RICE UNIVERSITY'S BAKER INSTITUTE FOR PUBLIC POLICY

Working Paper

A Cost-Benefit Analysis of the Jones Act: Petroleum Product Tankers

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Abstract

The Jones Act requires that all goods transported between US ports use ships carrying the US flag. In addition, the ships must be constructed in the United States and owned and crewed by US citizens and permanent residents. Despite the importance of the Jones Act, there is little in the economics literature devoted to a rigorous econometric evaluation of the costs and benefits that it generates. We study the welfare effects of the Jones Act in the market of petroleum product tankers. We estimate supply and demand functions in this market, then use the estimates to compute consumer, producer, and total surplus in the presence and in the hypothetical absence of the Jones Act. We find the economic welfare costs of the Jones Act in this segment amount to $759.1 million per year. While substantial, it may not be large enough to incent policy change because strong lobby efforts for small, well-organized groups that have much to lose can be effective in preserving status quo when costs are diffuse across a large population.

Keywords: Jones Act, Petroleum Product Tankers, Welfare

Introduction

Enacted in 1920, the Jones Act (JA), more precisely, the "United States Merchant Marine Act," is a federal statute meant to support the US commercial fleet. It is considered as one of the most important transportation-related laws in the United States. The JA regulates all maritime commerce in US waters and between US ports. It requires that all goods transported between US ports use ships carrying the US flag. In addition, the ships must be constructed in the United States, owned by US citizens, and crewed by US citizens and permanent residents. Furthermore, the steel of any foreign repair work on a JA vessel must be less than ten percent of its total weight. Waivers are only possible on temporary basis in cases involving national defense, or other emergencies.

The JA constitutes a legacy from a time before free trade became a principle that the US has generally adhered to and supported globally, including via its participation in the World Trade Organization. As such, there is an active debate about its merits that has centered on two major arguments. Proponents have argued that the JA ensures the viability of the US maritime industry[1] as it prevents foreign-flagged ships from carrying cargo between US ports. They also argue that the JA plays a role in the national security and sovereignty of the US. While this is more difficult to address though an economic lense, the claim is that the US commercial fleet helps to protect the nation and support US participation in military interventions abroad.

Those opposing the JA claim it has resulted in reduced competition in both building ships and transporting goods, and has led to higher prices and a long-term decline in the size of the US fleet. For example, JA ships can cost four to five times as much as those built in foreign shipyards.[2] A study by the US Maritime Administration (MARAD) found that in 2010, the average operating cost of a US-flag ship was 2.7 times greater than a foreign-flag ship.[3] Critics also argue that a large fraction of these costs is passed on to the final consumers, who pay higher prices for the transported goods, or for goods using high-cost inputs transported by JA vessels.[4] Others question the national security argument, seeing it as a cloak for protectionist measures.[5]

Despite the apparent importance of the JA as well as the unsettled dispute over its costs and benefits to the US economy, there is limited literature in economics devoted to a rigorous econometric evaluation of the matter. In this paper we attempt to begin filling this gap. We perform a comparison of the welfare effects associated with maritime services in the presence and in the hypothetical absence of the JA for a specific market, that of petroleum product tankers.[6] As is common in the economics literature, our welfare analysis relies on deriving measurements of the corresponding consumer and producer surplus associated with the regulation under study.

Clearly, the corresponding demand and supply elasticities with respect to the prices (freight rates) are central in this calculation. We proceed in two steps. First, we use price and quantity data to estimate supply and demand functions for JA product tankers. This estimation is of independent interest and, to our knowledge, it has not been performed in the past.[7] We then estimate the equilibrium price, quantity, and total consumer and producer surplus created in the presence of the JA. We interpret this as the "status quo." Finally, we compare these values to the corresponding ones in the hypothetical scenario when world prices emerge as a result of entry and competition from foreign producers.

In computing the resulting surpluses, we adopt a partial equilibrium approach. In other words, we will study industry equilibrium in the US product tanker sector, assuming that every other factor in the US, as well as in the world economy, remains constant. Many foreign-flag vessels operate in competitive, largely unregulated markets, and are often subject to low compliance costs. As a result, and since foreign and domestic vessels are largely considered to be substitutes in transportation, foreign competition would result in significant reductions in freight rates. However, the JA has far-reaching effects on the entire US transportation sector and beyond. Such effects are impossible to capture in their entirety. As an example, in the absence of the JA, the US trucking and rail industries, as well as the ports, would be affected in complex ways.[8] Perhaps most importantly, the domestic maritime industry could prove largely uncompetitive given its higher cost structure. Indeed, this is an important reason why the JA remains controversial; the absence of the JA would create winners *and* losers relative to the status quo. We find that the net welfare gain from removing the JA from the petroleum product tanker market when we consider changes to both consumer and producer surplus is about $759.1 million per year. The welfare gains are "net" gains because, as explained below, suppliers of JA services would lose while consumers would gain in the counterfactual where the JA does not exist.

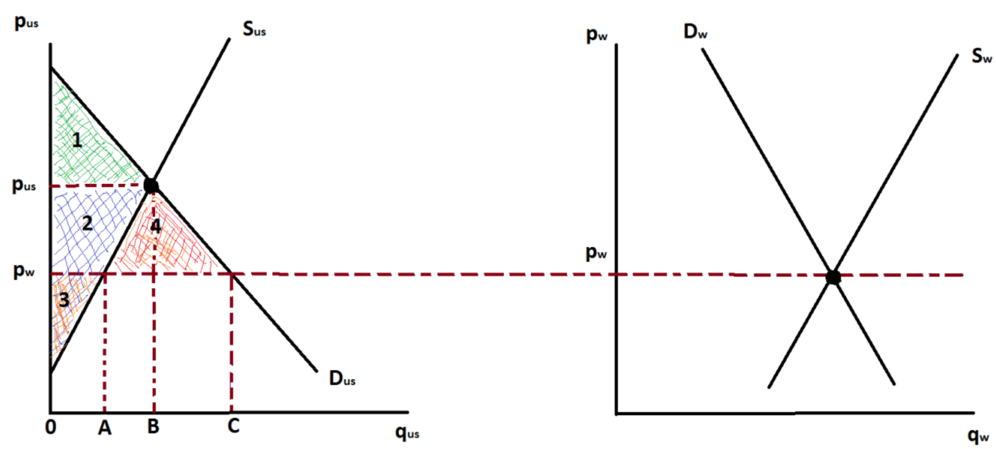
Although there are several articles on the JA published in non-academic outlets,[9] there are few academic studies applying rigorous econometric methodology to the study of the JA. One notable exception is Francois, Arce, Reinert, and Flynn (1996), who use an applied general equilibrium model to analyze the effects of the Jones Act on welfare, production, trade, and employment. They find that the JA imposes substantial economic costs, implying a welfare cost of around $3 billion in 1989.

Our methodology is different from theirs. We study the petroleum product tanker sector exclusively, and we are able to directly compute consumer/producer surplus in this sector by explicitly estimating the corresponding supply and demand functions. The focus on the tanker segment is justified as tankers are the biggest and best defined among the JA vessels. In addition, they are becoming increasingly important after the shale revolution. In his classic textbook, Stopford (2003) provides a comprehensive treatment of several topics related to maritime economics. We will use several insights from Stopford's work, including the theoretical underpinnings of industry cost functions. Smith (2004) documents the long-term decline in US merchant marine employment since the JA was implemented. Lewis (2013) uses information on operational margins from shipping companies to compute a lower bound for the losses associated with the JA. However, he does not estimate the supply and demand functions for JA transportation services and, as a result, he does not construct and compare the corresponding surpluses. Gius (2013) estimates a first-autoregressive model to test the effect of Jones Act waivers on gasoline spot prices and finds mixed results, in the sense that for some periods, waivers did not have an effect, but for others, they did. His estimation does not rely on a supply and demand analysis, nor does it include indicators of economic activity or cost structure for shipping companies. Thus, the model cannot be used to perform a welfare analysis of the JA. Olney (2019) studies the implications of the Jones Act over time. He finds that it has reduced domestic waterborne shipments into US states relative to other modes of transport. He also finds evidence that the reduction in domestic trade has increased consumer prices.

Supply and Demand for JA Petroleum Product Tankers

The qualitative aspects of our welfare analysis are shown in Figure 1, where we use linear supply and demand functions for easier exposition.[10] The graph on the right represents the world equilibrium freight rate, p_w, as determined by world supply and demand for product tankers. This is lower than p_{us}, the resulting rate under the Jones Act (left graph). The equilibrium quantity of JA transport services is represented by the horizontal distance *0B*. The total welfare created in the US is then given by the sum of the consumer surplus (area 1) plus the producer surplus (area 2+3).

Figure 1. Deadweight Welfare Loss



If permitted to enter, foreign vessels would want to supply capacity since $p_{us} > p_w$. This would increase supply in the US, bringing prices down to p_w. The total quantity of services in the US would increase. While foreign competition would increase the total quantity transported across US ports, the quantity transported by US-flagged vessels would *decline*. As a result, US consumer surplus would increase to area *1+2+4*, while US producer surplus would shrink to area *3*. Overall efficiency is improved by the elimination of *deadweight loss* (area *4*). Determining the magnitude of the efficiency gains is a quantitative question. To reach a rigorous conclusion, we will need to estimate a supply-demand model for petroleum product tanker services.

While qualitative analysis is useful in providing general intuition, for policy evaluation we would need to have a quantitative assessment of the magnitudes of the areas corresponding to the respective surpluses. To our knowledge, we are the first ones to estimate these relationships from historical data. Our first task is to estimate the supply and demand functions for US petroleum product tanker services. Since entry by foreign competition would change both quantities supplied and quantities demanded, we will need to compute equilibrium supply and demand in the presence and in the hypothetical absence of the JA. We assume that these represent stable, long-run relationships; we will not consider, for example, fluctuations at business cycle frequencies.

Data

We were able to locate monthly price data for JA petroleum product tankers for the period of January 2001-July 2017. Figure 2 shows the daily time charter equivalent (TCE) spot rate for a handymax 38,000 product tanker for a Houston – New York transit. The data points to two different cycles: from August 2001 to May 2011, and from May 2011 to August 2017. The average rate over the sample is $34,853.13/day. To convert to the more conventional unit of $/ton-miles, we first note that the trip from Houston to New York lasts about 7 days. Following Stopford (2009), we assume 82% of the deadweight tonnage (38,000) as cargo, and a distance of approximately 1,900 nautical miles per trip.[11]

Figure 2. Monthly Averages of Daily Charter Rates

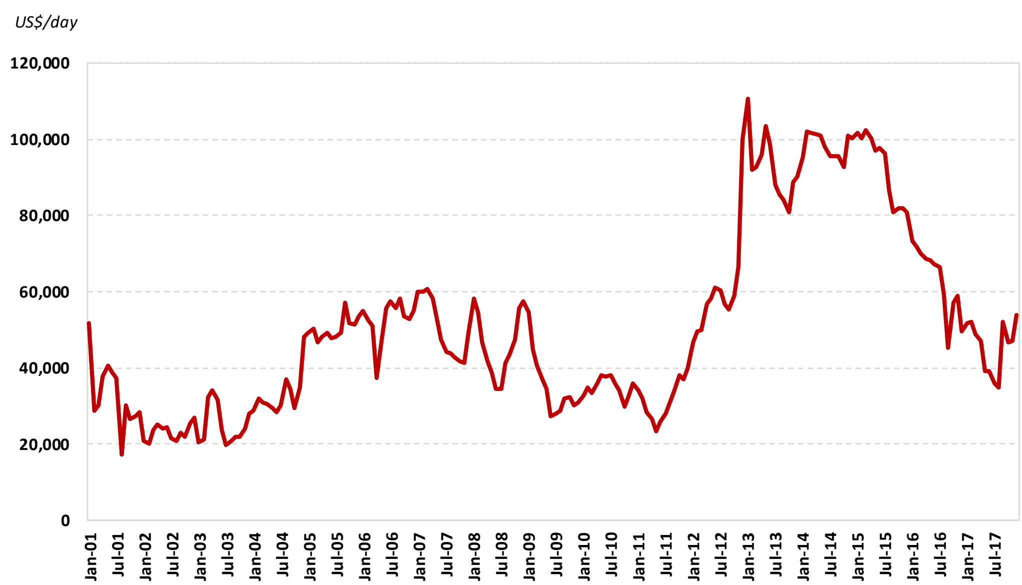


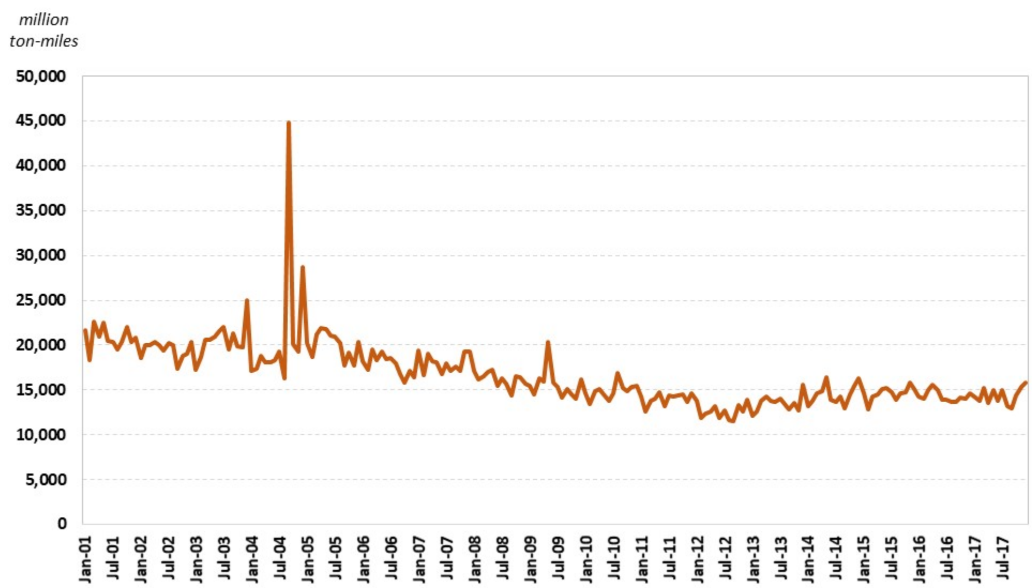
Table 1. Summary Statistics for Daily Charter Rates

	$ per day		*$ per ton-mile*	
	Mean	**Std. Dev.**	**Mean**	**Std. Dev.**
January	55,604.8	26,676.9	0.0056	0.0027
February	52,899.5	25,674.7	0.0054	0.0026
March	52,346.0	25,310.1	0.0053	0.0026
April	51,947.7	25,306.6	0.0053	0.0026
May	51,620.2	26,055.1	0.0052	0.0026
June	50,216.0	26,207.6	0.0051	0.0027
July	48,814.2	24,934.4	0.0049	0.0025
August	47,104.6	23,737.7	0.0048	0.0024
September	48,490.7	21,527.3	0.0049	0.0022
October	47,837.6	21,434.5	0.0048	0.0022
November	50,397.5	23,012.0	0.0051	0.0023
December	54,535.2	24,339.3	0.0055	0.0025

Table 1 gives rates in both $/day and $ per ton-mile.[12] In terms of averages of the data on a per month basis, rates seem to be lower from July to October and higher in the winter months, while quantities seem to be higher in December. This suggests the presence of seasonality in our sample.

Figure 3 plots the quantities transported over our sample period.[13] There appears to be an overall downward trend.[14] Quantities also exhibit seasonal variation. In the US, the average ton-miles per month for product tankers was 16.644 billion between January 2001 and December 2017.

Figure 3. Volume of oil products transported through tankers in the U.S.



Source: U.S. Army Corps of Engineers

As we are working with time series data, non-stationarity is a potential concern. In the presence of a unit root (and non-stationarity), the model would not capture a meaningful economic relationship between the variables. In our data, both the price and the quantity are non-stationary. As we are working with monthly data, serial correlation is also a concern. Indeed, the price data appears to be correlated (serial correlation of order 1).

Table 2. Summary statistics for quantity of oil products transported by tankers

	million ton-miles	
	Mean	**Std. Dev.**
January	16,253.6	2,710.8
February	15,450.6	2,593.2
March	16,978.9	3,093.3
April	16,816.4	2,895.0
May	17,415.9	2,970.6
June	16,266.6	3,042.5
July	16,710.1	2,978.5
August	15,979.2	2,713.6
September	17,266.3	7,578.4
October	16,347.8	2,683.1
November	16,356.4	2,544.3
December	17,888.6	4,056.6

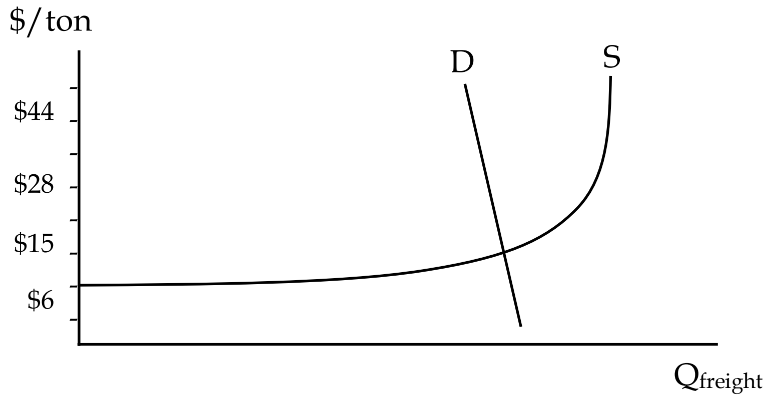
Source: U.S. Army Corps of Engineers

Model Specification and Estimation

As shipping is an input in the supply of petroleum products, the demand for product tankers is a derived demand. In other words, demand for product tanker services is derived from the demand for the products they move. In this sense, the factors that drive demand for oil products, such as the level of economic activity or seasonal patterns, will also drive the demand for product tanker services. Thus, in what follows we will choose indicators of economic activity as drivers for product tanker demand.

For the theoretical underpinnings of the supply curve for shipping, we follow Stopford (2009). Stopford argues that the supply schedule exhibits a non-linear, convex shape due to capacity constraints in the short run (see Figure 4). So, if product tanker demand spikes due high demand for oil products, we should expect tanker day rates to rise, climbing dramatically as tanker capacity is more heavily utilized.

Figure 4. Demand and supply schedule for shipping services



Source: Reproduced from Stopford (2009)

We posit a polynomial functional form for the supply function, given as

$$p_t = \beta_0 + \beta_1 (q_t)^n + \beta_2 bnk_t + \sum_{i=1}^{k} \beta_{2+i} p_{t-i} + \varepsilon_{1t}$$

where p_t is price at time *t*, q_t is quantity at time *t*, and bnk_t is bunker fuel price at time *t*. The degree of the polynomial, *n,* is determined through the Akaike Information Criteria (AIC). The number of lags, *k*, is determined by the statistical significance of the coefficients associated with each lag. We include several powers of quantities for the estimation. We chose the polynomial degree based on the highest power with individual significance. With this procedure, we choose *n =15* as the degree of the polynomial.[15]

To complete our system, the proposed functional form for demand is given as

$$q_t = \alpha_0 + \alpha_1 p_t + \alpha_2 util_t + \sum_{m=1}^{11} \alpha_{2+m} D_m + \varepsilon_{2t}$$

where $util_t$ is industrial capacity utilization at time *t*, D_m is a monthly dummy variable, and all other variables are as defined above. Monthly dummies are included to account for seasonal effects.

To deal with endogeneity and identification, we employ demand shifters to identify the supply parameters and supply shifters to identify the demand parameters. We use the real price of IFO 380 LA/Long Beach Bunker Fuel (bnk_t) as a supply shifter for the demand equation. This reflects changes in the cost of transportation due to fuel prices. For the supply equation, we use US industrial capacity utilization ($util_t$) as a demand shifter.[16]

Given the above specifications for supply and demand, we estimate the above equations simultaneously using three stage least quares (3SLS). The results are indicated in Table 3.

Table 3: 3SLS estimates for the supply-demand system

Demand		Supply	
α_0	-0.517	β_0	-3,241,488.6
	(0.397)		(2,218,250.6)
α_1	-7.03E-09 ***	β_1	46.277 *
	(6.70e-10)		(24.8)
α_2	3.438 ***	β_2	7,254,658.5 *
	(0.526)		(3,057,794.5)
Jan	-0.125	β_3	1.065 ***
	(0.076)		(0.0799)
Feb	-0.205 **	β_4	-0.233 *
	(0.076)		(0.1160)
Mar	-0.073	β_5	0.152 *
	(0.076)		(0.0744)
Apr	-0.070		
	(0.075)		
May	-0.012		
	(0.075)		
Jun	-0.138		
	(0.075)		
Jul	-0.105		
	(0.075)		
Aug	-0.189 *		
	(0.075)		
Sep	-0.199 **		
	(0.076)		
Oct	-0.143		
	(0.075)		
Nov	-0.119		
	-0.075		
# obs	199		
AIC	6767.60		
BIC	6830.20		

Standard errors in parentheses:
* p<0.05, ** p<0.01, *** p < 0.001

Capacity utilization is significant at the 1% confidence level. As expected, seasonal dummies and price lags are also significant. The price elasticity of demand is estimated to be -0.218, implying a relatively inelastic demand. Notably, the estimation results are similar regardless of the indicator of economic activity used as the demand shifter. Notice that the intercept of the supply curve (total cost for zero ton-miles delivered) is at $50,195.21/day, which is higher than the international price. According to the Schwarz Criteria and the Dickey-Fuller test, there is cointegration at the 1% level, so there is a meaningful relationship between the model variables.

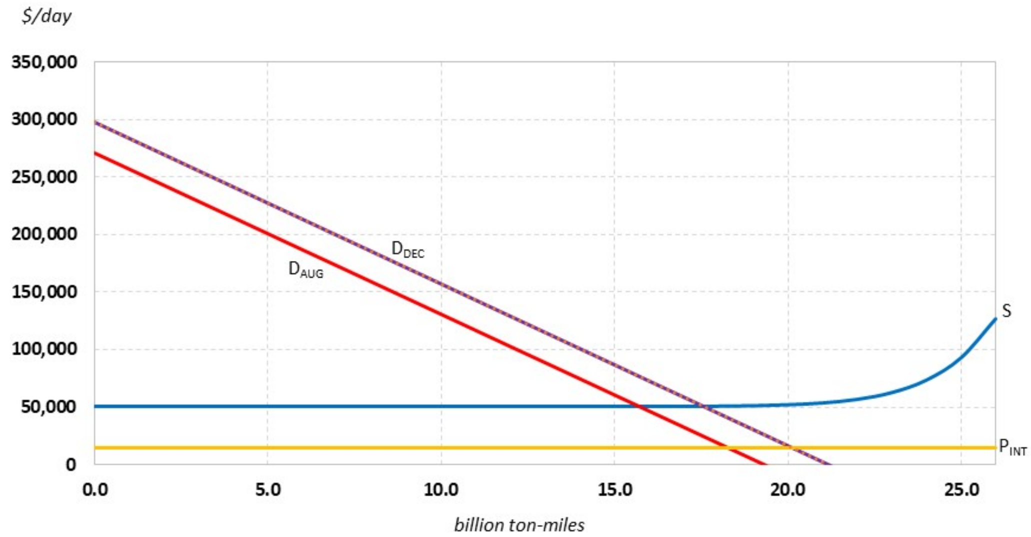
Estimated average price is $50,291/day, or $0.0051/ton mile (see Table 4). The actual sample average is $50,984/day, or $0.0052/ton mile. Prices are higher during the winter months when demand for petroleum products increases. Turning to quantities, the estimated average is 16.47 billion ton-miles/month, which is slightly lower than the average from the sample (16.64 billion ton-miles/month).

Table 4. Predicted equilibrium quantites and prices

	Price		Quantity
	$/ton-mile	*$/day*	*billion ton-miles*
January	0.00510	50,271.70	16.40
February	0.00509	50,230.84	15.60
March	0.00510	50,314.23	16.89
April	0.00510	50,317.03	16.92
May	0.00511	50,395.35	17.49
June	0.00509	50,261.18	16.24
July	0.00510	50,285.11	16.58
August	0.00509	50,236.07	15.73
September	0.00509	50,229.12	15.56
October	0.00509	50,256.40	16.16
November	0.00510	50,273.03	16.42
December	0.00511	50,418.55	17.62
Avg	**0.00510**	**50,290.72**	**16.47**

As shown in Figure 5, when demand is highest (during the winter months), prices begin to increase. During the rest of the year, prices remain relatively stable as capacity constraints do not seem to bind. This also implies that producer surplus is relatively small compared to consumer surplus ($1.84 million/year versus $2,318.3 million/year at the estimated domestic prices).

Figure 4. Estimated supply and demand schedules



Comparative Welfare Analysis

Here we perform a comparative welfare analysis under a hypothetical scenario in which the international price prevails as a result of competition from foreign vessels. For comparison, we will use an international rate of $15,000/day.[17] Consistent with the non-competitiveness of the JA fleet, we find that at this rate domestic producer surplus is zero. However, quantities transported and the corresponding consumer surplus increase significantly. Turning to our main finding, when we compute the net effect on welfare, accounting for both changes in consumer and in producer surplus, the total change over a year is close to $759.1 million.[18] A total of $1.84 million/year in producer surplus is lost, but the gain in consumer surplus of $760.9 million/year more than outweighs these losses.

While the total loss in producer surplus is far less than the total gain in consumer surplus, the constituencies over which the total surplus is distributed are far different. For example, the gain in consumer surplus is distributed across all consumers of oil products, but the lost producer surplus is distributed across a much smaller number of producers. So, the gains to individuals is small on a per capita basis. This renders a classic coordination problem in which it is difficult to motivate collective action amongst a large number of constituents because the individual gains are small. On the other hand, producers are more easily motivated to collective action due to their relatively small number and large individual gains. This could explain a great deal about why the JA still persists today.

Table 5. Estimated change in welfare (million US$)

	Consumer	Producer	Total
January	63.14	-0.12	63.02
February	60.19	-0.05	60.14
March	64.98	-0.19	64.79
April	65.08	-0.20	64.88
May	67.27	-0.33	66.94
June	62.54	-0.10	62.44
July	63.80	-0.14	63.66
August	60.67	-0.06	60.61
September	60.03	-0.05	59.98
October	62.24	-0.09	62.15
November	63.21	-0.12	63.09
December	67.78	-0.37	67.41
Average	**63.41**	**-0.15**	**63.26**
Sum	**760.94**	**-1.84**	**759.11**

Conclusion

The Jones Act restricts competition by foreign vessels in transportation between US ports. The costs of reduced competition to the US economy, in particular in connection to the transportation of energy commodities, are becoming more relevant as a result of the shale revolution. The US stands to benefit as a whole from the ability to efficiently move its abundant energy resources within its borders. With pipeline and storage capacity not always high enough to serve all regions at times of extraordinary demand, oil, product, and LNG tankers could have a balancing role. So far, high prices for US-built vessels have restricted the size of this market and have altogether prohibited LNG tanker availability. As a result, we have recently seen LNG imports from other countries, including Russia, landing on US shores.[19]

One hundred years after the establishment of the Jones Act, it is high time for its consequences to be evaluated in a rigorous manner, using formal econometric methods. In this paper we took the first step towards this goal by evaluating the net welfare costs of the Jones Act using estimated supply and demand functions for the market of product tankers. We found that the costs of the Act in this segment amount to $759.1 million/year. Of course, our analysis abstracts from many factors that might influence this figure, including highway congestion and environmental costs resulting from the long-term use of less efficient forms of transportation in order to avoid the increased costs imposed by the JA. In that sense, our partial equilibrium analysis can be thought of as providing a lower bound for the total costs. Proponents of the Act often point to its benefits for US national security. Although quantifying such benefits was beyond the scope of this paper, our analysis can be seen as quantifying part of the costs of providing them.

Our analysis emphasizes that opening US ports to competition from foreign vessels would lead not only to overall efficiency gains, but also to a sharp redistribution of the total surplus involved. A complex political economy issue involves proposing mechanisms through which the winners would be able to compensate the losers if such a regime change were to occur. Only when such compensation schemes are in place might a consensus emerge on moving towards a post-JA world. At face value, this may seem like a rather trivial notion. But, given the consumer welfare implications are spread over the entire population while the producer welfare implications are spread across a much smaller subset of the population, developing such a compensatory mechanism is not so straightforward, unless individual consumers become motivated to capture the potential welfare gain from pushing for change. Given the gains per person are not that significant, it is unclear this will occur.

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Appendix

Here we discuss some robustness checks performed on the basic model used in the main body of the paper. In order to identify the supply curve, we included two different measures of economic activity: US Industrial Production and the number of unemployment benefit claims in the US. To identify the demand curve, we used the fuel costs as an exclusion restriction. Using these variables, we estimated three different specifications of our supply-demand model. We include several powers of quantities for the estimation. We chose the polynomial degree based on the highest power with individual significance. With this procedure, we choose $n = 15$ as the degree of the polynomial. We included monthly dummies in the demand function in order to account for seasonal effects. We list the original model below for comparison:

Original Model

Supply: $$p_t = \beta_0 + \beta_1 (q_t)^n + \beta_2 bnk_t + \beta_3 p_{t-1} + \beta_4 p_{t-2} + \beta_5 p_{t-3} + \varepsilon_{1t}$$

Demand: $$q_t = \alpha_0 + \alpha_1 p_t + \alpha_2 util_t + \sum_{m=1}^{11} \alpha_{2+m} D_m + \varepsilon_{2t}$$

Model 2

Supply: $$p_t = \beta_0 + \beta_1 (q_t)^n + \beta_2 bnk_t + \beta_3 p_{t-1} + \beta_4 p_{t-2} + \beta_5 p_{t-3} + \varepsilon_{1t}$$

Demand: $$q_t = \alpha_0 + \alpha_1 p_t + \alpha_2 IP_t + \sum_{m=1}^{11} \alpha_{2+m} D_m + \varepsilon_{2t}$$

Model 3

Supply: $$p_t = \beta_0 + \beta_1 (q_t)^n + \beta_2 bnk_t + \beta_3 p_{t-1} + \varepsilon_{1t}$$

Demand: $$p_t = \alpha_0 + \alpha_1 q_t + \alpha_2 U_t + \alpha_3 p_{t-1} + \alpha_4 p_{t-2} + \alpha_5 p_{t-3} + \sum_{m=1}^{11} \alpha_{6+m} D_m + \varepsilon_{2t}$$

where IP_t denotes industrial production, U_t denotes jobless claims, and all other variables are defined as above. The 3SLS estimation results are shown in Table A1.

It is worth commenting here on the "jumps" in the quantity data in December 2003, September 2004, December 2004, and May 2009. As explained in Note 14, we present results from a sample removing September 2004 and December 2004. To evaluate the effects of the jumps in December 2003 and May 2009, we tried including dummy variables for each of the aforementioned months. The corresponding coefficients were not significant. Robustness checks that include the entire sample show none of the jumps significantly affect our welfare estimates.

It is also worth noting that the estimation results are also similar if we use a smaller degree in the polynomial describing the supply curve. To have a parsimonious model, we decided to include one term in the polynomial. This also helps us prevent multicollinearity issues. Finally, lags for fuel prices and economic activity were not significant in most cases. Estimation of the simultaneous equations system was done using 3SLS.

Table A1. Comparison of Models Results (3SLS parameter estimates)

	Demand				Supply		
	MODEL 1	MODEL 2	MODEL 3		MODEL 1	MODEL 2	MODEL 3
α_0	-0.517	2.187 ***	2.285 ***	β_0	-3,241,488.6	-2,551,545.6	-2,934,778.0
	(0.397)	(0.432)	(0.123)		(2,218,250.6)	(2,185,763.1)	(2,261,642.6)
α_1	-7.0E-09 ***	-5.6E-09 ***	-6.7E-09 ***	β_1	46.28 *	32.21	38.63
	(6.70e-10)	(9.89e-10)	(7.91e-10)		(24.80)	(24.83)	(25.77)
α_2	3.438 ***	-0.157	-0.525 *	β_2	7,254,658.5 *	7,229,568.8 *	7462082.2 *
	(0.526)	(0.469)	(0.224)		(3,057,794.5)	(2,960,323.8)	(3,055,850.4)
Jan	-0.125	-0.125	-0.121	β_3	1.065 ***	1.069 ***	1.066 ***
	(0.076)	(0.083)	(0.082)		(0.080)	(0.075)	(0.077)
Feb	-0.205 **	-0.198 *	-0.197 *	β_4	-0.233 *	-0.247 *	-0.240 *
	(0.076)	(0.083)	(0.082)		(0.116)	(0.109)	(0.113)
Mar	-0.073	-0.066	-0.065	β_5	0.152 *	0.154 *	0.152 *
	(0.076)	(0.083)	(0.082)		(0.0744)	(0.0698)	(0.0718)
Apr	-0.070	-0.057	-0.056				
	(0.075)	(0.082)	(0.081)				
May	-0.012	0.001	-0.001				
	(0.075)	(0.082)	(0.081)				
Jun	-0.138	-0.122	-0.126				
	(0.075)	(0.082)	(0.081)				
Jul	-0.105	-0.085	-0.093				
	(0.075)	(0.082)	(0.081)				
Aug	-0.189 *	-0.168 *	-0.177 *				
	(0.075)	(0.082)	(0.081)				
Sep	-0.199 **	-0.199 *	-0.199 *				
	(0.076)	(0.083)	(0.082)				
Oct	-0.143	-0.127	-0.133				
	(0.075)	(0.082)	(0.081)				
Nov	-0.119	-0.112	-0.116				
	(0.075)	(0.082)	(0.081)				
# obs	199	199	199				
AIC	6,767.6	6,779.4	6,786.4				
BIC	6,830.2	6,842.0	6,849.0				

Standard errors in parentheses
* p<0.05, ** p<0.01, *** p < 0.001

Elasticity

The estimated elasticity of demand across the three models are given in Table A2.

Table A2. Comparison price elasticity of demand

	Original Model	Model 2	Model 3
Price Elasticity of Demand	-0.218	-0.173	-0.208

Given the length of the time series data (monthly, 2001 to 2017) used in this analysis, we believe these values are consistent with a "long-run" elasticity value, and they suggest a rather inelastic demand curve.

Stationarity

We found that quantities, as well as some of the instruments used, are not stationary. We checked whether the residuals from our estimations are stationary, indicating cointegration and a long-run relationship between the variables, and superconsistency of the estimated parameters. We employed an augmented Dickey–Fuller test, with the residuals transformed via a generalized least squares (GLS) regression before performing the test. Elliott, Rothenberg, and Stock (1996) and later studies have shown that this test has significantly greater power than previous versions of the augmented Dickey–Fuller test. What follows are the results of three different methods for choosing the value of *k* (number of lags):

- Method 1: the Ng–Perron sequential *t*,
- Method 2: the minimum Schwarz information criterion (SIC),
- Method 3: the Ng–Perron modified Akaike information criterion (MAIC).

Table A3. Stationarity tests results

	DF-GLS			
	Opt Lag (Ng-Perron seq t)	SC	MAIC	Standard Dickey Fuller
Original Model		**		***
Model 2		**		***
Model 3		**		***
*** 1% significance level ** 5% significance level * 10% significance level				

Depending on the criteria we use to select the lag for the test, we reject the hypothesis at different significance levels. Following the Schwarz criteria, or the standard Dickey-Fuller test for stationarity, we conclude that there is cointegration and a long-run relationship between the variables.

Welfare Estimation

For models 1-3, the intercept for the supply curve is approximately at $0.0051/ton-mile (or between $50195/day and $50448/day). This does not indicate significant dispersion among the estimates. Notice also that the rate estimates from the original model lie between those from Models 2 and 3 (see Table A4).

Table A4. Comparison equilibrium prices and quantities

	Original Model			Model 2			Model 3		
	Price		Quantity	Price		Quantity	Price		Quantity
	$/ton-mile	$/day	billion ton-miles	$/ton-mile	$/day	billion ton-miles	$/ton-mile	$/day	billion ton-miles
Jan	0.00510	50,271.70	16.40	0.00512	50,492.67	16.22	0.00510	50,277.69	13.05
Feb	0.00509	50,230.84	15.60	0.00512	50,471.08	15.49	0.00510	50,276.45	12.29
Mar	0.00510	50,314.23	16.89	0.00512	50,525.01	16.81	0.00510	50,279.51	13.61
Apr	0.00510	50,317.03	16.92	0.00512	50,531.27	16.89	0.00510	50,279.86	13.69
May	0.00511	50,395.35	17.49	0.00513	50,585.98	17.47	0.00510	50,281.11	14.25
Jun	0.00509	50,261.18	16.24	0.00512	50,493.78	16.25	0.00510	50,277.51	12.99
Jul	0.00510	50,285.11	16.58	0.00512	50,512.39	16.61	0.00510	50,277.79	13.31
Aug	0.00509	50,236.07	15.73	0.00512	50,477.91	15.79	0.00510	50,276.58	12.47
Sep	0.00509	50,229.12	15.56	0.00512	50,470.84	15.48	0.00510	50,276.42	12.26
Oct	0.00509	50,256.40	16.16	0.00512	50,491.60	16.20	0.00510	50,277.24	12.91
Nov	0.00510	50,273.03	16.42	0.00512	50,498.03	16.34	0.00510	50,277.74	13.07
Dec	0.00511	50,418.55	17.62	0.00513	50,583.96	17.46	0.00510	50,280.87	14.23

The degree of the polynomial does not seem to affect the other estimated coefficients of the system. Prices and quantities show a seasonal pattern (consistent with the statistical significance of the indicator variables for months). Given the shape of the supply curve, seasonal variations are mostly reflected in quantities (see Table A4).

To investigate the robustness of our welfare findings, we also included an alternative scenario in which international prices are at $30,000 per day (TCE). The results for each of the models are reported in Tables A5-A7. Depending on the model, the average change in monthly consumer welfare given the change in prices and quantities oscillates between $51.4 million and $63.4 million when international prices are at $15,000 per day (TCE), and between $28.5 million and $35.4 million when international prices are at $30,000 per day (TCE). The total change for a year oscillates between $616.9 million and $760.9 million when international prices are at $15,000 per day (TCE), and between $342 million and $424.1 million when international prices are at $30,000 per day (TCE).

Producer surplus is unchanged as the supply remains fixed during the year, and seasonal variations only affect demand.[20] Given the high intercept for the supply, the estimated producer surplus is rather small (between $0.04 and $1.84 million/year). This drops to zero under international competition. In this case, the total net change in welfare when we consider both consumer and producer surplus over a year is between

$616.8 million and $759.1 million when international prices are $15,000 per day (TCE), and between $342.0 million and $424.3 million when international prices are at $30,000 per day (TCE).

Table A5. Model 1 – Estimated change in welfare (million US$)

	P_{int} = $15,000/day			P_{int} = $30,000/day		
	Consumer	Producer	Total	Consumer	Producer	Total
Jan	63.14	-0.12	63.02	35.19	-0.12	35.07
Feb	60.19	-0.05	60.14	33.47	-0.05	33.41
Mar	64.98	-0.19	64.79	36.28	-0.19	36.09
Apr	65.08	-0.20	64.88	36.34	-0.20	36.14
May	67.27	-0.33	66.94	37.66	-0.33	37.33
Jun	62.54	-0.10	62.44	34.84	-0.10	34.74
Jul	63.80	-0.14	63.66	35.58	-0.14	35.44
Aug	60.67	-0.06	60.61	33.75	-0.06	33.69
Sep	60.03	-0.05	59.98	33.37	-0.05	33.32
Oct	62.24	-0.09	62.15	34.67	-0.09	34.57
Nov	63.21	-0.12	63.09	35.23	-0.12	35.11
Dec	67.78	-0.37	67.41	37.97	-0.37	37.60
Average	**63.4**	**-0.15**	**63.3**	**35.4**	**-0.15**	**35.2**
Sum	**760.9**	**-1.84**	**759.1**	**424.3**	**-1.84**	**422.5**

Table A6. Model 2 – Estimated change in welfare (million US$)

	P_{int} = $15,000/day			P_{int} = $30,000/day		
	Consumer	Producer	Total	Consumer	Producer	Total
Jan	61.96	-0.07	61.90	34.90	-0.07	34.83
Feb	59.30	-0.03	59.27	33.35	-0.03	33.31
Mar	64.14	-0.12	64.02	36.18	-0.12	36.05
Apr	64.46	-0.13	64.33	36.37	-0.13	36.23
May	66.65	-0.23	66.42	37.67	-0.23	37.44
Jun	62.06	-0.07	61.99	34.95	-0.07	34.88
Jul	63.41	-0.10	63.31	35.75	-0.10	35.65
Aug	60.37	-0.04	60.33	33.97	-0.04	33.92
Sep	59.26	-0.08	59.18	33.32	-0.08	33.24
Oct	61.87	-0.07	61.80	34.84	-0.07	34.78
Nov	62.41	-0.08	62.33	35.16	-0.08	35.08
Dec	66.58	-0.22	66.36	37.63	-0.22	37.41
Average	**62.7**	**-0.1**	**62.6**	**35.3**	**-0.1**	**35.2**
Sum	**752.5**	**-1.2**	**751.2**	**424.1**	**-1.2**	**422.8**

Table A7. Model 3 – Estimated change in welfare (million US$)

	P_{int} = $15,000/day			P_{int} = $30,000/day		
	Consumer	**Producer**	**Total**	**Consumer**	**Producer**	**Total**
Jan	50.95	0.00	50.95	28.24	0.00	28.24
Feb	48.22	0.00	48.22	26.67	0.00	26.67
Mar	52.96	-0.01	52.96	29.40	-0.01	29.39
Apr	53.25	-0.01	53.24	29.56	-0.01	29.56
May	55.23	-0.01	55.22	30.70	-0.01	30.69
Jun	50.73	0.00	50.72	28.11	0.00	28.11
Jul	51.88	0.00	51.88	28.78	0.00	28.77
Aug	48.87	0.00	48.87	27.05	0.00	27.04
Sep	48.13	0.00	48.13	26.62	0.00	26.62
Oct	50.45	0.00	50.45	27.95	0.00	27.95
Nov	51.03	0.00	51.02	28.28	0.00	28.28
Dec	55.16	-0.01	55.15	30.66	-0.01	30.65
Average	**51.4**	**0.00**	**51.4**	**28.5**	**0.00**	**28.5**
Sum	**616.9**	**-0.04**	**616.8**	**342.0**	**-0.04**	**342.0**

Endnotes

[1] A recent PwC study commissioned by the Transportation Institute reports that the JA contributed as much as $150 billion annually to the US economy. See https://transportationinstitute.org/u-s-maritime-workforce-grows-to-650000/

[2] See Congresssional Research Service, "Shipping under the Jones Act: Legislative and Regulatory Background," p. 3. November 21, 2019. Available at: https://fas.org/sgp/crs/misc/R45725.pdf. Also see: Kinder Morgan, "Kinder Morgan Continues to Expand Its Growing Product Tanker Fleet for the Jones Act Trade,"

Press Release, August 10, 2015; Business Wire, "ExxonMobil Marine Affiliate Names Eagle Bay, New U.S.-Flag Tanker in Philadelphia," January 12, 2015.

[3] U.S. Maritime Administration, Comparison of U.S. and Foreign-Flag Operating Costs, September 2011. A 2018 GAO report states that the relative cost of operating a U.S.-flag vessel compared to a foreign-flag vessel has increased in recent years. See: https://www.gao.gov/assets/700/693802.pdf

[4] Critics also point out that the additional costs associated with JA ships have: 1) incentivized maintenance of older ships that are less efficient, less economical, and more polluting; 2) priced U.S.-built ships out of foreign markets; and 3) resulted in a narrow specialization of U.S. shipyards that limit themselves to building only ships that domestic operators need. See, for example, https://www.cato.org/publications/policy-analysis/jones-act-burden-america-can-no-longer-bear

[5] See, for example, Quartel (2019). See also https://www.cato.org/publications/policy-analysis/rust-buckets-how-jones-act-undermines-us-shipbuilding-national

[6] Product tankers are designed to transport refined petroleum products, such as gasoline, from refineries to locations near consumer markets. They are smaller and more specialized than crude carriers. As of January 2019, the tanker segment constituted over half of the US-flag oceangoing privately-owned merchant Jones Act fleet.

[7] We believe the reason for this gap in the literature is the difficulty in obtaining price data associated with JA vessels. We were able to obtain this data from industry sources.

[8] See Fitzgerald (2019) for a discussion of the environmental costs associated with the JA.

[9] See, for example, https://www.cato.org/project-on-jones-act-reform and https://transportationinstitute.org/jones-act/ for two opposing views.

[10] See Temzelides (2019).

[11] Clearly, the constant 82% load suggested by Stopford is only a benchmark. This value will likely fluctuate, for example, depending on market balance.

[12] Our $/ton mile values are computed directly from the product tanker price data we obtained from industry sources. They are somewhat lower than the aggregate estimates provided by the Bureau of Transport Statistics, partly because the Bureau's indirect methodology involves other segments, such as containerships. See https://www.bts.gov/content/average-freight-revenue-ton-mile

[13]U.S. Army Corps of Engineers, Cargo and Trips Data Files, Statistics on Foreign and Domestic

Waterborne Commerce Move on the United States Waters.

[14] There is a sudden increase in September and then in December 2004, for which we have no obvious explanation. We perform a test to detect outliers in our sample, using a test based on a Pearson-Hartley statistic (Barnett and Lewis, 1972, page 298), and find that September 2004 and December 2004 are

outliers. We present results removing these two months from the sample. Robustness checks that include the entire sample show these do not significantly affect our estimates.

[15] Estimation results are not sensitive to the choice of the polynomial degree.

[16] For robustness, we study other specifications in the Appendix. These include US industrial production and US unemployment-related benefit claims. The results are similar to those shown here.

[17] See http://www.scorpiotankers.com/wp-content/uploads/2015/04/Scorpio-Tankers-Inc-October-Investor-Presentation.pdf. If foreign-flag ships were allowed to carry US domestic cargo, their costs could rise as a result of additional regulations. To address this, we also consider an international rate of $30,000/day in the Appendix.

[18] Lewis (2013) reports the total consumer welfare gain from removing the Jones Act to be between $461 and $646 million per year. However, his findings are not based on an estimated supply/demand model. Our results are only limited to oil product tankers.

[19] This issue is not limited to oil and gas. For example, in the past, New Jersey had to request a JA waiver from Congress in order to bring in salt during particularly severe winter storms. For the same reason, Maryland imports rock salt from Chile and not from Louisiana.

[20] The presence of seasonal risk that is borne by the shippers might provide an additional argument for increased competition in the US shipping industry.