



Revising the Post-2022 Arctic Security Literature

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Arctic security has attracted growing scholarly attention in recent years, particularly after Russia's full-scale invasion of Ukraine in 2022. Commonly defined as the area north of the Arctic Circle (Stern, 2005), the Arctic has, since the end of the Cold War, largely been 'shielded' from geopolitical spillover (Gricius & Fitz, 2022). However, the ripple effects from the war in Ukraine have led several scholars to argue that this period of 'Arctic exceptionalism' has come to an end (e.g., Bennett, 2023; de Almeida Neto, 2025; Pedersen & Steinveg, 2024). The stability in the Arctic is further disrupted by rapid climate change. The region, which is mainly made up of the ice-covered Arctic Ocean (Stern, 2005), is warming nearly four times faster than the rest of the world (Rantanen et al., 2022), and by 2050, there will no longer be any sea ice covering the ocean during the summer months (Overland & Wang, 2013). Consequently, the Arctic is gradually being opened up to shipping, resource extraction and naval activity. Combined with the spillover from the war in Ukraine, this serves as a catalyst for strategic competition and increased tensions.

The Arctic's military significance long predates the current developments. Notably, the region acquired strategic importance during the Cold War. Since the shortest distance between the United States and the Soviet Union was transpolar, both superpowers were certain that a surprise nuclear attack would come over the Arctic, making it vital for early warning systems and missile defence (Tamnes & Holtsmark, 2014, pp. 21-22). Moreover, the Kola Peninsula, located in the Russian Arctic, was the home base of the Northern Fleet, which hosted the majority of the Soviet Union's strategic ballistic missile submarines (SSBNs). These submarines represented the country's most reliable second-strike capability. Importantly, with the introduction of longer-range submarine-launched ballistic missiles in the 1970s, the SSBNs were able to threaten the American homeland from or near their own home bases (Cameron, 2024, p. 368). This heightened the importance of the Arctic, as it was believed that a considerable share of the Northern Fleet would remain in proximity to home waters to safeguard the survival of the SSBNs in a 'bastion' (Tamnes & Holtsmark, 2014, p. 27).

The post-Cold-War period in the Arctic can broadly be divided into three phases. The first was characterised by an euphoric belief in cooperation and commitment. Tensions between the US and Russia had subsided, and the Arctic witnessed a notable decrease in US and NATO military presence (Vázquez, 2025, p. 99), as well as decaying Russian military capabilities (Åtland, 2011). Concurrently, the birth of several fora for Arctic cooperation took place, most notably with the launch of the Barents Euro-Arctic Council in 1993 and the establishment of the Arctic Council in 1996 (de Almeida Neto, 2025, p. 189). Additional forms of cooperation were also launched, such as the Barents Search and Rescue agreement in 1995 (Sydnes et al., 2017). Against this backdrop, the Arctic began to be regarded as an 'exceptional' region where geopolitical tensions were overcome for the

benefit of cooperation on common challenges (Hilde et al., 2024; K  pyl   & Mikkola, 2015).

The second phase, starting around the turn of the century, saw a continued belief in cooperation, but also a gradual realignment towards Russia. Putin’s revisionist ambitions were becoming increasingly apparent in the mid-to-late 2000s. They were nonetheless largely overshadowed by two more ‘prominent’ issues. The first was the region’s economic potential, which drew considerable attention following assessments of substantial undiscovered oil and gas reserves (U.S. Geological Survey, 2000; 2008). This generated significant optimism about joint Arctic petroleum development (NOU 2003: 32, 2003), exemplified by plans for the Shtokman field, though most such projects were ultimately shelved (Onsager & Stuv  y, 2022, p. 369; Tunsj  , 2020, pp. 141-142). The second issue was climate change. Researchers had discovered that the Arctic was warming faster than the rest of the world (Arctic Climate Impact Assessment, 2004). This opened two distinct avenues for cooperation: joint efforts to mitigate the changes, and joint exploitation of the economic opportunities a more accessible Arctic would bring. Thus, even after Russia invaded Georgia in 2008, annexed Crimea in 2014 and started to modernise its military capabilities in the region, cooperation continued, although in a more reserved form (S  reide, 2023, pp. 17-18;   sthagen, 2023a, p. 2).

The full-scale Russian invasion of Ukraine in 2022 marks the beginning of the third and current phase of Arctic policies. Characterised by the resurgence of great power rivalry and a breakdown of diplomatic ties between the West and Russia, it invites comparison with the Cold War. However, such a parallel is misleading in three respects. First, the region itself is markedly different today. Climate change has already reduced the amount of summer sea ice, enabling new commercial opportunities (Moe et al., 2024). For Russia, these developments matter profoundly, as it seeks to commercialise the Northern Sea Route – a shipping route linking western Eurasia with the Asia-Pacific – and monetise Arctic oil and gas. Moscow therefore no longer regards the Arctic as merely a theatre for nuclear exchange, but increasingly as a core economic interest (Kjell  n, 2022, p. 48). Second, where the Cold War pitted two roughly balanced blocs against one another, Russia now faces seven aligned states¹ (‘the Arctic 7’) (Wegge, 2025, p. 39). Third, Russia’s regional isolation has pushed it to seek partners beyond the Arctic, most notably by cooperating with China (Conley et al., 2024). Unlike during the Cold War, China has also emerged as an Arctic actor in its own right (Edstr  m et al., 2023; Pedersen, 2025).

These differences have prompted a substantial body of scholarship on Arctic security, much of it revisiting assumptions inherited from the Cold War. The following sections review that

1 These are Canada, Denmark (Greenland), Finland, Iceland, Norway, Sweden, and the United States.

literature, focusing primarily on work published since Russia's full-scale invasion of Ukraine. Emphasis will be on research concerning the European part of the Arctic, as well as the political concept of the 'Circumpolar Arctic' – referring to the challenges facing the region as a consequence of the rapidly melting sea ice (Tamnes & Offerdal, 2014, p. 5). The North American Arctic – composed of the polar regions of Alaska, Canada and Greenland – is therefore mostly excluded from the assessment. One can of course question how useful a regional distinction is; several researchers have called for a more coherent definition of the Arctic (Cickavage et al., 2026). Nonetheless, for the purposes of this paper, the distinction is made to limit the scope.

Cooperation and NATO enlargement

The post-2022 period has reordered Arctic cooperation along two axes: the multilateral fora that included Russia have contracted, while cooperation among the Arctic 7 has deepened. The immediate aftermath of the invasion saw work in the Arctic Council paused, cooperation with Russia in the Barents Euro-Arctic Council suspended – with Russia withdrawing altogether in 2023 – and research projects put on hold (Andreeva & Rottem, 2025, p. 75). Some scholars initially speculated that a new constellation for Arctic cooperation might be created without Russia (Gricius & Fitz, 2022; Koivurova, 2022). However, as time went on, the members of the Arctic Council demonstrated a commitment to resume work, gradually restarting projects. The survival of the Arctic Council has been covered extensively in the literature (Andreeva & Rottem, 2024; 2025; Koivurova & Shibata, 2023). Its fate has also been subject to normative debate, with some, such as Dyck (2024), arguing that efforts should be made to resume operations with full Russian participation, whereas others contend that the price of continued cooperation is currently too high (Paukkunen & Black, 2024).

Cooperation among the Arctic 7 has deepened and consolidated within NATO (Friis, 2026). Most notably, Finland and Sweden joined NATO in 2023 and 2024 respectively.² This has fundamentally altered the strategic balance in the European Arctic, as Russia now experiences a deepened sense of conventional vulnerability in a region in which it previously enjoyed control and security (Boulègue, 2024; 2026). Furthermore, Hilde et al. (2024) argue that it has contributed to increasing the relative importance of the Northern Fleet, as Russia's Baltic Fleet is now essentially surrounded by NATO countries, while the Black Sea Fleet is constrained by the war in Ukraine. Moreover, a growing body of literature has analysed the impact of the enlargement on Nordic military cooperation, including analyses of its broader implications (Forsberg & Christiansson, 2025; Friis & Tamnes, 2024; Ojanen & Väisänen, 2023; Saxi, 2025), its consequences for operational cooperation among Nordic

2 See Brommesson et al. (2024) for an account of the countries' decision to apply for NATO membership.

armed forces (Edström & Ångström, 2024; Jeppsson, 2026; Solvang & Wegge, 2023) and for the Nordic deterrence posture (Pesu, 2026).

Russian military modernisation and build-up

Russian military capabilities in the Arctic have been the subject of extensive scholarly attention. A central component of Russia's efforts to modernise the Northern Fleet has been the introduction of the new Yasen-class multi-purpose submarine (Søreide, 2023, p. 18; Friis, 2025, p. 244). These submarines have attracted particular attention in the West, as their ability to stay undetected and carry a wide variety of missiles makes them a considerable threat (Bredesen & Friis, 2020; Stefanick, 2025; Søreide, 2023). Furthermore, the introduction of the new class of stealthy SSBNs, the Borei-class, has similarly attracted attention, as it has demonstrated that Russia has the capability to modernise its strategic submarines (Stefanick, 2025, pp. 342-343). Over the years, the modernisation has resulted in a major restructuring of the Northern Fleet, which now has only around a tenth of the vessels it had at the height of the Cold War (Friis, 2025, p. 244). According to Friis (2025), this reflects a deliberate prioritisation of range and precision over quantity, as the new vessels are equipped with precision-guided cruise missiles that render them considerably more potent than their predecessors.

The modernisation of the Northern Fleet has prompted a debate about how to operationalise the bastion defence concept. During the latter part of the Cold War, Western analysts believed that Russia sought to protect its SSBNs in the Arctic through the establishment of a 'bastion'. This implied maintaining a zone of sea control in the Barents Sea (Halsne, 2022). Furthermore, in the event of a war with NATO, it was assumed that Russia would try to establish an outer zone of denial in the Norwegian Sea to hinder NATO access to Norwegian territory, airspace and surrounding waters (Brott et al., 2025). However, the reduction in the Northern Fleet's capacity, along with the technological developments allowing for long-range strike systems, implies that sustaining a forward presence in the Norwegian Sea is no longer plausible (Brott et al., 2025; Kjellén, 2025; Kvam, 2020). Instead, Russia now seems to concentrate its capabilities closer to home, east of the Bear Gap – the corridor between the Norwegian mainland and Svalbard's Bear Island. This shift appears to have been spurred on by the invasion of Ukraine, as argued by Åtland et al. (2024), who find that Russian exercise activity in the High North has shifted decisively from the Norwegian to the Barents Sea since 2022, and interpret this as a rebalancing from external signalling toward the internal bolstering of the bastion.

In addition to modernising, after the turn of the century, Russia enhanced its military presence in the Arctic. This build-up must be understood in the context of Russia's ambition to return as a great power and the dominant player in the Arctic. Moreover, as argued

by several researchers (e.g., Boulègue, 2024; Odgaard, 2022), Russia's own ambition to commercialise the Northern Sea Route (NSR) and monetise Arctic oil and gas exposes it strategically: expanding traffic along its coastline creates opportunities for increased foreign state activity. In an effort to counterbalance this insecurity, Russia expanded its footprint along its northern coastline, investing in dual-use infrastructure (Boulègue, 2022). Notably, bases and airfields were reinforced at key NSR chokepoints (Boulègue, 2024).

However, Moscow currently faces two major obstacles to strengthening its presence in the Arctic. The first is the war in Ukraine, which has forced Russia to decrease its ground presence in the Arctic to support ongoing operations (Strauss & Wegge, 2024, p. 3). The war has also been extremely costly for Russia – both in terms of increased defence spending and as a consequence of comprehensive Western sanctions – causing delays to ongoing projects in the Arctic (Ditrych, 2025; Yermakov, 2024). Nonetheless, evidence suggests that Russia intends to resume its build-up once the war ends (Boulègue, 2024). The second obstacle, however, will remain a challenge in the long term: the thawing of the permafrost. Roughly 60 per cent of Russian territory rests on permafrost, and its degradation is already damaging civilian and military infrastructure across the Arctic (Hjort et al., 2018; Streletskiy et al., 2019). As warming continues, this is likely to become an even greater constraint.

China: a 'near-Arctic state'

China has gradually increased its interest in the Arctic. In 2018, it published its first official Arctic policy and designated itself a 'near-Arctic state' – a formulation that stakes a claim to influence over Arctic governance (Moolenaar & Krishnamoorthi, 2024). Scholars disagree, however, over how much this ambition has actually translated into presence. Several argue that China's Arctic foothold is considerably exaggerated in both media and research (e.g., Edstrøm et al., 2023; Tunsjø, 2020). Pezard et al. (2022) attribute the limited footprint less to Chinese restraint than to Western strategy: proposed Chinese investments in the Arctic have repeatedly been restricted by the Arctic 7 states on security grounds. Similar concerns have been raised about scientific activity, where Western states have questioned the potential dual-use applications of Chinese research (Moolenaar & Krishnamoorthi, 2024; Pedersen, 2025). Research expeditions have attracted particular scrutiny in this regard, with China deploying a record number of icebreaking research vessels to the Arctic in 2026 (Nilsen, 2026b).

China has mainly been able to establish a presence in the Arctic through its relationship with Russia. Russia hosts by far the largest share of Chinese Arctic investment of any Arctic state – most notably the Yamal and Gydan liquefied natural gas projects – and China has framed its interest in the NSR as part of the Belt and Road Initiative, designating it the 'Polar Silk Road'. Although Russia has largely welcomed Chinese investments, Moscow has still

shown some wariness of Chinese military presence in the Arctic (Paukkunen & Black, 2024, p. 2647). However, some argue that this wariness has gradually been overtaken by Russia's need for international partners after its invasion of Ukraine (Conley et al., 2024). Against this backdrop, Hulme (2025) and Vicik (2025) both claim that the Chinese military partnerships with Russia in the Arctic have allowed Beijing to begin advancing its military capabilities in the region. Moreover, Pedersen (2025) contends that even though the Arctic is unlikely to be the main priority for China, a limited Chinese military presence in the European Arctic is likely in the near future.

Conflict risk

A new security environment is emerging in the Arctic, and with it a set of recurring assumptions. The most persistent is the notion of a 'Scramble for the Arctic': the prediction that as the ice melts and new territory becomes accessible, the great powers will compete for control of valuable resources (Borgerson, 2008). However, as contended by numerous Arctic scholars (Dodds & Nuttall, 2016; Tamnes & Offerdal, 2014; Østhagen, 2020), such a scenario remains unlikely. Most of the petroleum and mineral resources in the region are located within the Arctic littoral states' exclusive economic zones or on land (Claes & Moe, 2018). There are therefore few border disputes or similar geographical disagreements that could be sources of conflict in the Arctic (Hilde, 2014; Rottem & Østhagen, 2023). Instead, the Arctic states have an incentive to adhere to international law – something they themselves have also repeatedly emphasised. This is especially true for Russia, as it has major economic interests in the Arctic (Hilde et al., 2024). The country's behaviour appears consistent with this: Friis (2025) finds that day-to-day military activity in the European Arctic has remained largely unchanged even after the invasion of Ukraine, suggesting a continued interest in regional stability.

Although Russia has an incentive to maintain the status quo, it still seeks to test Western capabilities through sub-threshold activities. The extent and frequency of these activities – jamming, drone overflights and interference with critical undersea infrastructure among them – have increased in recent years (Boulègue, 2024; Gjørsv, 2024), constituting a growing challenge (Notaker, 2023). The maritime domain is especially vulnerable in this regard, due to the inherent difficulties in monitoring activity at sea, particularly linked to dual-use objects. The activity of GUGI, Russia's Main Directorate for Deep-Sea Research, illustrates the problem: the directorate is known to use survey ships and specialised submarines for covert operations (Loik, 2024, p. 10), and in April 2026 the UK and Norway exposed a GUGI operation near undersea infrastructure in their maritime areas (Nilsen, 2026a). Another example is Russian activity on Svalbard. Stensrud and Østhagen (2024) argue that although activity on the archipelago does not amount to 'hybrid warfare', a hybrid threat clearly exists. Moe and Jørgensen (2025) raise a related reservation, contending that Russia's

policy of presence on Svalbard is currently not well coordinated or strategic, largely owing to financial constraints.

Sub-threshold activity is only one part of the challenge, however. Strategic stability in the region is also under pressure, with a central factor being Moscow's growing sense of vulnerability and what this implies for a potential security dilemma in the region. Although Russia is acquiring capabilities intended to offset NATO's conventional superiority, for example in the air domain (Tørrisplass, 2023), Finnish and Swedish accession to the Alliance has amplified its conventional inferiority (Staun, 2023; Ven Bruusgaard, 2024). In addition, other NATO members – such as the US, UK, France, Germany and the Netherlands – have increased their Arctic presence in recent years (Friis, 2025). Taken together, these developments might lead to greater reliance on nuclear threats (Ven Bruusgaard, 2021). Ven Bruusgaard (2024, p. 350) contends that the consequence for the Arctic is a heightened risk of deterrent failure: both sides may feel compelled to deploy the forces the other most fears to the border regions – nuclear-capable weapon systems on the Russian side and conventional precision-strike and missile-defence assets on NATO's side. However, Heier (2025) argues that since the invasion of Ukraine, Russia and the US have adopted self-imposed restraints, driven by fear of nuclear escalation, as well as strategic necessity, since neither can currently afford overstretch. Thus, according to Heier, the war in Ukraine might have paradoxically increased stability in the Arctic.

A final challenge to strategic stability is unintended escalation (Boulègue, 2022; Kunz & Esser, 2026). This may be a consequence of accidents, the risk of which is currently growing as activity in the region increases while the arenas for communication that might once have contained misunderstanding contract (Andreeva & Rottem, 2025). It may also be a consequence of misinterpretations. Writing on Svalbard, Stensrud and Østhagen (2024) warn against treating every Russian action as a hybrid threat, as this risks securitising ordinary activity such as fishing and obstructing the management of genuine disputes. Furthermore, from a Russian perspective, Wilhelmsen and Hjermann (2022) find that official representations of NATO in the years after 2014 shifted from uncertainty about intentions to certainty of hostility. This leaves little room for interpreting Western activity as anything other than threatening. Overall, the two mechanisms reinforce one another: an accident may lead to escalation if it is read as intentional.

Key research issues

The Arctic is rapidly changing, with major implications for security in the region. This section highlights seven research issues that will shape the future of Arctic security. The first is climate change, which is already reshaping the region and will only grow in importance

over the coming decades, particularly as a ‘threat multiplier’ (Knutsen & Pedersen, 2024). On land, the thaw of the permafrost will be a major issue, especially for Russia, as it will degrade infrastructure (Hjort et al., 2018; Streletskiy et al., 2019), making it more difficult to sustain both a military presence and commercial projects. Meanwhile, at sea, the retreating ice will make the region more accessible for naval vessels. It will also impact anti-submarine warfare (ASW), as Russia’s SSBNs will no longer be able to hide under the sea ice to the same extent as earlier (Kwong, 2018). Finally, these security issues triggered by climate change are also in tension with the increased economic activity the region is expected to see due to climate change. Thus, striking a balance between security measures and economic development will continue to be a more prominent issue in the future.

Secondly, technological developments are likely to have a major impact on strategic stability in the Arctic. This is a broad field, but some central issues can be identified. One is the impact of emerging technology on ASW (e.g., Gottemoeller, 2021; Holmes, 2016; Lieber & Press, 2017). Researchers have identified three main categories of technology that may lead to ‘transparent oceans’, a situation in which the ability of SSBNs to evade detection is undermined. These three are: novel sensing techniques, uncrewed autonomous vehicles – including ‘drone swarms’ – and advanced computing capabilities such as artificial intelligence (Sanchez, 2026, pp. 125-126). However, the impact of new technology should not be exaggerated. Stefanick (2025) and Sanchez (2026) argue that modern SSBNs are likely to remain survivable in the foreseeable future, since new ASW technology can also be used defensively. The impact of new technology on the survivability of the SSBNs in the Arctic, along with the reduction of the sea ice as a cover, is nonetheless an important question to follow.

Two further technological developments that are significant for the security domain are advanced conventional weapons – particularly long-range strike weapons (LRS) – and space infrastructure. Recent scholarship has identified a new set of challenges posed by the development of LRS, particularly their strategic effects (e.g., Futter & Zala, 2021; Hoffmann, 2024; 2026). Hoffmann (2026), for example, finds that even limited LRS arsenals of small states can pressure strategic stability in a regional context, as the functional overlaps introduced by these weapon systems are perceived as a considerable threat. This is relevant to the Arctic, where the Nordic states are expanding their LRS capabilities. Space is also becoming increasingly vital to national security, intelligence and military operations (Sundlisaeter & Dyndal, 2025). Against the backdrop of resurgent great power competition, as well as a more unreliable American administration, Europe is seeking to develop independent space capabilities (Süß, 2026). In this regard, the Arctic, and Norway in particular, is bound to play a key role due to its space infrastructure (Prop. 87 S (2023–2024), pp. 62-63; Sundlisaeter & Dyndal, 2025).

The third issue is deterrence. Specifically, as argued by Cameron and Ven Bruusgaard (2024), existing concepts of strategic stability, derived primarily from the Cold War experience, may be insufficient for the current security environment. A core issue for NATO will therefore be to devise ways of effectively deterring Russia against the backdrop of a more complex and hostile security environment (NOU 2023: 14, 2023, p. 258; Piechowicz, 2025). Some central challenges for the Alliance have been emphasised, for example in relation to Svalbard (Baudu, 2023; Moe & Jensen, 2020; Zysk, 2026) and hybrid threats (Stensrud & Østhagen, 2024; Østhagen, 2023b). It has also been argued that Russia's preoccupation with Ukraine and NATO's strengthened capabilities in the Arctic, as well as China's still limited capacity in the region, provide NATO with a unique opportunity to strengthen its deterrence posture vis-à-vis Moscow (Paukkunen & Black, 2024). In this respect, scholars have called for the establishment of a dedicated NATO Arctic military force (Duffy et al., 2025; Vázquez, 2025), as well as emphasised the need to strengthen multi-spectrum situational awareness in the region (Piechowicz, 2025).

Deterrence is also worth exploring in relation to the bastion defence. Specifically, it will be important to assess what role the bastion defence will play for Russia's total defence in the context of a markedly different security environment, and subsequently, how NATO and member states should emphasise the bastion defence in their own military planning. One suggested response has been the Atlantic Bastion – a programme launched by the UK that seeks to create an advanced hybrid force to detect and inhibit Russian undersea forces in the North Atlantic (Ministry of Defence, 2025). However, questions regarding how the Atlantic Bastion should be operationalised, for example its geographic reach and technological components, remain (Kaushal & Black, 2026).

Fourth, a Norway-specific issue, which is related to the broader deterrence debate, is the question of what role reassurance should play in the relation with Russia. Norway has a long-standing practice of balancing deterrence and reassurance in its relationship with Russia (Cameron, 2024). However, the dynamic between the two concepts has not been constant, but varied over time (Bjur, 2022). Thus, after Russia's full-scale invasion of Ukraine, a debate about the role of reassurance is warranted. This is for example in relation to Norway's self-imposed restrictions on the stationing of foreign bases, military exercises and operations (Stormoen, 2023). In particular, Norwegian policies must be seen in the context of Finnish and Swedish practices now that both are NATO members, as well as in relation to LRS and increased allied presence on Norwegian territory (NOU 2023: 14, 2023, pp. 258-259).

The fifth issue concerns the future development of Russian military capabilities. The war in Ukraine has forced Russia to delay projects in the Arctic, but modernisation nonetheless continues at a slow pace as new classes of nuclear submarines are phased in and dual-use infrastructure is expanded. This process is expected to accelerate after the end of the war in Ukraine (Boulègue, 2024). It will therefore be vital to consider the consequences of new and strengthened Russian capabilities in the Arctic. Furthermore, this must be analysed in the context of Moscow's ability to deal with the effects of the thawing permafrost, and the extent to which Russia and China collaborate on military technology in the region (Tunsjø, 2020).

This brings us to the sixth issue: the evolving dynamic of the Sino-Russian relationship. As emphasised earlier, Russia has been China's main access point to the Arctic. Although Moscow has been wary of allowing a greater Chinese military presence in its own sphere of influence, recent developments suggest that the war in Ukraine has led this wariness to gradually become overtaken by Russia's need for international partners (Conley et al., 2024). Thus, the extent to which Russia is willing to allow Chinese presence will be a defining condition for the Arctic security order in the coming years.

The final issue concerns the future American footprint in the region. As the US pivots to Asia, its presence in the European Arctic is expected to be reduced, but by how much, and how far European states can compensate, remains an open question. This concern is further heightened by recent developments, most notably the American interest in acquiring Greenland, which has raised questions about the reliability of the US as a strategic partner.

The issues highlighted in this section all point to a new and more complex security environment in the Arctic. This shift also has major consequences for existing theoretical frameworks and concepts, which were developed under markedly different conditions. The task for future research will therefore be not only to track developments in the region, but to establish which of these concepts are still analytically useful.

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