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ORIGINAL ARTICLE

# Jones Act: protectionist policy in the twenty-first century

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## Abstract

The Jones Act is a protectionist policy intended to address cabotage, seamen's rights, and US maritime interests. This study estimates the economic impact of the Jones Act and coastwise restrictions from multiple economic points of view for 2006–2017. The building cost differential between domestic and foreign produced vessels represents a welfare loss to US consumers ranging from $5.2 billion to $6.6 billion, or $59.0 million to $74.6 million per Jones Act vessel. Average daily crew costs make up around 68% of the overall operating costs for domestic ships, compared to 35% for foreign-flagged vessels, and generate an additional per-vessel annual crew cost of $4.1 million, or an estimated annual loss of approximately $383 million for the Jones Act fleet. Differences between domestic and foreign-flagged ship operating costs (which include crew) average $923 million each year, with a total deficit for the entire period of $11.1 billion. Distributing that deficit across state-level imports finds that Texas accounts for $2 billion of the total, followed by Louisiana ($1.8 billion) and California ($1 billion). On a per capita basis, Louisiana is highest at $384, followed by Hawaii ($100). An analysis out of all domestic shipping reveals that Louisiana is again disproportionately disadvantaged. Breaking down the deficit by commodities finds crude petroleum and petroleum products most heavily affected.

**Keywords** Jones Act · Maritime policy · Protectionism · Cost–benefit analysis (CBA)

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## 1 Introduction

Protectionist policy has been used by countries for centuries as a part of shipping policy to control international navigation through commercial and military means. In large measure, these policies follow from a recognition that shipping provides the basic prerequisite and building block of international trade and is a key source of influence in world politics (Iheduru, 1996, p. 21). Adam Smith (1776) justified protectionist policies in regards to industries that provide defense for a country, but recognized such policies restrict foreign commerce and growth. Smith argued that restrictive policies are not warranted to support an ailing industry.

The United States has participated in protectionist shipping policies since its birth.[1] Jantscher (1975, p. 1) observes that "there are few industries in the United States in whose affairs the federal government has played so active a role as the merchant shipping industry", and emphasizes the government's active interest in a national merchant marine since the early days of the USA. Prior to WWI, the US maritime industry operated under an 1817 law entitled, *An Act Concerning the Navigation of the United States.* This act required all domestic trade to be conducted by US-flagged vessels. After WWI, Congress legislated the *Merchant Marine Act* of 1920, popularly known as the Jones Act, which provides the foundation of current cabotage laws. The purpose of the legislation is to maintain a merchant fleet with the capability of assisting the military interests of the United States. The Jones Act states:

> It is necessary for the national defense and for the proper growth of its foreign and domestic commerce that the United States shall have a merchant marine of the best equipped and most suitable types of vessels sufficient to carry the greater portion of its commerce and serve as a naval or military auxiliary in time of war or national emergency, ultimately to be owned and operated privately by citizens of the United States; and it is declared to be the policy of the United States to do whatever may be necessary to develop and encourage the maintenance of such a merchant marine… (Legal Information Institute, n.d.)

Inherent in the law is the restriction of foreign vessels from engaging in domestic trade, a restriction that served to protect the domestic fleet and ensure that US-flagged vessels are available and war ready. According to the World Economic Forum (2013), the Jones Act represents some of the most restrictive cabotage policies among industrialized nations and in the world. While the Jones Act includes *domestic build* and *origin of crewmen* requirements (Papazivas and Gardner 2009), an alternative mechanism to provide for wartime defense exists under the Maritime Security Program (MSP). The MSP allows foreign-built ships to be US-flagged (and

[1] In 1789, the US Congress imposed duties on goods transported on foreign vessels. Under the Navigation Acts of 1817, foreign vessels were first restricted from domestic commerce (as in the Jones Act), and those restrictions were extended to passenger vessels in 1886. US build requirements were first legislated in 1905. See U.S. Maritime Administration (n.d. a).

hence engage in domestic commerce), so long as the ships will be made available if called upon by the US government.

The present analysis explains the specifics of the Jones Act and ships covered, with parallel coverage of the MSP, and an overview of current US-flagged ships by vessel type. Next, prior studies of the Jones Act are reviewed, before turning to a new analysis of the costs of the Act, with particular emphasis on its effects for individual US states. A brief summary with implications follows.

## 2 Specific protections under the Jones Act

The Jones Act addresses three areas of cabotage, seamen's rights, and protection of US maritime interests. Cabotage is the first area addressed by the Jones Act, and protecting domestic coastal trade from foreign vessels. Specifically, the Act restricts the carriage of goods or passengers between US ports to vessels built and flagged by the USA, thus creating a protectionist barrier. Many foreign countries also exercise cabotage in varying degrees, amongst them Brazil and South Korea, receiving heavy protection from the state (Sapir and Lutz 1981; USDOT 1991).

The Act provides protection to American seamen in several ways. The first is a provision known as "personal injury to or death of seamen" and provides injured sailors the ability to make claims and collect from shipowners. The operative provision in the *Merchant Marine Act* of 1920, formerly known as 46 U.S.C. §30104, states, "Any sailor who shall suffer personal injury in the course of his employment may, at his election, maintain an action for damages at law, with the right to trial by jury, and in such action all statutes of the United States modifying or extending the common-law right or remedy in cases of personal injury… [shall apply]". This provision provides seamen an important capacity for legal recourse. Seamen are granted the right to bring legal action against shipowners, extending the rights set forth under international maritime law. Another protection provided to seamen is the *origins of crewmen* requirement, whereby a ship must be operated by a crew comprised of 75% US citizens. This requirement may maintain wages above international competition. Holland (2015) claims that American crews cost nearly 4.5 times more than foreign crews, and wages make up nearly 80% of the operating cost difference between the two.

The main rationale for the Act is to support the defense interests of the USA. "Virtually all protectionist laws pertaining to the merchant marine, including cabotage laws, are presented and vigorously defended in a national defense context" (Smith 2004, p. 16). Debate over the Act involves a variety of contradictory claims with regard to labor unions, national defense, economic viability, international trade, the maritime industry, proper responses to emergencies and natural disasters, the future of the merchant marine, and the cost of living, including the price of gasoline (Hill 2013). Proponents of protectionist barriers, to maintain a competitive advantage in shipbuilding, advance the first part of the national defense argument. Frittelli (2003) outlines the need for support to maintain a commercial shipbuilding industry, including not only a skilled labor pool of welders and fitters, but also the industrial infrastructure that can be called upon when our national security is threatened.

**Table 1** US-flagged, privately owned vessels, 2016

| Type of vessel | Number of vessels in the fleet | Jones Act eligible | Militarily useful | Militarily useful and Jones Act eligible |
|---|---|---|---|---|
| Ro/Ro | 28 | 9 | 28 | 9 |
| Tanker | 57 | 51 | 45 | 39 |
| Containership | 62 | 23 | 62 | 23 |
| General Cargo | 19 | 8 | 13 | 2 |
| Dry bulk | 5 | 2 | 0 | 0 |
| Total number of vessels | 171 | 93 | 148 | 73 |
| Share of total vessels (%) | – | 54.4 | 86.5 | 42.7 |

*Source* U.S. Maritime Administration (2016)

Although the Act serves to protect domestic production, both public and private shipyards have declined in the last century. Following the establishment of domestic public shipyards in 1767, the US industry grew to 15 public shipyards during WWII, and then declined to five public domestic shipyards as of 2011 (Colton 2011). Out of these five active public domestic shipyards, maintenance and decommissions are the only duties performed on the existing naval fleet. Out of the large private shipbuilders, 10 companies operate 20 active shipyards in the USA, and produce the Navy's big ships and submarines. According to Francois et al. (1996), domestic shipyard jobs and economic output are a part of the shipbuilding industry for which the Jones Act provides protection. Based on the authors' mid-range estimates (Francois et al. 1996), the Jones Act protects about 1800 jobs in shipyards (shipbuilding and repair), while ensuring an additional $163 million of direct, domestic activity in these sectors, at an annual economic cost of roughly $3.0 billion. The protected production represents less than 0.5% of total output in shipyards.

The second part of the national defense logic is to sustain a maritime fleet to support the military interests of the USA. Ferguson (1994) cites three specific military objectives: (1) having a commercial fleet that can support the military in emergencies, (2) having a reserve fleet for the same purpose, and (3) having a shipbuilding capability to supply new ships in wartime. The first two military objectives pertain to the existing stock of ships capable of aiding US military interests. According to Whitehurst (1985, p. 16), "Intermodal vessels, particularly roll-on/roll-off (RO/RO) vessels, are highly valued by the navy as defense assets, and smaller tankers, of 80,000 deadweight tons or less, are considered militarily useful".

Table 1 provides published data by the United States Maritime Administration on the existing stock of privately owned ships sailing under the US flag, and provides the foundation of the dataset used later in our economic impact analysis.

The 2016 report lists a total of 171 ships in the fleet; 54.4% (93 ships) are Jones Act eligible. The number of ships that are militarily useful and Jones Act eligible is 73 and makes up 42.7% of the total ships in the fleet. Less than half of all Jones Act eligible ships are military useful. A breakdown of the overall fleet shows a majority of the vessels being militarily useful. Nationalizing the fleet might be an option in emergency situations, given that 86.5% of all privately owned ships under the US

**Table 2** Vessels covered under the MSP, 2016

| Type of vessel | Number of vessels in MSP | Average age by vessel type |
|---|---|---|
| Ro/Ro | 16 | 2000 |
| Tanker | 2 | 2010 |
| Containership | 34 | 2002 |
| General cargo | 6 | 2009 |
| Dry bulk | 0 | – |
| Total number of vessels | 58 | – |
| Average age of MSP fleet | – | 2002.8 |

*Source* U.S. Maritime Security Program (2016)

flag are considered militarily useful. One aspect that remains unclear in the literature and in general is whether the sailors who operate Jones Act eligible vessels are qualified to operate those vessels in a time of war.

## 3 The maritime security program

Established in 1996, the Maritime Security Program (MSP) is another program aiming to provide privately owned ships for military purposes and was broadened by the signing of the *National Defense Authorization Act* (NDAA) in 2003. The Act requires consultation between the Secretary of Transportation and the Secretary of Defense, to establish a fleet of 60 active ships that are commercially viable, militarily useful, and privately-owned, to meet national defense and other security requirements. The MSP provides a fixed retainer payment to US-flag vessel owners in exchange for providing the Department of Defense with assured access to their vessels for related transportation services and infrastructure during times of war, national emergency, or when otherwise deemed necessary by the Secretary of Defense (U.S. Maritime Administration and PriceWaterhouseCoopers LLP 2011). An additional benefit to the carriers is the MSP's expedited flag-in process, which reduces the time to flag vessels entering MSP under the US registry. Based on industry consultations of impediments, carriers indicated that MSP vessels are automatically enrolled in the Voluntary Intermodal Sealift Agreement (VISA), which provides the military with assured access to carrier capacity while minimizing the impact on the carriers' normal operations (U. S. Maritime Administration and PriceWaterhouseCoopers LLP 2011). According to the Maritime Administration's website, "The MSP maintains a modern US-flag fleet providing military access to vessels and vessel capacity, as well as a total global, intermodal transportation network. This network includes not only vessels, but logistics management services, infrastructure, terminals facilities and US citizen merchant mariners to crew the government owned/controlled and commercial fleets." Membership in the program requires privately flagged vessels make their ships available during times of war or national defense. One of the main differences between the Jones Act and the MSP is that the latter does not have a domestic build requirement. Vessels covered under the Jones Act are not covered under the MSP, and vice versa. Table 2 provides the

composition of vessels that make up the MSP fleet. Out of the 17 vessels in the privately owned US-flagged fleet (Table 1), 58 are under the MSP. All 58 ships in the MSP fleet were constructed in foreign ports.

Putting together the information provided in Tables 1 and 2, there are a total of 151 ships (93 plus 58) which are covered under either the Jones Act or MSP. Out of the remaining 20 privately owned vessels under the US flag, 17 vessels are considered military useful. The three ships that are not considered militarily useful are a part of the VISA program. It seems these 20 vessels are a third tier of vessels available to the military if needed after the vessels in the Jones Act and the MSP.

## 4 Recent composition of US non-military ships

The number of non-military ships in the US maritime industry has witnessed a historic decline. In 1946, there were more than 2300 American cargo ships carrying nearly half of all imports and exports involving the USA and 45 years later, there were only 360 such vessels in service. By 2000, there were only 250 vessels, hauling only three percent of American imports and exports, and in 2007, the US ocean-going fleet was down to less than 200 (Hill 2013). Furthermore, the drop was not accompanied by a decline in international trade; quite the opposite (Hill 2013).

The most recent statistical snapshot of the US water transportation sector was released in 2013, covering three areas: trade indicators, fleet indicators, and macroeconomic indicators. Table 3 tracks the composition of the privately owned merchant fleet from 2006 to 2011, detailing the composition changes of the fleet by vessel type and further breaking down each type of vessel into Non-Jones Act eligible or Jones Act eligible. This table shows whether the merchant fleet was growing or contracting and how the composition of a particular type of vessel changed in regards to Jones Act eligibility. Over the 6-year period, the entire fleet decreased in size by 6.6%, with the largest decreases in Integrated Tug/Barge (66.7%) and Roll-on/Roll-off tonnage (20.4%). The Jones Act eligible ocean-going fleet decreased by 17.1%. A detailed breakdown by vessel type shows each sector experienced a negative percentage change over the 6-year period except for dry bulk vessels, which had no change. Integrated Tug/Barge and Roll-on/Roll-off ships realized the largest decreases in Jones Act eligibility, with decreases of 66.7 and 40.0%, respectively. One of the main rationales for supporting the Jones Act is to maintain a commercial shipbuilding industry with a skilled labor pool and an industrial infrastructure. Contractions in the overall fleet and reductions in the number of vessels eligible for the Jones Act indicate an ailing industry and a weakened capacity to support the domestic shipbuilding industry.

## 5 Prior studies examining the economic impact of the Jones Act

Although dated, several empirical studies have addressed the economic effects of the Jones Act. The United States International Trade Commission (ITC) (2002) has provided the most comprehensive reports and estimates of the different effects of the

**Table 3** US-flag, oceangoing, privately-owned merchant fleet, 2011

| Vessel type | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | % Ch. 06-11 |
|---|---|---|---|---|---|---|---|
| Containership | 73 | 70 | 78 | 76 | 80 | 79 | 8.2 |
| Non-Jones act eligible | 45 | 43 | 50 | 49 | 53 | 53 | 17.8 |
| Jones act eligible | 28 | 27 | 28 | 27 | 27 | 26 | −7.1 |
| Dry bulk | 12 | 12 | 12 | 12 | 12 | 12 | 0.0 |
| Non-Jones act eligible | 8 | 8 | 8 | 8 | 8 | 8 | 0.0 |
| Jones act eligible | 4 | 4 | 4 | 4 | 4 | 4 | 0.0 |
| General cargo | 20 | 20 | 19 | 19 | 18 | 20 | 0.0 |
| Non-Jones act eligible | 12 | 12 | 10 | 10 | 11 | 13 | 8.3 |
| Jones act eligible | 8 | 8 | 9 | 9 | 7 | 7 | −12.5 |
| Integrated tug/barge (ITB) | 12 | 12 | 12 | 9 | 9 | 4 | −66.7 |
| Non-Jones act eligible | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 |
| Jones act eligible | 12 | 12 | 12 | 9 | 9 | 4 | −66.7 |
| Roll-on/roll-off | 49 | 43 | 43 | 42 | 40 | 39 | −20.4 |
| Non-Jones act eligible | 29 | 27 | 27 | 29 | 27 | 27 | −6.9 |
| Jones act eligible | 20 | 16 | 16 | 13 | 13 | 12 | −40.0 |
| Tanker | 63 | 63 | 61 | 59 | 62 | 60 | −4.8 |
| Non-Jones act eligible | 6 | 7 | 6 | 6 | 6 | 6 | 0.0 |
| Jones act eligible | 57 | 56 | 55 | 53 | 56 | 54 | −5.3 |
| Total oceangoing fleet | 229 | 220 | 225 | 217 | 221 | 214 | −6.6 |
| Non-Jones act eligible | 100 | 97 | 101 | 102 | 106 | 107 | 7.0 |
| Jones act eligible | 129 | 123 | 124 | 115 | 115 | 107 | −17.1 |

Self-propelled, cargo-carrying vessels of 1000 gross tons and above. Fleet as of January 31, 2011

*Source* U.S. Maritime Administration (2013)

Jones Act on areas of the economy. In 1991, 1993 and 1995, the ITC report entitled *The Economic Effects of Significant U.S. Import Restraints* found the net annual economic impact in terms of gains from repealing the Act to range from a high of $9.8 billion in 1991 to a low of $2.8 billion in 1995. In a 2002 ITC report, a general equilibrium model was employed to discern the effects of the Jones Act under two different regime changes: complete liberalization of the policy, and partial liberalization where only the build requirement is lifted for ships operating in the domestic trade. Under complete liberalization of the policy, the resulting net welfare change would be an increase of $656 million, while partial liberalization would result in a welfare increase of $261 million. A breakdown of estimated gains and losses indicates water transportation (including coastwise and other sectors) gains of $253 million, with downstream sectors and the rest of the US economy gaining $321 million, imports in the shipbuilding industry rising by $271 million, while the removal of the domestic build requirement (only) would cost the US shipbuilding industry $503 million in annual revenue losses (U.S. ITC 2002).

Foreign-flag carriers are estimated to have a 59% cost advantage based on a weighted average of cost differentials for different types of cargo (U.S. ITC 2002).

An inherent problem with these estimates is the inability to identify domestic shipping rates for international shipowners, as they are excluded from competing in the domestic market. Furthermore, changes to cabotage policies are likely to change the operating cost structure of both foreign- and domestic-flagged vessels, and the limitation lies in the inability to identify the counterfactual cost structure after the policy has been changed. The ITC attempts to remedy this issue by analyzing the complete liberalization regime under two extreme cost differential scenarios. Under the first scenario, foreign shipowners hold a cost advantage of 80% (foreign shipowners operate at 80% of the cost of US shipowners), and in the second scenario foreign shipowners hold a cost advantage of 90%. Scenario one results in a net annual welfare gain of $262 million, and scenario two results in a net annual welfare gain of $119 million (U.S. ITC 2002).

The last part of the ITC analysis examined how the two regimes alter job losses or gains in specific sectors of the economy. Complete liberalization is found to decrease full-time jobs in water transportation by 8340, decrease full-time shipbuilding jobs by 3140, and increase downstream sector jobs in the rest of the US economy of 7230 (U.S. ITC 2002). Under the partial liberalization regime, the ITC finds coastwise transportation would lose 810 full-time jobs, other water transportation sectors would gain 710 full-time jobs, the shipbuilding industry loses 4,000 full-time jobs, and the downstream sectors in the rest of the US economy gain 2450 full-time jobs (U.S. ITC 2002). Ferguson (1994, p. 30) makes an important distinction in regards to labor changes: "There is, of course, a greater number of shoreside employees involved in everything from administration of the ocean carriers to providing services and goods to them and their shippers. While shoreside employees make up a large share of the ocean carrier sector, the origins of crew members requirement decreases labor competition, leading to inflated wages, which ultimately increases the costs of transporting goods domestically. An analysis by the U.S. Maritime Administration and PriceWaterhouseCoopers LLC (2011), finds 67% of survey respondents revealed the "Citizen Crew Requirement" negatively impacted their decision to register under the US flag (2011).

Francois et al. (1996) break down the gains and losses by industry sector for the case of complete liberalization of the Jones Act. Their study finds the greatest absolute increases in domestic output under a mid-range scenario in the water sector to be $1477 million, petroleum $158 million, chemicals $103 million, air transportation $91 million, plastics $40 million, lumber $32 million, and steel sectors $50 million. Employment loss is concentrated in the cabotage, consulting, shipbuilding, repair sectors and other service sectors. Employment gains for full-time workers are found in water, agriculture, trade, durable and non-durable manufacturing sectors. Furthermore, the authors find the resulting trade effects from the removal of the Jones Act: imports decline or remain virtually unchanged in all other sectors of the US economy, while exports increase in all other sectors except for shipbuilding. In a separate study, Lewis (2013) finds coastal water transport in the United States would be approximately 61% cheaper, and consumers using these services would stand to gain a minimum of ≈ $578 million annually in economic benefits following liberalization of the Jones Act.

Barriers restricting foreign vessels from trading in the US coastwise trade enable domestic firms to operate under decreased competition. "The Jones Act effects a transfer from US consumers of water transportation services to US maritime carriers, allowing the latter to charge rates substantially above comparable world prices. Estimates of the size of this transfer range in the billions of dollars" (Francois et al. 1996). Consumers in Hawaii, Alaska, and Puerto Rico bear a substantial portion of the burden, as they experience higher prices due to cabotage laws (Frittelli 2003). The Federal Reserve Bank of New York (2012) and the World Economic Forum (2013) concluded that Puerto Rico's economic development is hindered as a result of the Jones Act. According to Holland (2015), the Jones Act raises the cost of gasoline by 15 cents per gallon in Puerto Rico, and Puerto Rico's state-run authority pays 30% more than it otherwise would for liquefied natural gas. Furthermore, Holland (2015) claims that shipping prices, due to the Jones Act, have elevated the cost of living in Hawaii to nearly 12% above the next most expensive state in the union, Connecticut. The Act has also been shown to have negative effects on different commodities. In the timber trade, Austin and Darr (1975) find the Jones Act adds up to $15 to $18 per thousand board feet to the cost of shipping lumber from the Pacific Northwest to the East Coast. A representative from the road and salt industry complained that the mid-Atlantic states were importing road salt from Chile and Mexico rather than buying from mines in Ohio and Louisiana due to cheaper transport costs (U.S. House of Representatives 1996).

## 6 Prior studies: costs of the Jones Act

Protectionism reduces cost efficiency and innovation in the long-run. Critics of the Jones Act claim the protectionist restrictions drive up shipping costs, increase energy costs, and stifle competition and innovation, leading to a loss of competitiveness in international markets (Slattery et al. 2014).

Cost differentials related to protectionism show a significant difference between American-manned and American-built ships compared to foreign ships. Carriers participating in the PwC (2011) survey rated maintenance, repair, and shipyard costs as the second biggest driver of higher US-flag operating costs (behind crew costs). Eighty-nine percent of survey participants indicated that the *ad valorem* duty negatively impacts their decision to flag under the US registry. In fact, carriers stated that foreign shipyards are still used for American-flag ship repairs since the cost of having repairs performed overseas and paying the duty is often lower than the cost of having the repairs carried out in US shipyards.

Protectionism has been shown to increase differentials in shipping costs as well as energy costs. A shipment of oil originating in Texas costs about $6 per barrel to ship to the northeast region of the USA, while shipments to Canada and Europe cost $2 per barrel (Holland 2015). Sussman (2014) claims that the average daily cost for vessels operating between California and Alaska is about $11,500 for manning alone, compared to $2000 for a foreign crew. In terms of shipbuilding costs, it is estimated that the expense of constructing a Jones Act vessel in America is nearly four

times what it would cost for the construction of an Asian-built ship (Slater 2011).[2] Smith (2004, p. 68) finds that since "older vessels generally pay higher insurance, and American vessels tend to be substantially older than those of international fleets, there is a significant increase in insurance costs. However, ships of comparable [*sic*] age would pay comparable insurance." Capital costs are significantly higher for American-built ships, with the lowest differential in cost between an American-built ship and a foreign-built ship estimated at 50% (U.S. ITC 1999). Differentials in construction costs, insurance and capital costs can be contributing factors to increased shipping costs, but as the U.S. Government Accountability Office (GAO) (2013) states, "freight rates are determined by a number of factors, including the supply of vessels and consumer demand in the market, as well as costs that carriers face to operate, some of which (e.g., crew costs) are affected by Jones Act requirements".

## 7 Economic impact analysis

This section of the analysis addresses the economic impact of the Jones Act and how coastwise restrictions affect US citizens and states. To analyze the effects of the Jones Act, this study combines data from the United States Maritime Administration on the existing stock of privately owned ships sailing under the US flag, the Administration's Office of Shipbuilding Costs, along with a comprehensive maritime database with vessel specific data from MarineTraffic (see Appendix 1 for sources and methods). The combined dataset provides a range of detailed information for each vessel in the fleet, including the type of vessel, dead weight tonnage, and the build price for the specific type of vessel based on foreign or domestic production.

One of the requirements of the Jones Act is for each vessel in the program to be constructed in a US shipyard. While the official total for Jones Act vessels in the fleet is 93, the dataset includes four vessels that violate the domestic build requirement. The four vessels are the *Costal Trader*, *Coastal Venture*, *Mississippi Enterprise*, and *National Glory*, which were constructed in South Korea, Denmark, Japan, and Poland, respectively. The domestic build violation is thus accounted for, to avoid any bias in the estimates of construction costs for foreign and domestic vessels. This has brought the final total of Jones Act eligible ships that were constructed in US ports to 89 vessels. The entire US fleet of privately owned ships under US flag consists of 171 vessels, with 89 constructed in US ports and 82 constructed in foreign ports. Figure 1 provides a map of the world displaying where ships in the dataset were constructed.

Our economic impact analysis begins by applying the construction cost data to the specific type of vessel and accounting for changes in prices. Consistent with earlier studies, the average build price for a US-built vessel ranges from a low estimate of $92.92 million to a high of $113.54 million, relative to foreign-built vessels, which are estimated to range from $34.61 million to a high of $39.78 million. For example, in 1982, a 70,000 DWT tanker constructed in the USA was estimated to

[2] As suggested above, it may be the case that South Korean ships are subsidized by the government.

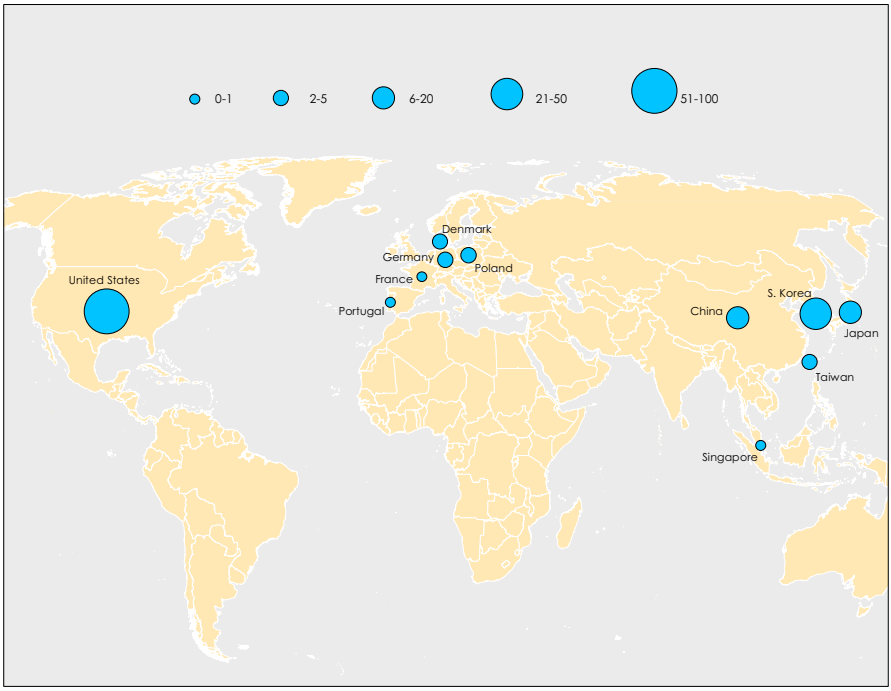


**Fig. 1** Location and number of vessels constructed

cost $85 million, compared to $35.2 million if foreign-built. US constructed vessels are found to be 268–285% more costly to build as a percentage of vessels built in foreign shipyards. Extending these construction costs across all 89 vessels in the Jones Act fleet yields two interpretations. The first is an interpretation of benefits derived from the Jones Act, as one of the policy directives is to promote the domestic shipbuilding industry. Through this lens, the costs for domestic production across the entire Jones Act fleet are estimated to range from $8.3 billion to $10.1 billion. In the second interpretation, consider the counterfactual of what the costs would be for the Jones Act fleet if the domestic production requirement did not exist and vessels were constructed in foreign yards. The cost of producing the Jones Act fleet in foreign yards ranges from $3.1 billion to $3.5 billion.

The cost differential between the two scenarios can be interpreted either as a welfare gain of $8.3 billion to $10.1 billion for domestic producers or a welfare loss ranging from $5.2 billion to $6.6 billion for domestic consumers. Dividing the welfare loss by the number of Jones Act vessels yields a cost to the private shipping companies ranging from $59 million to $74.6 million per vessel.

Next, consider the Jones Act protections provided to seamen, through the crewmen origin requirement, where a ship must be operated by a crew comprised of 75% US citizens. Figure 2 shows the average daily crew costs by vessel type. After applying the daily crew costs to the specific type of vessels in the dataset, foreign-flag vessels are found to operate at an average daily crew cost structure that is 81% cheaper.

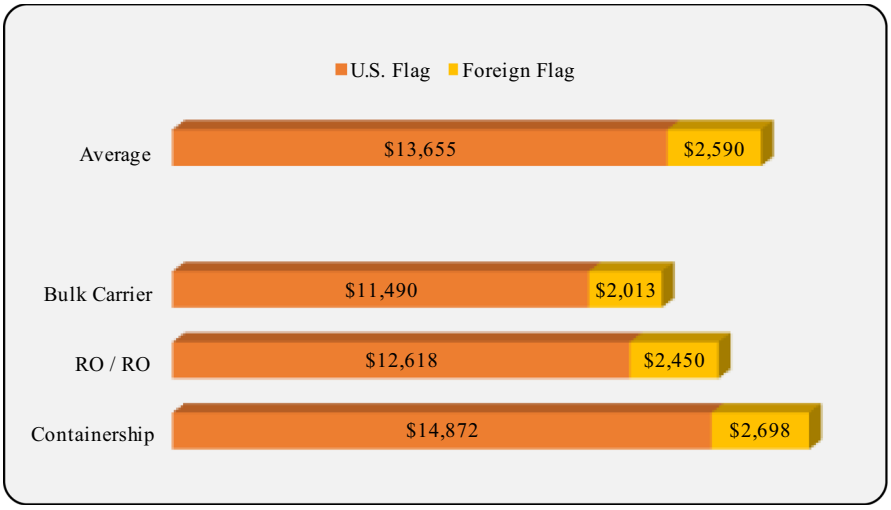


**Fig. 2** Average daily crew costs by vessel type. *Notes* US-flag costs are weighted by the number of vessels in each operator's US-flag fleet. Tanker costs are omitted to protect operator confidentiality. Average Costs are applied to these vessels. *Source* U.S. Maritime Administration (2011)

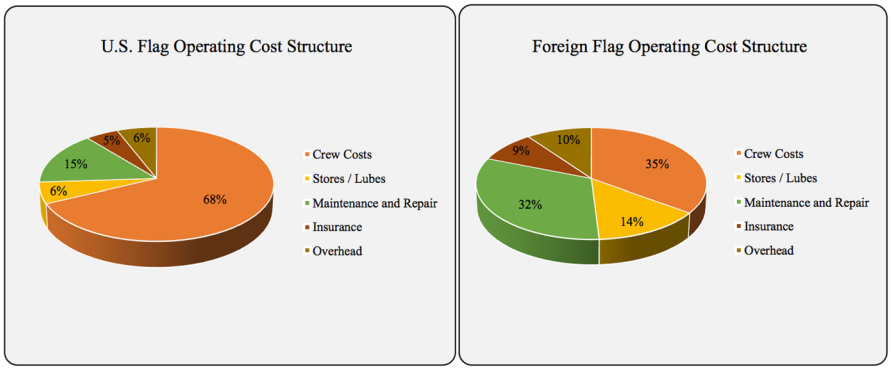


**Fig. 3** Operating cost structure differentials. *Source* U.S. Maritime Administration (2011)

By separating Jones Act vessels from the rest of the fleet, the cost differentials imposed on the vessels by the Act's *origin of crew* requirement can be estimated. The economic intuition will differ depending on who the stakeholder is. Extrapolating information from Fig. 2, Jones Act vessels incur an annual cost from the crew requirement of $4.1 million, and when applied to all 93 vessels in the Jones Act fleet the estimated loss is approximately $383 million. Crew costs constitute a large fraction of the overall costs for operating each vessel. Figure 3 illustrates the cost structure differentials between US- and foreign-flagged vessels. Average daily crew costs make up around 68% of the overall operating costs compared to 35% for foreign-flagged vessels.

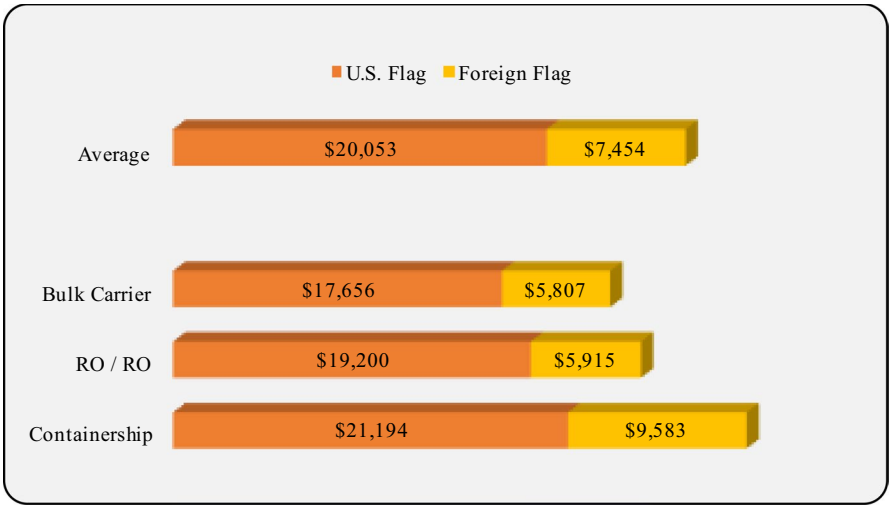


**Fig. 4** Average daily operating costs by vessel type. *Notes* US-flag costs are weighted by the number of vessels in each operator's US-flag fleet. Tanker costs are omitted to protect operator confidentiality. Average costs are applied to these vessels. *Source* U.S. Maritime Administration (2011)

The second part of the analysis presents estimates of how coastwise restrictions, including both Jones Act and MSP ships, effect US citizens and specific states.

Daily operating costs per vessel type are provided in Fig. 4.

Translating the average daily operating costs to annual estimates, and averaging across all ships, yields a domestic yearly operating cost of $7,319,345, and a foreign yearly operating cost of $2,720,710, with a per ship annual difference of $4,598,635. Multiplying this figure by the number of domestic ships in operation each year and averaging yields an annual deficit in operating costs of $923 million; the operating cost differential for the entire period is $11.1 billion.

Data were collected from the U.S. Army Corps of Engineers' Institute for Water Resources Navigation Data Center on the tonnage of all intra US shipments of commodities from origin port to destination port in the USA and territories from 2006 to 2017. Dividing the annual figures by the tonnage shipped on domestic ships each year, and averaging across 2006–2017, yields a deficit per ton of $0.52243.

Multiplying the deficit per ton by tons shipped domestically to each state yields an estimate of deficit by state, which can be reported as both average annual figures or cumulatively. Partial results are presented in Table 4 (see Appendix Table 8 for complete results), with a heat map of the average annual deficit in Fig. 5. The deficit is very unevenly distributed, with a high of close to $2 billion over the entire period for Texas, and with Louisiana not far behind, before dropping substantially for California and states below.

The state deficit can also be viewed in per capita terms, for the average burden per person across the entire time period, assuming the burden is dispersed evenly across the population of each state. Figure 6 presents these results. Table 5 presents the deficit per person in the 10 states most affected (for complete results,

**Table 4** Average annual and cumulative deficit from 2006 to 2017

| Rank | State | Average annual deficit | Cumulative deficit |
|---|---|---|---|
| 1 | Texas | $163.61M | $1.96B |
| 2 | Louisiana | $148.08M | $1.78B |
| 3 | California | $82.95M | $1.B |
| 4 | New Jersey | $50.89M | $.61B |
| 5 | Florida | $41.53M | $.5B |
| 6 | Ohio | $36.7M | $.44B |
| 7 | Pennsylvania | $34.19M | $.41B |
| 8 | Washington | $27.57M | $.33B |
| 9 | Indiana | $25.52M | $.31B |
| 10 | Alabama | $25.5M | $.31B |

*Source* Authors

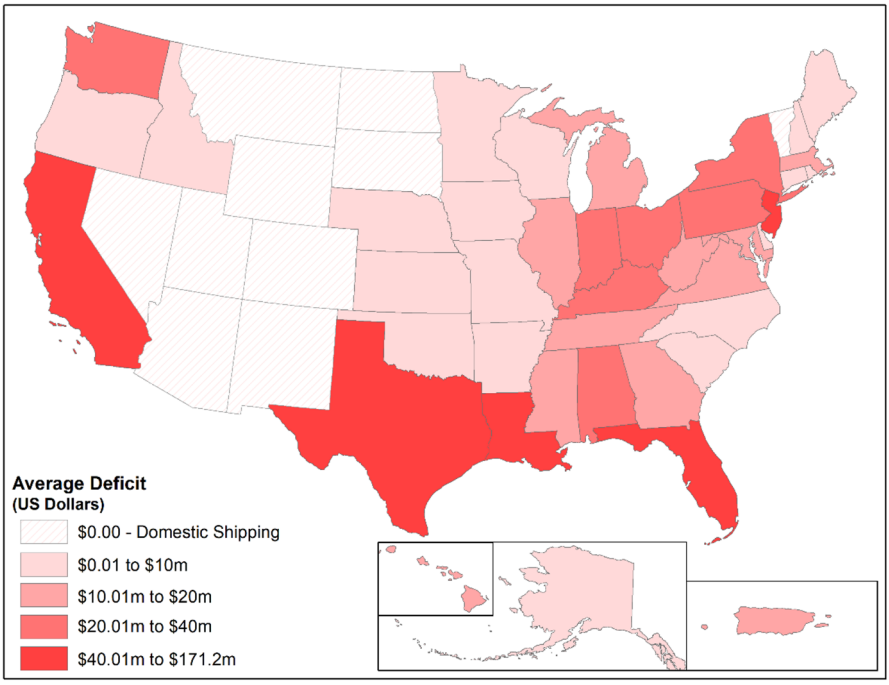


**Fig. 5** Average annual deficit by state (2006–2017). *Source* Author calculations

see Appendix Table 9). Individuals in Louisiana are affected most significantly per capita, at close to $400 per person for the period. After Louisiana, estimates are still above $60 per person for the next nine states, albeit 18 states have single dollar or zero estimates (see Appendix Table 9). Nonetheless, weighting all states equally, the mean deficit is above $33 per person.

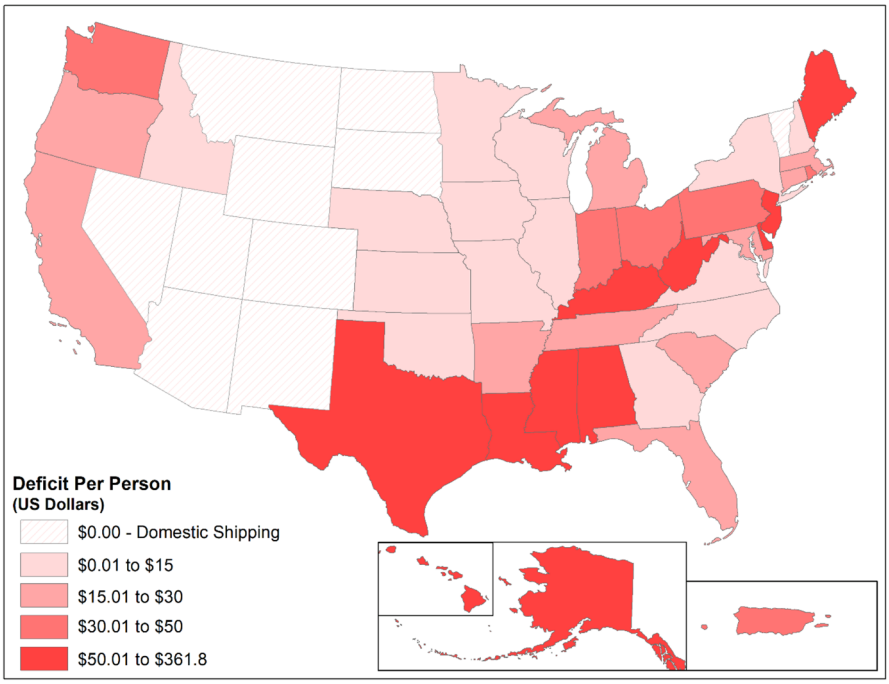


**Fig. 6** Deficit per person per state. *Source* Author calculations

**Table 5** Deficit per person (2006–2017)

| Rank | State | Deficit per person |
|---|---|---|
| 1 | Louisiana | $384.18 |
| 2 | Hawaii | $99.74 |
| 3 | West Virginia | $90.97 |
| 4 | Delaware | $86.86 |
| 5 | Maine | $78.29 |
| 6 | Alaska | $77.91 |
| 7 | Texas | $74.23 |
| 8 | New Jersey | $68.62 |
| 9 | Kentucky | $66.37 |
| 10 | Alabama | $63.31 |

*Source* Author calculations

Next consider how much of each state's imports are impacted by the coastwise restrictions. Table 6 provides partial results for domestic tons at the state of destination (see Appendix Table 10 for complete results), the proportion of those tons out of all shipments received (including foreign), and the total tons at the state of destination. Note that the state of origin is ignored to prevent double-counting of the same shipments. The table is ordered according to total tons received.

**Table 6** Domestic and foreign shipping by state of destination, 2006–2017 (measured in millions of tons)

| State | Domestic tons | Proportion domestic | Total tons |
|---|---|---|---|
| Texas | 1125.96M | 0.300 | 3757.99M |
| Louisiana | 2205.21M | 0.648 | 3401.41M |
| California | 363.87M | 0.191 | 1905.4M |
| New Jersey | 288.04M | 0.246 | 1168.99M |
| Florida | 538.16M | 0.564 | 953.87M |
| Ohio | 766.68M | 0.909 | 843.08M |
| Pennsylvania | 455.59M | 0.580 | 785.35M |
| Washington | 356.2M | 0.562 | 633.28M |
| Indiana | 566.92M | 0.967 | 586.11M |
| Alabama | 363.88M | 0.621 | 585.8M |

*Source* Author calculations

**Table 7** Commodity analysis

| Rank | Commodity name | Average annual shipping cost differential | Total shipping cost differential |
|---|---|---|---|
| 1 | Crude petroleum | 210.9M | 2530.3M |
| 2 | Petroleum products | 199.2M | 2390.3M |
| 3 | Coal, lignite, and coal coke | 102M | 1223.5M |
| 4 | Sand, gravel, shells, clay, salt, and slag | 82.8M | 993.9M |
| 5 | Food and food products | 70.3M | 844M |

*Source* Author calculations

Texas is above Louisiana in terms of total tonnage, but Louisiana has a proportion domestic double that of Texas, implying that the adverse effects of the Jones Act are felt more significantly in Louisiana, as this is also reflected in the domestic tonnage figures. Of these 10 states, New Jersey is affected the least in terms of the proportion domestic.

Finally, the analysis considers how different commodities are impacted by the coastwise restrictions. Table 7 (see Appendix Table 11 for complete results) separates the total number of commodities shipped from 2006 to 2017 between US ports by commodity code and determines the operating cost differential between shipping goods on domestic ships relative to a counterfactual of shipping with foreign ships, both on an annual and total basis for the 2006–2017 period. The average shipment cost differential impacts the Crude Petroleum industry the most, where on average shipping crude petroleum between US ports would be more than $2.5 billion cheaper if shipped on foreign ships over the entire period, or over $200 million on an annual basis. The high impact the coastwise restrictions have on the crude petroleum industry helps explain

the high costs imposed upon Texas and Louisiana, which the study has already established.

## 8 Conclusion

The economic effects of the Jones Act run contrary to the congressional majorities previously stated resolution, although the military security rationale was not analyzed in this paper. The Act has not been able to effectively support the domestic shipbuilding market, as the private and public sector have seen large decreases in the number of American, public and private, shipyards. Earlier studies suggest that protected production represents half a percent of total shipyard production, such that repealing the Jones Act would only reduce domestic shipbuilding by half a percentage point (Francois et al. 1996). Previous studies find the annual economic costs from the protectionist policy far exceed protected domestic activity. From a national defense perspective, only 42.7% of the fleet is Jones Act eligible and militarily useful, although the Act was invoked as recently as the early 1990s during the first Gulf War and, like most insurance policies, is not intended or designed for frequent utilization.

This study investigated and estimated the economic impact of the Jones Act and coastwise restrictions from multiple economic points of view. Focusing on the Jones Act and MSP vessels in the fleet of privately owned vessels under the US flag, production was split between 89 vessels produced in US shipyards, and 82 vessels produced in foreign shipyards. The split in production may be an indication of private shipping companies' preference for cheaper vessels on the foreign market when the *domestic build* requirement is absent. Depending on the stakeholder, the cost differential between domestic or foreign production represents a welfare gain or loss ranging from $5.2 billion to $6.6 billion. Furthermore, domestic build requirements for Jones Act vessels impose a cost per vessel to private shipping companies ranging from $59.0 million to $74.6 million. When analyzing the *origin of crewmen* requirement, the analysis finds Jones Act vessels incur an additional per vessel annual crew cost of $4.1 million and the entire fleet incurs an estimated annual loss of approximately $383 million.

The attention of the analysis then focused on the overall effects cabotage restrictions have on states and individuals. Forty-three states out of 53 (includes District of Columbia, Guam, and Puerto Rico) are estimated to have an annual and cumulative deficit resulting from the coastwise restrictions, with Louisiana and Texas accounting for one-third of the absolute difference, and Louisiana bearing a per capita burden that is many times larger than that of any other state or territory. Our analysis then estimates by how much shipping into each state is affected by coastwise restrictions, finding Louisiana to be most adversely affected, both in terms of absolute tons shipped and the proportion of domestic shipping out of all shipping. Last, an analysis of commodities revealed that the domestic cost burden most significantly affects crude petroleum and petroleum products.

This study sought to disentangle and analyze the different dimensions of cabotage policies in the USA. While the study did not analyze the Jones Act directive of fulfilling national defense objectives, we did analyze the economic impact of cabotage policies in the USA. The evidence suggests that Jones Act restrictions protect domestic shipbuilding and crew at the expense of economic efficiency and consumers. Furthermore, coastwise restrictions impose inequitable costs upon states and individuals.

Finally, although we did not estimate benefits from the Jones Act, there are solid reasons to believe that the cost estimates understate its adverse effects. While relevant estimates would be useful in the future, the analysis here clearly demonstrates an adverse economic impact from the Act.

## Appendix 1: Construction, daily crew and operating cost calculations

### Construction cost calculations

Construction costs are calculated as follows. To the best of our knowledge the only detailed construction cost data comes from a report by the Office of Technology Assessment (1983), where a table is cited by the U.S. Maritime Administration, Office of Shipbuilding Costs, "Construction Cost Estimates for United States and Foreign-Flag Vessels".

Construction Costs in 1982 are provided for Tanker and Dry-Bulk vessels depending on 25,000, 70,000, 120,000 and 265,000 dead weight tons for domestic and foreign produced vessels. The analysis accounts for a lower bound inflation of 1% and an upper bound of 2% for year-on-year price changes. Construction costs are then matched to each ship by the type of ship, year of construction and the size of the ship, based on dead weight tons. For containerships, Ro–Ro, and general cargo ships, an average of the Tanker and Dry-bulk prices is applied.

**Table 22.–Typicai U.S.- and Foreign-"Ship Construction Costs-1982 (miiiions of doiiars)**

| | *25,000* dwt | *70,000* dwt | *120,000* dwt | *265,000* dwt |
|---|---|---|---|---|
| ***Tanker*** | | | | |
| United States . . . . . | 59.0 | 85.0 | 109.0 | 189.0 |
| Foreign . . . . . | 23.0 | 35.2 | 44.3 | 75.7 |
| | 25,000 dwt | 60,000 dwt | 120,000 dwt | 150,000 dwt |
| ***Dry-bulk*** | | | | |
| United States . . . . . | 52.0 | 83,0 | 107.0 | 119.0 |
| Foreign . . . . . | 19.6 | 33.0 | 42.6 | 47.0 |

SOURCE: U.S. Maritime Administration, Office of Shipbuilding Costs, "'Construction Cost Estimates for United States and Foreign-Flag Vessels."

*Source* Office of Technology Assessment (1983)

**Table 8** Average annual and cumulative deficit (2006–2017)

| Rank | State | Average annual deficit | Cumulative deficit |
|---|---|---|---|
| 1 | Texas | $163.61M | $1.96B |
| 2 | Louisiana | $148.08M | $1.78B |
| 3 | California | $82.95M | $1.B |
| 4 | New Jersey | $50.89M | $.61B |
| 5 | Florida | $41.53M | $.5B |
| 6 | Ohio | $36.7M | $.44B |
| 7 | Pennsylvania | $34.19M | $.41B |
| 8 | Washington | $27.57M | $.33B |
| 9 | Indiana | $25.52M | $.31B |
| 10 | Alabama | $25.5M | $.31B |
| 11 | Kentucky | $24.31M | $.29B |
| 12 | New York | $20.76M | $.25B |
| 13 | Michigan | $18.26M | $.22B |
| 14 | Tennessee | $16.27M | $.2B |
| 15 | Illinois | $15.03M | $.18B |
| 16 | Mississippi | $14.13M | $.17B |
| 17 | West Virginia | $14.06M | $.17B |
| 18 | Maryland | $12.33M | $.15B |
| 19 | Hawaii | $11.67M | $.14B |
| 20 | Puerto Rico | $10.72M | $.13B |
| 21 | Georgia | $10.44M | $.13B |
| 22 | Massachusetts | $10.33M | $.12B |
| 23 | Virginia | $9.82M | $.12B |
| 24 | Maine | $8.67M | $.1B |
| 25 | South Carolina | $7.43M | $.09B |
| 26 | Connecticut | $7.07M | $.08B |
| 27 | Oregon | $6.94M | $.08B |
| 28 | Delaware | $6.7M | $.08B |
| 29 | Missouri | $5.86M | $.07B |
| 30 | Wisconsin | $4.8M | $.06B |
| 31 | Alaska | $4.77M | $.06B |
| 32 | Arkansas | $4.53M | $.05B |
| 33 | North Carolina | $4.43M | $.05B |
| 34 | Minnesota | $4.39M | $.05B |
| 35 | Rhode Island | $4.17M | $.05B |
| 36 | Iowa | $2.02M | $.02B |
| 37 | New Hampshire | $1.58M | $.02B |
| 38 | Oklahoma | $1.32M | $.02B |
| 39 | Guam | $.2M | $.B |
| 40 | Kansas | $.14M | $.B |
| 41 | District of Columbia | $.09M | $.B |
| 42 | Nebraska | $.02M | $.B |

**Table 8** (continued)

| Rank | State | Average annual deficit | Cumulative deficit |
|---|---|---|---|
| 43 | Idaho | $.02M | $.B |
| 44 | Arizona | $0 | $0 |
| 45 | Colorado | $0 | $0 |
| 46 | Montana | $0 | $0 |
| 47 | Nevada | $0 | $0 |
| 48 | New Mexico | $0 | $0 |
| 49 | North Dakota | $0 | $0 |
| 50 | South Dakota | $0 | $0 |
| 51 | Utah | $0 | $0 |
| 52 | Vermont | $0 | $0 |
| 53 | Wyoming | $0 | $0 |

$$\text{Build price as a percentage of foreign built ships} = \frac{\text{United States build price}}{\text{Foreign build price}}$$

US constructed vessels are found to be 268–285% more costly to build as a percentage of vessels built in foreign shipyards.

Our analysis calculates the total monetary cost to construct the Jones Act fleet in US shipyards, relative to a counterfactual scenario whereby Jones Act ships would be constructed in foreign shipyards. The total number of Jones Act ships in the fleet is 89.

$$\text{Total construction cost}_{\text{Domestic}} = 89 * \text{average construction cost}_{\text{Domestic}}$$

$$\text{Total construction cost}_{\text{Foreign}} = 89 * \text{Average construction cost}_{\text{Foreign}}$$

### Daily crew cost calculations

The daily crew cost calculations are as follows. Using Fig. 2 from the U.S. Maritime Administration (2011), the average daily crew costs are applied to each ship based, on the vessel type either and as an all American crew or under a scenario of a foreign crew cost structure. The differential for daily crew costs as a percentage is then calculated throughout the fleet.

The following formula specifies how the average differential in daily crew costs per type of vessel is calculated. An average of the daily crew costs demonstrates the average cost differential of maintaining the origins of crew requirement instead of allowing shipowners to employ foreign crew members.

$$\text{Differential in crew costs} = \frac{\text{Average daily crew costs}_{\text{United States}}}{\text{Average daily crew costs}_{\text{Foreign}}}$$

**Table 9** Deficit per person (2006–2017)

| Rank | State | Deficit per person |
|---|---|---|
| 1 | Louisiana | $384.18 |
| 2 | Hawaii | $99.74 |
| 3 | West Virginia | $90.97 |
| 4 | Delaware | $86.86 |
| 5 | Maine | $78.29 |
| 6 | Alaska | $77.91 |
| 7 | Texas | $74.23 |
| 8 | New Jersey | $68.62 |
| 9 | Kentucky | $66.37 |
| 10 | Alabama | $63.31 |
| 11 | Mississippi | $56.70 |
| 12 | Rhode Island | $47.58 |
| 13 | Washington | $47.46 |
| 14 | Indiana | $46.60 |
| 15 | Ohio | $38.07 |
| 16 | Puerto Rico | $33.61 |
| 17 | Pennsylvania | $32.12 |
| 18 | Tennessee | $30.05 |
| 19 | California | $25.97 |
| 20 | Florida | $25.49 |
| 21 | Maryland | $24.96 |
| 22 | Connecticut | $23.60 |
| 23 | Michigan | $22.15 |
| 24 | Oregon | $21.20 |
| 25 | South Carolina | $18.68 |
| 26 | Massachusetts | $18.52 |
| 27 | Arkansas | $18.39 |
| 28 | Guam | $14.69 |
| 29 | New Hampshire | $14.29 |
| 30 | Virginia | $14.26 |
| 31 | Illinois | $14.00 |
| 32 | Georgia | $12.88 |
| 33 | New York | $12.68 |
| 34 | Missouri | $11.64 |
| 35 | Wisconsin | $10.03 |
| 36 | Minnesota | $9.80 |
| 37 | Iowa | $7.85 |
| 38 | North Carolina | $5.35 |
| 39 | Oklahoma | $4.11 |
| 40 | District of Columbia | $1.68 |
| 41 | Kansas | $0.60 |
| 42 | Nebraska | $0.13 |
| 43 | Idaho | $0.12 |

**Table 9** (continued)

| Rank | State | Deficit per person |
|---|---|---|
| 44 | South Dakota | $0.00 |
| 45 | Arizona | $0.00 |
| 46 | Montana | $0.00 |
| 47 | Vermont | $0.00 |
| 48 | New Mexico | $0.00 |
| 49 | Utah | $0.00 |
| 50 | Nevada | $0.00 |
| 51 | North Dakota | $0.00 |
| 52 | Colorado | $0.00 |
| 53 | Wyoming | $0.00 |

**Table 10** Domestic and foreign shipping by state of destination (measured in millions of tons)

| State | Domestic tons | Proportion domestic | Total tons |
|---|---|---|---|
| Texas | 1125.96M | 0.300 | 3757.99M |
| Louisiana | 2205.21M | 0.648 | 3401.41M |
| California | 363.87M | 0.191 | 1905.4M |
| New Jersey | 288.04M | 0.246 | 1168.99M |
| Florida | 538.16M | 0.564 | 953.87M |
| Ohio | 766.68M | 0.909 | 843.08M |
| Pennsylvania | 455.59M | 0.580 | 785.35M |
| Washington | 356.2M | 0.562 | 633.28M |
| Indiana | 566.92M | 0.967 | 586.11M |
| Alabama | 363.88M | 0.621 | 585.8M |
| Kentucky | 558.41M | 1.000 | 558.41M |
| New York | 272.21M | 0.571 | 476.79M |
| Michigan | 361.92M | 0.863 | 419.52M |
| Tennessee | 373.64M | 1.000 | 373.64M |
| Illinois | 321.23M | 0.931 | 345.13M |
| Mississippi | 116.13M | 0.358 | 324.62M |
| West Virginia | 322.87M | 1.000 | 322.87M |
| Maryland | 102.94M | 0.363 | 283.28M |
| Hawaii | 167.37M | 0.624 | 268.05M |
| Georgia | 17.3M | 0.070 | 246.3M |
| Puerto Rico | 81.08M | 0.338 | 239.7M |
| Massachusetts | 87.64M | 0.369 | 237.28M |
| Virginia | 84.96M | 0.377 | 225.48M |
| Maine | 17.82M | 0.090 | 199.06M |
| South Carolina | 27.35M | 0.160 | 170.7M |
| Connecticut | 118.23M | 0.728 | 162.42M |
| Oregon | 112.91M | 0.708 | 159.5M |
| Delaware | 45.6M | 0.296 | 153.91M |

**Table 10** (continued)

| State | Domestic tons | Proportion domestic | Total tons |
|---|---|---|---|
| Missouri | 134.69M | 1.000 | 134.69M |
| Wisconsin | 87.39M | 0.793 | 110.23M |
| Alaska | 89.99M | 0.821 | 109.62M |
| Arkansas | 104.16M | 1.000 | 104.16M |
| Minnesota | 97.64M | 0.960 | 101.72M |
| North Carolina | 42.58M | 0.422 | 100.86M |
| Rhode Island | 38.81M | 0.405 | 95.77M |
| Iowa | 46.41M | 1.000 | 46.41M |
| New Hampshire | 6.31M | 0.174 | 36.21M |
| Oklahoma | 30.31M | 1.000 | 30.31M |
| Guam | 4.64M | 1.000 | 4.64M |
| Kansas | 3.32M | 1.000 | 3.32M |
| District of Columbia | 2.08M | 1.000 | 2.08M |
| Nebraska | 0.46M | 1.000 | .46M |

*Source* Author calculations

**Table 11** Commodity analysis

| Rank | Commodity name | Average annual shipping cost differential | Total shipping cost differential |
|---|---|---|---|
| 1 | Crude petroleum | 210.9M | 2530.3M |
| 2 | Petroleum products | 199.2M | 2390.3M |
| 3 | Coal, lignite, and coal coke | 102M | 1223.5M |
| 4 | Sand, gravel, shells, clay, salt, and slag | 82.8M | 993.9M |
| 5 | Food and food products | 70.3M | 844M |
| 6 | Unknown and not elsewhere classified products | 63.8M | 765.3M |
| 7 | Chemicals excluding fertilizers | 46.6M | 559.3M |
| 8 | Manufactured goods | 44.7M | 536.6M |
| 9 | Primary metal products | 33M | 395.6M |
| 10 | Iron ore, iron, and steel waste and scrap | 28.9M | 346.5M |
| 11 | Primary non-metal products | 19.9M | 238.4M |
| 12 | Chemical fertilizers | 13.7M | 164M |
| 13 | Non-ferrous ores and scrap | 10M | 119.7M |
| 14 | Lumber, logs, wood chips, and pulp | 7.9M | 95.3M |

## Daily operating cost calculations

Average daily operating costs from Fig. 4 are first applied to each ship in the dataset and then multiplied by 365 to arrive at yearly operating costs.

Subsequently, the yearly operating cost differential is calculated by taking the difference between United States vessels and a counterfactual whereby Jones Act vessels are capable of operating at a foreign operating cost structure.

$$\text{Cost differential} = \text{Average yearly operating cost}_{\text{United States}} - \text{Average yearly operating cost}_{\text{Foreign}}$$

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