The Impact of Increased Ocean Freight Rates on Soybean Spread between the United States and China during the Post-COVID Era

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Background

- Lingering effects of Covid-19, such as increased freight demand and supply chain disruptions, have led to a historic rise in ocean freight rates since late 2020 (UNCTAD, 2021).
- Ocean shipping plays a crucial role in international trade, accounting for 80-90 % of its volume and 60-70% of its value (UNCTAD, 2018).
- Specifically, more than 80% of grains are transported by sea via dry bulk carriers.
- Depending on the sensitivity of consumers to the commodity, increases in transportation costs can widen the marketing margin by passing on the costs to consumers in the form of higher commodity prices and to producers in the form of lower prices.
- The United States is one of the top soybean producers, exporting approximately half of its soybean output worldwide.
- China is the largest importer of U.S. soybeans.

Objective

- Many agricultural economic studies overlook the question of how transportation costs affect suppliers and consumers of commodities in international trade.
- This paper aims to investigate the incidence of transportation costs between the United States and Chinese soybean markets due to the spike in ocean freight rates during the post COVID-era.

Theoretical Foundation

- This study is founded on a two-region spatial equilibrium model (Yu and Fuller, 2005; Yu et al., 2010; Babcock and Fuller, 2007; Babcock and Gayle, 2014).
- This model is designed to illustrate the freight transport demand, which determines the equilibrium transportation rates and grain transported between two regions.

Figure 1. Two-Region Spatial Equilibrium Model and Derived Transportation Market

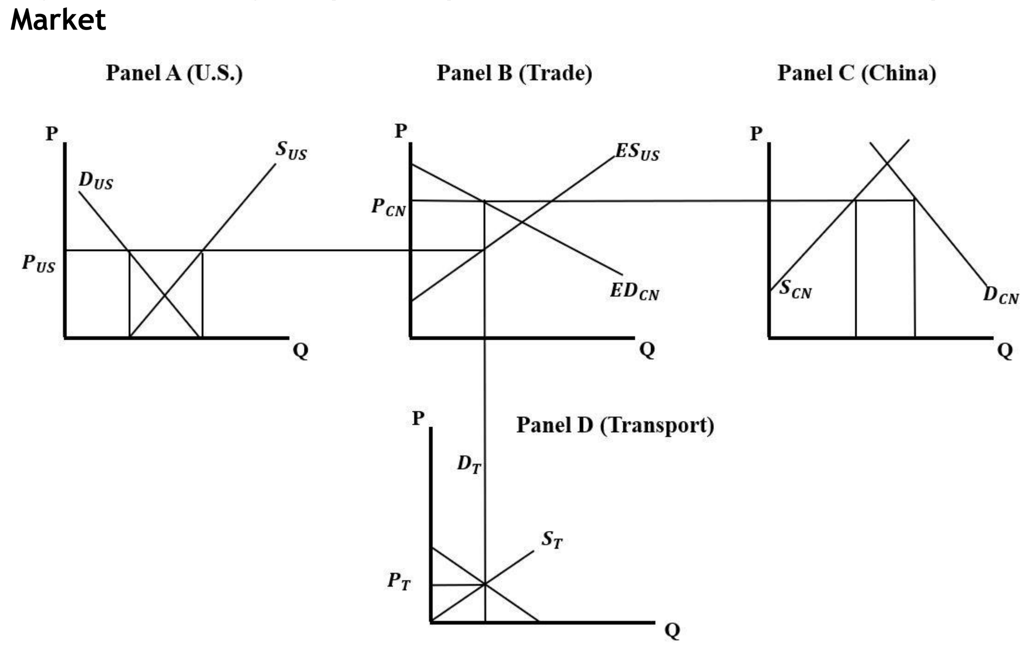


Figure 2. Impacts of Increased Ocean Freight Rates on the Spread between the United States and Chinese Soybean Markets

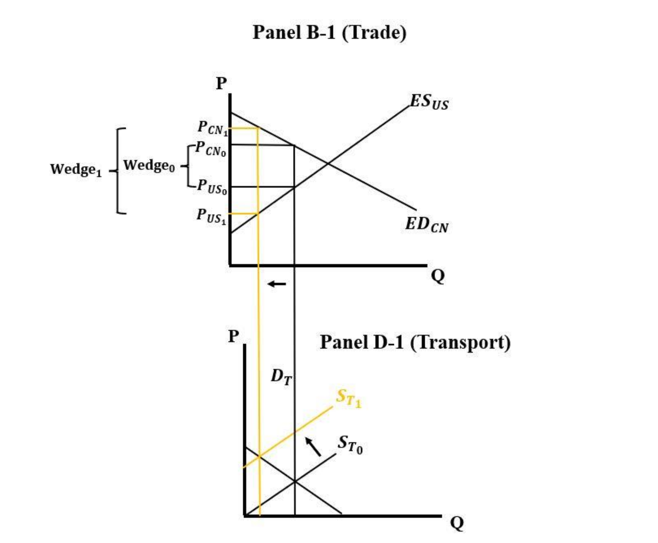


Figure 3. Elastic Soybean Excess Demand Relative to Excess Supply

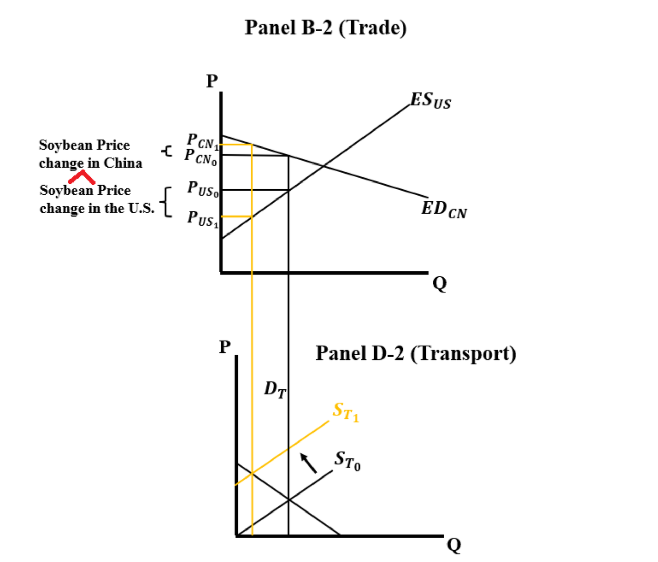
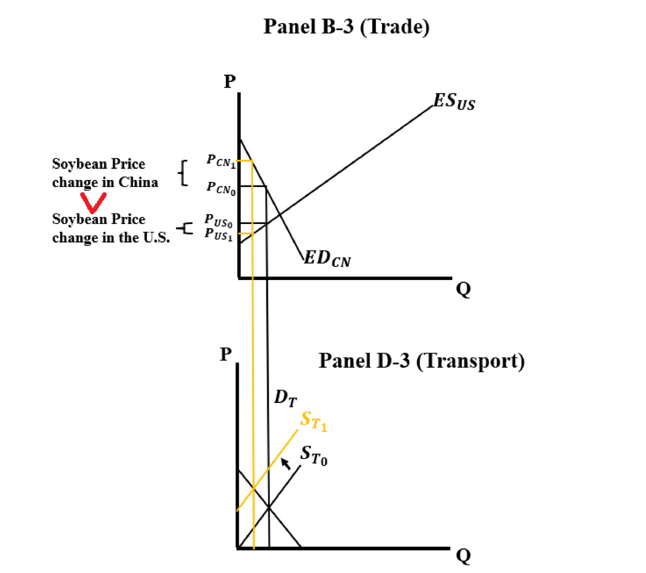


Figure 4. Relative Inelastic Soybean Excess Demand Relative to Excess Demand



Empirical Approach

❑ Impact of ocean freight rates on soybean spread between China and the United States

$$SoybeanSpreads_t = \beta Rates_t + \delta ExchangeRate_t + \sum_{m=1}^{12} [Production_y \times \theta_m] + \varepsilon_t$$

, where $SoybeanSpreads_t$ represents the simultaneous soybean spot prices at ports in Dalian, China and ports in U.S. Gulf pairs at week t (i.e., $P_{CN,t} - P_{US,t}$). $Rates_t$ represents the cost of shipping dry bulk commodities such as grains from Davant port in the United States to Dalian port in China by a Panamax-sized vessel. $ExchangRate_t$ is the Chinese Yuan Renminbi to U.S. Dollar spot exchange rate at week t. $Production_y$ is U.S. soybean production in a given marketing year. We control production size by interacting $Production_y$ with mean effects for a given month, θ_m.

❑ The incidence of increased ocean freight rates on soybean prices in the United States and China

Following Bushnell et al. (2022), we use a cointegrated error correction model to estimate the extent to which the burden of transportation costs was borne by the United States and China.

A Cointegrated Error Correction Model

$$\Delta P_{CN,t} = \alpha_{CN}(P_{CN,t-1} - P_{US,t-1} - \beta Rates_{t-1} - \delta) + \gamma_{11}\Delta P_{CN,t-1} + \gamma_{12}\Delta P_{US,t-1} + \gamma_{13}\Delta Rates_{t-1} + \epsilon_{CN,t}$$

$$\Delta P_{US,t} = \alpha_{US}(P_{CN,t-1} - P_{US,t-1} - \beta Rates_{t-1} - \delta) + \gamma_{21}\Delta P_{CN,t-1} + \gamma_{22}\Delta P_{US,t-1} + \gamma_{23}\Delta Rates_{t-1} + \epsilon_{US,t}$$

$$\Delta Rates_t = \alpha_{Rates}(P_{CN,t-1} - P_{US,t-1} - \beta Rates_{t-1} - \delta) + \gamma_{31}\Delta P_{CN,t-1} + \gamma_{32}\Delta P_{US,t-1} + \gamma_{33}\Delta Rates_{t-1} + \epsilon_{Rates,t}$$

Data

- Our data consists of weekly data spanning from January 2016 to December 2021.
- Ocean freight rates are measured using the Dry Freight Rates Panamax Grains, specifically from the United States (Davant) to China (Dalian), and are obtained from the Refinitiv workspace. These rates are expressed in US dollars per metric ton.
- For the soybean spread calculation, we use the soybean spot prices in the U.S. Gulf and China Dalian. The spread is calculated as the price in China Dalian minus the price in the U.S. Gulf. These prices are expressed in US dollars per bushel and are obtained from the Refinitiv workspace.
- We consider the US Gulf No.2 Yellow soybean spot price as the U.S. soybean price, while the U.S. No.2 Yellow soybean import price at Dalian port represents the U.S. soybean price in China. These prices are expressed in US dollars per ton and are available from the Bloomberg terminal.

Table 1. Descriptive Statistics

	Obs.	Mean	Std. Dev.	Min	Max
Ocean freight rates (USD)	313	38.57	13.30	16.3	79.92
Soybean spread (USD/Ton.)	313	3.52	1.13	0.45	6.95
Exchange rate (CYR to USD)	313	6.71	0.23	6.27	7.15
US soybean production (Million bushels)	313	4185.51	315.65	3551.91	4465.38

Preliminary Results

Table 2. Unit root and cointegration tests

	China price	U.S. price	Freight rates
Dickey-Fuller GLS test (5% CV=-2.891)	-1.059	-1.422	-1.913
Johansen Trace test			
- The null hypothesis of no cointegration (5% CV=29.68)		55.05**	
- The null hypothesis of one or fewer cointegrating vectors (5% CV=15.41)		6.70	

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 3. Diagnostic checks

	Diagnostics
Observations	313
Lag size	3
Log likelihood Function	-645.22
Correlation between $\epsilon_{CN,t}$ and $\epsilon_{US,t}$	0.65

Table 4. The impact of ocean freight rates on soybean spreads

	Soybean Price Spreads (the United States and China)		
	(1)	(2)	(3)
Ocean freight rates	0.033***	0.026***	0.015***
	(0.005)	(0.005)	(0.005)
Exchange rate	0.676***	0.394*	-0.068
	(0.238)	(0.226)	(1.147)
Constant	-2.300	-0.112	
	(1.628)	(1.576)	
Month effects	No	Yes	Yes
Production X Month effects	No	No	Yes
Observations	313	313	313
R^2	0.14	0.22	0.93
$Adj.R^2$	0.13	0.19	0.93

Robust standard errors in parentheses, clustered at the week level when time-fixed effects used.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 5. The cointegrated error correction model for soybean prices in the United States and China

	Cointegrated error correction model		
Ocean freight rates(β)		0.025**	
		(0.010)	
Constant (δ)		-2.949	
	Price in China	Price in the U.S.	Freight rates
Error correction equations			
- Lagged error correction term (α)	-0.130***	-0.055***	-0.311***
	(0.025)	(0.011)	(0.119)
- Lagged difference (LD.) in price in China (γ_1)	-0.556***	-0.644***	0.596*
	(0.066)	(0.029)	(0.318)
- Lagged difference (LD.) in price in the U.S. (γ_2)	0.287*	0.510***	-0.270
	(0.153)	(0.069)	(0.743)
- Lagged difference (LD.) in ocean rates (γ_3)	-0.006	0.001	0.257***
	(0.012)	(1.154)	(0.056)

Robust standard errors in parentheses, clustered at the week level when time-fixed effects used.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 6. Long-run impulse responses to ocean freight rates

	Price in China	Price in the U.S.	Freight rates
Long-run impulse response	0.009	-0.043	1

Notes: we assume that soybean prices cannot influence ocean freight rates in the same week for impulse responses identification.

Conclusion

- We found that increased ocean freight rates have a significantly positive impact on soybean spreads, with the incidence falling more on China than on the United States.
- Our research provides insights into the importance of transportation costs in shaping the dynamics of the global soybean market by estimating the changes in soybean spreads between the United States and China.