#Research Proposal

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## Background to the research

"We will demand that the Panama Canal be returned to us, in full, quickly and without question". This statement by President D. Trump in December 2024, in response to fees imposed by the Panama Canal Authority (PCA) and to growing Chinese investment, illustrates how the Canal, because of its *geoeconomic* importance is subject to *geopolitical risk* from hegemons, defined as "the threat, realization, and escalation of adverse events associated with wars, terrorism, and any tensions among states and political actors that affect the peaceful course of international relations." (Caldara and Iacoviello, 2022)

The willingness of the American President to regain control of the Canal reflects the strategic importance of major maritime trade corridors. The idea of linking the Atlantic and the Pacific oceans has been evoked since the 15th century with the Emperor Charles V. Built in the early 1900s and inaugurated in 1914, the Canal remained under U.S. control until 1977, after which it was jointly controlled with Panama. Panama then assumed sole control in 1999. The canal was extended in 2016 to accommodate larger vessels. Today, more than 80% of goods traded worldwide are carried by sea[1], and around 3% pass through the Panama Canal.

In addition to the geopolitical risk associated with the geoeconomic importance of the Canal, climate change has further highlighted vulnerabilities in key maritime corridors. In 2023, rainfall decreased by 30% compared to the historical average, leaving the Canal authority able to store only 50% of the hydraulic capacity needed for the 2024 dry season. This dramatic situation led the Panama Canal Authority to restrict the maximum number of daily transits, particularly during the last quarter of 2023 and the first two quarters of 2024. For fiscal year 2024[2], the total number of transits decreased by 28% - 21% in the Neopanamax locks, and 32% in the Panamax locks.[3].

[1] UN Trade & Development (UNCTAD). *Seaborne trade statistics.*, 2025.
[2] Fiscal year 2024 ran from October 1, 2023, to September 30, 2024
[3] Bureau of Transportation Statistics. *Transportation Statistics Annual Report.* 2024

Despite the decline in transits and toll revenues, [4] the Panama Canal Authority reported increased overall revenue and profit, primarily due to higher booking fees (a 45% rise in booking fees revenue compared to fiscal year 2023)[5]. Because of limitations on the number of ships allowed to transit, the Canal Waters Time[6] increased substantially. Bottlenecks developed in the Canal, forcing some ships to acquire expensive rights to transit or to take alternative routes *via* the Cap Horn or the Suez Canal, further increasing shipping time and cost. The impact on transportation costs is long-lasting. Due to heightened uncertainty and the growing risk of extreme weather events, the Panama Canal Authority has decided to implement a new reservation system, which is expected to further raise shipping expenses. Beginning in January 2025, the Panama Canal Authority will impose a new long-term auction-based allocation system, designed for reducing uncertainty, although it may also contribute to higher transit costs.[7]

The Panama Canal offers a unique case study, that can be used throughout my research agenda. Although hydrological records indicate that the level of the Gatún Lake - one of the main freshwater reservoirs supplying the Canal - returned to normal late August 2024, the growing climate and geopolitical risks suggest that maritime traffic could be affected over the long term. Given these risks, three research questions emerge: (i) How will the global system be impacted by a temporary reduction in traffic transiting through the Canal? (ii) How can current networks be optimally designed to adapt to a world without the Canal? (iii) How can Panama take advantage of U.S.-China competition to moderate the influence of global hegemons?

My PhD project is structured around three essays addressing these questions, both building on and contributing to ongoing research in International Trade, optimal transport network theory, and Geoeconomics.

In my first project (section 1), I aim to use the recent shocks affecting the Canal to quantify the effects of potential disruptions to this key corridor on the reallocation of trade flows under different scenarios. Assuming that the disruption is temporary, the transport network would be only marginally impacted. I intend to estimate the welfare impact of this short-term disruption around the initially observed allocation, following the framework of Allen and Arkolakis (2022). Focusing on the United States, I expect to observe moderate effects due to substitution toward other modes of transport, along with spillover effects that may increase congestion and prices across alternative modes and routes. To the best of my knowledge, this project would be the first attempt to quantify the reallocation of trade flows, using a multimodal transport network that includes air freight.

[4] According to the definition of the Panama Canal Authority: "fees paid by ships to use the Canal. In general, tolls are determined by ship measurement parameters." Panama Canal Authority. *Tolls Assessment.* May 2023.

[5] Panama Canal Authority. *Annual report.* 2024.

[6] The average time it takes a vessel to transit the Canal (including waiting time for passage)

[7] Panama Canal Authority. *Advisory to Shipping.* 01 August 2024.

In the second project (section 2), I address the need to reconsider the structure of the global transport network in light of growing geopolitical and environmental risks. Specifically, I aim to compare the current network with a theoretical, optimal multimodal transport network, with and without the Panama Canal. I plan to extend the seminal model from Fajgelbaum and Schaal (2020) to accommodate a multimodal network. Finally, this framework will be used to assess the relevance of alternative projects, such as the Nicaragua Canal, as strategies for diversifying these risks.

Finally, in my third project (section 3), I aim to contribute to the emerging Geoeconomics literature. While most of the theoretical work focuses on power and the formation of hegemons, I will focus on non-hegemonic countries. Indeed, while Panama, in response to American threats, agreed to revoke the Chinese Belt and Silk Road agreement, to reduce Chinese investment, and the deployment of American troops near the Canal, it refused to apply differentiated tariffs for American vessels. Benefiting from the competition between multiple hegemons, non-hegemonic countries can choose to join one sphere of influence or another, either to strengthen their own power or to escape the influence of another hegemon. By modeling a multihegemonic world, this project would help fill the gap in the literature identified by Clayton, Maggiori and Schreger (2025). Finally, I aim to test the model empirically by measuring foreign influence in Panamanian newspapers using natural language processing techniques.

# 1 How will the global system be impacted by a temporary reduction in traffic transiting through the Canal?

## 1.1 Contribution to the existing literature

One could have thought that the world was becoming flat. The price of transport gradually declined, in particular since the development of containers. While the transportation sector was previously labor intensive and time consuming, the development of intermodal transportation network, facilitated with the container, reduced freight rates (Hummels, 2007). However, despite this downward trend, Anderson and van Wincoop (2004) showed that trade costs remained high, especially for poor countries. An emerging empirical literature documents the effects of global chain disruptions and rising shipping costs on the macroeconomy (Carrière-Swallow et al., 2023; Bai et al., 2024; Finck and Tillmann, 2023; Gordon and Clark, 2023) I also, as part of my Master's thesis, tried to estimate the effect of increased transport costs, measured for both air and maritime freight, on the price of imported goods in Europe following the Covid-19 pandemic. My PhD project, by emphasizing the importance of a key maritime corridor, will also contribute to this strand of the literature. It will also complement existing and emerging literature related to the Canal. In particular, recent work has begun to examine the consequences of the opening of the Canal (Maurer and Rauch, 2022) and the macroeconomic effects of disruptions to this major maritime corridor (Känzig and Raghavan, 2025).

Conceptually, my work will relate to research on geography and trade (see Redding (2022) for a review). An older literature examines the role of geography on the distribution of economic activities (Krugman, 1991; Head and Mayer, 2004; Allen and Arkolakis, 2014). A more recent and expanding literature incorporates transportation networks into quantitative spatial equilibrium models, focusing on the role of transportation and networks on trade flows, welfare (Allen and Arkolakis, 2022), and market access (Donaldson and Hornbeck, 2016), leading to broader discussions about optimal investments in transport infrastructure (Fajgelbaum and Schaal, 2020).

While the literature has emphasized the impact of the container revolution on world trade, facilitating intermodal cargo movements between ships, trains, and trucks (Bernhofen, El-Sahli and Kneller, 2016; Coşar and Demir, 2018), it has mostly focused on a single mode of transport when analyzing disruptions in the transport network. To the best of my knowledge, the working paper of Fuchs and Wong (2024) based on Allen and Arkolakis (2022) presents the first model of multimodal transport networks built on transportation and quantitative spatial economics. It models the optimal choices of sourcing, routes, and transport modes in a multigraph framework, incorporating an elasticity of substitution across modes.

In a section of Fuchs and Wong (2024), the authors investigate the impact of Panama Canal disruptions and their interaction with the U.S. multimodal transportation network, accounting for both modal and route substitutions. They extend their benchmark U.S. multimodal transportation model by adding linkages from ports to foreign destinations. They find that truck and rail traffic flows within the U.S. increase in response to the shock, leading to higher greenhouse gas emissions. However, this analysis neglects possible substitution between air and maritime transport. Air freight is likely to replace maritime transport, in particular for high-quality goods originating farther from their destination. The literature has shown that the substitution between these two modes of transport depends on the price elasticity of demand and the value that consumers attached to fast delivery (Hummels and Schaur, 2013). Similarly, focusing on the expected impact of the International Maritime Organization's CO2 emissions cap on global maritime shipping, Lugovskyy, Skiba and Terner (2025), document a shift in demand from maritime transport toward air and road freight. High price firms located far from their destination are more likely to pay a premium for air shipping (Hummels and Schaur, 2013). As a result, it is necessary to include in an intermodal and international model of transport (i) the value of time as part of transport costs, and (ii) air shipping.

### 1.2 Methodology

Building on Fuchs and Wong (2024), I aim to incorporate to the model, air freight and the value of time. For modeling the U.S. multimodal network, I will follow Fuchs and Wong (2024). I will build a multigraph representation of the multimodal transport network, with mode-specific subgraphs, including mode-specific nodes and links, each associated with travel costs that depend on the mode and are endogenously determined by flow. In this model, the consumer decision of importing a good from origin to destination is a function of the origin being the least-cost producer, the route being the least-cost option, and the least-cost transport mode available along each segment of the network. In this model, the authors impose switching cost for changing transport modes. Fuchs and Wong (2024), examine how a mode-specific cost change (such as a new investment improving the road network) affects the equilibrium traffic flows of other modes, by decomposing the effect into two components (i) a direct effect - a substitution towards an alternative mode on the same link governed by the elasticity of modal substitution and proportional to the traffic share of the alternative mode (ii) an indirect complementarity effect - by lowering the cost of a mode on a segment, the aggregate transport cost decreases on that segment, increasing aggregate traffic on that segment and benefiting routes and trades using it. As such, depending on its centrality in the network, the degree of substitution across transport modes, and the traffic share of alternative modes, a positive or negative shock on a segment can propagate across the entire network.

However, they do not account for the value of time in substitution choices (only included in the measure of congestion), which is particularly important for capturing mode selection. For instance, parts and components are among the most time-sensitive products, and are more likely to be shipped by air. Following Hummels and Schaur (2013), who found that each day of transit is worth from 0.6 to 2.1% of the good's value ($\tau$), I will add to the mode-specific transport cost on a segment, a discount factor to capture the consumer's disutility from slow delivery $\exp(-\tau.days)$. This factor will capture the advantage in terms of fast delivery of choosing one mode of transport with absent congestion. Additional cost associated with additional time caused by an increase in traffic is already captured in the model through congestion. Including this new discount factor into the endogenous mode-specific transport cost model will improve the representation of the trade-off between more expensive modes of transport and the value of time. In particular, I expect that including this discount factor will better capture substitution between air and maritime transport.

I aim to extend this framework into an international trade model with two modes of transport for shipping goods to the U.S.: air and maritime freight. This analysis could be extended further by including the road and rail networks for Canada and Mexico. The cost-minimization problem will remain relatively similar to the one described above in a closed economy, with immobile labor across countries.

Empirically, the first step of the project will be to reconstruct the U.S. intermodal transport network using data on the main modes of transport. For each mode, I need data on the network (geo-spatial data), traffic, income, and population. A detailed description of the data is provided in the Appendix. The advantage of a model like the one presented by Fuchs and Wong (2024) is its tractability. Given observed traffic flows and model parameters (elasticity of substitution between transport modes, elasticity of route and trade substitution, parameters capturing local productivity and amenity spillover, and congestion elasticity), I can evaluate changes in the quality of the network, *at the margin*. While parameters for local productivity and amenity spillovers, and the elasticity of route and trade substitution are taken from the literature (Allen and Arkolakis, 2022), the authors need an estimate of the elasticity of modal substitution and terminal congestion to calibrate the model. Including air freight requires departing from the approach of Fuchs and Wong (2024), who assume a single elasticity of modal substitution. As part of their calibration, they estimate this elasticity based on Duranton and Turner (2011), using an instrument variable strategy focusing on substitution between rail and road. However, compared to the existing literature focused on the substitution between ocean and air freight (Harrigan, 2010; Hummels and Schaur, 2013; Lugovskyy, Skiba and Terner, 2025), their estimate is lower. They justify the difference by the high cost of air shipping, which leads to a higher elasticity of substitution. Given this difference, it would be interesting to rethink the model with specific elasticities of substitution to account for these differences across modes of transport. This will require estimating all elasticities to calibrate the model. As I have detailed data on flows, and historical transport network, and population, it should be feasible to replicate the approach of Duranton and Turner (2011) for some modes of transport within the U.S. For international trade, as a first step, I will focus on two transport modes only: maritime and air freight. For this elasticity, I can rely on the literature (Harrigan, 2010; Hummels and Schaur, 2013; Lugovskyy, Skiba and Terner, 2025). Similarly, Fuchs and Wong (2024) use the same estimate of intermodal terminal congestion for all intermodal terminals in their model, based on ports. Indeed, they have detailed AIS data, which enables them to precisely capture dwell times for maritime freight. Moreover, according to their findings, the correlation between railcar dwell times and port traffic is high, suggesting that port congestion can serve as a proxy for congestion at other terminals. By using data available on air freight (dwell time, traffic, imports), and applying the same method used for maritime transport (shift share IV), I will assess if the authors' estimate holds for air shipping.

After modeling the transport network, calibrating it following Fuchs and Wong (2024), and validating its accuracy by comparing predicted and observed trade flows, I will conduct counterfactual analysis using the hat algebra approach to examine changes in endogenous variables. That means that the equilibrium is divided into two parts: the transport equilibrium at the edge level, given market access terms, and the aggregate equilibrium capturing changes in market access terms given changes in endogenous transport costs derived from the first problem. The problem can be reduced to a fixed-point problem. Given a guess on the market access terms, the transport equilibrium at the edge level is derived in the first problem. Then the second problem is solved to obtain the aggregate equilibrium. The initial guess is then updated until convergence.

In this counterfactual exercise, I aim to test the scenario of a Panama Canal closure, simulated by extremely high prices on this segment. I can then observe possible substitution toward alternative maritime routes or air freight. The U.S. is the most affected country by the canal closure. Thus, it is expected to exhibit specialization of its ports. I may observe an overspecialization of U.S. ports toward the Pacific on the West Coast and the Atlantic on the East Coast. For example, I expect a decrease in imports at East Coast ports from countries along the U.S. East Coast - Asia route, and U.S. East Coast - South America's West route. However, these changes may be partially mitigated by the internal rail and road network within the U.S. Finally, comparing the two equilibria before and after the shock, I can calculate the resulting changes in U.S. GDP or other outcomes, such as the environmental costs associated with the substitution toward other transport modes.

# 2 How can current networks be optimally designed to adapt to a world without the Canal?

In the first project, I study the impact of a shock relative to an initial allocation. While this project enables to compute the effect of an additional investment, it does not give the solution to the global investment decisions. In this second project, which is more prospective, I aim to build an optimal transport network, with and without the Canal. Finally, I aim to use this framework to assess the relevance of new investment projects, such as the Nicaragua Canal. As suggested by Fajgelbaum and Gaubert (2025), analyses of optimal investments that account for intermodality are lacking in the literature. This project will require me to invest, at the beginning of my PhD, in both mathematical graph theory and transport network theory. I have already started reading the manuals from Galichon (2016), and Marc Bernot, Vicent Caselles and Jean-Michel Morel (2009).

## 2.1 Contribution to the existing literature

In parallel to Allen and Arkolakis (2022), Alder (2016), and Felbermayr, Gröschl and Heiland (2022), who focus on evaluating the welfare impact of investments around an observed allocation, a second strand of the literature focuses on optimizing the network itself, as in the seminal paper of Fajgelbaum and Schaal (2020). This planner's problem of designing an optimal transport network has been studied since the 18th century, starting with Monge and the problem of "remblais et déblais", which asks what is the most efficient way to move a pile of soil to an excavation. This problem was later augmented by Kantorovitch in the 1940s, who relaxed it with mass spitting. In his Chapter 8, Galichon (2016), taking the ancient Silk Road as a motivating example, models the problem of shipping a good produced and consumed at various locations through a network. In this optimal flow problem, it is assumed that the marginal transportation cost is constant, congestion is ignored, and supply and demand are exogenous. I want to build on the recent work from Fajgelbaum and Schaal (2020), which differs from the literature mentioned above by endogenizing supply and demand (responding to general-equilibrium forces). I want to contribute to this literature by considering optimal investment in a multimodal transport network.

## 2.2 Methodology

In the benchmark model from Fajgelbaum and Schaal (2020), transport costs are endogenous, depending on structural factors: resource endowment, geography, quantity shipped, and infrastructure quality. Within a neoclassical economy with multiple goods, factors, and locations, the social planner chooses the transport network, trade flows across the graph, and the allocation of production and consumption. In this model, transport costs are endogenous, increasing with trade flows (e.g. congestion leads to higher travel times and increases the per-unit cost) and decreasing with the amount of infrastructure invested (e.g. factors like the quality of the lane reduce travel times). The authors show that when congestion is sufficiently strong, their framework can be reduced to a global convex optimization problem, allowing the globally optimal transport network to be calculated using duality techniques. While solving on the space of networks can be challenging because of its dimensionality (i.e. changing a link impacts the whole network), the authors optimize on the space of optimal prices. There is one caveat to this model. The network investment problem is a convex optimization problem in cases of strong congestion in transport or when spatial spillovers are not internalized by the social planner. However, they also show that, when congestion is weak or absent (i.e. increasing returns in the transport technology), the global solution in the non-convex case can still be approximated by combining the duality approach with global-search numerical methods. In these cases, gains from optimal investments and losses from misallocation are larger. This results in a higher concentration of the network on fewer links, and the optimal network may take the form of a *tree*, as in other applications of the theory (e.g. blood vessels or irrigation systems). In the case of a multimodal transport network, one difficulty could arise from non-convexity on certain segments of the network depending on the transport mode, since modes may be differently affected by congestion and exhibit different returns in terms of transport technology.

Moreover, while this approach is appealing for its complete flexibility, it would be methodologically challenging due to dimensionality (choosing both the location of intermodal nodes and lines) and potential heterogeneous costs of investment across different lines. In the first step of the project, focused on exploring the theory, it is worth considering alternative approaches. In particular, Fajgelbaum et al. (2023) compared the optimal placement of rail stations with another network proposed by the social planner, and distorted by political incentives. In this framework, optimizing the entire network would require deciding both the railway lines and stations, resulting in a high-dimensional problem with potential heterogeneous costs of building lines at different locations. Instead, the authors defined a few alternative routes, based on cost and feasibility. They restrict the problem to placing stations along one route, and then they compare results across these few routes. I could follow this approach by considering only a few alternative segments of the actual network, built with the same data as in the first project. For instance, in the absence of the Canal, I could optimize the network under two proposed alternatives: extending the Panamanian rail network or building a new Canal: the Nicaragua Canal.

# 3 How can Panama take advantage of U.S.-China competition to moderate the influence of global hegemons?

The first project quantified the impact of a diminution of the traffic, focusing on the U.S., while the second explored investment projects that could mitigate these consequences. The third essay aims to clarify and model power relations between hegemons and a non-hegemonic state within a multi-hegemonic world characterized by strategic competition among great powers.

## 3.1 Background to the research

Despite its advantageous geography, Panama made some concessions to the United States in response to D. Trump's threats. The U.S. wanted to revoke fees applied to American vessels and reduce Chinese influence on the Canal. While Panama agreed in Spring 2025 to the deployment of American troops around the Canal and to revoke the Belt and Road agreement with China - a program to develop infrastructure abroad and expand Chinese influence over key transport corridors-, it refused to apply differentiated tariffs for American vessels, arguing that the Canal should remain neutral under existing treaties. Although Panama accepted the principle of neutrality, allowing all vessels to cross the Canal without differentiated tariffs, its independence is contested. Two questions emerge: Why did the Panama Government make these concessions? Did Panama benefit from the Chinese presence in its ports as a counterbalance to American influence, or were the costs of potential disturbance from applying the American threat too high to make it credible? In this project, I aim to build a model, based on the recent advances in Geoeconomics, with two hegemons, in which the non-hegemonic country is no longer passive but can potentially benefit from the competition between China and the U.S. Finally, I would like to test the consistency of the model with empirical evidence drawn from Panamanian newspapers.

## 3.2 Contribution to the existing literature

*Geoeconomics* as a *concept* in Economics often focuses on what political scientists call *economic statecraft*[8]. Indeed, the formulation of the neologism *geoeconomics* in 1990 by Luttwak[9], cautious of the prevalent optimism symbolized by Fukuyama's essay, *The End of History and the Last Man*, was synonym of a vision in which global market expansion and interstate power relations facilitate the use of economic power as a tool to achieve strategic objectives, amplifying the interest for *economic statecraft*, which is often confounded with *geoeconomics* as a concept. However, political

[8]"how states use economic and technological instruments in pursuit of their strategic interests; it focuses on how the executive branch of government formulates and implements a grand strategy." (Aggarwal and Cheung, 2025)

[9]This neologism is a reminiscence of older concept (see Mohr and Trebesch (2025) for a review of the literature)

scientists define *geoeconomics*, as a concept focused on the *structure*, or how "economics, technological innovation, and geography affect the distribution of capabilities in the system; it is concerned with structure, and it focuses on the great powers and structurally significant industries." (Aggarwal and Cheung, 2025). As Mohr and Trebesch (2025) note, the definition of *Geoeconomics*, as a *field* is broader: it is not only "a reincarnation of the older concept of *economic statecraft*, but rather as a new, broad field that combines questions of geopolitics and war with questions of international economics." My project, taking the the Panama Canal as a case study, would contribute to *Geoeconomics*, as a field, by emphasizing the spatial, or "geo", dimension of the concept *geoeconomics*. Despite being a small country, its geography endows Panama with a *geoeconomic tool* defined by Clayton, Maggiori and Schreger (2025), which could restrict or facilitate access to means of transport and infrastructure. By evaluating the importance of the Canal in the Global Trade Economy in my first project, I would demonstrate that Panama has a strategic geoeconomic importance, attracting the attention of hegemons.

In this third project, I aim to build a model in which non-hegemonic countries are no longer passive but can actively benefit from their strategic location and a multi-hegemonic world. Economists are currently working to develop theoretical frameworks of power and threat to guide future research, as illustrated by the current seminal work of Clayton, Maggiori and Schreger (2025). In this framework, power is modeled as the willingness of the targeted entity to take a privately costly action to avoid a punishment or earn a reward in response to a threat. Clayton, Maggiori and Schreger (2025) differentiate between a Government that can directly influence its domestic entities (firm, consumer, etc.) and a global hegemonic country that can influence foreign entities indirectly through credible threats. As noted by Clayton, Maggiori and Schreger (2025) and Mohr and Trebesch (2025), while some scholars have already started working on multihegemonic world, this area still requires formal modeling. While an older literature, emerging during the Cold War focused on the concept of "hegemonic stability", these questions and these ideas are currently formalized. In particular, Kleinman, Liu and Redding (2024) show empirically that, as countries become more economically dependent, they tend to be more aligned politically. Among more recent theoretical works, Broner et al. (2025) present a theoretical paper exploring the transition from a unipolar to a multipolar world, which is costly for globalization since trade increases with political alignment. In this article, the authors also introduce a model in which there is a threshold in terms of economic size at which a country begins to attract other countries into its sphere of influence, away from another hegemon. Moreover, an emerging literature examines why hegemons want to influence other countries (Antras and Padró I Miquel, 2023).

### 3.3 Methodology

I aim to make a conceptual contribution to this field by addressing this gap identified in the literature and proposing a model of power relations between two hegemons and a non-hegemonic country, starting from Clayton, Maggiori and Schreger (2025). They offer some inspiring starting points in their final section. I aim to incorporate some of these by developing a model in which multiple potential hegemons compete, offering different threats, rewards, and demanded actions for countries to join their sphere of influence. In this multi-stage game, the non-hegemonic country, attracting several hegemons, can benefit from the competition of hegemonic countries to reduce the influence of the current hegemon. The equilibrium would depend on the set of threats imposed by the two hegemons, their credibility, and the *geoeconomic* importance of the non-hegemonic country.

To assess the accuracy of my model and deepen my reflection on how to conceptualize power dynamics between two hegemons competing for influence over a non-hegemonic country, I propose to measure the pressures imposed on Panama and its alignment between China and the U.S., using Large Language Models (LLM) to analyze Panamanian newspapers. Factiva, provides access to major Panamanian newspapers across the political spectrum (e.g. El Siglo, La Prensa, La Critica Libre, La Estrella de Panama).

Building on recent advances in natural language processing (NLP), I will construct a "credibility" index of the American threat and classify articles according to their alignment with either China of the U.S. A simple proxy for the credibility of the U.S. threat of "retaking the Canal" is the frequency of references to Operation Just Cause, the U.S. military intervention in Panama in 1989-1990. Since this operation is a historical precedent, its invocation in contemporary media can signal the perceived possibility of renewed U.S. intervention. Relatedly, I can track the occurrence of fear-related terms and examine their correlation with mentions of the U.S. intervention. I will also apply sentiment analysis to classify articles, and understand the evolution of pro-U.S. or pro-China attitudes over time. With LLM, I can further generate hypotheses from the sample of articles regarding reasons underlying these positions (e.g. security concerns, economic dependence, investment benefits) and from these hypotheses, extract the occurrence of each reason. This exercise will help me to better model power dynamics.

As a predoctoral research assistant for Prof. Xavier Jaravel, I previously applied similar computational text-analysis methods to interview transcripts from hypothesis generation to data extraction (Geiecke and Jaravel, 2024). Through this work, I became familiar with model selection, prompt design, and advanced techniques in computational linguistics. This experience has equipped me with the necessary skills to carry out the proposed project. Conducting this kind of analysis often requires access to an API, which typically involves costs. However, as open-weight models become increasingly reliable, I expect to rely on an inexpensive model for the analysis. Alternatively, programs available to researchers provide API credits. For instance, the OpenAI Researcher Access Program provides up to $1,000 in API credits for academic research.

## Appendix - Building the intermodal transport network

This section presents all data used in the two first projects to build the intermodal transport network. I plan to assess the accuracy of my transport network by comparing the volumes and values shipped *via* the main domestic transport modes with aggregated data from the Freight Analysis Network. This dataset provides estimates of U.S. trade flows at both the state and metropolitan area levels starting from 1997.

### Maritime

- **Flows & Network**: Port Performance Freight Statistics, provide Customs data on the value, volume, and origin of imported goods entering the U.S., reported at the port level for each commodity (HS6) (monthly data, from 2010). Unfortunately, the reported values correspond to the Custom value, which excludes insurance and freight costs. While CIF values are available at the district level, I could infer that they are similar at the port-level given quantities shipped.
- **Dwell time**: IMF PORTWATCH (daily, from 2019): This dataset monitors port and trade activity for 1802 ports and 27 checkpoints around the world. It provides the daily number of cargo and tankers, as well as aggregated import and export volumes. This database will help reconstruct ship trajectories. Combined with Port Data (giving the origin of the goods), I could build an estimation of goods transiting through this maritime network. Moreover, I can use AIS data from Marine Casdastre (real-time data from 2015), vessel traffic data of ships transiting in the U.S. waters, as in Fuchs and Wong (2024) to estimate dwell times.

### Air

- **Network & Dwell time:** T-100 Domestic Segment (All Carriers) and T-100 Segment (All Carriers) data (monthly, from 1990) from the Bureau of Transportation Statistics. This database provides information on volume transported, carrier, destination, origin, airport, ramp-to-ramp time, air time for international and domestic flights. It can be used to calculate dwell times and reconstruct the network for air freight. I can then compare my estimate with the average and median Dwell times from the World Bank for the U.S. (yearly, Supply chain tracking data, 2007, 2010, 2012, 2014, 2016, 2018, 2022).
- **Flows**: Port Performance Freight Statistics. Similar to maritime freight, data on the value and quantity carried by air freight are also available for international trade.

### Inland Waterway

- **Network:** Geospatial data are available on the U.S. Army Corps of Engineers.
- **Flows:** The Transportation Operational Waterborne Statistics (TOWS) Database: This yearly database (2002-2023) provides information on the movement of foreign and domestic vessels and commodities with origins or destinations in the U.S.

### Rail

- **Network**: TIGER/Line Geodatabases from the Census Bureau (yearly from 20213): This dataset provides geodatabase of the national rail and road networks.
- **Flows** - Carload Waybill Sample: This dataset provides a stratified sample of carload waybills for all U.S. rail traffic. It includes information on origin/destination stations, the number of carloads weight, whether the shipment is domestic or international, and intermodality (indicating if the freight movement involves other transport modes). The Confidential Carload Waybill Sample can be accessed by submitting a detailed request to the Office of Economics. If Access is not granted, it is still possible to use the Public Use Waybill Sample, which does not include station and carrier information. Origin and Termination points are reported at a higher geographical level. Additionally, some waybills records are excluded. The public version only contains rail freight movements for commodities that were handled by at least three freight stations. Finally, some geographical information may be missing to prevent the disclosure of competitively sensitive data. Missing observations will need to be imputed. The Commodity Flow Survey, conducted every five years can serve as a reference.

### Road

- **Network**: TIGER/Line Geodatabases from the Census Bureau (yearly from 20213): This dataset provides geodatabase of the national rail and road networks.
- **Flow:** Commodity flow survey (yearly, 1997, 2002, 2007, 2012, 2017, 2022) and Highway Performance Monitoring System. I can also use data from Allen and Arkolakis (2022).

### Intermodal Terminals

I can identify the locations of intermodal terminals using the National Transportation Atlas Database from the U.S. Department of Transportation.

### Population and Income

Population and income data can be obtained from Allen and Arkolakis (2022).

## References


**Aggarwal, Vinod K., and Tai Ming Cheung,** ed. 2025. *The Oxford Handbook of Geoeconomics and Economic Statecraft.* Oxford University Press.

**Alder, Simon.** 2016. "Chinese Roads in India: The Effect of Transport Infrastructure on Economic Development." *Working paper.*

**Allen, Treb, and Costas Arkolakis.** 2014. "Trade and the Topography of the Spatial Economy *." *The Quarterly Journal of Economics*, 129(3): 1085–1140.

**Allen, Treb, and Costas Arkolakis.** 2022. "The Welfare Effects of Transportation Infrastructure Improvements." *The Review of Economic Studies*, 89(6): 2911–2957.

**Anderson, James E., and Eric van Wincoop.** 2004. "Trade Costs." *Journal of Economic Literature*, 42(3): 691–751.

**Antras, Pol, and Gerard Padró I Miquel.** 2023. "Exporting Ideology: The Right and Left of Foreign Influence." *Working paper.*

**Bai, Xiwen, Jesús Fernández-Villaverde, Yiliang Li, and Francesco Zanetti.** 2024. "The Causal Effects of Global Supply Chain Disruptions on Macroeconomic Outcomes: Evidence and Theory." *Working paper.*

**Bernhofen, Daniel M., Zouheir El-Sahli, and Richard Kneller.** 2016. "Estimating the effects of the container revolution on world trade." *Journal of International Economics*, 98: 36–50.

**Broner, Fernando, Alberto Martin, Josefin Meyer, and Christoph Trebesch.** 2025. "Hegemonic Globalization." *Working paper.*

**Caldara, Dario, and Matteo Iacoviello.** 2022. "Measuring Geopolitical Risk." *American Economic Review*, 112(4): 1194–1225. *Working paper.*

**Carrière-Swallow, Yan, Pragyan Deb, Davide Furceri, Daniel Jiménez, and Jonathan D. Ostry.** 2023. "Shipping costs and inflation." *Journal of International Money and Finance*, 130: 102771.

**Clayton, Christopher, Matteo Maggiori, and Jesse Schreger.** 2025. "Putting Economics Back Into Geoeconomics." *Working paper.*

**Coşar, A. Kerem, and Banu Demir.** 2018. "Shipping inside the box: Containerization and trade." *Journal of International Economics*, 114: 331–345.

**Donaldson, Dave, and Richard Hornbeck.** 2016. "Railroads and American Economic Growth: A "Market Access" Approach *." *The Quarterly Journal of Economics*, 131(2): 799–858.

**Duranton, Gilles, and Matthew A. Turner.** 2011. "The Fundamental Law of Road Congestion: Evidence from US Cities." *American Economic Review*, 101(6): 2616–2652.

**Fajgelbaum, Pablo, and Cecile Gaubert.** 2025. "Optimal spatial policies." In *Handbook of Regional and Urban Economics*. Vol. 6 of *Handbook of Regional and Urban Economics*, , ed. Dave Donaldson and Stephen J. Redding, 143–223. Elsevier.

**Fajgelbaum, Pablo, Cecile Gaubert, Nicole Gorton, Eduardo Morales, and Edouard Schaal.** 2023. "Political Preferences and Transport Infrastructure: Evidence from California's High-Speed Rail." *Working paper.*

**Fajgelbaum, Pablo D., and Edouard Schaal.** 2020. "Optimal Transport Networks in Spatial Equilibrium." *Econometrica*, 88(4): 1411–1452.

**Felbermayr, Gabriel, Jasmin Gröschl, and Inga Heiland.** 2022. "Complex Europe: Quantifying the cost of disintegration." *Journal of International Economics*, 138: 103647.

**Finck, David, and Peter Tillmann.** 2023. "The Macroeconomic Effects of Global Supply Chain Disruptions." *Working paper.*

**Fuchs, Simon, and Woan Foong Wong.** 2024. "Multimodal Transport Networks." *Working paper.*

**Galichon, Alfred.** 2016. *Optimal transport methods in economics.* Princeton:Princeton university press.

**Geiecke, Friedrich, and Xavier Jaravel.** 2024. "Conversations at Scale: Robust AI-led Interviews with a Simple Open-Source Platform." *Working paper.*

**Gordon, Matthew V., and Todd E. Clark.** 2023. "The Impacts of Supply Chain Disruptions on Inflation." *Economic Commentary (Federal Reserve Bank of Cleveland)*, , (2023-08).

**Harrigan, James.** 2010. "Airplanes and comparative advantage." *Journal of International Economics*, 82(2): 181–194.

**Head, Keith, and Thierry Mayer.** 2004. "Market Potential and the Location of Japanese Investment in the European Union." *The Review of Economics and Statistics*, 86(4): 959–972.

**Hummels, David.** 2007. "Transportation Costs and International Trade in the Second Era of Globalization." *The Journal of Economic Perspectives*, 21(3): 131–154.

**Hummels, David L., and Georg Schaur.** 2013. "Time as a Trade Barrier." *American Economic Review*, 103(7): 2935–2959.

**Kleinman, Benny, Ernest Liu, and Stephen J. Redding.** 2024. "International Friends and Enemies." *American Economic Journal: Macroeconomics*, 16(4): 350–385.

**Krugman, Paul.** 1991. "Increasing Returns and Economic Geography." *Journal of Political Economy*, 99(3): 483–499.

**Känzig, Diego R, and Ramya Raghavan.** 2025. "The Macroeconomic Effects of Supply Chain Shocks: Evidence from Global Shipping Disruptions." *Working paper.*

**Lugovskyy, Volodymyr, Alexandre Skiba, and David Terner.** 2025. "Unintended consequences of environmental regulation of maritime shipping: Carbon leakage to air shipping." *Journal of International Economics*, 155: 104081.

**Marc Bernot, Vicent Caselles, and Jean-Michel Morel.** 2009. *Optimal Transportation Networks.* Vol. 1955 of *Lecture Notes in Mathematics*, Berlin, Heidelberg:Springer. ISSN: 0075-8434.

**Maurer, Stephan, and Ferdinand Rauch.** 2022. "Economic geography aspects of the Panama Canal." *Oxford Economic Papers*, 75(1): 142–162.

**Mohr, Cathrin, and Christoph Trebesch.** 2025. "Geoeconomics." *Annual Review of Economics*, 17(Volume 17, 2025): 563–587.

**Redding, Stephen J.** 2022. "Trade and geography." In *Handbook of International Economics*. Vol. 5 of *Handbook of International Economics: International Trade, Volume 5*, , ed. Gita Gopinath, Elhanan Helpman and Kenneth Rogoff, 147–217. Elsevier.