ministry spokesperson Wang Wenbin said that the Chip Act will distort the global semiconductor supply chain and disrupt international trade [TASS 2022].

The Chinese Center for International Economic Exchanges, on the contrary, "expressed gratitude" to the US for the sanctions. The center's experts noted that before the sanctions were imposed, China imported $400 billion worth of microchips annually, and if the supply chains had remained unchanged, nothing would have changed. However, as a result of the sanctions and restrictions, China was forced to increase its own production. Now China itself exports microchips worth $70 billion in 2023, $85 billion in the first half of 2024, and, according to forecasts, by the end of this year, the country's revenue will reach $140 billion. Today, microchips are becoming the "main commodity" in China's exports: "We are especially grateful to some American politicians. If it weren't for such malicious suppression by the United States, the existing global production and distribution chains could have continued to function normally under the previous scheme. Despite the high price of American microchips, China would have continued to buy them. We could not even think about our own production, as we believed that it would require a great deal of effort. However, the United States stimulated the ambitions of the Chinese people" [IXBT.com 2024].

Since 2004, China has been the world leader in exports of office and telecommunications equipment. The communications and telecommunications sector is one of the largest and most dynamic in the Chinese electronics market. Most of China's microchip imports are not for domestic consumption, but for further re-export of

finished products, where the added value for the PRC is assembly and the production of "headset" components on site.

Mobile communication systems are seeing especially high sales growth. China's most successful company in this area, Huawei, is also under US sanctions. The pressure on it has eased somewhat in recent years. This can be attributed to the fact that US sanctions are now primarily targeted at social media (TikTok) and microchip production (with a focus on "bottlenecks" in their global value chains), while customs barriers are being introduced for electric vehicles. Telecommunications equipment has taken a back seat in this environment.

7. Taiwan's "silicon shield" and TSMC

Taiwan Semiconductor Manufacturing Company (TSMC) is a Taiwanese semiconductor manufacturing company founded in 1987.

Its share of global semiconductor production exceeds 60% (see Table 1 on p. 116), and its market capitalization at the end of 2024 was just under $1 trillion. Although the Taiwanese government is the largest individual shareholder, most of TSMC's shares are owned by foreign investors. TSMC accounts for about 30% of the main index of the Taiwan Stock Exchange.[15] This is directly analogous to Nokia's position in the Finnish economy in the mid-2000s.

Table 1. Market share of semiconductor manufacturers in 2023–2024, %

Manufacturer	Q1 2023	Q2 2023	Q3 2023	Q4 2023	Q1 2024	Q2 2024	Q3 2024
TSMC	61	58	59	61	62	62	64
Samsung Foundry	11	12	13	14	13	13	12
UMC	6	7	6	6	6	5	5
SMIC	5	6	6	5	6	6	6
GlobalFoundries	7	7	6	6	5	5	5
Others	10	11	10	9	9	9	8

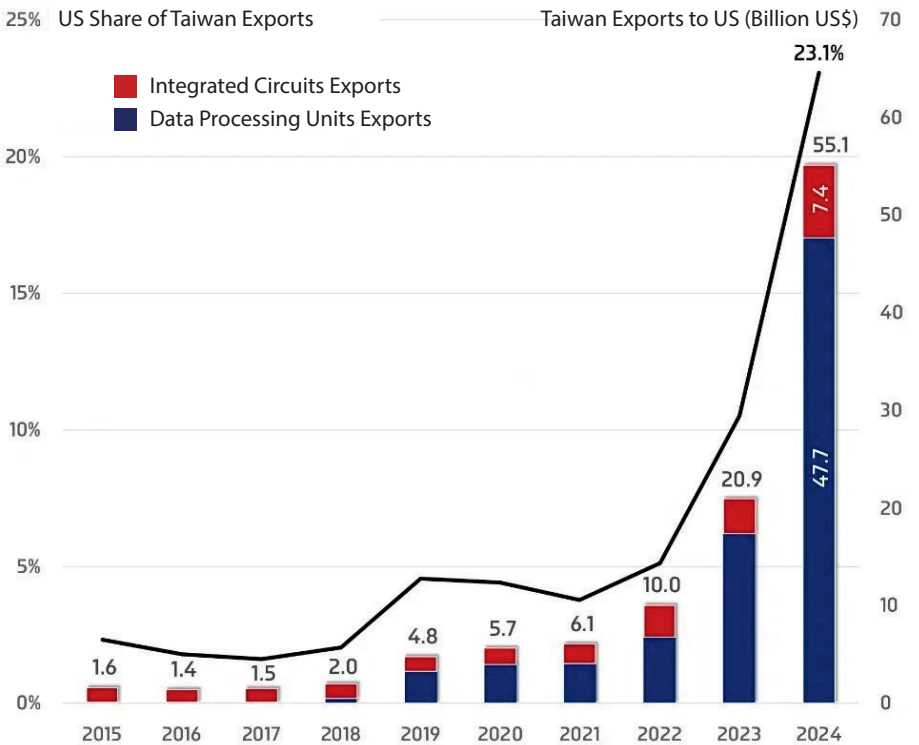
Source: https://www.counterpointresearch.com/insights/global-semiconductor-foundry-market-share/ (accessed 15 December 2024).

In 2022, Taiwan's exports of integrated circuits amounted to $184 billion, accounting for almost 25% of Taiwan's GDP, while Taiwan's share in the production of the most technologically advanced chips reached 70% [Statista 2024]. It is therefore no coincidence (although it is unclear how realistic they are) that all other countries that have joined this race have plans to knock Taiwan off its pedestal by 2030. In 2024, Taiwan's exports of microchips and data processing units to the US made an unprecedented, almost threefold jump to $55 billion. This is due to massive purchases of artificial intelligence and data storage systems. This makes Taiwan increasingly

[15] See, for example, the company's website: www.tsmc.com

"indispensable" to the US and dictates even greater urgency in transferring these industries to US territory (see Figure 7 on p. 117).

Figure 7. Imports of semiconductors from Taiwan to the US in 2015–2024



Source: Econovis, based on Taiwan customs data (accessed 17 March 2025).

TSMC has developed a large number of promising technologies, manufacturing processes, design tools, and standard architectures. It has pioneered the production of custom-designed microchips, unlike traditional vertically integrated manufacturers (the main example of those is Intel). This has enabled the company's customers to quickly launch production of end products without spending time and effort on building and managing their own factories, especially given the often unpredictable demand for future end-products.

In 2020, TSMC announced plans to open a factory in Phoenix, Arizona. It was expected to be fully operational in 2024, when the 5-nm process was predicted to be replaced by TSMC's 3-nm process as the latest technology [Yifan Yu, Cheng Ting-Fang, Lauly Li 2022]. At the time of launch, it was supposed to become the most advanced factory in the United States.

In December 2022, TSMC announced plans to triple its investment in Arizona plants in response to growing tensions between the US and China and supply chain disruptions that led to chip shortages, and in March 2025 there was already talk of an additional $100 billion in investments in the US—added during the Trump administration. In essence,

this is a "return" to the US of the dollars spent by the American tech giants on microchip purchases from Taiwan, despite all the problems the company has faced in the US.

However, TSMC quickly announced that it was facing serious financial problems, as the cost of the US factory was 4–5 times higher than that of a similar plant in Taiwan (due to higher labor costs, bureaucratic red tape, and staff training). Also, difficulties emerged in finding qualified personnel (to address this, the company hired American workers and sent them to Taiwan for 12–18 months of training [Yifan Yu, Cheng Ting-Fang, Lauly Li 2022]). These additional production costs will increase the cost of TSMC chips manufactured in the US by at least 50% compared to the cost of chips manufactured in Taiwan. In July 2023, TSMC warned that there were not enough qualified specialists in the US, so it would be necessary to bring in Taiwanese workers for a limited period of time and that the chip manufacturing plant would not begin operations until 2025 [Shilov 2023]. In September 2023, information emerged that the chips would still need to be sent back to Taiwan for packaging [Zuhair 2025]. In January 2024, TSMC Chairman Mark Liu again warned that Arizona lacks workers with specialized skills and that TSMC's second Arizona plant is unlikely to begin mass production of advanced chips until 2027 or 2028 [Toh 2024]. In April 2024, the US Department of Commerce agreed to provide TSMC with $6.6 billion in direct funding and up to $5 billion in loans to build semiconductor manufacturing capacity in Arizona. This measure falls under the CHIPS and Science Act and is aimed at stimulating domestic chip production in the US [Park 2024].

The reasons why the US has been unable to maintain its global leadership in the mass production of the most advanced microchips over the past decade are essentially summarized in the paragraphs above: a lack of personnel with the necessary qualifications and skills, high costs, and bureaucracy. This is probably also the root cause of Intel's current problems. Taiwan's engineering and manufacturing culture has proven to be more advanced.

Taiwan is expected to account for 70% of global semiconductor market revenue in 2024, with TSMC accounting for the majority of this revenue. Taiwan is also home to United Microelectronics Corporation (UMC), another major global semiconductor manufacturer. South Korea will account for about 11% of the global market by value, China for 8%, and the rest of the world for 11% [Statista 2024].

Semiconductor manufacturing is closely integrated not only into Taiwan's economic strategy, but also into its foreign and military-political strategy. The concept *of the "silicon shield"* assumes that Taiwan's role in the global semiconductor supply chain will serve as a deterrent against China. If chip production in Taiwan is disrupted, the global economy will face catastrophic consequences. Such a disruption would force international powers, particularly the United States, to intervene to protect these vital industries [Wu Jieh-min 2024].

Many in Taiwan are asking themselves whether the opening of factories in the US will lead to a loss of interest in Taiwan on the part of the US and whether this will strengthen the PRC's position on Taiwan's integration. This may also explain TSMC's reluctance to launch US fabs and its constant complaints about the unfavorable "circumstances" facing the company in the US, as well as possible restrictions by the Taiwanese authorities on the transfer of the most sensitive technologies and production stages to the US.

8. The European Union and ASML

The European Union has set a target of producing at least 20% of the world's semiconductors in value terms by 2030 [European Commission 2021]. Revenues from semiconductor sales in Europe are lower than in other regions [Clarke 2025]. Of course, this continent has some important advantages. One example is the production of chips for the automotive industry, in which companies such as NXP Semiconductors (Netherlands) and Infineon (Germany) specialize. Nevertheless, it seems that Europe has almost no chance of capturing 20% of the global market. This is partly due to the crisis in the European automotive and automotive electronics industries (an example is the German company Continental [Continental 2025]). There are no European companies left on the list of the largest semiconductor companies today.

However, one uniquely strong position has been retained. ASML is a Dutch company and the largest manufacturer of lithography equipment for the microelectronics industry, which is necessary for the manufacture of integrated circuits, memory chips, flash memory, and microprocessors.[16]

The company, originally called ASM Lithography, was founded in 1984 as a joint venture between Advanced Semiconductor Materials International (ASMI) and Philips. Subsequently, Philips retained only a small portion of ASML's shares. As of the end of 2024, the company has a market capitalization of approximately $250 billion.

The price of a single new latest-generation EUV-enabled machine is several hundred million dollars. Ninety-eight percent of the equipment manufactured by the company since 1988 is still in operation,[17] with a gradual shift over time toward the production of more affordable chips (those sold for less than 10 cents). This is a uniquely slow depreciation for manufacturing equipment; it also means that microchip production capacity is gradually accumulating globally; new equipment does not replace old equipment, but is added to it; the cost of capital for depreciated old lines is close to zero after several decades of operation, and the raw material is cheap sand.

According to estimates by the Semiconductor Industry Association (SEMI), global equipment sales will increase to $117 billion in 2024 [SEMI 2025]. This is largely due to accelerated purchases by China ($50 billion) and, in general, a global "race for capacity" between fab builders around the world.

Although ASML is undoubtedly a "digital" company, it stands somewhat apart because it uses many traditional technologies—in which Europe remains strong. These include, for example, ultra-smooth mirrors and glass from Zeiss and Berliner Glass. It is the use of these technologies that allows us to speak, on the one hand, about US control over the whole value chain on a global scale and, on the other hand, to mention a certain degree of "negative control" on the part of the EU: denying access to key German and Dutch technologies could paralyze the manufacture of photolithography machines at this quasi-monopoly.

Over the past decade, the European Union has lost the small handful of leaders in the digital race that it once boasted (Bull, Olivetti, and Alcatel are examples). The largest

[16] How ASML, TSMC, and Intel Dominate the Chip Market. CNBC Marathon - YouTube. Available at: https://youtu.be/2kJDTzFtUr4?feature=shared

[17] Ibid.

Franco-Italian microchip manufacturer, STMicroelectronics, has lost half of its market capitalization over the past year, following Intel, and is now worth only about $20 billion (less than a quarter of Intel's value), not even making it into the top 20 global rankings (see Figure 2 on p. 105). European projects initiated by foreign companies are also in question. One of them, Intel's planned $10 billion plant in Germany, was shut down before it even started—due to Intel's own problems.

Most likely, there are no companies left in the EU in the microchip manufacturing sector that are capable of ever catching up with their American, Taiwanese, Korean, and Chinese counterparts. This is confirmed by recent data on national purchases of microchip manufacturing equipment: in 2024, Europe purchased 10 times less than China and almost three times less than the US and Canada [SEMI 2025].

At the same time, it cannot be said that the entire European Union is unequivocally a victim of American dominance in the semiconductor industry. For example, thanks to its offshore status, cultural proximity to the US, and EU membership, Ireland has been able to surpass its former metropole, the UK, in most economic and social development indicators. It has become a convenient location for the treasuries of the Big Data companies, with hundreds of billions of offshore profits, as well as sales offices of American giants and even large microchip manufacturing plants.

9. Conclusion

The production of integrated circuits has become one of the key technologies that have changed the global economy and technological landscape over at least the last half-century. Its progress was often invisible, "dissolved" in the general flow of digitalization, the rapid development of communication technologies, software, and social networks, until the mid-2020s. It once again came to the fore with the emergence of artificial intelligence technologies, unprecedented growth in market capitalization in this segment, and a sharp intensification of competition between the US and China in this area.

The stock market boom created unprecedented giants and a whole class of influential players, almost exclusively American or US-controlled, who gained unprecedented wealth. Their positions currently appear exceptionally strong, regardless of whether the bubble of inflated capitalization bursts or not.

The main investments—in fixed assets, data center equipment, and AI—are being made on a global scale, but mainly by American players. When trillions of dollars of stock market "achievements" of a narrow circle of American companies are at stake, protecting their technological dominance becomes a key geopolitical factor. Despite "delegating" a number of technological competencies to foreign players (largely out of necessity and possibly temporarily due to a lack of specific resources in some areas), the US continues to unilaterally control the entire value chain. There is no multipolarity here—this world, the world of Moore's Law, remains unipolar for now. The US goal is to maintain global dominance through the monopolization of limited resources and control over the "bottlenecks" of the value chain where there are only one or two players under direct or indirect US control. Such control in the field of artificial intelligence, where there are already dozens of large language models that are fairly comparable in terms of

performance, is more problematic today. And it is easier for the US to try to deprive its competitors of the building blocks for developing their own effective artificial intelligence.

The US is trying to counter China, but it is still limited by its internal "perimeter," as in the field of social networks and platforms. Its achievements are still catch-up, selective, and interim in nature, but there is probably still more to come. The PRC is moving forward at a truly rapid pace and has already overtaken the US in a number of indicators (in particular, the efficiency of using available processors).

The EU has fallen behind almost hopelessly in this technological race. This will become one of the points of tension within the EU and in the bloc's external positioning. This lag coincided with the presidency of Ursula von der Leyen, many of whose statements on this subject (in particular, on Russia's use of microchips from washing machines) raised legitimate questions about her competence.[18]

It can be assumed that excess production capacity accumulated at the global level, especially in the manufacture of the cheapest chips and in the mid-range segment, against the backdrop of active "non-market-driven" construction of factories financed by state subsidies, will eventually lead to a decline in the profitability and attractiveness of the industry as a whole. The desire of national governments to have and control these production facilities on their territory has played a cruel joke on the "mass" semiconductor industry. The industry may not survive in its current form with the simultaneous expansion of capacity in China, the US, Europe, and Asia (mainly in Taiwan, South Korea, and Malaysia).

The current stage of development in the industry is inextricably linked to artificial intelligence. It is in AI processors developed by the American company Nvidia and manufactured by TSMC in Taiwan that the US has identified its main advantage in the field of AI and decided to maintain it by imposing draconian restrictions on exports to "unfriendly countries," thereby protecting the three American leaders in cloud data storage (Microsoft, Amazon Web Services, and Google). Within the US, a minimum level of competition is ensured, while on the external market they act jointly as America Inc.

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[18] For example, her statements about microchips "from washing machines:" https://www.forbes.com/sites/erictegler/2023/01/20/is-russia-really-buying-home-appliances-to-harvest-computer-chips-for-ukraine-bound-weapons-systems/

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On the Chinese Model of Economic Development, State History, and Social Values[1]

Book review: Popov, V.V. The Chinese Model: Why China Used to Lag Behind the West and Is Now Overtaking It. Yerevan: Fortis Press, 2025. 392 pp.

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The book by the renowned economist Vladimir Viktorovich Popov, "The Chinese Model" (Yerevan: Fortis Press, 2025), is a study of China's economic rise. It is obviously motivated by the unflattering comparison for us, Russian citizens, between the Chinese experience of reform and our own experience at home. The book is inherently interesting by virtue of its topic and the questions it raises, and since it is also written in a very accessible style—even in the sections dealing with economic theory—it makes for truly captivating reading.

The author, who has extensive international experience, including living in East Asia, examines the topic very broadly. He deals not only with purely economic matters but also with related issues of history, culture, and state-building. Towards the end of the book, he proposes his own outline for a theory of economic development that follows logically from the entire narrative.

While I agree with the author's core ideas, I would like to offer some assessments and comments written from a sociologist's perspective. I do not claim these to be the ultimate truth, especially in the field of economic science. Nevertheless, they may be of interest both to the author and to the book's readers.

[1] The article is published in the author's edition.

A major component in the recipe for successful economic development proposed by Popov is the presence of strong state institutions, which need not be necessarily democratic. This thesis resonates with sociological theories focusing on the state in the tradition of Max Weber.[2] Furthermore, as the author notes, prominent economists have also distinguished between economic catastrophes caused by market failures versus those caused by state failures [Leontief 1974].

It is difficult to disagree with this position. In hindsight, it is obvious that the Soviet perestroika effectively destroyed the state. Freedom, against a backdrop of destroyed institutions and the resulting unpredictability and lack of a long-term planning horizon, resulted in predatory behavior, including among the elites. As the author notes, similar phenomena, in the absence of state control, emerged in some parts of China at the grassroots level—for example, in some villages where the "democratized" local authorities and wealthy individuals connected to them engaged in trafficking women and drugs (p. 229). However, whereas such behavior was rather an exception in reform-era China, for Russia in the 1990s it was more like the rule.

In fact, my main criticism of the book's author is his insufficiently consistent application of the state-centric principle he himself puts forward. Specifically, the proposition about the critical importance of a strong state becomes particularly obvious in light of the fact that attempts to catch up with the West have been successful primarily in East Asia. While many authors link this success to a distinct East Asian culture (a temptation to which Popov also succumbs, as I will discuss later), there is research indicating that the long-term existence of a stable state by itself creates robust and self-reproducing state institutions—something that one might call a state instinct or inertia. Moreover, the longer a stable state exists, the stronger these institutions become [Bockstette et al. 2002]. The same research shows that the state antiquity is statistically correlated not only with low murder rates, etc., but also with economic growth in the second half of the 20th century. And it is no coincidence that it is precisely the states of East Asia that feature long, continuous histories.[3]

A long continuous history of having a stable state profoundly changes the society. Social order (measured, among other things, by low murder rates but manifesting in a wide spectrum of phenomena), the capacity for large-scale projects involving multitudes of workers, and other characteristics of old, stable states create a unique institutional environment. In the late 20th century it was such environment that facilitated the rise of China (as opposed, for example, to Mozambique).

To illustrate this point, I will indulge myself in sharing a story from my father, who served in the air force during the Korean War. Our pilots needed to set up an airfield on Chinese territory adjacent to the Korean border. This required selecting a suitable site and coordinating the choice with local authorities. The terrain in those parts is hilly, and the officer tasked with making the selection made his Chinese comrades impatient because he couldn't find a site he deemed sufficiently safe for takeoff and landing: one thing was wrong here, another there. Finally, the Chinese said: "You say this site would be perfect if it weren't for that neighboring hill. So, what if we level it?" There were no excavators or

[2] Theories of state breakdown are summarized by Collins [Collins 1999]; see also [Skocpol 1979; Goldstone 2013].

[3] From this point of view, Japan has a more stable history than China, albeit a shorter one.

bulldozers in China at that time, at least not in that area. However, the authorities mobilized residents from neighboring villages, drew up a schedule, and thousands of people, working in shifts (almost around the clock), came to the site with picks, shovels, and wheelbarrows and managed to demolish that hill in a very short time. The organization, in terms of coordinating the different shifts, was excellent; the discipline was ironclad; the work capacity was immense. The moral of the story is that both China and Mozambique were technologically backward in 1950, but China, unlike Mozambique, was socially advanced. This allowed, in both ancient and modern times, to plan and execute grand projects.

Popov's book includes an ancient Chinese parable (p. 81) that remarkably echoes my family story:

> An old man and his two sons decided to level two huge mountains blocking the entrance to their home using nothing but hoes. When his neighbor laughed and called him a fool, he replied like this: the mountains are high, but they do not grow. So if I and my sons take a little bit away from the mountain every day, and then my grandsons, and then my great-grandsons, and so on, we will eventually move these mountains. The perseverance of the Old Fool of the North Mountain (that is how his name, Bei Shan Yu-gong, translates) moved God, and he sent two saints to earth who carried the mountains away. "We also have two mountains," Mao continued, "imperialism and feudalism. If we work tirelessly to level these two mountains, we will also move God. Our God is none other than the masses of the Chinese people. If they all stand up, can we not move the mountains?"

Another instance of insufficient consideration of state-centric sociological theories has to do with the next component of Popov's recipe: an export-oriented economy, whose advantages are opposed to the import-substituting strategy. The problem here is that states do not exist in isolation, but rather in competition or cooperation with each other. Therefore this ingredient of the recipe is not always applicable for any country. When in the mid-20th century the American economy constituted about half of the world economy, access to the American market and other markets controlled by the United States was critical for the success of an export-oriented strategy. However, such access depended on the relations with the world center (cf. [Wallerstein 1979]). The rapid rise of Japan and Germany in the post-war period is hard to imagine without such access. The USSR had almost none, while China acquired it as a result of Mao Zedong's rapprochement with the United States in the early 1970s, when Chinese exports began to grow—yes, as the author correctly notes, even before the start of Deng Xiaoping's reforms (p. 143), but he still leaves the geopolitical factor out of the equation, as if attributing the growth of exports exclusively to factors of internal organization.

In fact, a long history provides government bureaucracies with a lot of successful and failed examples of both domestic and foreign policies, which is another advantage of ancient states. Jared Diamond writes about the Inca emperor, whom the Spaniards repeatedly deceived after the Battle of Cajamarca, extorting more and more gold only to eventually execute him [Diamond 1997]. The fact is, Diamond explains, that the Incas, unlike the Chinese or Europeans, had virtually no history of relations with other states,

so they were completely inexperienced and naive in these matters.[4] On the other hand, Chinese chronicles, let's say, of the Three Kingdoms period (3rd century AD) or even older ones, provide a wealth of information about how warring states and leaders enter into coalitions with each other, then betray each other, and ultimately the most cunning one wins. Every Chinese knows these stories since they make the context of novels and plays that are still popular today. Perhaps this is why Mao was more cunning not only than the 16th century Incas, but also than some of his contemporary foreign leaders.

In this regard, the author's assertion that China did not have the opportunity to participate in what Wallerstein called "development by invitation" (p. 51) evokes my strong disagreement: American capital, technology, and market access certainly played a critical role in the rise of the Chinese economy. Popov believes that China made an offer that the United States could not refuse, lending to America and allowing it to consume more than it produced. The value of such a "gift" is, in my opinion, very ambiguous, but in any case, without the US favor, China's development would have followed a completely different trajectory.

Nowadays, of course, the economic balance of power has already changed significantly. As a result, there is an opportunity now to establish large-scale trade relations more or less independent of the West and, accordingly, a successful export-oriented strategy. However, since such a development undermines the Western monopoly, we observe resistance by means of various trade restrictions, as well as military pressure quite in the spirit of Weberian theories (cf. [Collins 1999]). The resolution of these contradictions is important not only in terms of world politics, but also in terms of economic development, especially in non-Western countries. We will probably soon witness the resolution of this conflict; in any case, this is a priority issue on the world agenda.[5]

The author also underestimates the role of competition between states and power prestige in some less essential issues. For example, the idea that a critically important factor of the Russian revolution was land inequality (pp. 105–108) is not supported by calculations in the book, yet the author leaves out the effects of the First World War, which was lost not only by the Russians (who lost the most people), but also by the Germans (including the Austrians), thence all their empires fell apart against the backdrop of revolutionary movements. The previous Russian revolution of 1905, too, was obviously related to the defeat in the Russo–Japanese War, which stirred up the rise of many national movements both in the Russian Empire and in some non-Western countries impressed by the success of a modernized Oriental power.

It is difficult to dispute in principle another key component of the recipe for success proposed by Popov, namely the accumulation of domestic savings for investment. Here the author prioritizes domestic investment over foreign, since the former is evidence of healthy institutions, while the latter does not guarantee success in the absence of the former. The author writes that during the period of capital accumulation in England its ruling class took the risk of social instability in order to squeeze the juices out of the

[4] The Soviet elite's prolonged self-isolation ultimately led to similar naivety and disastrous outcomes during their rapprochement with the West.

[5] I do not consider the strategy of currency devaluation, which Popov singles out as a separate component of success, because it is essentially part of an export-oriented strategy.

population so as to save and invest, whereas in the 18th century China (or even earlier) they did not. As a result, China fell behind the advanced European countries. The author sees the source of this difference in the Confucian desire of the Chinese elite for internal harmony and its collectivist orientation. Of course, there are other explanations for this difference. Thus, Jared Diamond points to the very early concentration of power in China in a single center, which led to the suppression of any large-scale competition in principle [Diamond 1997]; Randall Collins, too, writes about the anxiety the authorities of East Asian societies had about power competition in the face of emerging big and independent economic actors who were therefore destroyed [Collins 1999]; and Douglass North and his co-authors explain the English case by a special structure of incentives that developed in the wake of Great Geographical Discoveries: the small old elite simply did not have enough manpower to exploit the vast captured territories; therefore, its ranks had to be expanded, allowing for the autonomy of corporations [North, Wallis & Weingast 2009]. Jack Goldstone [Goldstone 2008] offers a detailed explanation of the European phenomenon. However, no book can cover the entire universe of explanations, and the author is free to choose what seems most important and interesting to him in constructing his theory.

But since the author attaches great importance to the cultural characteristics of China, including values, I cannot help but react to this, as I myself have devoted a lot of time to such studies. To begin with, I would like to note that all people, including scientists, tend to make mistakes in causality attribution. Success tends to produce a halo effect, when its consequences or even some completely unrelated features of the object of admiration are taken as the cause of success. Despite the fact that I am personally convinced that culture does matter, including for economic development, establishing causal links between the economy and culture is still, unfortunately, a controversial subject and often fraught with errors.

Popov sets much store in his book by the well-studied "individualism-collectivism" dimension (IND-COLL). He believes that China's collectivist orientation largely explains its development trajectory, starting from the above-mentioned rejection of capital accumulation using the "English" method and ending with Deng Xiaoping's reforms. Meanwhile, recent studies of value orientations show that China (and East Asia in general) do not stand out from the rest of the world on the IND-COLL dimension. Whereas East Asia, indeed, has significantly lower scores on individualism than Northern Europe, it actually scores slightly higher than Russia or the world average on this parameter [Minkov et al. 2018]. However, East Asia really stands out in the recently proposed "flexibility-monumentalism" dimension, orthogonal to IND-COLL [Minkov et al. 2018]. Monumentalism is one's confidence in one's own perfection and the ability to maintain this confidence despite any failures; the extreme pole is the equatorial part of Latin America. On the contrary, East Asia is the pole of flexibility in the sense that people of this region are more prone to consider themselves imperfect and therefore in need of (self-)correction. Looking at it from a slightly different angle, East Asia has a widespread culture of shame, a desire not to be condemned by one's neighbors and not to lose face. Perhaps this is why, as Popov notes, there were no duels in Japan in the European sense of the word, but "suicides of honor" used to be widespread.

In any case, this value dimension at the country level correlates with a number of interesting indicators such as (for the flexibility pole) the exceptional rarity of parental absenteeism, low obesity rates, high academic achievement, and the prevalence of myopia (probably because they study hard). I believe that the statistics of sexually transmitted diseases (extremely low in China) noted by Popov also reflect the value orientation that Minkov calls "flexibility."

The value attached to education can be partly interpreted as a result of the centuries-old tradition of appointing Chinese officials based on the results of state examinations. This meritocratic system, while ensuring the elite quality, at the same time served as a means of upward mobility and gave education a special prestige. Thus, this cultural feature is probably also related to the ancient state tradition. Nowadays, it certainly contributes to economic growth.

Nevertheless, the logic described by Karl Polanyi in *The Great Transformation*, one that reduces all human relations to economic transactions, apparently affects the cultures of East Asia as well. Medvedev et al. note that East Asia, compared to the West, is still more inclined to respond to non-material incentives [Medvedev et al. 2024]. However, if we look closely at the differences between China and Japan in the graphs and tables they present, we can see that Japan has gone further than China along the path of the "Great Transformation," which is probably due to a longer period of exposure to the Western model of capitalism.[6]

One cannot but agree with Popov's position that excessive inequality undermines the quality of institutions. It is highly likely that the transformation of domestic policy in China under the current leader is indeed, as the author shows, partly a reaction to dissatisfaction with inequality, which has grown sharply as a result of the reforms initiated by Deng Xiaoping. This observation echoes the paradoxical decline in subjective well-being in China against the backdrop of rapid economic growth in the 2000s, which my colleagues noted back in the 2010s and showed to be related precisely to the growth of inequality [Brockmann et al. 2009].

At the same time, Popov's generalized statement to the effect that Westernization corrupts institutions by increasing inequality (and with it come crime and corruption) is probably applicable only to those countries that had strong home-grown institutions (probably also China), but is unlikely to apply, for example, to equatorial Africa, where institutions were tribal, not state-based. Also, the author's reasoning on pp. 49–50 in the same vein about the Westernization of Russia by Peter the Great, in my opinion, is anachronistic; the final enslavement, which turned the majority of the Russian population into disenfranchised slaves, occurred under Boris Godunov (probably in 1592), that is long before Peter, and a little later than serfdom was abolished in England (1574).

I have more minor comments, which I keep to myself, so as not to go beyond the limits of a review. The criticisms in my comments do not in any way negate the excellent value of the book, either educational or aesthetic.

[6] Incidentally, although Popov criticizes liberals for believing that freedom facilitates economic growth, liberal theorists of modernization are well aware of the complex (indirect and reciprocal) causal links between values, institutions, and economic development, which they support with sophisticated calculations. See, for example, [Welzel 2013].

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