# The fragility of the global trading system*

Stephan Maurer[†], Luke Heath Milsom[‡], Ferdinand Rauch[§]

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**Abstract**

We use a parsimonious gravity framework to simulate and compare five potential shocks to the global shipping system: closures of the Panama Canal, the Suez Canal, and the Strait of Malacca, and openings of the Northwest Passage and a hypothetical Kra Canal. Applying a single, consistent methodology across all five scenarios allows relative comparisons. Using carefully measured seaborne distances between ports under each hypothetical geography, we find that a Panama closure would be the most consequential shock, reducing global trade by nearly 3% compared to a default gravity prediction, followed by Suez (2.5%), Malacca, (1.7%), a Kra opening (+0.7%), and the Northwest Passage (+0.6%). Aggregate GDP and welfare effects are more muted, but show sizable heterogeneity across countries. For example, Panama loses over 9% of GDP from a Panama closure, Egypt and Sudan over 5% from Suez, and Malaysia over 4% from Malacca.

**Keywords**: Gravity, Panama, Suez, Kra, Malacca, Northwest Passage
**JEL Classification**: F14, F17, O18

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[†]UPF Barcelona School of Management and CEP, stephan.maurer@bsm.upf.edu
[‡]KU Leuven, luke.heathmilsom@kuleuven.be
[§]University of St Gallen, ferdinand.rauch@unisg.ch

# 1 Introduction

In March 2021, strong winds caused the cargo ship *Ever Given* to get stuck in the Suez Canal, blocking the canal and all shipping through it for 6 days. According to a WTO report, this delay of less than one week at one point in the trading system reduced world trade by between US$6 and US$10 billion (WTO 2024). This event highlighted the vulnerability of global trade to disruptions and the extent to which the world economy still depends on international trade and functioning shipping routes. And indeed, the world remains vulnerable to trade shocks. Around 90 percent of global trade take place on ships (Kaluza et al, 2010). 12-15 percent of global maritime trade in 2023 passed the Suez Canal (UNCTAD 2024), and another six percent pass through the Panama Canal (European Commission 2025). Both canals are vulnerable to risks arising from geopolitical tension, terrorism, climate change and political uncertainty. In this paper, we assess losses to trade and welfare caused by such shocks, and also the benefits of further improvements in global shipping routes.

We separately simulate five shocks to the trading system: A closure of (i) the Panama Canal, (ii) the Suez Canal, (iii) the Strait of Malacca, the opening of (iv) the Northwest Passage, and (v) the Kra Canal, a hypothetical strait across Thailand, connecting the Gulf of Thailand with the Andaman Sea.[1] As we explain below, all these events have some probability of becoming reality, and they all have important geopolitical consequences. Three of these shocks are negative, and two are positive. All these shocks come in the form of changes in the distance matrix of shipping routes. We use empirical gravity models (Anderson and van Wincoop, 2003; Head and Mayer, 2014; Yotov et al., 2016) and hypothetical seaborne distances, and apply tools from the large theoretical literature on how such changes affect welfare. Because the same model, the same elasticities, and the same geographic machinery are applied across all five scenarios, the resulting magnitudes are internally consistent and directly comparable.

Our approach is deliberately parsimonious. First, we measure pairwise distances between ports in the world as it is, and on five hypothetical world maps corresponding to the five shocks. We use these port-to-port distances to calculate population-weighted seaborne distances between countries, and then use these distances in a standard country-to-country gravity model. We first

[1]The Strait of Hormuz is another major bottleneck in global trade. However, our gravity framework is primarily designed to estimate substitution across alternative shipping routes. Since the Arabian Gulf has no viable exit other than the Strait, the model cannot capture meaningful substitution for these ports and is therefore not well-suited to this context. Moreover, a simulation of a closure of the Strait of Hormuz should focus on the trade of oil. Modeling oil and its particular trade network, demand structure and supply chains would need a different model altogether.

calculate gravity-predicted trade flows in the “default world", and then compare them to gravity predictions when using the new distances in our five scenarios. We assume that distance over water is a useful approximation to trade costs, given that we study trade on ships only. We ignore waiting times at canals, fees for using canals, risks from pirate attacks, and navigation problems caused by ice, wind, and currents. This conventional approximation might lead to some bias due to measurement error in our estimates. To address this error, we instrument distances over water with Euclidean distances between country capitals. Shipping is the only mode of transport that is directly affected by the shocks we study. Some estimates suggest that up to 90 percent of global trade takes place using ships (Kaluza et al, 2010).

Our results show that in terms of aggregate trade effects, a closure of the Panama Canal would have the largest consequences, reducing global trade by nearly 3%. Closing the Suez Canal (2.5%) or the Strait of Malacca (1.7%) would have notable, but weaker results, whereas the opening of the Kra Canal would boost global trade by 0.7%. with similar effects for the opening of the Northwest Passage (0.6%) In all five cases, there is a large heterogeneity in exposure, with several countries predicted to lose more than 20% of trade from the closure of the Panama, Suez, or Malacca waterways.

In order to assess welfare consequences, we pursue two approaches. First, we use an estimate for the trade elasticity of GDP from Feyrer (2021) to translate predicted trade changes into output changes. Secondly, we use the welfare formula derived by Arkolakis et al (2012) to calculate theoretical welfare chains from predicted trade volume changes. Results for GDP and welfare are smaller than for trade, but show the same ordering: Closing the Panama Canal would have the largest ramifications, followed by the closures of the Suez Canal and the Strait of Malacca, the opening of the Kra Canal, and the opening of the Northwest Passage.

Our approach only measures short-run reactions to the five trade shocks. It is purposefully parsimonious. Permanent changes to the trading system would lead to responses of GDP, migration flows, and port infrastructure, as new ports might open. Modeling these changes is difficult, as it would require difficult assumptions on, for example, the extent to which migration to more attractive regions will be facilitated politically. Adjustments of infrastructure and the location of people and firms will increase the benefits from increased trade, and mitigate the losses from negative shocks. Yet, we believe that short-run results that do not make assumptions on such reactions are still useful. They are more credible because they require fewer assumptions, and they are informative of the immediate effects, before endogenous changes to infrastructure take place. We also expect long-run losses and benefits to correlate with short-run effects.[2] Another shortcoming of our approach is that we do not model the heterogeneity of goods. Substitutability between different modes of transport could also play a role that we do not observe. However, there are recent estimates that suggest that such substitution between modes is limited (Tolva 2024).[3]

This paper proceeds as follows. In section 2 we discuss the related literature, section 3 introduces the data and methods of this paper, 4 presents our simulation results, and is followed by section 5 that assesses the impact on GDP and welfare. Section 6 provides a comparison of the five different shocks, and section 7 concludes.

# 2 Literature - Comparison with existing approaches

The robustness of the global trading system to disruptions of global shipping routes is a question of great geopolitical importance. Thus, there have been many papers studying these effects, and many more will be written over the years to come. Most of these papers we discuss here have estimated the effects of only some of the shocks we study in this paper. Our approach differs substantially from all those we are aware of. Particularly, the combination of global coverage and hypothetical distances over water that are measured with care in ArcGIS is, to our knowledge, new. Our empirical setting also differs in terms of scope — by studying many potential shocks with a consistent methodology, we are able to compare relative effects across potential shocks.

Bekkers, Francois, and Rojas-Romagosa (2018) study the effect of commercial shipping via the Northern Sea Route. The approach is based on a multi-sectoral Eaton-Kortum model with intermediate linkages. We differ in using higher geographic resolution. Maurer and Rauch (2023) and Dajud-Umana (2017) study the effects of the opening of the Panama Canal on population and employment in the US and Canada, respectively. The approach is similar in its port-level distance perspective, but differs in its limited geographic coverage (focusing exclusively on the effects in North America), and it does not make predictions on other types of shocks, and so

[2] We anticipate a crucial asymmetry: while the positive impacts of openings tend to amplify over time, negative shocks are likely to be dampened.

[3] In the Appendix, we present results when port substitution within countries is costless and within-country transportation is cheaper than seaborne transportation, so that countries always trade via the two ports that are closest. In this extreme and for many cases quite unrealistic scenario, aggregate trade effects for the Panama Canal and the Northwest Passage are considerably lower. For the Suez, Malacca and especially Kra scenario, results are also lower, but less dissimilar to our main results.

cannot compare between them. Galiani, Jaramillo, and Uribe-Castro (2025) also consider the impact of the Panama Canal on the development of Canadian manufacturing, taking a market access approach. Galiani, Jaramillo, and Uribe-Castro (2023) further extend the analysis of the Canal's opening to migration responses within the United States. Heiland et al (2025) use novel satellite data to estimate the economic effects of the Panama Canal expansion in 2016, finding significant global real income gains.

Feyrer (2021) and Jacks, Meissner, and Wolf (2024) study the impact of the Suez Canal. Feyrer (2021) estimates the impact of distance on trade and trade on income, leveraging exogenous variation from the closing of the Suez Canal between 1967 and 1975. In a similar vein, Hugot and Dajud (2016) use variation from both the Suez and Panama Canals' closing to estimate distance elasticities. Jacks, Meissner, and Wolf (2024), on the other hand, aim to estimate the total impact of the opening of the Suez Canal in 1869. They take a country-level event-study gravity approach, finding large gains, but focusing only on the impact of opening the Suez Canal.

Cosar and Thomas (2021) study the closure to maritime traffic of the South China Sea and all the east-west passages in the Indonesian archipelago using an approach not dissimilar to our own. Within a similar geographical scope, Wang and Ma (2024) study the impact of increasing Arctic trade on East Asia. Again, these studies focus on shocks and/or impacts within a limited geographical area.

Brancaccio, Kalouptsidi, and Papageorgiou (2020) take a structural approach to modeling the transport sector and use their model to estimate the impact of closing the Suez and Panama canals, as well as the Straits of Gibraltar. Although closer to our paper in that they consider various shocks, Brancaccio et al. (2020) take a completely structural approach and do not use multiple shocks to compare effects across scenarios.

What we add to this literature is that we estimate all five shocks using a consistent methodology, which enables direct comparison and thus a perspective on the relative magnitudes of their impact. Our port-level data allows us to be precise on the geographic impact of each shock, rather than relying on simple straight-line distances between countries. Closest in spirit to our consistent approach across several scenarios are the papers by Bodenschatz et al (2026) and Pratson (2023) that both study several maritime "choke points" including the Panama Canal, Suez Canal, the Strait of Malacca, and others. The former looks at Germany only and quantifies how much of German trade flows through these choke points. The latter examines how closing choke points would affect rerouting, delays, and seaport activity. In contrast to ours, both papers only consider closures of waterways, and not the opening of new ones such as the Northwest Passage or the Kra canal. In addition, neither uses a gravity framework to look at aggregate trade, GDP or welfare effects. Mo et al (2026) use a similar framework to ours to study how reductions in trucking costs would impact trade in the US.

There is also a more general literature on network resiliance and shocks applied to the trade network (a few examples include Catalayud et al 2017, Foti et al 2013, Li et al 2024, Xie et al 2021). To this literature, we add a specific application with magnitudes and relevant parameters that could complement such models.

# 3 Data and the Gravity model

## 3.1 Data sources and dataset creation

Our main dataset is created by merging port data from two sources: (i) the Word Port Index, and (ii) trade flows and gravity control variables from the Centre for Prospective Studies and International Information (CEPII)'s Gravity database (Conte et al 2022). For welfare analysis, we further include (iii) bilateral trade data from CEPII's Trade and Production Database (Mayer et al 2023). To discuss each in turn: (i) The World Port Index (WPI) is a database of worldwide maritime port information, such as infrastructure, size, and capacity of global ports. The WPI provides the general geographic location with over 100 key characteristics and services of thousands of ports around the globe. The principal sources of information in the WPI are the Sailing Directions and charts published by the National Geospatial-Intelligence Agency (NGA), but where information from those sources is lacking or incomplete, other authoritative sources, both domestic and foreign, are used. The information is supposed to be accurate on the date on which we obtained it.[4] (ii) The CEPII gravity dataset provides aggregate trade flows from Compstat and gravity control variables.[5] (iii) The CEPII Trade and Production Database (TradeProd) contains bilateral trade data from Comtrade and allows the calculation of domestic trade shares.

We use the World Port Index to calculate sea-borne distances between ports under various scenarios. To do so, we focus on the ports that the WPI classifies either as "large" or "medium".

[4] We downloaded this database from https://msi.nga.mil/Publications/WPI in November of 2023.

[5] These datasets were downloaded from https://www.cepii.fr/CEPII/en/bdd_modele/bdd_modele.asp in June 2024.

We use latitude and longitude information provided by the WPI to create a shapefile and merge this with coastline data from the Global Self-consistent Hierarchical High-resolution Geography (GSHHG)[6]. The GSHHG comes in several resolutions and with different coverage of waterbodies. Given our focus on long-distance oceanic trade, we do not need the full level of detail and instead opted for the high-resolution version of the dataset that details the boundary between land and ocean, excepting Antarctica (dataset L1h). We then create a global fishnet of cells sized 20km x 20km and keep all cells that fall on the sea or are within 10km from the coastline. These cells form the basis for our seaborne distance calculation. As calculation points, we use all ports that are within 20km of the coast. For computational ease, we assign all these ports to the closest coastal calculation point. To further speed up computations, we restrict the geographic scope to ports between 85 degrees South and 85 degrees North. Overall, this leaves us with 455 port locations (some of which are home to several actual ports, like Brooklyn and New York).

We then use the ArcGIS CostDistance tool to calculate least-cost paths between all our ports. This gives us our default sea-borne distances between ports. In this world, the Panama and Suez Canals and the Strait of Malacca are open, the Northwest Passage is closed[7], and the Kra Canal does not exist. We then create five variations of this default dataset: In one, we close the Panama Canal by removing water cells at the canal's mouth from the map. In another one, we perform a similar exercise for the Suez Canal. In a third exercise, we close the Strait of Malacca, again by removing cells roughly between 102.3 and 102.5 degrees of eastern longitude and betwen 0.7 and 2.2 degrees northern latitude from our cost raster. We also open the Kra Canal in Thailand by adding artificial sea points between roughly 98.7 and 99.1 degrees eastern longitude and 10.1 and 10.3 degrees northern latitude. Finally, in our fifth exercise, we remove the blockage of the Northwest Passage. We then calculate the distance between ports in each of these scenarios.

Every projection of the spherical globe onto a two-dimensional space, like a map, leads to biases. We attempt to minimize these by using a World Mercator projection throughout. We further multiply the cost of each cell by the cosine of its latitude to address the World Mercator's scale issues as one goes further from the equator.[8] One final complication is that the two-dimensional projection "begins" on the left at 180 degrees western longitude and "ends"

[6]Available from https://www.soest.hawaii.edu/pwessel/gshhg/

[7]For simplicity, in our default cost raster, we model this by not allowing travel between 113 and 114 degrees western longitude and north of 67 degrees northern latitude

[8]We thank Andrea Matranga for this suggestion.

at 180 degrees eastern longitude, without taking into account that it is of course possible to sail across the 180 degree line, i.e. to "leave" the map on the right/east and reenter it on the left/west. Consider the distance from Santiago de Chile to Auckland. Clearly, the shortest route is to sail west from Santiago and cross the Pacific. However, on a two-dimensional map, this is not possible, and we will instead find a path from Santiago around the Southern tip of South America, eastwards across the Atlantic and the Indian Oceans, and thence to New Zealand. We solve this by adding calculation points on the right and left edges of our map and including them alongside our ports in the distance calculation. For every port, we then calculate distances with and without these calculation points and take the shortest route. In the example of Santiago-Auckland, we will compare the route eastward across the Atlantic and Indian Ocean to the shortest route that goes westward from Santiago to the calculation points on the left/western edge of the world and then continues from the right/eastern edge of the world to Auckland.

## 3.2 Gravity regression

Our simulations of the five shocks all rely on one single gravity model, which we keep fixed throughout this paper. We use a Poisson pseudo-maximum-likelihood (PPML) estimation model (Santos Silva and Tenreyro 2006). As recommended when using PPML, the dependent variable $trade_{ij}$ is trade flows included in levels rather than logs. To be precise, the estimation equation we use follows the conventional PPML equation, which is estimated without log-linearization using PPML:

$$trade_{ij} = \exp\left(\beta ln\_dist_{ij} + X_{ij}\gamma + \tau_i + \lambda_j + \epsilon_{ij}\right) \quad (1)$$

$trade_{ij}$ measures total directed trade flows from country $i$ to $j$, measured in 2019 (i.e. before the impacts of the COVID19 pandemic). $ln\_dist_{ij}$ is the log sea-based distance between the two countries. This is the key variable that will be changed by either closing or opening new water routes. In order to go from port-to-port distances calculated above to the country level, we calculated population-weighted distances. First, we use 2020 gridded population data from WorldPop to assign population to areas. Then we compute "Thiessen Polygons"that measure the area in a country that is closest to each port in that country. From this, we can calculate the share of a country i's population that is closest to a given port p, $wpop_{ip}$.[9] The distance

[9]For countries with only one port in our dataset, this share is 1 by construction.

between two countries i and j with ports $p$ and $q$ is then given as[10]

$$dist_{ij} = \sum_{p \in i} \sum_{q \in j} wpop_{ip} \cdot wpop_{jq} \cdot distance_{pq}$$

Matrix $X_{ij}$ contains standard gravity controls provided by CEPII: Whether the two countries in which the ports are situated are part of a regional trade agreement, ever were in a colonial or dependency relationship, share a common language, and are contiguous. $\beta$ and vector $\gamma$ are coefficients to be estimated, and $\epsilon_{ij}$ is the error term. We also include country of origin and country of destination fixed effects. Standard errors are twoway clustered at the country of origin and country of destination level. Our dataset comprises 8,695 trade flows between 100 countries.

Results are displayed in Table 1, using Comtrade trade flows averaged between the reports of country of origin and country of destination.[11] Column 1 shows a simple gravity specification, estimated via ppmlhdfe. Variable *ln_dist* is significant and negative, as typical in this literature. Control variables appear to give sensible coefficients when statistically significant: Free trade agreements foster trade, as does a common language and contiguity. To address potential measurement error, we estimate the same regression as PPML IV regression, where we use Euclidean distances between country capitals as instruments for measured distances over water. We implement this via a control function approach. These results are presented in Column (2) (first stage) and Column (3) (second stage). In line with potential measurement error, the distance coefficient becomes more negative when instrumenting.

## 3.3 Simulation

For our five simulations, we take the results from this gravity equation (the version in Column 3) and make predictions in which we keep all variables and all estimated coefficients fixed, but change the distance variable according to port-to-port distances as per our five hypothetical worlds. We then compare gravity-predicted trade flows in the default world to gravity-predicted trade flows in each scenario. We thus compare gravity-predictions with another rather than with actual trade flows to increase internal consistency. With this approach, the only factor that differs between our five simulations and the default scenario is the distance variable entering

[10] Weighted distances are common in gravity models, see Mayer and Zignago 2011 and Head and Mayer 2002.

[11] When trade volume is reported only by one side, we take this value.

the prediction, the rest of the model is held constant throughout. Thus, the magnitudes of our simulation are influenced directly by estimates of the distance coefficient.

# 4 Trade results

## 4.1 A closure of the Panama Canal

The Panama Canal is vulnerable to political, economic, and environmental risk factors. The complicated lock system involving the lifting of ships and the dependence on freshwater creates risks. These include droughts, flooding, tropical storms, earthquakes, and landslides. Mechanical breakdowns and infrastructure degradation might also lead to unexpected closures. Ship groundings or collisions, terrorism or sabotage, and political factors such as strikes or conflicts could all lead to a break in the operations of the canal. Some of these scenarios are not just hypothetical, but have, in parts, manifested in recent years. In 2023, the Panama Canal Authority restricted ship traffic following an extended drought. Daily canal transits were cut by nearly half. The maximum underwater depth of ships in transit was temporarily reduced. Some vessels offloaded cargo to pass through a shallower canal; most waited in queues for days or weeks to transit (Carse 2024).

Our estimation of how trade flows are affected is depicted in Figure 2 in the Appendix. The more intense the red, the greater are the relative losses to a country if the Panama Canal were to close. The map shows that a closure of the Panama Canal would affect mainly countries in the Americas, particularly on the Pacific coast and in the Caribbean. Australia and New Zealand would also be notably affected. Losses in Western Europe and Africa would be smaller, but still non-negligible. In terms of numbers, as shown in Table 2, the most affected countries are Panama and Peru with 45 and 31 percent trade losses, respectively.[12] Overall, we find global trade losses of nearly 3%, making the Panama canal the most consequential of the five trade shocks that we analyze.

There are aggravating factors that we do not consider in this estimation. For instance, a closure of the Panama Canal would increase demand for using the Suez Canal, which might result in increased wait times or fees to cross it. Other shipping routes might also experience increased traffic, which could cause additional delays and costs. Since we do not model these

[12] Table 2 focusses on the 20 most affected countries. A full list of countries with their trade impacts for all five scenarios can be found in Table 7 in the Appendix.

additional factors, our estimate is a lower bound estimate. On the other hand, our model should be seen as very short-run and does not allow for substitution of domestic for seaborne transport. In this sense, losses for countries like Panama are likely overstated, as shipping goods to one coast and then transporting them via land to the other would entail only short distances. For large countries like the US, this overstatement is less grave.

## 4.2 A closure of the Suez Canal

The Suez Canal is also a vulnerable artery of the global trading system. It is located in a region marked by recurring military conflict and pirate attacks, and was closed between 1967 and 1975 as a consequence of the Six-Day War. It is also vulnerable to shipping accidents, as demonstrated by the incident involving the cargo ship *Ever Given* mentioned above. Our results highlight the importance of this waterway. Trade losses are large in many locations, as revealed by Figure 3 in the Appendix. The most affected region spans from South Asia via the Gulf of Persia to the Eastern Mediterranean, but there are also sizable losses in the central Mediterranean and North Africa. Table 2 shows the 20 most affected countries. Aggregated global trade losses are 2.5%. Egypt is the most affected country, with trade reductions exceeding 40%, and Sudan and Yemen also would suffer trade losses of more than 20%. The estimates from this scenario can be compared to Feyrer (2021). They are similar, but also differ in important aspects. For example, Feyrer (2021) estimates a trade loss of around 30% for Pakistan[13], while we find losses of roughly 10%. The likely explanation is that since the 1970s, Pakistani trade has grown particularly with Asian countries like China, where the Suez canal does not need to be crossed. On the other hand, and likely for the same reason, we find a larger impact of the Suez closure for Greece (8.1%) than Feyrer (5.9%).

For the Suez canal, the running aground of the freight ship *Ever Given* in March 2021 provides a recent actual example of a temporary closure. In the Appendix, we use stock market data from 15 countries to show that our predicted trade losses correlate positively with actual stock market losses during this event.

[13]Specifically, he finds a trade-weighted increase in sea distance of 31.4% and estimates a relationship between the Suez shock and actual trade of around -1.

## 4.3 A closure of the Strait of Malacca

In a further exercise, we close the Strait of Malacca. In our simulation, we remove cells roughly between 102.3 and 102.5 degrees of eastern longitude and between 0.7 and 2.2 degrees northern latitude from our cost raster. Thus, on our simulated map, we include a barrier slightly east of Malacca. Routes around Indonesia, such as the Sunda Strait and the Timor Sea further East, are not affected by this shock and are unrestricted. The map in Appendix Figure 4 shows that losses are found primarily in South and Southeast Asia, but the effects extend towards the Easter Mediterranean and Gulf regions.

Table 2 shows that Malaysia, Singapore, Indonesia, Bangladesh, India, and Sri Lanka are the most affected countries, all with losses of more than 5%. We estimate aggregate trade losses of 1.7%. This number is itself sizable, but particularly impressive as our simulation leaves viable alternative routes further South via Indonesia.

## 4.4 Opening of the Kra Canal

The Kra Canal refers to several proposals for a canal that would connect the Gulf of Thailand with the Andaman Sea across the Kra Isthmus in southern Thailand. Ferdinand de Lesseps, who was instrumental in the construction of the Suez and Panama Canals, considered building a canal in this part of the world as well (Tseng and Pilcher 2022). Such a canal would provide an alternative to the Strait of Malacca, and lower the distance for many shipment routes between China or Japan and Europe. The construction of this canal has been frequently considered since the days of de Lesseps. As a recent example, in 2020, the parliament of Thailand set up a committee to study such a project,[14] and it remains a topic of academic and policy debate (Abdul Rahman et al., 2016).

As we show in Table 2 and and Appendix Figure 5, such a canal would lead to increased trade, and the geographic distribution of gains is similar to that of losses in the case of closing the Strait of Malacca. South and Southeastern Asia would benefit the most, with effects extending towards East Asia and East Africa as well. Our estimated global trade gains are 0.7%. Interestingly, while Thailand would be a major beneficiary of the canal, the biggest trade gains accrue to Bangladesh.

[14] Reported in the press, such as here: "Time to revisit canal project". Bangkok Post. 20 January 2020. Downloaded February 2025.

## 4.5 Opening the Northwest Passage

The Northwest Passage refers to the sea lane between the Atlantic and Pacific oceans through the Arctic Ocean, near the northern coast of North America, via waterways through the Arctic Archipelago of Canada. Although this route has been navigated regularly since its first passing in 1906, it has been difficult to use for trading purposes.[15] However, the ice layer is thinning and shifting, and navigation has become noticeably easier over time. In 2007 and 2008, the passage opened sufficiently to be passable without the need for icebreakers. Uncertainty remains whether and when the passage will open sufficiently for predictable use for trading purposes (Smith and Stephenson, 2013). Initially, the passage will only be navigable for a few months of the year. Frequent speculation that this passage may become usable leads us to include it in our analysis, despite these uncertainties about when and how this will manifest.

Detailed country numbers are displayed in Table 2. Global trade gains are a 0.6% for this waterway. North Atlantic countries like the US, Canada, and Iceland would gain particularly, with gains spreading until the Caribbean. Another major beneficiary would be East Asia, where China, Japan, Taiwan, Hong Kong, and South Korea would register trade gains of more than 1%. Benefits could be even larger if climate change leads to an increase in activity in northern parts of the world; however, such gains are outside of the scope of this simulation exercise.

# 5 GDP and Welfare effects

## 5.1 GDP

A large literature has found a positive causal effect of trade on growth (Frankel and Romer 1999, Redding and Venables 2004, Feyrer 2019, Pascali 2019, Feyrer 2021). The most relevant among these papers for our study is Feyrer (2021), who focuses on sea-borne trade and employs data from the second half of the 20th century. Using the closure of the Suez Canal after 1967 as a natural experiment, he estimates an elasticity of GDP with respect to trade of around 0.15-0.25. In Table 3, we use the midpoint of this range (0.2) to translate estimated trade changes into GDP changes. This again highlights the central role of the Panama canal, whose closure is predicted to lead to aggregated GDP losses of 0.58%, with many countries experiencing losses of more than 2%. For the Suez canal, aggregate losses are slightly smaller, but again many

[15] One reference for the development of shipping in this region is Wang et al, 2022, and Wang et al, 2024.

countries would register sizable losses. The closure of the Strait of Malacca shows an aggregate GDP drop of 0.33%. Opening the Kra canal would lead to medium-run GDP gains of 0.13%, with Bangladesh and Thailand predicted to see increases of more than 1%. The opening of the Northwest Passage would have similar aggregate effect, but with less pronounced extremes. Even the biggest beneficient, the US, would only see a GDP boost of 0.35%.

## 5.2 Welfare

In this section, we present estimations to translate predicted changes to trade flow into changes in welfare. Arkolakis et al (2012, henceforth ACR) show that many common models of international trade give a similar answer on how changes to trade systems affect welfare. In models that assume Dixit-Stiglitz preferences, one factor of production, linear cost functions, complete specialization, and iceberg trade costs, the resulting change in welfare will be a function of the domestic trade share and the trade elasticity. We take this model to translate changes in trade flows into changes in welfare, because it provides a simple and model-independent estimate of welfare gains using changes in trade intensity and the trade elasticity. More complex approaches based on sectors, firms, or household heterogeneity can't be used, given that our data does not distinguish these dimensions.

One way to characterize the key equation is:

$$\frac{W^H}{W^A} = \left(\frac{\lambda^H}{\lambda^A}\right)^{\frac{1}{\epsilon}} \tag{2}$$

In this equation, $W$ refers to welfare, $\lambda$ denotes the domestic trade share, the share of trade that happens within a country relative to trade with the rest of the world. If $T_d^H$ denotes domestic trade in the hypothetical case and $T_i^H$ international trade, then $\lambda^H = T_d^H/(T_d^H + T_i^H)$. Further, $\epsilon < 0$ denotes the elasticity of trade with respect to variable trade costs. There are two different states of the world, actual and hypothetical, indicated by $A$ and $H$ in the equation above. We do not measure domestic trade in our exercise, and so we obtain it from CEPII TradeProd.[16]

For countries with multiple ports, we could also measure changes to domestic trade. However, this measure is severely limited. First, we only obtain it for countries with multiple ports, which might lead to selection bias. In addition, some countries have ports on different coasts and seas, while others have multiple ports that are all close to each other. Second, domestic

[16]We lose 11 countries that are not contained in the TradeProd dataset.

trade relies less on shipping than international trade, and more on other forms of transport that we do not observe. For these reasons, we do not use this measure in our welfare calculation and compute changes in the domestic trade share only from our estimated changes to international trade flows. If we set $T_d^H = T_d^A = T_d$, then equation 2 becomes:

$$\frac{W^H}{W^A} = \left( \frac{T_i^A + T_d}{T_i^A + T_d + \Delta T_i^H} \right)^{\frac{1}{\epsilon}} . \tag{3}$$

We estimate these quantities as follows: $T_d$ is domestic trade from CEPII TradeProd. $T_i^A$ is international trade predicted by our gravity model in the default world with unchanged waterways. $\Delta T_i^H = T_i^H - T_i^A$ denotes the additional trade, positive or negative, in levels, caused by our five shocks and predicted by our gravity model. For $\sigma$, we assume a value of $-4$, following Simonovska and Waugh (2014).

This exercise is limited by various approximations. We only observe changes to shipping and miss other forms of trade. We also ignore that changes to international trade might also change domestic trade. Further, we ignore dimensions of heterogeneity that could influence welfare calculations such as Eaton and Kortum (2002) who model comparative advantage and heterogeneous sectors, Melitz (2003) who models heterogeneous firms, heterogeneous households as in Fajgelbaum and Khandelwal (2016) or multi-sector versions of this model such as in Caliendo and Parro (2015) or Costinot and Rodriguez-Clare (2014). Still, we hope that this exercise is useful in giving a rough indication of how strong the welfare effects of these shocks might be.

The results are displayed in Table 4. Welfare effects are quite small. Even for the Panama canal, aggregate global welfare only drops by 0.22% in case of a closure. However, there is substantial heterogeneity. Mexico, Panama, Haiti, and Venezuela would suffer welfare losses of more than 3%. Qatar would lose 2.9% in the case of a Suez closure, and Malaysia 3.8% if the Strait of Malacca closed. On the other hand, Thailand would gain 0.7% from the Kra canal. The Northwest passage again has more muted welfare effects. Canada and Hong Kong would gain 0.2%, and several other countries around 0.1%.

Generally, welfare effects appear small compared to the trade or even GDP effects. However, such “missing gains from trade" in terms of welfare are a typical finding of gravity-consistent models of trade (Melitz and Redding 2014). For example, Arkolakis, Costinot, and Rodriguez-Clare (2012), estimate that the total gains from trade (i.e. comparing autarky to trade) for the US would be between 0.7% and 1.4%. Given that the trade implications of our waterway scenarios are less extreme, our results are very much in line with theirs.

The ACR framework excludes some effects of trade, and so gives a lower bound estimate of welfare effects of trade shocks. For example, when tradeable intermediate goods are required to produce other tradeable intermediate goods, this creates an input-output loop that amplifies gains from trade. Campos et al (2025) derive a more generalised framework to simulate the general equilibrium (GE) effects of trade frictions within a universal gravity framework. In the appendix we present two alternative GE computations following this method, and find that welfare effects are indeed more substantial in the alternative model. For instance, in the case of a Panama Canal closure the more flexible alternative model predicts 48 percent higher welfare losses than ACR.

# 6 Comparing scenarios

Sections 4 and 5 estimated trade, GDP, and welfare effects for each of our five scenarios separately. Because those sections use a common gravity model, a common set of estimated coefficients, and a common geographic framework, the resulting magnitudes are directly comparable across scenarios in a way that has not previously been possible. In this section, we bring the five scenarios together into a single table and draw out the patterns that emerge when they are placed side by side.

Table 5 reports the aggregate global effects of all five shocks on three outcome measures—trade, GDP, and welfare. The five shocks we consider are comparable in the abstract sense that each is a plausible, policy-relevant change to a major maritime chokepoint, but their aggregate implications are very different. Closures of the Panama canal, Suez canal, or Strait of Malacca would reduce global trade by 2.9%, 2.5% and 1.7%, between three and five times as much as the gains from the opening of the Northwest Passage (0.6%). The opening of a Kra Canal—which would partially substitute for Malacca—falls somewhere in between and produces gains of 0.7 percent. The same ranking holds for GDP and welfare. The implication is that concern about the resilience of the global trading system to maritime disruption should be concentrated heavily on the Panama and Suez canals, with Malacca a distant but non-negligible third. The much-discussed prospect of Arctic shipping routes if the Northwest Passage becomes reliably navigable would have more muted effects that would be in the aggregate similar to the opening of the Kra canal.

# 7 Conclusion

In this paper, we provide predictions of how five shocks to the global trading system would affect trade flows and welfare. The five shocks considered are: A closure of (i) the Panama Canal, (ii) the Suez Canal, (iii) the Strait of Malacca, the opening of (iv) the Northwestern passage, and (v) the Kra Canal. Our estimation framework is deliberately simple and uses only techniques that have been well established in the trade literature. Our contribution is firmly in the results we present, not in any methodological innovation. We think that relying on tested tools in a simple way makes the predictions as credible as they can be. While modeling second order effects (such as port relocations or migration following these shocks) or goods heterogeneity would add interesting additional dimensions, they would also require us to use more assumptions and parameters, and hence make the predictions more noisy.

Our simulations suggest modest gains of global trade in response to the opening of the Northwestern passage or the Kra Canal, increasing global trade flows by 0.6 and 0.7 percent. On the other hand, closing the Panama Canal, Suez Canal, or the Strait of Malacca would hurt trade flows substantially, decreasing global trade flows by 2.9, 2.5, and 1.7 percent, respectively. Most of these shocks have global impacts, with the most affected countries typically smaller economies closest to the affected regions. Translating this to GDP and welfare effects shows more muted, but still notable aggregate effects and considerable heterogeneity. For example, while the closure of the Panama canal would reduce aggregated global GDP and welfare by 0.6 and 0.2 percent, Mexico would lose 5.6 percent of GDP and 4.2 percent of welfare. The United States and China are among the most affected countries by the closures of Panama and Malacca, respectively. Both would also gain from an opening of the Northwest Passage, but to a lesser degree.

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**Table 1**: Main gravity equation

| | (1) | (2) | (3) |
|---|---|---|---|
| | PPML | PPML IV | |
| | | 1st stage | 2nd stage |
| | Trade Flows | Ln dist | Trade Flows |
| Ln distance | -0.585*** | | -0.743*** |
| | (0.0556) | | (0.0664) |
| FTA/WOT | 0.434*** | -0.0110*** | 0.266*** |
| | (0.0845) | (0.00286) | (0.0752) |
| Colonial history | 0.000299 | -0.00800* | 0.0257 |
| | (0.138) | (0.00425) | (0.130) |
| Common ethnolinguistic | 0.159** | 0.00378** | 0.172*** |
| | (0.0650) | (0.00174) | (0.0612) |
| Contiguous | 0.691*** | -0.0167 | 0.356*** |
| | (0.168) | (0.0114) | (0.123) |
| Ln distance capitals | | 0.110*** | |
| | | (0.00267) | |
| Control function | | | 0.703*** |
| | | | (0.0792) |
| N | 8695 | 8695 | 8695 |

Note: Main gravity equation, estimated in PPML. Column (3) uses Euclidian distances between country capitals to instrument for distances over water, Column (2) shows the respective first stages. All regressions control for country of origin and country of destination fixed effects. Standard errors twoway-clustered at the country of origin and country of destination level.

* (p<0.10), ** (p<0.05), *** (p<0.01)

**Table 2:** Trade Effects by Country

| **Panama** | $\Delta T$ | **Suez** | $\Delta T$ | **Malacca** | $\Delta T$ | **Kra** | $\Delta T$ | **NW** | $\Delta T$ |
|---|---|---|---|---|---|---|---|---|---|
| Panama | -45.078 | Egypt | -41.394 | Malaysia | -23.674 | Bangladesh | 7.948 | United States | 1.761 |
| Peru | -30.603 | Sudan | -27.557 | Singapore | -9.302 | Thailand | 6.27 | Canada | 1.679 |
| Mexico | -27.757 | Yemen | -21.155 | Indonesia | -6.916 | India | 4.66 | China | 1.293 |
| Cuba | -23.014 | Iran | -17.23 | Bangladesh | -6.874 | Sri Lanka | 3.51 | Japan | 1.228 |
| Colombia | -21.939 | Lebanon | -15.224 | India | -5.538 | Cambodia | 3.26 | Taiwan | 1.192 |
| Dominican Republic | -19.536 | Saudi Arabia | -14.785 | Sri Lanka | -5.165 | Pakistan | 2.86 | Hong Kong | 1.169 |
| Jamaica | -18.941 | United Arab Emirates | -14.621 | Thailand | -4.658 | Iran | 1.724 | South Korea | 1.118 |
| The Bahamas | -18.289 | Kuwait | -14.34 | Cambodia | -3.85 | Oman | 1.724 | Bermuda | 1.044 |
| Haiti | -16.48 | Syria | -14.113 | Pakistan | -3.686 | United Arab Emirates | 1.716 | The Bahamas | .923 |
| Venezuela | -16.232 | Bahrain | -14.014 | Hong Kong | -2.909 | Yemen | 1.529 | British Virgin Islands | .914 |
| Chile | -15.665 | Oman | -13.428 | United Arab Emirates | -2.383 | Saudi Arabia | 1.449 | Guyana | .75 |
| British Virgin Islands | -13.907 | Israel | -13.131 | Oman | -2.378 | Malaysia | 1.425 | Philippines | .739 |
| Bermuda | -13.588 | Qatar | -13.035 | China | -2.334 | Bahrain | 1.419 | Trinidad and Tobago | .693 |
| Trinidad and Tobago | -12.093 | Somalia | -13.034 | Iran | -2.319 | Qatar | 1.412 | Thailand | .598 |
| Guyana | -10.356 | Turkey | -10.374 | Taiwan | -2.153 | Hong Kong | 1.405 | Iceland | .597 |
| Canada | -10.342 | Pakistan | -10.16 | Saudi Arabia | -2.033 | Somalia | 1.387 | Cambodia | .566 |
| United States | -10.234 | Kenya | -10.068 | Yemen | -2.02 | China | 1.382 | Haiti | .515 |
| New Zealand | -4.723 | India | -9.652 | Bahrain | -1.993 | Kuwait | 1.354 | Cuba | .494 |
| Australia | -3.458 | Libya | -9.357 | Qatar | -1.973 | Sudan | 1.236 | Dominican Republic | .48 |
| Falkland Islands | -2.362 | Sri Lanka | -9.349 | Christmas Island | -1.962 | Taiwan | 1.18 | Macau | .439 |
| Global effect | -2.892 | | -2.48 | | -1.65 | | .67 | | .625 |

Notes: The table reports the 20 most affected countries under each of the five scenarios. Entries are percentage changes in total directed trade, computed by comparing gravity-predicted trade flows under the scenario geography to predicted flows under the default (current) geography, holding all estimated coefficients and non-distance regressors fixed. The final row reports the aggregate global trade change, computed as the percentage change in the sum of predicted trade flows across all country pairs. Numbers are rounded to two decimal places. Negative values indicate trade losses; positive values indicate gains.

**Table 3**: GDP Effects by Country

| **Panama** | $\Delta GDP$ | **Suez** | $\Delta GDP$ | **Malacca** | $\Delta GDP$ | **Kra** | $\Delta GDP$ | **NW** | $\Delta GDP$ |
|---|---|---|---|---|---|---|---|---|---|
| Panama | -9.016 | Egypt | -8.279 | Malaysia | -4.735 | Bangladesh | 1.59 | United States | .352 |
| Peru | -6.121 | Sudan | -5.511 | Singapore | -1.86 | Thailand | 1.254 | Canada | .336 |
| Mexico | -5.551 | Yemen | -4.231 | Indonesia | -1.383 | India | .932 | China | .259 |
| Cuba | -4.603 | Iran | -3.446 | Bangladesh | -1.375 | Sri Lanka | .702 | Japan | .246 |
| Colombia | -4.388 | Lebanon | -3.045 | India | -1.108 | Cambodia | .652 | Taiwan | .238 |
| Dominican Republic | -3.907 | Saudi Arabia | -2.957 | Sri Lanka | -1.033 | Pakistan | .572 | Hong Kong | .234 |
| Jamaica | -3.788 | United Arab Emirates | -2.924 | Thailand | -.932 | Iran | .345 | South Korea | .224 |
| The Bahamas | -3.658 | Kuwait | -2.868 | Cambodia | -.77 | Oman | .345 | Bermuda | .209 |
| Haiti | -3.296 | Syria | -2.823 | Pakistan | -.737 | United Arab Emirates | .343 | The Bahamas | .185 |
| Venezuela | -3.246 | Bahrain | -2.803 | Hong Kong | -.582 | Yemen | .306 | British Virgin Islands | .183 |
| Chile | -3.133 | Oman | -2.686 | United Arab Emirates | -.477 | Saudi Arabia | .29 | Guyana | .15 |
| British Virgin Islands | -2.781 | Israel | -2.626 | Oman | -.476 | Malaysia | .285 | Philippines | .148 |
| Bermuda | -2.718 | Qatar | -2.607 | China | -.467 | Bahrain | .284 | Trinidad and Tobago | .139 |
| Trinidad and Tobago | -2.419 | Somalia | -2.607 | Iran | -.464 | Qatar | .282 | Thailand | .12 |
| Guyana | -2.071 | Turkey | -2.075 | Taiwan | -.431 | Hong Kong | .281 | Iceland | .119 |
| Canada | -2.068 | Pakistan | -2.032 | Saudi Arabia | -.407 | Somalia | .277 | Cambodia | .113 |
| United States | -2.047 | Kenya | -2.014 | Yemen | -.404 | China | .276 | Haiti | .103 |
| New Zealand | -.945 | India | -1.93 | Bahrain | -.399 | Kuwait | .271 | Cuba | .099 |
| Australia | -.692 | Libya | -1.871 | Qatar | -.395 | Sudan | .247 | Dominican Republic | .096 |
| Falkland Islands | -.472 | Sri Lanka | -1.87 | Christmas Island | -.392 | Taiwan | .236 | Macau | .088 |
| Global effect | -.578 | | -.496 | | -.33 | | .134 | | .125 |

Notes: The table translates the predicted trade changes from Table 2 into GDP changes by applying a trade-income elasticity of 0.2, the midpoint of the 0.15–0.25 range estimated by Feyrer (2021). The 20 most affected countries are reported for each scenario. Because this calculation is a simple multiplicative transformation of trade effects, the ranking of countries and the relative magnitudes across scenarios are preserved from Table 2; only the absolute magnitudes differ. The final row reports the aggregate global GDP change.

**Table 4**: Welfare Effects by Country

| **Panama** | $\Delta W$ | **Suez** | $\Delta W$ | **Malacca** | $\Delta W$ | **Kra** | $\Delta W$ | **NW** | $\Delta W$ |
|---|---|---|---|---|---|---|---|---|---|
| Mexico | -4.173 | Qatar | -2.88 | Malaysia | -3.772 | Thailand | .729 | Canada | .244 |
| Panama | -3.88 | Oman | -2.525 | Singapore | -1.614 | Bangladesh | .581 | Hong Kong | .236 |
| Haiti | -3.616 | Somalia | -2.411 | Hong Kong | -.595 | Sri Lanka | .33 | The Bahamas | .109 |
| Venezuela | -3.365 | United Arab Emirates | -2.404 | Thailand | -.552 | Oman | .311 | Haiti | .107 |
| Peru | -2.873 | Libya | -2.273 | Indonesia | -.521 | Qatar | .297 | United States | .106 |
| The Bahamas | -2.228 | Bahrain | -2.094 | Bangladesh | -.511 | Hong Kong | .284 | South Korea | .092 |
| Colombia | -1.892 | Kuwait | -1.712 | Sri Lanka | -.492 | United Arab Emirates | .271 | Iceland | .085 |
| Chile | -1.553 | Syria | -1.679 | Oman | -.433 | Cambodia | .27 | Trinidad and Tobago | .08 |
| Canada | -1.543 | Saudi Arabia | -1.514 | Qatar | -.42 | India | .261 | Philippines | .078 |
| Dominican Republic | -1.482 | Yemen | -1.464 | United Arab Emirates | -.38 | Somalia | .246 | Singapore | .074 |
| Trinidad and Tobago | -1.426 | Israel | -1.286 | Somalia | -.345 | Malaysia | .214 | Thailand | .07 |
| Jamaica | -1.42 | Egypt | -1.123 | Cambodia | -.322 | Bahrain | .205 | Japan | .07 |
| Cuba | -1.128 | Bulgaria | -1.103 | India | -.313 | Libya | .163 | Bermuda | .052 |
| Bermuda | -.681 | Lebanon | -1.003 | Bahrain | -.29 | Pakistan | .161 | Macau | .05 |
| United States | -.621 | Romania | -.975 | Kuwait | -.226 | Kuwait | .157 | Cambodia | .047 |
| New Zealand | -.544 | Malta | -.973 | Libya | -.213 | Mozambique | .147 | China | .044 |
| Australia | -.481 | Turkey | -.915 | Pakistan | -.209 | Saudi Arabia | .145 | Ireland | .043 |
| Gabon | -.204 | Sri Lanka | -.895 | Saudi Arabia | -.204 | Yemen | .103 | Mexico | .04 |
| Nigeria | -.198 | Ukraine | -.821 | Philippines | -.186 | Bulgaria | .094 | Venezuela | .039 |
| Cote D'Ivoire | -.192 | Greece | -.794 | Yemen | -.137 | Syria | .093 | Dominican Republic | .036 |
| Global effect | -.216 | | -.184 | | -.122 | | .05 | | .047 |

Notes: The table reports the 20 most affected countries under each of the five scenarios in terms of welfare changes, computed using the framework of Arkolakis, Costinot, and Rodriguez-Clare (2012). Because we do not directly observe changes in domestic trade, we hold domestic trade fixed at its observed value from CEPII's Trade and Production Database and compute the change in the domestic trade share from the change in international trade predicted by our gravity model. Entries are percentage changes in welfare; the final row reports the aggregate global welfare change, computed as the trade-weighted average across countries.

**Table 5**: Aggregate effects across scenarios

| | *Trade (%)* | *GDP (%)* | *Welfare (%)* |
|---|---|---|---|
| Panama Canal closure | −2.892 | −0.578 | −0.216 |
| Suez Canal closure | −2.48 | −0.496 | −0.184 |
| Strait of Malacca closure | −1.65 | −0.33 | −0.122 |
| Kra Canal opening | +0.67 | +0.134 | +0.05 |
| Northwest Passage opening | +0.625 | +0.125 | +0.047 |

*Notes:* Entries are aggregate percentage changes in global trade, GDP, and welfare relative to the default geography. Trade effects are computed from the PPML IV gravity model in column (3) of Table 1. GDP effects apply the trade-income elasticity of 0.2 from Feyrer (2021). Welfare effects apply the Arkolakis et al. (2012) formula with a trade elasticity of $-4$ from Simonovska and Waugh (2014). Scenarios are ordered by the absolute magnitude of the short-run trade effect. Entries are rounded to three decimal places.

# 9 Appendix

## 9.1 Stock market reaction to the Ever Given accident

Many economic data are not collected at high temporal frequency, and thus are not suitable to measure short term reactions to news and shocks. Stock market data are an exception, they come at high frequency, and they represent investor sentiment on economic developments of countries and sectors around the world. To assess the economic impact of the *Ever Given* incident, we collect stock market prices of leading international stock market index funds from different countries. This incident lasted from March 23 to March 29, 2021, we collect data from February 1st 2021 to May 01 2021, covering several weeks before and after the incident. We collect these data from the historic charts provided by the website "investing.com", taking the “price” variable as our estimate, which represents an average price of the day rather than an extreme or simple opening or closing price. We then transform this daily average price into daily percentage returns.

The indices and countries we use are United States (S&P 500), China (CS100), Germany (DAX), UK (FTSE 100), France (CAC40), Canada (TSX), Mexico (BMV), Australia (ASX200), Sweden (OMX), Japan (Nikkei 225), India (Nifty50), South Korea (KOSPI), Brazil (Bovespa), the Netherlands (AEX) and Hong Kong (Hang Seng). This list includes the largest economies in the world, and the best developed stock markets. It also includes a wide geographic spread.

In order to test whether our predicted trade and welfare changes for an unexpected, short-run closure of the Suez canal correlate with stock market movements, we calculate cumulative abnormal returns during the *Ever Given* event (MacKinlay 1997). Specifically, for each of our 15 stock markets, we first calculate average daily returns for the time period from the February 1 to March 22. We use this average as our measure of expected daily returns. For March 23 to March 26, we then calculate daily abnormal returns as the difference between each index's daily returns and its expected returns. Cumulative abnormal returns $car_i$ are then calculated for each country $i$ as the sum of abnormal returns over these 4 days.[17] In Column 1 of Table 6, we then correlate country i's actual stock market impact with our predicted trade losses (Column 1). As can be seen, countries that are predicted to suffer larger trade losses from a closure of the Suez canal also had a more adverse stock market reaction during the *Ever Given* incident. In Column 2, we use ACR welfare losses instead of trade. The estimated correlation is noisier,

[17] The *Ever Given* was stuck from March 23 to March 29. We exclude March 29, as it got freed during this day. March 27 and March 28 were weekend days with no trade

but points in the same direction.

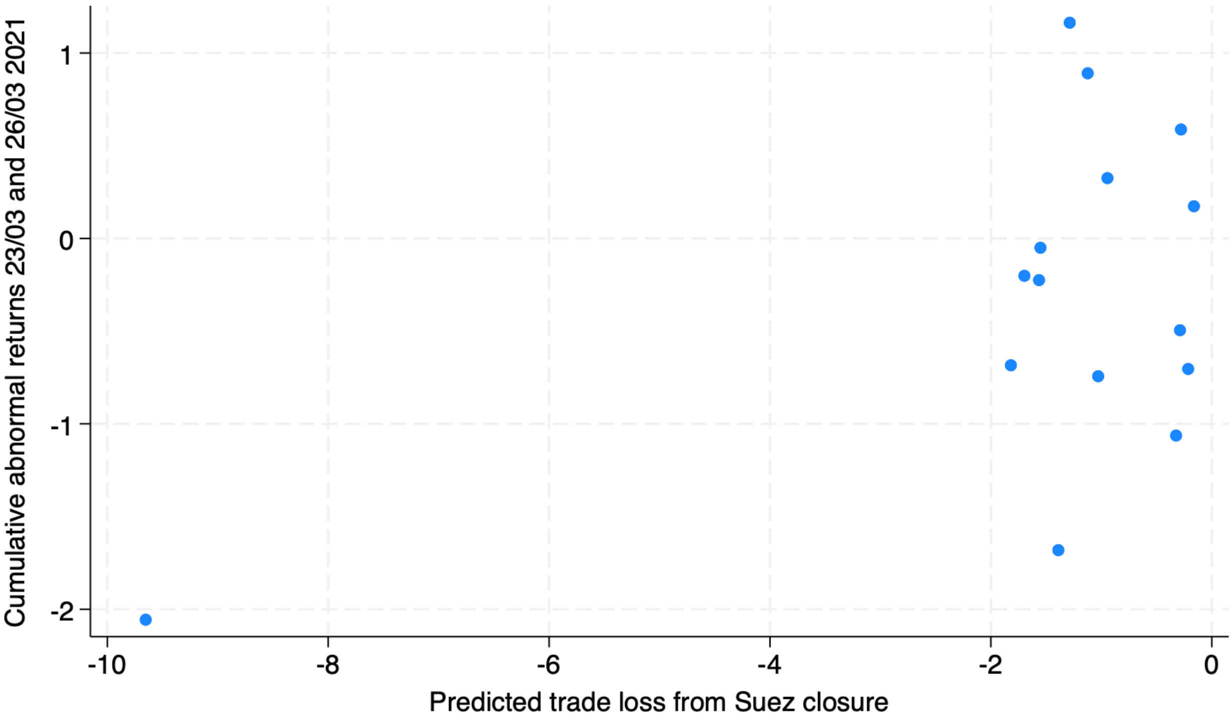
We do not want to over-interpret these results, as they are based on only 15 countries, and India with a particularly adverse stock market reaction and trade impact seems a key driver of the relationship. However, it is heartening that actual stock market reactions and our predicted trade losses move together, and it gives some external validity to our predictions.

**Table 6**: Correlation predict and stock market reactions to the Suez closure

| | (1) | (2) |
|---|---|---|
| | Cum. abnormal returns | |
| Predicted trade losses | 0.202*** | |
| | (0.0307) | |
| Predicted welfare losses | | 2.522 |
| | | (1.505) |
| N | 15 | 15 |

Robust Standard errors in parentheses
* (p<0.01), **p<0.05), *** (p<0.001)

**Figure 1**: Correlation between a country's predicted trade losses and its cumulative abnormal stock market returns during the *Ever Given* incident.




Notes: Each dot represents one of the 15 countries whose stock market data we use. The horizontal axis plots the country's predicted trade loss from a Suez Canal closure under the short-run specification from Table 2, in percent. The vertical axis plots the country's cumulative abnormal stock market return over 23–26 March 2021, computed as described in the notes to Table 8. The underlying correlation is reported in column (1) of Table 8. A downward-sloping relationship, with countries facing larger predicted trade losses (further left on the horizontal axis) experiencing more negative abnormal returns during the event, is consistent with financial markets pricing in country-level exposure to the Suez closure in a manner that correlates with our model's predictions.

## 9.2 Mapping impacts

The following five maps show the reaction of ports to each of the five shocks we study. The losses following closures of the Suez Canal, the Panama Canal or the straight of Malacca are displayed in red, gains following an opening of the North West Passage or the Kra Canal are shown in green.

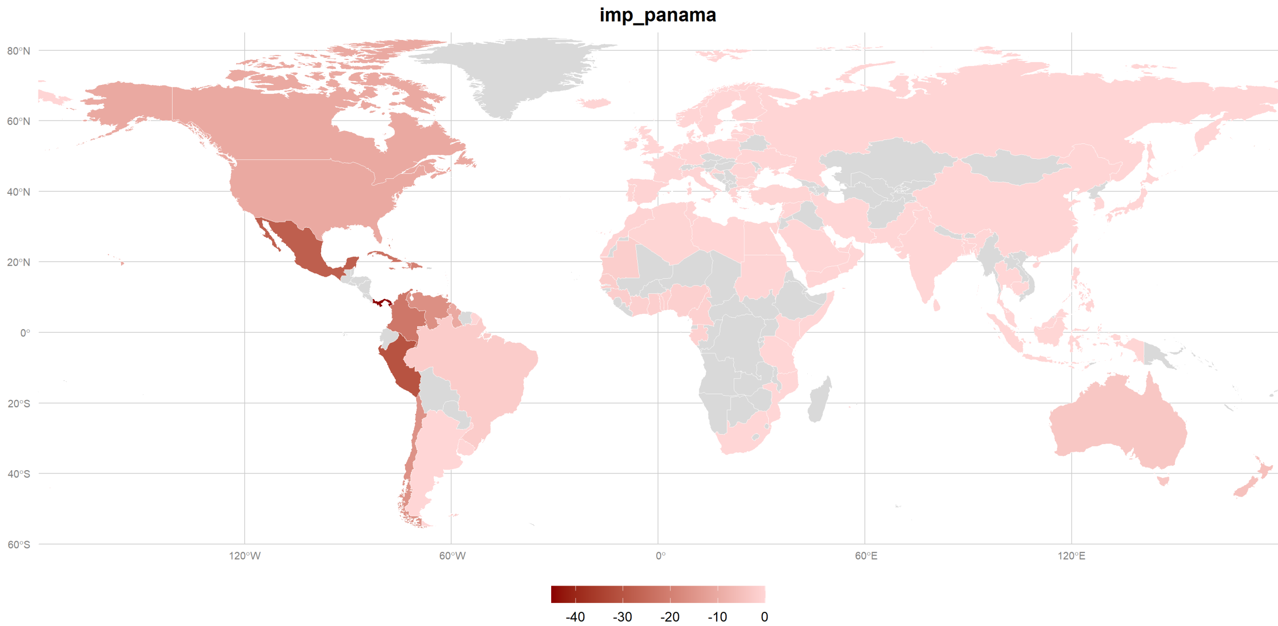



**Figure 2**: The map shows the estimated effects of a closure of the Panama Canal. Darker shades of red indicate greater losses.

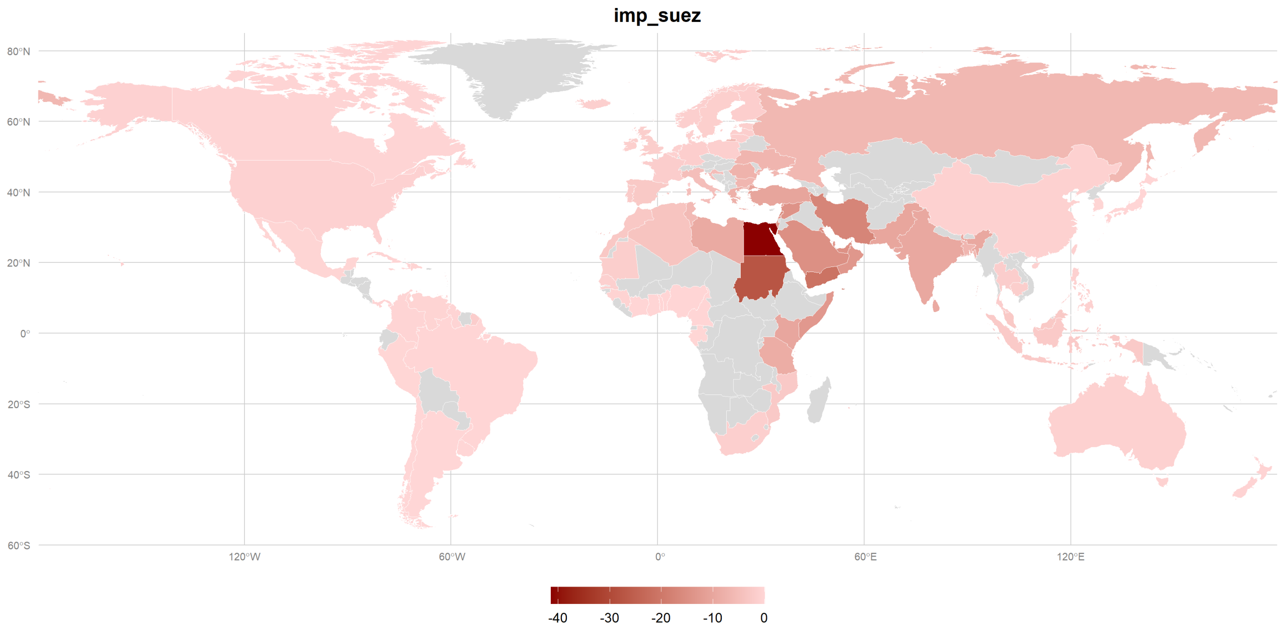



**Figure 3:** The map shows the estimated effects of a closure of the Suez Canal. Darker shades of red indicate greater losses.

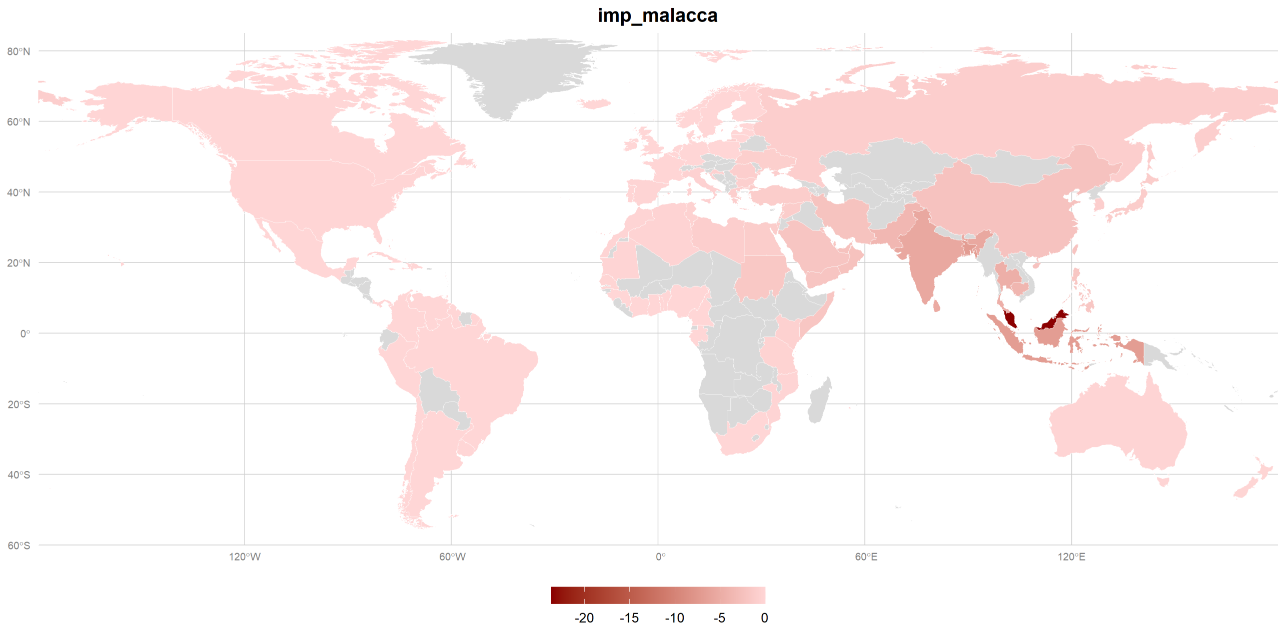



**Figure 4**: The map shows the estimated effects of a closure of the Strait of Malacca. Darker shades of red indicate greater losses.

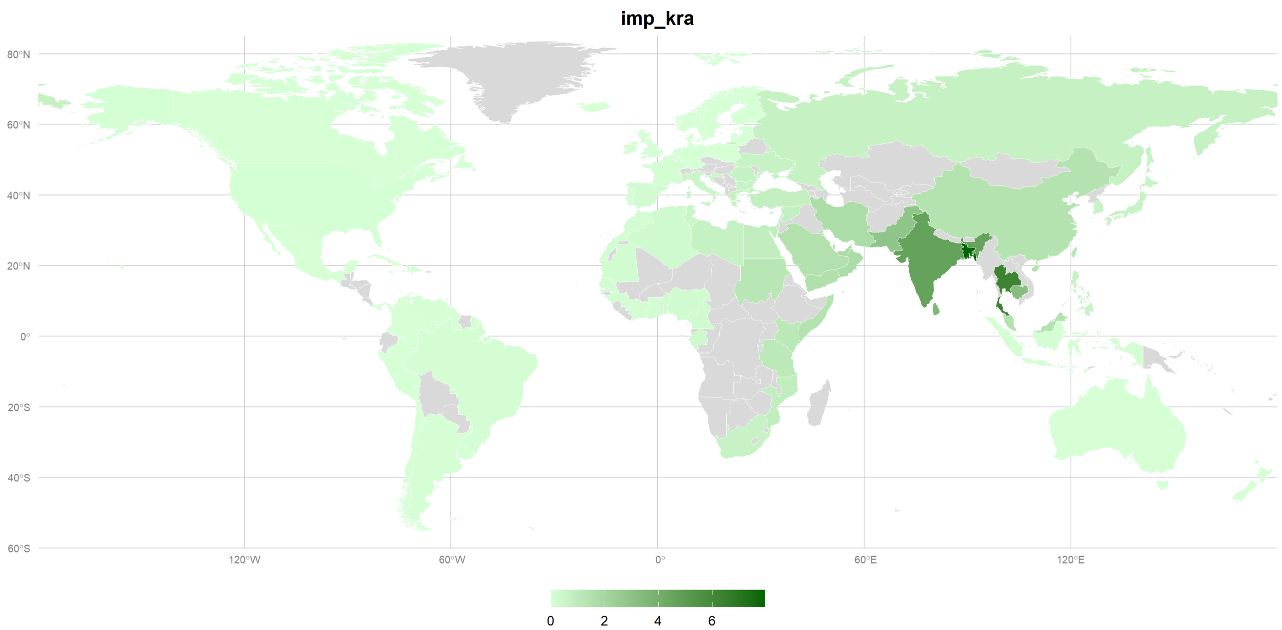



**Figure 5**: The map shows the estimated effects of an opening of the Kra Canal. Darker shades of green indicate greater gains.

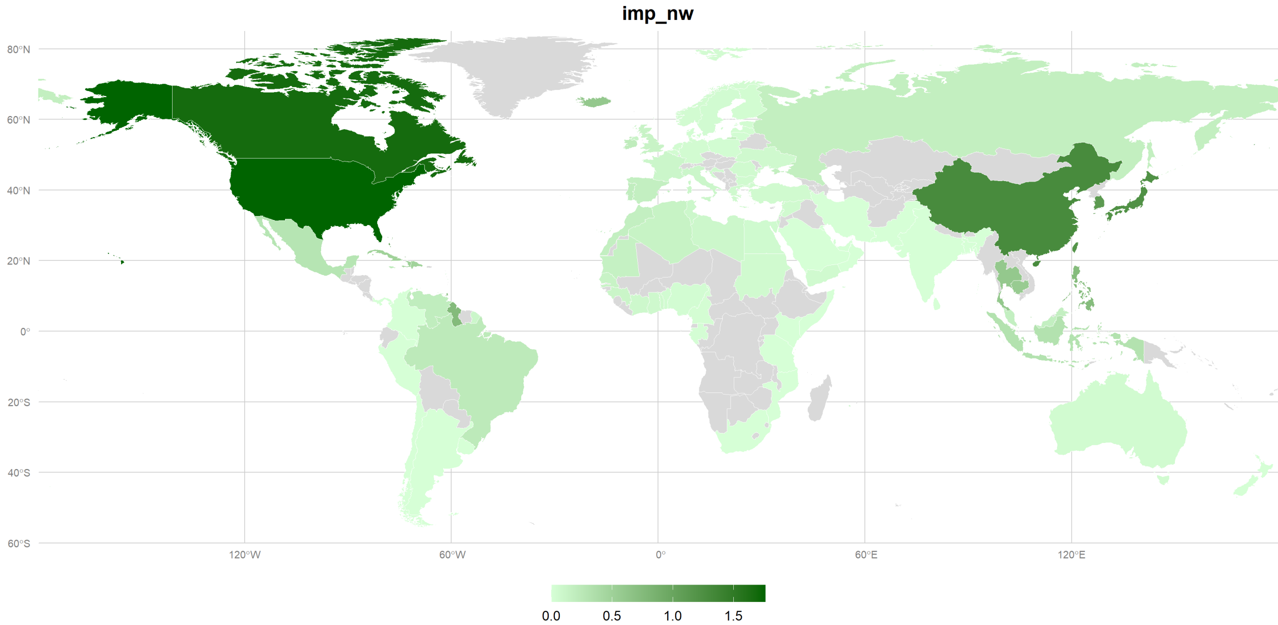



**Figure 6**: The map shows the estimated effects of an opening of the North-Western passage. Darker shades of green indicate greater gains.

## 9.3 Trade impacts: full country list

**Table 7**: Trade impacts per country and scenario

| Country | Panama | Suez | Malacca | Kra | NW |
|---|---|---|---|---|---|
| Algeria | -.339 | -3.82 | -.336 | .295 | .135 |
| Argentina | -.004 | -.039 | -.002 | .025 | 0 |
| Australia | -3.458 | -1.123 | -.214 | .005 | .044 |
| Bahrain | -.05 | -14.014 | -1.993 | 1.419 | 0 |
| Bangladesh | 0 | -6.736 | -6.874 | 7.948 | 0 |
| Belgium | -.155 | -1.074 | -.028 | .026 | .039 |
| Benin | -1.077 | -.129 | 0 | .234 | .042 |
| Bermuda | -13.588 | -.729 | -.046 | .033 | 1.044 |
| Brazil | -2.214 | -.162 | 0 | .083 | .227 |
| British Virgin Islands | -13.907 | -.564 | -.063 | .035 | .914 |
| Bulgaria | -.32 | -6.823 | -.806 | .593 | .053 |
| Cambodia | -.058 | -1.673 | -3.85 | 3.26 | .566 |
| Cameroon | -1.128 | -.111 | 0 | .255 | .02 |
| Canada | -10.342 | -.323 | -.038 | .02 | 1.679 |
| Chile | -15.665 | -.014 | -.012 | .005 | 0 |
| China | -.134 | -1.028 | -2.334 | 1.382 | 1.293 |
| Christmas Island | -.025 | -3.023 | -1.962 | 0 | .281 |
| Colombia | -21.939 | -.433 | 0 | 0 | 0 |
| Cote D'Ivoire | -1.429 | -.204 | 0 | .141 | .078 |
| Croatia | -.335 | -5.133 | -.648 | .51 | .065 |
| Cuba | -23.014 | -.407 | -.016 | .018 | .494 |
| Denmark | -.159 | -1.242 | -.002 | .006 | .034 |
| Dominican Republic | -19.536 | -.502 | -.031 | .03 | .48 |
| Egypt | -.293 | -41.394 | -1.133 | .819 | .059 |
| Estonia | -.179 | -1.558 | -.002 | .008 | .037 |
| Falkland Islands | -2.362 | 0 | -.012 | .025 | 0 |
| Finland | -.182 | -1.57 | -.002 | .008 | .037 |

*Continued on next page*

Table 7 – continued

| Country | Panama | Suez | Malacca | Kra | NW |
|---|---|---|---|---|---|
| France | -.261 | -1.819 | -.11 | .096 | .097 |
| Gabon | -1.17 | -.095 | 0 | .315 | .016 |
| Germany | -.188 | -1.564 | -.019 | .021 | .039 |
| Ghana | -1.555 | -.239 | 0 | .168 | .075 |
| Gibraltar | -.426 | -2.317 | -.265 | .211 | .192 |
| Greece | -.37 | -8.052 | -.905 | .675 | .062 |
| Guinea | -1.952 | -.704 | 0 | .149 | .112 |
| Guyana | -10.356 | -.374 | -.025 | .039 | .75 |
| Haiti | -16.48 | -.558 | -.026 | .027 | .515 |
| Hong Kong | -.117 | -1.389 | -2.909 | 1.405 | 1.169 |
| Iceland | -.397 | -1.37 | -.003 | 0 | .597 |
| India | -.015 | -9.652 | -5.538 | 4.66 | 0 |
| Indonesia | -.108 | -2.429 | -6.916 | .086 | .312 |
| Iran | -.039 | -17.23 | -2.319 | 1.724 | 0 |
| Ireland | -.271 | -1.522 | -.047 | .038 | .21 |
| Israel | -.365 | -13.131 | -1.129 | .82 | .082 |
| Italy | -.405 | -5.023 | -.537 | .492 | .095 |
| Jamaica | -18.941 | -.543 | -.009 | .013 | .221 |
| Japan | -.171 | -.214 | -1.13 | .559 | 1.228 |
| Kenya | -.015 | -10.068 | -.627 | 1.113 | 0 |
| Kuwait | -.05 | -14.34 | -1.937 | 1.354 | 0 |
| Latvia | -.177 | -1.576 | -.002 | .008 | .036 |
| Lebanon | -.284 | -15.224 | -1.12 | .811 | .059 |
| Libya | -.158 | -9.357 | -.904 | .696 | .091 |
| Lithuania | -.174 | -1.618 | -.002 | .008 | .036 |
| Macau | -.044 | -.584 | -.978 | .477 | .439 |
| Malaysia | -.024 | -2.728 | -23.674 | 1.425 | .168 |
| Malta | -.417 | -6.054 | -.669 | .551 | .091 |
| Mauritania | -1.822 | -1.738 | -.193 | .212 | .152 |

*Continued on next page*

Table 7 – continued

| Country | Panama | Suez | Malacca | Kra | NW |
|---|---|---|---|---|---|
| Mexico | -27.757 | -.288 | -.031 | .016 | .286 |
| Morocco | -.584 | -3.023 | -.181 | .168 | .168 |
| Mozambique | -.037 | -2.716 | -.215 | .849 | 0 |
| Netherlands | -.18 | -1.286 | -.028 | .026 | .038 |
| New Zealand | -4.723 | -.594 | -.168 | .006 | .005 |
| Nigeria | -1.352 | -.169 | 0 | .26 | .034 |
| Norway | -.195 | -1.421 | -.004 | .003 | .039 |
| Oman | -.04 | -13.428 | -2.378 | 1.724 | 0 |
| Pakistan | -.031 | -10.16 | -3.686 | 2.86 | 0 |
| Panama | -45.078 | -.34 | -.01 | 0 | 0 |
| Peru | -30.603 | -.092 | -.013 | 0 | 0 |
| Philippines | -.156 | -1.001 | -1.765 | .612 | .739 |
| Poland | -.159 | -1.449 | -.002 | .007 | .032 |
| Portugal | -.564 | -2.243 | -.107 | .11 | .195 |
| Qatar | -.05 | -13.035 | -1.973 | 1.412 | 0 |
| Romania | -.276 | -7.388 | -.897 | .66 | .056 |
| Russia | -.243 | -6.307 | -.934 | .672 | .173 |
| Saint Helena | -1.962 | -.004 | 0 | .127 | .023 |
| Saudi Arabia | -.055 | -14.785 | -2.033 | 1.449 | 0 |
| Senegal | -2.06 | -1.305 | -.177 | .203 | .129 |
| Singapore | -.005 | -2.669 | -9.302 | .002 | .438 |
| Somalia | -.032 | -13.034 | -1.924 | 1.387 | 0 |
| South Africa | -.062 | -1.458 | -.015 | .616 | 0 |
| South Korea | -.088 | -.279 | -.927 | .559 | 1.118 |
| Spain | -.611 | -2.74 | -.218 | .173 | .171 |
| Sri Lanka | -.012 | -9.349 | -5.165 | 3.51 | 0 |
| Sudan | -.264 | -27.557 | -1.681 | 1.236 | .058 |
| Sweden | -.192 | -1.551 | -.002 | .008 | .041 |
| Syria | -.237 | -14.113 | -1.1 | .802 | .053 |

*Continued on next page*

Table 7 – continued

| Country | Panama | Suez | Malacca | Kra | NW |
|---|---|---|---|---|---|
| Taiwan | -.132 | -1.084 | -2.153 | 1.18 | 1.192 |
| Tanzania | -.018 | -8.661 | -.358 | 1.081 | 0 |
| Thailand | -.061 | -1.831 | -4.658 | 6.27 | .598 |
| The Bahamas | -18.289 | -.567 | -.037 | .028 | .923 |
| Togo | -1.126 | -.152 | 0 | .232 | .064 |
| Trinidad and Tobago | -12.093 | -.544 | -.049 | .036 | .693 |
| Tunisia | -.344 | -5.802 | -.457 | .468 | .089 |
| Turkey | -.301 | -10.374 | -1.087 | .771 | .058 |
| Ukraine | -.259 | -6.856 | -.853 | .631 | .061 |
| United Arab Emirates | -.058 | -14.621 | -2.383 | 1.716 | 0 |
| United Kingdom | -.246 | -1.697 | -.048 | .034 | .128 |
| United States | -10.234 | -.945 | -.112 | .062 | 1.761 |
| Uruguay | -.003 | -.037 | -.002 | .024 | 0 |
| Venezuela | -16.232 | -.491 | -.027 | .029 | .196 |
| Yemen | -.229 | -21.155 | -2.02 | 1.529 | .053 |

## 9.4 Trade losses with costless within-port substitution and cheap domestic transportation

In our main analysis, we calculate effective distances between countries as weighted distances between ports, where the weights are given by the share of the countries' populations that are closest to the respective ports:

$$dist_{ij} = \sum_{p \in i} \sum_{q \in j} wpop_{ip} \cdot wpop_{jq} \cdot distance_{pq}$$

We believe this is a sensible approach, as it takes into account the economic geographies of the two countries. A port combination that is closer, but represents a small population share thus gets down-weighted relative to a port combination that is further away, but closer to the respective population centers.

An alternative approach would be to instead take the minimum distance port combination between both countries. This approach assumes that all trade between, for example, Europe and the United States would happen between Europe and the US East Coast, whereas all trade between Asia and the US would happen via the US West Coast. Clearly, this is not true in practice: In 2023, more than 121 million long tons of cargo passed the Panama canal going from the East Coast of the US to Asia or vice versa. Another 5 million long tons passed between Europe and the US West Coast. (Bureau of Transportation Statistics 2024). These trade flows would not occur if countries only traded via their closest port pairs.

On the other hand, using minimal distances allows for some substitution of ports as distances between countries change. Consider trade between the United Arab Emirates and Algeria: In the default world as we know it, the shortest distance port combination is from Khawr Fakkan to Annaba in Eastern Algeria. If the Suez Canal were to close, this connection would become longer and no longer optimal: With a closed Suez Canal, the shortest connection between the two countries would now be from Khawr Fakkan to Oran in Western Algeria. With minimal distances, we would thus see all trade between the two countries rerouted from the Khawr Fakkan-Annaba route to Khawr Fakkan-Oran. This assumes that port infrastructure can fully adapt, and that the domestic transportation system is such that it can transport goods within the country cheaper than via sea. Such costless substitution of ports is of course unrealistic even in the long run. However, we see it as an interesting extreme scenario and have therefore repeated our analysis based on using minimal port combinations between countries. Table 8 first repeats our gravity model. Results are similar, though the distance coefficients are bit more muted, likely due the lower average distances in this case.

When we then calculate trade effects in Table 9 we generally find lower effects. This is particularly true for the Panama canal, where trade losses fall from 2.89 percent with population weighted distances to 0.15 with minimal distances combinations. The key reason for this is the United States, which has ports both on the Atlantic and Pacific coast. Because of this, when looking only at minimal distances, many country pairs are not affected at all, as they are assumed to only trade via one coast anyways. With population weighted distances instead, these countries are also affected, as they are assumed to also trade with the coast further away from them (e.g. Europe with the West Coast and Asia with the East Coast). Similar effects are at play for all other countries with both Atlantic and Pacific ports. The most extreme case is Panama, which in our baseline calculation has trade losses of 45.08%. With minimum distance port pairs, Panama is not affected at all, since each trade partner is assumed to choose a port on the closer coast. While this assumption might not be implausible for a small and “thin" country like Panama, it is clearly unrealistic for Canada or the United States, where we know that substantial trade flows happen between Asia and their East Coasts and between Europe and their West Coasts.

The Suez canal is on aggregate less affected by this extreme assumption on substitution. Aggregate trade losses fall from 2.48 to 1.61 percent. However, for Egypt, a similar issue arises as for Panama: The country has ports both in the Mediterranean and Red Sea. With population weighted distances, trade partners from Europe see the distances to the Red Sea increase a lot if the Suez canal were to close, and trade partners from Asia and Southern Africa see a similar change for Mediterranean ports. On the other hand, with minimal distances, each partner chooses a port closest, and the Suez closure has no effect at all on Egypt. For the closure of the Strait of Malacca, aggregate losses decline from 1.65 to 0.78%. On the other hand, the Kra canal is less affected: Aggregate gains drop from 0.67 to 0.63%, and the ordering of the most affected countries is very similar. For the opening of the Northwest passage, costless port substitution within ports leads to almost no trade gains at all, apart from the Caribbean.

**Table 8**: Main gravity equation

| | (1) | (2) | (3) |
|---|---|---|---|
| | PPML | PPML IV | |
| | | 1st stage | 2nd stage |
| | Trade Flows | Ln dist | Trade Flows |
| Log distance | -0.431*** | | -0.580*** |
| | (0.0297) | | (0.0677) |
| FTA WTO | 0.423*** | -0.00683* | 0.320*** |
| | (0.0815) | (0.00384) | (0.0715) |
| Colonial history | 0.175 | -0.0124 | 0.0736 |
| | (0.108) | (0.0106) | (0.120) |
| Common ethnolinguistic | 0.109* | 0.00804*** | 0.150** |
| | (0.0595) | (0.00281) | (0.0641) |
| Contiguous | 0.211** | -0.125*** | -0.0119 |
| | (0.0943) | (0.0173) | (0.136) |
| Ln distance capitals | | 0.133*** | |
| | | (0.00405) | |
| Control function | | | 0.360*** |
| | | | (0.128) |
| N | 8,695 | 8,695 | 8,695 |

Note: Main gravity equation, estimated in PPML. Log distance here is the log of minimal distances between country ports. Column (3) uses Euclidian distances between country capitals to instrument for distances over water, Column (2) shows the respective first stages. All regressions control for country of origin and country of destination fixed effects. Standard errors twoway-clustered at the country of origin and country of destination level.

* (p<0.10), ** (p<0.05), *** (p<0.01)

**Table 9**: Trade Effects by Country under costless port substitution within countries

| **Panama** | $\Delta T$ | **Suez** | $\Delta T$ | **Malacca** | $\Delta T$ | **Kra** | $\Delta T$ | **NW** | $\Delta T$ |
|---|---|---|---|---|---|---|---|---|---|
| Peru | -13.275 | Sudan | -23.176 | Indonesia | -6.63 | Bangladesh | 6.991 | Bermuda | .93 |
| Chile | -7.905 | Yemen | -19.237 | Bangladesh | -5.995 | Thailand | 5.587 | British Virgin Islands | .772 |
| Falkland Islands | -2.432 | Iran | -12.266 | India | -5.623 | India | 5.568 | The Bahamas | .7 |
| Colombia | -2.334 | Somalia | -11.791 | Sri Lanka | -4.445 | Sri Lanka | 4.051 | Guyana | .643 |
| Venezuela | -1.614 | Oman | -11.004 | Singapore | -4.341 | Cambodia | 2.667 | Trinidad and Tobago | .595 |
| Jamaica | -1.288 | United Arab Emirates | -10.983 | Pakistan | -2.817 | Pakistan | 2.264 | Haiti | .442 |
| Haiti | -1.056 | Lebanon | -10.783 | Thailand | -2.068 | Iran | 1.48 | Dominican Republic | .434 |
| Dominican Republic | -.887 | Saudi Arabia | -10.61 | Cambodia | -1.998 | Oman | 1.434 | Cuba | .399 |
| Cuba | -.777 | Kuwait | -10.239 | Iran | -1.884 | United Arab Emirates | 1.423 | Brazil | .28 |
| Trinidad and Tobago | -.769 | Bahrain | -9.732 | United Arab Emirates | -1.884 | China | 1.358 | Iceland | .223 |
| Guyana | -.569 | Syria | -9.638 | Oman | -1.883 | Yemen | 1.352 | Jamaica | .196 |
| The Bahamas | -.473 | Qatar | -9.415 | Yemen | -1.742 | Hong Kong | 1.229 | Venezuela | .11 |
| Bermuda | -.395 | Kenya | -8.838 | Saudi Arabia | -1.616 | Saudi Arabia | 1.205 | Mauritania | .105 |
| British Virgin Islands | -.347 | Pakistan | -8.468 | China | -1.586 | Qatar | 1.139 | Senegal | .101 |
| United States | -.223 | Israel | -8.439 | Kuwait | -1.525 | Somalia | 1.134 | Guinea | .092 |
| Iceland | -.148 | Turkey | -8.075 | Qatar | -1.522 | Kuwait | 1.116 | Japan | .09 |
| New Zealand | -.145 | Tanzania | -7.726 | Somalia | -1.484 | Bahrain | 1.103 | Portugal | .074 |
| Portugal | -.108 | Libya | -7.062 | Bahrain | -1.475 | Sudan | 1.069 | Gibraltar | .061 |
| Spain | -.104 | India | -6.819 | Sudan | -1.408 | Taiwan | 1.012 | South Korea | .052 |
| Mauritania | -.103 | Romania | -6.338 | Hong Kong | -1.355 | Kenya | .914 | Morocco | .052 |
| Global effects | -.147 | | -1.613 | | -.781 | | .626 | | .02 |

Notes: The table reports the 20 most affected countries under each of the five scenarios, assuming countries trade on minimum distance port combinations. Entries are percentage changes in total directed trade, computed by comparing gravity-predicted trade flows under the scenario geography to predicted flows under the default (current) geography, holding all estimated coefficients and non-distance regressors fixed. The final row reports the aggregate global trade change, computed as the percentage change in the sum of predicted trade flows across all country pairs. Numbers are rounded to two decimal places. Negative values indicate trade losses; positive values indicate gains.

## 9.5 Alternative welfare calculation

ACR mention in the extension of their paper, that when tradeable intermediate goods are required to produce other tradeable intermediate goods, this creates an input-output loop that amplifies gains from trade. Campos et al (2025) derive a framework to simulate the general equilibrium (GE) effects of trade frictions within a universal gravity framework that generalizes the ACR model by introducing a positive supply elasticity ($\psi > 0$) through "roundabout production". Constraining the supply elasticity to zero ($\psi = 0$), the welfare equation collapses to the rigid baseline in ACR, which (as seen above) evaluates welfare effects solely on changes in domestic trade shares ($\lambda$) and trade elasticity ($\theta$). Moreover, this generalised model introduces trade diversion and terms-of-trade shifts by solving for endogenous output prices across countries.

Building on our estimated distance coefficient as a proxy for iceberg trade costs, we simulated the general equilibrium (GE) effects by applying a supply elasticity ($\psi$) of 1.24, following Campos et al (2025), alongside the previously established trade elasticity ($\theta$) of 4. As expected, aggregate results are significantly larger in comparison to ACR welfare effects. For a Suez Canal closure, aggregate global welfare drops by 0.210%, compared to 0.184% in the ACR results. Similarly, for the Panama Canal and the Strait of Malacca, the aggregate GE losses are 0.319% and 0.140%, respectively, compared to 0.216% and 0.122% of the ACR baseline. In the cases of openings, global welfare increases by 0.055% for the Kra Canal and 0.080% for the Northwest Passage. When we set the supply elasticity to zero ($\psi = 0$), GE averages tend to be smaller than in ACR. Geographic heterogeneity is still prevailing, sometimes even amplifying. Under a rigid supply elasticity, Libya, for example, experiences a loss of 4.073%. Conversely, Somalia whose welfare drops by 2.411% in case of a closure of the Suez under the ACR, only incurs a loss of 0.285% in GE.

Generally, setting the supply elasticity to zero ($\psi = 0$) reduces the magnitude of both aggregate and country-level empirical welfare effects by approximately 50%. This demonstrates that roughly half of the economic impact of maritime chokepoints is driven by intermediate supply chains. This aligns with the mechanics of roundabout production: when a negative trade shock hits, and supply elasticity is positive, firms responding to the higher input prices reduce their output, thereby worsening welfare effects. Conversely, when supply elasticity is eliminated from the firm's production function, the economy returns to a rigid endowment. With input price shocks insulated and labour supplied inelastically, firms are prevented from reducing output and true welfare damage is understated. The inverse is true for positive trade shocks, however, where firms would like to increase their produced quantity as input prices decrease. Hence, a positive supply elasticity acts as a critical amplifier while a rigid supply assumption dampens the welfare effects.

Lastly, the GE framework's ability to model trade diversion points to two major effects. First, even in the case of closures, there can be net winners. For instance, the Republic of Congo gains 1.412% in case of a closure of the Suez. Second, landlocked countries that were not included in our ACR analysis as they simply do not have any maritime borders, can now be affected through trade diversion effects. Rwanda, for example, loses 0.168% of welfare even though they are landlocked, which is possibly driven by trade friction increases in neighbouring coastal countries like Tanzania (which loses 0.752%).

**Table 10**: Welfare Effects Averaged for the 89 Sample Countries (in %)

| | **GE ($\psi = 1.24$) (%)** | **GE ($\psi = 0$) (%)** | **ACR (%)** |
|---|---|---|---|
| Panama Canal closure | −0.319 | −0.151 | −0.216 |
| Suez Canal closure | −0.210 | −0.107 | −0.184 |
| Strait of Malacca closure | −0.140 | −0.065 | −0.122 |
| Kra Canal opening | +0.055 | +0.027 | +0.050 |
| Northwest Passage opening | +0.080 | +0.040 | +0.047 |

*Note:* Comparison of the welfare effects of three different GE models.