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Michael C. Grubb

MERCHANT SHIPPING IN A CHINESE BLOCKADE OF TAIWAN

Lieutenant Michael C. Grubb, U.S. Navy

There is a substantial literature on the various methods and tactics the armed forces of the People's Republic of China (PRC) could employ to enforce a naval blockade of Taiwan during a Taiwan Strait crisis.[1] However, there has been very little assessment of how the qualities of today's global maritime shipping industry might affect the effectiveness of a blockade. If China chose to implement a blockade, would the global maritime industry continue to utilize Taiwan's ports and support its import/export trade in the face of Chinese threats? If international merchant shipping abandoned the Taiwan market, does the maritime industry of the Republic of China have sufficient capacity to keep its supply lines filled on its own?

This article attempts to answer these questions, making the case that the global maritime trade industry is not likely to support Taiwan's seaborne trade in the face of a PRC blockade, leaving Taiwan's merchant fleet to meet the island's strategic resupply needs. Although the merchant fleet owned by Taiwan-based interests is theoretically able to meet most of the island's critical energy and food supply demands on its own, the dynamics of vessel corporate ownership and flag-of-convenience registry will likely place the burden of the resupply effort on the small percentage of ships actually registered under the Republic of China (ROC) flag. Without support from foreign-flagged vessels, Taiwan's strategic resupply lines cannot be sustained.

Finally, recommendations for policy makers in Taiwan are offered: possible methods to mitigate capacity deficiencies in specific areas of the ROC maritime

Lieutenant Grubb is a submarine officer currently studying at the Naval War College. He received a BSE degree in naval architecture and marine engineering from the University of Michigan and has previously served aboard the USS Miami *(SSN 755) and on the staff of Destroyer Squadron 22.*

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trade industry; measures to offset physical vulnerabilities in shore-based infrastructure; and considerations for fully exploiting the capabilities of modern merchant ships. Shipping-related considerations for the United States and Japan are also included, since a Taiwan Strait crisis could significantly impact international maritime trade in the entire East Asian theater.

THE GLOBAL MARITIME SHIPPING INDUSTRY: WOULD IT SUPPORT TAIWAN IN A CRISIS?

The global maritime shipping industry is a true reflection of global economic interdependence. It is an ever more networked system in which the ships and ports are portions of a seamless, interlocked land-sea transportation web. It strives to deliver products from source to customer "just in time," minimizing costs of warehousing and delay. This goal has led to larger and faster ships that exploit economies of scale and rely on large "megaports." These megaports are central destinations for containerized cargo shipped between major trade regions; then they serve as transshipment distribution centers, shipping cargo on smaller "feeder" ships to lesser intraregional ports in hub-and-spoke fashion.[2] Asia, befitting its growing strength as the world's leading manufacturing center, now handles 62 percent of the world's total container trade and hosts twenty of the top thirty container ports by volume (including the top six). Taiwan's port of Kaohsiung ranks sixth in the world in container trade, handling 9.71 million TEUs (twenty-foot-equivalent units) in 2004. Adding in Taiwan's other ports, total container traffic through Taiwan exceeds twelve million TEUs per year.[3]

Despite Taiwan's growing influence as an economic and transportation hub, it is doubtful that regional and global shipping interests would continue to use its ports in the face of an open Chinese blockade of the island. There is little economic incentive for ship or cargo owners to take that risk when the megaports of Hong Kong, Singapore, Kalang, Tokyo, and Pusan can also transship non-Taiwan-specific cargoes. These alternate transshipment points can absorb the loss of Kaohsiung's throughput, maintaining cargo distribution to lesser regional ports. Removing Taiwan from the East Asian and global transportation network would have noticeable short-term downstream economic effects on shipowners, shippers, and consumers while adjusting to the disruption, but they would be negligible compared to the risks and possible costs of sending shipping into an active war zone.

In an analysis of the economic impact of major labor disruptions that stopped trade in American west coast ports during the fall of 2002, Peter V. Hall demonstrates that there is little macroeconomic impact from even large shipping disruptions until actual capacity is removed from the system.[4] This implies that the sinking of ships in a blockade of Taiwan could have significant

downstream economic effects but also that shipowners would seek alternatives, even if it meant short-term financial losses. Hall observes that suppliers and consumers have an uncanny ability to exploit flexibility in the global trade system in order to work around localized trade disruptions. If shippers who regularly use Taiwan's ports as a transshipment point can easily find alternative arrangements, consuming industries that rely on Taiwan's exports will likewise be able to find alternative sources. The short-term economic impact, then, may be noticeable in certain market sectors, but a disruption in Taiwan's trade will simply shift the competitive advantage of Taiwan's exports (table 1) to exporters who are not threatened by Chinese ballistic missiles and blockading forces.

TABLE 1
TOP FIVE TAIWAN EXPORTS (2003)

Export Commodity	Value (billion USD)	Share of Total ROC Exports (%)	World Market Share (%)
Transistors, valves, etc.	20.37	14.49	7.44
Office, automatic data processing (ADP) machine parts, etc.	11.21	7.98	7.26
ADP equipment	10.68	7.60	5.47
Telecom equipment, parts, accessories	6.56	4.67	3.02
Electrical machinery	5.04	3.59	4.98
All export commodities	140.60	100.00	2.05

Source: United Nations Council on Trade and Development, *UNCTAD Handbook of Statistics 2005,* Document TD/STAT.30 (New York: United Nations, 2005), p. 163.

There are important parallels with the reaction of merchant shipping to the "tanker wars" of the Iran-Iraq conflict in the 1980s, but they do not hold up with regard to the economics of Taiwan's maritime trade. Contrary to some analysts, the motivation of tankers to continue sailing through the war zone of the Persian Gulf should not be used to predict how shipping might react in a China-Taiwan scenario.[5] The economic influences of oil were significantly greater and more complex in the tanker wars than would be any cargo involved in Taiwanese trade.

During the tanker wars, there was no alternative free-market source for the quantity of oil the Middle East could produce (figure 1). Despite reduced world consumption following the "oil shocks" of the 1970s, the demand was sufficient to buoy tanker freight rates well above anything shipowners could have gotten on other trade routes. The enormous supertankers that carry Middle East crude are specifically designed for the economics of the large-volume, long-distance crude oil trade and were cost-prohibitive to operate on any other route at the time.[6] The rapid expansion of the world tanker fleet in the early 1970s, followed by market instability and a global economic slowdown, reduced demand and produced a severe overcapacity of tankers from 1979 to 1985 (figure 2). Hundreds of tankers laid up, and the resale prices of new ships plummeted to scrap value.[7]

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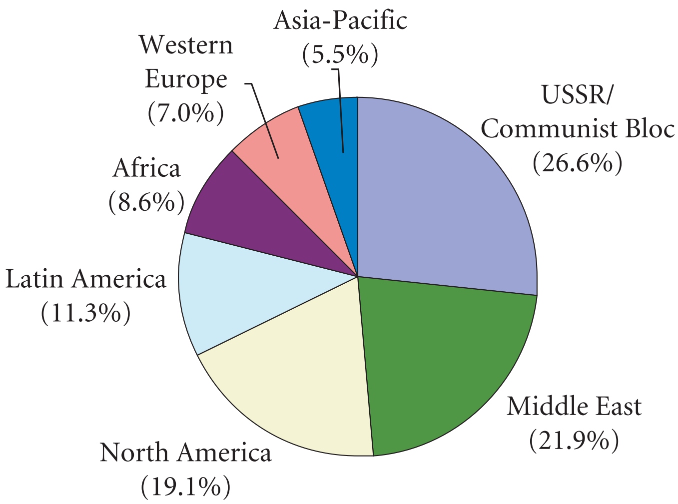
FIGURE 1
WORLD OIL PRODUCTION BY REGION, 1987



Source: Data derived from the British Petroleum Co., *BP Review of World Energy—1988* (London: British Petroleum, 1988), pp. 4–5.

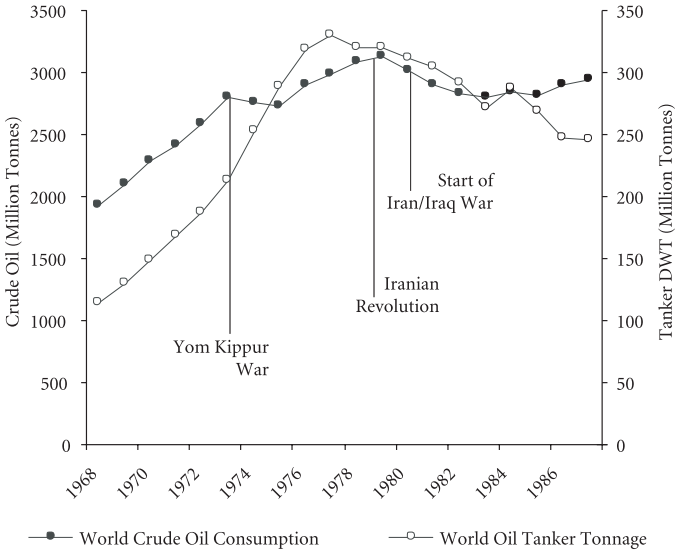
Faced with heavy debt burdens and the depreciating value of their ships, then, owners had a real economic incentive to risk sending their ships into the Persian Gulf war zone. For many the only other option was bankruptcy. In the Taiwan scenario, however, there is no similar overpowering economic force to drive neutral ship and cargo owners to risk attack from blockading forces.

Similarly, the profiteering motivation for shipowners to sail into danger in World Wars I and II is not an apt comparison with regard to the specifics and scope of a China-Taiwan scenario.[8] The world wars were full-scale, global conflicts. The dramatic rise in freight rates seen then resulted from a prewar supply of merchant ships and rapidly increasing demand once the wars started. For Great Britain, this demand ranged from importing raw materials to the home islands to ferrying troops and supplies around the world. A scarcity of shipping resulted, until, with all the inherent delays, wartime emergency fleets could be built. The volume and diversity of trade involved in the allied war efforts were orders of magnitude greater than would be required to support Taiwan in a cross-strait crisis.

Furthermore, much of the debated profiteering by British shipowners in World War I occurred early in the first year of the war, before the government took full control of shipping. During this period most routes were relatively safe, as unrestricted submarine warfare had not yet emerged. Martin Doughty argues that although British shipowners were quite willing to take advantage of high freight rates on safer routes outside active war zones, when it came to frontline danger, "experience had shown that owners were unwilling to charter for such services, no matter how generous the rates offered."[9] When unrestricted U-boat warfare threatened the very survival of the country, patriotism sometimes overcame this reluctance; otherwise, the government found ships for high-threat routes by requisitioning, taking them up from trade.

Of course, some neutral shipowners and crews would be willing to run a Chinese blockade for financial gain. History is filled with examples of mercenaries,

FIGURE 2
WORLD OIL CONSUMPTION AND TANKER TONNAGE, 1968–88



Sources: Data derived from Michael Champness and Gilbert Jenkins, *Oil Tanker Data Book—1985* (London: Elsevier Applied Science, 1985), pp. 5–19; and UN Council on Trade and Development, *Review of Maritime Transport 1987* (New York: United Nations, 1988), p. 12.

privateers, and blockade runners risking death in conflicts to which they had no apparent patriotic, ideological, or personal connection—but not in sufficient numbers to have an impact on the ultimate outcome. Such privateers may arise in a Taiwan scenario, but it would be a grave error for Taipei to expect large volumes of neutral-flagged shipping to sail into blockaded ports for the money. Consequently, if five thousand ships a month now call at Taiwan's ports, blockading PRC forces are likely to find a much less target-rich environment.[10] With most neutral shipping driven away, the PRC would be well on its way to cutting off trade to the island.

The remaining consideration would be whether the ROC merchant marine was capable of sustaining Taiwan on its own. There is little doubt that the combination of a ballistic missile barrage and naval blockade would devastate Taiwan's economy, but if its populace chose to defy Chinese pressure, could the island's merchant marine supply food and energy at a basic survival level? Answering this question requires a detailed examination of Taiwan's food and energy supply lines and the capacity and capability of the ROC shipping industry.

TAIWAN'S MERCHANT MARINE FLEET

Taiwan boasts an impressive commercial fleet. According to Lloyd's of London, the fleet of merchant vessels owned by ROC-based interests ranks eleventh in the world by deadweight, and sixth in Asia, behind Japan, China, Singapore, Hong Kong, and South Korea.[11] Its 28.40 million tonnes of shipping represents 2.8 percent of the world's total deadweight tonnage, exceeding the proportional value of global trade generated by Taiwan (approximately 2 percent).[12] This makes Taiwan one of the few major trading nations that contributes a surplus of shipping capacity to the world market, relative to its own economic production. Of the 897 merchant vessels under ROC ownership, 767 are of one hundred gross tons or more. Since vessels under a hundred gross tons do not contribute significantly, further references to ROC-owned vessels apply only to those 767.[13]

Determining the ownership and controlling interest of merchant vessels, however, is not always a clear-cut process. It is not uncommon for ships to have different managers, operators, registered owners, and ultimate (actual) owners, of different nationalities and in different locations. Of the 767 vessels ultimately owned by ROC-based interests, only 383 (50 percent) are actually registered to Taiwan corporations.[14] Registered owners are often (but not always) subsidiaries of larger parent corporations that actually own the vessels, established overseas to exploit various tax, regulatory, and legal advantages. Furthermore, many corporate shipowners are "nonoperating" or "absentee owners," owners only in the sense that they hold majority financial interests. Some large shipping conglomerates have financial interests in large fleets but actually operate vessels only in certain market sectors; other owners are international financial and investment holdings companies that charter their vessels to independent shipping companies on long-term operating contracts. Locating the actual controlling interest of a particular vessel at any given time, then, can be a challenging endeavor involving a maze of corporate relationships and contractual legalese.

But more important than legal ownership in determining what merchant vessels would be available in a national emergency is flag of registry. The number of these ships actually sailing under the Republic of China's flag is considerably smaller than the fleet owned by ROC-based interests. Of the 767 ROC-owned vessels, only 213 (28 percent) are registered under the Republic of China flag—by deadweight tonnage, 4.96 million tonnes, or 17 percent of the fleet total.[15] Of the remainder, over 80 percent are registered in Panama or Liberia.

The relatively high proportion of ROC-owned merchant ships under foreign registry raises several security implications for Taiwan. Most significantly, the foreign-flagged vessels would be effectively out of Taipei's direct jurisdictional reach in a crisis. While the government could immediately direct nationally registered shipping through legislative or executive action, extending centralized control to foreign-flagged vessels would require the active cooperation of shipowners.[16] Even if ROC owners of foreign-flagged ships realigned their operations to support a war effort, they would have a loophole by which they could pull their ships out of danger should Taiwan's prospects or their own allegiances waver.

The question of allegiance and sense of duty also applies to the crews. As with most other major maritime trading nations, Taiwan's domestic labor laws and regulations extend to all ROC-flagged vessels, and they require that all nationally registered ships have predominantly domestic crews.[17] Conversely, foreign-flagged vessels, being free of the costs and union restrictions of domestic labor, typically employ diverse, multinational crews.[18]

Registering ships under foreign "flags of convenience" dates back to the early 1800s, but only a very small percentage of ships were so registered prior to the 1950s.[19] Consequently, the nationalities of most Allied mariners in World War II corresponded to the registries of their ships (the crews of British-flagged ships were predominantly British nationals, and so on).[20] Nonetheless, British and American merchant fleets both experienced inefficiencies due to absentee and discipline issues prior to 1940–41. In particular, employer-union relations in the U.S. merchant fleet were tumultuous prior to American entry into the war. The fall of France and the attack on Pearl Harbor galvanized the merchant mariners into the brave, highly dedicated force that is remembered as one of the keys to victory in the Battle of the Atlantic.[21] Today, however, with a high proportion of foreign-flagged, foreign-crewed ships, the Republic of China cannot count on such spirit in its merchant fleet.

The Taiwan government recognizes this dilemma, but there are no quick fixes or easy answers. The Ministry of Transportation and Communications (MOTC) has revised regulatory structures in order to encourage national registry of new ships.[22] However, Taiwan's entrance into the World Trade Organization (WTO) has exposed to foreign competition domestic shipping sectors that had previously favored national-flag carriers. Additionally, a recent survey of shipowners in Taiwan revealed that the high cost of domestic crews remains a significant disincentive to registering vessels under the ROC flag. A chronic shortage of qualified domestic mariners, in fact, impedes any expansion of the national-flagged fleet. Survey respondents also cited special requirements upon ships registered in Taiwan—restricting them from calling directly at PRC ports and mandating enrollment in multiple ship-classification societies—as major economic disincentives.[23]

As a whole, the ROC merchant fleet is dominated numerically by containerships and dry bulk carriers. Combined, they account for 50 percent of the ships and 73 percent of the total deadweight. The container sector forms the core strength of the fleet; Evergreen Marine Corporation alone owns seventy modern containerships, with a total capacity in excess of 280,000 TEUs.[24] Evergreen is the largest container owner-operator line in Asia and second in the world only to the A. P. Moller Group of Denmark (the parent company of Maersk Lines).[25] Not far behind, Taiwan's Yang Ming Marine Transport Company and Wan Hai Lines own container fleets of forty-seven (83,934 TEU) and forty (124,513 TEU) ships, respectively.

One hundred fourteen of Taiwan's containerships are modern, high-speed vessels with service speeds in excess of twenty knots; of these, forty-one are capable of sustained speeds of twenty-five knots or more.[26] Containerships are typically considered to have less strategic lift utility than roll-on/roll-off (RO/RO) vessels with respect to support of armed forces (since tanks, trucks, artillery

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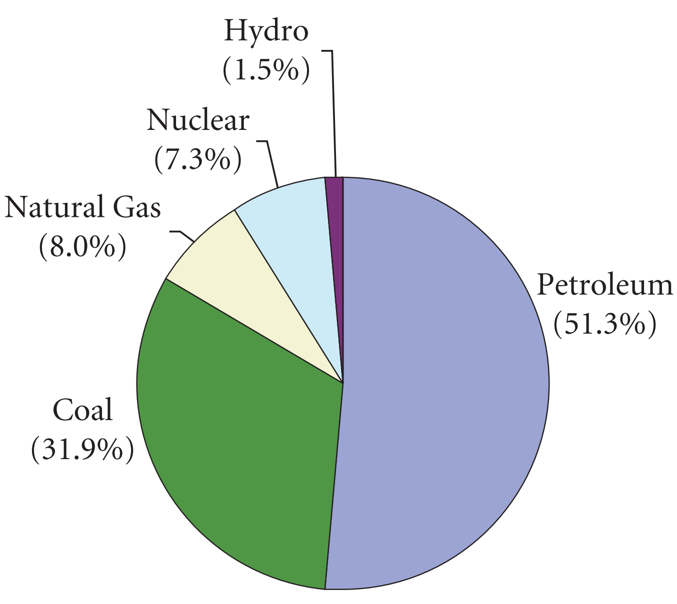
pieces, etc., do not fit neatly into standard shipping containers), but Taiwan's large, high-speed containerships could be valuable assets in resupply. High speed increases cargo throughput by minimizing delivery cycle times and reduces vulnerability to submarine attack. While it is typically uneconomical under normal peacetime conditions, both liquid and dry bulk cargoes can be containerized, and the ability to transport these cargoes at sustained speeds of twenty to twenty-five knots offers notable advantages.

CRITICAL CARGO CAPACITY: ENERGY AND FOOD SUPPLY

Maintaining a flow of energy to Taiwan through a PRC blockade would pose formidable challenges for ROC leadership. Taiwan is not blessed with abundant natural resources; aside from the electrical power produced by its three nuclear power plants and a small contribution from hydro power, virtually all of its energy is supplied from imported oil, coal, and natural gas.[27] An August 2005 U.S. Department of Energy study found that Taiwan has proven in-ground petroleum reserves of only four million barrels, yielding approximately 8,400 barrels per day in domestic production.[28] Since domestic demand consumes approximately a million barrels per day, this can hardly be counted as a strategic reserve. The inadequacy in natural reserves is offset by regulatory requirements that Taiwan's petroleum refiners maintain at least a sixty-day supply of product against potential supply disruptions. Additionally, the Taipei government established an oil stockpile in 2001, sized to meet domestic demand for thirty days.[29]

FIGURE 3
TAIWAN'S ENERGY SUPPLY STRUCTURE, 2005



Source: Taiwan Bureau of Energy, Ministry of Economic Affairs, "Energy Supply (by Energy Form), www.moeaec.gov.tw/.

This combined ninety days of gasoline and other petroleum-based products, however, offers no security for the industrial and power-generation sectors, which are heavily dependent on (imported) coal and natural gas. To protect them, an Energy Management Law mandates that an unspecified coal "safety level" be maintained in storage. Likewise, the Regulations for Implementing the Energy Management Law require utilities supplying natural gas to cities to maintain gas storage facilities, again without setting a minimum reserve

level.[30] Literature indicates that the Taiwan Power Company (TaiPower) maintains a sixty-day supply of coal and that the Chinese Petroleum Corporation (CPC) maintains a seven-day supply of liquefied natural gas in storage against disruptions.[31]

In the oil sector, 77 percent of Taiwan's imports come from the Middle East. The remaining 23 percent is imported from a variety of sources, primarily West African and Southeast Asian petroleum suppliers.[32] Virtually all of the imports are ultimately handled by one of two petroleum companies that dominate the Taiwanese market. One of them, CPC, held a monopoly over all aspects of Taiwan's petroleum market until deregulation in the late 1990s and WTO membership in 2001 allowed the Formosa Petrochemical Company to make inroads.

To supply their refining and distribution networks in Taiwan, both CPC and Formosa Petrochemical own and operate fleets of oil tankers.[33] Together, their forty tankers account for 65 percent of the ROC-owned tanker fleet (sixty-two ships) and 70 percent of its total deadweight (5.49 million tonnes).[34] Taiwan's tanker fleet includes seventeen very large crude carriers (tankers of 150,000–299,999 deadweight tonnes, commonly referred to as VLCCs), all of them owned by either Chinese Petroleum, Formosa Petrochemical, the Sincere Navigation Company, or the Taiwan Maritime Transportation Corporation. The remaining forty-five hulls comprise a variety of smaller shuttle tankers, chemical tankers, and petroleum product tankers. These smaller tankers would play a vital role in a blockade scenario, since the deep draft of fully laden VLCCs prohibits them from entering Taiwan's ports. VLCCs must discharge their cargo at one of Taiwan's two offshore moorings or transfer cargo to smaller shuttle tankers for delivery to port.[35]

Forty percent of Taiwan's total owned tanker fleet is domestically flagged, which represents only 30 percent of the total tanker deadweight (table 2). Of the seventeen VLCCs, only the six owned by CPC fly the Republic of China flag. This becomes potentially important with respect to the ROC tanker fleet's ability to meet the petroleum demand should international carriers abandon the Taiwan market in the face of a Chinese blockade.

As table 3 illustrates, the total ROC-owned tanker fleet has, theoretically, enough capacity to meet 105 percent of Taiwan's crude oil demand. Realistically, however, without foreign-flagged tankers only 31 percent of the current monthly oil import demand could be accommodated (table 4). Even including ROC-owned but foreign-flagged tankers, there would be little margin for losses in the fleet. Any losses, whether resulting from interdiction by blockaders, routine mechanical or operational casualties, or failure of political allegiance among owners or crews, would have immediate consequences for Taiwan's energy supply.

TABLE 2
TAIWAN'S MERCHANT FLEET BY SHIP TYPE AND FLAG OF REGISTRY

	ROC-Owned	ROC-Flagged		Total DWT (t)	ROC-Flagged	
		Number	%		DWT (t)	DWT (%)
Containerships	197	32	16	7,151,211	841,248	12
Oil tankers	62	25	40	5,490,698	1,620,767	30
LNG tankers	1	0	0	76,210	0	0
LPG tankers	6	0	0	134,053	0	0
Dry bulk carriers	186	25	13	13,639,555	2,253,998	17
General cargo carriers	130	20	15	1,113,150	71,838	6
Others	185	111	60	795,625	175,679	22
Total	767	213	28	28,400,502	4,963,530	17

Source: Compiled from Lloyd's Maritime Intelligence Unit, *Lloyd's Maritime Directory 2006,* pp. 978–93.

Note: Includes only vessels of 100 gross tons or more. Combination oil and dry bulk carriers are counted under the Oil Tanker category. All other combination carriers are counted as General Cargo Carriers. Bulk cement and woodchip carriers are counted as Others vice Dry Bulk Carriers. The unit (t) represents metric tonnes (1t = 1,000 kg = 0.98 long tons).

This lack of capacity margin is especially acute given the size of individual tankers. For example, the loss of Chinese Petroleum's VLCC M/T *Dar Yun,* at 262,618 tonnes deadweight, would take a 4.8 percent bite out of Taiwan's total fleet, 16.2 percent of the ROC-flagged crude oil transport capacity. German U-boats in World War II had to sink over fifteen of the T2-SE-A1 tankers of the day (16,613 tonnes deadweight each) to destroy as much British crude oil. Likewise, the loss of just five VLCCs would equal the gross tonnage U-boats claimed by sinking 144 ships in June 1942, their deadliest month in the entire war.[36]

The security of Taiwan's energy transport is even more tenuous in the liquefied natural gas (LNG) and liquefied petroleum gas (LPG) sectors. Following world energy market trends, the use of LNG and LPG is rapidly expanding in Taiwan. Over six million tonnes of LNG is imported annually (equating to over nine billion cubic meters of natural gas, once re-gasified), and demand is projected to increase as more industries shift to cleaner-burning fuels.[37] To meet this import demand there is currently only one LNG tanker in the ROC-owned merchant fleet—the Liberian-flagged M/T *Golar Mazo* is under long-term contract to supply LNG to Taiwan. The ship is co-owned by Golar LNG Company and CPC (a minority owner, with a 40 percent share).[38] The *Golar Mazo* is able to meet only 23 percent of the import demand; the remainder of the LNG shipping capacity is made up by foreign-owned LNG tankers.

Although the lack of additional ROC-owned LNG tankers represents a strategic vulnerability, it is striking that the *Golar Mazo* alone is able to meet roughly a quarter of the import demand of Taiwan. Consequently, on one hand, only four average-sized LNG tankers are required to be operating at any one time to meet Taiwan's total import demand. This is primarily due to the relatively close

TABLE 3
ROC MERCHANT FLEET CAPACITY FOR CRITICAL CARGOES: ALL ROC-OWNED SHIPS

	Annual Import Demand (Mt)	Avg. Monthly Import Demand (Mm^3)	Fleet Cargo Capacity (Mm^3)[a]	Max. Possible Cargo Import Cycles per Month[b]	Max. Possible Cargo Import Volume per Month (Mm^3)	Monthly Import Surplus (Deficit) (Mm^3)	Monthly Import Capacity as % of Demand
Crude oil	52.25	5.05	6.34	0.84	5.33	0.28	105
Liq. natural gas (LNG)	6.40	1.30	0.14	2.10	0.29	-1.01	23
Liq. petroleum gas (LPG)	0.89	0.14	0.19	0.84	0.16	0.02	114
Dry bulk cargoes (total)	69.22	7.08	17.05	1.12	19.10	12.02	270
Coal	60.37	6.04	-	-	-	-	-
Wheat grain	1.29	0.14	-	-	-	-	-
Corn	5.10	0.63	-	-	-	-	-
Soybeans	2.46	0.27	-	-	-	-	-

Sources: All ship capacity data derived from Lloyd's Maritime Intelligence Unit, *Lloyd's Maritime Directory 2006,* pp. 978–93*;* and Lloyd's Register–Fairplay Ltd., *Register of Ships 2006–2007.* Import demand data from the Taiwan Bureau of Energy, "Energy Balance Sheet 1-26.94"; and Council of Agriculture, "Food Balance Sheet."

Note: Mt = million metric tonnes. Mm^3 = million cubic meters.

a. Total dry bulk capacity includes bulk cargo capacity of applicable general cargo ships.

b. Based on average transit cycle time to primary import sources for each commodity. Assumes two-day load/unload time in port and 14-knot average transit speed.

geographic proximity of natural gas exporters to Taiwan; 58 percent of Taiwan's natural gas imports in 2004 came from Indonesia and 40 percent from Malaysia.[39] Where the distances to crude oil and LPG suppliers in the Middle East are such that each VLCC and LPG tanker can make less than one round-trip delivery to Taiwan per month, each LNG tanker can complete an average of 2.1 round trips per month.[40] On the other hand, the large proportion of Taiwan's LNG trade represented by each tanker makes them particularly high-value targets. LNG tanks worldwide are in high demand and scarce; the loss of any would quickly produce detrimental downstream effects on Taiwan's electrical system, which relies on natural gas for 23 percent of its total installed generation capacity.[41]

Although smaller than LNG in total volume consumed, liquefied petroleum gas also plays a key role in meeting Taiwan's energy needs. Unlike LNG, most of Taiwan's LPG supply goes to residential and commercial markets. (There are roughly ten thousand LPG-fueled vehicles on Taiwan's roads.)[42] To supply this demand there are six LPG tankers in the ROC-owned fleet, none of which fly the Republic of China flag. Despite its small numerical size, this fleet of six LPG tankers under normal circumstances meets 114 percent of Taiwan's monthly LPG import demand, providing a limited margin of excess capacity.

As with the LNG sector, the vulnerabilities for Taiwan in the LPG tanker sector arise from the small number of its ships in the trade, the fact that all are

TABLE 4
ROC MERCHANT FLEET CAPACITY FOR CRITICAL CARGOES: ROC-FLAGGED SHIPS ONLY

	Annual Import Demand (Mt)	Avg. Monthly Import Demand (Mm^3)	Fleet Cargo Capacity (Mm^3)[a]	Max. Possible Cargo Import Cycles per Month[b]	Max. Possible Cargo Import Volume per Month (Mm^3)	Monthly Import Surplus (Deficit) (Mm^3)	Monthly Import Capacity as Pct. of Demand
Crude oil	52.25	5.05	1.84	0.84	1.55	-3.50	31
Liq. natural gas (LNG)	6.40	1.30	0.00	2.10	0.00	-1.30	0
Liq. petroleum gas (LPG)	0.89	0.14	0.00	0.84	0.00	-0.14	0
Dry bulk cargoes (total)	69.22	7.08	2.62	1.12	2.93	-4.15	41
Coal	60.37	6.04	-	-	-	-	-
Wheat grain	1.29	0.14	-	-	-	-	-
Corn	5.10	0.63	-	-	-	-	-
Soybeans	2.46	0.27	-	-	-	-	-

Sources: All ship capacity data derived from Lloyd's Maritime Intelligence Unit, *Lloyd's Maritime Directory 2006,* pp. 978–93; and Lloyd's Register–Fairplay Ltd., *Register of Ships 2006–2007*. Import demand data from the Taiwan Bureau of Energy, "Energy Balance Sheet 1-26.94"; and Council of Agriculture, *Food Supply & Utilization Annual Report 2003*.

Note: Mt = million metric tonnes. Mm^3 = million cubic meters.

a. Total dry bulk capacity includes bulk cargo capacity of applicable general cargo ships.

b. Based on average transit cycle time to primary import sources for each commodity. Assumes two-day load/unload time in port and 14-knot average transit speed.

foreign-flagged, and the disproportionate capacity of individual vessels. Two of the LPG tankers operated by the Formosa Plastics Marine Company represent together 81 percent of the fleet's cargo capacity and are Taiwan's only vessels suited for efficient long-haul deliveries from LPG suppliers in the Middle East.[43]

Coal is the third pillar of Taiwan's imported energy supply. Surpassing natural gas, coal provides 29 percent of the generation capacity of Taiwan's electrical power grid, accounting for 76 percent of the 60.37 million tonnes of coal Taiwan imported in 2005.[44] Indigenous coal production ceased in 2001; Taiwan now purchases 10 percent of total coal imported worldwide, behind only the European Union (30 percent as a whole) and Japan (25 percent).[45] Of some strategic concern in a China-Taiwan scenario would be the fact that a plurality of Taiwan's imported coal supply comes from mainland China (41 percent in 2004), the remainder primarily from Indonesia (32 percent) and Australia (21 percent). This concern is offset by the overall strength of the global coal supplies; such large coal producers/exporters as Australia, Russia, Indonesia, and the United States could easily supply Taiwan's demand if supplies from the mainland were cut.[46]

When assessing the ability of Taiwan's merchant fleet to sustain coal imports in a crisis, however, the entire range of dry bulk imports must be considered. The same dry bulk carriers used to transport coal to Taiwan will also be in demand to carry critical agricultural bulk cargoes, especially wheat grain, corn products, and

soybeans. Whereas other food imports, such as beef, chicken, fruits, vegetables, and processed foods, are typically containerized, most cereals are transported in loose bulk form. Taiwan depends on considerable quantities of the latter, and they would compete with coal for dry bulk import capacity.

Food security is also a national security concern. Like energy, a substantial proportion of Taiwan's basic food supplies is imported and could be threatened in a China-Taiwan conflict. Changing demographics on traditional family farms and the opening of domestic agricultural markets to foreign imports following Taiwan's WTO membership have caused considerable shifts in food import-export trade patterns and, in turn, a review of Taiwan's food security and agricultural policies.[47]

Taiwan was self-sufficient in rice, fruits, vegetables, and meat through 2003, but the long-term health of these sectors is not assured; the farming population is shrinking, and trade protections are being dropped in accordance with WTO regulations. Furthermore, less than 1 percent of the demand for wheat and soybeans is met by domestic production. Domestic corn production is sufficient for human consumption but meets less than 1 percent of the nearly five million tonnes required for livestock feed. To make up domestic shortfalls, 5.10 million tonnes of corn, 2.46 million tonnes of soybeans, and 1.29 million tonnes of wheat grain are imported annually.[48] The United States is the primary supplier of these commodities, providing 99 percent of the corn cereals, 74 percent of the soybeans, and 71 percent of the wheat grain imported to Taiwan as of June 2005. Wheat from Australia (27 percent) and soybeans from Brazil (26 percent) make up the majority of the remainder.[49]

In order to support price stability and enhance food security, the ROC government regularly buys stocks of key agricultural products. The exact sizes of these stockpiles vary with market prices, but on average the government-held stocks roughly equate to a 4.5-month supply of rice, a 3.4-month supply of wheat, and a 1.8-month supply of corn.[50]

Although critical to sustaining Taiwan's food supply, the combined 0.74 million tonnes of imported corn, soybeans, and wheat each month is small compared to the five million tonnes of coal per month that would compete for shipping during a crisis scenario. Fortunately, the dry bulk sector that must carry the combined load is one of relative strength for the ROC merchant marine. It is the second largest by number of total ships owned (186) and leads the way in combined deadweight, at 13.64 million tonnes. It is largely a new and modern fleet, and it could readily handle the combined 5.77 million tonnes per month of combined coal and agricultural commodities if fully available in a crisis (see table 3). In fact, thanks to the short average delivery cycle times resulting from the availability of coal in Indonesia and both wheat and coal in Australia, total import delivery capacity is nearly triple the domestic monthly demand for

critical coal and agricultural bulk products. This large capacity of the total dry bulk fleet allows a significant margin for losses. Further, the total ROC-owned dry bulk fleet is sized to accommodate a wide variety of import and export dry bulk products that would not be considered vital in a China-Taiwan conflict. Bulk commodities such as iron ore and coke imports for steel production and exported quarry products like sand, gravel, and limestone aggregate are vital to the long-term health of the Taiwan economy but not critical to basic survival.[51]

Optimism arising from excess capacity in the dry bulk sector, however, must be tempered by realism. First, limiting the dry bulk fleet to critical cargoes would require convincing (or coercing) owners with vested financial interest in non-critical cargoes (such as China Steel Express Corporation, the shipping subsidiary of a major Taiwanese steel manufacturer) to shift away from them for the greater good of the island's populace. A second area of risk is inherent in flags of convenience, as shown in tables 2 and 4. Were ROC shipowners with foreign-flagged vessels to abandon Taiwan, the dry bulk capacity margin would vanish. In a worst-case scenario, the ROC-flagged dry bulk fleet could itself hope to meet less than half (41 percent) of Taiwan's import demand. This highlights the influence that the decisions of the ROC shipowners with foreign-flagged vessels would have on the ability of Taiwan to endure a blockade.

MARITIME TRADE INFRASTRUCTURE VULNERABILITIES

The concerns for Taiwan's merchant shipping industry's ability to sustain the nation in a time of war are not limited to the ships themselves. Its shore-based infrastructure is also subject to question, in regard to geography and redundant capacity. The concerns regarding geography are fairly evident and have been well covered elsewhere.[52] Taiwan has seven major ports: Kaohsiung, Keelung, Suao, Taipei, Taichung, Hualien, and Anping. Kaohsiung handles 67 percent of the total cargo volume, with Keelung second at 15 percent.[53] Kaoshiung is also the home of Taiwan's only shipyard capable of dry-docking large, deep-draft vessels, as well as of its most productive oil refinery.[54] The disproportionate concentration of facilities at Kaohsiung makes it an obvious target of any Chinese blockade, and the shallow-water bathymetry of its approaches would favor PLAN submarines and mines over Taiwan's ASW and mine clearance.

The infrastructure limitations become even more evident with regard to specific market sectors. For containerized commodities, the ports of Keelung, Taipei, and Taichung, with substantial container-handling capacity, could relieve pressure on Kaohsiung, but only Keelung and Taichung are deep enough (i.e., more than fifteen meters) to handle the largest modern containerships. None of the major container ports are on Taiwan's east coast, where they could be better sheltered from PRC blockade forces. In the energy sector, Chinese Petroleum's Ta-Lin-Pu

and Sha Lung offshore oil terminals are the only facilities capable of discharging VLCCs directly to shore, and Yungan has currently the country's only LNG receiving terminal.[55] As in the container sector, none of these major terminals are on Taiwan's east coast, and a single west-coast port, Taichung, handles a disproportionately high volume of Taiwan's coal imports (45 percent in July 2006).[56]

The equipment at Taiwan's ports poses vulnerability concerns as well. As a result of growth in the size of ships and an overall maritime trade industry push for greater efficiency, few of today's container or dry bulk carriers are capable of loading or unloading themselves. Only two of Taiwan's containerships with capacities over two thousand TEUs can do so, and only 42 percent of the ROC-owned dry bulk carriers are equipped with cranes or derricks. This fraction drops to only 6 percent for ROC-flagged bulk carriers alone. As is typical of the maritime industry worldwide, only smaller general-cargo carriers that serve local and regional feeder routes are equipped with their own cranes or derricks. Seventy-eighty percent of Taiwan's 133 general-cargo carriers are self-load/unload capable, but they are small, with a combined capacity of only 10,977 TEUs (roughly equivalent to two large containerships).[57]

All this makes the shore-based cargo-handling equipment an attractive target for air or ballistic-missile attack. Furthermore, much of the port terminal equipment is highly specialized and difficult to replace or work around. Container-handling cranes are mammoth pieces of machinery, and only they can reach efficiently across the thirty-to-forty-meter beams of large containerships. The same applies to sophisticated bulk cargo–handling gear, which can unload coal or the like at rates of up to two thousand tonnes per hour.[58] Unloading large container and bulk cargo ships with ad hoc, temporary cranes following an attack on port facilities would produce substantial delays, making ships more vulnerable to attack in port and slowing the flow of vital supplies into the country. Likewise, only the terminal at Yungan has the specialized equipment and storage facilities necessary for re-gasifying imported LNG, making it another tempting target for air strikes. Destruction of such key terminals would make the ability of Taiwan's merchant ships to supply them irrelevant.

POLICY IMPLICATIONS FOR TAIPEI, TOKYO, AND WASHINGTON

For the People's Republic of China, hitting a few of Taiwan's merchant ships, even nonlethally, may be enough to achieve the desired effect. The delays incurred in nursing damaged merchant ships into port (possibly under fire) and making repairs could remove enough capacity from service to have serious repercussions. Also, the spectacle of damaged, burning ships could give pause to owners or flag states of foreign-registered vessels; while Taiwan's energy and food import needs could theoretically be met by the total fleet of ROC-owned

shipping, it is not realistic to expect that this full capacity would be available in a China-Taiwan conflict. Any losses in tanker or dry bulk throughput capacity, whether due to actual loss of or damage to ships, their removal from the market by wavering resolution among their owners or crews, or disablement of port facilities will have severe consequences for Taiwan's ability to sustain the inflow of critical energy and food supplies.

Taiwan, then, occupies a tenuous position with respect to its merchant marine. Its policy makers would do well to continue and support efforts to ease regulatory and economic barriers to the expansion of the ROC-flagged merchant fleet. Such efforts might include education and training initiatives to increase the pool of native merchant mariners, as well as subsidies to encourage local shipowners to register under the Taiwan flag. Admittedly, the latter would be politically difficult both home and abroad, since it is often viewed as "corporate welfare" and would undercut WTO attempts to reduce shipping industry subsidies.[59]

Secondly, Taiwan might develop contingency plans for increasing the capacity of ROC-controlled shipping in an emergency. Relying on Taiwan's financial reserves to charter or purchase vessels from the international market has been proposed.[60] The former, however, is not a simple or guaranteed solution; vessels available for charter in peacetime may not be when tensions rise. This leaves outright purchase as an option, but as shipping market conditions fluctuate, ships of types that are particularly useful for national security may not be available in sufficient quantity when needed. Finally, since the Chinese would most likely control the timing of crisis escalation, they would be in position to charter or buy up available shipping before Taipei could do so.[61]

More realistically, Taiwan could increase the cargo throughput capacity of its east coast ports. Possible approaches include expansion and diversification of facilities at existing harbors, as well as the construction of additional artificial harbors like the new port at Ho-Ping.[62] Such improvements would, of course, entail making sure that the road and rail infrastructure is sufficient to move cargo inland efficiently from east coast ports should they become of primary importance during a conflict.

Relatedly, nontraditional and improvised methods for unloading cargo from merchant ships could be developed and rehearsed. They might involve provisions for ad hoc pierside facilities or small, crane-equipped ships for lightering larger deep-draft vessels that cannot enter Taiwan's small east coast ports. Likewise, the ability to salvage cargo from damaged vessels stranded offshore should not be underemphasized. Taipei might also investigate containerization of petroleum products and dry bulk cargoes. In that way, in extremis, the strength of the ROC containership fleet could be leveraged to alleviate strain on the tanker and dry bulk carrier sectors.

Finally, it would be important to ensure that plans for the naval control and protection of shipping are kept current and periodically exercised. These ends can be served by convoy exercises and regular hydrographic mapping of safety corridors in and out of ROC ports, in order to minimize the time required for mine-countermeasure efforts in an actual conflict.

Of course, it is by no means required or certain that either Japan or the United States would become directly involved in a China-Taiwan conflict, but at a minimum both nations would need to consider the larger impact on merchant shipping in the region. For instance, in view of the potential for spillover into a larger regional conflict, any U.S.-Japanese response to a Chinese blockade would necessarily involve naval cooperation and guidance for shipping (NCAGS) in the entire East Asian theater. Preparation for such a prospect is a lofty challenge, requiring extensive intergovernment and interagency coordination, since the existing NCAGS structure in the Pacific is less mature than in traditional NATO operating areas.[63] Nonetheless, it could capitalize upon the post-9/11 cooperation in multinational maritime domain awareness, as well as upon the NCAGS framework developed through Pacific and Indian Ocean Shipping Working Group's BELL BUOY exercises.[64]

A blockade is just one of the numerous coercive options, in a continuum of force, that the People's Republic of China could employ against Taiwan. It can exploit vulnerabilities of Taiwan's maritime trade industry to force capitulation without an all-out attack that would be risky in itself and might turn the island into rubble. But as others have concluded, the question ultimately boils down to Taiwan's will to resist.[65] If a blockade triggers a spirit of nationalism and resistance on Taiwan, the latent strengths of the ROC merchant marine could quickly emerge and validate Vice Admiral Ko Tun-hwa's declaration that "unless each farmer's house is bombed, there will still be enough vegetables, chickens, eggs, and pigs to live on. All of the buses and cars may be forced to stop running due to shortage of fuel, but people can still travel on foot or on bicycles, and the buses can still be towed by water buffalo or horses."[66]

But there is an equal chance that the sight of the first tanker burning off Kaohsiung will exacerbate Taiwan's sense of vulnerability, tear rifts in national identity and political allegiance, and incite panic on the island.[67] This possibility alone makes a blockade a completely viable option for the PRC. Furthermore, in the age of "CNN warfare," the sight of merchant ships burning may be enough to prevent shipowners from allowing their ships to enter the war zone, or, even more significantly, deter the American public from redeeming Taiwan's hope that U.S. forces will come riding over the horizon to their rescue.

NOTES

1. See David Shambaugh, *Modernizing China's Military* (Berkeley: Univ. of California Press, 2002), pp. 320–22, and "A Matter of Time: Taiwan's Eroding Military Advantage," *Washington Quarterly* 23, no. 2 (Spring 2000), pp. 119–33; Bernard D. Cole, *The Great Wall at Sea* (Annapolis, Md.: Naval Institute Press, 2001), pp. 154–58, and *Taiwan's Security* (New York: Routledge, 2006), pp. 32–51; Michael D. Swaine, *Taiwan's National Security, Defense Policy, and Weapons Procurement Process* (Santa Monica, Calif.: RAND, 1999), pp. 57–58; Martin L. Lasater, ed., *Beijing's Blockade Threat to Taiwan* (Washington, D.C.: Heritage Foundation, 1986); Eric McVadon, "PRC Exercises, Doctrine, and Tactics toward Taiwan: The Naval Dimension," in *Crisis in the Taiwan Strait,* ed. James R. Lilley and Chuck Downs (Washington, D.C.: National Defense Univ. Press, 1997), pp. 249–76; Michael A. Glosny, "Strangulation from the Sea? A PRC Submarine Blockade of Taiwan," *International Security* 28, no. 4 (Spring 2004), pp. 125–60; Thomas J. Christensen, "Posing Problems without Catching Up: China's Rise and Challenges for U.S. Security Policy," *International Security* 25, no. 4 (Spring 2001), pp. 5–40; Michael O'Hanlon, "Why China Cannot Conquer Taiwan," *International Security* 25, no. 2 (Fall 2000), pp. 51–86; Lyle Goldstein and William Murray, "Undersea Dragons," *International Security* 28, no. 4 (Spring 2004), pp. 161–96; and Andrew Erickson, Lyle Goldstein, and William Murray, "Chinese Mine Warfare: The PLA Navy's 'Assassin's Mace,'" manuscript, Naval War College, Newport, R.I., April 2006.
2. For a full discussion on global maritime trade and its strategic significance and vulnerabilities, see Sam J. Tangredi, ed., *Globalization and Maritime Power* (Washington, D.C.: U.S. Government Printing Office, 2002); and Andrew Forbes, ed., *The Strategic Importance of Seaborne Trade and Shipping: A Common Interest of Asia Pacific* (Canberra: Commonwealth of Australia, 2003).
3. United Nations Conference on Trade and Development [hereafter UNCTAD], *Review of Maritime Transport 2004* (New York: United Nations, 2004), p. 100, and *Review of Maritime Transport 2005* (New York: United Nations, 2004), p. 76. For container specifications, see "Equipment—Container Specifications," Evergreen Marine Corporation, www.evergreen-marine.com/tei1/jsp/TEI1_Containers.jsp.
4. Peter V. Hall, "'We'd Have to Sink the Ships': Impact Studies and the 2002 West Coast Port Lockout," *Economic Development Quarterly* 18, no. 4 (November 2004), pp. 354–67.
5. See Glosny, "Strangulation from the Sea?" p. 148.
6. Martin S. Navais and E. R. Hooton, *Tanker War: The Assault on Merchant Shipping during the Iran-Iraq Crisis, 1980–1988* (London: I. B. Tauris, 1996), p. 184.
7. See ibid., pp. 86, 127; John Newton, *A Century of Tankers: The Tanker Story* (Oslo: InterTanko, 2002), pp. 100–108; and Mike Ratcliffe, *Liquid Gold Ships: A History of the Tanker 1859–1984* (London: Lloyd's of London, 1985), pp. 152–66.
8. See Glosny, "Strangulation from the Sea?" p. 148.
9. Martin Doughty, *Merchant Shipping and War: A Study in Defense Planning in Twentieth Century Britain* (London: Royal Historical Society, 1982), p. 20. Causes for high wartime freight rates were hotly contested in Britain, but Doughty concludes that "profiteering was rather forced upon the shipowners than engineered by them, although, naturally, they did not resist this situation." Also see J. Russell Smith, *Influence of the Great War upon Shipping* (New York: Oxford Univ. Press, 1919), pp. 153–84, esp. 156–59.
10. See Glosny, "Strangulation from the Sea?" pp. 130, 136–37 (including note 52). Glosny uses the peacetime volume of 1,250 ships entering or departing ROC ports per week (5,000 ships/month) throughout his analysis. This is a fair estimate of normal *peacetime* shipping volume, as 3,357 vessels entered and 3,341 vessels departed ROC ports in July 2006. See ROC Ministry of Transportation and Communications [hereafter MOTC] Department of Statistics, *Monthly Statistics of Transportation and Communications,* "Table 6-2: Incoming and Outgoing Vessels in Harbors by

Nationality in Taiwan Area—July 2006," available at www.motc.gov.tw/en/.

11. Lloyd's Maritime Intelligence Unit, *Lloyd's Maritime Directory 2006* (London: Informa UK, 2006), p. 23. Ranked by owner nationality, Taiwan is tenth in the world by deadweight (page 22).
12. UNCTAD, *Review of Maritime Transport 2005,* p. 52. Deadweight data from *Lloyd's Maritime Directory 2006,* pp. 19–22. A tonne (t) is a metric ton (1 tonne = 1,000 kg = 0.98 long tons). Metric units are throughout this article unless otherwise noted.
13. The 767 vessels under ROC ownership correspond to the 766 vessels listed in *Lloyd's Maritime Directory 2006,* pp. 978–93, plus the M/T *Golar Mazo.* The *Golar Mazo* is only 40 percent owned by ROC-based interests but is included due to its significance as an LNG tanker involved in ROC trade.
14. *Lloyd's Maritime Directory 2006,* pp. 978–93. The "registered owner" is the individual or corporation listed on the ship's registration papers, not necessarily the ultimate owner of the vessel. See *Lloyd's Maritime Directory 2006,* p. 4, and Lloyd's Register—Fairplay Ltd., *Registry of Ships 2006–2007* (Surrey, U.K.: 2006), p. iv.
15. *Lloyd's Maritime Directory 2006,* pp. 978–93.
16. Article 25 of the ROC National Defense Act (2003) allows for the "requisition of private assets and their operators" in support of defense mobilization. Also see articles 20 and 29 of the ROC Shipping Law (1981, amended 2002) and the ROC Regulations for Administering Vessel Carriers and Vessel Chartering Operators (1962, amended 2002). For full texts, see ROC Ministry of Justice, *Laws and Regulations Database of the Republic of China,* available at law.moj.gov.tw/eng/.
17. See the ROC Seafarer's Law (1999, amended 2002) and Employment Service Act, ROC Ministry of Justice, *Laws and Regulations Database of the Republic of China,* available at law.moj.gov.tw/eng/.
18. The Philippines, Indonesia, Turkey, China, and India supply 60 percent of the world's merchant mariners. See UNCTAD, *Review of Maritime Transport 2004,* p. 111.
19. Henry S. Marcus et al., *Increasing the Size of the Effective United States Control Fleet* (Cambridge, Mass.: MIT Press, 2002), pp. 14–19, and Newton, *A Century of Tankers,* pp. 106–107.
20. For crew nationality on British-controlled shipping in World War II, see C. B. A. Behrens, *Merchant Shipping and the Demands of War* (London: Her Majesty's Stationery Office [hereafter HMSO], 1955), pp. 157, 179–80.
21. See ibid., pp. 154–77, and Robert Earle Anderson, *The Merchant Marine and World Frontiers* (New York: Cornell Maritime, 1945), pp. 102–10.
22. "Water Transportation," Ministry of Transportation and Communications, www.motc.gov.tw/en/.
23. Cheng-Chi Chung and Cherng-Chwan Hwang, "Analysis on Vessel Registration and Operational Performance of Bulk-Shipping Firms," *Proceedings of the Eastern Asia Society for Transportation Studies* 5 (2005), pp. 633–36. For more on the dual-classification issue, see "ROC Regulations for Supervising Classification Societies" (1963, amended 1976), Ministry of Justice, *Laws and Regulations Database of the Republic of China,* law.moj.gov.tw/eng/. For general information on ship classification issues, see "IACS," International Association of Classification Societies, www.iacs.org.uk/index1.htm.
24. *Lloyd's Maritime Directory 2006,* pp. 981–82. For a breakdown of total vessels operated (rather than owned) by ROC-based interests, see Lloyd's Register—Fairplay Ltd., *World Shipping Directory* 2006–2007 (Exeter, U.K.: 2006), pp. 1-701 to 1-702.
25. UNCTAD, *Review of Maritime Transport 2005,* p. 64.
26. *Lloyd's Maritime Directory 2006,* pp. 981–82.
27. A fourth nuclear power plant is under construction. Its two reactors are expected to become operational in 2009 and 2010. See "Facilities Development and Construction," Taiwan Power Company, www. taipower.com.tw/indexE.htm.
28. U.S. Energy Dept., "Country Analysis Briefs: Taiwan," Energy Information Administration, www.eia.doe.gov/emeu/cabs/taiwan.html.
29. Petroleum Administration Law, October 2001, art. 24. For full text, see the Ministry of

Justice, *Laws and Regulations Database of the Republic of China.* For further discussion, see Masahiro Atsumi, *Taiwan's Energy Security Issues: Domestic Energy Policies and Transporting Energy by Sea*, IIPS Policy Paper 300E (Tokyo: Institute for International Policy Studies, November 2003). Of note, refiner-held petroleum reserves are a common practice in Asia. Japan and South Korea follow similar regulatory practices.

30. Taiwan Bureau of Energy, "Laws and Regulations," Ministry of Economic Affairs, www.moeaec.gov.tw/English/laws.asp.

31. For discussion of coal stockpile, see William Chandler, *Taiwan Electric Power Futures,* Report PNWD-3123 (Richland, Wash.: Pacific Northwest National Laboratory, December 2001), p. 4. For natural gas, see Michael Watson, ed., *Gas Storage in the APEC Region: Development of Commercial Structure* (Tokyo: Asia Pacific Energy Research Centre, 2002), pp. 36–37.

32. Taiwan Bureau of Energy, "Petroleum," Ministry of Economic Affairs, *Energy Situation in Taiwan, ROC,* www.moeaboe.gov.tw/ePublication/; and U.S. Energy Dept., "Country Analysis Briefs: Taiwan."

33. FPC's vessels operate under the Formosa Plastics Marine Corporation, a subsidiary of the Formosa Plastics Group. See "Organization and Operational Structure," Formosa Plastics Group, www.fpg.com.tw/html/eng/org.htm.

34. *Lloyd's Maritime Directory 2006,* pp. 978–93.

35. The limitation on VLCCs entering port is not unique to Taiwan. Very few ports are deep enough to accommodate a fully laden VLCC. For detailed description of ROC port facilities, see Lloyd's Register—Fairplay Ltd., *Ports and Terminals Guide 2005–2006* (Exeter, U.K.: 2004), pp. 4-1 to 4-17.

36. S. W. Roskill, *The War at Sea 1939–1945* (London: HMSO, 1956), vol. 2, pp. 104, 485. German U-boats accounted for 144 Allied and neutral ships lost in June 1942, totaling 700,235 gross tonnes. The average ROC-owned VLCC is 140,000 grt each. For additional information on T2 tankers of World War II, see Newton, *A Century of Tankers,* pp. 80–82, and *The T2 Tanker Page,* www.t2tanker.org/.

37. Allison Ball, Jane Mélanie, and Karen Schneider, *Natural Gas in Taiwan: Prospects for LNG*, Australian Bureau of Agricultural and Resource Economics eReport 06.1 (Canberra: Commonwealth of Australia, 2006), available at www.abareconomics.com.

38. See "Vessel Information," Golar LNG, www.golar.com/Vessel_Info.html; and Chinese Petroleum Corporation, *Chinese Petroleum Corp. 2006* (Taipei: 2006), p. 40, corporate annual report available at www.cpc.com.tw.

39. Taiwan Bureau of Energy, "Natural Gas," Ministry of Economic Affairs, *Energy Situation in Taiwan, ROC*, www.moeaboe.gov.tw/ePublication/.

40. The monthly delivery cycle used is based on time-distance calculation along normal trade routes. These results are supported by the fact that the M/V *Golar Mazo* made twenty-eight round-trip deliveries between Indonesia and Taiwan in 2005. See *Chinese Petroleum Corp. 2006,* p.40.

41. Natural gas–fired power plants consumed 75 percent of the total natural gas supply in Taiwan in 2004. Ninety-two percent of the total natural gas supply (9.78 billion cubic meters) is imported; 8 percent is indigenously produced. See Taiwan Bureau of Energy, "Natural Gas."

42. The goal is to increase the number of LPG-fueled cars in Taiwan by eighteen thousand over the next three years. See ROC Ministry of the Interior, "EPA Announces Subsidy of NT$30,00 for Car Owners," available at www.moi.gov.tw/english/.

43. For further data on Taiwan's LPG supplies, see "Asia, North America Lead Growth of NGL, LPG Trade," PennWell Petroleum Group, www.pennwellpetroleumgroup.com/Articles/; U.S. Energy Dept., "Country Energy Data Report," Energy Information Administration, www.eia.doe.gov/emeu/world/country/cntry_TW.html.

44. For a breakdown of electrical power generation capacity in Taiwan through 2004, see Taiwan Bureau of Energy, "Electricity," Ministry of Economic Affairs, *Energy Situation in Taiwan, ROC*, www.moeaboe.gov.tw/ePublication/. For more recent (2005) statistics on volume and utilization of coal imports, see Taiwan Bureau of Energy, "Energy Balance Sheet

1-26.94 (2005)," Ministry of Economics, www.moeaec.gov.tw/ePublication/energy_balance/main/default.htm.

45. UNCTAD, *Review of Maritime Transport 2005,* p. 13.

46. U.S. Energy Dept., *Annual Energy Outlook 2006* (Washington, D.C.: Energy Information Administration, 2006), pp. 98–102, and *International Energy Outlook 2006* (Washington, D.C.: Energy Information Administration, 2006), pp. 51–61.

47. Beatrice Knerr, "Food Security versus WTO Membership in Taiwan," School of Oriental and African Studies, 2005, www.soas.ac.uk/taiwanstudiesfiles/EATS2006/abstract/panel5knerrabstract.pdf.

48. All food commodity data derived from Council of Agriculture, Executive Yuan, ROC, "Food Balance Sheet—2003," *Food Supply and Utilization Annual Report,* eng.coa.gov.tw/./list.php?catid=9351, and "Quantity of Agricultural Imports," *Monthly Report of Agriculture,* eng.coa.gov.tw/. The *Food Supply and Utilization Annual Report* of 2003 is the last comprehensive report available from the Taiwan Council of Agriculture that breaks down imported agricultural cereal product by individual commodities. Its statistics are consistent with conservative monthly combined cereal import quantities in later reports and are used here in all calculations.

49. Council of Agriculture, Executive Yuan, ROC, "Top 10 Agricultural Import Product by Value and the Supplying Countries," June 2005, *Monthly Report of Agriculture,* eng.coa.gov.tw/.

50. Calculations based on stock and consumption data in U.S. Agriculture Dept., *Taiwan Grain and Feed Annual 2006*, Agricultural Service Grain Report TW6013 (Washington, D.C.: 2006), available at www.fas.usda.gov/grainfiles/200606/146197902.pdf.

51. For a summary of Taiwan's other import and export commodities, see Government Information Office, Republic of China (Taiwan), "Economy" and "Transport and Communications," December 2005, *Taiwan Yearbook 2005,* www.gio.gov.tw/taiwan-website/5-gp/yearbook/.

52. See Michael McDevitt, "The Security Situation across the Taiwan Strait," *Journal of Contemporary China* (August 2004), pp. 411–25, esp. 411–13; Shambaugh, "A Matter of Time," pp. 122–23; and Glosny, "Strangulation from the Sea?" pp. 129–30.

53. Government Information Office, "Transport and Communications."

54. For dry-dock data, see Lloyd's Register—Fairplay Ltd., *Ports and Terminals Guide 2005–2006,* pp. 4-1 to 4-17. For oil refinery capacities, see *Chinese Petroleum Corp. 2006,* pp. 14–15; and Taiwan Bureau of Energy, "Petroleum."

55. Additional capacity for discharging VLCCs is being built at Mailiao (also on Taiwan's west coast), for the oil refinery there (Lloyd's Register—Fairplay Ltd., *Ports and Terminals Guide 2005–2006,* pp. 4–13). Additionally, a second LNG receiving terminal is being built by the CPC at the port of Taichung; it is to reach full operation by the end of 2009 (*Chinese Petroleum Corp. 2006,* pp. 22–23).

56. MOTC Department of Statistics, *Monthly Statistics of Transportation and Communications,* "Table 6-20: Volume of Cargo Handled by Commodities and Harbors in Taiwan Area—July 2006," www.motc.gov.tw/en/.

57. All statistical data in this paragraph is based on analysis of *Lloyd's Maritime Directory 2006,* pp. 981–82, and Lloyd's Register—Fairplay Ltd., *Register of Ships 2006–2007.*

58. Lloyd's Register—Fairplay Ltd., *Ports and Terminals Guide 2005–2006,* pp. 4-1 to 4-17. The 2,000-tonne/hour unloading capacity cited is for the coal handling gear at berths 101 and 102 in Taichung Harbor.

59. For WTO shipping issues, see UNCTAD, *Review of Maritime Transport 2005,* pp. 83–84; and "Maritime Transport" and associated links, World Trade Organization, www.wto.org/english/tratop_e/serv_e/transport_e/transport_maritime_e.htm.

60. See Glosny, "Strangulation from the Sea?" pp. 148–49.

61. This was pointed out by John F. Tarpey over twenty years ago at a roundtable discussion held by the Heritage Foundation regarding the PRC blockade threat. With China's sizeable economic growth since then, this possibility has only increased. See Lasater, *Beijing's Blockade Threat to Taiwan,* p. 22.

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62. The artificial harbor at Ho-Ping is twenty nautical miles north of Hualien on Taiwan's east coast. It opened in 2000. See Lloyd's Register—Fairplay Ltd., *Ports and Terminals Guide 2005–2006,* pp. 4-2 to 4-3.

63. For U.S. and NATO NCAGS doctrine and organization, see U.S. Navy Dept., *Naval Control and Guidance for Shipping (NCAGS),* NTTP 3-07.12 (Washington, D.C.: 24 October 2003); and North Atlantic Treaty Organization, *Naval Control and Guidance for Shipping Manual (NCAGS),* ATP-2(B), vol. 1 (Brussels: NATO Standardization Agency, May 2004).

64. See the PACIOSWG website, www.pacioswg.org, and Bill Hoogendoorn, "The Protection of Seaborne Trade: An Australian Perspective," in *The Strategic Importance of Seaborne Trade and Shipping: A Common Interest of Asia Pacific,* ed. Andrew Forbes (Canberra: Commonwealth of Australia, 2003), pp. 185–90.

65. See Glosny, "Strangulation from the Sea?" and Cole, *Taiwan's Security*, pp. 167–68.

66. Ko Tun-hwa, as quoted in Lasater, *Beijing's Blockade Threat to Taiwan,* p. 12. Vice Adm. Ko Tun-hwa served as the ROC's vice minister of national defense and deputy general chief of staff.

67. For more on divisions in ROC public opinion, will to resist, and rifts in civil-military relations, see Richard C. Bush, *Untying the Knot: Making Peace in the Taiwan Strait* (Washington, D.C.: Brookings Institution, 2005), pp. 122–28; Cole, *Taiwan's Security,* pp. 135–51, 171–72; and Michael D. Swaine, *Deterring Conflict in the Taiwan Strait: The Successes and Failures of Taiwan's Defense Reform and Modernization Program,* Carnegie Paper 46 (Washington, D.C.: Carnegie Endowment for International Peace, 2004).