

Tariffs, Trade, and OR: Impacts on Producers, Consumers, and Labor

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Acknowledgment

I'd like to thank Ruth Kaufman for all her work in organizing this very interesting session. The photo below was taken after my Blackett Lecture at The Royal Society in London on December 5, 2024.



International Trade

International trade provides us with commodities throughout the year and has benefits for producers and consumers alike.



Supply Chains Are Essential to Global Trade

- **Global supply chain networks** have made possible the wide distribution of goods, from agricultural products to textiles and apparel as well as aluminum and steel.
- **Nations engage in trade to increase their productivity levels, employment rates, and general economic welfare.**
- The increased level of world trade has also garnered **the attention of government policy makers.**
- Governments may attempt to protect their domestic firms from the possible effects of the **highly competitive** global arena.



World's Biggest Importers

Largest Importers In The World



In 2022, global imports climbed to \$25.6 trillion in value, or about the size of the U.S. GDP. As an engine of growth, global trade broadens consumer choices and can lower the cost of goods. For businesses, it can improve the quality of inputs and strengthen competitiveness.

*(in Billion USD)

 United States	\$3,376B
 China	\$2,716B
 Germany	\$1,571B
 Netherlands	\$899B
 Japan	\$897B
 United Kingdom	\$824B
 France	\$818B
 South Korea	\$731B
 India	\$723B
 Italy	\$689B
 Hong Kong SAR	\$668B
 Mexico	\$626B
 Belgium	\$621B
 Canada	\$582B
 Spain	\$493B
 Singapore	\$476B
 Taiwan	\$436B
 UAE	\$425B
 Poland	\$381B
 Türkiye	\$364B

 VietNam	\$359B
 Switzerland	\$356B
 Australia	\$309B
 Thailand	\$303B
 Malaysia	\$294B
 Brazil	\$290B
 Russia	\$242B
 Indonesia	\$237B
 Czech Republic	\$236B
 Austria	\$232B
 Sweden	\$202B
 Saudi Arabia	\$188B
 Hungary	\$163B
 Ireland	\$146B
 Philippines	\$144B
 South Africa	\$136B
 Romania	\$132B
 Denmark	\$127B
 Portugal	\$115B
 Slovakia	\$113B

Source: World Trade Organization, USAFacts

www.rankingeroyals.com

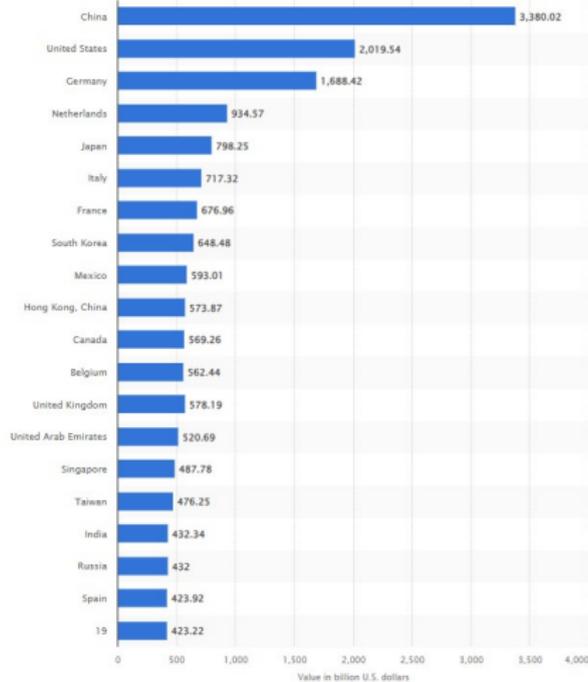
 RankingRoyals



World's Biggest Exporters

Leading export countries worldwide in 2023

(in billion U.S. dollars)



Global Trade Policies

Examples of policy instruments that have been applied by governments to modify trade patterns include: **tariffs**, **quotas**, and a combination thereof - **tariff rate quotas**.



Tariffs, which are taxes, have been around since ancient Greece and Rome. There are different types of tariffs: unit tariffs, ad valorem tariffs, and tariff rate quotas.

- A tariff rate quota (TRQ) is a **two-tiered tariff**, in which a lower **in-quota tariff** is applied to imports until a quota is attained and then a higher **over-quota tariff** is applied to all subsequent imports.
- The Uruguay Round in 1996 induced the creation of more than 1,300 new TRQs.
- The world's four most important food crops: rice, wheat, corn, and bananas have all been subject to tariff rate quotas.



Tariffs Are Again Big News

Tariffs continue to dominate the news.

Canada | Newsroom | United States

Trump's Proposed 25% Tariff on Canada and Mexico: Potential Impacts on Agriculture and Trade

By Jim Cullis - January 23, 2025



NEWS

Shipping companies warn of delays and new charges from Trump's China tariffs

Temu, Shein, and Amazon Haul are about to get wrecked



/ Delays, taxes, & shipping from just got more co

What might be the impact on agriculture of tariffs on Canadian and Mexican imports?

// BLOG // WHAT MIGHT BE THE IMPACT ON AGRICULTURE OF TARIFFS ON CANADIAN AND MEXICAN IMPORTS?

Tariffs on Canadian and Mexican Imports: The Impact on Agriculture

It should come as no surprise that Mexico and Canada are the top-two US agricultural export markets

PUBLISHED ON JANUARY 29, 2025

America's favorite beer, avocados, gas and cheap stuff from Temu will get more expensive as economists warn of Trump tariffs impact

By Renny Reyes

Published Feb. 2, 2025, 6:29 p.m. ET

1.9K Comments

New Tariffs That Start Tomorrow Could Affect Farmers and Food Prices

The Trump administration will impose a 25 percent tariff on imports from Canada and Mexico, the U.S.' first and third largest suppliers of agricultural products.

BY LISA HELD • JANUARY 31, 2025

Trump's tariffs will hurt UK wherever they're imposed, says Bank

A global trade war would hit growth even if Britain is not a 'direct recipient' of the US president's levies on imports, the Bank of England governor says

NEW

LOCAL NEWS

Colorado agriculture producers brace for tariff impacts



By Olivia Young
February 3, 2025 / 1:07 AM MST / CBS Colorado



Tariffs Are Again Big News

- The tariffs that are being imposed by the Trump administration, in his second term, are resulting in a great deal of uncertainty for businesses and for consumers.
- Some of the tariffs have been pulled back or delayed, whereas other such as those on aluminum and steel have been increased.
- Countries, including China, are retaliating, even banning exports of critical rare earths needed for high tech products.
- **OR models and tools can provide very valuable insights as to who wins and who loses in the case of tariffs.**

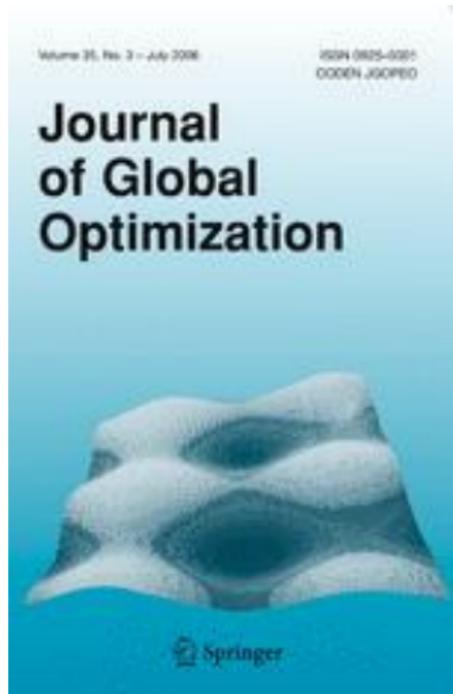
We, over the past 25 years, have been constructing **computable operational mathematical models** that enable the assessment of the impacts of trade policy instruments such as tariffs, subsidies, quotas, and also tariff rate quotas on consumer prices, trade flows, as well as on the profits of producers/firms.

Some of Our Studies on Tariffs

Some of our papers on tariffs and applications using OR.



A. Nagurney, D. Besik, and L.S. Nagurney, “Global Supply Chain Networks and Tariff Rate Quotas: Equilibrium Analysis with Application to Agricultural Products, *Journal of Global Optimization* 75 (2019), pp 439-460.



A. Nagurney, D. Besik, and J. Dong, “Tariffs and Quotas in World Trade: A Unified Variational Inequality Framework,” *European Journal of Operational Research* 275(1) (2019), pp 347-360.



A. Nagurney, M. Salarpour, and J. Dong, “Modeling of Covid-19 Trade Measures on Essential Products: A Multiproduct, Multicountry Spatial Price Equilibrium Framework,” *International Transactions in Operational Research* 29(1) (2022), pp 226-258.



The Multicommodity International Trade Model

A. Nagurney, D. Hassani, O. Nivievskiy, and P. Martyshev, “Exchange Rates and Multicommodity International Trade: Insights from Spatial Price Equilibrium Modeling with Policy Instruments via Variational Inequalities,” *Journal of Global Optimization* 87 (2023), pp 1-30.

Journal of Global Optimization
https://doi.org/10.1007/s10898-023-01232-6

Exchange rates and multicommodity international trade: insights from spatial price equilibrium modeling with policy instruments via variational inequalities

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Abstract

In this paper, we construct a multicommodity international trade spatial price equilibrium model of special relevance to agriculture in which exchange rates are included along with policy instruments in the form of tariffs, subsidies as well as quotas. The model allows for multiple trade routes between country origin nodes and country destination nodes and flows independent on individual flows under flow conservation and in- or out- through distinct countries. We capture the impacts of exchange rates through the definition of effective profit costs and identify the primary multicommodity international trade spatial equilibrium conditions, which are then formalized as a variational inequality problem in product price flows. Existence results are established and a computational procedure presented. The illustrative numerical example and a case study are inspired by the impacts of the war against Ukraine on agricultural trade flows and product prices. The modeling and algorithmic framework allows for the quantification of the impact of exchange rates and various trade policies, as well as the addition or deletion of supply markets. Annual market surplus review, on supply and demand market prices in food categories, and on the volume of product trade flows with implications for food security.

Keywords Exchange rates · Spatial price equilibrium · International trade · Networks · National agriculture · Agriculture

1 Introduction

Exchange rates represent the value (price) of one currency relative to another currency. They are important economic parameters in international trade, with changes in the exchange rate affecting the decision-making of individuals, businesses, and governments. A response

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What Our Research Has Shown

Whether in the context of supply chain networks under oligopolistic (imperfect) competition or perfect competition, our studies reveal that tariffs:

- increase prices for consumers;
- reduce the volume of the product;
- decrease consumer welfare;
- reduce profits for producers, and
- they can result in the same impacts as that of quotas.

Tariffs can, however, offer some protection to domestic producers but one has to evaluate whether this will happen quantitatively through OR models.

Our Research is Deeply Influenced by Practice

Multicommodity Trade, Tariffs, and Rerouting

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April 2025

Accepted for publication in: *Convex and Variational Analysis with Applications: In Honor of Terry Rockafellar's 90th Birthday*. Panos M. Pardalos and Themistocles M. Rassias, Editors, Springer Nature Switzerland AG.

Abstract: The concept of "equilibrium" is fundamental to many disciplines, including economics and operations research. The theory of variational inequalities continues to provide a rich methodological framework for the formulation, analysis, and solution of a wide range of equilibrium problems with many recent applications, because of their relevance, including policies associated with the trade of commodities. In this paper, we add to the literature on multicommodity trade by constructing a spatial price equilibrium model with tariffs that allows for the investigation of rerouting of commodities to evade tariffs, as has been happening for several years now, along with "trade wars."

Key words: multicommodity trade, tariffs, networks, equilibrium problems, rerouting, variational inequalities

Our Research is Deeply Influenced by Practice

The paper constructs a network model of tariff evasion with a case study on tea, China, Vietnam, and the US.

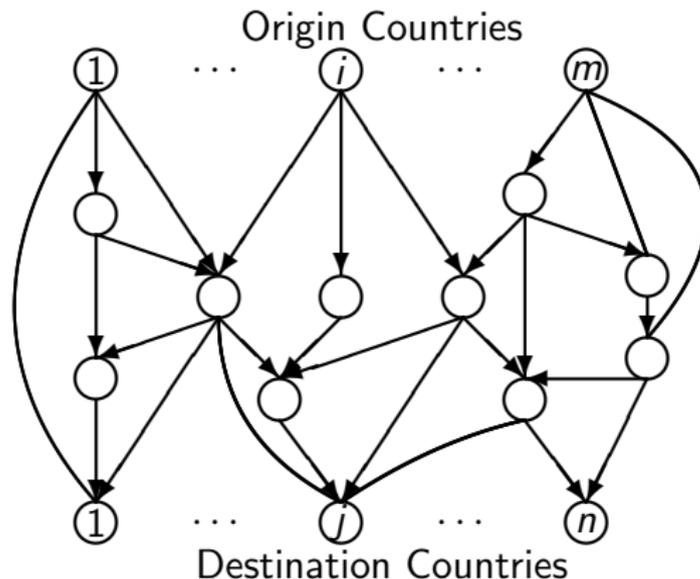
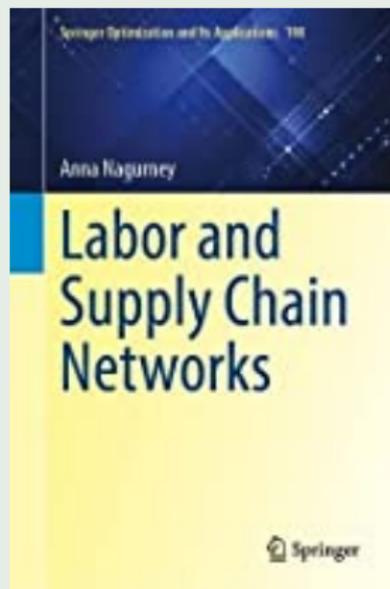


Figure: An Example of a Spatial Price Network Topology with Origin Countries and Destination Countries

Our Research is Deeply Influenced by Practice



Our ongoing research examines how ad valorem tariffs impact labor in terms of employment, using fundamental supply chain network models introduced in my book.

Responding to Media Requests on Tariffs

I believe that it is important to respond to media requests on topics that your research can inform, such as that of our work on tariffs and trade.

wbur
From vinegar to vanilla: Trump tariffs leave Massachusetts small businesses in the lurch

Tariff impact is already felt by Western Massachusetts companies

NEWSTALK
WHMP
102.5FM/400AM

The New York Times
Trump's Tariffs Would Deal a Big Blow to the Auto Industry
Automakers and parts suppliers would struggle if President-elect Donald J. Trump followed through on his threat to impose 25 percent tariffs on imports from Canada and Mexico.

NEWS
Dash to the dealership?: Local consumers, car sellers brace for auto tariffs to kick in Wednesday

VIDEO

Navigation icons: back, forward, search, etc.

OR models and associated analyses on tariffs and trade can provide valuable insights (including unexpected ones) for policy-makers and decision-makers.

Thank You Very Much!



The Virtual Center for Supernetworks

Supernetworks for Optimal Decision-Making and Improving the Global Quality of Life

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Panel with K.S.E. Exchange Students
February 27, 2025

The Virtual Center for Supernetworks is an interdisciplinary center at the Isenberg School of Management that advances knowledge on large-scale networks and integrates operations research and management science, engineering, and economics. Its Director is Dr. Anna Nagurney, the Eugene M. Isenberg Chair in Integrative Studies.

Mission: The Virtual Center for Supernetworks fosters the study and application of supernetworks and serves as a resource on networks ranging from transportation and logistics, including supply chains, and the Internet, to a spectrum of economic networks.

The Applications of Supernetworks Include: decision-making, optimization, and game theory; supply chain management; critical infrastructure from transportation to electric power networks; financial networks; knowledge and social networks; energy, the environment, and sustainability; cybersecurity; Future Internet Architectures; risk management; network vulnerability, resiliency, and performance metrics; humanitarian logistics and healthcare.

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Professor Anna Nagurney's Blog	Network Classics	Doctoral Dissertations	Conferences	Journals	Societies	Archive

<p>Announcements and Notes from the Center Director Professor Anna Nagurney Updated: June 8, 2025</p>	<p>Professor Anna Nagurney's Blog RENeW Research, Education, Networks, and the World: A Female Professor Speaks</p>	<p>Sustaining the Supply Chain Mathematical Moments Podcast</p>	<p>PBS VIDEO America Revealed</p>
<p>New Books Competing on Supply Chain Quality Operational Resilience: How Supply Chains, Health, and People Thrive</p>	<p>Photos of Center Activities</p>	<p>The Braess Paradox Translation Information Photos</p>	<p>Publications On a Frontier of Traffic Planning Environmental Impact Assessment of Transportation Networks with Degradable Links in an Era of Climate Change Ann Nagurney, Ghanshyam Patel, Lakshmi V. Rajaguru</p>

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