Projecting the Share of Russian Crude Oil Exports to China Routed via the Northern Sea Route (NSR) by 2035: A Scenario Analysis

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1 Background

The Russian Federation is the largest exporter of crude oil to the People's Republic of China, having exported upwards of $13 billion worth of crude oil in the first quarter of 2025 alone. Following the Russian invasion of Ukraine in February 2022 and the subsequent sanctions imposed by the United States and the European Union, China's importance as a purchaser of Russian crude oil has grown substantially as the market for Russian crude has contracted. Pipeline exports to China are limited to roughly 35 MMt per year due to capacity constraints of the Eastern Siberia–Pacific Ocean (ESPO) and Atasu–Alashankou pipelines, which remain well below Chinese demand. Consequently, Russian suppliers have increasingly relied on seaborne exports. The Northern Sea Route (NSR), traditionally closed for much of the year due to heavy ice cover, has become more navigable due to declining Arctic ice extent, enabling greater seasonal use for crude shipments. Although NSR-based shipments currently remain marginal, improving navigability, Arctic infrastructure expansion, and deepening Sino–Russian cooperation could elevate its role in Russian export logistics and Chinese energy security.

2 Research Question

How much of Russia's crude oil exports to China could shift to the NSR by 2035 under differing assumptions about Arctic navigability and Chinese crude oil demand?

3 Economic Framework

This paper adopts an energy security portfolio framework where Russia allocates crude exports to China across multiple shipping routes with different cost and risk characteristics. Traditional southern routes that have historically carried the vast majority of Russia's seaborne crude exports are increasingly exposed to sanctions and congestion, as well as a higher risk of being targeted by the Ukrainian strike campaign on Russian vessels, while the NSR offers relative safety from strikes, potential cost savings, diversification and sanction avoidance benefits but is constrained by Arctic navigability, Arctic-equipped fleet capacity, and terminal infrastructure. Climate driven increases in navigable days as well as Chinese crude oil demand raise the potential share of the NSR in Russia's export route portfolio, but only if Arctic-capable fleet size and terminal capacity expand in parallel. Under sanctions pressure and elevated risk to assets on southern routes, an unconstrained version of the framework would therefore allow the NSR share of Russia's crude exports to China to grow faster than overall Russia–China trade. The simulations below deliberately focus on a capacity-constrained case, in which NSR throughput quickly hits hard limits so that higher demand primarily shows up as additional volumes on southern routes rather than as a rising NSR share.

4 Methods & Model

The throughput of crude oil along the NSR is constrained by Arctic navigability, the effective capacity of the tanker fleet, terminal capacity, insurance and port operability, and Chinese crude oil demand. In the model, the tanker fleet is represented by a core ice-class shuttle fleet that can operate throughout the open season and a seasonal component of non-ice or lightly ice-strengthened tankers that can be deployed in lighter-ice conditions. To isolate the combined impact of navigability and Chinese demand growth on the share of Russian crude transported via the NSR, the analysis treats terminal capacity, fleet composition, and insurance/port operability as exogenous scenario parameters over the 2025–2035 time period, varying them explicitly between cases rather than modeling them endogenously.

4.1 Fixed Parameters

Variable	Definition
$IceFleet$	Number of ice-class tankers in the core NSR fleet
$AvgLoad$	Average cargo per voyage (Mt)
$RoundTripDays$	Average round-trip time
$InsureOper$	Share of fleet permitted (NSR + PRC port)
$TermCap$	Terminal capacity (Mt)
λ_t	Proportional uplift from seasonal non-ice / low-ice tankers
$RU \to CN_t$	Total Russian crude exports to China (Mt)

4.2 Forecasting Russia–China Crude Trade

To keep the focus on route allocation and NSR capacity rather than on econometric demand identification, I model Russia's crude exports to China using simple growth scenarios anchored to the 2024 baseline volume. Let $RU \to CN_t$ denote China's crude oil imports from Russia in year t (in Mt), and let $V_{2024} = 108.5$ Mt be the baseline 2024 volume reported by Chinese customs and summarized by international news agencies (Reuters, 2025). For $t \geq 2025$, I assume that Russia's crude exports to China evolve according to a constant annual growth rate g:

$$RU \to CN_t = V_{2024}(1+g)^{(t-2024)}. \tag{1}$$

Three values of g are considered,

$$g \in \{0.00, 0.02, 0.04\},$$

representing, respectively, a *flat* path where Russia's crude exports to China remain near their 2024 level, a *moderate* growth path with 2% annual growth, and a *high-demand* path with 4% annual growth. These values are intended to span a plausible range consistent with recent growth in Russia–China crude trade and medium-term projections of Chinese oil demand, without claiming to recover a structural demand function.

For each g and each year t from 2025 to 2035, this formula generates a corresponding path for $RU \to CN_t$. These three trajectories serve as the low, baseline and high-demand scenarios that enter the NSR capacity model as the $RU \to CN_t$ term in the equations in Section 4.3.

4.3 NSR Capacity

For each year and navigability scenario, the physical capacity of the NSR to carry crude oil is estimated. Navigability, expressed as the number of navigable days per season ($OpenSeason_t$), determines the number of trips each ice-class tanker in the core fleet can complete:

$$Cycles_t^{ice} = \left\lfloor \frac{OpenSeason_t}{RoundTripDays} \right\rfloor, \tag{2}$$

$$FleetCap_t^{ice} = IceFleet \times AvgLoad \times Cycles_t^{ice}. \tag{3}$$

The contribution of non-ice and lightly ice-strengthened tankers, which are employed on the NSR only in lighter-ice summer and autumn conditions, is captured through a proportional uplift parameter λ_t. The effective fleet capacity in year t is then

$$FleetCap_t^{eff} = FleetCap_t^{ice} \times (1 + \lambda_t), \tag{4}$$

$$OperableCap_t = FleetCap_t^{eff} \times InsureOper, \tag{5}$$

$$NSRThroughput_t = \min(OperableCap_t, TermCap, RU \to CN_t), \tag{6}$$

$$NSRShare_t = \frac{NSRThroughput_t}{RU \to CN_t}. \tag{7}$$

In the conservative scenarios, $\lambda_t = 0$ so that only the ice-class core fleet contributes to NSR capacity. Central and high-capacity scenarios allow $\lambda_t > 0$ to reflect the observed, but policy-dependent, use of non-ice or lightly ice-strengthened tankers on the NSR during ice-free periods. Taken together, these equations define the maximum share of Russia–China crude trade that could be routed through the NSR under given assumptions about navigability, demand, and the extent of seasonal fleet deployment.

4.4 Scenario Definitions

Both *open-season length* and *Chinese demand conditions* vary independently. For demand, I use the low, baseline, and highdemand paths $RU \to CN_t$ generated by the constant-growth scenarios described in Section 4.2, corresponding to annual growth rates $g \in \{0.00, 0.02, 0.04\}$.

The analysis tests a set of nine combinations:

Navigability	Open-Season Days	Demand Scenario
Conservative	100	Low
Conservative	100	Baseline
Conservative	100	High
Central	130	Low
Central	130	Baseline
Central	130	High
Optimistic	160	Low
Optimistic	160	Baseline
Optimistic	160	High

Each combination yields one projection of $NSRShare_t$, enabling sensitivity analysis of both navigability and demand conditions across a plausible 2025–2035 range.

5 Data

The model combines publicly reported trade statistics, peer-reviewed estimates of Arctic navigability, descriptive data on NSR shipping and fleet composition, information on Arctic crude export terminals, and analyses of sanctions-induced changes in Russian oil shipping. All data points are chosen to be transparent and literature based. This section documents the data sources, how each quantity enters the model, and the reasoning for the selected values and ranges.

5.1 Russia–China Crude Trade

The baseline volume of Russian crude exports to China in 2024 is $V_{2024} = 108.5$ Mt. This corresponds to 2.17 million barrels per day of total Russian crude imports (pipeline and seaborne) reported by China's General Administration of Customs and summarized by international news agencies (Reuters, 2025). Using customs-based trade data as the baseline ensures consistency with the official statistics that inform most secondary analyses of Russia–China crude flows.

Rather than estimating a structural demand function, the analysis uses this baseline V_{2024} to construct three simple growth scenarios for Russia's crude exports to China. For each year t between 2025 and 2035, the volume $RU \to CN_t$ is generated by

$$RU \to CN_t = V_{2024}(1+g)^{(t-2024)}, \quad g \in \{0.00, 0.02, 0.04\},$$

representing flat, moderate, and high growth paths. These scenarios are calibrated to span a plausible range consistent with the observed increase in Russia–China crude trade over the past decade, while keeping the modeling of Chinese demand deliberately parsimonious. The resulting trajectories for $RU \rightarrow CN_t$ enter directly into the NSR capacity model as the denominator of $NSRShare_t$ and as an upper bound on potential NSR throughput.

5.2 Arctic Navigability

The open-season parameter $OpenSeason_t$ is calibrated to both observational and modeling evidence on the navigability of the NSR. Industry navigation guidance and NSR handbooks describe the present-day operational season for ice-class vessels as running approximately from early July to the second half of November, implying a practical navigation window of roughly 130–140 days under current conditions (American Bureau of Shipping [ABS], 2014; Oil Companies International Marine Forum [OCIMF], 2018). Climatological analyses of the continuous ice-free period along the entire NSR for merchant ships that are not structurally adapted to heavy ice suggest a much shorter season, typically on the order of 70–100 days in recent years (Marsz & Pastusiak, 2024). Climate-model projections indicate a further lengthening of the NSR navigation season under continued warming, with mid-century estimates ranging from roughly 4.5 months to more than 6 months of navigability for ice-strengthened vessels, depending on emissions scenario and ship class (Zhang et al., 2023; Zhao et al., 2024).

To translate this evidence into model inputs, three stylized navigability scenarios are defined: a *conservative* case with $OpenSeason_t = 100$ days, approximating the continuous ice-free window suitable for non-ice or lightly ice-strengthened tankers; a *central* case with $OpenSeason_t = 130$ days, corresponding to the current practical navigation season for ice-class tankers with icebreaker support; and an *optimistic* case with $OpenSeason_t = 160$ days, reflecting mid-century projections of a 4.5–6 month NSR navigation season for ice-strengthened vessels (Zhang et al., 2023; Zhao et al., 2024). These values are not intended as point forecasts, but as a literature-based range for sensitivity analysis of how climate-driven changes in navigability affect the feasible NSR share of Russia–China crude trade.

5.3 Fleet Capacity and Composition

The core ice-class fleet parameter $IceFleet$ is calibrated to the dedicated shuttle tankers serving Gazprom Neft's Novy Port ("Arctic Gate") project. Company reports and industry sources indicate that Arctic Gate has a design capacity of approximately 8.5 Mt/year and is served by a series of six Arc7 ice-breaking shuttle tankers designed for year-round operation between the Gulf of Ob and Murmansk, each with a cargo capacity of roughly 38–41 thousand tonnes (Gazprom Neft, 2020; Sovcomflot, 2021; Maritime Executive, 2018). The model therefore sets $IceFleet = 6$ and $AvgLoad = 0.038$ Mt in the baseline, and chooses $RoundTripDays$ such that, under the central navigability scenario, the implied annual capacity of the core fleet is on the order of 5–6 Mt, consistent with observed Novy Port exports. This provides a conservative and well-documented anchor for ice-class crude-carrying capacity on the NSR.

Descriptive statistics from the Arctic Ship Traffic Data (ASTD) system and reports by the Center for High North Logistics (CHNL) indicate that recent NSR oil traffic also involves a non-trivial share of non-ice or lightly ice-strengthened tankers, including vessels with no formal ice class that transit in late summer under light-ice conditions (Center for High North Logistics, 2023; Sander & Mikkelsen, 2025). Explicitly modelling every such vessel would require proprietary AIS and fleet-register data beyond the scope of this study. Instead, the contribution of non-ice and low-ice tankers is represented parsimoniously through a proportional uplift parameter λ_t applied to the core ice-class fleet capacity,

$$FleetCap_t^{eff} = FleetCap_t^{ice}(1 + \lambda_t).$$

In conservative scenarios, $\lambda_t = 0$ and NSR capacity is provided solely by the Arc7-type core fleet. Central scenarios allow λ_t in the range 0.3–0.5, intended to capture the observed contribution of non-ice or low-ice tankers during the late-summer window. High-capacity "shadow-fleet" scenarios consider λ_t up to 1.0, reflecting a world in which Russia relies heavily on older non-ice tankers for NSR exports in light-ice conditions. These values are calibrated to the qualitative and quantitative evidence on the rising share of non-ice-class tankers in NSR oil traffic, while avoiding the claim that such deployment is sustainable outside narrow seasonal and regulatory conditions.

5.4 Terminal Capacity

The terminal-capacity constraint $TermCap$ represents the combined throughput limit of Arctic crude export infrastructure that can plausibly feed NSR shipments towards China. The primary anchor is again the Arctic Gate terminal at Novy Port, whose design capacity is reported at approximately 8.5 Mt/year, with a maximum daily loading rate of roughly 40 thousand tonnes (Gazprom Neft, 2020; Maritime Executive, 2018). Additional Arctic crude export volumes are handled via other terminals and floating storage units, such as the Umba floating storage and offloading unit near Murmansk, which has been reported to re-export on the order of 18 Mt/year of Russian Arctic crude in some years (The Barents Observer, 2020).

Rather than reconstructing a full engineering model of all Arctic terminals, the analysis sets $TermCap$ to a stylized value in the 10–20 Mt/year range, interpreted as an upper bound on the volume of Russian crude that could be routed through NSR-linked Arctic export infrastructure towards China over the 2025–2035 horizon. Sensitivity checks confirm that, for the parameter ranges considered, $TermCap$ binds only in high-demand, high-navigability scenarios; in other cases, NSR throughput is primarily constrained by fleet capacity and navigability.

5.5 Sanctions, Insurance, and Port Operability

Sanctions, access to maritime services, and port restrictions are captured by the parameter $InsureOper$, defined as the fraction of physical fleet capacity that is effectively permitted to operate along the NSR and call at Chinese ports. Empirical analyses of the European Union oil embargo and G7 price cap suggest that an increasing share of Russian crude exports is carried by a "shadow fleet" of older, non-Western-insured tankers—on the order of 60% of Russian seaborne crude exports by late 2024—while the remainder continues to use G7-linked tankers and insurance (European Parliament, 2024; International Working Group on Russian Sanctions, 2024). Other studies note that the share of European carriers in Russian oil shipping has fluctuated around 40–50% as enforcement of the price cap has tightened and relaxed (Bank of Finland Institute for Emerging Economies, 2024; Reuters, 2024). These patterns underscore that the set of vessels practically available for NSR–China trades is shaped by sanctions policy and enforcement, not just by physical fleet size.

Because there is no NSR-specific dataset on insurance coverage and port admissibility, $InsureOper$ is introduced as a scenario parameter anchored in the observed global split between shadow-fleet and conventionally insured tonnage. Conservative scenarios set $InsureOper \approx 0.4$, corresponding to a world of strict enforcement in which only a minority of Russian-controlled tonnage can be deployed on NSR–China routes. Central scenarios use $InsureOper \approx 0.7$, reflecting a mixed regime where both shadow-fleet and some G7-linked vessels service Russian exports. High scenarios allow $InsureOper = 1.0$, representing a permissive environment in which sanctions constraints on NSR shipping are largely non-binding. In all cases, the parameter enters multiplicatively via

$$OperableCap_t = FleetCap_t^{eff} \times InsureOper,$$

so that sanctions and insurance restrictions effectively scale down the physical NSR capacity implied by navigability and fleet composition. The scenario structure makes explicit that these figures are not direct measurements, but are used to bracket plausible bounds on operable NSR capacity under different policy environments.

5.6 Summary of Key Parameters

Table 1 summarizes the main exogenous parameters, their baseline values or ranges, and the primary data sources and motivations.

Parameter	**Value(s)**	**Source / Rationale**
V_{2024}	108.5 Mt	Chinese customs via UN Comtrade Database (2025)
$OpenSeason_t$	100, 130, 160 days	ABS (2014); OCIMF (2018); Marsz & Pastusiak (2024); Zhang et al. (2023); Zhao et al. (2024)
$IceFleet$	6 ships	Novy Port Arc7 shuttle fleet (Gazprom Neft, 2020; Sovcomflot, 2021)
$AvgLoad$	0.038 Mt	Arc7 cargo capacity, 38–41 kt (Maritime Executive, 2018)
λ_t	0–1	Uplift from non-ice tankers (CHNL; Sander & Mikkelsen, 2025)
$TermCap$	10–20 Mt	Arctic Gate + other Arctic exports (Gazprom Neft, 2020; The Barents Observer, 2020)
$InsureOper$	0.4–1.0	Shadow vs G7-insured shares (European Parliament, 2024; IWG Sanctions, 2024; BOFIT, 2024)

Table 1: Key exogenous parameters, values, and data sources.

6 Empirical Strategy & Limitations

This approach should be interpreted as a structural simulation rather than an econometric identification strategy. In identification terms, the effect of Arctic navigability and Chinese demand growth on the NSR share is pinned down by the functional relationships in the NSR equations and by the maintained assumption that fleet size, terminal capacity, and insurance/port operability are exogenous and scenario-driven over 2025–2035. That simplification isolates the route-capacity mechanism, but it also introduces potential sources of bias. Important determinants of NSR throughput—such as future investments in ice-class tonnage, changes in NSR-specific insurance premia and icebreaker availability, shifts in port fees, and variation in non-Chinese demand for Russian crude—are not modeled explicitly, so any co-movement of these factors with navigability or sanctions pressure could distort the simulated marginal impact of navigability and demand. In addition, the framework abstracts from self-selection in routing: in practice, Russia may preferentially route certain grades, contract structures, or destinations via the NSR rather than southern routes, whereas the model treats all barrels as homogeneous and allocates flows purely on capacity grounds. More fundamentally, navigability, Chinese demand, sanctions, and NSR capacity are likely to respond to common geopolitical and climatic shocks, which means that the two "drivers" in the model are not strictly exogenous in the real world. I partially address these concerns by keeping all non-modeled parameters fixed and transparent, by conducting scenario-based sensitivity analysis, and by presenting the results as conditional projections within this structural framework rather than as unbiased causal estimates of the real-world effect of climate change and demand growth on NSR utilization.

7 Results and Discussion

Table 2 reports the simulated share of Russia–China crude trade that could be routed via the NSR in 2025, 2030, and 2035 under nine combinations of navigability and demand growth, holding fleet composition, terminal capacity, and sanctions/insurance parameters fixed at their central values ($\lambda = 0.3$, $InsureOper = 0.7$). Three main findings emerge.

Scenario (navigability, g)	NSR share 2025 (% of RU–CN crude)	NSR share 2030 (%)	NSR share 2035 (%)
Low nav, $g = 0\%$	0.96	0.96	0.96
Central nav, $g = 0\%$	1.15	1.15	1.15
High nav, $g = 0\%$	1.53	1.53	1.53
Low nav, $g = 2\%$	0.94	0.85	0.77
Central nav, $g = 2\%$	1.13	1.02	0.92
High nav, $g = 2\%$	1.50	1.36	1.23
Low nav, $g = 4\%$	0.92	0.76	0.62
Central nav, $g = 4\%$	1.10	0.91	0.75
High nav, $g = 4\%$	1.47	1.21	0.99

Table 2: Simulated NSR share of Russia–China crude trade in 2025, 2030, and 2035 under alternative navigability and demand growth scenarios (assuming $\lambda = 0.3$ and $InsureOper = 0.7$).

First, the NSR remains a marginal export corridor in volumetric terms across all scenarios. Even in the most favorable case considered—high navigability (160 days) and flat Russia–China trade (0% annual growth)—the NSR accounts for only about 1.5% of total Russian crude exports to China between 2025 and 2035. In the more realistic configurations with positive demand growth, the NSR share lies between roughly 0.6% and 1.2%. Given that total Russia–China crude trade in the model is on the order of 110–170 Mt per year over this horizon, these percentages correspond to absolute NSR throughputs of approximately 1.0–1.7 Mt per year. In other words, even under optimistic assumptions about Arctic navigability and fleet deployment, the NSR functions as a niche route rather than a competitor to the established southern corridors.

Second, increases in navigability systematically raise the feasible NSR share for any given demand scenario. When trade is flat ($g = 0$), moving from the low navigability case (100 days) to the high case (160 days) increases the simulated NSR share from about 0.96% to 1.53%. Under moderate demand growth ($g = 2\%$), the corresponding 2035 shares rise from 0.77% (low) to 1.23% (high), while under rapid growth ($g = 4\%$) they rise from 0.62% to 0.99%. Across rows in Table 2, lengthening the navigation season thus boosts the NSR share by roughly 50–70%, reflecting the fact that more open-water days allow each tanker in the fleet to complete more round trips. This is the pure climate and navigability channel emphasized in the conceptual framework: for a given fleet and sanctions environment, more ice-free days translate directly into higher potential NSR utilization.

Third, higher Chinese demand growth reduces the NSR share in this model, despite leaving NSR throughput in absolute terms essentially unchanged. Comparing down the columns of Table 2, the 2035 NSR share in the central navigability scenario falls from roughly 1.15% under flat demand to 0.92% under 2% annual growth and 0.75% under 4% growth. A similar pattern is visible in the low and high navigability scenarios. This is not because the model forces NSR volumes to decline; by construction, NSR throughput quickly hits the operable capacity implied by fleet size, λ, terminal capacity, and $InsureOper$, and remains at that level whenever Russia–China trade is large enough to fill it. Instead, rising demand increases the denominator, $RU \to CN_t$, faster than the fixed NSR capacity, so the NSR share is gradually diluted over time. With $g = 0$, both the numerator and denominator are constant, and the NSR share is flat between 2025 and 2035; with $g = 2\%$ or 4%, the share declines gently even as NSR volumes remain at their assumed capacity ceiling.

This pattern is fully consistent with the portfolio framework once the hard capacity constraint is taken seriously: in the absence of additional investment in Arctic-capable tonnage or terminals, the marginal barrels generated by higher demand must be routed through the southern corridors, so the NSR's relative share declines even as its absolute throughput remains at its operable capacity ceiling.

Overall, the results point to two things: physical capacity matters, and demand dynamics shape how visible the NSR becomes in Russia–China trade. Climate-driven improvements in navigability substantially raise the potential NSR share relative to a low-ice scenario, but the effect is bounded by the assumed ice-class fleet, the seasonal contribution of non-ice tankers captured by λ, terminal capacity, and sanctions and insurance constraints. At the same time, strong growth in Russia–China crude trade does not automatically translate into a larger NSR role: without parallel investment in Arctic-capable tonnage and infrastructure, and without a relaxation of service restrictions, the NSR's relative importance actually declines as bilateral trade expands. In this sense, the model's NSR shares should be interpreted as upper bounds on the route's contribution under the specified capacity and policy constraints, rather than as forecasts that the NSR will capture a large and growing portion of Russia's crude exports to China.

7.1 Policy Implications

The simulation results have several implications for Russian, Chinese, and Western policymakers thinking about the NSR as part of the Russia–China energy relationship.

For Russia, the model suggests that improvements in Arctic navigability alone are insufficient to transform the NSR into a major crude export corridor to China by 2035. Even under optimistic ice conditions, the NSR carries approximately 1–2 Mt per year in the scenarios considered, compared with well over 100 Mt of total Russia–China crude trade. To raise the NSR share substantially beyond the 1–2% range, Russia would need to expand the ice-class tanker fleet, increase the seasonal deployment of non-ice tonnage in light-ice conditions, and invest in additional Arctic terminal capacity. Such investments are capital intensive and exposed to sanctions risk, and the returns may be limited if Chinese buyers continue to favor more flexible southern routes. From a Russian planning perspective, the NSR therefore appears more as a supplementary outlet and bargaining chip than as a realistic backbone for diverting a large fraction of crude exports to China.

For China, the results indicate that the NSR is unlikely to become a quantitatively significant pillar of oil supply security over the next decade under current trends. Even under favorable assumptions, the route contributes at most a few percent of Russia's crude exports to China and an even smaller fraction of China's total crude imports. The NSR can still play a useful role as a diversification option and as a demonstration corridor linking China to the Arctic, but the bulk of Chinese crude supply will continue to arrive via pipelines, traditional seaborne routes through the Suez Canal and around Africa, and imports from non-Russian suppliers. Policymakers in Beijing thus face a portfolio problem: the NSR is worth investing in to as a hedge, but over-investing in its logistics dimension may yield limited insurance benefits relative to alternative measures such as storage, diversification of suppliers, or demand-side management.

For Western policymakers, the model underscores that the near- to medium-term threat of the NSR enabling a wholesale circumvention of sanctions on Russian oil exports to China is limited by structural capacity constraints. Even if Russia exploits the NSR to its operable limit, the volumes are small relative to total exports. This does not mean the NSR is strategically irrelevant—its symbolic and long-term geopolitical significance, and its role in dual-use Arctic infrastructure development, remain important—but it does suggest that fine-tuning sanctions and service restrictions on ice-class shipping, Arctic terminals, and insurance can effectively cap the NSR's role in sanctions evasion. At the same time, because the route's contribution to global oil flows is modest, there is space to calibrate such measures without triggering dramatic disruptions in physical supply.

More broadly, the analysis highlights a tension between climate dynamics and policy constraints. Warming-driven increases in Arctic navigability expand the technically feasible use of the NSR, but whether those additional open-water days translate into meaningful shifts in oil trade patterns depends on deliberate choices about fleet investment, infrastructure, and sanctions enforcement. In that sense, the NSR is not an exogenous "game changer" for Russia–China oil trade by 2035; it is a conditional opportunity whose realization is likely to be incremental, contested, and bounded by both economic and regulatory constraints.

8 Conclusion

This paper asked how much of Russia's crude oil exports to China could realistically be shifted to the Northern Sea Route by 2035 under different assumptions about Arctic navigability, Chinese demand growth, fleet composition, and sanctions constraints. Within a transparent structural framework calibrated to literature-based parameters, the NSR remains a niche corridor in volumetric terms: even under optimistic assumptions, it carries on the order of 1–2 Mt per year, corresponding to at most roughly 1–2% of total Russia–China crude trade in the 2025–2035 horizon. In more realistic settings with positive demand growth and unchanged capacity, the NSR share gradually declines as overall trade expands.

These findings highlight that climate-driven improvements in navigability do not, by themselves, turn the NSR into a major route for Russian crude to China. Without significant investment in Arctic-capable tonnage and terminal capacity, and absent a loosening of sanctions and insurance constraints, the NSR's role in Russia–China oil logistics is likely to remain supplementary. Future research could relax the simplifying assumptions of exogenous fleet size and terminal capacity, incorporate vessel-level data, and embed the NSR route choice in a broader general-equilibrium framework for Russian oil exports and Chinese import portfolios.

References

American Bureau of Shipping. (2014). Navigating the Northern Sea Route: Technical and operational challenges. ABS.

Bank of Finland Institute for Emerging Economies. (2024). Russian oil exports and the “shadow fleet” under the G7 price cap [BOFIT Policy Brief]. Bank of Finland.

Center for High North Logistics. (2023). NSR shipping statistics and Arctic Ship Traffic Data (ASTD). Centre for High North Logistics.

European Parliament. (2024). Implementation of the EU embargo on Russian seaborne crude oil and petroleum products [Briefing]. European Parliamentary Research Service.

Gazprom Neft. (2020). Novy Port (“Arctic Gate”) oil terminal: Project overview and logistics. Gazprom Neft PJSC.

International Energy Agency. (2024). Oil market report 2024. IEA.

International Monetary Fund. (2024). World Economic Outlook database. IMF.

International Working Group on Russian Sanctions. (2024). Implementation of the price cap on Russian oil exports: State of play and shipping patterns. Stanford University.

Maritime Executive. (2018). Novy Port exports grow via Arctic shuttle tanker operations. The Maritime Executive.

Marsz, A. A., & Pastusiak, T. (2024). Sea-ice conditions and the length of the navigation season along the Northern Sea Route, 1979–2021. [Trans Nav Journal].

Oil Companies International Marine Forum. (2018). Guidelines for the safe operation of oil tankers in ice-covered waters (2nd ed.). OCIMF.

Reuters. (2025). China’s crude imports from Russia hit new high in 2024. Reuters.

Sander, G., & Mikkelsen, A. (2025). Arctic shipping 2013–2022: The traffic has grown, with big regional differences. Polar Research.

Sovcomflot. (2021). Annual report 2021. PAO Sovcomflot.

The Barents Observer. (2020). Russia’s Umba storage ship re-exports Arctic crude to global markets. The Barents Observer.

U.S. Energy Information Administration. (2024). Petroleum and other liquids: Spot prices and crude oil imports by origin. U.S. Department of Energy.

World Bank. (2024). World Development Indicators [Data set]. World Bank.

Zhang, Y., Sun, X., Zha, Y., Wang, K., & Chen, C. (2023). Changing Arctic Northern Sea Route and Transpolar Sea Route: A prediction of route changes and navigation potential before mid-21st century. Journal of Marine Science and Engineering, 11(12), 2340. https://doi.org/10.3390/jmse11122340

Zhao, P., Li, X., & co-authors. (2024). Ships are projected to navigate whole year-round along the Northern Sea Route by 2100. [Communications Earth & Environment].