Estimating the effects of the container revolution on world trade[1]

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Abstract

Many historical accounts have asserted that the container revolution triggered complementary organizational changes in global freight transport that accelerated the growth of world trade. We are the first to suggest identification strategies for estimating the effects of this revolution on world trade. Our first approach exploits time and cross-sectional variation in countries' first adoption of container facilities to construct a time-varying bilateral container technology variable and estimate its effects on a large panel of product level trade flows. Our second approach builds an instrument for container adoption based on historical evidence on the diffusion of container technology by the US military during the Vietnam War. Both strategies suggest economically large concurrent and cumulative effects of containerization and lend support for the view of containerization being a driver of 20th century economic globalization.

JEL classification: F13

Keywords: containerization, 20th century global transportation infrastructure, growth of world trade.

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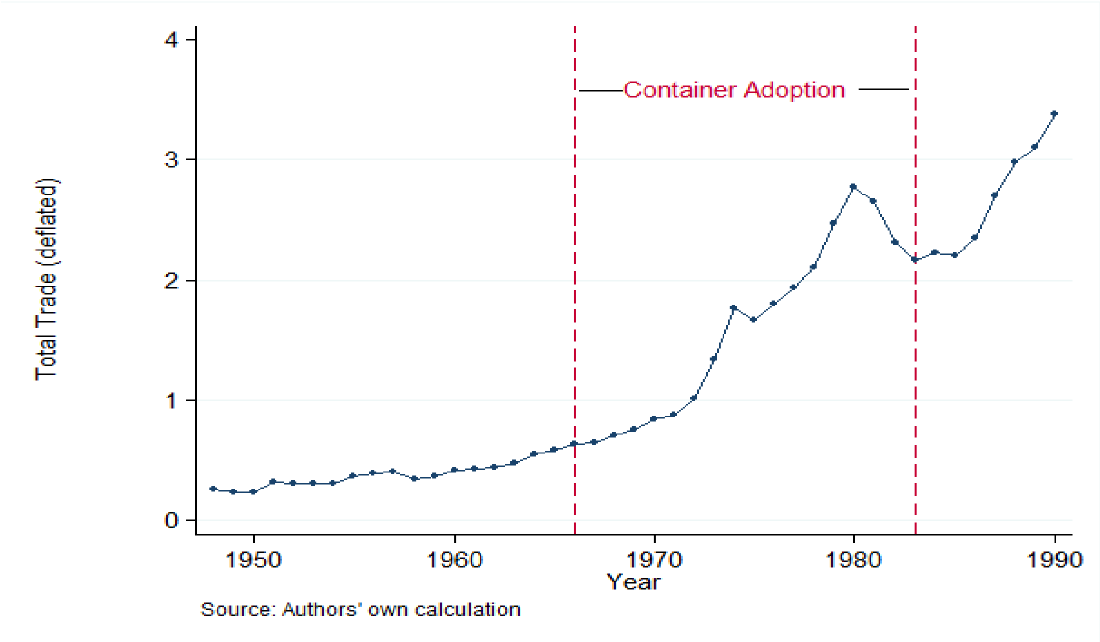
1. Introduction

One of the most striking developments in the global economy since World War II has been the tremendous growth in international trade. As shown in Figure 1, the increase in world trade accelerated dramatically during the early 1970s, with world trade growing in real terms from 0.45 trillion dollars in the early 1960s to 3.4 trillion dollars in 1990, by about a factor of 7. A central question is what accounts for this dramatic growth in world trade. Two broad explanations have been identified: (i) trade policy liberalization and (ii) technology-led declines in transportation costs.[2]

Figure 1: The growth of world trade (deflated): 1948-1990



A vast literature on transportation economics has argued that containerization was the major change in 20th century transportation technology responsible for the acceleration of the globalization of the world economy since the 1960s.[3] Figure 1 reveals that the dramatic increase in the growth in world trade coincides indeed with the period of global container adoption in international trade which occurred between 1966 and 1983. However, a quantitative assessment on the effect of containerization on international trade appears to be missing. In fact, in an influential and well-researched book on the history of the container revolution, Mark Levinson (2006, p.8) asserts that "how much the container matters to the world economy is impossible to quantify". Our paper

[2] See Krugman (1995) for a prominent discussion on the growth of world trade.
[3]See Levinsohn (2006) and Donovan and Booney (2006) for good overviews of containerization and references to case studies on the effects of containerization from a business history perspective.

challenges this claim and suggests an empirical identification strategy that allows us to estimate the effect of containerization on international trade.

Containerization was invented and first commercially implemented in the US in the mid 1950s. After ten years of US innovation in port and container ship technologies, followed by the international standardization in 1965, the adoption of containerization in international trade started in 1966. Numerous case studies have documented that containerization has not only affected the operation and relocation of ports but the entire transportation industry.[4] Specifically, the introduction of containerization has gone hand in hand with the creation of the modern intermodal transport system, facilitating dramatic increases in shipping capacities and reductions in delivery times through intermodal cargo movements between ships, trains and trucks.

Based on information scattered in transportation industry journals, we are able to identify the year in which a country entered the container age by first processing cargo via port and railway container facilities. Since the intermodal feature of the container technology required a transformation of the entire journey from the factory gate to the customer, we capture containerization as a country-pair specific qualitative technology variable that switches from 0 to 1 when both countries entered the container age at time t. Time and cross-sectional variation of this technology variable permits us to apply it to a large panel of bilateral trade flows for 157 countries during the time period of 1962-1990. Our time horizon includes 4 years of pre-container shipping in international trade, the period of global container adoption 1966-1983 and 7 years where no new country in our sample started to adopt containerization. Since our time horizon precedes the period of dramatic reductions in the costs of air transport, our study excludes the other major 20th century change in the global transportation sector. Because our data provides information on both port and railway containerization, our analysis captures the main modes of international transport during this period.[5]

We take two separate approaches to identify the effects of containerization. The first approach exploits variations in the bilateral timing of adoption in a difference-in-difference framework. The inclusion of country-and-time effects allows us to capture multi-lateral resistance identified by the structural gravity literature and other time-varying factors that might be correlated with countries' decisions to invest in container ports[6]. Difficult to measure geographic factors, like government desires to act as container port hubs, are captured by country-pair specific fixed effects.

[4] See McKinsey, (1967, 1972) and the various issues in Containerization International (1970-1992).
[5] Since the adjustment of container transportation via truck followed the adoption of port and railway container facilities we capture the main modes of cargo transport during this period.
[6] See Feenstra (2004, p.161-163) for a good discussion on the use of country fixed effects to deal with multilateral resistance.

The panel nature of our data set permits us not only to estimate the cumulate average treatment effects (ATE) of containerization but also allows us to evaluate the size of the estimates in comparison to the time-varying trade policy liberalization variables that have been used in the literature.

The period of international container adoption coincided with major reductions of economy-wide activity triggered by the dramatic changes in the price of crude oil, which increased by over 650 percent between 1972 and 1980. The 1970s oil crisis and the accompanying government policy measures aimed at reducing aggregate consumption will mask the effects of container adoption on aggregate trade flows. For this reason and because not all products are containerizable, we examine variations in bilateral trade flows at a disaggregated level. This allows us to exploit a 1968 study by the German Engineers Society which classifies 4-digit product groups as to whether they were suitable for container shipments as of 1968.

Restricting our sample to North-North trade, which are mainly the early adopters, our benchmark specification suggests that the cumulative average treatment effect (ATE) of containerization was about 500% over a 15-year time period following its bilateral adoption. For all countries we find an effect that is smaller but still of economic importance at 370%. Although the contemporaneous effect of containerization is quite similar to the North-North analysis, the dynamic effects of containerization are much weaker for trade flows that involve developing economies. This might be explained by the reduced penetration of the technology to include other parts of the transport system in developing countries. Consistent with this interpretation, across all specifications we find stronger effects when considering 'port or railway containerization' versus 'port alone containerization'. The effects of containerization are also much larger that the effects of the trade policy liberalization variables.

Interpreting the results from the above regressions relies on trade between non-containerized pairs of countries providing a valid counterfactual. We test this using information on trade flows in the pre-containerization period. Here we find a difference between the North-North sample (early adopters) and the sample containing all countries (early and later adopters). For the early adopters the returns to containerization were much more uncertain and it is perhaps of no surprise that when we consider only North-North trade, we find no statistical evidence of a difference in pre-containerization trade, whereas we do when we add later-adopters. A causal interpretation would therefore appear valid only for the North-North sample.

Our second identification strategy proposes an instrumental variable for containerization involving the later adopters. The construction of our instruments is motivated by historical accounts of the importance of container technology for the US military build-up during the Vietnam War with the resulting military induced dissemination of 'container knowledge' and the availability of empty containers on 'return journeys' encouraging a number of countries to adopt containerization. Based on this evidence we use the distance from Vietnam and the presence of a U.S. military base prior to 1967 as instruments for the adoption of the container. We use this to predict containerization for the trading partners of those non-U.S. countries (Germany, the Netherlands and the U.K) that had already containerized prior to the U.S. military build-up. Our finding that a larger distance from Vietnam decreased the probability while the presence of a US military base (interacted with distance) increased the probability of container adoption between 1965 and 1975 provides not only econometric justification for the use of our instruments but provides also the first quantitative support for the hypothesis that the US military operations during the Vietnam War did in deed stimulate container adoption in East Asia.[7]

Our instrumental variable estimates suggest an impact of containerization on those induced to containerize because of the Vietnam War was close to 200%, which is of a similar magnitude to what we found in our difference-in-difference regressions. We also show that the instruments are not valid for the period after the U.S. military build-up and for products that were not containerizable at the time. This lends further support for interpreting these results as causal.

Our paper contributes to the broader literature that aims to quantify the effects of changes in transportation technology on economic activity. Starting with Fogel's (1964) pioneering study on the effects of US railroads on economic growth, a number of studies have investigated the effects of railroad construction on economic performance and market integration. Based on detailed archival data from colonial India, Donaldson (2012) provides a comprehensive general equilibrium analysis of the impacts resulting from the expansion of India's railroad network during 1853-1930.[8] While the introduction of rail and steamships were the main changes in transportation technology that underpinned the first wave of globalization (1840s-1914), students of transportation technology and prominent commentators link the post World War II growth of world trade to containerization. For example, Paul Krugman writes (2009, p. 7):

> *"The ability to ship things long distances fairly cheaply has been there since the steamship and the railroad. What was the big bottleneck was getting things on and off the ships. A large part of the costs of international trade was taking the cargo off the ship, sorting it out, and dealing with the pilferage that always took place along the way. So, the first big thing that changed was the introduction of the container. When we think about technology that changed the world, we think*

[7] Our instruments also pass standard tests again weak instruments and overidentification.

[8] Donaldson (2012) tests several hypotheses of the effects of railroads that he derives from a multi-region, multi-commodity Ricardian trade model. Hurd (1975) follows Fogel (1964) in applying a social savings methodology to estimate the impacts of Indian railroad construction.

about glamorous things like the internet. But if you try to figure out what happened to world trade, there is a really strong case to be made that it was the container, which could be hauled off a ship and put onto a truck or a train and moved on. It used to be the case that ports were places with thousands and thousands of longshoremen milling around loading and unloading ships. Now longshoremen are like something out of those science fiction movies in which people have disappeared and been replaced by machines".

The current state of the empirical trade literature does not appear to support the view that the decline in transportation costs played a significant role in the growth of world trade. In an influential paper studying the growth of world trade, Baier and Bergstrand (2001) have found that the reduction in tariffs is more than three times as important as the decline in transportation costs in explaining the growth of OECD trade between 1958-60 and 1986-88.[9] In his survey of how changes in transportation costs have affected international trade in the post world War II period, Hummels (2007) has detected an actual increase in ocean shipping rates during 1974-84, a period after the adoption of containerization in the US. Using commodity data on US trade flows, Hummels finds that freight cost reductions from increasing an exporter's share of containerized trade have been eroded by the increase in fuel costs resulting from the 1970s hike in oil prices. [10]

Our findings of a strong effect of containerization is reconciled by recognizing that our identification strategy focuses on the adoption of intermodal transportation (port and railway) at the economy wide level. In fact, our findings confirm Hummels' (2007, p. 144) intuition that "*the real gains from containerization might come from quality changes in transportation services…To the extent that these quality improvements do not show up in measured price indices, the indices understate the value of the technological change*". Our findings are also compatible with Yi (2003) who has stressed the role of vertical specialization and disintegration of production as a major factor in explaining the growth of world trade.[11] Experts in transportation economics have emphasized repeatedly that the global diffusion of intermodal transport was a prerequisite for the disintegration of production and the establishment of global supply chains (Notteboom and Rodrigue, 2008).

[9] Because of data limitations, Baier and Bergstrand (2001, Table 1, p.14) use only a multi-lateral rather than a bilateral index of changes in transportation costs. Their index suggests that Austria's transportation costs versus the rest of the world has actually increased between 1958 and 1986, which does not appear plausible. Although land-locked, Austria has been an early entrant in the container age through their construction of container railway terminals in 1968 which connected it to the main container ports in Europe.

[10] Another study that investigates the effects of containerization on US imports in the post adoption period is Blonigen and Wilson (2008). Building on Clark, Dollar and Micco (2004), they estimate the effects of port efficiency measures on bilateral trade flows and find that increasing the share of trade that is containerized by 1 percent lowers shipping costs by only 0.05 percent.

[11] Baier and Bergstrand (2001) are quite honest in pointing out that their final goods framework excludes this potential source of the growth of world trade.

The next section of the paper provides a historical discussion on the origins and effects of containerization. Our historical narrative fulfills three purposes. First, by describing the different channels through which container adoption reduced trade costs we point to the mechanisms that appear to be responsible for our estimated effects. Second, our historical evidence on the speed of diffusion of container technology within the transportation structure of two selected economies provides the rationale for our identification strategy of capturing containerization. Third, our description of the spread of containerization to the Asian-Pacific region provides the background for our choice of instruments for the adoption of the container. Section three introduces our empirical specifications and discusses our empirical findings. Section four concludes.

2. The container revolution and intermodal transport

> *"Born of the need to reduce labor, time and handling, containerization links the manufacturer or producer with the ultimate consumer or customer. By eliminating as many as 12 separate handlings, containers minimize cargo loss or damage; speed delivery; reduce overall expenditure".*
> *(Containerisation International, 1970, p. 19)*

2.1 Historical background

Before the advent of containerization, the technology for unloading general cargo through the process of *break-bulk* shipping had hardly changed since the Phoenicians traded along the coast of the Mediterranean. The loading and unloading of individual items in barrels, sacks and wooden crates from land transport to ship and back again on arrival was slow and labor-intensive. Technological advances through the use of ropes for bundling timber and pallets for stacking and transporting bags or sacks yielded some efficiency gains, but the handling of cargo was almost as labor intensive after World War II as it was during the beginning of the Victorian age. From a shipper's perspective, often two-thirds of a ship's productive time was spent in port causing port congestion and low levels of ship utilization. Following the spread of the railways, it became apparent already during the first era of globalization that the bottleneck in freight transport was at the interface between the land and sea transport modes.

Before World War II, US, British and French railway companies experimented with methods of sealing goods in different sizes and shapes of boxes before transporting them. However, the lack of specialized capital equipment like specialized cranes for loading and loading combined with union resistance to changes in work practices at the docks delayed the development of container shipping until the mid-1950s.

The genesis of the container revolution goes back to April 26, 1956 when the *Ideal- X*, made its maiden voyage from Port Newark to Houston, Texas. The ideal X was a converted World War II tanker that was redesigned with a reinforced deck to sustain the load of 58 containers. As so common in the history of innovation, the breakthrough of containerized shipping came from someone outside the industry, Malcom McLean, a trucking entrepreneur from North Carolina. Concerned about increased US highway congestion in the 1950s when US coastwise shipping was widely seen as an unprofitable business, McLean's central idea was to integrate coastwise shipping with his trucking business in an era where trucking and shipping were segmented industries. His vision was the creation of an integrated transportation system that moved cargo door to door directly from the producer to the customer. The immediate success of the first US container journey resulted from the large cost savings from the mechanized loading and unloading of containerized cargos. Shortly after the *Ideal-X* docked at the Port of Houston, McLean's enterprise, which later became known as Sea-Land Service, was already taking orders to ship containerized cargo back to Newark.

The 1956 container operation by the *Ideal X* involved a ship and cranes that were designed for other purposes. McLean's fundamental insight, which was years ahead of his time, was that the success of the container did not rest simply in the idea of putting cargo into a metal box. Instead, it required complementary changes in cranes, ships, ports, trucks, trains and storage facilities. Three years following *Ideal X's* maiden voyage, container shipping saw additional savings through the building of purpose-built container cranes followed by the building of large purpose-built containerships. On January 9, 1959 the world's first purpose-built container crane started to operate and was capable of loading one 40,000-pound box every three minutes. The productivity gains from using this container crane were staggering, as it could handle 400 tons per hours, more than 40 times the average productivity of a longshore gang.[12] Investment in larger shipping capacity became now profitable since containerization dramatically reduced a ship's average time in ports.

Given the large investment costs, industry experts revealed a considerable amount of uncertainty and skepticism regarding the success of the container technology at the time. Many transportation analysts judged container shipping as a niche technology and did not anticipate the dramatic transformations that this technology was about to bring to the entire domestic and international transportation sector. In the first decade following the *Ideal- X'*s maiden voyage, innovation and investment in container technology remained an American affair. But, as Levinson (2006, p. 201) points out, "ports, railroads, governments, and trade unions around the world spent those years studying the ways that containerization had shaken freight transportation in the United

[12] See Levinson (2006, p. 65).

States". The early initiatives came from US shipping lines and by the early 1960s, containerization was firmly established on routes between the US mainland and Puerto Rico, Hawaii and Alaska. Ten years of US advancement in container technology set the foundation for containerization to go global in 1966.[13] In that year, the first container services were established in the transatlantic trade between the US and European ports in the UK, Netherlands and West Germany.

2.2 Economic effects of containerization

From a transportation technology perspective, containerization resulted in the introduction of intermodal freight transport, since the shipment of a container can use multiple modes of transportation -ship, rail or truck- without any handling of the freight when changing modes. By eliminating sometimes as many as a dozen separate handlings of the cargo, the container resulted in linking the producer directly to the customer. Since containerization resulted in a reduction of the total resource costs of shipping a good from the (inland) manufacturer to the (inland) customer, its impact is not adequately captured by looking at changes in port to port freight costs.[14]

Containerization started as a private endeavor by the shipping lines. In the early stages, shipping lines had to bear most of the costs since many ports such as New York and London were reluctant to spend significant funds on ‘a new technology’ with uncertain returns at the time. Many shipping lines had to operate from small and formerly unknown ports and install their own cranes. The process was extremely expensive. After the container proved to be successful, ports warmed up to containerization and a race started among ports to attract the most shipping lines by building new terminals and providing the infrastructure to handle containers. Containerization required major technological changes in port facilities, which often led to the creation of new container ports. In the United States, the new container ports in Newark and Oakland took business from traditional ports like New York and San Francisco. In the UK, the ports of London and Liverpool, which handled most of the British trade for centuries, lost their dominant position to the emerging container ports of Tilbury and Felixstowe.

In many countries, port authorities fall under the administration of the government. Because of the high costs, careful planning and analysis had to be undertaken by governments to study the

[13] Australia was the first country to follow the US and adopted container technology in 1964, but not in international trade.

[14] Reliable data on comparable changes in door-to-door and ocean freight rates before and after containerization are not available. However, Eyre (1964) uses data from the American Association of Port Authorities to illustrate the composition of estimated door-to-door costs of shipping one truckload of Medicine from Chicago to Nancy (France) in the pre-container age. Astonishingly, ocean shipping amounted only 24.4% of total costs, whereas total port costs constituted 48.7%, freight to the US port city 14.3%, European inland freight 8.6% and local freight in port vicinity 4%. This supports the view that the bulk of costs savings from containerization stemmed from efficiency gains in the sea-land interface.

feasibility of containerization. In the UK, the government commissioned McKinsey (1967) to conduct a cost and benefit analysis before spending significant public funds on container port facilities. Five years later, McKinsey (1972) provided a quantitative assessment of the effects of containerization following the first five years after its adoption in the UK and Western Europe. Table 1 provides a summary of the sources and magnitude of resource savings from the adoption of container technology between 1965 and 1970/71.

Table 1: Effects of containerization (UK/Europe)

	Pre-container: 1965	**Container: 1970/71**
Productivity of dock labor	1.7 (tons per hour)	30 (tons per hour)
Average ship size	8.4 (average GRT)	19.7 (average GRT)
Port concentration (number of European loading ports, southbound Australia)	11 ports	3 ports
Insurance costs (Australia-Europe trade for imports)	£0.24 per ton	£0.04 per ton
Capital locked up as inventory in transit (Route: Hamburg-Sydney)	£2 per ton	£1 per ton

Source: Authors' own compilation from various sources in McKinsey (1972).

One of the major benefits of containerization was to remove the bottleneck in freight transport in the crucial land-sea interface. The construction of purpose-designed container terminals increased the productivity of dock labor from 1.7 to 30 tons per hour (Table 1). Improvement in the efficiency and speed of cargo handling allowed shipping companies to take advantage of economies of scale by more than doubling the average ship size. The resulting increase in port capacity provided opportunities and pressures for the inland distribution of maritime containers. In the UK the introduction of railway container terminals went in tandem with port containerization and by 1972 the Far East service alone already operated trains between an ocean terminal and six inland rail terminals.

In the pre-container age, port managers handled and organized the trade of their own industrial hinterlands. With the railways taking over the inland distribution, containerization eliminated the notion of a port hinterland and containerized freight became concentrated in a few major terminals. For example, whereas in 1965 ships in the (southbound) Australian trade called at any of 11 loading ports in Europe, by 1972 the entire trade was shared among the three ports of Hamburg, Rotterdam and Tilbury. Within a few years, a hub-and-spoke system already emerged.

A major benefit of sealing cargo at the location of production in a box to be opened at the final destination is that it reduced the pilferage, damage and theft that were so common in the age of break-bulk shipping. A common joke at the New York piers was that the dockers' wages were "twenty dollars a day and all the Scotch you could carry home". The resulting reduction in insurance costs from containerization was considerable. On the Australia-Europe trade, between 1965 and 1970/71 the insurance costs fell from an average of 24 pennies per ton to 4 pennies per ton (Table 1).

Intermodal transport also decreased the time in transit between cargo closing and availability. Containerization cut the journey between Europe and Australia from 70 to 34 days. Given that the average cargo at the time was worth about £60 per ton and assuming that the opportunity cost of capital tied up in transit is about 15%, the 36 day improvement cut the capital cost of inventory by about a half (Table 1).

The importance of labor in the operation of ports in the pre-containerization age resulted in the emergence of strong labor unions, which resisted not only labor-saving organizational changes but were also well-organized and effective in calling for strikes. The replacement of capital for labor, which emerged through containerization, ended the frequent delays and uncertainties in shipping caused by these strikes.[15]

2.3 Diffusion of container technology

The early use of containers was driven by private shipping companies who used container sizes and loading devices that best fit their cargo and shipment routes. The first fully containerized ships used 35 foot containers, which was the maximum allowable length for truck traffic on US highways. However, since a fully loaded container of this size was too heavy for a crane to lift, other companies used much smaller sizes which could be much easier stacked and moved with forklifts. A major force for the international adoption and diffusion of container technology was the standardization of container sizes. The standardization process was initiated in the US by the Federal Maritime Board and involved stake holders from the maritime sector, truck lines, railroads and trailer

[15] We thank David Smith, Economics Editor of the *Sunday Times*, for pointing out the elimination of strikes as a channel for cost reductions from containerization.

manufacturers. In 1961, the Federal Maritime Board established the standard nominal dimension of containers - 8 feet wide, 8 feet high and 10, 20, 30 and 40 feet long- and announced that only containerships designed for these sizes were able to receive construction subsidies from the US government.

Following the setting of standards in the US, the International Standards Organization (ISO) started to study containerization with the purpose of establishing worldwide guidelines as a prerequisite for firms and governments investing in internationally compatible container technology. Following a compromise between US and European interest groups, the ISO formally adopted the 10- ,20- , 30- and 40-foot containers plus a few smaller sizes favored by the Europeans as ISO standards in 1964. Besides container size, strength requirements and lifting standards were other major aspects the ISO was able to standardize in 1965. The standardization of container technology was followed by the rise of container leasing companies who had now the incentives to expand their fleets and allowing shippers the flexibility to lease containers and therefore significantly reducing the fixed costs of using this technology. The ability for land and sea carriers to handle each other's containers in different locations set the foundation of global container adoption around the globe.

The adoption of container technology in international trade started in 1966 and the period of 1966-1983 has been labeled by geographers as the era of global diffusion of container technology around the globe (Kuby and Reid, 1992).[16] The introduction of container technology started with a country's investment in container port facilities but quickly progressed to engulf other parts of the transportation network, like rail and road transport. Accompanying technological changes were larger ships and trains and increased use of computers and telecommunications for managing and tracking intermodal movement.

From our calculations of an underlying sample of 157 countries, 122 entered the container age by first processing container cargo via port or railway facilities between 1966 and 1983 while 35 countries remained uncontainerized as of 1990. Appendix Table 3 lists all sample countries and reveals considerable cross-sectional and time variation of countries' adoption of container port facilities during the sample period.

Historical accounts suggest an important role for the US military build-up in Vietnam to stimulate the diffusion of container technology in East Asia. Initially, US military leaders were skeptical about the adoption of container technology for the shipment of military cargo. However Malcom McLean's persistence and vision that his brainchild could alleviate the logistical challenges

[16] According to Kuby and Reid (1992, p.285) "…after 1982 the industry reached maturity, characterized by low margins and greatly improved services….the containerization trend stabilized between 1985 and 1988, as near-saturation of the new technology occurred."

associated with the rapid buildup of military forces in Vietnam after 1965 won the argument in favor of the container. And by 1970 half of the military cargo was already containerized on critical routes.[17] A key feature of the military use of containerization during the Vietnam conflict was that McLean's ships were loaded with military freight on their west-bound journey to Vietnam while the return east-bound journey carried initially empty containers. Levinson (2006) has argued that the regional availability of this container capacity provided a motive for the adoption of container facilities in East Asia, most notably in Japan. In section 3.4 we provide quantitative evidence for Levinson's conjecture about the US military build-up in Vietnam to diffuse containerization and use this to construct an instrument for container adoption.

2.5 Capturing the degree of container utilization for two island economies

How quickly did containerization diffuse through an economy's transportation sector following its initial adoption of container port facilities? In answering this question, two things need to be recognized. First, some tradable goods like assembled automobiles, heavy machinery, construction equipment and some steel products can't be put into containers. Second, technological advancement in container technology has expanded the range of containerizable products over time. For example, initially food products were not containerizable, but through the development of refrigerated containers, food became containerizable in later years. A measure of the *degree of container utilization* of the international transportation system of an economy i at time t, is then the ratio of the economy's traded containerized cargo over its traded containerizable cargo,

$$\text{container utilization}_{it} = (\text{traded containerized cargo}_{it})/(\text{traded containerizable cargo}_{it}) \quad (1)$$

Fortunately, the denominator of (1) can be calculated based on a study by the *Verband deutscher Ingenieure* (German Engineers Society) which classified 4-digit SITC industries according to whether they were suitable for containers as of 1968.[18] The calculation of (1) faces the challenge that containers can cross borders through different modes of transport (sea, rail, truck and air) and that there exist no data on traded container tonnage via rail, trucks or air. However, for island economies like the UK and Japan, where (at the time) the majority of international trade went through sea ports, it is possible to trace their growth of container utilization following their first

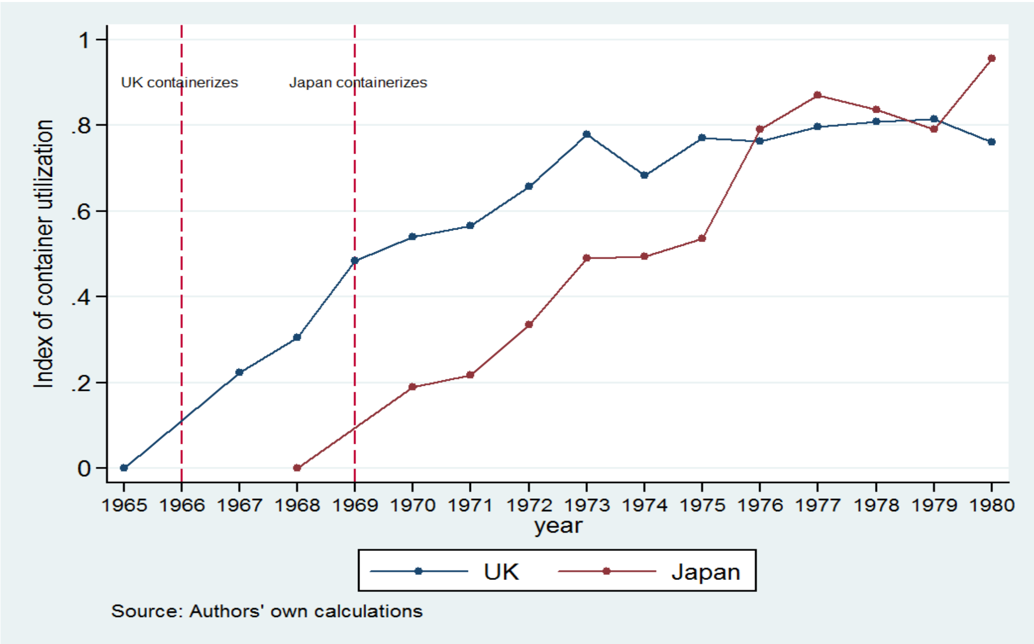
[17] Levinson (2006), p. 183

[18] The engineering study classifies industries into Class A: suitable for containers, Class B: goods of limited suitability for containers and Class C: goods not suitable for containers as of 1968. For the purpose of constructing our container utilization index, we only include goods in Class A as containerizable.

adoption of the technology.[19] For these two countries, (1) can be calculated by combining data on container tonnage going through sea ports available from *Containerisation International* with tonnage of trade in containerizable industries provided by the *OECD International Trade by Commodity Statistics*.

Figure 2 depicts the index of container utilization in international trade for the UK and Japan during the period of 1965-1979. [20] The UK adopted its first container facilities in 1966 and the technology diffused quite rapidly. The utilization grows from 20% in 1967 to about 80% in 1973 and remains then quite flat, which can be explained by the oil shock and the recession following the oil crisis. The picture for Japan is quite similar. Japan adopted containerization in 1969 and the utilization index grows from 20% in 1970 to 80% in 1976.

Figure 2: Changes in container utilization in the UK and Japan



2.6 Containerization and land transport

A defining element of the adoption of container technology is the creation of intermodal transport. Containerization was quickly picked up by railways in different countries. For example, in response to port containerization, and in an effort to avoid being left out, the railways of Europe came together in 1967 and formed *Intercontainer*, The International Association for Transcontainer Traffic. This company was formed to handle containers on the Continent and compete with

[19] Between 1965 and 1979, 99% of UK trade went through sea ports.
[20] Total trade is defined as (exports+imports)/2. Because of missing data in the years of container adoption, the graph depicts linear segments between 1965 and 1967 for the UK and between 1968 and 1970 for Japan.

traditional shipping lines.[21] Railway containerization allowed landlocked countries like Austria and Switzerland to ship their goods in containers to sea ports in neighboring countries destined to overseas destinations. In many cases, this was cheaper and less laborious than road transportation. In a comprehensive cost study for the UK, McKinsey (1967) calculated that container transport was cheaper by rail than truck for journeys above 100 miles. *Containerisation International* (1972) estimated that the cost of moving 1 TEU (twenty foot equivalent unit container) between Paris and Cologne in 1972 was about 75% of the equivalent road costs.[22]

Although the majority of non-land locked countries adopted railway container facility after their introduction of container sea ports, for some the ordering was reversed. For example, Norway entered the container age via their railway network in 1969, five years before the adoption at their sea ports. This suggests that countries could enter the container age either through the introduction of rail or sea ports container facilities. In the subsequent analysis we investigate the differential effects of sea port only containerization and sea or railway containerization.

3. Empirical implementation

3.1. Quantifying containerization

Our objective is to estimate the effect of containerization on international trade. The key question that arises is how to capture this technological change quantitatively. Since the adoption of container technology triggered complementary technological and organizational changes that affected an economy's entire transportation system this suggests quantifying this technological change at the economy level. If data on the international shipments via rail or truck were available and the containerizability of an industry were fixed over time, the container utilization index (1) would be a sensible measure of the technological change. However, because of the absence of the appropriate data and the occurrence of technological change regarding containerizability, we can't go this path. Alternatively, the quick rise in the container utilization for the UK and Japan justifies quantifying containerization by a qualitatively variable that switches from 0 to 1 when country i enters the container age at time t. Entrance into the container age can occur through the first use of either sea ports or inland railway ports. An advantage of this specification is that it captures the

[21] At the time, British Rail was already operating a cellular ship service between Harwich, Zeebrugge and Rotterdam and a freightliner service between London and Paris. Initially 11 European countries formed Intercontainer and were later joined by 8 more.

[22] We are not aware of any studies that document the spread of road containerization equivalent to that for port or rail containerization. The historical narrative suggests however that the developed countries that we focus on this was concurrent to port and/or rail containerization. Outside of this the assumption is less certain. We found for example photographic evidence that the Comoros Islands were using containers without either rail or port container depots (they were instead dropped onto modified rowing boats).

intermodal aspect of containerization since it encompasses land-locked countries like Austria and Switzerland who entered the container age via rail connection to the container sea ports of Rotterdam and Hamburg. Based on the information provided in the published volumes of *Containerisation International* between 1970 and 1992, we construct a time-varying container adoption variable for country *i*, $adoptcont_{it}$, defined as:

$$adoptcont_{it} = \begin{cases} 1 \ \ if\ country\ i\ uses\ sea\ or\ rail\ container\ ports\ in\ year\ t \\ 0 \ \ \ \ otherwise \end{cases} \quad (2)$$

Although a country's adoption of container technology is expected to have some effect on its overall trade, the nature of container technology suggests that containerization is more adequately captured in a bilateral trading context since this allows us to specify the presence of container technology of a country's trading partner. This suggests capturing containerization by a time-varying bilateral technology variable, defined as:

$$fullcont_{ijti} = \begin{cases} 1 \ \ if\ i\ and\ j\ have\ both\ containerized\ ports\ or\ railways\ \ in\ year\ \ t \\ 0 \ \ \ \ \ \ \ \ otherwise \end{cases} \quad (3)$$

From an econometric point of view, there are several advantages quantifying containerization by a time-varying bilateral variable. Since we are interested in exploring causal effects of container technology on trade, one worries about potential selection bias in the adoption of container technology. Armed with "ex post" knowledge that containerization revolutionized global freight transport, one would be inclined to infer that countries that initially traded a lot would be most likely to adopt container technology. However, as we have pointed out in our historical narrative in section 2, from the relevant decision point of view of the 1960s, containerization was by many viewed as a niche technology with little perceived impact on the volume of international trade. For example, Levinson (2006, p. 276) writes:

"*The huge increase in long-distance trade that came in the containers wake was foreseen by no one. When he studied the role of freight in the New York region in the late 1950s, Harvard economist Benjamin Chinitz predicted that containerization would favor metropolitan New York's industrial base by letting the region's factories ship to the South more cheaply than plants in New England or the Midwest. Apparel, the region's biggest manufacturing sector, would not be affected by changes in transport costs, because it was not 'transport-sensitive'. The possibility that falling transport costs could decimate much of the U.S. manufacturing base by making it practical to ship* *almost everything long distances simply did not occur to him. Chinitz was hardly alone in failing to recognize the extent to which lower shipping costs would stimulate trade. Through the 1960s, study after study projected the growth of containerization by assuming that existing export and import trends would continue, with the cargo gradually shifted into containers*".

This line of reasoning has been substantiated in a recent study by Rua (2012) who found that a country's share of world trade does not always have a significant effect on its likelihood to adopt containerization.[23] Given that a country's trade share did not necessarily affect its decision to containerize, the bilateral technology adoption variable $fullcont_{ijt}$ is likely to be characterized by a higher degree of serendipity than the unilateral adoption variable $adoptcont_{it}$.

Given the important role of maritime trade in overall trade we also examine the sole impact of port containerization by defining a port containerization variable $portcont_{ijt}$ as:

$$portcont_{ijt} = \begin{cases} 1 & if\ i\ and\ j\ have\ both\ containerized\ seaports\ in\ year\ t \\ 0 & otherwise \end{cases} \qquad (4)$$

3.2 Research design and empirical specification

The time frame of our analysis is dictated by the availability of bilateral trade data at the product level and the timeline of container adoption in international trade. Fortunately, the world trade data set compiled by Feenstra et al. (2005) goes back to 1962 and covers bilateral trade flows from 1962-2000 at the 4-digit product level.[24] Since the adoption of containerization in international trade started in 1966 and ended in 1983, we chose 1962-1990 as our sample period, which includes 4 years prior to the first adoption and 7 years past the last adoption year. We chose to exclude the 1990s because of both the redrawing of the political map after the end of the Cold War and the reduction in the costs of air transport which started to kick in in the early 1990s. Although there is limited data on changes in the mode of transport in international trade, a reading of the transportation industry literature suggests that during our chosen sample period containerization was the main technological change affecting the three major modes of transport (sea, rail and road) in international trade.

Our next consideration is the nature of our outcome variable. Given that containerization might have different effects on different product lines, we examine variations in bilateral trade flows

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[23] Rua (2012) also finds that labor costs and trade with the US to have a neutral or negative effect on the adoption of containerization. This implies that adoption decisions were not necessarily driven by economic fundamentals.
[24] The data set is constructed from the United Nations trade data and is available from NBER.

at the 4-digit product level and control for product-specific changes by time-varying product fixed effects. For that purpose, we take advantage of the 1968 study by the German Engineer's society, reported in *Containerisation International Yearbook* (1971), which classifies 4-digit product lines whether they are suitable for container shipments as of 1968. We use data only on those products that were containerizable as of 1968.[25] So our dependent variable pertains to the bilateral trade flows between countries i and country j in product group k at time t, x_{ijkt}. Our empirical equation to be estimated is then given by:

$$\ln x_{ijkt} = \beta_0 + \beta_1 Cont_{ijt} + \beta_2 \overrightarrow{Policy_{ijt}} + \beta_3 \overrightarrow{D_{ijkt}} + u_{ijkt}, \qquad (5)$$

where $Cont_{ijt}$ pertains to one of the container variables defined in (3) and (4), $\overrightarrow{Policy_{ijt}}$ pertains to a vector of time-varying bilateral policy variables, $\overrightarrow{D_{ijkt}}$ includes a (large) vector of country- time and product-time specific fixed effects and u_{ijkt} denotes the error term.

An attractive feature of our panel specification is that it allows us to examine the dynamic aspects of containerization over a time period 1962-1990 characterized, as argued above, by little other transportation technological changes affecting international trade. Following the advice of the panel literature (Wooldridge, 2002) we examine changes in trade flows at 5 year intervals. In our context, the advantage of focusing on 5 year variations is that it mitigates the effect of differences in the speed of adoption (recall Figure 2) as well as allowing time for the build-up of the intermodal transport system. We estimate equation (5) on 7 time periods: 1962, 1967, 1972, 1977, 1982, 1987 and 1990.

To our knowledge, (5) is the first specification in the literature that identifies a time-varying bilateral technological change and aims to estimate its impact on international trade. An advantage of this specification is that allows for a comparison to other time-varying bilateral policy changes for a country pair *i* and *j*, like entrance into a free trade agreement (FTA) or both being a member in the GATT, which have been treated extensively in the literature. Specifically, (5) allows for a horse race between our container technology variables and these trade liberalization variables.

An advantage of our panel specification is that it allows us to use fixed effects to avoid omitted variable biases associated with multi-lateral resistance terms identified from the structural

[25] Recall that we used this classification of our utilization index (1) used in Figure 2. Because of technological progress expanding the scope of containerizability and complementarities between products that were initially containerizable (autoparts) and those that became later containerizable (cars), this classification cannot be used as a counterfactual in our difference-in-difference analysis. However, we will exploit this classification in our IV estimation strategy, where the focus is on the contemporaneous impact of containerization during the period of the Vietnam War.
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approach to gravity.[26] Specifically, the inclusion of time-varying importer (*it*), exporter (*jt*) and product (*kt*) fixed effects in $\overrightarrow{D_{ijkt}}$ capture time-varying product and country-specific factors that are either difficult to pin down or measure.[27] In addition to multilateral resistance, the country-time dummies will also capture other changes that effect trade flows of a country. These include the infrastructure investments or other changes that were necessary to adopt the container and would otherwise be captured by the $adoptcont_{it}$ variable set out in equation (2). Because bilateral containerization requires investments by the private and public sectors in two countries we view the timing of the bilateral adoption of the container is, conditional on these other covariates, as good as random. Trade between non-containerized pairs of countries is then used as the counterfactual for containerized pairs.

We opted for first differencing the data across our 5-year time periods such that our dependent variable becomes $\text{dln}\boldsymbol{x}_{\boldsymbol{ijk},\boldsymbol{t}-(\boldsymbol{t}-\boldsymbol{1})}$.[28] Woolridge (2002, chapter 10) suggests that first-differencing a panel data set yields advantages if unobserved heterogeneity in trade flows is correlated over time. In our context, by differencing the data we remove the need to include *ijk* fixed effects and it has also the advantage of not assuming that *ijk* effects are time invariant.[29] So we regress $\text{dln}x_{ij,t-(t-1)}$ on $Cont_{ij,t-(t-1)}$ and the other first differenced country-pair time-variant policy variables like being in a free trade agreement (FTA) or a member in the GATT.

3.3 Empirical findings

Although our entire data set covers a total of 157 countries we initially report results for a sub-set of 22 industrialized countries, which we denote as North-North trade.[30] Because we expect a quicker and deeper penetration of container technology in industrialized countries (recall Figure 2), we initially apply specification (5) on an empirical domain where our technology variables are expected to capture relatively similar transformations of the transportation sector. As these were also the early adopters the returns to containerization would have been more uncertain, increasing the likelihood that the bilateral container variable is exogenous with respect to trade flows. In addition, restricting ourselves to North-North trade yields a full panel of country pairs. Afterwards, we extend the empirical domain to total sample of 157 countries, labeled as 'World Trade'.

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[26] See Bergstrand and Egger (2011) and Feenstra (2004, chapter 5) for good surveys of the gravity literature.
[27] Since the country-time fixed effects preclude the inclusion of time-varying 'economic mass' variables like GDP and GDP per capita, we refrain from calling our specification a gravity equation.
[28] We experimented with time periods of different lengths, but this has little effect on the main findings from the paper.
[29] Also given the limits of computer power available to us first differencing is a necessary transformation of the data.
[30] Our selection criteria was OECD membership as of 1990. It is probably of no coincidence that these countries were also almost all early adopters of the container and indeed that could be used as an alternative label for this group. The countries are identified in Appendix Table 3.

Our dependent variable is the log of exports and imports between a country pair i and j in a 4-digit product line k. We only considered observations with trade occurring in at least one direction, and implicitly categorized missing observations with a zero trade flow.[31] The rationale behind this is that bilateral containerization should affect total bilateral trade rather than a specific direction. Because not all country pairs trade the same set of products in all years even in North-North trade, for which the panel is balanced on the 'country-pair dimension', the panel is 'naturally' imbalanced in the product dimension. However, we restricted our sample by including only products which appear during the whole time period for at least one country pair. Finally, we choose to report results for both port containerization and 'full' containerization in order to explore whether containerization is best thought of as a port-only technology, or as the historical literature suggests, as a complete transformation of transportation from the producer to the consumer.

Our complete set of panel estimates is reported in Table 2. Columns (1)-(4) restrict the analysis to North-North trade, while columns (5)-(8) report results for World-Trade. The first two columns within each sample, (1)-(2) and (5)-(6), report results using sea port containerization variable, while the final two columns use the full-containerization variable, (3)-(4) and (7)-(8).

Overall, the results in Table 2 suggest that containerization had statistically significant and economically large effects on the volume of bilateral trade, irrespective of whether we use a measure based on just the sea-port or full containerization and whether we restrict the analysis to North-North or World-Trade. The coefficients of the lagged effects reveal that containerization had strong and persistent effects even 15 years after bilateral adoption.

A key objective of our paper is to examine the causal effects of containerization on international trade using non-containerized bilateral pairs as a counterfactual. Our historical narrative and discussion in section 3.1 have suggested serendipity in the determination of our bilateral container variable (3) during the first decade of the container revolution. The panel nature of our data allows us to test for exogeneity of our technology variable. Following the advice of Wooldridge (2002, p. 285), we add a future change of containerization, denoted by $\Delta cont_{ij,t+1}$, in our regression equation (5). The size and statistical significance of $\Delta cont_{ij,t+1}$ can be viewed as a falsification test for whether the container variable captures the effect of the introduction of this new transportation technology rather than any trend to bilateral trade that was also present prior to the adoption of containerization. If the effect captured by the container dummy were simply related to trends already

[31] In communication with the creators of the data base we were told that the missing observations are really missing. So contrary to what one reads in the empirical trade literature, measurement error appears to be the bigger issue than the prevalence of zero observations.

present in trade between that country-pair, we would expect the coefficient on years prior to the adoption of the container to be as large and significant as the coefficient on our variable of interest.

Specifications (2) and (4) include pre-treatment variables on containerization and the other bilateral co-variates *fta* and *GATT* for North-North trade and specifications (6) and (8) for the entire sample. Columns (2) and (4) reveal that the coefficients of $\Delta cont_{ij,t+1}$ are both statistically insignificant and also very small compared to the contemporaneous and lagged variables, suggesting that trade between non-containerized countries was statistically similar to that for containerized countries prior to their containerization. Because the parallel trends assumption appears to be satisfied, the estimates can be interpreted a capturing a causal effect of containerization on North-North trade. By contrast, columns (6) and (8) reveal a different picture. The coefficients on $\Delta cont_{ij,t+1}$ are statistically significant and also relatively large for the world sample. This implies that if one includes less developed economies (or late adopters), the container coefficients are only suggestive of a high correlation as containerization was also adopted in response to increased trade. Overall, these results are consistent with the historical narrative.

Let's take a closer look at the estimates in our benchmark specification (3) for North-North trade. The estimated coefficient of 1.247 on the *fullcont* variable in the upper panel suggests that the concurrent effect of containerization was to raise bilateral trade flows on average by 248% (=$e^{1.247}$-1) compared to where both countries had not yet adopted the container technology. The coefficients on the lag variables reveal that over the next 5-year periods the effect was 160% (=$e^{0.956}$-1) and 110% (=$e^{0.739}$-1) respectively. The cumulative average treatment effect (ATE) of containerization over a 15 year time period amount to a staggering 517%.[32] This may appear large, although it should be remembered that this relates to product level bilateral trade flows, the mean (median) value for which is $2.5 million ($0.078 million) in our dataset.

A striking feature of the estimates in columns (1) and (2) is that the magnitudes of the coefficient on the concurrent and lagged coefficients of *portcont* are significantly smaller than the corresponding coefficients of *fullcont* in columns (3) and (4). The concurrent effects drop from 248% (=$e^{1.247}$-1) to 90% (=$e^{0.639}$-1) and the lagged effects drop from 160% (=$e^{0.956}$-1) and 110% (=$e^{0.739}$-1) to 95% (=$e^{0.667}$-1) and 74% (=$e^{0.554}$-1). The total drop of the cumulative average treatment to 258% suggests an important role of intermodality.

How do the effects of containerization compare to the time-varying trade policy variables that are also included in the regression? As mentioned above, we included two sets of policy variables. The *fta* dummy indicates whether a country pair i,j belonged either to the same regional free trade

[32] The cumulative ATE is sum of the concurrent and lagged effects.

block or had a free trade agreement in a specific year. The GATT variable switches to 1 if both countries i and j are members of the GATT, the precursor of the WTO, at time t. The inclusion of lagged effects permits us also to investigate the dynamic effects of these variables.

Overall, we find that the estimated effects of containerization are generally much bigger than the estimated effects of the trade policy variables in all specifications. So we can concentrate again on our benchmark estimates in column (3). The concurrent and the first two lags of the *fta* variable have the expected positive sign and are highly significant. The concurrent effect of a free trade agreement is to raise trade by an average of 37% (=$e^{0.315}$-1), which is about 15% of the concurrent effect of full containerization. The coefficients on the lags of the *fta* variable reveal that over the next 5-year periods the effect was 10.7% (=$e^{0.102}$-1) and 12.1% (=$e^{0.114}$-1) respectively. The cumulative ATE of a free-trade agreement amount then to about 60%. It is reassuring that our cumulative ATE estimates of the *fta* variable is similar in magnitude to the estimates reported by Baier and Bergstrand (2007, p.91), who consider a panel data on aggregate trade flows.

The concurrent and three lag effects of the GATT are all statistically significant and lie in economic magnitude between the container and the *fta* variables. The concurrent effect of bilateral GATT membership is to raise trade by an average of 40.2% (=$e^{0.338}$-1), which is a similar effect to the FTA variable. The coefficients on the lags of the GATT variable reveal relatively persistent long-term effects, 10+ years following bilateral membership. Over the next 5-year periods the effect was 37% (=$e^{0.315}$-1) and 24.1% (=$e^{0.216}$-1) respectively. The cumulative ATE of GATT membership for bilateral trade is then estimated to amount to 101%, considerably higher than the average effect on free trade agreements, but less than a quarter the accumulated effect of containerization.

Regarding the presence of pre-treatment effects, column (4) shows that the coefficient of the pre-treatment variable $\Delta fta_{ij,t+1}$ is both statistically significant and relatively large, i.e. 14.8% (=$e^{0.138}$-1). This suggests the presence of anticipation effects of regional trade agreements in our sample. This suggests the presence of the anticipation of regional trade agreements in North-North trade. Column (8) reveals anticipation effects also for the world sample. The estimated coefficient of the pre-treatment variable $\Delta GATT_{ij,t+1}$ is also statistically insignificant for the North-North sample but not for the entire sample.

As mentioned before, the statistical significance of the pre-treatment variables in columns (6) and (8) are only suggestive of high correlations between containerization and international trade for the entire sample. However, a comparison of the estimated concurrent and lagged container coefficients in columns (3) and (7) reveal interesting differences from including trade with developing economies. Specifically, the drop of the cumulate ATE from 517% to 370% stems mainly from the much lower size of the lagged coefficients in column (7). This provides quantitative evidence for the notion that the effects of containerization was more short-lived for developing economies' trade as they lacked the manufacturing base and/or the internal transportation infrastructure in order to take as much advantage of this new technology as the industrial world.

Table 2: First differenced panel estimates (with country-time and product-time fixed effects)

	North-North				World Trade			
	Port Containerisation		Full Containerisation		Port Containerisation		Full Containerisation	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\Delta\ \mathbf{cont}_{ij,t}$	0.639***	0.668***	1.247***	1.251***	0.837***	0.911***	1.204***	1.281***
	(0.0456)	(0.0469)	(0.0806)	(0.0806)	(0.0116)	(0.0119)	(0.0133)	(0.0135)
$\Delta\ \mathbf{cont}_{ij,t-1}$	0.667***	0.674***	0.956***	0.955***	0.434***	0.495***	0.704***	0.768***
	(0.0275)	(0.0277)	(0.0314)	(0.0314)	(0.0108)	(0.0111)	(0.0120)	(0.0122)
$\Delta\ \mathbf{cont}_{ij,t-2}$	0.555***	0.560***	0.739***	0.739***	0.146***	0.182***	0.293***	0.332***
	(0.0194)	(0.0194)	(0.0210)	(0.0210)	(0.0099)	(0.0100)	(0.0104)	(0.0105)
$\Delta\ \mathbf{cont}_{ij,t+1}$		0.106		0.031		0.255***		0.301***
		(0.0684)		(0.0905)		(0.0094)		(0.0098)
$\Delta\ \mathbf{fta}_{ij,t}$	0.325***	0.334***	0.315***	0.324***	0.314***	0.327***	0.318***	0.330***
	(0.0140)	(0.0141)	(0.0139)	(0.0140)	(0.0135)	(0.0135)	(0.0135)	(0.0135)
$\Delta\ \mathbf{fta}_{ij,t-1}$	0.118***	0.126***	0.102***	0.109***	0.095***	0.106***	0.125***	0.132***
	(0.0138)	(0.0138)	(0.0137)	(0.0138)	(0.0136)	(0.0136)	(0.0136)	(0.0136)
$\Delta\ \mathbf{fta}_{ij,t-2}$	0.094***	0.094***	0.114***	0.114***	0.014	0.017	0.044*	0.049**
	(0.0157)	(0.0157)	(0.0156)	(0.0138)	(0.0175)	(0.0175)	(0.0174)	(0.0174)
$\Delta\ \mathbf{fta}_{ij,t+1}$		0.147***		0.138***		0.120***		0.051**
		(0.0201)		(0.0200)		(0.0175)		(0.0174)
$\Delta\ \mathbf{GATT}_{ij,t}$	0.679***	0.672***	0.338***	0.342***	0.462***	0.463***	0.315***	0.304***
	(0.0605)	(0.0607)	(0.0757)	(0.0757)	(0.0136)	(0.0136)	(0.0138)	(0.0138)
$\Delta\ \mathbf{GATT}_{ij,t-1}$	0.584***	0.581***	0.315***	0.320***	0.214***	0.210***	0.116***	0.110***
	(0.0490)	(0.0492)	(0.0583)	(0.0582)	(0.0123)	(0.0123)	(0.0124)	(0.0124)
$\Delta\ \mathbf{GATT}_{ij,t-2}$	0.326***	0.331***	0.216***	0.223***	0.009	0.007	-0.017	-0.017
	(0.0356)	(0.0357)	(0.0366)	(0.0366)	(0.0119)	(0.0119)	(0.0119)	(0.0119)
$\Delta\ \mathbf{GATT}_{ij,t+1}$		0.125	0.238	0.141		0.095***	0.054***	0.054***
		(0.2284)	(0.2393)	(0.2281)		(0.0148)	(0.0149)	(0.0148)
Obs	169114	169114	169114	169114	897413	897413	891731	891731
Countries	22	22	22	22	157	157	157	157
No. Products	332	332	332	332	344	344	344	344
R^2	0.159	0.159	0.161	0.161	0.106	0.107	0.110	0.111
FE	it,jt,kt	it,jt,kt	it,jt,kt	it,jt,kt	it,jt,kt	it,jt,kt	it,jt,kt	it,jt,kt
$Total\ ATE^a$	258%	266%	517%	518%	201%	233%	370%	415%

Standard errors in parentheses
** p<0.05, ** p<0.01, *** p<0.001*
a Total ATE is the sum of statistically significant container estimates.
i denotes origin country, j destination country and t denotes time

Table 3: First differenced panel estimates: Alternative specifications

	North-North				World Trade			
	(1) **3-digit level**	**(2)** **Av Values>100k**	**(3)** **Obs count > 4**	**(4)** **Incl. limited container. products**	**(5)** **3-digit level**	**(6)** **Av Values>100k**	**(7)** **Obs count > 4**	**(8)** **Incl. limited container. products**
$\Delta\ \mathbf{cont_{ij,t}}$	1.062***	1.092***	0.863***	1.178***	1.211***	1.611***	1.097***	1.305***
	(0.1084)	(0.122)	(0.136)	(0.0753)	(0.0147)	(0.0190)	(0.0225)	(0.0125)
$\Delta\ \mathbf{cont_{ij,t-1}}$	0.789***	0.757***	0.708***	0.935***	0.641***	0.656***	0.847***	0.765***
	(0.0431)	(0.0354)	(0.0361)	(0.0289)	(0.0134)	(0.0156)	(0.0167)	(0.0113)
$\Delta\ \mathbf{cont_{ij,t-2}}$	0.735***	0.539***	0.559***	0.743***	0.203***	0.212***	0.411***	0.336***
	(0.0281)	(0.0226)	(0.0231)	(0.0191)	(0.0116)	(0.0125)	(0.0124)	(0.0097)
$\Delta\ \mathbf{cont_{ij,t+1}}$	-0.286*	-0.0524	-0.452	0.056	0.317***	0.327***	0.276***	0.310***
	(0.1310)	(0.251)	(0.2830)	(0.0846)	(0.0111)	(0.0199)	(0.0224)	(0.0092)
$\Delta\ \mathbf{fta_{ij,t}}$	0.311***	0.315***	0.317***	0.324***	0.303***	0.326***	0.301***	0.336***
	(0.0155)	(0.0150)	(0.0141)	(0.0132)	(0.0161)	(0.0160)	(0.0140)	(0.0127)
$\Delta\ \mathbf{fta_{ij,t-1}}$	0.092***	0.118***	0.112***	0.119***	0.099***	0.100***	0.144***	0.146***
	(0.0154)	(0.0147)	(0.0140)	(0.0129)	(0.0161)	(0.0157)	(0.0141)	(0.0127)
$\Delta\ \mathbf{fta_{ij,t-2}}$	0.058***	0.072***	0.118***	0.103***	0.057**	0.021	0.041*	0.048**
	(0.0176)	(0.0163)	(0.0156)	(0.0146)	(0.0209)	(0.0189)	(0.0168)	(0.0162)
$\Delta\ \mathbf{fta_{ij,t+1}}$	0.119***	0.123***	0.137***	0.150***	0.054**	-0.046*	0.020	0.058***
	(0.0216)	(0.0234)	(0.0211)	(0.0189)	(0.0202)	(0.0217)	(0.0186)	(0.0164)
$\Delta\ \mathbf{GATT_{ij,t}}$	0.548***	1.012***	1.166***	0.366***	0.285***	0.468***	0.291***	0.322***
	(0.0968)	(0.113)	(0.123)	(0.0710)	(0.0147)	(0.0200)	(0.0202)	(0.0129)
$\Delta\ \mathbf{GATT_{ij,t-1}}$	0.483***	0.507***	0.658***	0.357***	0.150***	0.109***	0.114***	0.104***
	(0.0728)	(0.0800)	(0.0894)	(0.0543)	(0.0133)	(0.0174)	(0.0176)	(0.0116)
$\Delta\ \mathbf{GATT_{ij,t-2}}$	0.324***	0.219***	0.255***	0.237***	-0.028*	-0.061***	0.005	-0.018
	(0.0414)	(0.0461)	(0.0448)	(0.0341)	(0.0127)	(0.0163)	(0.0154)	(0.0112)
$\Delta\ \mathbf{GATT_{ij,t+1}}$	0.447	0.467	0.363	0.194	0.032	-0.032	0.081***	0.057***
	(0.3659)	(0.796)	(0.324)	(0.2200)	(0.0165)	(0.0230)	(0.0209)	(0.0139)
Obs	111561	144803	161224	198334	770160	551710	636193	1023720
Countries	22	22	22	22	157	157	157	157
No. Products	218	332	332	407	220	344	344	421
R^2	0.148	0.186	0.168	0.154	0.112	0.143	0.131	0.106
FE	it,jt,kt	it,jt,kt	it,jt,kt	it,jt,kt	it,jt,kt	it,jt,kt	it,jt,kt	it,jt,kt
Total ATE^a	418%	383%	315%	490%	348%	517%	384%	424%

Standard errors in parentheses
** p<0.05, ** p<0.01, *** p<0.001*
a Total ATE is the sum of statistically significant container estimates.
i denotes origin country, j destination country and t denotes time

The estimated effects of containerization in Table 2 are large. As already mentioned, one possible explanation might be the inclusion of a large number of small value and temporary trade flows. Table 3 takes the regression specifications with the full containerization variable from columns (4) and (8) in Table 2 and examines robustness. Columns (1) and (5) in Table 3 aggregate the data to the 3-digit HS product level. The other columns continue with our use of 4-digit level data. Columns (2) and (6) restrict the data to trade flows in a given country-pair-product combination with an average value of greater than $100,000 over the time periods of our sample. Columns (3) and (7) include only observations where trade flows in any given country-pair-product combination are positive in at least 5 of our 7 time periods. Finally, columns (4) and (8) extend the set of the products that we describe as being affected by containerization to include those that were viewed as partially containerizable by the 1968 German Engineers Society report. This increases the number of products from 332 to 407 for North-North trade and from 344 to 421 for world trade.

We find that the main results are robust in all of these regressions. We continue to find evidence that containerization had a strong positive effect on bilateral trade flows and that the effects are larger than the effects of the policy liberalization variables. We also continue to find no pre-treatment effect for North-North trade and a pre-treatment effect for world trade. The magnitude of the effects of containerization fall across all specifications for North-North trade. The cumulative average treatments effects drop only a little bit in columns (1), (2) and (4) and a bit more in column (3). For world trade, the picture looks a bit different. The cumulative treatment effects drop in columns (5) and (7) and actually rise in columns (6) and (8).

3.4 Instrumental Variables

Until now we have argued that while the timing of container adoption for a single country is an endogenous choice, a country has less control over the timing of adoption by its trading partners. Identification therefore rests on the assumption that when a particular bilateral trade route becomes containerized is as good as random, conditional on the country-time dummies that are used to account for those factors which determine the adoption by an individual country. The results in the previous section suggest that this identification strategy is viable for North-North trade only. If one includes the later adopters, the presence of pre-treatments effects suggests anticipation effects. This is consistent with the historical narrative that uncertainties about the prospect of the container to be a characteristic during the pioneering period of the container revolution.

In this section, we propose and implement an identification strategy that exploits historical information about the role of the containerization in the US military build-up during the Vietnam War. Specifically, we construct an instrument of container adoption for the sample of 'later adopters' and apply it to bilateral trade flows to three European countries with pre-determined containerization. In section 2.4 we have already discussed Levinson's (2006) conjecture about the role of the US-military in diffusing containerization. The instruments we construct arise out of the use of containers to ship U.S. military equipment during build-up during the Vietnam War and the use of those containers for non-military purposes on the return leg. According to Levinson (2006) this non-trade related set of circumstances led to the adoption of container by countries that were close to Vietnam. This logic behind the instrument is that the costs of adopting container facilities were lowered for countries close to Vietnam and this occurred for reasons other than the expected growth of future trade. Within these regressions identification of the effects of containerization comes from why it occurs rather than when it occurs. Building on this we construct an instrument with two components. As a measure of the availability of empty containers within the region we measure the distance of each country from Vietnam. The second instrument is a zero-one indicator of whether there was a U.S. military base within the country prior to 1967, interacted with the distance from Vietnam.[33] From this variable we hope to capture the use of U.S. military bases, such as that in the Philippines, to ship military equipment to Vietnam.

Instruments should fulfill two requirements: (i) they should be correlated with the endogenous variable (instrument relevance) and (ii) they should be uncorrelated with the error term (instrument exogeneity). Our above reasoning addressed 'instrument relevance'. We try to achieve 'instrument exogeneity' by restricting the sample of countries to include the trade flows of non-US countries that had containerized prior to the start of the military build-up in 1967, namely the Netherlands, Germany and the UK. For these three countries their containerization is pre-determined when considering their partner countries adoption. The instrument therefore predicts when the bilateral partners of the Netherlands, Germany and the U.K. adopted the container using information on the distance of those bilateral partners from Vietnam and that variable combined with whether those partners had a U.S. military base prior to 1967. Other than the effect of the Vietnam War on the spread of containerization we see no reason why the distance of a country from Vietnam or the location of a U.S. military base should be correlated with future trade flows between non-Vietnam and non-U.S. countries with the Netherlands, Germany or the U.K. It is not the case for example, that the distance of a country from Vietnam is strongly correlated with the distance from Germany, Netherlands or the U.K.[34] We also note that during this time period there were additional world factors that might plausibly have reduced the expected future trade between Germany, Netherlands and the U.K., namely the closure of the Suez Canal between 1967 and 1974. This increased the distance that ships needed to travel between Northern Europe and the Asian-Pacific countries. If the potential future trade between Germany, Netherlands or the U.K were indeed a determinant of

[33] The countries with U.S. military bases prior to 1967 include Philippines, Japan, Thailand, Korea, Italy, Turkey, Panama, Spain, Portugal, Greece, Belgium, Taiwan and Canada.
[34] There is a weak negative correlation of -0.11

container adoption of the Asian-Pacific countries then this would have actually reduced those expected returns, making investment less likely.

Given the importance of the Vietnam-U.S. conflict for the plausibility of this instrument we also restrict the data period to end in 1975. This prevents us from including lagged effects in the regression. In line with the previous regressions, we again first difference the data to remove the effects of all other time invariant bilateral country-product factors.

Table 4 reports the results of the instrumental variable regressions under different specifications.[35] The results in column (1) of Table 4 suggest that the distance from Vietnam and the presence of a U.S. military base are significant determinants of the adoption of the container. The greater the distance from Vietnam the lower is the probability of adopting the container, while the presence of a U.S. military base offsets this effect. The *F*-test of the joint significance of the instruments in the first-stage regression shows that jointly the instruments have the expected predictive power. As indicated by the Hanson *J*-Statistics that is also reported in the table, there is evidence that jointly these instruments are orthogonal to the error term. The instruments can therefore be viewed as valid.

The second stage regression results suggest a downward bias to the OLS estimates. In the instrumental variable estimates in column (1) we find that the estimated effect of containerization to be 232% (=$e^{1.202.}$-1), compared to just 15% (=$e^{0.14.}$-1) when using OLS. This contemporaneous local average treatment effect is of remarkably similar order of magnitude to the contemporaneous effect found in the difference-in-difference regressions in columns (3) and (7) in Table 2.[36]

For distance from Vietnam and the presence of a U.S. military base to be valid instruments they must not affect the dependent variable in any other way than through containerization. This implies that the decision to containerize was not affected by regional characteristics that also affect trade. To further establish the plausibility of the Vietnam War as an instrument for the containerization that took place in neighbor countries during the early years of containerization in column 3 we report the results from the first stage regression on data following the end of the war. That is we use distance from Vietnam and the presence of a U.S. military base to predict containerization for the years 1980, 1985 and 1990. If the distance from Vietnam is correlated with some other feature of geography that makes it more likely that they will trade with the Netherlands, Germany and the U.K. we might anticipate the same negative sign on this variable. Similarly, the non-war period provides a test of whether there are some other institutional features of the

[35] In this section we only consider the full containerization variable.

[36] The contemporanous container coefficients in columns (3) and (7) of Table 2 were 1.247 and 1.204. Interestingly, the FTA coefficient of 0.352 in column (1) of Table 4 is also quite similar to the contemporanous FTA coefficients in columns (3) and (7) of Table 2.

Netherlands, Germany and the U.K., such as their membership of NATO, make them more likely to trade with allies of the U.S.[37] We find in this regression no evidence for such effect. In fact, the signs on the instruments are reversed compared to those in regression 1, presumably because of the containerization that took place as a consequence of the Vietnam war. In addition we find that these variables fail the overidentification test. We conclude that the instruments are valid only during the period of the military build-up to the Vietnam War.

Table 4: Instrumental variable regressions

	Containerizable Products			Non-containerizable products
years	1965, 1970, 1975		1980, 1985, 1990	1965, 1970, 1975
	(1) IV	(2) OLS	(3) IV	(4) IV
2^{nd} stage results				
Δ $\mathbf{cont_{ij,t}}$	1.202***	0.140***	-2.446***	0.307
	(0.0838)	(0.0094)	(0.1100)	(0.1997)
Δ $\mathbf{fta_{ij,t}}$	0.352***	0.082***	0.606***	0.195***
	(0.0290)	(0.0186)	(0.0317)	(0.0649)
Δ $\mathbf{GATT_{ij,t}}$	0.116***	0.122***	0.053**	0.004
	(0.0125)	(0.0153)	(0.0228)	(0.0250)
1^{st} stage results				
$\mathbf{ln}\ \boldsymbol{Dist}_{\mathbf{jVIET}}$	-0.028***		0.018***	-0.027***
	(0.0013)		(0.0012)	(.0025)
$\mathbf{USbase} * \mathbf{ln}\ \boldsymbol{Dist}_{\mathbf{jVIET}}$	0.011***		-0.011***	0.008***
	(0.0003)		(0.0002)	(.0005)
Obs	187005	133500	168821	58939
F	422.96	394.56	811.80	86.42
Overid(p-value)	0.915	-	0.000	0.000

Standard errors in parentheses
** p<0.05, ** p<0.01, *** p<0.001*
i denotes origin country, j destination country and t denotes time
We include GDP per capita and population in the controls.

An alternative objection to the Vietnam War as an instrument would be that the trade potential of East Asian countries with the rest of the world was well recognized and Sea-Land and others were encouraged to upgrade international trade infrastructure in the region in order to facilitate trade more generally. If such effects were present we might anticipate that the instruments also help to explain the growth of trade in non-containerizable products suggesting our current results are upward biased. As already noted some of these products become containerized, but this

[37] A potential objection to the use of the presence of a U.S. military base interacted with distance from Vietnam as an instrument might be the potential correlation between the U.S. military base part of the variable with institutional or cultural factors that are also correlated with trade. We tested the sensitivity of our results to the use of this instrument by using the distance from Vietnam as a single instrumental variable. We find similar sized effects for contaneirization to those found in column 1.

was largely for the period after 1975. In regression 3 in Table 4 we further test the robustness of our instruments by using trade in non-containerizable products. Here we anticipate that trade in non-containerizable products between the Germany, the Netherlands and the U.K. and their bilateral partners induced to containerize because of the instrument should be unaffected. This is indeed what we find. The instruments remain powerful predictors of containerization within the first stage regression, but fail the overidentification test and yield have no statistically significant effect on trade in the second stage.

4. Conclusion

International trade is a key dimension of globalization and globalization plays a central for economic development and economic growth. But what are the drivers of international trade and globalization? Business experts and historians who have studied or made a living from the shipment of goods across international borders have long conjectured that "the shipping container made the world smaller and the world economy bigger" (Levinson's (2006) subtitle). In his recent world history of technology, Daniel Headrick (2009, p.146) discusses containerization as the major 20th century technological change that "…has propelled the globalization of the world economy". To the best of our knowledge, we are the first attempt to examine these claims in a rigorous manner. Our findings suggest indeed large effects of containerization. Our first identification strategy provides evidence for containerization to be a large driver of 20th century globalization between the industrialized countries. Our second identification strategy exploits the US military build-up during the Vietnam War to construct an instrument for container adoption of developing economies.

The findings in this paper should be of interest beyond academia. In assessing its support for trade, the World Bank has recognized the importance of trade barriers beyond tariffs (World Bank Independent Evaluation Group, 2006). In fact, a significant portion of the World Bank's lending budget is allocated to transportation infrastructure projects[38]. However quantitative studies on the impacts of transportation infrastructure on the magnitude and patterns of international specialization are still in its infancy. The estimates in our study suggest that the effects of the adoption of port containerization on trade involving developing economies was relatively small compared to trade among industrialized countries characterized by better domestic infrastructures. Our identification strategy allowed us to draw inferences for what might be called 'the early period of the container age: 1966-1990'. We leave it for future research to assess the effects of containerization for the post 1990 period.

[38] A large portion of the 2010 African Development Report is devoted to port capacity and containerization.

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Appendix

Appendix Table 1: Variables and Data Sources

Variables	Data Sources
Trade Flows	Feenstra et al. (2005)
Container variables	Containerisation International Yearbook (several years)
Policy variables	CEPII, Paris

Appendix Table 2: Correlations between variables

	North-North			
	$portcont_{ij}$	$fullcont_{ij}$	fta	GATT
$portcont_{ij}$	1			
$fullcont_{ij}$	0.716	1		
fta	0.106	0.260	1	
GATT	0.237	0.331	0.119	1
	Entire Sample			
	$portcont_{ij}$	$fullcont_{ij}$	fta	GATT
$portcont_{ij}$	1			
$fullcont_{ij}$	0.853	1		
fta	0.129	0.199	1	
GATT	0.199	0.278	0.229	1

Appendix Table 3: Countries in the sample

Panel A: Countries that containerize by port or rail 1966-1983 (122 countries)

1966	West Germany(P)*	Netherlands(P)*	UK(P)(R)*	USA(P)*	India (R)
1968	Australia(P)*	Austria(R)*	Belgium(P)*	Canada(P)*	Denmark(P)*
	East Germany(R)	France(P)*	Hungary(R)	Ireland(R)*	Italy(P)*
	Spain(R)*	Sweden(R)*	Switzerland(R)*	Taiwan(P)	
1969	Finland(P)*	Yugoslavia(R)	Japan(P)*	Norway(R)*	Portugal(P)*
1970	Hong Kong(P)	USSR(R)	Greece(P)*	Israel(P)	Romania(R)
	Singapore(P)				
1971	Cote D'Ivoire(P)	New Zealand(P)*	Philippines(P)	Poland(P)	Trinidad(P)
1972	Bulgaria(R)	Czechoslovakia(R)			
1973	Bahamas(P)	Brazil(P)	Iceland(P)*	Jamaica(P)	Malaysia(P)
1974	Cameroon(P)	Chile(P)	Colombia(R)	Nigeria(P)	Panama(R)
	South Africa(P)				
1975	Barbados(P)	Honduras(P)	Indonesia(P)	Korea Rep(P)	Peru(P)
	Thailand(P)				
1976	Argentina(P)	Benin(P)	Kenya(P)	Mexico(P)	N. Caledonia(P)
	Saudi Arabia(P)	UAE(P)			
1977	Bahrain(P)	Cyprus(P)	Ghana(P)	Iran(P)	Jordan(P)
	Kuwait(P)	Lebanon(P)	Morocco(P)		
1978	Ecuador(P)	Egypt(P)	Gibraltar(P)	Haiti(P)	Iraq(P)
	Mozambique(P)	Oman(P)	Papua N. Guinea(P)	Samoa(P)	Sierra Leone(P)
	St. Kitts Nevis(P)	Tanzania(P)			
1979	Algeria(P)	Angola(P)	China(P)	Congo(P)	Djibouti(P)
	El Salvador(P)	Mauritius(P)	Neth.Antilles(P)	Nicaragua(P)	Pakistan(P)
	Qatar(P)	Sri Lanka(P)	Syria(P)		
1980	Guatemala(P)	Liberia(P)	Libya(P)	Madagascar(P)	Sudan(P)
	Uruguay(P)				
1981	Brunei/Bhutan(P)	Bangladesh(P)	Belize(P)	Costa Rica(P)	Dem.Rep.Congo(P)
	Dominican Rep(P)	Fiji(P)	Guadeloupe(P)	Seychelles(P)	Togo(P)
	Tunisia(P)	Turkey(P)	Venezuela(P)		
1982	Gambia(P)	Kiribati(P)	Mauritania(P)	St.Helena(P)	
1983	Bermuda(P)	Ethiopia(P)	Guinea(P)	Malta(P)	Myanmar(P)

(P) denotes that the country containerized by port first.
(R) denotes that the country containerized by rail first.
(*) denotes that the country is in the North-North sample.

Panel B: Countries that do not containerize by port or rail 1966-1983 (35 countries)

Afghanistan	Chad	Greenland	Mongolia	Senegal
Albania	Cuba	GuineaBissau	Nepal	Somalia
Bolivia	Eq. Guinea	Guyana	Niger	Suriname
Burkina Faso	Falkland Islands	Laos	North Korea	Uganda
Burundi	French Guiana	Macao	Paraguay	Viet Nam
Cambodia	French Overseas	Malawi	Rwanda	Zambia
Cen. African Rep	Gabon	Mali	St. Pierre Miquelon	Zimbabwe

Appendix Table 4: List of industries[39]

Panel A

Class A: Containerizable products (4-digit SITC in 1968, 712 products)

Code	**Good Description (number of underlying 4-digit products)**
035	Fish, dried, salted or in brine smoked fish (1)
037	Fish, crustaceans and molluscs, prepared or preserved (3)
042	Rice (3)
046	Meal and flour of wheat and flour of meslin (1)
047	Other cereal meals and flours (1)
048	Cereal preparations & preparations of flour of fruits or vegetables (6)
056	Vegetables, roots & tubers, prepared/preserved, n.e.s. (4)
058	Fruit, preserved, and fruit preparations (1)
061	Sugar and honey (6)
062	Sugar confectionery and other sugar preparations (1)
071	Coffee and coffee substitutes (3)
072	Cocoa (4)
073	Chocolate & other food preptions containing cocoa (1)
074	Tea and mate (3)
075	Spices (3)
081	Feed.stuff for animals (not including unmilled cereals) (6)
091	Margarine and shortening (3)
098	Edible products and preparations n.e.s. (1)
111	Non alcoholic beverages, n.e.s. (1)
112	Alcoholic beverages (5)
121	Tobacco, unmanufactured; tobacco refuse (4)
122	Tobacco manufactured (4)
211	Hides and skins (except furskins), raw (7)
212	Furskins, raw (including astrakhan, caracul, etc.) (1)
222	Oil seeds and oleaginous fruit (excluding flours and meals) (7)
223	Oils seeds and oleaginous fruit, whole or broken (including flours and meals) (7)
23	Crude rubber (including synthetic and reclaimed) (5)
244	Cork, natural, raw & waste (including in blocks/sheets) (1)
25	Pulp and waste paper (7)
26	Textile fibres (except wool tops) and their wastes (30)
277	Natural abrasives, n.e.s (including industrial diamonds) (3)
291	Crude animal materials, n.e.s. (3)
411	Animal oils and fats (3)
423	Fixed vegetable oils, soft, crude, refined/purified (7)
424	Other fixed vegetable oils, fluid or solid, crude (7)
431	Animal & vegetable oils and fats, processed & waxes (5)
53	Dyeing, tanning and colouring materials (11)
54	Medicinal and pharmaceutical products (8)
55	Essential oils & perfume materials; toilet polishing and cleansing preparations (9)
58	Artificial resins, plastic materials, cellulose esters and ethers (29)
59	Chemical materials and products, n.e.s. (13)
61	Leather, leather manufactures, n.e.s. and dressed furskins (13)
62	Rubber manufactures, n.e.s. (13)
63	Cork and wood manufactures (excluding furniture) (13)
64	Paper, paperboard, articles of paper, paper-pulp/board (15)
65	Textile yarn, fabrics, made-up articles, related products (61)
664	Glass (10)
665	Glassware (5)
666	Pottery (1)
667	Pearls, precious & semi-prec.stones, unwork./worked (5)

[39] Here we list all industries classified by the *Verband Deutscher Ingenieure*. Because of few trading years and missing values our regressions are run on a smaller subset of products. For example, class A covers 712 product lines, but our regressions in Table 2 are run only on 332 product lines for North-North trade.

673	Iron and steel bars, rods, angles, shapes & sections (5)
674	Universals, plates and sheets, of iron or steel (8)
675	Hoop & strip, of iron/steel, hot-rolled/cold-rolled (1)
677	Iron/steel wire, wheth/not coated, but not insulated (1)
678	Tubes, pipes and fittings, of iron or steel (6)
679	Iron & steel castings, forgings & stampings; rough (1)
681	Silver, platinum & oth.metals of the platinum group (3)
682	Copper (3)
683	Nickel (3)
684	Aluminium (3)
685	Lead (3)
686	Zinc (3)
687	Tin (3)
689	Miscell.non-ferrous base metals employ.in metallgy (3)
692	Metal containers for storage and transport (3)
693	Wire products and fencing grills (4)
694	Nails, screws, nuts, bolts etc.of iron, steel, copper (1)
695	Tools for use in hand or in machines (5)
696	Cutlery (2)
697	Household equipment of base metal, n.e.s. (5)
699	Manufactures of base metal, n.e.s. (10)
71	Power generating machinery and equipment (26)
723	Civil engineering and contractors plant and parts (4)
724	Textile & leather machinery and parts (7)
725	Paper and pulp mill mach., mach for manuf.of paper (4)
726	Printing and bookbinding mach.and parts (6)
727	Food processing machines and parts (2)
728	Mach. & equipment specialized for particular ind. (5)
73	Metalworking machinery (11)
741	Heating & cooling equipment and parts (6)
742	Pumps for liquids, liq.elevators and parts (7)
743	Pumps & compressors, fans & blowers, centrifuges (8)
7449	Parts of the machinery of 744.2- (1)
745	Other non-electrical mach.tools, apparatus & parts (2)
749	Non-electric parts and accessories of machines (5)
75	Office machines & automatic data processing equipment (15)
76	Telecommunications & sound recording apparatus (16)
77	Electrical machinery, apparatus & appliances n.e.s. (31)
7840	Parts & accessories of 722--, 781--, 782--, 783—(1)
7929	Parts of heading 792--, excl.tyres, engines (1)
8	Miscellaneous manufactured articles (114)

Panel B

Class B: Products with limited containerizability (4-digit SITC in 1968, 126 products)

Code	**Good Description (number of underlying 4-digit products)**
01	Meat and meat preparations (15)
02	Dairy products and birds' eggs (9)
034	Fish, fresh (live or dead), chilled or frozen (5)
036	Crustaceans and molluscs, fresh, chilled, frozen etc. (1)
054	Vegetables, fresh, chilled, frozen/preserved; roots, tubers (7)
057	Fruit & nuts (not including oil nuts), fresh or dried (9)
248	Wood, simply worked, and railway sleepers of wood (4)
271	Fertilizers, crude (5)
287	Ores and concentrates of base metals, n.e.s. (9)
288	Non-ferrous base metal waste and scrap, n.e.s. (3)
292	Crude vegetable materials, n.e.s. (8)

51	Organic chemicals (29)
52	Inorganic chemicals (14)
671	Pig iron, spiegeleisen, sponge iron, iron or steel (4)
691	Structures & parts of struc.; iron, steel, aluminium (4)

Panel C

Class C: Non-containerizable products (4-digit SITC in 1968, 152 products)

Code	**Good Description (number of underlying 4-digit products)**
001	Live animals chiefly for food (7)
041	Wheat (including spelt) and meslin, unmilled (3)
043	Barley, unmilled (1)
044	Maize, unmilled (1)
045	Cereals, unmilled (no wheat, rice, barley or maize) (4)
245	Fuel wood (excluding wood waste) and wood charcoal (1)
246	Pulpwood (including chips and wood waste) (1)
247	Other wood in the rough or roughly squared (4)
273	Stone, sand and gravel (5)
274	Sulphur and unroasted iron pyrites (3)
278	Other crude minerals (7)
281	Iron ore and concentrates (4)
282	Waste and scrap metal of iron or steel (2)
289	Ores & concentrates of precious metals; waste, scrap (1)
3	Mineral fuels, lubricants and related materials (25)
56	Fertilizers, manufactured (5)
57	Explosives and pyrotechnic products (5)
661	Lime, cement, and fabricated construction materials (5)
662	Clay construct.materials and refractory constr.mater (3)
663	Mineral manufactures, n.e.s (8)
672	Ingots and other primary forms, of iron or steel (5)
676	Rails and railway track construction material (1)
721	Agricultural machinery and parts (5)
722	Tractors fitted or not with power take-offs, etc. (3)
744	Mechanical handling equip.and parts (5)
781	Passenger motor cars, for transport of pass., goods (1)
782	Motor vehicles for transport of goods and materials (3)
783	Road motor vehicles, n.e.s. (3)
7841	Chassis fitted with engines for motor vehicles (1)
7842	Bodies for the motor vehicles of 722/781/782/783 (1)
785	Motorcycles, motor scooters, invalid carriages (4)
786	Trailers and other vehicles, not motorized (4)
791	Railway vehicles and associated equipment (7)
7921	Helicopters (1)
7922	Aircraft not exceeding an unladen weight 2000 kg (1)
7923	Aircraft not exceeding an unladen weight 15000 kg (1)
7924	Aircraft exceeding an unladen weight of 15000 kg (1)
7928	Aircraft, n.e.s.balloons, gliders etc and equipment (1)

793	Ships, boats and floating structures (5)
9	Commodities and transactions not elsewhere classified (7)