The Interrelationship Between Coastal, Great Lakes, Inland, and Deep-Sea Freight Rates: A Longitudinal Approach

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This study examines freight rates in four key areas of the U.S. water freight transportation industry – coastal, Great Lakes/St. Lawrence River, inland waterways, and deep-sea shipping. The data involved in this study includes more than 20 years of longitudinal data on freight rates on all four of these sectors. The interrelationship between the freight rates is tested through forecasting methods to see if an increase or decrease in a freight rate in a given month leads to increases or decreases in other freight rates in the next month. This method assesses whether or not you can forecast one freight rate using data from another freight rate.

We find that inland freight rates are predictive of all three other freight rates, as an increase in inland freight rates is shown to lead to increases in all three other freight rates in the following month. Coastal and Great Lakes freight rates do not have any predictive power on other freight rates. However, deep sea freight rates do predict inland freight rate but at a much slower rate. An increase deep sea freight rate leads to an increase in inland freight rates after two months instead of one.

Explanations for this result may be that inland shipping is highly fragmented and competitive with more than 500 operators (Schlubach, 2019). Inland shipping also has lower barriers to entry with far less expensive vessels than ocean-going ships. By comparison coastal shipping has far higher barriers to entry than inland shipping due to much more costly ocean-going vessels and thus has fewer market participants (Rodrigue, 2020). As a result, inland shipping faces more competition than coastal shipping and thus may be quicker to adjust freight rates to meet market conditions. Other sectors such as coastal shipping have less flexibility and thus may be slower to adjust their rates to market conditions. Hence the most competitive sector, inland shipping, is the most predictive of the three less competitive sectors.

Deep sea shipping, like coastal shipping, has high barrier to entry but unlike coastal shipping this sector is involved in foreign trade and faces competition from foreign carriers. Hence deep-sea shipping freight rates may be predictive of future trends in international trade and thus may predict future trends in domestic transportation markets such as inland shipping. Implications of this study may be that maritime industry executives as well as customers of water freight transportation freight services can use inland freight rates to better predict trends in revenues and costs. Likewise, investors may be able to use inland freight rates to predict maritime stock prices. Both inland freight rates and deep sea freight rates may have potential to predict domestic and global economic trends and may improve economic forecasting accuracy.

1. Introduction and Literature Review

There has been strong interest in the academic literature on the role of ocean shipping rates as indicators of economic activity, although this has mostly been confined to the Baltic Dry Index (BDI). The BDI is a measure of global dry bulking shipping rates, and prior research has found that the BDI is a leading indicator for global stock market indices (Apergis and Payne, 2013; Manoharan and Visalakshmi, 2019, Lin et al., 2019). Other research has shown that BDI may predict GDP growth (Ghiorghe and Gianina, 2013; Bildirici et al., 2016), industrial production (Bakshi et al., 2012), or exchange rates (Han et al., 2020). The BDI has also been found to have significant interrelationships with prices of commodities such as gold (Bildirici et al., 2016) as well as iron ore (Gu et al., 2019). The BDI has also been found to be a significant predictor of ship prices (Xu et al., 2011, Ma and Sun, 2017).

Proposed reasons for the predictive ability of the BDI include the notion that dry bulk demand is a predictor of future industrial production (Lin et al., 2019; Bildririci et al., 2016). Shipping rates are also less prone to government manipulation than other indicators such as inflation and unemployment (Bakshi et al., 2012) and less prone to speculation than indicators such as stock and bond prices (Köseoğlu and Sezer, 2012). A more general reason for maritime shipping rates to be strong economic indicator includes the central role of all maritime shipping accounting for 80% of all goods shipped in global trade. (Han et al., 2020; Papapostolou et al., 2016). Hence it may be the case that other water transportation freight rates besides the BDI may also be valuable economic indicators.

Research on other water shipping rates has been extremely limited, but also show the potential of shipping rates other than the BDI to have economic forecasting value. Hsiao, et al. (2016) extend prior BDI research to include container shipping rates. They find that the BDI is a better economic indicator during an economic upturn due to dry bulk being a strong indicator of demand for raw materials, and container shipping rates to be a better indicator during an economic downturn due their role as an indicator of demand for finished goods. Similarly, Kim and Chang (2017) find that a Chinese index of global container freight rates predicts the BDI but not vice versa, again indicating that freight rates other than the BDI may be valuable economic indicators. Other research has found that clean tanker rates but not dirty tanker rates are good indicators of future economic trends (Li et al., 2018), perhaps due to clean tankers flexibility to convert to become a dirty tanker if economic conditions warrant it (Michail and Melas, 2020).

In spite of a significant amount of prior research on global ocean freight indices, there has been very little research on domestic water shipping rates. A limited number of studies have examined the domestic China Coastal Bulk Freight Index (CCBFI). This index was found to have no ability to predict the BDI (Xuying, 2009) or port activity (Jarrett et al., 2015), but some ability to predict investment activity (Gong and Lu, 2009). Domestic inland freight shipping rates have been used to predict choice of ports in Colombia (Cantilo et al., 2018) and Taiwan (Chou, 2009), but little or no research has been done on the ability of inland freight rates to predict other transportation freight rates or macroeconomic factors. In particular, little research has been done on inland shipping rates in the U.S. which has a very large inland waterway shipping sector that ships 630 millions tons annual with goods valued over $73 billion (Waterways Council, Inc., 2021). Given the size of the U.S. economy and emphasis on dry bulk in the inland shipping center, it may be the case that inland shipping rates (like the BDI) may be an important indicator of economic activity.

In summary, much research has shown that maritime shipping rates are strong economic indicators but most of this research has been done using the BDI. Some limited research suggests that global container and tanker freight rates may be solid economic indicators. Research on domestic coastal shipping has been limited primarily to China, with some research on inland shipping rates in Colombia in Taiwan. In spite of being the world's largest economy, largest importer, and second largest exporter there has been very little research on water transportation freight rates in the United States. This study will extend the work of Hsiao, et al. on the interrelationship between different global shipping rates by examining the interrelationship between shipping rates in four different sections in the U.S. water transportation market. Similar to prior studies on the BDI, we will also examine the ability of these four freight rates to predict future economic trends. This paper is organized as follows. Section 2 will provide an overview of the four water transportation sectors in the U.S. and explain why they might possess different economic signals. Section 3 will present the data, and Section 4 will present the results. Section 5 will conclude with an overview of the results along with implications and suggestions for future research.

2. Overview of U.S. Water Transportation Sectors

The four main sectors of the U.S. water transportation industry all differ greatly by size of ship, number of competitors, use of long-term contracts, and type of cargo. Coastal shipping refers to shipping along or between U.S. coasts. The primary cargo in this sector is liquid bulk, with 75% of vessels being tankers or tank barges (US MARAD, 2020). The primary routes of these tankers are from Alaska to West Coast refineries, between West Coast refineries, and from the Gulf and East Coasts to Florida.). While they are protected from foreign competition by the U.S. Jones Act, they are required to purchase U.S.-built ships which cost roughly $190 to $250 million and are several times more expensive than foreign-built ships (Fritelli, 2017). As a result, this is a relatively small sector with only 27 carriers.

The Great Lakes and St. Lawrence River sector is unique and consists of large fresh-water bodies populated by an aging fleet of lake freighters, some of which are 1000-foot and many are over 30-years old. This aging fleet primarily ships dry bulk, and shipping is done heavily through time charters with fixed freight rates. The cost of a U.S.-built Great Lake freighter is tough to accurately estimate since the last finished construction of a new freighter was in 1983 (Maritime Executive, 2021), but a Chinese-built lake freight was recently purchased by a Canadian carrier for around $250 million (Tinsley, 2014). A U.S.-built freighter would likely cost considerably more indicating a high barrier to entry. This may explain why there are only 17 carriers in this sector.

The inland waterway sector is by far the most competitive of the four sectors with over 500 carriers (Schlubach, 2019). Vessel costs in this sector are far lower than a U.S.-built coastal-size ship or a lake freighter, with the cost of a U.S.-built river barge tow ship being around $25 million (Fritelli, 2017). Not only is it the most competitive sector it is also the largest as it ships over 500 million short tons per year, more than all of the other three sectors combined. Like the Great Lakes sector, it also primarily ships dry bulk.

The deep-sea sector involves U.S.-flagged ships that ship between U.S. and non-U.S. ports. This sector is unique in that they are not required to purchase U.S.-built ships, which dramatically lowers the cost of a vessel to $25 to $30 million compared to the much higher cost of U.S.-built ships in the coastal sector (Fritelli, 2017). Deep-sea carriers are still required to use a U.S. crew, the cost of which are partially covered by U.S. subsidy programs. There are 21 U.S. carriers in this sector (U.S. Department of Transportation Maritime Administration, 2017), but they must compete with numerous non-U.S. carriers which makes this sector much more competitive. The primary cargo is finished goods – container ships and roll-on/roll-off ships (United States Government Accountability Office, 2018).

In summary, two of the sectors (deep-sea and inland) have lower barriers to entry and operate in more competitive environments. The other two sections (Great Lakes and coastal) are marked by high barriers to entry, long-term charter contracts, and only a small number of competitors. Each sector also specializes in one specific type of cargo – dry bulk (inland and Great Lakes), liquid bulk (coastal), and finished goods (deep-sea). Table 1 provides a summary of the four sectors.

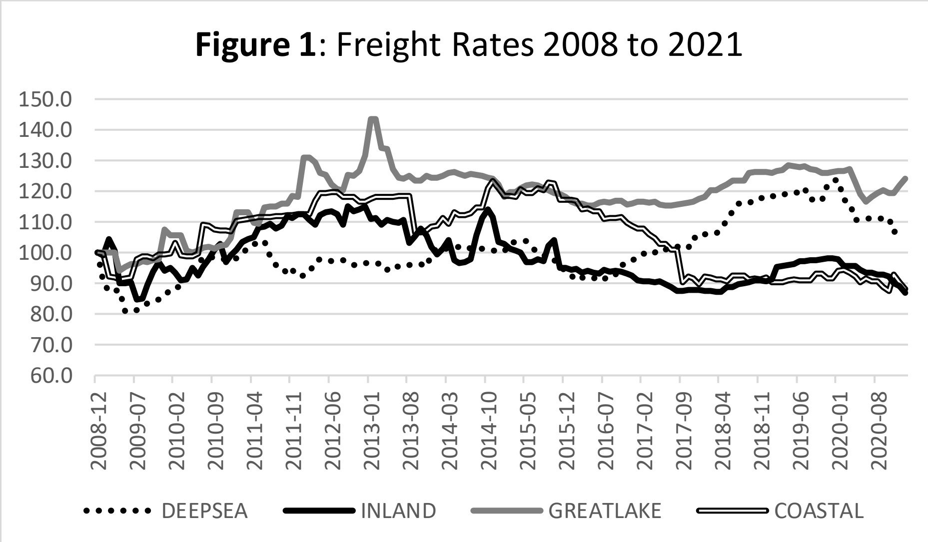
Table 1: Summary of Four U.S. Water Transportation Sectors

Sector	# of U.S. competitors	# of U.S. vessels	Freight (in million short tons, 2019)	Primary Cargo	Avg Vessel Cost***
Great Lakes	17	54	82.1	Dry bulk	Not available (none built since 1983 but likely similar to coastal)
Inland	Over 500*	39,670	502.3	Dry bulk	~$25 million
Coastal	27	~270	154.1	Liquid bulk	$190-$250 million
Deep Sea	10 U.S. ~75 foreign	84	21.2**	Finished goods (containers and vehicles)	$25-$30 million

Data from U.S. Army Corps of Engineers Waterborne Transportation Statistics except where stated.
*(Schlubach, 2019)**(Buzby, 2018, USACE IWR Pt 5, 2019), ***(Fritelli, 2017)

3. Data

Monthly freight data covering the period 12/1/2008 to 1/1/2021 was obtained from the U.S. Bureau of Labor Statistics, which publish a series of producer price indices for different modes of freight transportation. This includes INLAND, which are the freight rates for inland waterway transportation. COASTAL referes to coastal and intracoastal maritime transportation freight rates. GREATLAKES are the freight rates for transportation for the Great Lakes and St. Lawrence River. Finally, DEEPSEA is an index for freight rates for U.S. flagged ships that provide services between U.S. ports and non-U.S. ports. Figure 1 below shows the changes in freight rates over time. The rates appear to move relatively independently from each other, with DEEPSEA and GREATLAKE having a slight upward trend and the other rates having a slight downward trend. All rates are normalized at 100 for 12/1/2008.



Additional macroeconomic variables that might influence cost or demand for freight transportation was also collected. TRADE refers to total U.S. exports and imports, and the source of this data is the U.S. Census Bureau. CRUDE refers to crude oil prices, and the data was obtained from the International Monetary Fund. CPI is the consumer price index published by the U.S. Bureau of Labor Statistics. WATERTON refers to water tonnage shipped through inland waterways. Monthly GDP data is not widely available, so as an alternative measure of economic activity we chose primary industrial production (PRIMIND) which can measure demand for bulk materials. Table 2 summarizes the variables and the sources of data.

Table 2: Data Description and Sources

Variable	Description	Source
COASTAL	U.S. coastal and intracoastal freight rates	U.S. Bureau of Labor Statistics
DEEPSEA	U.S. flagged freight rates between U.S. and foreign ports	U.S. Bureau of Labor Statistics
INLAND	U.S. inland and intracoastal waterway freight rates	U.S. Bureau of Labor Statistics
GREATLAKE	U.S. freight rates on the Great Lakes and St. Lawrence River	U.S. Bureau of Labor Statistics
TRADE	Sum of U.S. imports and exports	U.S. Census Bureau
CPI	U.S. Consumer Price Index	U.S. Bureau of Labor Statistics
WATERTON	Tonnage for internal U.S. waterways	U.S. Bureau of Transportation
INDPRO	Industrial production for U.S. primary industry	Federal Reserve Board of Governors
CRUDE	Crude oil prices	International Monetary Fund

Data analysis was done using logged first differences rather than absolute levels of each variable. The first reason for this is that logged first differences lend to easier economic interpretation, as they approximate percentage changes from month to month. Thus we can assess how a percentage change in one variable can lead to a percentage change in another variable. The second reason is the Dickey-Fuller and Phillips-Perron unit root tests show that the data for all freight rates are non-stationary for levels but stationary for first differences The same holds true for PRIMIND, CPI, and CRUDE. WATERTON is the only variable which is stationary at levels for both unit roots (but also stationary for first differences). Non-stationary data can lead to spurious and unreliable results (Zivot and Wang, 2007) , so first differences are used to ensure all variables used in the analysis are stationary.

Table 3 presents the descriptive statistics for logged first differences of all variables included in this study. All four of the freight rates have similar properties, which mean and median monthly changes of close to zero and standard deviations around 0.02. The low skewness values indicate a normal distribution, but the high kurtosis values indicate that larger outliers are experienced compared to what one would expect with a normal distribution. Of the remaining macroeconomic variables, CPI and PRIMIND have lower standard deviations than the freight rates. WATERTON, TRADE, and CRUDE have considerably higher standard deviations than the freight rates with CRUDE having the highest standard deviation at 0.115 and also by far the largest range between minimum and maximum monthly changes. Overall, the variables show low average monthly changes and generally have leptokurtic rather than normal distributions.

Table 3: Descriptive Statistics of Logged Monthly Changes

	N	Mean	Std. Dev.	Min	Max	Median	Kurtosis	Skewness
COASTAL	143	-0.001	0.022	-0.112	0.091	0	12.783	-1.071
DEEPSEA	143	0	0.019	-0.097	0.045	0.001	9.298	-1.659
INLAND	143	-0.001	0.026	-0.112	0.078	0	6.695	-0.88
GREATLAKE	143	0.001	0.021	-0.068	0.104	0	11.581	1.497
TRADE	143	0.003	0.059	-0.231	0.177	-0.01	4.565	0.286
CPI	143	0.001	0.003	-0.007	0.01	0.001	3.084	-0.039
WATERTON	143	0.001	0.072	-0.249	0.2	0.002	3.555	-0.144
PRIMIND	143	0	0.016	-0.126	0.045	0.001	28.996	-3.328
CRUDE	143	0	0.115	-0.575	0.538	0.011	12.068	-0.841

Another diagnostic we perform is for optimal lag length. We use lagged values of variables in this study to examine whether past values of some variables lead to future changes in other variables. Following Liew we use two different criteria to assess optimal lag length, the final prediction error (FPE) and the Aikake Information Criteria (AIC). Both criteria suggest a lag length of three. One lag is used for the first differencing process, which leaves two lags for the regression analysis. A final diagnostic we perform is the Johansen test for cointegration (Johansen, 1995). The null hypothesis of no cointegrating vectors cannot be rejected, which suggests that it is not necessary to control for a long-term cointegrating relationship in our regression models.

4. Methodology and Results

The primary regression method used for the analysis is a vector autoregressive (VAR) model (Eroglu and Hofer, 2011; Johansen, 1988), which uses the principle of Granger causality (Granger, 1969) to determine if past changes in variables predict future changes in other variables. Granger causality starts with the assumption that future events do not predict past events, but if past events predict future events it is evidence of a causal relationship or an information flow. A VAR model with the four freight rates involves four different regressions, one with each of the four freight rates as a dependent variable. We add TRADE as an indicator of demand for transportation services as a fifth variable. The regressors for each model are identical with lagged values of each of the four freight rates. The purpose of these models is to see if past values of any of the freight rates predict future values of any of the freight rates, and allows us to assess potential directions of causality or information flows.

Equation 1 in the VAR model is:

$$\Delta lnTRADE_t = \alpha_0 + \alpha_1 \Delta \ln TRADE_{t-1} + \alpha_2 \Delta lnTRADE_{t-2} + \alpha_3 \Delta \ln INLAND_{t-1} + \alpha_4 \Delta lnINLAND_{t-2} + \alpha_5 \Delta lnCOASTAL_{t-1} + \alpha_6 \Delta lnCOASTAL_{t-2} + \alpha_7 \Delta lnDEEPSEA_{t-1} + \alpha_8 \Delta lnDEEPSEA_{t-2} + \alpha_9 \Delta lnGREATLAKE_{t-1} + \alpha_{10} \Delta lnGREATLAKE_{t-2} + \mu_t \quad (1)$$

This equation tests the predictive power of the four freight rates on the level of international trade volume. The independent variables are the freight rates and TRADE with a one month lag (t-1) and a two month lag (t-2).

The remaining question equations have identical regressors as Equation 1, but each one of them as a different freight rate. Equations 2-5 with lagged first differences of INLAND, COASTAL,

$$\Delta lnINLAND_t = \alpha_0 + \alpha_1 \Delta \ln TRADE_{t-1} + \alpha_2 \Delta lnTRADE_{t-2} + \alpha_3 \Delta \ln INLAND_{t-1} + \alpha_4 \Delta lnINLAND_{t-2} + \alpha_5 \Delta lnCOASTAL_{t-1} + \alpha_6 \Delta lnCOASTAL_{t-2} + \alpha_7 \Delta lnDEEPSEA_{t-1} + \alpha_8 \Delta lnDEEPSEA_{t-2} + \alpha_9 \Delta lnGREATLAKE_{t-1} + \alpha_{10} \Delta lnGREATLAKE_{t-2} + \mu_t \quad (2)$$

$$\Delta lnCOASTAL_t = \alpha_0 + \alpha_1 \Delta \ln TRADE_{t-1} + \alpha_2 \Delta lnTRADE_{t-2} + \alpha_3 \Delta \ln INLAND_{t-1} + \alpha_4 \Delta lnINLAND_{t-2} + \alpha_5 \Delta lnCOASTAL_{t-1} + \alpha_6 \Delta lnCOASTAL_{t-2} + \alpha_7 \Delta lnDEEPSEA_{t-1} + \alpha_8 \Delta lnDEEPSEA_{t-2} + \alpha_9 \Delta lnGREATLAKE_{t-1} + \alpha_{10} \Delta lnGREATLAKE_{t-2} + \mu_t \quad (3)$$

$$\Delta lnDEEPSEA_t = \alpha_0 + \alpha_1 \Delta \ln TRADE_{t-1} + \alpha_2 \Delta lnTRADE_{t-2} + \alpha_3 \Delta \ln INLAND_{t-1} + \alpha_4 \Delta lnINLAND_{t-2} + \alpha_5 \Delta lnCOASTAL_{t-1} + \alpha_6 \Delta lnCOASTAL_{t-2} + \alpha_7 \Delta lnDEEPSEA_{t-1} + \alpha_8 \Delta lnDEEPSEA_{t-2} + \alpha_9 \Delta lnGREATLAKE_{t-1} + \alpha_{10} \Delta lnGREATLAKE_{t-2} + \mu_t \quad (4)$$

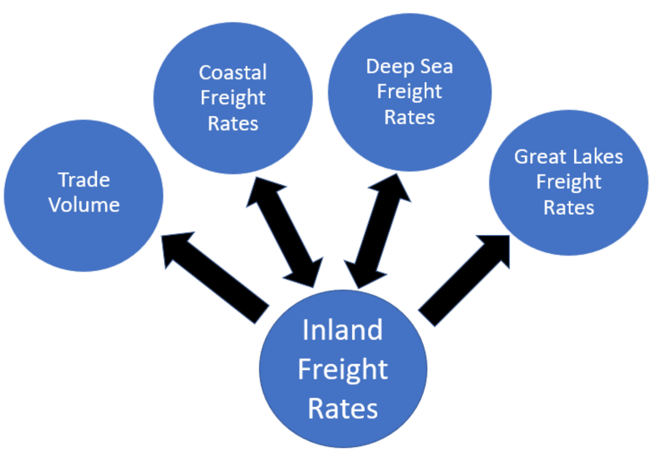
$$\Delta lnGREATLAKE_t = \alpha_0 + \alpha_1 \Delta \ln TRADE_{t-1} + \alpha_2 \Delta lnTRADE_{t-2} + \alpha_3 \Delta \ln INLAND_{t-1} + \alpha_4 \Delta lnINLAND_{t-2} + \alpha_5 \Delta lnCOASTAL_{t-1} + \alpha_6 \Delta lnCOASTAL_{t-2} + \alpha_7 \Delta lnDEEPSEA_{t-1} + \alpha_8 \Delta lnDEEPSEA_{t-2} + \alpha_9 \Delta lnGREATLAKE_{t-1} + \alpha_{10} \Delta lnGREATLAKE_{t-2} + \mu_t \quad (5)$$

Table 4 presents the results of Equations 1 through 5. The most striking result in that lagged values of INLAND significanly predict TRADE as well as all three other freight rates. DEEPSEA also significantly predicts INLAND and GREATLAKE. COASTAL significantly predicts INLAND, but GREATLAKE does not predict any of the other variables. Interestingly TRADE does not predict any of the freight rates. It appears than INLAND may be a predictor of future economic trends, include future import and export trends.

Table 4: Summary of Regression Results With Equations 1 Through 5

Regressor	Dependent Variable (5) $\Delta \ln TRADE_{t-1}$	(1) $\Delta \ln INLAND_{t-1}$	(2) $\Delta \ln COASTAL_{t-1}$	(3) $\Delta \ln DEEPSEA_{t-1}$	(4) $\Delta \ln GREATLAKE_{t-1}$
$\Delta \ln TRADE_{t-1}$	-0.392***	1.989	0.038	0.004	-0.0281
	(0.084)	(3.823)	(0.033)	(0.026)	(0.033)
$\Delta \ln TRADE_{t-2}$	-0.119	3.473	0.011	-0.006	-0.003
	(0.083)	(3.777)	(0.032)	(0.026)	(0.032)
$\Delta \ln INLAND_{t-1}$	0.004**	0.0870	0.002**	0.001**	0.001*
	(0.002)	(0.0787)	(0.001)	(0.0005)	(0.0007)
$\Delta \ln INLAND_{t-2}$	-0.0005	-0.186**	-0.0001	0.00002	-0.00001
	(0.002)	(0.083)	(0.001)	(0.001)	(0.001)
$\Delta \ln COASTAL_{t-1}$	-0.155	0.554	-0.055	-0.0263	-0.011
	(0.215)	(9.811)	(0.084)	(0.067)	(0.084)
$\Delta \ln COASTAL_{t-2}$	0.187	17.41*	-0.006	-0.051	-0.075
	(0.208)	(9.519)	(0.081)	(0.065)	(0.081)
$\Delta \ln DEEPSEA_{t-1}$	0.199	11.53	0.090	0.105	-0.034
	(0.274)	(12.51)	(0.107)	(0.086)	(0.107)
$\Delta \ln DEEPSEA_{t-2}$	0.119	24.19**	-0.032	0.174**	0.209**
	(0.250)	(11.41)	(0.097)	(0.078)	(0.098)
$\Delta \ln GREAT_{t-1}$	-0.189	-0.401	-0.009	0.096	0.111
	(0.213)	(9.734)	(0.083)	(0.067)	(0.083)
$\Delta \ln GREAT_{t-2}$	0.0645	-1.075	0.153	0.030	-0.012
	(0.212)	(9.698)	(0.083)	(0.066)	(0.083)
Constant	0.006	-0.142	-0.0004	0.001	0.0011
	(0.005)	(0.206)	(0.002)	(0.001)	(0.002)
Adjusted R^2	0.127	0.056	0.072	0.028	0.006
Observations	141	141	141	141	141

Figure 2: Summary of Regression Results



For additional analysis, we include CPI, PRIMIND, CRUDE, and WATERTON as substitutes for TRADE in Equation 1 through 5 in a series of additional VAR models. This allows for an analysis as to whether or not INLAND can predict other economic indicators. Table 5 summarizes the results of these VAR models.

Table 5: Regression results with INDPRO, CPI, CRUDE, and WATERTON

	INDPRO	CPI	CRUDE	WATERTON
INLAND	n/a	INLAND (-) → CPI*	n/a	INLAND→ WATERTON**
COASTAL	n/a	COASTAL (-) → CPI*	n/a	n/a

DEEPSEA	DEEPSEA →INDPRO*	DEEPSEA → CPI**	DEEPSEA → CRUDE*	n/a
GREATLAKES	n/a	n/a	GREATLAKE← CRUDE*	n/a

The freight rate with the most explanatory power in these regressions is DEEPSEA, which significantly predicts INDPRO, CPI, and CRUDE. INLAND significantly predicts CPI and WATERTON, and COASTAL predicts CPI. Interestingly, CPI does not predict freight rate changes but three of the freight rates significantly predict CPI. The macroeconomic variables show little ability to predict freight rates, with the exception of CRUDE which significantly predicts GREATLAKE.

5. Conclusion

Overall this study finds that inland and deep sea shipping rates have the best predictive power. Inland freight rates can predict deep sea, coastal, and Great Lake shipping rates. Inland freight rates can also predict trade volume, inflation, and water tonnage. Deep sea freight rates can predict inland freight rates but not other freight rates, but it is a significant predictor of inflation, industrial production, and crude oil prices. Interestingly, the macroeconomic variables are not effective predictors of freight rates. These results suggest that freight rates may possess signals about the future direction of the economy.

Inland in particular is highly competitive with a large number of carriers and low barriers to entry, which means their freight rates can rapidly adjust to changes in freight demand. Inland also primarily ships dry bulk which is an indicator of an early stage of an economic upturn. Deep sea freight only has a small number of competitors, but unlike other U.S. flagged water transportation modes they face competition from foreign competitors. Deep sea also primarily ships finished goods in container or roll-on/roll-off ships. Finished goods represent the level of demand from consumers, which can also be a valuable indicator of future economic trends. The lack of much significant predictive ability of coastal and Great Lake freight rates may be due to the smaller number of carriers, high barrier to entry, and long-term fixed contracts which all means that these freight rates cannot quickly adjust.

A major implication of this study is that the BDI is not the only water freight rate that can be used for economic forecasting. More accurate forecasting may be achieved if inland and deep sea freight rates are included. Maritime professionals might also be able to better prepare future projections of trends in the water transportation industry by using inland and deep sea freight rates. An implication for policymakers is that while inland and deep sea transportation seem to have competive, market based freight rates, the same cannot be said for coast and Great Lake shipping. Given the large scale energy efficiencies of water transportation compared to ground or air transportation (Berg, 2016), policymakers may wish to change regulations to make these freight rates more competitive to encourage more marine shipping over less energy efficient transportation modes.

A limitation of this study is that the data is limited to U.S. shipping companies and it is not clear if the results are generalizable to other countries. Inland shipping in the U.S. is primarily limited to north/south transportation and mostly to the central and east portion of the U.S. Other regions of the world such as the European Union, Russia, and China have more extensive inland waterway networks. Coastal shipping in the U.S. is unique in that carriers are legally required to purchase domestic ships which cost two to fours times as much as the international market rate for ships. It is possible that coastal freight rates may be a better economic indicator in countries without the domestic ship purchase requirement. Thus future research should be done to see if the results from this study hold up in countries considerably different market conditions in the water transportation sectors.

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