Geopolitical Effects on Newbuilding Prices: Evidence from Three Shipping Segments

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Abstract

This paper studies the impact of geopolitical uncertainty on the shipbuilding prices in the case of three segments of the shipping industry: Bulk carriers, Oil tankers and LNG carriers. Using monthly data for the 1991-2024 period, we make use of the threshold autoregressive methodology that accounts for possible asymmetric impacts. We find that, (a) for all segments, adverse geopolitical shocks lead to a higher speed of adjustment as opposed to the peaceful ones that are characterized by downwards price stickiness, (b) in the long-run geopolitical shocks lead to shipbuilding cycles of shorter duration and lower volatility, and (c) due to its higher price elasticity, the LNG shipbuilding sector is proven to be the most adaptable one, which implies lower cost push inflation in equilibrium. A major policy implication of our findings is that reducing the rigidities in the shipbuilding market will lead to diminishing geopolitical costs in terms of price inflation, for all shipbuilding segments.

Keywords: geopolitical effects; newbuilding prices, asymmetric adjustment, shipbuilding

JEL Classification : C24, E32, F51

1. Introduction

Intuitively, the impact of geopolitical uncertainty on the shipbuilding industry is adverse. Just like any other venture aiming to fetch a stream of revenue in the future, investment in new ships would be curtailed in times of uncertainty due to both supply side and demand side reasons. On the supply side, geopolitical uncertainty would imply unpredictability surrounding the factors that affect new ship production, including the prices and the delivery of materials needed to produce ships. The uncertainty in production costs would, in turn, lead to unpredictability of final ship prices, deterring new vessel production. On the demand side, challenges associated with geopolitical tensions range from a slowdown of international commerce to disruptions in the supply chain and from potential changes in regulations to higher cost of operations that have an adverse effect upon, and imply bleak prospects for, the shipbuilding industry.

However, one cannot preclude the emergence of opportunities for shipbuilding in times of geopolitical crises. New shipping markets, patterns and routes, along with potentially increased needs for building ships for defense purposes during periods of geopolitical tensions may be seen as counterbalancing the pessimistic picture implied by geopolitical uncertainty. This is corroborated by the fact that shipbuilding constitutes a traditional pillar of industrial policy in developed and developing countries alike, and tends to be subsidized to various extents by governments all around the globe (see, for example, Hossain & Zakaria, 2017; Barwick et al., 2024).

The motivation for this study stems from the limited extant research on the effects of geopolitical considerations on industrial policy in general and particularly on policy directed to the shipbuilding industry. Although there is abundant literature that explores the impact of economic and political uncertainty upon shipbuilding, including new vessels price volatility, research evaluating the extent to which new vessels' prices and geopolitical uncertainty evolve as nonlinear processes and, if so, the degree to which they are asymmetrically cointegrated, is scant. We fill this gap by deploying a Momentum Threshold Auto-Regressive approach, which reveals that positive and negative shocks result in different adjustment for each variable involved in the process in short-run and in the long-run. The shipbuilding industry segments studied are Bulk carriers, Oil tankers and LNG carriers. We use monthly data for the period 1991-2024.

Our results bear interesting implications for shipping sector researchers, investors, and policymakers. Specifically, we find that, (a) for all segments, adverse geopolitical shocks lead to a higher speed of adjustment as opposed to the peaceful ones that are characterized by downwards price stickiness, (b) geopolitical shocks lead to shorter and of lower volatility shipbuilding cycles in the long-run, (c) due to its higher price elasticity, the LNG shipbuilding sector is proven to be the most adaptable one, which implies lower cost push inflation in equilibrium. A major policy implication of our findings is that reducing the rigidities in the shipbuilding market will lead to diminishing geopolitical costs in terms of inflation, for all shipbuilding segments.

The rest of the paper is organized as follows: in Section 2 we discuss the relevant literature. In section 3 we present our theoretical model and set the testable hypotheses. Section 4 describes the data along with the econometric methodology. Section 5 presents the empirical results and discusses the policy implications. Section 6 offers a summary of the study and concluding remarks.

2. Review of Prior Literature

Price dynamics in shipbuilding are generally affected by freight rates, inflation, and expectations on the part of both buyers and sellers (Stopford, 2009). In the 1980s and the 1990s, research on factors affecting new vessel prices focused on shipbuilding costs, shipyard capacity, vessel orders, freight rates, oil prices, and secondhand vessel prices (see, for example, Beenstock, 1985; Beenstock & Vergottis 1989a; Beenstock & Vergottis, 1989b; Jin, 1993; Volk 1994). Along those lines, the economic analysis performed by Haralambides et al. (2005) revealed that newbuilding prices in all segments of the shipping industry are cost-driven, rather than market-driven as in the case of secondhand ships. Other factors, such as time-charter rates, shipyard capacity, exchange rates, as well as asset pricing and speculative considerations were found to have an effect on the prices of new ships only for selective vessel types and industry segments.

The study of Merikas et al. (2008) finds that when freight rates are on the up, demand for second-hand vessel increases to take advantage of the booming market swiftly, whereas when freight rates are depressed, ship-owner tend to order new vessels that need a lot of time to be built, anticipating a recovery of the market in the future. The time needed to build a new vessel is also spotted as a factor that accentuates the volatility of investment in the shipping industry in the study of Kalouptsidi (2014), who advocates that investment in shipping is strongly inversely related to the availability of time to build a vessel.

Shin & Lim (2013) focus on the microeconomics of the shipbuilding industry in Japan, China and South Korea under different global conditions. They find deviations between different countries, with late-comers in the industry (China and Korea) continuing aggressively shipbuilding expansion, in both good times and in times of extreme uncertainty, influenced more by the behaviour of their local competitor, while established powers in the sector (Japan) tend to focus on international conditions to augment their market share. This is in contrast to European shipbuilding which appears to follow a rationally adaptive strategy, slowing down immediately in times of crises and eventually conceding market share to China and South Korea.

On the demand side, new vessel prices appear to be demand-inelastic as illustrated by their low responsiveness to changes in demand for new ships compared to the pertinent sensitivity observed in the case of time-charter rates or oil prices (Dikos, 2004). The study of Dikos (2004) corroborates the so-called Zanettos-Strandenes argument. However, in contrast to Zannetos (1966) and Strandenes (2002), who attribute the lower-than-equilibrium new building prices to externalities, such as government subsidization of shipyards, shipping labour market imperfections, and shipping credit constraints, the non-stabilising nature of new ship prices is attributed to the nature of marginal costs of new buildings. According to Dikos (2004), because ship building is primarily assembling of ready-made parts, when demand falls, prices fall swiftly to the lowest marginal cost.

The impact of geopolitical risks on the shipping industry is often assessed by looking into the volatility of freight rates and oil prices. The pioneering work of Kavoussanos (1996) shows that large changes in ship price volatilities tend to occur around certain periods of time, preceded and followed by small changes in volatility. Specifically, volatility is high during and just after periods of large imbalances and shocks to the industry, such as the Iran-Iraq war in the 1980s, the oil crisis that followed suit, and the Gulf crisis of the early 1990s. Several studies (indicatively, Xu et al., 2011; Dai et al., 2015), confirm freight rate volatility as leading and being positively correlated with newbuilding price volatility in the case of oil tankers.

Furthermore, Khan et al. (2021a) demonstrate that instability in the price of oil caused by geopolitical uncertainties depress the performance of the shipping industry through freight rates. Specifically for the tanker segment of the shipping sector, Khan et al. (2021b) find that the performance of the Baltic Tanker Index (BDTI) is determined by oil market movements, with the price of oil leading the BDTI in the short-run, geopolitical and economic uncertainty impacting the price of oil in the medium-run, and geopolitical uncertainty being correlated with the BDTI in the longer-run. The authors also find that the correlation between oil prices and the BDTI becomes more pronounced in the presence geopolitical uncertainty.

Drobetz et al. (2021) demonstrate that geopolitical and economic shocks impact dry bulk shipping freight rates differently, with geopolitical shocks having an immediate but gradually decreasing positive effect on freight rates and country-specific economic shocks (for the U.S., Brazil, and China) causing a prolonged negative effect on freight rates. Bai (2021), who investigates the asymmetric and time-varying dependence structure between global economic and geopolitical risks and freight rates in the case of tankers, demonstrates significant variation in the dependence of the two variables under different market conditions and time horizons. Palaios et al. (2024) attribute the marginal variation in LNG freight rates to economic and geopolitical uncertainty, with the impact of uncertainty on the LNG rates becoming more intense at the tails of the distribution.

In the study of Fan & Yin (2016), where the newbuilding price is set as the as dependent variable by the use of the causality test, the results obtained confirm the existence of structural changes in the correlation among ship prices and freight rates, suggesting that in a decreasing market, the newbuilding price is more active than the time charter rate and the second-hand price. Raju et al. (2016) analyse the volatility of new LNG vessel prices using GARCH and EGARCH methods. The authors assert the high volatility of pertinent ship prices, stressing that according to their results negative shocks were more persistent than positive shocks.

Ferrari et al. (2018) document the nonlinear relationship between shipbuilding production, in the case of liquid and dry bulk carriers, and economic cycles. Shipbuilding output is asymmetrically affected by macroeconomic variables fluctuations. They find that the lagged effects (GDP fluctuations in the previous two years) are stronger than contemporaneous effects. Shipbuilding is procyclical, increasing with upturns in business cycles and in industry-specific factors, such as the price of steel, fleet size, for tankers and dry bulk carriers, the order book as a measure of market saturation of capacity, demolitions as a proxy to ships life-cycle, and the prices of second-hand vessels. Michail and Melas (2022) corroborate the tendency of geopolitical shocks to increase the cost of the spot charter rates for LNG and LPG carriers.

Recently, a strand of research focuses on shipbuilding capacity as a key factor affecting demand for ships. For, example, Wada et al. (2022) underline the importance of oversupply of new ships compared to the demand forecast due to intense global competition, underlining the uniqueness of the sector in that demand for new ships is indirectly influenced by adjustments in supply. The authors construct a demand-forecasting / ship-price prediction model, which they test to show that rapid construction is profitable in the short-term but not in the longer term. They note that imbalances between supply and demand in shipping drive ship prices, claiming that the persistent downturn of ship prices following the peak of 2008 would not have occurred if the shipbuilding activity had been appropriately controlled.

A large number of studies deploy VAR methodology to depict dynamic relationships between economic/geopolitical variables and shipping prices, including Drobetz et al. (2021) and Michail and Melas (2022) and many others (see, for example, Gu and Liu, 2022, on the impact of manufacturing expansion upon dry bulk freight rates in the case of China). Other researchers deploy machine learning methods to explore different determining factors of ship prices and attempt pertinent forecasting, in the case of newbuilding (see, for example, Syriopoulos et al. 2021), secondhand ships (see, for example, Adland et al. 2021; Lee and Park, 2022), as well as the newbuilding, the secondhand and the scrap markets (Wang et al., 2023). Moreover, there is algorithm-based research supporting the inter-relationship between newbuilding prices and secondhand prices (see, for example, Gao et al., 2022). Further, based on Bayesian VAR analysis, positive geopolitical shocks appear to have a short-term positive, but diminishing in the longer-term, effect on ship prices (Laopodis & Triantafillou, 2024, mimeo). This study asserts that negative shocks are associated with increased freight rate volatility and, as a result, ship price volatility in the newbuilding market, while positive shocks are associated with lower freight rates and ship price volatility.

3. Modelling the Theoretical Background

The shipbuilding market is one of the most competitive markets worldwide and it is characterized by a high degree of instability and, therefore, price volatility. The main forces behind that instability are both supply and demand driven. First, when it comes to the supply side, we observe a high degree of inflexibility due to the inability of the shipyards to adjust their capacity, especially in the short-run period (Figure 1, left side). Thus, in the short-run, the adjustment towards equilibrium takes place through changes in the level of newbuilding prices, as the supply curve cannot shift. In contrast, in the long-run, equilibrium is achieved through capacity, namely supply side, adjustments (Figure 1, right side). As a result, different types of adjustment, depending on the time frame, are expected to lead to differences in the speed and the process of short- and long-run adjustment. Second, when it comes to the demand side, because of the delivery lag of shipyards, ordering of new vessels usually reaches a maximum at the peak of the cycle. Consequently, when the vessels are delivered, the business cycle has already entered its negative phase thus strengthening the recession. As a result, shipyard delivery lags distort the synchronization between shipping and business cycles (Karakitsos and Varnavides, 2014). As Volk (1994) describes it, “Shipbuilding is characterized by heavy fluctuations of demand over the short-term and by high inertia of supply”, which implies short phases of growth and long phases of recession. This is corroborated by Stopford (2009), who notes that the combination of opportunism on the demand side and of inflexibility on the supply side results in an a very low speed of adjustment in the shipbuilding industry, implying longer cycles.

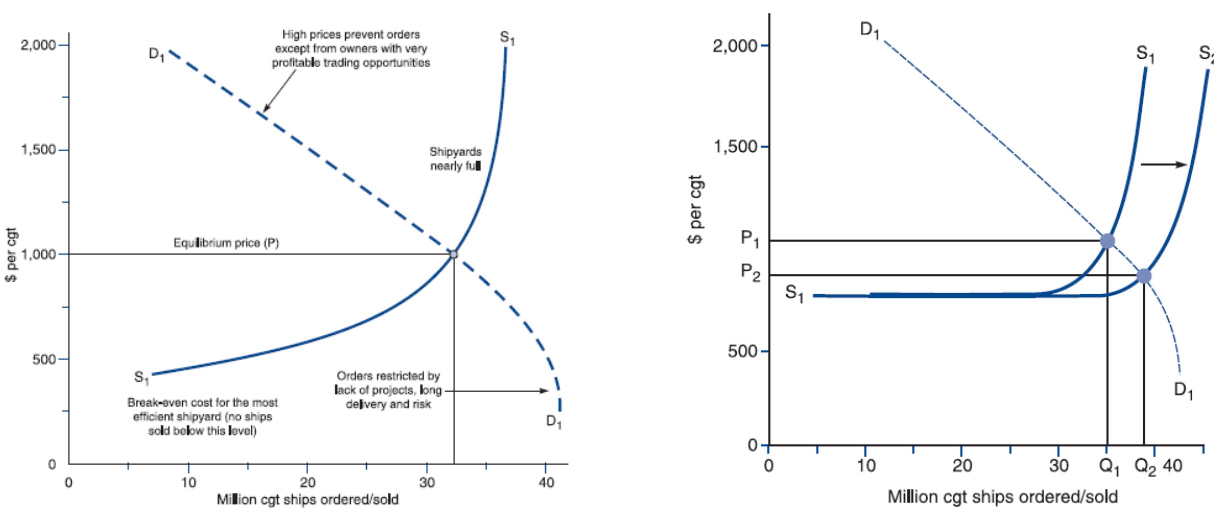

Figure 1: Short (left side) and long (right side) run equilibrium in shipbuilding industry (Source: Stopford, 2009)

The determinants of shipbuilding demand and supply in the shipbuilding industry are described by Stopford (2009). Specifically, demand for shipbuilding can be expressed as a function of the freight rates (Fr_i), cost of capital ($libor$), newbuilding prices (P_i^{NB}) and secondhand vessels prices (P_i^{SH}). Macroeconomic disruptions due to the impact of wars and political tensions, like the recent Russian invasion of Ukraine and the tensions in the Middle East, are also possible and affect shipbuilding demand through the channel of sentiment. To account for possible geopolitical effects, we add in our analysis the geopolitical risk index (gpr). Further, supply for shipbuilding can be expressed as a function of shipbuilding capacity (shipyard), exchange rates (e) and newbuilding price (P_i^{NB}). Based on the above theory, we expand the econometric modelling of Haralambides et al. (2005) by including geopolitical risk as a determinant. Therefore, aiming to provide a reasonably simple derivation of a newbuilding price function, we express the demand and supply functions for shipbuilding as in Equations 1 and 2, respectively.

$$Q_{NB,i}^{D} = f\left(Fr_i, P_i^{NB}, P_i^{SH}, gpr, libor\right) \tag{1}$$

$$Q_{NB,i}^{S} = f(e, P_i^{NB}, gpr, steel, capacity) \tag{2}$$

In equilibrium, $Q_{NB,i}^{D} = Q_{NB,i}^{S}$, which implies that the function can be inverted to get the newbuilding price function, in the following form:

$$P_i^{NB} = f(Fr_i, P_i^{SH}, gpr, capacity, steel, libor, e) \tag{3}$$

In all cases i denotes the different types of vessels, implying that our data is disaggregated, namely shipbuilding segment specific (Bulk carrier, Oil tanker, LNG). Given the above-described framework, we set the following testable hypotheses:

H1: The impact of geopolitical uncertainty on the equilibrium newbuilding prices is positive (direct).
H2: The speed of adjustment after an adverse (positive) geopolitical shock is expected to be faster after a peaceful (negative) due to downwards price stickiness.
H3: Due to short-run supply side inertia, the adjustment speed of the shipbuilding market after a geopolitical shock is characterized by asymmetries and, specifically, it is expected to be faster in the long-run period.

4. Data statistical properties and econometric methodology

4.1. Data sources and statistical properties of variables

We select our variables based on Stopford's (2009) shipbuilding theory and the model we developed in the theoretical background (Section 3), so that we capture both the demand and the supply side. All variables, their explanation and source are reported in Table 1. Due to limitations in the availability of data for LNG secondhand prices the data for this segment is restricted to the period 2014m9-2022m12. For Bulk carriers and Oil Tankers the sample period is 1991m6-2024m11. On the demand side, we select freight rates, newbuilding prices, secondhand prices, geopolitical risk and LIBOR. To account for the cost of capital we use in all our specifications the London Interbank Offered Rate (LIBOR). Tsolakis et al. (2003) mention that a long-term interest rate is a better indicator of shipowners' liquidity and therefore, we use the monthly 5-year $10m finance rate based on the LIBOR average p.a. To account for the geopolitical risk, we employ the geopolitical risk index of Caldara and Iacoviello (2022). On the supply side, as a proxy for the shipyard capacity, we employ the percentage change in the fleet development (fleet growth %Yr/Yr). We also use the exchange rate, which has an important impact on shipbuilding supply as it determines the cash the shipyard receives in local currency (Stopford, 2009). Specifically, since shipbuilding is a global industry, we use the Exchange Rate SDR (Special Drawing Rights), which is a representative exchange rate indicator, as its value is based on a basket of five currencies - the US dollar, the euro, the Chinese renminbi, the Japanese yen and the British pound sterling. Additionally, we use the price of steel, which represents a major production cost, along with newbuilding prices, and geopolitical risk.

Table 1: Variables and Sources

Variable notation	Variable explanation	Source
gpr	GPR (Geopolitical Risk Index), Geopolitical Risk Index is a measure of geopolitical events and associated risks based on newspaper articles. periodicity: monthly	Caldara and Iacoviello (2022), https://doi.org/10.1257/aer.20191823, https://www.matteoiacoviello.com/gpr.htm https://www.policyuncertainty.com/gpr.html
P_i^{NB}	Newbuilding price for each vessel type i, where $i =$ Bulker, Oil tanker, LNG. periodicity: monthly	Clarksons Research: Bulkcarrier Newbuilding Price Index, code:20651 Oil Tanker Newbuilding Price Index, code:29454 Gas Carrier Newbuilding Price Index, code:21365

Variable notation	Variable explanation	Source
Fr_i	Freight rates for each vessel type i , where i = Bulker, Oil tanker, LNG. periodicity: monthly	Clarksons Research: Clarksons Average Bulker Earnings ($/day), code:97730[1] Clarksons Average Tanker Earnings ($/day), code:97726[2] LNG 160K CBM 1 Year Timecharter Rate, code:532720
P_i^{SH}	Secondhand price for each vessel type i, where i = Bulker, Oil tanker, LNG. periodicity: monthly	Clarksons Research: Bulk Carrier Secondhand Price Index, code:86174 Tanker Secondhand Price Index, code:12508 LNG Carrier 160k cbm 5yr old Secondhand Prices, code: 542204
$capacity_i$	Orderbook as percentage of the fleet, proxy for the shipyard capacity, periodicity: monthly	Clarksons Research: Bulkcarrier Orderbook % Fleet, code:534436 Total Tanker Orderbook % Fleet, code: 547641 LNG Orderbook % Fleet, code: 542128
$steel$	price of Cold Rolled Steel Sheet and Strip, periodicity: monthly	U.S. Bureau of Labor Statistics, Producer Price Index by Commodity: Metals and Metal Products: Cold Rolled Steel Sheet and Strip [WPU101707], retrieved from FRED, Federal Reserve Bank of St. Louis. https://fred.stlouisfed.org/series/WPU101707
$libor$	5 Year interest based on LIBOR Average pa. Periodicity: monthly	Clarksons Research (5 Year $10m Finance based on Libor Avg pa), code:22566
e	Exchange Rates SDR (USD), periodicity: monthly	Exchange Rates SDR (USD), code:12467

4.2. Econometric methodology

In our empirical analysis we perform TAR and MTAR regressions following Enders and Siklos, 2001), as expanded by Stevans (2004) for the multivariable framework. The main advantage of this methodology is that it captures the impact of asymmetric shocks, both in the short and the long term Therefore, it can account for the impact of shocks of different directions and magnitudes, as opposed to the conventional mean approach, which assumes an average shock along the distribution.

4.2.1. Long-run effects: Threshold cointegration analysis

[1] Timeseries tracks average vessel earnings across the bulk carrier sector, weighted by the number of ships in each segment.

[2] Timeseries tracks average vessel earnings across the tanker sector (crude and products), weighted by the number of ships in each segment.

To account for the long-run asymmetric effects, we estimate the long-run equilibrium relationship (eq. 4) and use the residuals to estimate the asymmetric threshold model (eq. 5), which consists of two regimes, representing positive (adverse) geopolitical shocks, namely shocks above the threshold and negative (beneficial) geopolitical shocks, namely shocks below the threshold.

$$P_{i,t}^{NB} = a_0 + a_1 gpr_t + a_2 Fr_{i,t} + a_3 P_{i,t}^{SH} + a_4 shipyard_{i,t} + a_5 steel_t + a_6 libor_t + a_7 e_t + \varepsilon_t \quad (4)$$

$$\Delta\hat{\varepsilon}_t = \rho_1 I_t \hat{\varepsilon}_{t-1} + \rho_2 (1 - I_t)\hat{\varepsilon}_{t-1} + \sum_{i=1}^{\rho} \varphi_i \, \Delta\hat{\varepsilon}_{t-1} + \mu_t \quad (5)$$

$$I_t = 1, \;\; gpr_{t-1} \geq 0, \qquad 0 \; oherwise \quad (5.1)$$

$$I_t = 1, \;\; \Delta gpr_{t-1} \geq 0, \qquad 0 \; oherwise \quad (5.2)$$

$P_{i,t}^{NB}$, gpr_t, $Fr_{i,t}$, $P_{i,t}^{SH}$, $shipyard_{i,t}$, $steel_t$, $libor_t$ and e_t are the variables of our model described in Section 4.1. a_i are coefficients and ε_t is the error term. $\rho_1, \rho_2, \varphi_i$ are coefficients to be estimated, *p*, is the number of lags, $\mu_t \approx iid(0, \sigma_\varepsilon^2)$, selected using AIC and BIC statistics. I_t is Heaviside indicator, where τ, is the value of threshold for positive and negative geopolitical shocks, $gpr_{t-1}, \Delta gpr_{t-1}$ are the threshold values of the geopolitical shocks for the TAR and MTAR models. *i* refers to the three shipbuilding segments, namely Bulk carriers, Oil tankers and LNG carriers. To examine the validity of the equilibrium relationship we test the null hypothesis of no cointegration ($H_0\colon \rho_1 = \rho_1 = 0$) using the Φ statistic (non-standard *F*). As the Φ-statistic does not follow the standard distribution, a Monte Carlo simulation to determine the critical values is performed. To test the existence of asymmetric impact of the geopolitical shocks on the newbuilding prices we evaluate the null hypothesis of symmetric adjustment ($H_0\colon \rho_1 = \rho_1$), performing a standard F-test.

4.2.2. Monte Carlo simulation

Since the Φ – statistic for testing the cointegration hypothesis ($H_0\colon \rho_1 = \rho_1 = 0$) is a non-standard *F*-statistic that does not follow the standard distribution we calculate its critical values by performing Monte Carlo simulations as in Enders and Siklos (2001) and Stevans (2004). The critical values have been simulated for all variables of our long-run relationship and T=402 observations for Bulk carrier and Oil tanker shipbuilding markets and T=100 observations for the LNG shipbuilding market. We use random walk processes with 5000 trials as in the following below and for each of the 5000 series, we follow the methodology described in section 3.2.1 to estimate the consistent TAR and MTAR models and record the corresponding statistic (Table 2).

$$lngpr_t = lngpr_{t-1} + u_{gpr,t} \qquad u_{gpr,t} \approx N(0,1) \tag{6}$$

$$lnP_{i,t}^{NB} = lnP_{i,t-1}^{NB} + u_{P^{NB},t} \qquad u_{P^{NB},t} \approx N(0,1) \tag{7}$$

$$lnFr_{i,t} = lnFr_{i,t-1} + u_{Fr,t} \qquad u_{Fr,t} \approx N(0,1) \tag{8}$$

$$lnP_{i,t}^{SH} = lnP_{i,t-1}^{SH} + u_{confl,t} \qquad u_{P_t^{SH},t} \approx N(0,1) \tag{9}$$

$$lnshipyard_{i,t} = lnshipyard_{i,t-1} + u_{shipyard,t} \qquad u_{shipyard,t} \approx N(0,1) \tag{10}$$

$$lnsteel_t = lnsteel_{t-1} + u_{steel,t} \qquad u_{libor,t} \approx N(0,1) \tag{11}$$

$$lnlibor_t = lnlibor_{t-1} + u_{libor,t} \qquad u_{libor,t} \approx N(0,1) \tag{12}$$

$$lne_t = lne_{t-1} + u_{e,t} \qquad u_{e,t} \approx N(0,1) \tag{13}$$

Table 2: The distribution of Φ (simulated critical values)

		0 lags			1 lag			2 lags			3 lags		
Shipbuilding market	Threshold variable	10%	5%	1%	10%	5%	1%	10%	5%	1%	10%	5%	1%
Bulk carrier	$lngpr_{t-1}$	2.191	3.223	3.973	2.046	3.037	3.707	1.930	2.951	3.625	1.980	2.952	3.558
	$\Delta lngpr_{t-1}$	2.253	3.173	3.914	2.047	2.922	3.647	1.941	2.882	3.572	1.924	2.822	3.495
Oil tanker	$lngpr_{t-1}$	2.081	3.025	3.720	1.993	3.040	3.689	1.969	2.949	3.643	1.968	2.960	3.560
	$\Delta lngpr_{t-1}$	2.075	2.967	3.664	1.983	2.935	3.597	1.849	2.878	3.559	1.850	2.856	3.510
LNG	$lngpr_{t-1}$	2.495	3.698	4.488	2.310	3.516	4.224	2.082	3.196	3.967	1.965	3.035	3.743
	$\Delta lngpr_{t-1}$	2.382	3.586	4.325	2.236	3.372	4.045	1.977	3.077	3.706	1.821	2.856	3.504

4.2.3 Short-run effects

Next, we focus on the short-run dynamics by developing asymmetric error correction models (ECM) with threshold cointegration, one for each of the shipbuilding segments, identified in the previous section. The ECM models allow to examine the short-run dynamics after a geopolitical shock and specifically, the existence of possible asymmetries on the shipbuilding prices after geopolitical events. The ECM models take the following form:

$$\Delta P_{i,t}^{NB} = \theta_{i,t} + \delta_i^{+} E_{t-1}^{+} + \delta_i^{-} E_{t-1}^{-} + \sum_{j=1}^{J} a_{i,j}\, \Delta P_{i,t-j}^{NB} + \sum_{j=1}^{J} \beta_{i,j}\, \Delta gpr_{i,t-j} + \sum_{j=1}^{J} \gamma_{i,j}\, \Delta Fr_{i,t-j} +$$
$$+ \sum_{j=1}^{J} \zeta_{i,j}\, \Delta P_{i,t-j}^{SH} + \sum_{j=1}^{J} \eta_{i,j}\, \Delta capacity_{i,t-j} + \sum_{j=1}^{J} \kappa_{i,j}\, \Delta steel_{i,t-j} + \sum_{j=1}^{J} \mu_{i,j}\, \Delta libor_{i,t-j}$$
$$+ \sum_{j=1}^{J} \psi_{i,j}\, \Delta e_{i,t-j} + u_{i,t} \qquad (14)$$

where: $\Delta P_i^{NB}, \Delta gpr_i, \Delta Fr_i, \Delta P_i^{SH}, \Delta capacity_i, \Delta steel, \Delta libor, \Delta e$ are the first differences of the natural logarithm of the variables of our model for each shipbuilding section i. $\theta_{i,t}$, is the constant, $\alpha_i, \beta_i, \gamma_i, \zeta_i, \eta_i, \kappa_i, \mu_i, \psi_i$ are the coefficients of the lagged first differences, j denotes the number of lags, u is the error term and E are the error correction terms, $E_{t-1}^{+} = I_t \hat{\varepsilon}_{t-1}$ and $E_{t-1}^{-} = (1 - I_t)\hat{\varepsilon}_{t-1}$. They are constructed from the threshold cointegration regressions in equations (5), (5.1), (5.2) and account for the asymmetric level of the newbuilding prices, after positive and negative geopolitical shocks. Diagnostics analysis on the residuals is performed using AIC and BIC criteria.

5. Empirical analysis and discussion

The empirical analysis is structured as follows: In section 5.1, we establish the long-run equilibrium relationship of our model. Thereafter, we examine the response of the newbuilding prices of the three segments after positive (adverse) and negative (beneficial) geopolitical shocks, both in the long-run (threshold cointegration model), Section 5.2, and the short-run (error correction model), Section 5.3.

5.1. Geopolitical and macroeconomic effects on the equilibrium

Table 3 presents the coefficients of our long-run (equilibrium) relationship, according to our OLS estimates. We observe that the impact of all variables is statistically significant, consistent with the expected signs. Since our variables have been transformed into natural logarithms, the estimated coefficients can be interpreted as elasticities.

Table 3: Long-run (equilibrium) relationship estimates. Dependent variable is P_i^{NB}

Shipbuilding segment VARIABLES	Bulk carriers (1) P_i^{NB}	Oil tankers (2) P_i^{NB}	LNG (3) P_i^{NB}
P_i^{NB}	0.352*** [12]	0.246*** [12]	1.030*** [12]
	(0.0307)	(0.0318)	(0.175)
gpr	0.0268*** [12]	0.0192** [11]	0.0554*** [12]
	(0.00934)	(0.00856)	(0.0162)
Fr_i	0.0319*** [12]	0.0196*** [12]	0.0372*** [12]
	(0.00875)	(0.00610)	(0.0108)
P_i^{SH}	0.391***	0.537***	0.0931
	(0.0145)	(0.0199)	(0.150)
$capacity$	-0.0670***	-0.0248**	0.303***
	(0.0106)	(0.0114)	(0.0485)
$steel$	0.0363*** [12]	0.0674*** [12]	0.141*** [12]
	(0.0127)	(0.0171)	(0.0218)
$libor$	0.111	-0.214***	-0.652***
	(0.0753)	(0.0746)	(0.207)
e	0.0826	0.452***	-0.492***
	(0.106)	(0.0673)	(0.174)
Constant	0.877***	1.195***	9.120***
	(0.104)	(0.0936)	(0.793)
Observations	335	335	88
R-squared	0.938	0.936	0.889

Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Following Haralambides et al. (2005), we add one year (12 months) lagged values for the dependent variable, freight rates and secondhand prices. The only exception concerns geopolitical risk for oil tankers that becomes statistically significant at 11 months. In all cases the impact of geopolitical threat is positive, implying that an increase in geopolitical risk increases the cost of production and creates general limitations in the shipbuilding industry, thus increasing the equilibrium prices of new vessels (cost push inflation). Further, higher geopolitical risk may lead to higher newbuilding prices through the demand channel (demand pull inflation), due to shipowners that want to take advantage of the higher revenues due to the risk premium charged in freight rates. Specifically, a 1% increase in the geopolitical threat risk leads to a 0.0192% increase in the price of newbuilding Oil tankers, 0.0268% increase in the prices of Bulk carriers and 0.0554%

increases in the prices of LNG carriers. Therefore, LNG carriers' newbuilding prices are more flexible, adjust faster after an adverse geopolitical shock which means that the shocks will be fully digested (absorbed) faster compared to the other segments. An increase in the price of steel is associated with higher cost of production and thus higher prices (cost-push inflation).

The freight market is the leading market in the shipping industry and the most important source of cash inflow. According to our estimates, the freight rates are positively related to the newbuilding prices. A positive shock in the freight rate improves the profit expectations of the shipowners, who increase the demand for new vessels by placing new orders, thereby increasing the prices of newbuilding. According to our findings the freights of all market segments are positively related to the new-building market, with the impact of Bulk carrier's freight rate being the strongest.

The coefficient of secondhand vessels is found to be positive, implying that newbuilding and secondhand vessels are substitutes. A higher price of secondhand vessels increases the demand for new vessels and as a result their prices. It should also be noted that the strongest impact of secondhand prices on the newbuilding ones is observed in the Oil tankers segment, where a 1% increase in the price of secondhand vessels leads to a 0.537% increase in the price in the newbuilding prices followed by the bulk carriers (0.391%). The substitution relationship is found to be statistically weak in the case of bulk carriers (0.0931%). A higher shipyard capacity increases supply for new vessels and thus it is expected to have a negative effect on new building prices. According to our findings the elasticity of shipyard capacity is negative for all segments, except for the LNG segment. Moreover, in all segments the elasticity of newbuilding prices with respect to the cost of capital is negative, meaning that an increase in LIBOR limits the access of shipowners to liquidity. The only exception concerns the bulk carriers. Finally, a change in the exchange rate leads to mixed results. It should be noted that while the impact of exchange rates is important, the expected sign heavily depends on the nationality of the shipyard.

Overall, our results confirm our hypotheses HI, according to which the impact of geopolitical uncertainty on the equilibrium newbuilding prices is positive (direct).

5.2 Long-run asymmetric dynamics (threshold cointegration model)

Having established the long-run equilibrium relationship, we examine the long-run adjustment dynamics towards the equilibrium, after positive and negative shocks and reveal possible asymmetries in the speed of adjustment. In total, we developed six models. Specifically, we developed two models (cTAR and cMTAR) for each segment, namely four models for each segment. Since we have three segments, we run in total six models. The models are reported in Table 4. For each market segment and for each threshold variable, we select the cTAR or cMTAR model with the lowest AIC and BIC value. It should be noted that the joint null hypothesis of no cointegration ($H_0: \rho_1 = \rho_2 = 0$) is tested, using the Φ statistic (non-standard F) as in Enders and Siklos (2001), Stevans (2004) and Sun (2011). Since Φ statistic does not follow the standard distribution (Enders and Siklos, 2001), we conduct a Monte Carlo simulation to calculate the critical values. The results and the methodology of the simulation are presented in the Appendix.

Table 4: Results of threshold cointegration estimations

Shipbuilding segment	Bulk carriers		Oil tankers		LNG	
Equation	TAR	MTAR	TAR	MTAR	TAR	MTAR
Threshold variable	$lngpr_{t-1}$	$\Delta lngpr_{t-1}$	$lngpr_{t-1}$	$\Delta lngpr_{t-1}$	$lngpr_{t-1}$	$\Delta lngpr_{t-1}$
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
ρ_1	-0.132***	-0.129***	-0.132***	-0.148***	-0.307**	-0.273**
	(0.0344)	(0.0307)	(0.0357)	(0.0347)	(0.119)	(0.128)
ρ_2	-0.0777**	-0.0903***	-0.112***	-0.0951***	-0.181*	-0.214**
	(0.0304)	(0.0311)	(0.0333)	(0.0344)	(0.107)	(0.105)
φ_1	0.120**	0.266***	0.175***	0.184***	-0.120	-0.168
	(0.0561)	(0.0533)	(0.0543)	(0.0547)	(0.109)	(0.108)
Diagnostics						
AIC	-1559.053	-1584.896	-1608.623	-1609.658	-454.827	-440.695
BIC	-1547.638	-1573.471	-1597.198	-1598.233	-447.509	-433.332
Hypotheses						
$\Phi(H_0: \rho_1 = \rho_2 = 0)$	10.22***	12.86***	12.15***	12.70***	4.54**	4.06**
Standard F test	7.09***	14.41***	9.68***	10.05***	4.75***	5.47***

Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Initially, we use the geopolitical risk as threshold variable in the bulk carriers' segment (columns 2 and 3). One lag provides the lowest AIC and BIC statistics for both TAR and MTAR models. Finally, we choose the MTAR because it has the lowest AIC (-1584.896), BIC (-1573.471) values. Testing the hypothesis of no cointegration $\Phi(H_0: \rho_1 = \rho_2 = 0)$ shows that the variables of our equilibrium relationship are cointegrated in the long-run period. Moreover, the null hypothesis of symmetry $F(H_0: \rho_1 = \rho_2)$ is rejected. This finding implies that, when a geopolitical shock occurs, the adjustment process of the newbuilding prices of Bulk carriers towards the new equilibrium point is asymmetric, namely it differs depending on whether the shock is positive (adverse) and negative (beneficial). As a result, the length of the shipbuilding cycle will also be asymmetric. Specifically, we find that the point estimate for the adjustment process of shipbuilding prices after a positive (adverse) geopolitical shock, is -0.129, statistically significant at 1% level. The corresponding point estimate for the adjustment process after a negative (beneficial) geopolitical shock, is -0.090, statistically significant at 1%. Therefore, after a shock in geopolitical uncertainty, the long-run adjustment process of the newbuilding prices towards the new equilibrium point is faster when the shock is positive (adverse). Consequently, after a beneficial (negative) shock in geopolitical uncertainty, newbuilding prices decrease slower than they increase after an adverse (positive) geopolitical shock, implying that newbuilding prices of Bulker carriers exhibit downwards stickiness.

For the segment of oil tankers (columns 4 and 5) one lag provide the lowest AIC and BIC statistics for both models, but finally the MTAR is selected according to the diagnostics. Again, we observe that our relationship is characterized by cointegration and asymmetry, as both of the relevant hypotheses are rejected. As in the case of the bulk carriers we find that after a geopolitical shock the adjustment process of the newbuilding prices is faster when the shock is positive (adverse). The evidence implies that newbuilding prices decrease slower than they increase after an adverse (positive) geopolitical shock, implying that newbuilding prices of oil tankers exhibit downwards stickiness. Similar findings emerge for the LNG carriers (columns 4 and 6), where the TAR model is selected according to the diagnostics.

Across the shipbuilding segments, the faster speed of adjustment after a positive (adverse) geopolitical shock has been detected in the LNG newbuilding prices, followed by the oil tankers and the bulk carriers. When it comes to the speed of adjustment after a negative (beneficial) geopolitical shock, the largest price stickiness is observed in Oil Tankers followed by the Bulkers and the LNG newbuilding prices. Further, in all segments we observe a downwards stickiness of prices after a geopolitical negative (beneficial) geopolitical shock, as the relevant speed of adjustment towards the new equilibrium point is faster when newbuilding prices increase, namely after a positive (adverse) geopolitical shock. Of all shipbuilding segments, the LNG is characterized by the higher degree of price flexibility, as the adjustment speed is faster compared to the other segments, both in the short and long-run. Our results confirm our testable hypothesis H2, according to which the speed of adjustment after an adverse (positive) geopolitical shock is expected to be faster after a peaceful (negative).

5.3 Short-run asymmetric dynamics (ECM model)

Next, we estimate the short-run dynamics of our model. Specifically, we develop three asymmetric error correction models, one for each of the three shipbuilding sectors and examine the impact of geopolitical shocks on the short-run adjustment process of the newbuilding prices (Table 5). The specification with the lowest value of AIC, BIC is the one-lag length for all segments.

Table 5: Results of asymmetric error correction models

Shipbuilding segment	Bulk carriers	Oil tankers	LNG
Threshold variable	$lngpr_{t-1}$	$lngpr_{t-1}$	$\Delta lngpr_{t-1}$
	(1)	(3)	(4)
δ^{+}	-0.0422*	-0.0911*	-0.524*
	(0.0216)	(0.0484)	(0.308)
δ^{-}	0.0167	0.0273	0.113
	(0.0215)	(0.0490)	(0.361)
α_1	0.297 ***	0.272 ***	0.317***
	(0.0544)	(0.0560)	(0.108)
β_1	0.000347	-0.00102	-0.0182
	(0.00346)	(0.00675)	(0.0212)
γ_1	0.00416	0.0176 **	0.0115
	(0.00601)	(0.00695)	(0.0566)
ζ_1	0.0919 ***	-0.0632	-0.0817
	(0.0202)	(0.112)	(0.625)
η_1	0.00210	0.00505	0.186***
	(0.00461)	(0.00588)	(0.0673)
κ_1	0.0644 ***	0.0100	0.204
	(0.0200)	(0.0374)	(0.765)
μ_1	0.223	0.323	0.115
	(0.159)	(0.315)	(1.428)

Shipbuilding segment	Bulk carriers	Oil tankers	LNG
Threshold variable	$lngpr_{t-1}$	$lngpr_{t-1}$	$\Delta lngpr_{t-1}$
	(1)	(3)	(4)
ψ_1	0.0363	0.188 *	0.400
	(0.0591)	(0.105)	(0.570)
constant	0.000271	0.000846	0.00798
	(0.000871)	(0.00170)	(0.00550)
Diagnostics			
AIC	-51.25205	-49.06599	-59.00718
BIC	-50.50524	-48.29819	-57.16801
Hypothesis			
Symmetry Standard F test	3.68 *	2.91 *	2.74*

Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

When it comes to the Bulk carriers (columns 2 and 3), the point estimate of ECM's coefficient for positive geopolitical shocks, is -0.0422, while the point estimate for negative shocks is statistically insignificant. Further, the null hypothesis of symmetric adjustment $F(H_0: \delta^+ = \delta^-)$ after a geopolitical shock is rejected. Consequently, after a beneficial (negative) shock in geopolitical uncertainty, newbuilding prices decrease slower than they increase after an adverse (positive) geopolitical shock, implying that newbuilding prices of Bulker carriers exhibit downwards stickiness. When it comes to the Oil tankers (columns 4 and 5), the point estimate of ECM's coefficient for positive geopolitical shocks is -0.0911, while the point estimate for negative shocks is statistically insignificance. Further, the null hypothesis of symmetric adjustment $F(H_0: \delta^+ = \delta^-)$ after a geopolitical shock is rejected. As a results, after a beneficial (negative) shock in geopolitical uncertainty, newbuilding prices decrease slower than they increase after an adverse (positive) geopolitical shock, implying that newbuilding prices of Tanker carriers exhibit downwards stickiness. Similar findings emerge for the LNG carriers (columns 5 and 6),

Overall, in all cases we observe an asymmetric adjustment of newbuilding prices after a geopolitical shock. As in the case of the long-run period, we observe that the speed of adjustment is higher after a positive (adverse) geopolitical shock. Further, the speed of adjustment after a geopolitical shock is slower in the short-run period, compared to the long-run, due to the short-run inertia of shipbuilding supply. Therefore, in the short-run period, due to the lower speed of newbuilding price adjustment, we expect that the price volatility will be more intense, since the delayed return to equilibrium after a shock increases the duration and magnitude of deviations from the equilibrium. As a result, the short-term shipbuilding cycles are expected to be larger. The findings confirm H3 hypothesis.

6. Policy Implications and Conclusions

This study examines the impact of geopolitical uncertainty on the shipbuilding prices of three shipping industry segments, Bulk carriers, Oil tankers and LNG carriers. In doing so, we use an asymmetric econometric methodology, namely TAR and MTAR, introduced by Enders and Siklos (2001) and expanded by Stevans (2004) in a multivariate environment. The main advantage of this methodology is that it accounts for possible asymmetric impacts, as opposed to the conventional mean techniques.

We contribute to the existing literature by finding strong and consistent empirical evidence in favor of an asymmetric response of the newbuilding prices after positive (adverse) and negative (peaceful) geopolitical shocks. Specifically, our results show that, first, in all segments, both in the short and long-run period, the speed of adjustment of newbuilding prices to the higher equilibrium point is faster after positive (adverse) geopolitical shocks, like the Russian invasion of Ukraine and the tensions in Middle East. On the contrary, newbuilding prices are characterized by a relative downwards stickiness after negative (peaceful) geopolitical shocks. The lower speed of adjustment after positive geopolitical events implies longer deviations from the equilibrium and therefore, longer shipbuilding cycles and higher price volatility. Second, we find that, for all shipbuilding segments, the speed of adjustment of newbuilding prices is faster in the long-run period, which can be attributed to the short-run supply inertia of the shipbuilding sector. Therefore, we expect longer shipbuilding cycles and higher price volatility in the short-run period. Third, we find that, across segments, both in the short and the long-run, the newbuilding price speed of adjustment is higher in the LNG shipbuilding sector, followed by Bulk carriers and Oil tankers.

Our results have important policy implications revealing that the shipbuilding market participants discount the peaceful geopolitical events in their choices path, while adverse shocks affect their behavior more intensively, leading to higher newbuilding price inflation. In contrast, due to downwards price stickiness, peaceful geopolitical events are expected to give way to a longer period of price adjustment. Moreover, the time horizon matters, as the short-run lower speed of price adjustment implies higher price volatility and longer deviations from the equilibrium newbuilding price, leading to longer and unstable shipbuilding cycles. When it comes to the different shipbuilding segments, our study demonstrates that the LNG shipbuilding sector proves to be the most adaptable one, acting more promptly, which implies that inflation shocks will be absorbed faster. A major policy implication of our findings is that a higher newbuilding price flexibility (elasticity) leads to higher speed of adjustment and thus to a weaker geopolitical effect. Therefore, reducing the rigidities in the shipbuilding market will lead to diminishing geopolitical costs in terms of price inflation for all shipbuilding segments.

Statements

Author contributions

The authors have equally contributed to all parts of this paper. All the authors have read and approved the final manuscript.

Data Availability Statement

The data employed in this research paper can be accessed according to the sources in Table 1. The codes to replicate the results are available upon request.

Consent for publication

This study presents original material that has not been published elsewhere.

Disclosure Statement

The authors declare that they have no competing interests, or other interests that might be perceived to influence the results and/or discussion reported in this paper.

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