The Russia-Ukraine War and Wheat Supply Chain in South Africa: A Port-Level Analysis

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The Russia-Ukraine War and Wheat Supply Chain in South Africa: A Port-Level Analysis

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Russia-Ukraine War and Global Wheat Supply

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War in Ukraine + Add to myFT

Russia attack on Ukraine set to hit global food supply chains

The warring countries account for a third of the world's wheat exports and a fifth of its corn trade

The New York Times

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How Russia's War on Ukraine Is Worsening Global Starvation

Moscow blocks most shipments from Ukraine, one of the world's largest wheat producers, and its attacks on the country's energy grid also disrupt the flow of food.

Background

- The longstanding Russo-Ukrainian War, initiated in 2014, witnessed a notable escalation on 24 February 2022, marked by Russia's invasion of Ukraine.
- Escalating worries emerge due to Russian efforts aimed at crippling Ukrainian grain exports, raising concerns about a potential food crisis.
- Russia, the world's largest wheat exporter with over 18% of global exports, partnered with Ukraine in 2019 to collectively supply 25.4% of the world's total wheat exports.

Motivation

- Multiple studies have drawn attention to the direct link between the ongoing conflict and the subsequent global shortage in wheat supply, which has led to a crisis in prices (Rose, Chen, and Wei (2023), Novotná, Rowland, and Janek (2023), Bertassello, Winters, and Müller (2023), Carter and Steinbach (2023)).
- Several studies raise specific concerns about the broader food security issue, particularly focusing on African countries.(Balma et al. (2022), Kohnert (2022), McGuirk and Burke (2022)).
- Nevertheless, there remains limited understanding of how the war has impacted African countries' responses to the disruption in wheat trade.

Research Question

This research investigates the implications of the Russia-Ukraine war on wheat trade responses, with a specific focus on South Africa.

- We study the war's impact on the wheat trade flow of Africa's largest importing economy and analyze how South Africa mitigates geopolitical risks by diversifying its sourcing at the granular port level.

Research Question

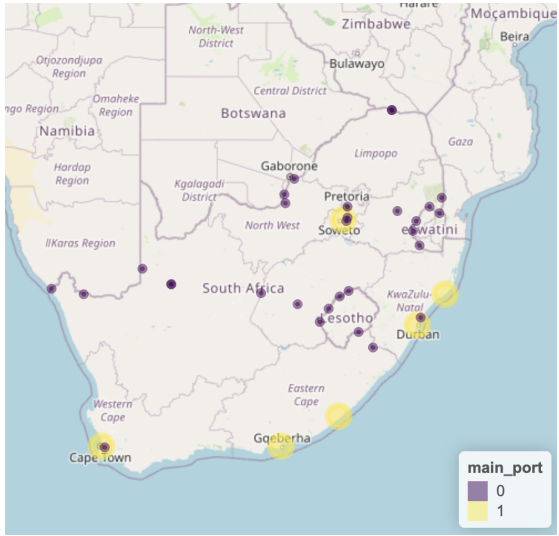
We specifically address the following `four` research questions:

- War impact on South Africa's wheat import
- War impact on South Africa's port-level import diversification
- Port-level diversification and its import volatility
- War impact on South Africa's wheat export

Data

- Primary Data: Port-level trade data (*from* The Observatory of Economic Complexity).
  - → Year: From January 2015 to July 2023
  - → Geographic unit: Port (trading district office)
- For the import analysis, we restricted the sample to 6 major ports because most of wheat imports are maritime trade and it occurs through 6 major ports.
  - → Major ports: Cape Town, Durban, East London, Johannesburg, Port Elizabeth, Richards Bay
- For the export analysis, we includes all ports that are observed with trade records in the data.

Map of South Africa



Notes. Yellow circle indicates major ports and the purple dots indicate the the other ports

1. War impact on South Africa's wheat import

The main specificaiton is as follows:

$$y_{ijt} = exp[\beta_0 + \beta_1 \textit{Post}_t + D_{mo(t)} + D_{yr(t)} + \gamma_i + \delta_j]\varepsilon_{ijt}$$

- The subscript t indicates time in month-year. $\textit{Post}_t$ is a binary variable equal to 1 in any time after the event (Feburary 2022) otherwise 0.
- $D_{mo(t)}$: month dummies, $D_{yr(t)}$: year dummies, γ_i: major port FEs, δ_j: exporter FEs

Result 1: War impact on South Africa's wheat import

Dependent variable: Import Quantity (1000 MT)		
	(1)	(2)
Post	-0.045	-0.067
	(0.327)	(0.446)
Port Fixed Effects (FEs)	✓	✓
Exporter FEs	✓	✓
Month FEs	✓	✓
Year FEs		✓
Observations	9,579	9,579
Pseudo R2	0.516	0.518

Notes. Parameters are estimated using Poisson Quasi MLE. Standard errors are clustered at port-exporter pair and reported in parentheses. The p-values read as follows: $^{+} < .10, ^{*} p < .05, ^{**} p < .01, ^{***} p < .001$.

2. War impact on South Africa's port-level import diversification

Import Diversification

The measure is Hirschman-Herfindahl Index (HHI) defined for each port *i* as follows:

$$HHI_i = \sum_j \left[\frac{M_{ji}}{\sum_j M_{ji}} \right]^2$$

where M_{ji} is the import quantity of wheat from source country j at the port i. We calculate this index for each time period t.

2. War impact on South Africa's port-level import diversification

The main specificaiton is as follows:

$$HHI_{it} = \alpha_1 HHI_{i,t-1} + \beta_1 \textit{Post}_t + D_{mo(t)} + D_{yr(t)} + \gamma_i + \varepsilon_{it}$$

Add some variation on post-war shock:

$$HHI_{it} = \alpha_1 HHI_{i,t-1} + \beta_1 \textit{Importance}_i \times \textit{Post}_t + D_{mo(t)} + D_{yr(t)} + \gamma_i + \varepsilon_{it}$$

where *Importance*$_i$ represents the importance of ports in terms of trade linkage associated with the total output of the economy. importance

Result 2: War impact on South Africa's port-level import diversification

DEPENDENT VARIABLE: Port-level diversification measure (HHI)

	(1)	(2)	(3)	(4)
Lag HHI	0.140	0.106	0.269	0.223
	(0.174)	(0.155)	(0.179)	(0.152)
Post	-0.057	-0.067**		
	(0.195)	(0.254)		
Exposure (Importance*Post)			0.024	-0.159*
			(0.025)	(0.084)
Marginal Effects [Post, Exposure]	-0.018	-0.205***	0.007	-0.050*
	(0.064)	(0.062)	(0.008)	(0.026)
Port FEs	✓	✓	✓	✓
Month FEs	✓	✓	✓	✓
Year FEs		✓		✓
Observations	612	612	612	612

Notes. Parameters are estimated using QMLE fractional probit regression. Standard errors are clustered at port level and reported in parentheses. The p-values read as follows: $^{+} < .10, ^{*} p < .05, ^{**} p < .01, ^{***} p < .001$.

3. Port diversification and annual import volatility

Import Volatility

First we define residual change of monthly import between *i* and *j* as follows:

$$\Delta imp_{ij,y,m} = imp_{ij,y,m} - imp_{ij,y,m-1} = \overline{\Delta imp}_{ij,m} + v_{ij,y,m}$$

By this specification, residual change ($v_{ij,y,m}$) is defined as the change that is not explained by the average monthly changes in port-exporter import during the sample period ($\overline{\Delta imp}_{ij,m}$).

3. Port diversification and annual import volatility

Import Volatility

Then the import volatility ($\sigma_{ij,y}$) is defined as a standard deviation of the residual change in a window of 12 month.

$$\sigma_{ij,y} = \sqrt{\frac{1}{w}\sum_{m=2}^{w} v_{ij,y,m}^2} \qquad \text{for } y = 2015, ...2023$$

3. Port diversification and annual import volatility

The main specificaiton is as follows:

$$\sigma_{ijy} = \alpha_0 + \beta_0 \textit{Post}_y + \beta_1 HHI_{iy} + \beta_2 \textit{Post}_y \times HHI_{iy} + \gamma_i + \delta_j + \varepsilon_{ijy}$$

- The subscript y indicates year. $\textit{Post}_y$ is a binary variable equal to 1 after the event (years 2022 and 2023), otherwise 0.
- HHI_{iy} is average monthly HHI of the major port i in year y

Result 3: Port-level diversification and import volatility

Dependent variable: Import volatility				
	(1)	(2)	(3)	(4)
Post	-0.066	-0.053	-0.087	-0.129
	(0.178)	(0.164)	(0.183)	(0.199)
HHI	1.911***	0.776+		
	(0.380)	(0.471)		
HHI*Post	-5.559***	1.174		
	(1.104)	(0.947)		
Lag HHI			1.647**	-0.088
			(0.606)	(0.565)
Lag HHI*Post			-2.222*	0.612
			(1.130)	(0.896)
Port FEs		✓		✓
Exporter FEs	✓	✓	✓	✓
Observation	846	846	752	752
Pseudo R2	0.430	0.838	0.411	0.827

Notes. Parameters are estimated using Poisson Quasi MLE. Standard errors are clustered at port-importer pair and reported in parentheses. The p-values read as follows: $^{+} < .10, ^{*}\ p < .05, ^{**}\ p < .01, ^{***}\ p < .001$.

4. War impact on South Africa's export

The main specificaiton is as follows:

$$y_{ikt} = exp[\beta_0 + \beta_1 \textit{Post}_t + D_{mo(t)} + D_{yr(t)} + \gamma_i + \eta_k]\varepsilon_{ikt}$$

- $\textit{Post}_t$ is a binary variable equal to 1 in any time after the event (Feburary 2022) otherwise 0.
- $D_{mo(t)}$: month dummies, $D_{yr(t)}$: year dummies, γ_i: port FEs, η_k: importer FEs

Result 4: War impact on South Africa's export

Dependent variable: Export Quantity (1000 MT)						
	All		Landlocked		Others	
	(1)	(2)	(3)	(4)	(5)	(6)
Post	1.042***	0.236	1.084***	0.169	0.937***	0.555*
	(0.167)	(0.259)	(0.206)	(0.288)	(0.283)	(0.266)
Port FEs	✓	✓	✓	✓	✓	✓
Importer FEs	✓	✓	✓	✓	✓	✓
Month FEs	✓	✓	✓	✓	✓	✓
Year FEs		✓		✓		✓
Observations	11,845	11,845	2,678	2,678	8,755	8,755
Pseudo R2	0.562	0.586	0.500	0.533	0.527	0.550

Notes. Parameters are estimated using Poisson Quasi MLE. Standard errors are clustered at port-importer pair and reported in parentheses. The p-values read as follows: $^{+} < .10, ^{*}\ p < .05, ^{**}\ p < .01, ^{***}\ p < .001$.

Conclusion

Main Takeaways:

- The impact of the war is not statistically significant on South Africa’s wheat imports.
- Our finding indicates that ports become more diversified after the war.
- We find negative relationship between port-level diversification and import volatility in post-war period.
- The increase in the exports of wheat is statistically significant to both neighbored landlocked and other countries after the war.

Contribution

(`We wish...`) This paper contributes to the following literature:

- Diversifying Global Supply Chains for Resilience
- Food Security and Political Conflict
- Risk Management in Agricultural Trade at the Port Level

Appendix: About `importance` measure

- Verschuur, Koks, and Hall (2022) creates the coefficients that represent the connection between the link between the transport model and the multi-regional input-output tables (MRIO) for 1,278 ports in 178 countries.
- They quantify the domestic and global economic dependencies on trade flows through ports (i.e. the port supply-chain layer) and link the commodities that flow through ports the global supply-chains they serve.
- We use their port output coefficient as our $importance_i$ the industry output and final consumption which is linked to the trade-flows going through a port.