

Trade From Space: Shipping Networks and The Global Implications of Local Shocks

Inga Heiland took part in the Globalization, Shipping and Trade workshop organized by the PSE Chair of Globalization on 12 October 2023. She presented a paper on the network effects of the Panama Canal expansion. The widening of the Panama Canal in June 2016 removed a bottleneck in maritime transport, allowing much larger ships to pass through. This policy brief presents a summary of this work co-authored with Karen Helene Ullveit-Moe, Andreas Moxnes and Yuan Zi which quantifies the direct and indirect effects of the expansion on global trade flows and welfare.

The article "Trade from Space: Shipping Networks and the Global Implications of Local Shocks" is one of the first to use disaggregated maritime data to complement the analysis of international trade flows. Maritime data refers to

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> the Automatic Identification System (AIS), which is now compulsory on board container ships and which transmits the geographical coordinates of the vessel in real time. The AIS system offers all stakeholders (other sailing vessels, port

officials, the general public and researchers) the possibility of knowing in real time the position of any vessel on any part of the planet, as shown on the map in *Figure 1* below (the colors refer to the different types of vessel).

Figure 1. Snapshot of AIS data



Source: https://www.marinetraffic.com/



The AIS system therefore makes it possible to track the position of a given vessel over time and to reconstruct its route by examining the ports visited successively. The paper presented by Inga Heiland uses this AIS data on the world container ship fleet for the year 2016 to study a major event that took place in the middle of that year, namely the expansion of the Panama Canal. Their work focuses on container ships, which typically carry manufactured goods and account for around two-thirds of world trade based on values.

The paper begins by outlining the infrastructure works that have

taken place on the canal and explains how to measure the exposure of pairs of countries to the canal. It then measures the effects of the expansion, firstly on bilateral trade, and then on world trade and global well-being after indirect effects have been taken into account.

The expansion of the Panama Canal

The expansion of the Panama Canal decided in 2006 was undertaken for two reasons. Firstly, the Canal Authority forecast that it would reach its maximum sustainable capacity between 2009 and 2012. Secondly, the increase in the size of container ships over the last few decades has made a large number of larger vessels incompatible with the Canal's existing infrastructure. The decision to widen the canal involved the introduction of a new, deeper and wider traffic lane. Commercial operations in the widened canal began in June 2016.

Figure 2. International shipping routes with versus without the Panama Canal



Source: https://www.ajot.com/news/panama-canal-inauguration-a-strategic-route-for-world-trade-and-cma-cgm-gro.

From the point of view of the economic theory of international trade, the widening of the canal represents a shock to transit times through Panama which is likely to reduce the journey time of many trade flows and thus modify world trade routes. Measuring the effect of the reduction in journey times on traffic flows ultimately makes it possible to quantify the overall impact of such a shock on world trade and, consequently, on the income of countries.



Measuring the exposure to the widening the Panama Canal

The key step in quantifying the effects of the enlargement of the Panama Canal is to determine which countries are likely to be affected by the event, particularly because their international trade passed through the Canal before enlargement. While AIS maritime data provide detailed location and identification of ships, they do not (yet) provide information on the contents or the exact route taken by containers transported across the seas from a port of origin to a port of destination. To find out whether a container containing goods exported, for example, from Germany to the west coast of the United States, crosses the Atlantic and passes

through the Panama Canal or passes through the Suez Canal and then crosses the Pacific Ocean, the authors rely on an algorithm that calculates the route that minimizes the journey time between ports. Among the set of optimal routes connecting two ports at different points in time, they select the route - the sequence of intermediate ports - that is used most frequently. These calculations suggest that only 6% of country-to-country maritime links are direct. Trade between these directly connected countries accounts for only 54% of world trade, which means that a large share of global trade does not travel on direct routes, but on routes with

multiple hops. In fact, 50% of all country-to-country connections involve stops in more than two other countries in between. The fact that the Panama Canal was used for the optimal voyage between two given ports before its enlargement in mid-2016 is aggregated at the level of each pair of origin and destination countries in order to approximate the share of maritime trade that passes through the Panama Canal for that pair. The authors refer to this share as "exposure to the Panama Canal". As Figure 3 shows, countries are exposed to the Panama Canal in very different ways.

Figure 3. Panama Canal Exposure by country



Source: Computations by the authors



Quantifying the effect of the Canal's expansion on bilateral trade

The purpose of widening the Panama Canal was to allow the largest container ships to cross the American continent instead of navigating around its southern part. The journey time for the pairs of countries "exposed to the Canal" is therefore likely to be reduced after the opening of the Canal in mid-2016, and their trade volume is likely to increase accordingly.

The authors estimate the

increase in bilateral trade over time between the pre-expansion period (from 2013 to mid-2016) and the post-expansion period (from mid-2016 to the end of 2019). The exercise involves measuring the change in bilateral trade over time for countries exposed to the Canal, and comparing it to the change in bilateral trade over the same period for countries not exposed to the Canal, holding all other factors constant. The results

indicate that trade increased by around 10% after the expansion for countries whose routes are fully exposed to the Panama Canal. For countries where the Panama Canal exposure variable is positive and varies from partner to partner, trade increased by an average of 2.27% when the exposure variable increased by 2.21%.

Quantifying the effect of the Canal®s expansion on world trade

Given that world maritime trade has the characteristics of a network, a shock to one of the links will have an impact not only on the volume of trade between the end nodes of that link, but also on the volume of trade on the other links in the network.

Quantifying these mechanisms requires the use of a theoretical trade model in which the trade network environment is characterized by indirect routes linking countries. Trade is channeled through shipping volumes of goods through the different links that characterize a journey from the origin to the destination country. The model features straightforward gravity mechanisms on each of these links, applied to traffic flows: the volume of shipping on a given link is proportional to the size of the two end nodes (in terms of demand and supply capacity of goods to be shipped) and inversely proportional to transport costs on that link. Last, there is a simple mapping between the value of traffic freight and the volume of trade, so that when traffic gets impacted by a shock on travel time for example, traffic flows adapt on each of the links and modify trade flows between origin and destination countries. This international trade model adapted to the maritime transport network thus allows to predict the effects of a reduction in crossing time through the Panama Canal, all other things being constant, on the value of maritime freight transport and bilateral trade flows around the world.

The observed increase in freight traffic between the preexpansion and post-expansion periods implies that the canal expansion lowered transport costs by around 2-3 percent. The authors are able to isolate whether the increase in freight traffic is due to a change in vessel size, in the frequency with which vessels call at the canal, or in the level of vessel loading. They show that while the last two margins have not changed significantly, infrastructure works have greatly facilitated the passage of much larger ships through the Panama Canal.

The four authors calibrate the theoretical model and obtain a trade flow matrix simulating how world trade flows have been modified by combining the effect of the canal expansion and the resulting adjustments in freight traffic. As trade volumes are directly related to countries' incomes, changes in countries' trade volumes allow the authors to derive the impact on countries' real income, and therefore on welfare.



International externalities

The results show that the expansion was associated with a significant positive effect on third countries (which are not directly linked to the canal). The presence of significant positive international externalities in resolving the bottleneck linked to the narrowness of the Panama Canal can be approached by comparing the variation in world real income generated by the expansion with the variation in Panama's real income. According to the results, this ratio is 3.14, i.e. the gains for the world was more than three times greater than the income gains for Panama alone. Not surprisingly, the change in real income had a positive effect on the countries whose ports are closest to the canal, which naturally gained the most. However, some more distant ports, such as Colombia, Ecuador and the Caribbean, have also enjoyed significant welfare gains as a result of the canal's expansion.

The work by Inga Heiland and her co-authors makes a significant contribution to the literature by leveraging for the first time the geography of freight flows within international trade models and quantifications. Their quantitative results point to the interdependences created by the global shipping network, and suggest that as long as infrastructure costs are not shared across countries, the presence of positive externalities implies that the world invests too little in global transportation networks.

References

A. Moxnes, K. H. Ulltveit-Moe, and Y. Zi, 2023, "<u>Trade From Space: Shipping Networks and The Global</u> <u>Implications of Local Shocks</u>", CEPR Discussion Paper No. 14193.

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