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Abstract.

Transport costs and globalization: the container.

In the last three decades, international trade flows have increased dramatically. On average, world merchandise exports have grown at a 7 percent rate per year (in dollar terms). Furthermore, international trade has grown almost twice as fast as world output – in this context, global supply chains have gained an increasing importance. This spur in trade flows has been possible because of *containerization* – which is the generalized diffusion of containers as the preferred means to ship products on international and national markets. In fact, the container accounts for the movement of 90 percent of non-bulk commodities. Thanks to its efficiency, it constitutes the logistical spinal cord of globalization. In this paper, we will first analyze technological innovation as a driving force of globalization, driving down transportation costs. We will then concentrate on one particular innovation : the container. It has "revolutionized" the transport industry – from one simple idea that, in time, generated the integration of different freight transportation modes and networks, which we call *intermodalism* – underlining the profound logistical nature of containers and examining the interaction with Information Communication Technology (ICT). Lastly, we will observe some of the economic effects of containerization such as the impact of transportation costs and the emergence of new supply chains.

Globalization is a vague and multidimensional concept. It can be defined as a process describing the changing costs of distant economic interaction and the effects on the geographic distribution of economic activity. Since we will focus on the dimension of globalization concerned with international trade, we will adopt O'Rourke and Williamson's definition, which define this process as the integration of international markets. Identifying the starting point of globalization is as complex as defining the term. Some view the origins of globalization in 1492 or 1498 – with the discovery of the Americas and Vasco da Gama's voyages. Others argue that globalization stretches back even further, around 1250 and 1350, when international trade connected North Europe to China – where the Pax Mongolica made trade safe and possible. Lastly, there are those who believe that the world economy was poorly integrated before the 1800's. If we concentrate only on our definition of globalization – which measures international markets' integration through *price convergence* – and imagine that there were no transport costs or trade barriers, international

commodity markets would be perfectly integrated. Prices would be the same in the home country and abroad. As transport costs and trade barriers decline, prices converge and trade volumes increase. Thus, the only empirical evidence of globalization is price convergence. Trade between distant continents developed as transportation costs, monopolies, mercantilist intervention and various international conflicts declined. In fact, because of trade costs, long-distance trade prior to the 18th century, was limited to high value non-competing goods, namely silk, exotic spices and precious metals, that could sustain the high costs of transportation. Between the 17th and 19th century, conflicts were frequent as the major European powers fought for control over resources, territories and new markets. Even though a complex network linked Europe to the rest of the world, there is very little or no evidence of price convergence. In fact, there was price divergence. The divergence between prices paid by the British East India Company for Indian cloth in India and the one paid in London, remained stable at a 100% rate throughout 1660 to 1760. To explain this stability we must consider the lack of technological innovation in the field of navigation and the perennial state of war that characterized the epoch. Therefore, we can speak of international trade before the 19th century – considering large trade volumes – but we cannot quite talk of globalization before 1820, as there is no empirical evidence to support this statement.

There is a vast consensus among economic historians in identifying the first wave of globalization in those fifty years that preceded the Great War (1860-1913), which abruptly brought it to an end. The second wave – which is still in progress – started in the 1960's. After the two World Wars, the Great Depression and the so called *de-globalization* epoch. There are two main driving forces of globalization: on the one hand, technology decreased the costs of economic interaction for centuries, and on the other hand, institutions occasionally raised them through protectionist trade barriers. To understand the global trade system in which we live today, we must focus on the technological innovations in the field of transportation and communication. These came with the Industrial Revolution (I.R.) in the late 1700's – which constantly drove down the cost of moving goods, capitals and people in the "First Globalization" era, resulting in price convergence. What distinguishes the I.R. from other episodes of economic growth – such as the Islamic Golden Age in the last centuries of the first millennium, etc. – is that none of them resulted in a sustained growth of per capita income. In fact, it lasted throughout and after the 19th century. Above all, the IR – which consisted in the systematic application of science to the production and organizational processes – triggered the expansion of trade through that set of technological innovations in the field of transportation, thus, eroding what Geoffrey Blainey (1968) called the "tyranny of distance". In 1750, more than 50 percent of industrial world output was produced in China and India compared to just 18 percent in Western Europe. In the 80 years that followed,

European industrial output more than doubled. As Cipolla (2013) points out, it all started with steam. The steam engine is a typical "General Purpose Technology" (GPT) – which is characterized by pervasive use across a wide range of sectors. First introduced by James Watt in 1769, it required many improvements to become widely used and affordable. Between 1820 and 1890, its annual cost decreased by 80 percent. The I.R. created an asymmetry between Europe and its offshoots with a high pro capita income, high level of industrialization, demographic growth and political and military power; at the same time, the new technologies integrated international markets like never before. Even though the "transport revolution" followed road improvements in the major European countries – which cut travel time from Manchester to London from four to five days in 1780 to 36 hours in 1820 – the more affordable alternative were canals, accessible for a quarter or half the price of roads. In fact, the length of navigable waterways in Great Britain quadrupled between 1750 and 1820. In the United States (U.S.), the construction of the Erie Canal in 1825, cut transport costs from Buffalo to New York by 85% percent and travel time went from 21 days to eight. One key transport-related innovation of the 19th century was the steamship. They were mainly used on rivers, the Great Lakes and inland seas, until the first steamship crossed the Atlantic in 1830. Up to 1860 steamships could only carry high value goods – such as mail and people – because of the high costs of fuel, which were drastically reduced by the introduction of the compound engine. Furthermore, the opening of the Suez Canal in 1869 cut the distance from Great Britain to Bombay from 10,667 miles to 6,224. Another major development in transportation was the railroad – the growth in mileage during the late 19th century was phenomenal: for example, in the U.S. in 1869, a transcontinental line linked the East and West Coasts, playing an important role in creating a national market. Steam revolutionized trade in the first half of the 19th century, then another wave of technologies contributed to the decline of trade and communication costs: refrigerated ships in 1870 allowed to ship meat from the U.S to Europe; underwater telegraph cables have been crucial to ensure the flow of information across the oceans, contributing to the integration of global markets. International trade grew rapidly after 1820. The cost of inland transportation fell by 90 percent between 1870 and 1910; transatlantic transport costs fell almost by 60% between 1870 and 1900 and in the meantime, exports rose by an average rate of 3,4 percent per year. However, this first wave of globalization came to an end with the First World War, which destroyed the liberal economic order. We must wait until the *re-globalization* period, after 1945, to speak of globalization again. Nevertheless, war fueled innovation in trans-oceanic shipping, new boilers to convert steam were developed and coal-fired plants were replaced by oil and diesel engines. The Suez Canal crisis of 1956 stimulated the shipping industry to invest into specialized bulk carriers and world maritime trade increased from 500 million tons in 1950 to 4,200 million tons in 1992.

Railroad networks expanded, especially in emerging countries. The use of automobiles became ever more frequent, especially in the U.S. The Air transport industry also grew exponentially and by 1980 real cost of air transport fell to one fourth of the pre-World War II level. Another fundamental innovation of the 20th century is containerization, which reduced costs of handling and port transit time by 90 percent and as Levinson (2006) notes, favored the expansion of international trade. Lastly, the "ICT revolution", which started with computerization, was crucial to coordinate supply chains and share information, especially for "just in time" delivery, reducing communication costs.

The purpose of transportation is of geographic nature since it seeks to facilitate movement between different locations. Thus, playing a role in the structure and organization of space and territories, which may also vary according to the level of development. Transportation is an essential component of the economy; it is a multidimensional activity with a historical, social, political, environmental and economic relevance. In the mist of trade costs, along with trade barriers (tariffs and non-tariff barriers) are transport costs. Transport costs determine trade volumes which in turn are determined by geographic characteristics, quantity and quality of transport infrastructures, competition in the transportation sector, technological innovation, fuel costs and the quality and value per weight of goods being traded. Time has also become crucial, in fact, a too extended lead time represents an additional cost and a barrier to trade. As for delivery time, it has become extremely important in today's supply chains. In this context, technological innovation has played a crucial role, in reducing these components of transport costs. For this reason, we will now focus on one technological innovation of the 20th century: the container.

The container is a unit of transportation in which goods are shipped. What makes the container interesting is not the object per se but the fact that it is the center of an automatized transport system that moves goods around the world. The first containership was the *Ideal-X* and sailed on April 26th 1956 from Newark in New Jersey, five days later it arrived in Houston and thus began the era of containerization. The container was born as a solution to high handling costs; although there had been some experiments on the matter, they had to be abandoned with the start of the Second World War. After WWII, handling costs accounted for 36,8 percent of shipping costs. The solution to this problem came from Malcolm Purcell McLean, from Maxton (North Carolina) – a young truck driver owner of "McLean Trucking Company", with no experience in shipping and an obsession with reducing costs. The key to his success was in fact offering lower tariffs than his competition and a propensity to innovate. In 1953, when McLean Trucking was already one of the most successful companies in the U.S., the first intuition came to him: to load trailers on ships and ferry them along the coast. In 1954, he acquired the Pan-Atlantic Steamship Corporation and the next year, the Waterman Steamship Corporation only to realize that loading trailers on ships wasn't

as convenient because the wheels would take too much space. His second idea, which consisted of loading just the metal box, led the first containership to sail in 1956 after being loaded in less than eight hours. The first containers to cross the Atlantic transported two types of goods: whisky to America and military supplies to Europe. In fact, containerization found its biggest ally in the Army that needed to ship goods to soldiers in West Germany. The final boost to containerization came with the Vietnam War, from which it extended to Japan – because McLean noticed that containers came back empty and thought of making one more stop on the way back to the US. In 1969 containerships docked in the port of Hong Kong. The following year, other services connected Australia to Europe, North America and japan, while the Sea-Land (former Pan-Atlantic) was on its way to South Korea. Danish Maersk Line of A.P. Moller owned its first containership in 1973 and in 2005 it gained control of 500 containerships, and of some of the most important companies in the industry, such as Nedlloyd and even McLean's Sea-Land. Half a century after the first containership sailed, almost 300 million 20 foot containers sail the oceans every year. Malcolm McLean was not the inventor of the container nor of the shipment through containers, but containerization started from his first intuition: that is, the shipping industry does not move ships but cargo, requiring a whole new management system.

Containerization is a logistical innovation because it generalized the use of containers as a unit of transportation, a standardized means which contributed to the emergence of intermodalism – which is the transport of goods with one mean of transportation which then utilizes two or more other means that transport goods without handling the merchandise. This reduces handling costs, labor costs and packaging costs, resulting in a more efficient way of employing time and resources. Containerization allowed to mechanize handling of cargo, placing it in these "boxes" of standardized dimensions, to then be loaded and unloaded on and from ships in few minutes. Standardization was a long process, in fact, even the word "container" in the 1950's had different meanings around the world: in Europe it described simple wooden boxes and in the U.S it referred to the *conex*, the steel box, used in the army. To put an end to the initial chaotic state, the International Standards Organization (ISO) intended to establish the guide lines for companies around the world, focusing on interchangeability of containers. It wasn't until 1970 that they established base dimensions, and the reference sizes were 10,20,30 or 40 feet long; 8 feet high and 8 feet wide. One of the most important logistical effect of the container was that it reduced turn-around time in port, from 3 weeks to 24 hours. Which means ships spend less time in port and they can spend more time sailing, making containerships more convenient. Therefore, we can say that standardized containers have contributed to making the transport system more efficient, especially because it made the diffusion of intermodalism possible.

Containerization is responsible for the integration of the transport system. This in turn has made it necessary to have more sophisticated management and logistics systems. The ICT revolution has followed that of the container, in the 1990s with the Internet, the web, e-commerce and the e-mail. This revolution contributed to the success of containerization by providing computerized systems to control the movement of containers, organize reservations, print bills of lading and invoices and share information. These new management systems reduced time cycles by 40 percent and errors by 30 percent. Furthermore, containers have now been incorporated with tracking devices which allow an increased logistic efficiency in the industry – namely through Radio-Frequency Identification (RFID), which has been adopted to meet the security and efficiency requirements of the shipping industry. Along with RFID technologies, Electronic Data Interchange (EDI) has been increasingly diffused to share information between trade partners and has been proven to minimize transaction and communication costs.

From 1950 to 2004, international trade has grown at an annual rate of 5,9 percent. This recent growth in trade volumes can be attributed – just like the "first globalization" trade growth has been attributed to the I.R. – to falling transport costs. Containerization has been crucial in decreasing direct port costs, such as warehousing and labor costs; as well as indirect costs, which come from transit time in port and can be quite critical. Although Hummels (2007) argues that real liner shipping prices have not declined and their 2003 level is the same it was in 1955, real tramp shipping prices have been declining in the past fifty years. Levinson (2006) suggest that most of the historical data available on the subject only considers port-to-port costs and not door-to-door costs – which in Levinson's opinion have declined the most because containerization has increased efficiency. So what declined the most are those extra-costs, such as storage costs, damage costs, etc. which are actually the most relevant to the shipper. The fact that containers offer a more rapid turn-around is crucial for just in time delivery and global supply chains of modern times. Finally, world exports volumes have grown at a 6,2 percent rate, while maritime trade has increased from 550 million tons in 1950 to 5,5 billion tons in 2002 – which represents a 4,5 percent growth rate – and in the same period, world fleet has quadrupled.

After the 1980's companies went from being vertically to horizontally integrated. The world was discovering just in time strategy – which originated in Japan, at the Toyota Motor Company – which increased quality and efficiency, eliminating stocks and inventory. Time became so important that clients would require contracts that penalized delays. Thanks to modern communication and transport systems, new supply chains emerged. When Baldwin (2011) speaks of the *Second Unbundling* he refers to the fragmentation of supply chains, where different stages of production are no longer required to be located near one another. Containerization made

transportation more reliable and reduced delays, avoiding the risk of breaking the chain of production. When just in time production became popular in the U.S., companies like Dell and Wal-Mart reshaped their whole strategy around the movement of goods from producer to client in the shortest time possible. In the center of the logistical revolution that underwent Wal-Mart Inc., is the container, present in every port, warehouse and rail yard. Wal-Mart's sales move more than 230,000 containers across the Pacific Ocean every year. According to Levinson (2006), the container has made international transportation more convenient and reliable. In this context, we must note that China probably would not have become the new "workshop of the world" without containerization.

Until the 1990's, containerships could transport up to 5000 containers (20 foot), from then on there has been an explosion in the dimensions of these ships – which reflects their fundamental role in globalization. Every year the maritime industry moves goods for 13 billion dollars. What draws our attention today is the Mary Maersk, a Triple-E, 1,300 feet long containership owned by A.P.Moller-Maersk. The Mary Maersk symbolizes the global trade market and an industry that is always expanding. In conclusion, we have seen how transportation and transport costs are crucially tied to globalization and containerization. Thus allowing the diffusion of intermodalism which contributed to making the transport industry more efficient – becoming an important driving force of globalization.